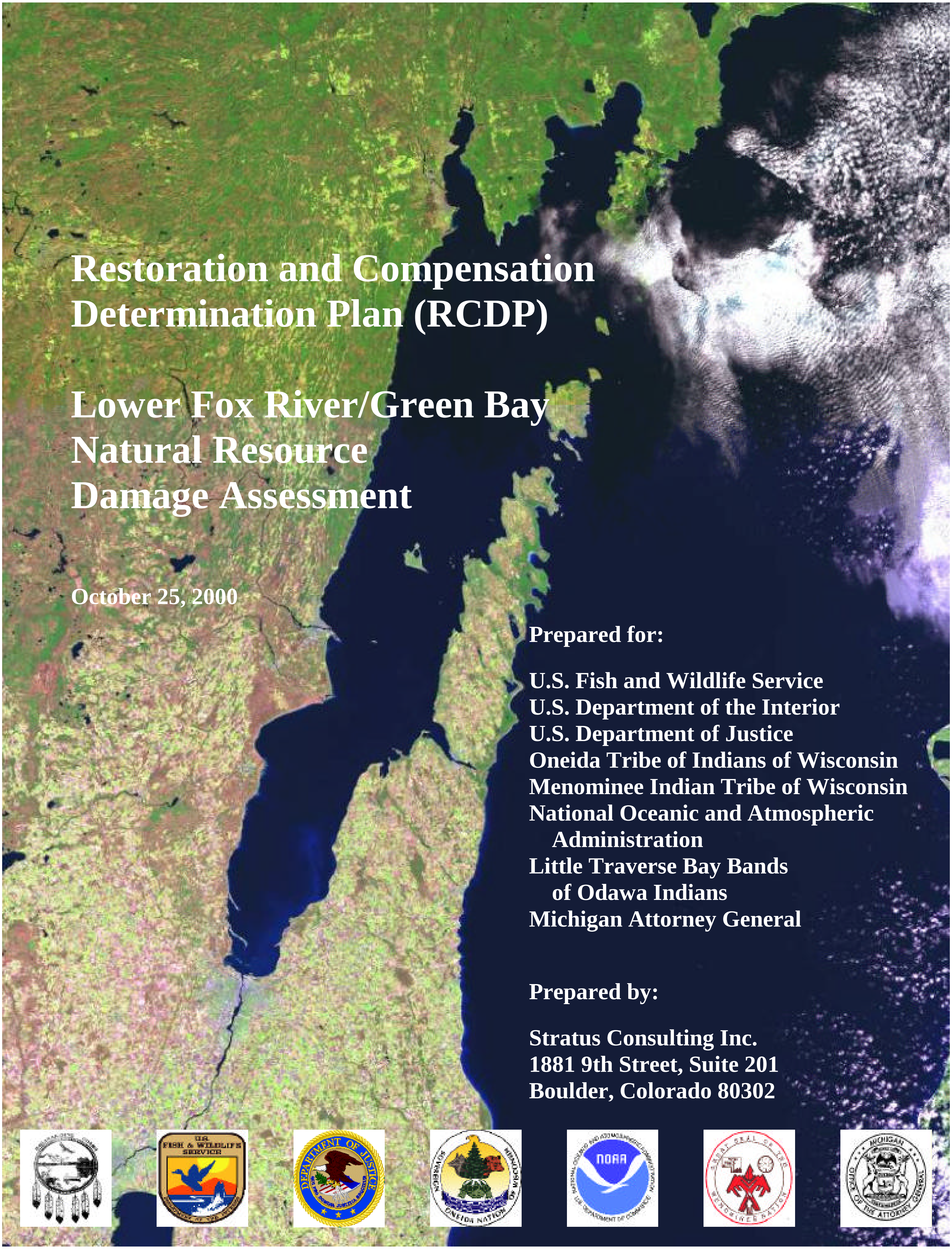

Restoration and Compensation Determination Plan (RCDP)

Lower Fox River/Green Bay Natural Resource Damage Assessment

October 25, 2000

Prepared for:

U.S. Fish and Wildlife Service
U.S. Department of the Interior
U.S. Department of Justice
Oneida Tribe of Indians of Wisconsin
Menominee Indian Tribe of Wisconsin
National Oceanic and Atmospheric Administration
Little Traverse Bay Bands of Odawa Indians
Michigan Attorney General

Prepared by:

Stratus Consulting Inc.
1881 9th Street, Suite 201
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October 25, 2000

William F. Hartwig
U.S. Fish and Wildlife Service, Regional Director and Authorized Official

Contents

Acronyms

CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CWA	Clean Water Act
EPA	U.S. Environmental Protection Agency
FCA	fish consumption advisory
FRG	Fox River Group
GBMBS	Green Bay Mass Balance Study
GLWQC	Great Lakes Water Quality Guidance
IGP	Intergovernmental Partnership
iRCDP	initial restoration and compensation determination plan
MITW	Menominee Indian Tribe of Wisconsin
MOA	Memorandum of Agreement
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
NRDA	natural resource damage assessment
OTIW	Oneida Tribe of Indians of Wisconsin
RCDP	Restoration and Compensation Determination Plan
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
WCA	waterfowl consumption advisory
WDNR	Wisconsin Department of Natural Resources

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1. Introduction and Summary

1.1 Introduction

The Department of the Interior (Department) acting through the U.S. Fish and Wildlife Service (the Service), the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce, the Menominee Indian Tribe of Wisconsin (MITW), the Oneida Tribe of Indians of Wisconsin (OTIW), the Michigan Attorney General, and the Little Traverse Bay Bands of Odawa Indians (collectively, the Co-trustees)[1] are conducting an assessment of natural resource damages (known as a natural resource damage assessment, or NRDA) that have resulted from releases of PCBs to the Lower Fox River/Green Bay ecosystem. Section 107 of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, more commonly known as the federal “Superfund” law) [42 U.S.C. § 9607], Section 311 of the Federal Water Pollution Control Act (CWA, commonly known as the Clean Water Act) [33 U.S.C. § 1321], and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [40 CFR Part 300] provide authority to the Co-trustees to seek such damages.

The Co-trustees’ NRDA follows an administrative process that is outlined in federal regulations at 43 CFR Part 11 (Department regulations). The objective of this NRDA process is to compensate the public, through environmental restoration, for losses to natural resources that have been caused by releases of PCBs into the environment. The results of this administrative process are contained in a series of planning and decision documents that have been published for public review. The Department completed a Preassessment Screen and Determination in May 1994 (U.S. FWS, 1994), which concluded that there was sufficient information to proceed with an NRDA for the Lower Fox River and Green Bay Environment. In August 1996, the Co-trustees published for public comment an assessment plan (U.S. FWS and Hagler Bailly Consulting, 1996) for the Lower Fox River and Green Bay Environment. This plan provided

1. These agencies are referred to as natural resource “Co-trustees” because they have agreed to work together to perform a single, comprehensive, joint natural resource damage assessment with the aim of restoring natural resources that have been injured as a result of releases of PCBs. The Wisconsin Department of Natural Resources (WDNR) declined a 1993 invitation to conduct a joint NRDA and entered into an agreement in 1997 to conduct a separate assessment led by the Fox River Group (FRG) of paper mills. However, in 2000 the WDNR entered a joint assessment plan addendum with the Co-trustees designed to merge compatible parts of the FRG-led NRDA with the Co-trustees’ NRDA, and WDNR subsequently has endorsed parts of the Co-trustees’ NRDA (U.S. FWS, 2000; WDNR, 2000). The Co-trustees have also invited other state and tribal agencies in Michigan to join the Fox River and Green Bay NRDA because much of Green Bay is in Michigan waters, Fox River PCBs contaminate natural resources that routinely cross between Wisconsin and Michigan, and many opportunities for environmental restoration in and around Green Bay are in Michigan.

information on which natural resources would be assessed for injuries, the Co-trustees' authority for conducting the assessment, and coordination among Co-trustees. In addition, the assessment plan confirmed water, sediment, fish, and wildlife exposure to PCBs, discussed the recovery period for natural resources exposed to PCBs, and outlined pathway and injury assessment approaches, damage determination methodologies, and quality assurance measures. The Co-trustees published for public comment three addenda to the assessment plan. The first (U.S. FWS and Hagler Bailly Services, 1997) outlined additional approaches that the Co-trustees would use, including additional detail on injury studies of walleye, waterfowl, tree swallows, and Forster's terns; assessment of transportation service interruptions due to injured sediments; and assessment of injuries and damages specific to the Oneida Tribe. The second addendum (U.S. FWS and Hagler Bailly Services, 1998) was an initial restoration and compensation determination plan (iRCDP), which provided an overview of the restoration planning and damage determination process. In particular, the iRCDP described criteria for determining project acceptability, project focus, project implementation, and project benefits; the process for ranking and scaling projects (including the total value equivalency economic assessment); and the process and methodologies for determining compensable values, including the recreational fishing damages economic assessment. The third addendum (U.S. FWS, 2000) set forth a process that could result in a unified NRDA acceptable to both the Co-trustees and the WDNR.

In addition to these planning and decision documents, specific results and findings of the Co-trustees' NRDA were published for public review in a series of reports addressing PCB transport pathways, natural resource injuries, and economic damage determinations (U.S. FWS and Stratus Consulting, 1998, 1999a, 1999b, 1999c, 1999d, 1999e, 1999f).

This Restoration and Compensation Determination Plan (RCDP) represents the next phase of the NRDA process. In it, the Co-trustees present their planned approach for restoring injured natural resources and compensating the public for losses caused by releases of PCBs. As such, the RCDP ties together the Co-trustees' previous injury determinations, completes the economic valuation of damages, and presents an evaluation of the type and scale of environmental restoration required to make the public whole. The public is afforded an opportunity to comment on the RCDP, and the Co-trustees will respond to those comments in the Report of Assessment.[2]

In addition to providing for the recovery of natural resource damages, the Superfund Law provides for cleanup of the environment by federal and state response agencies in order to address ongoing risks to human health and the environment. The U.S. Environmental Protection Agency (EPA) has proposed the site for inclusion on the National Priorities List (NPL) of Superfund sites, and EPA and WDNR currently are performing a Remedial Investigation/

2. If, as a result of public comments, the Co-trustees make substantive changes to their restoration and compensation approach, the RCDP may be revised and finalized in a subsequent public release document.

Feasibility Study (RI/FS) to evaluate possible cleanup activities. The culmination of this ongoing process will be the publication of a Record of Decision (ROD) by EPA in which the EPA's decisions regarding remedial actions for the site will be documented.

As described in the Co-trustees' iRCDP (U.S. FWS and Hagler Bailly Services, 1998), final assessment of natural resource damages is dependent on the results of the RI/FS process because the potential for restoration and the nature and extent of future damages will depend on the extent of PCB cleanup undertaken by the response agencies. Therefore, the final natural resource damage claim will be calculated after EPA has issued the ROD for the site. After publication of the ROD, the Co-trustees will issue a report of assessment [43 CFR § 11.90] that will make any necessary updates to previous determinations, will summarize and respond to comments provided on the assessment plan and addenda, and will result in a claim, on behalf of the public, for a sum certain, which is a definitive damage claim.[3] Once a damages award has been determined, the Co-trustees will develop a detailed restoration plan (the post-award restoration plan) for public comment that will provide a detailed description of the Co-trustees' restoration measures, including descriptions of the specific projects that will be undertaken to restore, rehabilitate, replace, or acquire natural resources and thereby compensate the public for harm caused by PCBs.

The RCDP is organized as follows: the remainder of Chapter 1 presents a summary of the Co-trustees' Restoration and Compensation Determination Plan. Chapter 2 presents a summary of the Co-Trustees' determination and quantification of injuries to natural resources in the Lower Fox River/Green Bay ecosystem. Chapter 3 describes the Co-trustees' selected restoration and compensation determination approach. Chapter 4 provides a summary of the Co-trustees' planning and coordination activities. Finally, detailed descriptions of key elements of the Co-trustees' restoration and compensation determination are provided in technical appendices to this RCDP.

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3. A final damage claim for the Fox River/Green Bay site cannot be completed until EPA and WDNR's response actions have been selected because of the relationship between the extent of site cleanup undertaken by the response agencies and total natural resource damages. As was discussed in the iRCDP, the quicker and more complete the remedy or cleanup, the less the total harm to the environment that must be addressed through restoration. At sites like the Lower Fox River and Green Bay Environment, where decades of harm have already occurred and where even the best available remedies will not compensate the public for past harm, restoration activities are necessary to compensate the public for losses incurred. In addition, even the most aggressive cleanup in the river cannot prevent further harm in Green Bay, where most of the PCBs released by Fox River paper mills now reside, and injuries will continue in the Fox River for some time in the future. The final claim for damages therefore will require evaluation of the extent and timing of site cleanup and the rate of recovery of natural resources to baseline conditions.

1.2 Summary of Co-Trustees' RCDP for the Lower Fox River/Green Bay NRDA

The Co-trustees' natural resource damage assessment includes three primary elements: injury determination, injury quantification, and damage determination [43 CFR § 11.60(b)]. The Co-trustees have previously completed the first two elements, which yielded the following determinations for the Fox River/Green Bay natural resource damage assessment: PCB Pathway Determination (August 1999), Injuries to Surface Water Resources (November 1999), Injuries to Fishery Resources (November 1999), and Injuries to Avian Resources (May 1999).

This RCDP, along with the iRCDP published in September 1998 and the Recreational Fishing Damages Determination published in November 1999, describes the activities that constitute the third element of the assessment — damage determination. Under the Department's regulations, damage determination includes four primary trustee activities: development of a reasonable number of possible alternatives for restoration, rehabilitation, replacement, and/or acquisition of equivalent resources; selection of the most appropriate alternative; identification of methods for estimating the costs of the restoration alternative selected; and identification of methods for determining the compensable value of the services lost to the public associated with the selected alternative [43 CFR §§ 11.80, 11.82-11.83]. These activities serve as a blueprint for producing the final natural resource damage claim, which comprises the cost of restoration to baseline of the natural resources and the services they provide, the compensable value of services lost until baseline is achieved, and the Co-trustees' reasonable assessment costs [42 U.S.C. § 9607(a)(4)(C), 43 CFR § 11.80(b)].

To select a preferred restoration alternative, the Co-trustees compiled and analyzed a list of more than 600 potential projects, in light of the factors set out in 43 CFR § 11.82(d) and decision-making criteria published in the iRCDP. In addition, the Co-trustees conducted a total value equivalency study (Appendix A) to help determine the types and scale of restoration projects that would be necessary to restore the natural resources to baseline, as measured by the value of the services they provide, and to compensate for any ongoing and future losses of services. CERCLA prohibits natural resource trustees from any double recovery for natural resource damages [42 U.S.C. § 9607(f)(1)]. To avoid double counting between the value of restoration projects and compensable values measured in the recreational fishing study, the Co-trustees propose to use the recreational fishing study for past damages only, and costs of restoration for future damages only.

In selecting their preferred restoration alternative, the Co-trustees rejected the no-action/natural recovery alternative. Under this alternative, no further actions would be undertaken to restore natural resources. In addition, the Co-trustees rejected a PCB removal alternative because PCB removal is currently being evaluated by EPA and WDNR as part of the ongoing RI/FS.

Instead, the Co-trustees' preferred restoration alternative focuses on performing resource-based restoration actions to improve the environmental health of the Lower Fox River and Green Bay Environment and thereby compensate for losses resulting from PCB injuries. The Co-trustees' restoration plan for the NRDA will involve a mix of actions designed to provide ecological and social benefits. A central element of the Co-trustees' restoration approach is ensuring that the restoration addresses the full geographic and ecological scope of the injuries to natural resources. Therefore, in developing their final restoration plan, the Co-trustees will ensure that restoration activities:

- address the entire Lower Fox River and Green Bay Environment, from Little Lake Butte des Morts in the south to the Bays des Noc in the north
- encompass the unique range of habitats in the Green Bay region, including the aquatic habitat of the bay itself, the coastal wetlands on the west shore, the rich riverine habitats that connect to the bay, and the valuable ecological habitats of the Door Peninsula and the Bays des Noc
- provide for long-term recovery, protection, and enhancement of the unique natural resource endowment of the Lower Fox River and Green Bay Environment
- consider human uses of the natural environment to provide for ongoing and long-term active and passive uses of Green Bay natural resources.

The specific restoration actions that constitute the Co-trustees' preferred alternative include wetland preservation, wetland restoration, and reduction of nonpoint source runoff loads into the bay from cropland through conservation tillage and installation of vegetated buffer strips along streams. These actions will provide valuable environmental benefits that will compensate for the injuries caused by PCBs:

- Wetlands provide valuable habitat for many fish and bird species. They are highly productive areas, and help reduce wave erosion, contain nonpoint source runoff, and recycle nutrients. Many fish species of Green Bay rely on coastal wetlands for breeding and rearing, including yellow perch, northern pike, and largemouth bass, as well as shiners and minnows, which are essential prey items for many birds and larger fish. Many bird species also rely on wetlands for breeding and feeding, such as herons, rails, eagles, and terns. Coastal, riparian, and near-shore wetlands historically were an integral component of the habitat and wildlife diversity of the Green Bay area. However, most of the wetlands around Green Bay have been drained or filled, making preserving the remaining wetlands an important priority. Actions to preserve and restore wetlands thus can improve the environmental quality of the Lower Fox River and Green Bay

Environment to compensate for the ecological and human use of service losses caused by PCB injuries.

- Nonpoint source runoff pollution into Green Bay can stimulate the growth of blue-green algae, which causes the periodic algae blooms in inner Green Bay. The blue-green algae also contribute to low oxygen conditions (when the algae die), making the water less habitable for some native fish species and more hospitable to species such as carp, which can survive in low-oxygen waters. Blue-green algae contribute little to the aquatic food chain of the bay, and can release a chemical when they die that can irritate people's skin and eyes on contact. The decreased light penetration in the bay caused by runoff limits the growth of submerged aquatic vegetation that provides important habitat for fish and waterfowl, and can also reduce the feeding success of sight-feeding fish such as sport fish like walleye and northern pike. Reducing nonpoint source runoff pollution can improve the quality of the Lower Fox River and Green Bay Environment, thereby compensating for the decrease in environmental quality caused by PCBs.

- Runoff control through vegetated buffer strips and conservation tillage practices also provides some habitat services for wildlife. The streambank stabilization caused by the roots of the vegetation used in buffer strips helps to maintain stream geometry, thereby enhancing neighboring stream habitat for fish and macroinvertebrates. The vegetative cover of the buffer strip can provide wildlife nesting and feeding habitat, and can serve as connecting corridors that enable wildlife to move safely from one habitat to another. Conservation tillage can provide cover for birds and small mammals and higher quality habitat for soil invertebrates (which, in turn, are fed upon by small mammals and birds).

In addition, the Co-trustees also included consideration of improvements to existing recreational facility improvements as a component of the restoration. The scale of the environmental restoration projects necessary to compensate the public for injuries to natural resources of the river and bay was determined through a total value equivalency study. The value to the public of the improvement in the environment that will be attained through wetland preservation, wetland restoration, and nonpoint source pollution reductions is balanced with the value of the resources and services lost to the public because of the PCB injuries.

Table 1.1 summarizes the past compensable values (from the recreational fishing damages assessment) and the estimated costs of restoration to address present and future PCB injuries. The restoration costs shown in Table 1.1 are illustrative only, for the amount of restoration required depends on the level of PCB cleanup that will be conducted by the response agencies. In addition, different possible mixes of restoration projects are possible, and the composition of the mix affects the total restoration cost. The Co-trustees prefer a mixture of project types so that the full range of ecological service types lost because of PCB injuries are restored and the public's values and attitudes toward restoration of Lower Fox River and Green Bay Environment resources are adequately addressed. Furthermore, a mix of project types allows for the flexibility necessary to actually implement a restoration plan. The final mix of restoration projects will be determined in the Co-trustees' post-award restoration plan.

Table 1.1. Potential damages under different remediation scenarios[a] (millions of dollars, 2000 present value).

Remediation scenario	Past interim damages (recreational fishing losses)	Present and future damages (restoration costs)[b]	Total
Intensive PCB cleanup (baseline achieved in 20 years)	$65	$111-191	$176-256
Intermediate PCB cleanup (baseline achieved in 40 years)	$65	$158-268	$223-333

a. Table does not include the reasonable and necessary costs of conducting the assessment, which will be included in the final claim.

b. Values are from illustrative mixes of restoration project types and are not intended to necessarily represent the costs that will be used in the final claim. See Section 3.2.9.

2. Natural Resource Injuries

The purpose of the natural resource damage assessment is to establish restoration of and compensation for natural resources that have been injured as a result of releases of hazardous substances. Therefore, restoration and compensation planning relies on the Co-trustees' assessment of natural resource injuries in the Lower Fox River and Green Bay Environment. The results of the injury assessment are presented in a series of reports that have been released previously to the public:

- Fish Consumption Advisories in the Lower Fox River/Green Bay Assessment Area (U.S. FWS and Stratus Consulting, 1998)
- Association between PCBs, Liver Lesions, and Biomarker Responses in Adult Walleye (*Stizostedium vitreum vitreum*) Collected from Green Bay, Wisconsin. (U.S. FWS and Stratus Consulting, 1999a)
- Injuries to Avian Resources, Lower Fox River/Green Bay Natural Resource Damage Assessment (U.S. FWS and Stratus Consulting, 1999b)
- Injuries to Fishery Resources, Lower Fox River/Green Bay Natural Resource Damage Assessment (U.S. FWS and Stratus Consulting, 1999c)
- Injuries to Surface Water Resources, Lower Fox River/Green Bay Natural Resource Damage Assessment (U.S. FWS and Stratus Consulting, 1999d)
- PCB Pathway Determination for the Lower Fox River/Green Bay Natural Resource Damage Assessment (U.S. FWS and Stratus Consulting, 1999e).

Each of the above reports is available at the Service's Lower Fox River/Green Bay NRDA website at http://www.fws.gov/r3pao/nrda/index.html and has been presented at public meetings (see Appendix B). Moreover, the results of these injury determinations have been accepted by the WDNR and adopted as the basis for joint restoration planning pursuant to the Third Addendum to the Assessment Plan for the Lower Fox River/Green Bay NRDA (WDNR, 2000). This chapter establishes the foundation for the Co-trustees' restoration and compensation determination by providing a brief summary of the results of the injury phase of the NRDA. This summary is based on the above-cited reports.

2.1 Natural Resources of the Lower Fox River and Green Bay Environment

As part of the larger Lake Michigan and Great Lakes ecoregion (Figure 2.1), the Lower Fox River and Green Bay form a unique and important ecosystem. The terrestrial, wetland, and aquatic habitats of the Lower Fox River and Green Bay Environment assessment area (Figure 2.2) support a wide diversity of birds, fish, and mammals, including many rare, threatened, and endangered species. The health of the ecosystem and the quality of its ecological habitats are vital to the invertebrates, plants, fish, and wildlife of the area. Human use services of these resources, such as recreational fishing, boating, and swimming, and tribal cultural uses, also depend on the health and quality of the Lower Fox River and Green Bay Environment.

Figure 2.1. The Great Lakes Basin, and location of Green Bay.

Figure 2.2. The Lower Fox River and Green Bay Environment assessment area.

The assessment area contains diverse aquatic habitats that include riverine, near-shore, and open water habitats. Riverine habitats are found in the Lower Fox River and in tributaries to Green Bay. The warm, shallow waters typical of shorelines and of Lower Green Bay support warm water fish such as white bass (Bertrand et al., 1976; Brazner, 1997). Sandbars and estuaries, vital spawning and nursery habitats for many fish species such as yellow perch and northern pike (Brazner, 1997), characterize the western and southern shores of Green Bay, whereas rocky steep shorelines are typical of the eastern shore. Cold, deep waters characterize the open waters of outer Green Bay, generally defined as the section of the bay north of Chambers Island. These waters support cold-water fish such as trout and salmon (Bertrand et al., 1976).

This diversity of habitats supports a diversity of fish species at different trophic levels (University of Wisconsin-Green Bay, 1993). Small forage fish, including alewives, gizzard shad, and spottail shiners, feed on insects, zooplankton, and bottom-dwelling invertebrates and occupy nearshore habitats where aquatic vegetation provides cover and forage. These forage fish provide an important trophic link between zooplankton and game fish such as walleye, northern pike, trout and salmon. Bottom feeders such as channel catfish provide another trophic link between bottom-dwelling invertebrates and higher level predators (University of Wisconsin-Green Bay, 1993).

The fishery resource, one of the most productive in the Great Lakes, is of central importance to the Green Bay food web because it provides food for the region's many piscivorous (i.e., fish-eating) birds and mammals (U.S. EPA and Environment Canada, 1995). Birds and mammals that depend on the fishery resource for food include bald eagles, terns, herons, ducks, double-crested cormorants, otter, and mink (Linscombe et al., 1982; Toweill and Tabor, 1982; Allen et al., 1987). Nationally significant fish stocks of the area, as classified by the Great Lakes Fish and Wildlife Restoration Act (16 U.S.C. 941), include lake trout, yellow perch, lake sturgeon, and walleye (U.S. FWS and Stratus Consulting, 1999c).

Situated on one of the major bird migration routes in North America, the Mississippi Flyway, the Lower Fox River and Green Bay Environment provides essential habitat for large populations of breeding and migratory birds (Temple and Cary, 1987; Erdman and Jacobs, 1991; Robbins, 1991; U.S. FWS and Stratus Consulting, 1999b). Over 250 bird species have been recorded in the five Wisconsin counties immediately adjacent to the bay and river (Temple and Cary, 1987), and 91 bird species have been recorded in the townships adjacent to the Michigan Green Bay shore (Brewer et al., 1991). At least 16 species listed by either the State of Wisconsin, the State of Michigan, or the federal government as threatened or endangered are found in the assessment area, including bald eagle, peregrine falcon, great egret, and Caspian and Forster's terns (U.S. FWS and Stratus Consulting, 1999b).

The assessment area is located within a transitional zone where plant communities typical of both colder and warmer climates converge (Curtis, 1959). Thus, upper Green Bay is characterized by conifer forests whereas lower Green Bay and the Lower Fox River are characterized by hardwood forests, resulting in the occurrence in the assessment area of species typical of both habitats (U.S. FWS and Stratus Consulting, 1999b). The wetlands located along the bay provide key habitat for migratory and nesting birds, and the small uninhabited islands of Green Bay provide nesting sites for large colonies of breeding waterbirds such as terns and herons, free from human disturbance and mammalian predators. Because of its comparatively undeveloped nature and the quality and extent of its habitats, the assessment area supports more diverse bird communities than are found elsewhere in the Great Lakes region (U.S. FWS and Stratus Consulting, 1999b).

Human uses of the Green Bay/Lower Fox River resources include waterfowl hunting; recreational, commercial, and sustenance fishing; and tribal cultural uses (U.S. FWS and Stratus Consulting, 1999b, 1999c). During the fall influx of migratory ducks and geese, the waterfowl in and around Green Bay are intensively hunted and comprise an important recreational resource (K. Stromborg, U.S. Fish and Wildlife Service, personal communication, 1998).

The avian and fishery resources of the Lower Fox River/Green Bay ecosystem are vital food sources and are of great cultural significance to the Oneida and Menominee nations (U.S. FWS and Stratus Consulting, 1999b, 1999c). After the Oneida people were relocated from New York to the reservation near the city of Green Bay, they obtained most of their meat from local game, including waterfowl, turkey, and other small game. In addition, the local birds, including the bald eagle, play an important spiritual role in the lives of the Oneida and Menominee people (U.S. FWS and Stratus Consulting, 1999b). The fishery resource is also an integral part of the Oneida and Menominee tribal cultures. For the Oneida people, the annual fish migrations were historically a focus for cultural events and community gatherings, and also provided a means of income supplementation (U.S. FWS and Stratus Consulting, 1999c). Similarly, the lake sturgeon was historically an important source of food for the Menominee people, and it is a spiritual being in the creation of the Menominee and remains a strong cultural and spiritual symbol (D. Cox and R. Wilson, Menominee Indian Tribe, personal communication, October 2000).

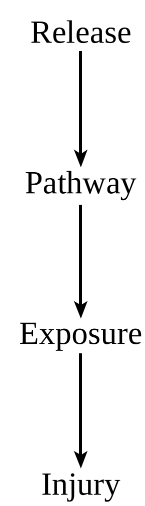

Figure 2.3. The natural resource injury chain of events.

2.2 Injury Determination

Figure 2.3 shows the chain of events that has resulted in injuries to natural resources. Injuries to natural resources were evaluated pursuant to the Department's regulations at 43 CFR Part 11, as described in the

Assessment Plan (61 FR 43,558) and three addenda to the Assessment Plan (62 FR 67,888; 63 FR 43,558; and 65 FR 33,823), and in individual injury reports. Considerable amounts of data were available for the site, including data collected as part of the Green Bay Mass Balance Study (GBMBS), Wisconsin and Michigan State fish and wildlife contaminant monitoring databases, and field data collected by numerous university and government researchers. These data were supplemented by the Co-trustees with several focused injury studies (Table 2.1). Because of the size and the diversity of the assessment area, evaluation of injuries to every species was not feasible. Instead, the Co-trustees focused the injury assessment on selected representative resources and injury categories (Table 2.2).

Table 2.1. Supplemental data collected for the Co-trustees' injury assessment.[a]

Fish	Birds
PCB exposure data (lake trout, brown trout, walleye)	PCB exposure data in eggs (Forster's tern, common tern, tree swallow)
Fish health data (lake trout, brown trout, walleye)	PCB exposure data in waterfowl (lesser scaup, mallard, greater scaup, bufflehead, common goldeneye ruddy duck, common merganser, red-breasted merganser, tree swallows)
Fish reproduction data (lake trout)	
PCB toxicity data (lake trout)	

a. These studies are described in the Assessment Plan and Addendum for the Lower Fox River/Green Bay NRDA (U.S. FWS and Hagler Bailly Consulting, 1996; U.S. FWS and Hagler Bailly Services, 1997).

2.2.1 PCB releases

Starting in the mid-1950s, Lower Fox River paper companies and associated waste treatment facilities released PCBs to the Lower Fox River (U.S. FWS and Stratus Consulting, 1999e). These releases comprised byproducts of a process that made, converted, or recycled carbonless copy paper containing PCBs. Multiple Lower Fox River paper companies contributed to the releases, including Appleton Coated Paper, PH Glatfelter — Bergstrom Division (formerly Bergstrom Paper), Wisconsin Tissue Mills, Fort James Green Bay West Mill (formerly Fort Howard), and other secondary fiber producers. In addition, releases occurred from Arrowhead Park landfill and the City of Appleton and Neenah-Menasha POTWs, all of which handled wastes received from the paper companies (U.S. FWS and Stratus Consulting, 1999e). A schematic diagram that illustrates the flow and releases of PCBs associated with NCR paper production is provided as Figure 2.4.

Table 2.2. Injury assessment approach.

Natural resource	Injury definitions evaluated	Representative species or matrix evaluated	Biological effects evaluated (where relevant)	Evaluation approach	NRDA injury determination reports
Birds	Adverse changes in viability [43 CFR § 11.62(f)(1)(i)]	Forster's tern	Reduced hatching success; embryonic deformities; behavioral effects	Evaluate existing studies to determine whether the biological resource has undergone any of the adverse changes in viability that are specified in the NRDA regulations as causing injury[a]; evaluate cause of any adverse effects observed	U.S. FWS and Stratus Consulting, 1999b
		Common tern	Reduced hatching success; embryonic deformities		
		Caspian tern	Embryonic deformities; behavioral abnormalities		
		Double-crested cormorant	Reduced hatching success; embryonic/chick deformities		
		Black-crowned night heron	Physical deformations		
		Tree swallow	Reduced breeding success		
		Red-breasted merganser	Reduced breeding success		
		Bald eagle	Reduced breeding productivity		
	FDA exceedences [43 CFR § 11.62(f)(1)(ii)]	Waterfowl (ducks and geese)	NA	Compare tissue concentrations to FDA tolerance	
	Consumption advisory exceedences [43 CFR § 11.62(f)(1)(iii)]	Waterfowl (ducks and geese)	NA	Evaluate State advisory programs	

Table 2.2. Injury assessment approach (cont.).

Natural resource	Injury definitions evaluated	Representative species or matrix evaluated	Biological effects evaluated (where relevant)	Evaluation approach	NRDA injury determination reports
Fish	Adverse changes in viability [43 CFR § 11.62(f)(1)(i)]	Walleye	Fish health (cancer, disease, physiological malfunction, deformation)	Collect supplemental data to determine whether fish have undergone any of the adverse changes in viability that are specified in the NRDA regulations as causing injury[a]; evaluate cause of any adverse effects observed	U.S. FWS and Stratus Consulting, 1999a
		Brown trout	Fish health (cancer, physiological malfunction, deformation)		U.S. FWS and Stratus Consulting, 1999c
		Lake trout	Fish reproduction (embryomortality and deformities); fish health (cancer, physiological malfunction, deformation)		
	FDA exceedences [43 CFR § 11.62(f)(1)(ii)]	Species with available data	NA	Compare tissue concentrations to FDA tolerance	U.S. FWS and Stratus Consulting, 1998
	Consumption advisory exceedences [43 CFR § 11.62(f)(1)(iii)]	Species with available data	NA	Evaluate State advisory programs	U.S. FWS and Stratus Consulting, 1999c
Surface water	Water quality exceedences [43 CFR § 11.62(b)(1)(iii)]	Lower Fox River and Green Bay surface water	NA	Compare surface water PCB concentrations to applicable criteria	U.S. FWS and Stratus Consulting, 1999d
	Injury to biological resources exposed to surface water resource [43 CFR § 11.62(b)(1)(v)]	Species evaluated in assessment of injuries to avian and fishery resources	NA	Determine whether avian and fishery resources have been injured as a result of exposure to PCBs in surface water and sediments	U.S. FWS and Stratus Consulting, 1999b U.S. FWS and Stratus Consulting, 1999c

a. The adverse viability changes addressed in the NRDA regulations are death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations.

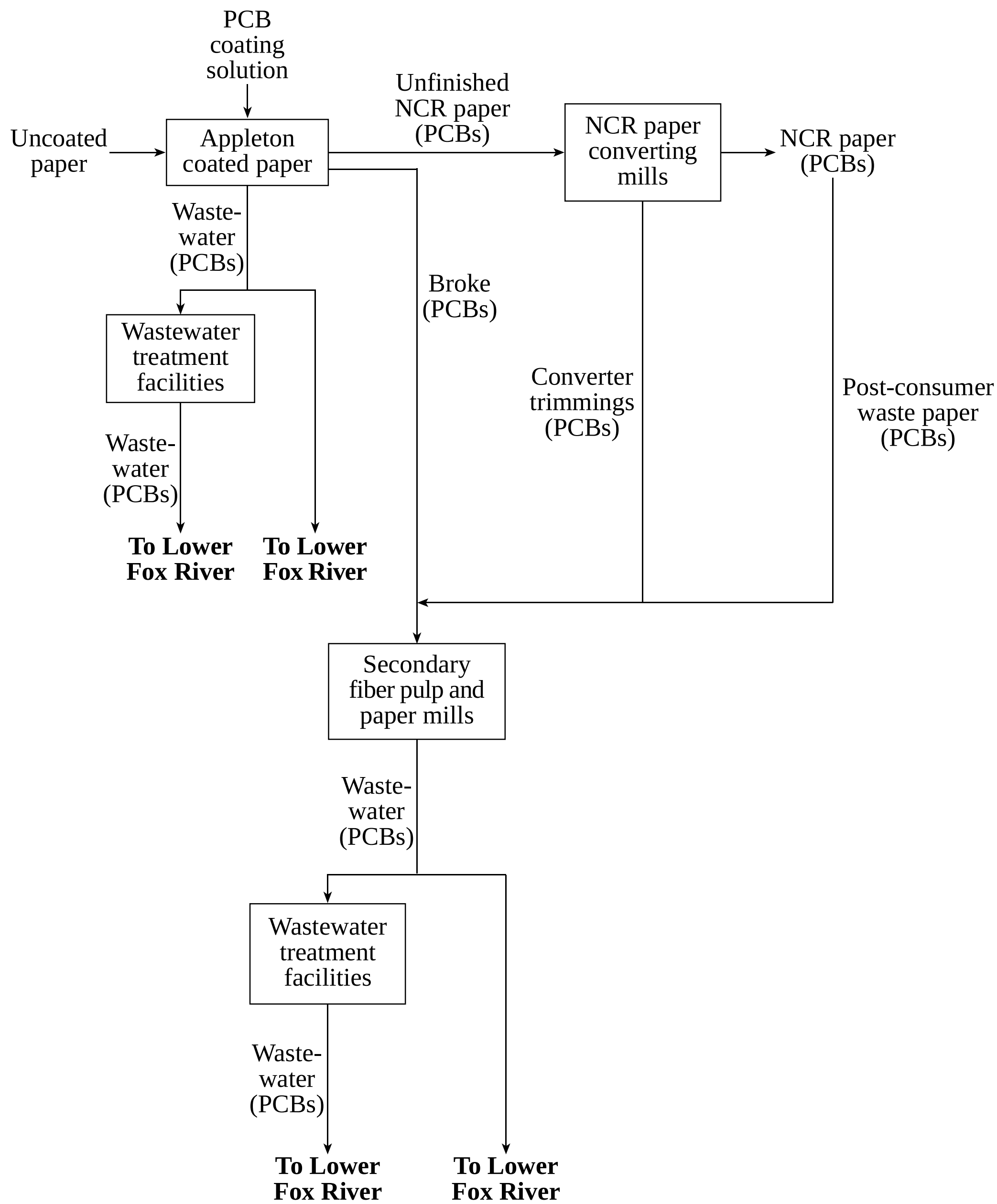

Figure 2.4. Schematic diagram for PCB releases to the Lower Fox River.

The PCB releases began in 1954, when commercial production of a carbonless copy paper called NCR paper that contained PCBs began. The PCBs were applied in a coating solution to paper stock at Appleton Coated Paper Company in Appleton, Wisconsin from 1954 to about April 1971. Coated papers were sold to paper converters who manufactured the finished product. During and after this period, Appleton Coated Paper discharged process wastewater to the City of Appleton sewage system for disposal (U.S. FWS and Stratus Consulting, 1999e).

During preparation of the NCR paper, there were losses of coating solution containing PCBs as well as coated side trimmings, off-grade paper, and waste paper generated during paper machine breaks. Collectively, these paper losses are called “broke.” The broke, which contained approximately 3.4% PCBs by weight, was sold to waste paper brokers and to secondary fiber pulp and paper mills, where it was processed with other waste papers to make secondary fiber pulp and paper products (U.S. FWS and Stratus Consulting, 1999e).

PCB releases to the Lower Fox River therefore came from many paper company related sources (Figure 2.4). The majority of PCB releases from paper companies were associated with losses of PCBs from paper coating operations and from recycling of NCR paper broke, followed by recycling of NCR paper converter trim and finally by processing of post-consumer waste paper containing NCR paper. Loss of PCB emulsions occurred during the paper coating process, primarily at Appleton Coated Paper. Secondary fiber mills that processed NCR paper broke and other PCB-containing waste papers and that are estimated to have had the largest PCB releases are Fort James Green Bay West Mill in the City of Green Bay, PH Glatfelter — Bergstrom Division in Neenah, and Wisconsin Tissue Mills in Neenah. Other important PCB releases were discharges from the City of Appleton sewerage system and wastewater treatment plant, which received wastewater from Appleton Coated Paper; releases from the Neenah-Menasha wastewater treatment plant, which received wastewater discharges from Wisconsin Tissue and other secondary fiber mills; and releases from the Arrowhead Park landfill, which received waste products from PH Glatfelter (U.S. FWS and Stratus Consulting, 1999e).

WDNR (1999a) has estimated the total amount of PCBs released to the Lower Fox River between the mid-1950s and 1997 as approximately 300,000 kg (660,000 lb). Direct PCB releases to the Lower Fox River began in the 1950s, increased through the 1960s, peaked in 1969, and dropped sharply after 1971. Nevertheless, the Lower Fox River continues to be the dominant source of PCBs entering Green Bay (Figure 2.5). Although the use of

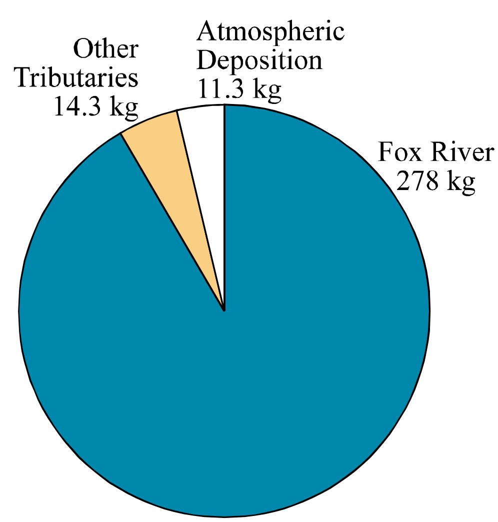

Figure 2.5. PCB loadings into Green Bay, 1989. Data from DePinto et al. (1994).

PCBs in the production of NCR paper ceased in 1971, NCR paper broke and converter trim containing PCBs remained in the recycled fiber stream for several years, and releases are expected to have occurred for years after production of NCR paper ceased. Furthermore, PCBs continue to be released into the environment through surface water and sediment transport processes. An estimated 39,400 to 47,300 kg of PCBs (13-16% of the total released) remain in bed sediment throughout the Lower Fox River (WDNR, 1999b).

2.2.2 Pathways

The movement and distribution of PCBs in Green Bay is determined by the water current patterns in the bay, and where PCB-contaminated sediment settles to the bay floor (U.S. FWS and Stratus Consulting, 1999e). Figure 2.6 illustrates the general movement of PCBs from release points in the Lower Fox River throughout Green Bay. PCBs enter the food chain when they are taken up by benthic invertebrates and phytoplankton, which serve as food for higher trophic level fish.

Figure 2.6. The movement of PCBs from the Lower Fox River throughout Green Bay. Water circulation patterns in the river and bay determine the movement of the PCBs.

Surface water, sediment, and air pathways

PCBs released from paper company facilities into the Lower Fox River are carried downstream and into Green Bay, dissolved in the water column and adsorbed to suspended sediment particles. This is illustrated in Figure 2.7, which shows that PCB concentrations and loads measured between 1989 and 1995 in the Lower Fox River are lowest upstream of the paper companies and highest downstream of the paper companies.

Once PCBs enter Green Bay in surface water and sediments of the Lower Fox River, they are carried by the water currents that circulate through the bay. Green Bay water circulation is complex but has an overall counterclockwise pattern. It is controlled by factors such as surface water elevation changes induced by wind and barometric pressure, wind speed and direction,

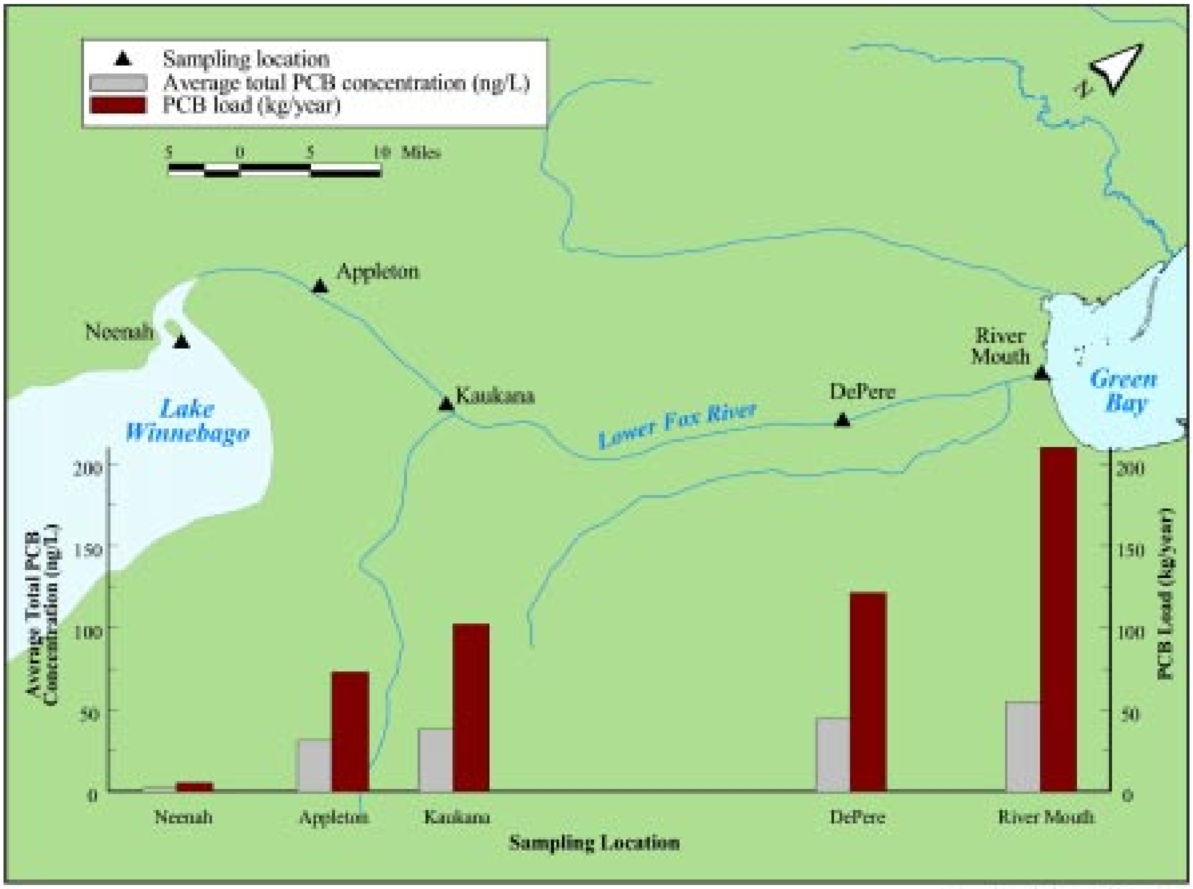

Figure 2.7. PCB concentrations and loads in the Lower Fox River. Concentrations and loads are lowest at Neenah, which is upstream of paper company facilities, and increase downstream of paper companies starting at Appleton. Data for Neenah, Appleton, Kaukana, and DePere are from Steur et al. (1995). Data for River Mouth are from ThermoRetec Consulting and Natural Resource Technology (1999).

river discharge, upwelling of the thermocline in Lake Michigan, thermal and density gradients between the bay and Lake Michigan, ice cover, and the Coriolis effect.

The Lower Fox River is the dominant tributary to Green Bay, and the Lower Fox River plume can be tracked within the bay. The Lower Fox River plume moves up the bay along the eastern shore for 20-40 km under the influences of both prevailing southwesterly winds and the Coriolis effect. Mixing of water is limited in the southernmost portion of the bay. Although water movement between the inner and outer bay and between Green Bay and Lake Michigan is complex, net water movement between these areas is from the inner to the outer bay and from the outer bay to Lake Michigan. Overall exchange is very high, providing a mechanism by which

PCBs are transported from the inner bay to the outer bay and from Green Bay into Lake Michigan (U.S. FWS and Stratus Consulting, 1999e).

Most of the PCB-laden sediment from the Lower Fox River is deposited in inner Green Bay, especially along the eastern half, where the Lower Fox River plume is directed by the bay water currents. Sediment that has been deposited can be re-entrained and transported. Approximately 10% to 33% of the inner bay tributary sediment load (the majority of which is from the Lower Fox River) is resuspended and transported to the outer bay, along with the PCBs carried within the sediments. The Green Bay Mass Balance Study (GBMBS), a comprehensive modeling effort of the movement of PCBs in and out of the Green Bay system, found an annual net estimated transfer of 122 kg of PCBs from Green Bay to Lake Michigan for 1989 (U.S. FWS and Stratus Consulting, 1999e).

PCB congener patterns in outer Green Bay are consistent with the transport and weathering of PCBs from the Lower Fox River and are inconsistent with the transport and weathering of Lake Michigan PCBs. Therefore, the Lower Fox River rather than Lake Michigan is the dominant source of the PCBs in outer Green Bay (U.S. FWS and Stratus Consulting, 1999c).

Biotic pathways

As illustrated in Figure 2.8, PCBs can enter the aquatic food chain from contaminated surface water and sediment via uptake by phytoplankton and benthic invertebrates. PCBs that accumulate in phytoplankton are passed on to zooplankton, which consume phytoplankton. Forage fish (e.g., rainbow smelt, gizzard shad, and alewife) take up PCBs by consuming zooplankton, and in turn serve as a PCB pathway to predator fish such as walleye and brown trout. Similarly, PCBs that enter the food chain via benthic invertebrates are transferred to benthic feeding fish such as catfish. This food chain pathway is therefore the dominant PCB pathway for top-level fish predators in the Lower Fox River and Green Bay Environment (U.S. FWS and Stratus Consulting, 1999e).

Because PCBs accumulate in biota and biomagnify up the food chain, the dietary pathway also is the primary route by which birds and piscivorous mammals are exposed. Of the birds that nest and feed on and near the assessment area, piscivorous species (i.e., those that consume fish) such as Forster’s and Caspian terns and predatory species (i.e., those that consume other birds) such as bald eagles are the most highly exposed to PCBs, since their food items are the most highly contaminated with PCBs. Waterfowl such as mallards also contain elevated PCB concentrations, most likely as a result of exposure to sediment, surface water, phytoplankton, and zooplankton contaminated with PCBs (U.S. FWS and Stratus Consulting, 1999e).

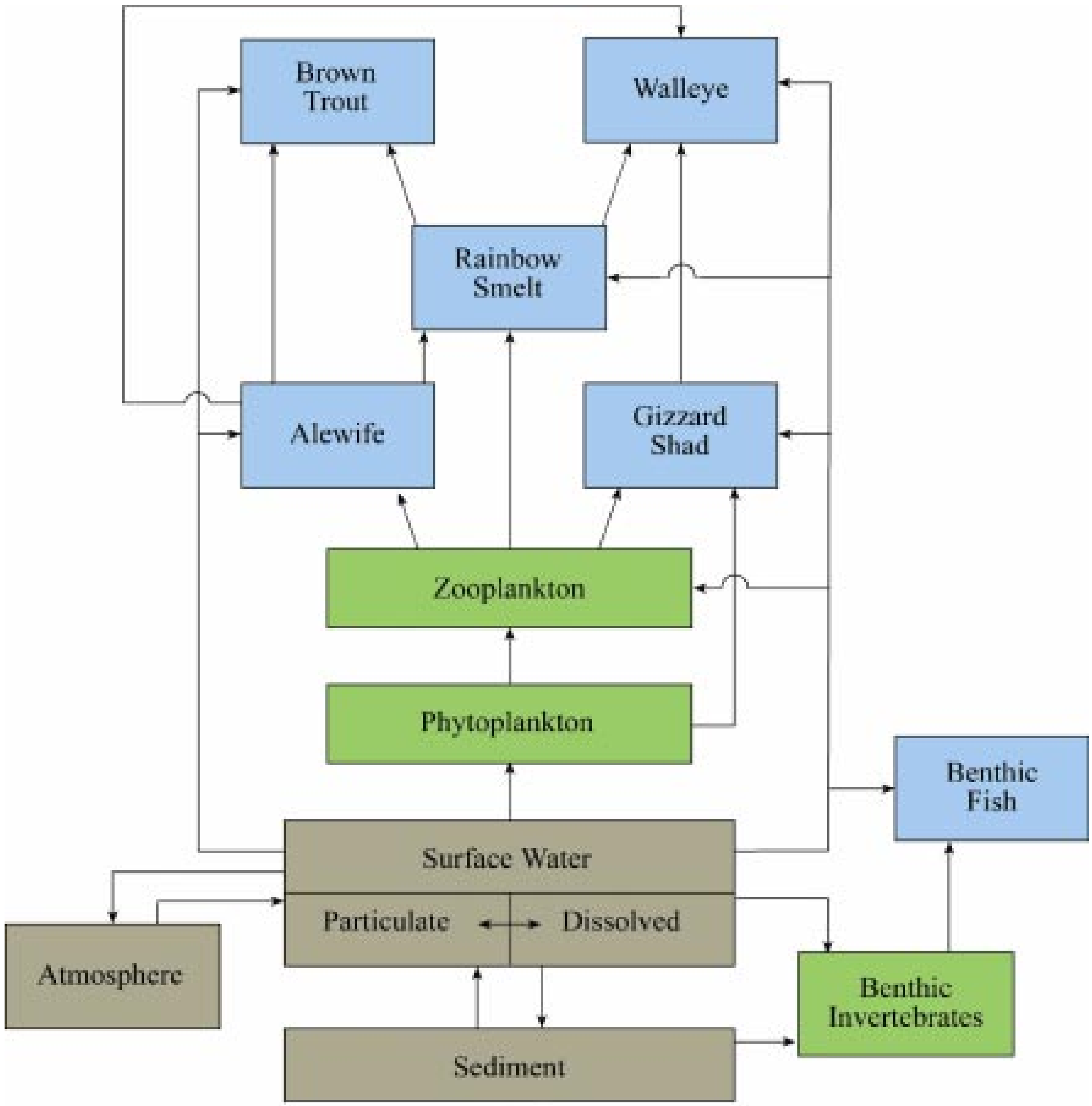

Figure 2.8. PCB pathways in Lower Fox River and Green Bay Environment. Abiotic media are in brown, primary producers and invertebrates are in green, and fish species are in blue.

Fish and birds exposed to PCBs in the Lower Fox River and Green Bay Environment that migrate to other areas serve as PCB pathways by transporting PCBs to other areas. Several fish species, including northern pike, walleye, smallmouth bass, yellow perch, and lake sturgeon, have been documented to migrate between Green Bay and its tributaries. Fish migration has also been documented between Green Bay and Lake Michigan and within Green Bay itself. This migration of contaminated biota may serve as a particularly important transport pathway for natural resources on the Reservation of the Oneida Tribe of Indians of Wisconsin (U.S. FWS and Stratus Consulting, 1999e).

The release and transport of PCBs has resulted in elevated PCB exposure in natural resources throughout Green Bay. Furthermore, the spatial and temporal distributions of PCB concentrations in these media are consistent with the Lower Fox River as the source of the PCBs.

Surface water and sediment

Figure 2.9 shows elevated PCB concentrations in Green Bay sediment. Data were collected in 1989-1990 as part of the GBMBS. PCB concentrations are higher in the inner bay than in the outer bay, and concentrations in the inner bay are highest along the eastern shore, where Green Bay circulation patterns carry contaminated water and sediment discharged from the Lower Fox River.

Fish

Elevated concentrations of PCBs have been found in all of the components of the aquatic food web, including surface water, sediment, plankton, and forage fish (see Figure 2.8). PCB accumulation has been documented in over 45 fish species at all trophic levels and from all Lower Fox River/Green Bay habitats, including coastal wetlands, coastal beaches, near-shore areas, and open water habitat. Because of biomagnification of PCBs in the food chain, PCB concentrations in predatory fish such as walleye and brown trout tend to be higher than concentrations in forage fish (U.S. FWS and Stratus Consulting, 1999c).

Fish PCB concentrations vary spatially throughout the bay. PCB concentrations tend to be highest in the Lower Fox River and along the eastern shore of the inner bay, as shown in Figure 2.10, consistent with the Lower Fox River as the source of the PCBs and the patterns seen in sediment and surface water. PCB concentrations in fish were highest in the 1970s, declined through the late 1970s and mid 1980s, and have reached a state of much slower decline since the mid to late 1980s.(U.S. FWS and Stratus Consulting, 1999c).

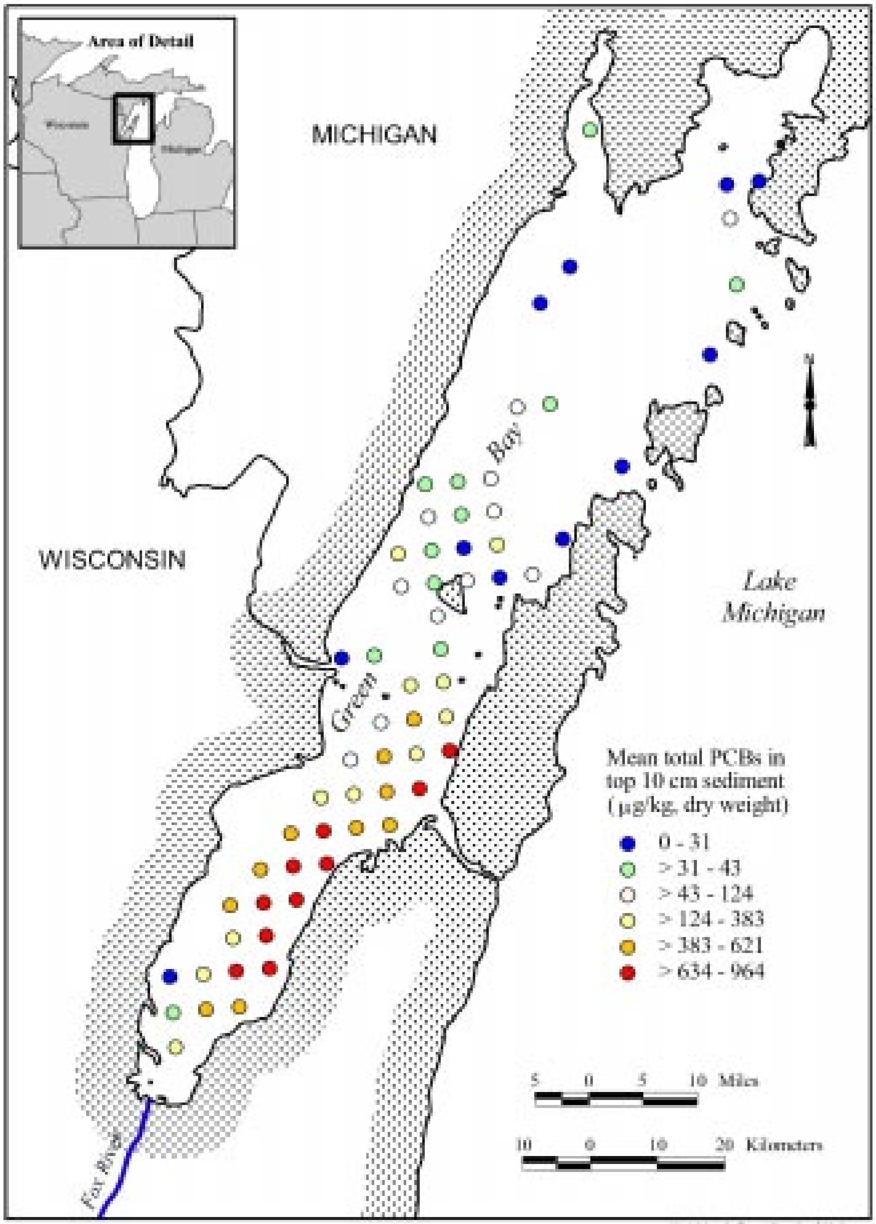

Figure 2.9. **Mean total PCB concentrations in the top 10 cm of Green Bay sediment, 1989.** Each symbol represents a single sediment sampling location. Sediment for PCB analysis was collected only from locations with soft sediment

Source: GBMBS data from the WDNR sponsored database at http://www.ecochem.net/FoxRiverDatabaseWeb/default.asp, downloaded July 1999, as cited in U.S. FWS and Stratus Consulting (1999e).

Birds

PCBs have been measured in the eggs, adults, or chicks of over 25 bird species collected throughout the Lower Fox River/Green Bay ecosystem. These species include birds from all trophic levels, including waterfowl and predatory species, and PCB concentrations in assessment area birds are consistently higher than concentrations in reference area birds. For example, mean assessment area PCB concentrations are up to approximately eight times greater than reference area concentrations for double-crested cormorant, black-crowned night heron, and bald eagle. PCB concentrations in other species are two to fives times greater in the assessment area than in reference areas. (U.S. FWS and Stratus Consulting, 1999b).

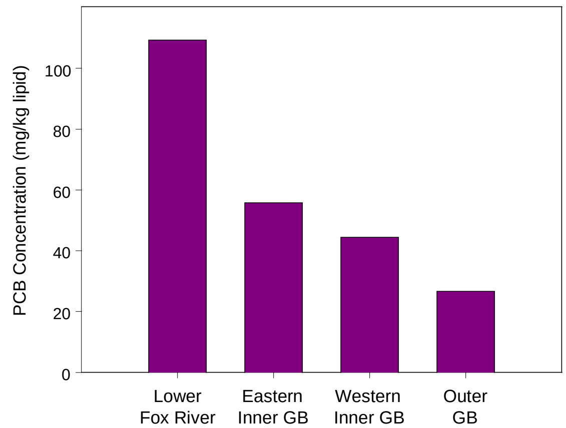

Figure 2.10. Decreases in walleye PCB concentrations with distance from PCB sources, 1989-1990.

Temporal trends of PCB concentrations in Big Sister Island herring gull eggs collected from 1971 to 1997 are shown in Figure 2.11. PCB concentrations in Lower Fox River/Green Bay herring gull eggs were highest in the 1970s, when the herring gull PCBs concentrations were first measured, and declined through the mid-1980s after the PCB releases from Lower Fox River paper companies ceased. Since the mid-1980s, concentrations have stabilized or are declining at a much slower rate than previously (U.S. FWS and Stratus Consulting, 1999b).

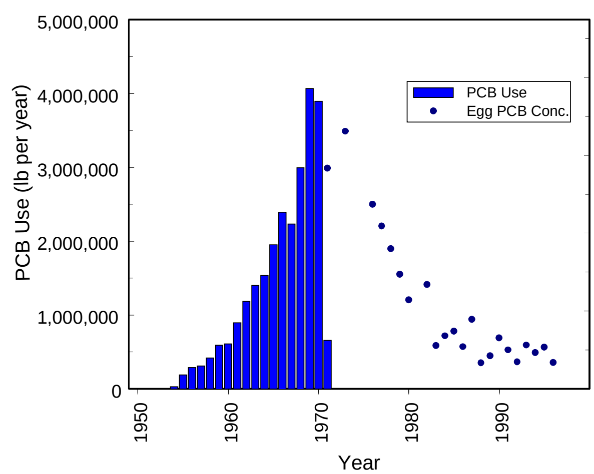

Figure 2.11. Temporal trend in PCB use in NCR paper and PCB concentrations in Green Bay herring gull eggs. Source: U.S. FWS and Stratus Consulting (1999b).

2.2.3 Injury

The Department's regulations provide definitions of injury for natural resources. Injury to natural resources of the Lower Fox River/Green Bay was evaluated pursuant to these definitions (see Table 2.2).

Surface water resources

PCB concentrations in surface water consistently have exceeded, and continue to exceed, the U.S. EPA's Great Lakes Water Quality Guidance (GLWQC) value and the State of Wisconsin surface water quality standard of 0.12 ng/L for PCBs (U.S. FWS and Stratus Consulting, 1999d). These exceedences represent a *per se* injury according to the Department's NRDA regulations [43 CFR § 11.62(b)(1)(iii)]. Figure 2.12 compares average PCB concentrations measured in the assessment area to the injury threshold. PCB concentrations measured in every sample from every Lower Fox River location in three separate studies (GBMBS; Lake Michigan Mass Balance Study; and Blasland, Bouck & Lee data) exceed the 0.12 ng/L injury threshold. The lowest concentrations measured in these studies are consistently an order of magnitude higher than the injury threshold. Furthermore, as summarized in the following sections, fish in the assessment area are injured as a result of their exposure to PCBs in the surface water resource.

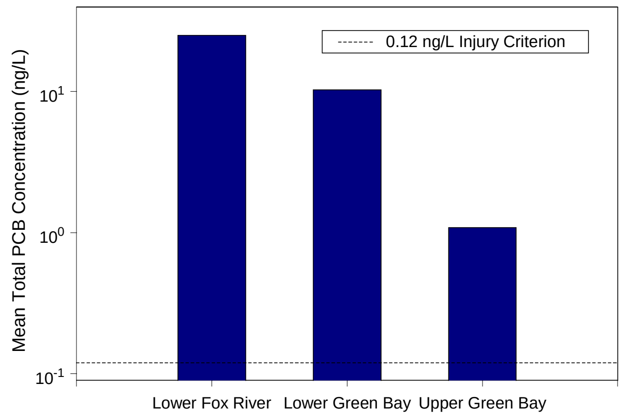

Figure 2.12. PCB concentrations in surface water compared to the 0.12 ng/L injury criterion. Source: U.S. FWS and Stratus Consulting (1999d).

Fishery resources

Fishery resources in the Lower Fox River/Green Bay are injured because of PCB fish consumption advisories, exceedences of FDA tolerances for PCBs, and adverse biological effects to walleye.

Fish consumption advisories and FDA exceedences

Wisconsin and Michigan have issued fish consumption advisories for the Lower Fox River and Green Bay Environment since 1976 and 1977, respectively, and continue to issue advisories

(U.S. FWS and Stratus Consulting, 1998, 1999c). Therefore, fish are injured according to the Department's NRDA regulations [43 CFR § 11.62(f)(1)(iii)]. Advisories have been issued by Wisconsin for 15 species in the Lower Fox River and by Wisconsin or Michigan for more than 20 species in Green Bay and northern Lake Michigan. The species, spatial and temporal extent, and degree of fish consumption advisory injuries for Lower Fox River/Green Bay fish are summarized in Tables 2.3 and 2.4. Advisories for carp, brown trout, lake trout, and rainbow trout have continued since the inception of the advisory program, and many other species, including walleye, chinook salmon, splake, white bass, and coho salmon, have been under advisories for the last 10 or more years. (U.S. FWS and Stratus Consulting, 1998, 1999c).

Table 2.3. Summary of fish species in the Lower Fox River for which PCB consumption advisories have been issued by Wisconsin, 1976-1999.

	1976-1977	1978-1983[a]	1984-1986	1987-1994	1995-1996	1997-1999
Black crappie		•				•
Bluegill		•				•
Bullhead		•		•	•	
Carp	•	•	•	•	•	•
Channel catfish		•		•	•	•
Drum		•		•	•	
Northern pike		•	•	•	•	•
Rock bass		•				•
Sheepshead		•				•
Smallmouth bass		•				•
Walleye		•	•	•	•	•
White bass		•	•	•	•	•
White perch		•				•
White sucker		•		•	•	•
Yellow perch		•				•

• = Consumption advisory (either "no consumption" or "limit consumption") issued. A blank cell means no advisory was issued.

a. From 1978 to 1983, a "limit consumption" advisory was issued for all species in the Lower Fox River.

Source: U.S. FWS and Stratus Consulting (1999c).

Exceedences of the FDA tolerance level for PCBs in edible fish tissue have been documented since 1971 in Green Bay and since 1975 in the Lower Fox River. This also constitutes an injury to fishery resources [43 CFR § 11.62(f)(1)(ii)]. The spatial extent of the exceedences of the FDA tolerance level in edible fish tissue includes all of the Lower Fox River and Green Bay. The FDA tolerance was exceeded in 13 species in the Lower Fox River and 23 species in Green Bay.

Table 2.4. Summary of fish species in Green Bay for which PCB consumption advisories have been issued by Wisconsin or Michigan, 1976-1999.

	1976-1977	1978-1983	1984-1986	1987-1994	1995-1996	1997	1998	1999
Brook trout	•	•	•	•	•	•		
Brown trout	•	•	•	•	•	•	•	•
Bullheads		•						
Burbot								
Carp	•	•	•	•	•		•	•
Catfish		•	•			•	•	•
Chinook salmon	•	•	•	•	•	•	•	•
Coho salmon	•	•	•					
Lake trout	•	•	•			•	•	•
Lake whitefish			•					
Longnose sucker								•
Northern pike			•	•	•	•	•	•
Rainbow trout	•	•	•	•	•	•	•	•
Smallmouth bass			•			•	•	•
Splake				•	•	•	•	•
Sturgeon				•	•	•	•	•
Walleye			•	•	•	•	•	•
White bass			•	•	•	•	•	•
White perch						•	•	•
White sucker			•	•		•	•	•
Whitefish		•				•	•	•
Yellow perch						•	•	•

• = Consumption advisory (either “no consumption” or “limit consumption”) issued. A blank cell means no advisory was issued.

Note: The table excludes advisories issued by Michigan for mercury only.

Source: U.S. FWS and Stratus Consulting (1999c).

Adverse health effects

In 1996 and 1997, the Service conducted a study of health effects on Lower Fox River/Green Bay walleye (see U.S. FWS and Stratus Consulting, 1999c). Health parameters assessed included liver tumors and pre-tumors, immunological responses, infections, and physiological responses. Lower Fox River/Green Bay walleye were found to be injured as a result of increased incidence of liver tumors and pre-tumors. Of the assessment area fish aged 5-8 years (the only age bracket for which sufficient data from both assessment and reference areas are available for comparison), 26% had liver tumors or pre-tumors compared with 6% of reference area fish. Assessment area fish also had higher concentrations of PCBs in the liver. The mean total PCB concentration across all assessment area sampling locations was 4.56 µg/g (sd = 2.62), compared to 0.460 µg/g (sd = 0.60) in reference areas (Figure 2.13).

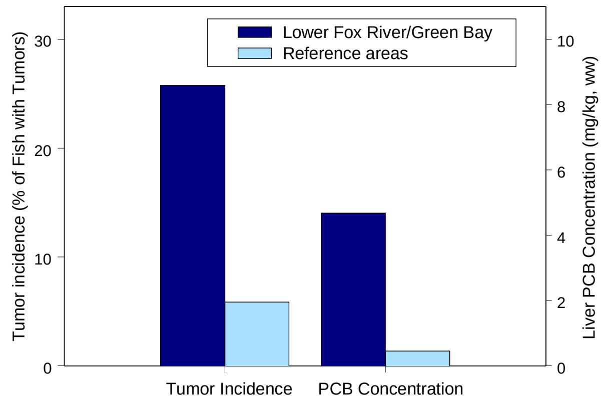

Figure 2.13. Incidence of liver tumors or pre-tumors and liver PCB concentration in walleye. Source: U.S. FWS and Stratus Consulting (1999c).

The Co-trustees also conducted studies on brown trout health and the reproductive failure of lake trout populations in Green Bay and Lake Michigan. Brown trout were analyzed for various health endpoints, including cancer and physiological malfunction. The lake trout investigation included laboratory analysis of the interactions of thiamine, PCBs, and other dioxin-like compounds in causing lake trout embryomortality. Based on these investigations, the Co-trustees concluded that currently available evidence does not support a determination of biological injury to these species (other than consumption advisories).

Avian resources

Waterfowl in the Lower Fox River/Green Bay ecosystem are injured as a result of waterfowl consumption advisories and exceedences of FDA tolerances for PCBs, and Forster's terns, common terns, double-crested cormorants, and bald eagles have suffered adverse toxicological as a result of exposure to PCBs (U.S. FWS and Stratus Consulting, 1999b).

Waterfowl consumption advisory injuries

A consumption advisory for mallards from the Lower Fox River and inner Green Bay was issued by the WDNR and the Wisconsin Division of Health in 1987 and remains in effect. Waterfowl in the Lower Fox River and inner Green Bay are also injured as a result of PCB accumulation in edible bird tissues in excess of the FDA tolerance [43 CFR § 11.62(f)(1)(ii); 43 CFR § 11.62(f)(1)(iii)]. Figure 2.14 shows the areas covered by the consumption advisory. Among waterfowl samples collected by the Service in 1997, PCB concentrations exceeded the FDA tolerance in 8 of 10 mallards and in 18 of 38 diving ducks, including samples of scaup, common goldeneye, bufflehead, red-breasted merganser, and ruddy duck.

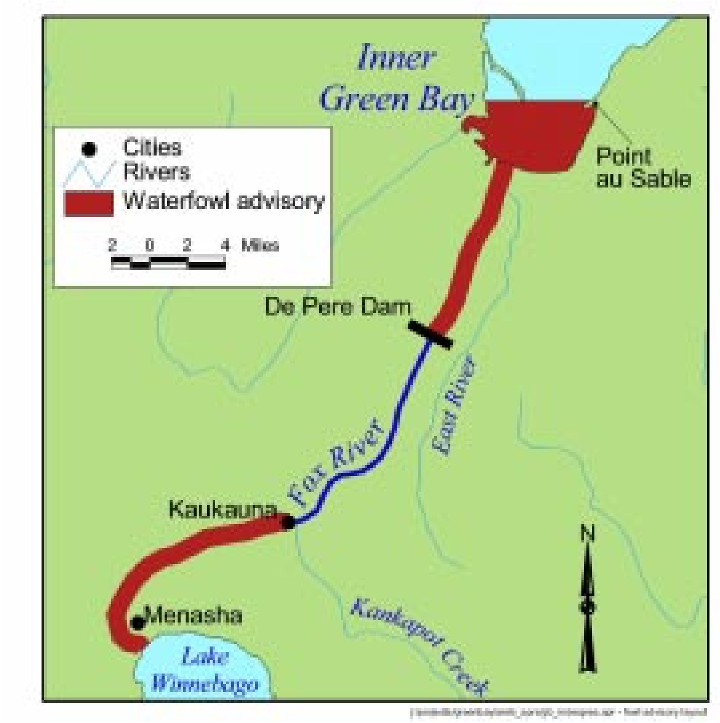

Figure 2.14. Areas covered by the Wisconsin waterfowl consumption advisory.

Adverse health effects

Forster's terns, common terns, double-crested cormorants, and bald eagles have suffered adverse toxicological effects that were most likely a result of PCB exposure in the assessment area. Numerous studies have been conducted on the adverse effects to Green Bay birds resulting from exposure to and accumulation of PCBs. Although some of the studies were inconclusive, many of the species evaluated have been injured according to the Department's regulations [43 CFR § 11.62(f)(1)(iii)] as a result of exposure to PCBs. The available data and thereby the Co-trustees' evaluation are limited to only a small subset of the Lower Fox River and Green Bay bird species.

Terns are colonially-nesting birds that consume fish as a large portion of their diet. Tern species that nest in Green Bay are common tern, Forster's tern, and Caspian Tern, all of which are listed as endangered species by the State of Wisconsin. Green Bay Forster's terns have been documented to have embryonic deformities, skeletal deformities, edema, and reduced reproductive rates resulting from exposure to PCBs (U.S. FWS and Stratus Consulting, 1999b).

Figure 2.15 compares the hatching success and egg PCB concentrations of Forster's terns from Green Bay and reference areas. Common terns in Green Bay have suffered from increased deformity rates compared to reference area terns, as shown in Figure 2.16, and may have also had reduced hatching success. Although field studies on Caspian terns are not as conclusive, one study found reduced reproduction and higher rates of deformities in Green Bay Caspian terns relative to terns from reference locations.

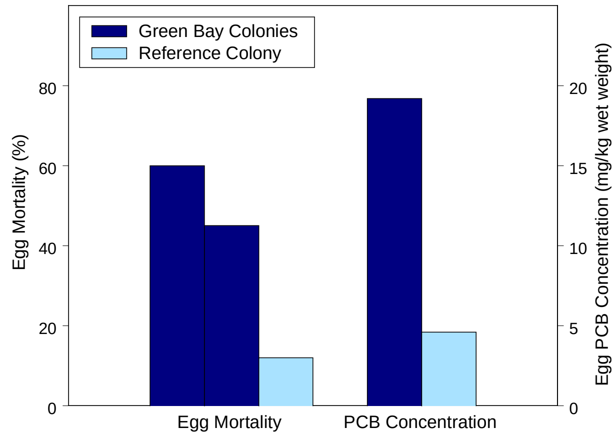

Figure 2.15. Egg mortality and PCB concentrations in Forster's terns. Source: U.S. FWS and Stratus Consulting (1999b).

PCBs have also most likely caused reduced reproductive success and embryonic deformities in Green Bay double-crested cormorants (U.S. FWS and Stratus Consulting, 1999b). Bill deformity rates among cormorant embryos and nestlings in the assessment area are higher than background rates, but the evidence for other types of deformities such as edema and hemorrhaging is not as conclusive. The deformities are believed to be caused by PCBs. Available evidence suggests that both PCBs and DDE have contributed to reduced hatching observed among Green Bay cormorants (U.S. FWS and Stratus Consulting, 1999b).

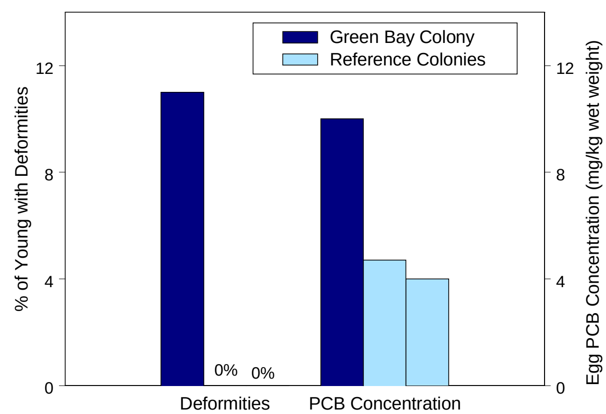

Figure 2.16. Incidence of deformities among Common tern embryos/hatchlings and egg PCB concentrations. Source: U.S. FWS and Stratus Consulting, 1999b.

Bald eagle populations in Green Bay have been studied extensively (U.S. FWS and Stratus Consulting, 1999b). PCB concentrations in bald eagle eggs and chick plasma from Green Bay are significantly higher than those in eggs and chicks from reference areas, and reproductive productivity among Green Bay bald eagles was significantly reduced relative to reference area eagles from 1974 until at least the mid-1990s. Figure 2.17 shows that reproductive productivity is reduced in bald eagles from Green Bay compared to bald eagles from inland Wisconsin. Both PCBs and DDE have most likely contributed to the reduced productivity (U.S. FWS and Stratus Consulting, 1999b).

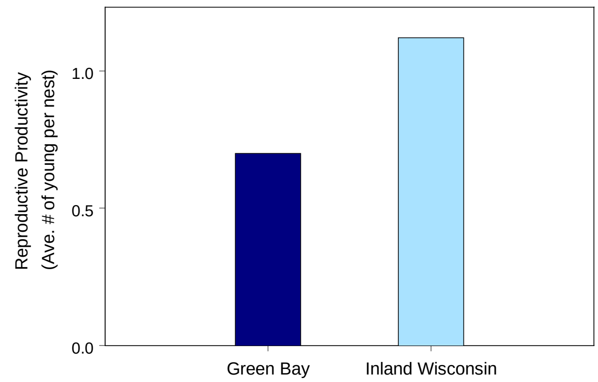

Figure 2.17. Bald eagle productivity. Source: U.S. FWS and Stratus Consulting (1999b).

Other avian species evaluated for injuries were black-crowned night heron, tree swallow, and red-breasted merganser. Although Green Bay black-crowned night herons have suffered from higher rates of deformities, the available data does not support the conclusion that PCBs caused the deformities. The Co-trustees found no evidence that tree swallows or red-breasted mergansers in the assessment area have suffered adverse health or reproductive effects from exposure to PCBs.

2.2.4 Conclusions

Releases of PCBs have resulted in injuries to natural resources throughout the Lower Fox River/Green Bay ecosystem. Table 2.5 summarizes the natural resource injuries in the assessment area and shows that the spatial extent of injuries encompasses all regions and habitats of the Lower Fox River and Green Bay. Natural resource injuries have been documented in aquatic and shoreline habitats throughout the assessment area. Injury to aquatic habitats of Green Bay tributaries, Little and Big Bays de Noc, and Lake Michigan has also occurred through fish consumption advisories in these locations. Natural resource injuries most likely began occurring as early as the mid-1950s, when PCBs were first released from Lower Fox River paper companies, although data on PCB concentrations in the environment were not available until the 1970s. Injuries to fishery, avian, and surface water resources continue to the present, because the environmentally persistent PCBs continue to be recycled through the sediments, surface water, and all levels of the diverse Lower Fox River/Green Bay food web.

Table 2.5. Summary of natural resource injuries.

Resource		Lower Fox River: Aquatic habitat	Lower Fox River: Shoreline habitat	Inner and outer Green Bay: Aquatic habitat (near shore and open water)	Inner and outer Green Bay: Shoreline habitat (wetlands, shores, and islands)	Other aquatic habitats: Green Bay tributaries[a]	Other aquatic habitats: Little and Big Bays de Noc	Other aquatic habitats: Lake Michigan[b]
Surface water resource (includes sediment)		Water quality criteria/standard exceedences	-	Water quality criteria/standard exceedences	-			
Fishery resource	Forage fish	FCAs,[c] exceedence of FDA tolerance level	-	FCAs,[c] exceedence of FDA tolerance level	-	FCAs[c]	FCAs[c]	FCAs[c]
	Game fish	Walleye tumors, FCAs,[c] exceedence of FDA tolerance level		Walleye tumors, FCAs,[c] exceedence of FDA tolerance level	-	FCAs[c]	FCAs[c]	FCAs[c]
Avian resource	Piscivorous birds	-		-	Forster's tern reproduction and deformities, common tern reproduction, cormorant reproduction	-	-	-
	Omnivorous birds	-	Bald eagle reproduction	-	Bald eagle reproduction	-	-	-
	Waterfowl	WCAs,[d] exceedence of FDA tolerance level		WCAs,[d] exceedence of FDA tolerance level				

a. Includes Duck Creek, Oconto River, Peshtigo River, Menominee River, Cedar River, and other tributaries.

b. Includes Lake Michigan north of Frankfurt, Michigan, and Wisconsin waters of Lake Michigan and its tributaries up to the first dam, including the Root River, Milwaukee River, Sheboygan River, Manitowoc River, and Kewaunee River.

c. FCA = Fish consumption advisory.

d. WCA = Waterfowl consumption advisory.

- = Not Applicable

2.3 Injury Quantification

2.3.1 Purpose and quantification approach

The previous section of this chapter presented a summary of natural resource injuries to the Lower Fox River/Green Bay ecosystem. This section summarizes the quantification of those injuries.

The purpose of injury quantification is for use "in determining the appropriate amount of compensation" in a damage assessment [43 CFR § 11.70(b)]. Quantification can be expressed in terms of the extent to which the natural resource has been injured [43 CFR § 11.71(b)(1)] or by directly measuring changes in services[1] provided by natural resources when:

- the change in the services from baseline can be demonstrated to have resulted from the injury to the natural resource
- the extent of change in the services resulting from the injury can be measured without also calculating the extent of change in the resource
- the services to be measured are anticipated to provide a better indication of damages caused by the injury than would direct quantification of the injury itself [43 CFR § 11.71(f)].

The Co-trustees have quantified injuries to natural resources both in terms of direct quantification of the extent of injury to natural resources themselves, and in terms of quantification of human services.

Extent of injury to natural resources

Quantification of the extent of injury to natural resources includes the spatial and temporal extent of injury as well as the degree to which natural resources were injured. Section 3.2 and the individual injury reports cited in that section provide detailed information on the extent of injury.

Surface water resources have been injured throughout the Lower Fox River, from Little Lake Butte des Morts to the mouth and throughout the entire waters of Green Bay. Injuries to surface water resources continue to the present.

1. "Services" are the physical and biological functions performed by natural resources, including the human uses of those functions [43 CFR § 11.14 (nn)].

Fishery resource injuries include fish consumption advisory injuries and physiological impairments to walleye. The extent of fish consumption advisory injuries is presented in U.S. FWS and Stratus Consulting (1998). Fish consumption advisories are in place throughout the Lower Fox River and Green Bay. Physiological impairments to walleye are described as the frequency of impairments in Lower Fox River/Green Bay walleye relative to reference locations. Liver pre-tumors and tumors occurred in 26% of assessment area fish aged 5-8 years, the only age range with sufficient data for comparison, compared to 6% of reference area fish. This difference was more dramatic in females, with 34% of assessment area females having liver tumors or pre-tumors versus 7% of reference area females. Although physiological impairment injuries were observed throughout the Lower Fox River and Green Bay and were observed in both 1996 and 1997, the full spatial and temporal extent of these injuries is not known with specificity.

Injuries to bird resources include both waterfowl consumption advisory injuries and biological injuries. Waterfowl consumption advisories injuries are present in the Lower Fox River. Adverse health effects, including reduced reproduction and physical deformities, have been documented in several piscivorous species such as bald eagle and Forster's tern in the Lower Fox River and Green Bay Environment. Injuries to bald eagles, which nest along the length of the western shore and on the northern shore of Green Bay, were documented on a bay-wide basis. Injuries to colonial nesting birds were found in nesting sites throughout Green Bay, primarily on islands and other sites located along the eastern and southern shorelines.

Baseline conditions

Baseline conditions are those conditions that would be expected to occur in the assessment area absent the releases of PCBs [43 CFR § 11.14(e)]. Baseline conditions are reflected by conditions observed in reference or control areas, and by consideration of conditions in the Fox River/Green Bay ecosystem without PCBs. The baseline condition for natural resources in the assessment area has been determined by the Co-trustees to be as follows:

- Surface water resources would not exceed water quality criteria and standards for PCBs and would not serve as a PCB transport or exposure pathway to other resources.
- Sediment resources would not contain elevated concentrations of PCBs and therefore would not act as a PCB transport or exposure pathway to other resources.
- Fish would not be contaminated with PCBs and fish consumption advisories would be eliminated; FDA tolerances for PCBs would not be exceeded.
- Walleye would have substantially lower levels of liver tumors and pre-tumors, consistent with those observed at reference locations.

- Waterfowl would not be contaminated with PCBs and, as a result, consumption advisories would be eliminated.
- Bird reproduction and health would not be impaired as a result of exposure to PCBs and would be similar to reference levels.

Direct quantification of services

As described in greater detail in Chapter 3, the Co-trustees used the direct quantification of services approach [43 CFR § 11.71(f)] as the primary injury quantification method in scaling the preferred restoration alternative. The direct quantification of services approach involved the application of a total value equivalency study to establish the scale of restoration actions necessary to provide equivalent natural resource services to the public as compensation for injuries to natural resources. The total value equivalency approach, described in Section 3.2.4, therefore represents a direct measure of services lost by the public.

2.3.2 Resource recoverability

Another aspect of the injury quantification phase is the resource recoverability analysis, which involves estimating the time needed for injured natural resources to recover to baseline levels [43 CFR § 11.73(a)]. The analysis includes determination of the recovery period if no restoration actions beyond response actions are conducted [43 CFR § 11.73(a)]. The length of time required for resources to return to baseline is an important component of the restoration plan described in Chapter 3, because the amount of restoration required is dependent in part on how long recovery would take absent any restoration beyond the response action. This resource recoverability analysis considers resource recoverability under response actions ranging from no further action to the intensive cleanup of PCB-contaminated sediments.

PCBs are persistent in the environment, and once released into a waterbody have a strong affinity for sediment (Erickson, 1997). The dominant mechanism of PCB loss from the Lower Fox River and Green Bay Environment, as well as other similar aquatic systems, is sediment burial (DePinto et al., 1994). PCBs can also be lost through volatilization and transport via air currents or through water flow into Lake Michigan, but the mass of PCBs removed from the system via these processes is much smaller than the mass of PCBs in the sediment (DePinto, 1994). Similarly, although PCBs can be degraded by microbial communities under some environmental conditions (see, e.g., Brown and Wagner, 1990; Flanagan and May, 1993), microbial degradation is much slower for PCBs than for most other organic compounds (Erickson, 1997). Evidence suggests that degradation of PCBs in sediment slows dramatically below approximately 30 mg/kg (U.S. EPA, 1997), which is well above the PCB concentration in sediments throughout Green Bay and most of the Lower Fox River. Detailed measurements of PCB dechlorination in the Hudson River, a site contaminated with PCBs similar to those in the Lower Fox River and Green Bay, show that PCB degradation has reduced the mass of PCBs present in the river sediment by less than 10%, and that the remaining PCBs will most likely not be significantly further degraded (U.S. EPA, 1997).

As PCBs adhered to sediment particles become deposited on the bottom of the river or bay, they can become covered with cleaner sediment that enters the system. However, PCBs buried in sediment can be periodically re-released through sediment erosion, such as can occur during storm events. Evidence suggests that the sediment bed of the Lower Fox River shifts dramatically over small spatial and temporal scales, exposing sediment in some areas and depositing new sediment over others (WDNR, 1999c). Thus, although sediment burial is the primary long-term loss mechanism of PCBs, some buried PCBs may still be accessible, resulting in periodic increases in biota exposure to PCBs.

An examination of the past rate of PCB decline in the Lower Fox River and Green Bay Environment can provide insight into the future rates of decline that can be expected if no sediment remediation occurs. Concentrations measured in birds, fish, and sediment (via sediment cores) are consistently highest in the early 1970s (although there are no fish or bird tissue data prior to this time period) and have declined since then, coinciding with decreases in PCB releases from paper company facilities (U.S. FWS and Stratus Consulting, 1999e). However, the rate of decline has not been constant in all environmental media since the early 1970s. An analysis of PCB temporal trends in Green Bay fish conducted by the Co-trustees shows the following (U.S. FWS and Stratus Consulting, 1999e):

- PCB concentrations show a stronger and more consistent decline in forage fish (e.g., yellow perch and perhaps alewife) than in predator fish (walleye and brown trout). Possible explanations for this difference include shifts in walleye and brown trout diet over time, and increased “lag time” for the reductions in PCBs to be detectable in the longer lived predatory species.

- PCB concentration declines in fish are more prominent in inner Green Bay than in outer Green Bay. A possible explanation for this trend is that the signal of decreased PCB loadings from the Lower Fox River may take longer to reach the portions of the bay that are farther from the river.

- Except in the innermost portion of the bay, PCB concentrations do not show a decline between 1989 and 1996. This conclusion is based on a comparison of fish PCB data from the same fish species collected in similar locations and analyzed using similar methods.

Thus the rate of PCB decline in the Lower Fox River and Green Bay Environment appears to be slowing. Detailed studies of PCB concentrations in Lake Michigan fish (for which much more data are available than for Green Bay alone) show a similar temporal pattern of higher rates of decrease in the late 1970s and early 1980s, and much lower rates of decrease since then (Stow et al., 1995; Stow et al., 1999). These results are also consistent with a recent analysis conducted as part of the RI/FS, which concluded that trends in fish PCB concentrations in the Lower Fox River and inner Green Bay are highly variable, and that future trends cannot be predicted reliably (Mountain Whisper Light Statistical Consulting and ThermoRetec Consulting, 2000). Given the evidence for a decreasing rate of PCB decline, along with uncertainties regarding how the Lower Fox River and Green Bay Environment will respond to large storm events or other unusual processes in the future, it is not likely that the PCB declines observed in the 1970s and 1980s, immediately after PCB releases were dramatically reduced, will continue into the future.

Therefore, if no or limited sediment PCB cleanup actions are conducted, the time required for resource recovery to baseline is expected to be very long. PCB fate and transport models developed as part of the Green Bay Mass Balance Study indicate that absent PCB cleanup, the natural recovery period for the Lower Fox River and Green Bay Environment is 90 to 100 years or more (Patterson et al., 1994; WDNR and Bureau of Watershed Management, 1997).

Response actions are likely to reduce the resource recovery time. Removal of PCB-contaminated sediments can rapidly reduce PCB concentrations in the river and decrease PCB loadings carried by the river into Green Bay. However, given the large mass of PCBs already in Green Bay, response actions focused on the Lower Fox River cannot directly address recoverability of bay resources, but can only reduce the amount of new PCBs being contributed to the bay. The Green Bay Mass Balance Study models indicate that even under intensive remediation of PCB-contaminated sediments in the Lower Fox River, recovery will take 20 years or more for the Lower Fox River and much longer for Green Bay as a whole (WDNR and Bureau of Watershed Management, 1997).

Once the response action remedy is selected, the Co-trustees will conduct a final resource recoverability analysis as part of developing the final claim. The magnitude of the final claim depends on the scale of resource restoration required, and the restoration scale is dependent in part on the length of time required for recovery following the response action. To determine the post-remedy recovery period, the Co-trustees will evaluate relevant information from the RI/FS, such as an alternative-specific risk assessment of residual injuries, any mass balance modeling results, or the evaluation of the long-term effectiveness of the selected remedy. The Co-trustees may also review or evaluate similar or other PCB fate and transport models that are available for predicting future PCB concentrations in the Lower Fox River and Green Bay Environment under different cleanup scenarios. Under even an intensive PCB cleanup scenario, the recovery period is not expected to be less than 20 years for Lower Fox River resources and somewhat longer for Green Bay resources. Recovery periods under lesser amounts of PCB cleanup will be longer, with periods under a no action cleanup alternative being 100 years or more.

3. Restoration and Compensable Value Determination

Chapter 2 described the natural resource injuries in the Lower Fox River and Green Bay Environment that have resulted from Lower Fox River PCB releases. This section of the RCDP describes the approach and results of the Co-trustees' determination of the restoration and compensable value damages necessary to address the natural resource injuries.

3.1 Overview of Restoration and Compensable Value Determination Approach

As described in the iRCDP, a damage determination is intended to establish the amount of money to be sought in compensation for injuries to natural resources resulting from a . . . release of a hazardous substance [43 CFR § 11.80 (b)]. The measure of damages is defined as *restoration costs* plus, at the discretion of the Co-trustees, *compensable values for interim losses* [43 CFR § 11.80 (b)].

Restoration can be accomplished by restoring or rehabilitating resources or by replacing or acquiring the equivalent of the injured natural resources and their service flows. Restoration should be distinguished from *remediation* or *response actions* being considered by the U.S. EPA and the WDNR pursuant to CERCLA or the NCP. The cost of the response action is not included in a damage claim.

Compensable values include the value of lost public use of the services provided by the injured resources [43 CFR § 11.83 (c)(1)]. Under CERCLA, the compensable values for interim services lost to the public (interim losses) accrue from the time of discharge or release or 1980, whichever is later, until restoration is complete [see 43 CFR § 11.80 (b)]. Under the CWA, damages accrue from 1976 [33 U.S.C. § 1321(f)(5)].

The Co-trustees' selected restoration and compensation determination (RCD) approach involves two components:

1. *Recreational fishing damages determination.* This component involves determining monetary damages from injuries to fishery resources associated with the imposition of fish consumption advisories (FCAs) as a result of PCB contamination. The recreational fishing damages are the compensable values for the loss of recreational fishing services to the public. Other natural resource injuries and service losses are not included in this

component of the Co-trustees' damage assessment. A detailed description of the recreational fishing damage determination is presented in Section 3.3.

2. *Restoration planning and cost analysis.* This component involves selecting a preferred alternative for restoration of natural resources and estimating costs associated with implementing the preferred alternative. The restoration planning analysis addresses multiple natural resource injuries and service losses, rather than focusing solely on recreational fishing. Section 3.2 describes in detail the restoration determination approach employed by the Co-trustees, and the results.

In applying this approach, the Co-trustees have decided to apply the recreational fishing damages determination to quantifying compensable values for past interim loss damages, whereas the restoration planning analysis is applied to current and future losses. This approach is designed to avoid double counting of damages. Double counting can occur when damages have been counted more than once in the assessment [43 CFR §11.84 (c)(1)]. Because the two components of the RCD approach, compensable values and restoration, address different, nonoverlapping time periods, the Co-trustees' assessment avoids double counting. Another aspect of avoiding double counting is ensuring that any beneficial effects of response actions are taken into consideration by the Co-trustees [43 CFR §11.84 (c)(2)]. As noted in the iRCDP, response actions undertaken by the WDNR, U.S. EPA, and the responsible parties are likely to benefit natural resources and improve natural resource services. The Co-trustees have accounted for the potential effects of response actions by incorporating natural resource recovery rates into the restoration alternatives scaling approach, as described in greater detail in Section 3.2.5. To the extent that response actions result in more rapid recovery of natural resources, restoration actions are more limited; to the extent that recovery is more protracted, the scale of restoration actions is increased. Moreover, the scale of restoration measures will not be finalized until after selection of a final remediation plan for the Fox River basin and publication of a Record of Decision by WDNR and the U.S. EPA.

3.2 Restoration Determination

3.2.1 Restoration plan overview

As discussed in greater detail below, the Co-trustees' restoration plan will involve several component actions. These component actions include a mix of wetland restoration and wetland preservation to protect and enhance important habitats for fish, birds, and other natural resources, and farmland conservation tillage and vegetated buffer strip installation to reduce nonpoint source runoff into Green Bay and thereby improve water and habitat quality. These actions will improve the environmental quality and ecological and human use services of the Lower Fox

River and Green Bay Environment and thereby will accelerate the return to baseline services and compensate for the PCB injuries from now until the injuries no longer occur.

In addition to the above actions that address acceleration of the return to baseline and future compensable values, past compensable value damages (associated with the recreational fishing damages, as described in Section 3.3) will also be used for restoration activities. However, the compensable value damages will not be applied to achieve the restoration that addresses future injuries. Instead, past compensable value damages will be used to provide: (1) enhancement of recreational fishing opportunities, (2) additional restoration actions consistent with the Co-trustees' stated restoration objectives, and (3) funding for any future proposals for additional restoration actions, consistent with overall restoration planning objectives. Thus, restoration will be funded by both the recovered costs to restore resources (which includes acceleration of the return to baseline and future compensable values) and the recovered past compensable value damages.

A central element of the Co-trustees' conceptual restoration plan is ensuring that the overall plan addresses the full geographic and ecological scope of the injuries to natural resources. Therefore, in developing their final restoration plan, the Co-trustees will ensure that restoration activities:

- address the entire Fox River/Green Bay region, from Little Lake Butte des Morts in the south to the Bay des Nocs in the north
- encompass the unique range of habitats in the Green Bay region, including the aquatic habitat of the bay itself, the coastal wetlands on the west shore to the rich riverine habitats that connect to the bay, and the valuable ecological habitats of the Door Peninsula and the Bays des Noc
- provide for long-term recovery, protection, and enhancement of the unique natural resource endowment of the Green Bay ecosystem
- consider human uses of the natural environment to provide for ongoing and long-term active and passive uses of Green Bay natural resources.

The restoration plan described here was developed using the following steps, as described in the following sections. First, three fundamental restoration alternatives were identified and considered. The Co-trustees then selected their preferred alternative. The preferred alternative was then further clarified with the identification of a set of component actions that constitute the preferred alternative. The methods for scaling the components, estimating the benefits and costs of the components, and combining the components into a single, coherent plan were then developed.

3.2.2 Restoration alternatives considered by the Co-trustees

The following three overall restoration alternatives were considered by the Co-trustees:

1. *No Action-Natural Recovery.* This alternative must be considered by the Co-trustees [43 CFR §11.84 (c)(2)]. The No Action alternative assumed that no restoration, replacement, acquisition, or resource enhancement activities would be undertaken.

2. *PCB Cleanup.* The PCB Cleanup alternative includes actions involving removal of PCBs from the Lower Fox River and Green Bay Environment. PCB removal was considered because (1) PCB removal from sediments will speed recovery of natural resources and their services to baseline (Patterson et al., 1994), and (2) PCB declines in Green Bay fish and wildlife have slowed from the 1980s to present (Stow et al., 1995; U.S. FWS and Stratus Consulting, 1999e; Mountain Whisper Light Statistical Consulting and ThermoRetec Consulting, 2000), suggesting that natural recovery alone will not sufficiently address PCB injuries to natural resources.

3. *Resource-Based Restoration Projects to Provide Enhanced Ecosystem Services.* The Resource-Based Restoration alternative involves restoration projects that would not directly remove PCBs from the system but would, rather, provide enhanced ecosystem services as compensation for losses caused by PCBs. Resource-based restoration projects include activities such as wetland restoration or preservation, which would provide habitat for fish and wildlife species; nonpoint source runoff control, which would improve water quality, aquatic habitat, and human recreational services; and direct resource restoration projects, such as projects designed to improve bald eagle reproduction.

3.2.3 Selection of the preferred alternative

Co-trustees' evaluation and selection of the preferred alternative relied on factors identified in the Department's NRDA regulations [43 CFR §11.84(d)]:

1. technical feasibility
2. the relationship of the costs of the alternative to the expected benefits
3. cost-effectiveness
4. the results of actual or planned response actions
5. the potential for additional injury resulting from the proposed actions
6. the natural recovery period
7. ability of the resources to recover with or without alternative actions
8. potential effects of the action on human health and safety

9. consistency with relevant federal, state, and tribal policies
10. compliance with applicable federal, state, and tribal laws.

This section of the RCDP summarizes the Co-trustees' selection of the preferred restoration alternative.

No Action-Natural Recovery. The No Action alternative was not selected by the Co-trustees as their preferred alternative. Although the No Action alternative is technically feasible, would not cause incremental injuries, would not impose incremental effects on human health and safety, and is consistent with applicable laws, the Co-trustees rejected the No Action alternative for the following reasons:

- It would not restore injured natural resources or compensate the public for current, ongoing natural resource injuries.

- Estimates of natural recovery periods, without additional remediation, are 90 to 100 years or more (Patterson et al., 1994; WDNR and Bureau of Watershed Management, 1997, 1997). Even under intensive remediation scenarios, natural resource injuries are projected to continue for some 20 years in the Lower Fox River and inner Green Bay, and much longer for Green Bay as a whole (WDNR and Bureau of Watershed Management, 1997). Therefore, the No Action alternative does not adequately compensate the public for natural resource injuries and offers no public benefits.

PCB Cleanup. As noted previously, the WDNR and U.S. EPA are currently engaged in performing a Remedial Investigation/Feasibility Study (RI/FS) for the Lower Fox River and Green Bay. At this time, the Co-trustees' evaluation of restoration alternatives assumes that the response agencies will adequately address PCB cleanup. Criteria used by the response agencies to select remedial alternatives under CERCLA include technical feasibility, cost-effectiveness, effects on human health and safety, and compliance with relevant laws (U.S. EPA, 1988). The Co-trustees anticipate that further PCB removal, beyond that selected as part of the CERCLA response, is unlikely to pass the NRDA's feasibility and cost-effectiveness criteria and therefore would be unnecessary and inappropriate. For example, the cost to dredge the estimated 465 million cubic yards of Green Bay sediment estimated to be contaminated with PCBs above a concentration of 50 μg/kg (ThermoRetec Consulting and Natural Resource Technology, 2000) is approximately $111 billion, based on an average cost for remedial dredging projects of $238 per cubic yard (Cushing, 1999). Therefore, the Co-trustees do not intend to pursue the PCB removal alternative at this time. However, the Co-trustees wish to emphasize that this alternative will be reexamined following publication of the Record of Decision by WDNR and the U.S. EPA. To the extent that the Co-trustees believe that insufficient PCB removal is being conducted, the Co-trustees may reconsider PCB removal and/or immobilization actions.

Resource-Based Restoration. Resource-Based Restoration actions were determined by the Co-trustees to be the preferred alternative. Such restoration actions are known to be technically feasible, can provide beneficial natural resource services, are more cost-effective than either No Action or additional PCB removal (beyond that performed by response agencies), will not cause additional injury, can provide enhanced natural resource services to compensate for ongoing service losses, and can be designed in compliance with applicable laws and policies. However, the Co-trustees note that many different types of actions can be implemented within this alternative. Therefore, to further ensure compliance with NRDA evaluation criteria [43 CFR § 11.84 (d)], the Co-trustees engaged in additional, detailed evaluation of individual resource restoration approaches and projects in an iterative manner. This more detailed evaluation is presented in the following sections.

3.2.4 Development of the preferred alternative

Having selected Resource-Based Restoration as the preferred alternative, the Co-trustees then worked to define the specific types of projects that would constitute the preferred alternative. The process used by the Co-trustees to develop the types of projects that constitute the preferred alternative takes into account the following two facts:

- An extensive amount of resource-based restoration planning has already been conducted for the Green Bay area by a variety of government agencies and private organizations. Cumulatively, these planning efforts reflect the types of restoration projects, if not the actual projects, that best address the stresses and resulting impacts that the resources of the Lower Fox River and Green Bay are under. Thus, these previous planning efforts provide the Co-trustees with a foundation for evaluating the resource-based restoration needs of the area.

- The NRDA restoration planning objectives and limitations are likely to be different than those of the previous planning processes. Therefore, the Co-trustees will apply NRDA criteria and factors specified in the NRDA rule to the extensive planning work already conducted by other parties.

Figure 3.1 summarizes the process used by the Co-trustees to identify the types of preferred restoration projects. First, a database of restoration projects proposed by various government and private agencies was constructed. Second, projects that did not meet minimum NRDA acceptability criteria established by the Co-trustees were removed from further consideration. Third, the remaining individual projects in the database were grouped into categories of similar projects based on their goals and methods. The project categories were then scored against Co-trustee ranking criteria. The subsequent relative ranking of projects by their score produced a final set of restoration project types that constitute the preferred alternative: restoring selected

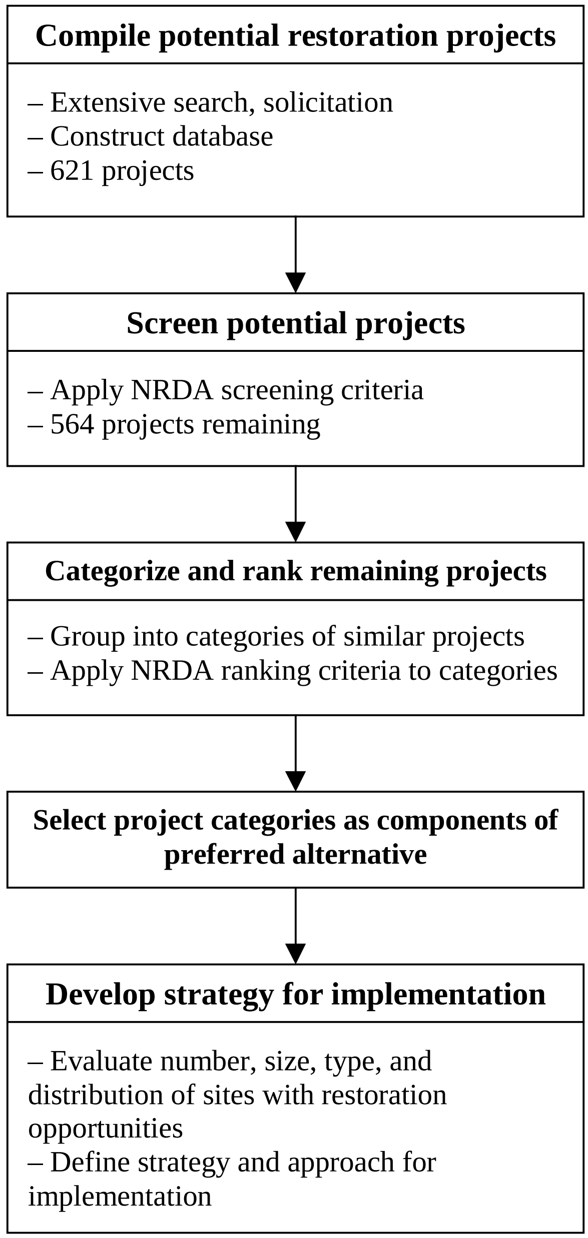

Figure 3.1. Process used by the Co-trustees to define the types of projects that comprise the preferred restoration alternative.

lost wetlands around Green Bay; preserving selected existing wetlands; and reducing nonpoint source pollution into Green Bay through both installing vegetated buffer strips along streams in agricultural areas and inducing farmers to adopt tillage practices that reduce erosion. These types of restoration actions can improve the quality of the Lower Fox River and Green Bay Environment to compensate for the losses caused by PCB injuries, as described in Section 3.2.6. Finally, the Co-trustees developed a strategy for implementing the selected project types that is based on the type, number, size, and distribution of sites that provide opportunities for restoration.

Step 1: Compiling potential restoration projects

The Co-trustees conducted an extensive search to identify the results of restoration and resource planning efforts by other organizations for the Lower Fox River and Green Bay. This search identified documents ranging in scope and level of specificity from very detailed city and county parks and recreation plans to the more general proposals in regional development, land conservation, and resource management plans. Table 3.1 presents the published sources from which projects were obtained. Of the published sources identified in this search, the *Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern* (WDNR, 1988) and the *Green Bay Habitat Restoration Workshop: Summary 1994.* (Author unknown, 1994) stand out because of the number of projects they include, the expertise of those involved in developing the projects, and their focus on addressing problems that affect the entire Green Bay ecosystem.

Table 3.1. Document sources of potential restoration project proposals used in the Co-trustees' projects database.

Document	Author (year)
Final Project Summaries of the Habitat Restoration Workgroup	Habitat Restoration Workgroup (1997a)
Green Bay Habitat Restoration Workshop: Summary 1994	Author unknown (1994)
Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	WDNR (1988)
Menominee Reservation Lake Sturgeon Management Plan	Author unknown (1995)
Potential Habitat Restoration Projects Reviews	Habitat Restoration Workgroup (1997b)

The Habitat Restoration Workgroup, which was assembled by the WDNR, also was an important source of restoration projects for the database developed by the Co-trustees. The Habitat Restoration Workgroup consisted of natural resource experts from several different agencies such as the WDNR, the Green Bay Metropolitan Sewerage District, the City of Green Bay, the University of Wisconsin — Green Bay, and the Menominee and Oneida Indian Tribes who were knowledgeable about natural resources and potential restoration actions in the Lower Fox River and Green Bay. Throughout its meetings in 1997 and 1998, the group developed and updated lists of potential restoration project proposals that were intended to provide the basis for the selection of restoration projects.

In addition to its project lists, the Habitat Restoration Workgroup produced a collection of potential restoration project written reviews. The reviews were prepared by the individual members of the workgroup to summarize projects from the lists. These reviews also provided members of the workgroup with the opportunity to present projects that had not yet been incorporated into the groupwide project lists and that the members felt should be considered. The projects described in the individual reviews and those in the project lists were both incorporated in the project database developed by the Co-trustees.

Restoration project proposals were also actively solicited by the Co-trustees from organizations. A list of the organizations that were contacted for potential restoration projects is presented in Table 3.2.

Table 3.2. Organizations contacted for potential restoration project proposals.

Brown County Land Conservation Department	Oconto County Office of Land Conservation
Brown County Park Department	Oneida Tribe of Indians of Wisconsin
Clean Water Action Council	Outagamie County Land Conservation Department
Fox River Group of paper companies	University of Wisconsin – Green Bay
Fox-Wolf Basin 2000	U.S. Army Corps of Engineers
Menominee Tribe of Wisconsin	U.S. Fish and Wildlife Service
Michigan Department of Environmental Quality	Winnebago County Land Conservation Department
The Nature Conservancy	Wisconsin Department of Natural Resources
Northeast Wisconsin Land Trust	Wisconsin Waterfowl Association

Each restoration project was entered into a database designed to simplify the tracking and categorizing of the projects. After removing duplicate records, the database contained 621 distinct potential restoration projects. The database, which is included in Appendix C, includes information such as the project description, location, what the project would attempt to achieve, how the project would achieve it, and the source(s) of information for the project. This database of projects served as the starting point for the Co-trustees' subsequent restoration planning steps.

Step 2: Screening the projects database

In the second step, the projects in the database were screened against acceptability criteria that projects must pass for them to be considered further in the NRDA planning process. These criteria, which were published in the iRCDP, were developed by the Co-trustees to aid in eliminating those projects that are clearly inconsistent with the requirements of the NRDA. In essence, the acceptability criteria stipulate that a restoration project must comply with all applicable laws and regulations, address resources or services at least broadly connected to those injured by PCBs, and be technically feasible to implement.

Table 3.3 shows the results of the project screening step. In comparing each project against each criterion, projects were assumed to meet the criterion unless the available information clearly indicated otherwise. Therefore, if available project information was not sufficient to determine whether it met a criterion, it was assumed that it did. These projects were classified as either “pass/more information,” which means the available information suggests that the project passes but more information is needed to determine with certainty, or “more information,” which means that no information is available to determine if the project passes. This approach was taken to ensure that the projects retained for further consideration encompass the full range of potentially applicable projects. Furthermore, additional information can be gathered on the projects in later steps to eliminate those projects that do not meet the criteria.

A total of 93 projects were removed from further consideration (Table 3.3). Examples of the types of projects that were eliminated in this step include:

- projects that are primarily evaluations or investigations rather than actual improvements in resources or services
- projects that enhance recreational activities that are not related to natural resources (e.g., creating historical parks, restoring band shells)
- improvements to sports parks (e.g., municipal golf courses, ball fields)
- public education programs
- controlling pollution point sources such as industrial discharges or landfill leakage.[1]

1. Controlling pollution point sources was screened out from further consideration because it did not meet the criterion of complying with all applicable laws and regulations. Since controlling pollution point sources falls under the purview of other state or federal regulatory programs, it is considered inconsistent with these programs for the NRDA to conduct such actions.

Table 3.3. Results of screening the full project list against the acceptability criteria.

	Projects receiving score	
Possible project evaluation scores	**Number**	**Percentage**
Pass	318	51%
Pass/more information	111	18%
More information	99	16%
Fail	93	15%

Step 3: Ranking potential restoration projects

The next step was to rank potential restoration projects against the remaining Co-trustee criteria for the NRDA. As described in detail below, the ranking procedure resulted in four types of restoration projects: (1) wetland restoration, (2) wetland preservation, (3) installing vegetated buffer strips along farmlands and (4) inducing changes in agricultural practices. The latter two project types are intended to reduce nonpoint source pollution into Green Bay. The Co-trustees also selected a unique category of projects that provide resources or services of cultural importance to Indian tribes.

The Co-trustees developed criteria to evaluate and rank potential restoration projects and published the criteria in the iRCDP. The criteria were grouped into three categories that reflect the aspects of the projects that the criteria evaluate: “focus” criteria, which evaluate project objectives; “implementation” criteria, which evaluate project methods; and “benefits” criteria, which evaluate the types and characteristics of the benefits the projects aim to achieve. These criteria reflect the Co-trustee requirements and priorities for NRDA restoration, as well as the criteria for selecting the preferred alternative specified in the Department’s NRDA regulations [43 CFR §11.84(d)]. The purpose of the criteria is to provide a means of ranking potential restoration projects against each other by considering the objectives and requirements of the NRDA restoration planning process.

Rather than apply the ranking criteria to each individual project, the criteria were applied to categories of projects that were similar in their objectives, methods, and benefits provided. Projects were grouped into one of 15 project categories, which are listed in Table 3.4. In addition, the 15 project categories all fall within one of three broad types of projects: nonpoint source pollution control, habitat/species programs, and recreational facilities improvements. No other types of projects passed the screening step. The Co-trustees evaluated the 15 project categories and concluded that they adequately encompass the range of projects that the NRDA planning process should consider.

Table 3.4. Project categories and numbers of projects in each category in the project database.

Project category	Number of projects in database
Nonpoint source pollution reduction	
Restore riparian habitat as buffer strips	22
Improve agricultural practices	13
Stabilize eroding streambanks	35
Improve animal waste handling practices	11
Control urban nonpoint source pollution	11
Habitat/species programs	
Restore wetlands	29
Restore island habitat	6
Preserve wetlands	41
Create artificial fish habitat	7
Create artificial bird habitat	2
Rare/endangered species programs	11
Remove shoreline rip-rap, seawalls	3
Exotic species control	5
Recreational facilities	
Create or improve parks and trails	278
Improve recreational fishing access	96

In this step the Co-trustees used a subset of the available ranking criteria to rank the project categories, for some of the ranking criteria are best applied to individual projects rather than project categories. For example, the degree to which a restoration project achieves environmental equity and justice is best evaluated at the individual project level rather than at the project category level. Similarly, since costs are dependent in part on the specific aspects of a project, cost comparisons will be addressed later at the individual project level. The following five criteria (from those listed in the iRCDP) were used to rank the project categories against one another:

- *Restores habitat on-site.* This criterion evaluates the degree to which the project restores habitat in the Lower Fox River and Green Bay Environment, including on tribal lands. This criterion incorporates a preference for projects that address natural habitat over those that address only the services provided by habitat. This criterion was identified as a higher priority criterion in the iRCDP.

- *Benefits can be scaled to PCB injuries and can be measured.* For a project to provide benefits that can be scaled to PCB injuries, it must provide benefits that can be both predicted and related to PCB injuries and services losses. As described in Section 3.2.5, the Co-trustees' total value equivalency study provides a means of comparing nonpoint source runoff, habitat, and recreational facility benefits to PCB injuries. Thus, this criterion primarily evaluates the degree to which the benefits are predictable. This is a higher priority criterion.

- *Provides a broad scope of benefits to a wide area or population.* Project categories may differ in their tendencies to provide a range of benefits over a wide area or population. Those that are focused on a limited set of benefits to a limited area or population are less preferred. This is a higher priority criterion.

- *Has a high probability of success.* Projects that use reliable, proven methods are preferred over those that rely on experimental, untested methods. Other factors that can affect project success, such as validity of assumptions inherent in the project approach, are also considered. This is a medium priority criterion.

- *Maximizes the time over which benefits accrue.* Projects that provide long-term benefits that begin immediately after project implementation are preferred. In applying this criterion, we assume that any operations and maintenance activities required for long-term success will be conducted. This is a lower priority criterion.

These five criteria were applied to the 15 restoration categories using the following system. The degree to which a restoration category met each criterion was assigned a score of high, medium, or low, which were assigned point values of 5, 3, and 0 points. These point values were multiplied by a weighting factor of 5 for higher priority criteria, 3 for medium priority criteria, and 1 for lower priority criteria. For example, a restoration category that scores medium on a higher priority criterion would be assigned a score of 15 points for that criterion (3 x 5). Each project category's priority-weighted criterion scores were then summed to produce an overall project category score. These scores were used only as an indication of project categories relative rankings, and do not necessarily represent a quantitative means of comparing the desirability of different categories. For example, a project category that scores 90 points is not necessarily twice as preferred as a project category that scores 45 points.

Table 3.5 shows the results of the ranking process. Appendix D describes the scoring and ranking methods used. The total score for each project category is used to rank the projects from highest to lowest. Both installation of farmland buffer strips and wetland restoration scored high for every criterion and are the highest ranked project categories. The next highest category is reducing nonpoint source pollution through improving agricultural practices, followed by

Table 3.5. Summary projects scoring.

Project category	Relative ranking
Buffer strip installation	1
Wetland restoration	1
Agricultural practice improvements	3
Wetland preservation	4
Streambank stabilization	5
Island habitat restoration	5
Shoreline softening	7
Exotic species control	8
Animal waste handling improvements	9
Urban nonpoint source control	9
Rare/endangered spp. programs	11
Waterfront parks or trails	12
Recreational fishing access improvements	12
Fish artificial habitat creation	14
Bird artificial habitat creation	14

wetland preservation. The bottom ranking projects are artificial habitat creation for birds and fish and new or improved parks, trails, or recreational fishing access.

Conclusion: Selection of restoration project types for the preferred alternative

Based on the analysis described above, the Co-trustees selected four types of projects to constitute the preferred alternative: wetland restoration, wetland preservation, vegetated buffer strip installation, and improvements in agricultural practices to reduce nonpoint source pollution. The next section describes how the Co-trustees determined the scales of these components that are required for restoration, and the subsequent section provides a more complete description of these four project types.

The ecological and human use services of the Lower Fox River and Green Bay Environment will be enhanced and improved through these restoration actions. Wetlands are a vital component of the area's ecosystem, and provide valuable breeding and feeding habitat for many fish, birds, and other organisms. Reducing nonpoint source pollution will improve the water quality of Green Bay, making it a much better habitat for fish and birds. Therefore, these restoration actions can compensate the public for the losses associated with the PCB injuries to natural resources.

The Co-trustees also included a different type of project that addresses a different type of benefit: restoration/preservation of specific areas or resources that have significant cultural value to the Indian tribes in the area. Examples of these types of projects may include the following:

- The preservation of the property associated with nine gathering sites historically used by Oneida tribal members for fishing and ceremonies along Duck Creek.

- The restoration of wild rice beds in selected areas. This action would be beneficial to the culture of the Menominee Tribe, and it would accomplish important ecological goals identified by the preferred alternatives in the RCDP. Rice beds also provide excellent buffer strips, protection to shoreline banks, and would aid in wetland restoration projects.

- Continued efforts toward management and restoration of lake sturgeon. Lake sturgeon are integrally important as a focus of cultural activity for the tribes.

These and other similar projects may be included as a distinct type of restoration action to specifically address the loss of cultural services that has been experienced by the tribes as a result of PCB injuries. Therefore, as part of the Co-trustees' post-award restoration plan, individual projects will be evaluated for their tribal cultural importance, and the preservation of such sites may be considered as a "credit" toward the preservation/restoration of wetlands or other natural areas.

3.2.5 Scaling the preferred alternative

Restoration scaling refers to determining the amount of the preferred restoration alternative that is required to compensate the public for injuries to natural resources. The scaling of restoration actions under the preferred alternative is supported by a total value equivalency (TVE) study. The TVE study also addresses the scaling of improvements in regional park facilities, since such actions have been proposed by various organizations around the bay. A summary of the TVE report is presented here, and the full report is included as Appendix A.

The TVE study supports restoration planning in two ways. First, the study explicitly obtains public input regarding the priorities and values for alternatives types of restoration projects, which aids the Co-trustees in evaluating the benefits of alternatives [43 CFR § 11.82(d)(2)] and ensures that there is public input on the selection of alternatives [43 CFR § 11.90]. Second, the study provides value-based methods to determine the appropriate scale of restoration actions.

For a large share of the PCB-caused service flow losses in the assessment area, particularly within Green Bay, where most of the PCBs have come to be located, providing restoration with the same or very similar services may not be technically feasible (i.e., the Co-trustees may be unable to find or develop resources that are sufficiently extensive to be developed in sufficient quantities), is undesirable (e.g., increasing the population of fish or birds that may continue to experience injuries from PCB exposure), or may be too expensive. Therefore, it is preferable to select restoration actions that provide resources and services of a similar but different type or quality than those injured. In these cases, value-based scaling methods provide a basis for selecting and scaling restoration activities.

Value-to-value scaling is used in the TVE study to scale restoration projects that provide services similar to, but not the same as, those lost.[2] Scaling is computed such that the value of the services gained through restoration equals the value of PCB-caused losses. Value is measured by the utility (benefits or satisfaction) that people derive from all active and passive uses of the resources. Dollar measures of value are not required for value-to-value scaling.

In the TVE study, the Co-trustees focus on restoring all human use losses, including active use losses related to well-identified active, and often on-site, resource uses such as recreational fishing, and passive use losses arising from services individuals receive from resources apart from their own readily identified and measured active uses.

Certain active use losses may be cost-effectively and readily individually measured and valued, as the Co-trustees have done for recreational fishing active use losses (U.S. FWS and Stratus Consulting, 1999f). However, focusing solely on these losses omits consideration of other potentially significant losses, thus understating the services to be restored. The TVE study is a total value assessment because it cost effectively addresses most or all PCB-caused service flow losses, including but not limited to recreational fishing and other recreational losses such as waterfowl hunting and wildlife viewing; casual or indirect losses such as reduced enjoyment while driving or walking by or working near a site, and when hearing about, reading about, or seeing photographs of a site; and option and bequest losses tied to preserving resource services for future use for oneself or for others.

Value-to-cost scaling can be used to select the type and scale of restoration projects such that their cost equals the value of the lost services. This is the same as computing compensable values [CFR 43 § 11.83-11.84] and applying the recovered damages to selected restoration projects [43 CFR § 11.93 (b)]. This study supports the selection of the mix and scale of restoration projects once damages are recovered by identifying project preferences and the relative value of alternative mixes of projects. While not the primary focus, the study can provide a measure of

2. See also 15 CFR § 990.53(d) for additional discussion of value-based scaling concepts and methods.

compensable values for interim losses from 2000 until services are returned to baseline using a willingness-to-pay (WTP) measure [43 CFR §11.83(c)(2)].[3,4]

TVE approach

Survey of preferences and values

To obtain public preferences and values, a survey was conducted with residents of 10 Wisconsin counties surrounding the Wisconsin waters of Green Bay. The survey focused on four types of natural resource restoration programs for the Green Bay area that were selected because the majority of proposed natural resource restoration actions for the Green Bay area fall into one of these groups. The action levels for each program were selected reflecting relevant options and responses from respondents in survey focus groups and pretests.

1. *Restore wetlands* near the waters of Green Bay. Wetlands restoration will provide increased spawning and nursery habitat and increased food for a wide variety of fish, birds, and other wildlife. This provides wildlife services similar to, but not the same as, those injured by PCBs. Priorities and values for restoration of wetlands can also be applied as an indicator of the priorities and values for other habitat enhancement projects. Restoration levels range from taking no action up to a 20% increase in wetlands within five miles of Green Bay within Wisconsin (although restoration could also take place in Michigan).

2. *Reduce runoff* that contributes to pollution of the waters of Green Bay. Controlling runoff improves water quality by lessening algae growth and improving water clarity, especially in the lower bay. This improves aquatic vegetation and habitat for fish and some birds and improves recreation. The runoff control in this case provides similar, but not the same, services as those injured by PCBs. The runoff control levels considered range from no change in the amount of runoff up to a 50% reduction, reflected by changes in water quality measures.

3. *Enhance outdoor recreation* in counties surrounding Green Bay. Enhanced recreation includes increasing facilities at existing parks such as adding picnic grounds, boat ramps, and biking and hiking trails, and development of new parks. These facilities provide

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3. Compensable values include “the value of lost public use of the services provided by the injured resources, plus lost nonuse values such as existence and bequest values” [43 CFR § 11.83(c)(1)].

4. The values provided in this study could also be used to support value-to-value scaling of the compensable values for the total interim recreational fishing losses (U.S. FWS and Stratus Consulting, 1999f) to the value of the restoration programs addressed herein.

recreation services, although not the same as those lost as a result of the presence of PCBs. The levels of recreation enhancements considered range from no improvements up to a 10% increase in facilities at existing parks and a 10% increase in new park acreage.

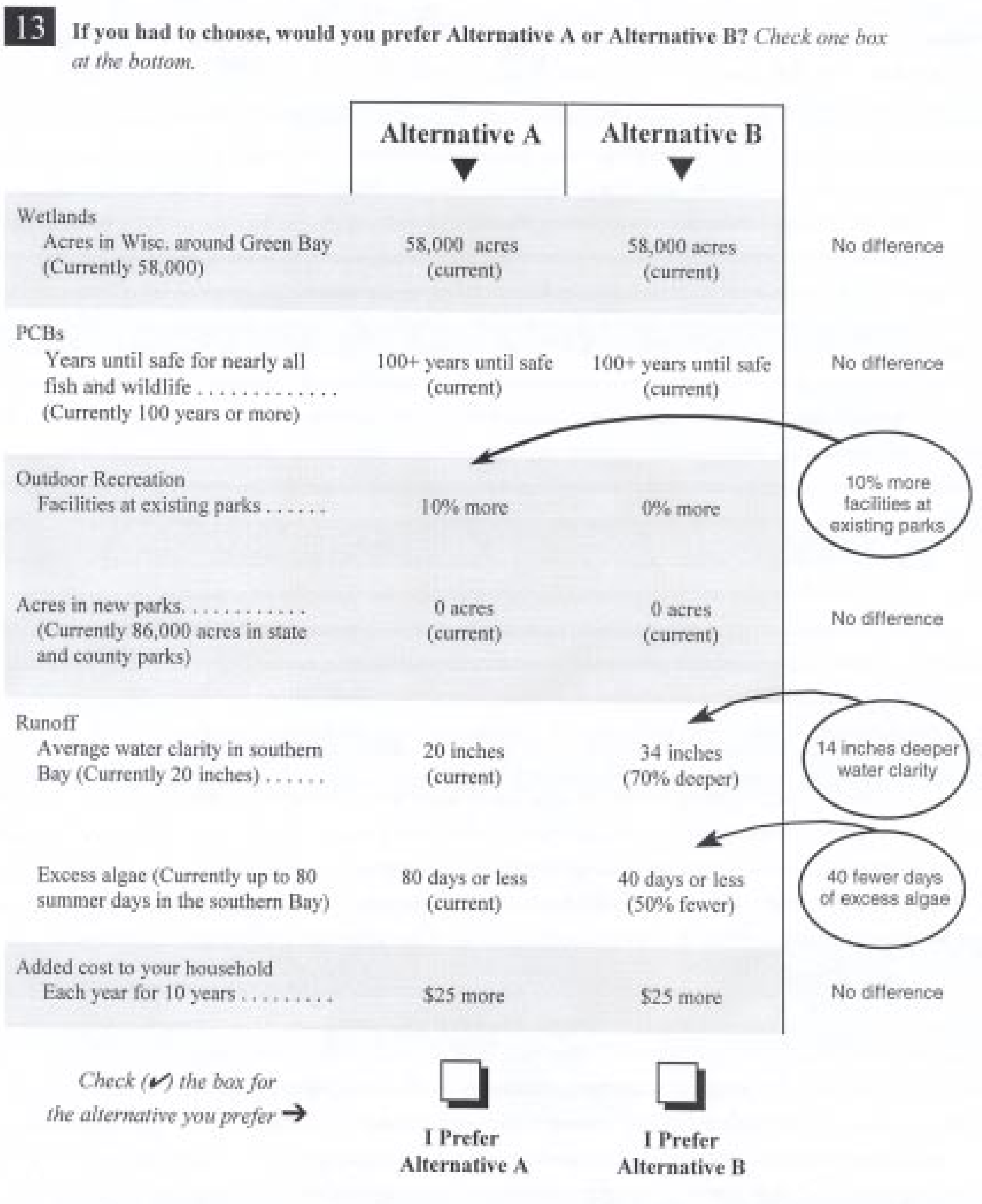
4. *Remediate PCBs* in the sediments of the assessment area. Removing PCBs will reduce the number of years until FCAs and the injuries to wildlife are eliminated. The levels of removal considered result in the number of years until PCBs are at safe levels (i.e., a return to baseline conditions) ranging from 100 years (no additional removal) to 20 years with intensive remediation.

The TVE study supports restoration planning by providing a large-scale perspective of public preferences across alternative types of restoration programs, and providing a method to scale programs that provide equivalent value to the service flow losses. The study was not intended to provide a selection of individual projects such as specific wetland acres or specific recreational facilities. That task is left to the Co-trustees and regional planners who have a detailed knowledge of needs, technical effectiveness, and cost-effectiveness and will be undertaken as part of the post-award restoration plan.

The survey describes each of the four natural resource restoration programs and asks a variety of questions to elicit preferences about the programs and the program levels. Next, the survey includes six stated preference choice questions, where respondents state their preferences by choosing which of two alternatives (A or B) they prefer, where each alternative has a specified level for each of the four restoration programs.

Figure 3.2 provides an illustration of the choice questions presented to respondents. In this question, respondents are making a choice between enhanced outdoor recreational facilities at existing parks versus increased levels of runoff control. By varying the program mixes and levels across questions and examining the choices made, mathematical methods (knows as random utility models) are used to determine how much of one kind of restoration has equivalent value to different amounts of other kinds of restoration.

The alternatives, and the choice between alternatives, are designed to reflect realistic and meaningful options for natural resource management in the study area. To present realistic choices, each of the alternatives includes a dollar cost to the household associated with the alternative. The dollar values presented differ across choice pair, and across survey versions, which allows for calculation of the public’s WTP for the value of PCB-caused losses, or compensable values (see Appendix A), and for the natural resource enhancements considered.



13 **If you had to choose, would you prefer Alternative A or Alternative B?** *Check one box at the bottom.*

	Alternative A	Alternative B	
Wetlands Acres in Wisc. around Green Bay (Currently 58,000)	58,000 acres (current)	58,000 acres (current)	No difference
PCBs Years until safe for nearly all fish and wildlife . . . . (Currently 100 years or more)	100+ years until safe (current)	100+ years until safe (current)	No difference
Outdoor Recreation Facilities at existing parks	10% more	0% more	10% more facilities at existing parks
Acres in new parks. . . . . (Currently 86,000 acres in state and county parks)	0 acres (current)	0 acres (current)	No difference
Runoff Average water clarity in southern Bay (Currently 20 inches)	20 inches (current)	34 inches (70% deeper)	14 inches deeper water clarity
Excess algae (Currently up to 80 summer days in the southern Bay)	80 days or less (current)	40 days or less (50% fewer)	40 fewer days of excess algae
Added cost to your household Each year for 10 years	$25 more	$25 more	No difference

Check (✔) the box for the alternative you prefer →

☐ **I Prefer Alternative A** ☐ **I Prefer Alternative B**

Figure 3.2. Sample choice question.

The TVE survey was implemented through a mail survey of a stratified random sample of households in 10 counties near Green Bay. Of the 650 eligible respondent households, 470 responded, for a 72% response rate. An evaluation of the sampling plan and responses indicates that any potential sampling and response biases are likely to be small and thus have a minimal impact on the results.

Remediation scenarios

The TVE study determines what level of enhancements in the selected natural resource programs has a value that is equivalent to the value of PCB-caused losses over various time periods for alternative remediation scenarios. Figure 3.3 illustrates how ongoing PCB-caused losses depend on the rate of remediation of services. In the figure, Area A represents past losses experienced before initiation of remediation begins at the site (assumed to be 2000); these losses are not addressed in the TVE study. Area B reflects an assumption of a 10 year period (2000-2009) for remediation actions during which time limited, if any, recovery may occur. Areas C-F are ongoing losses after remediation (if any), depending on the level of remediation. Several scenarios were considered:

1. *Intensive remediation.* This scenario assumes losses continue largely unabated during the remediation period (Area B), then linearly decline to baseline over another 10 years (Area C) for a total of 20 years of ongoing losses. This scenario reflects the Fox River Global Meeting Goal Statement (FRGS-97) by the Fox River Global Meeting Participants (1997), and is similar to the more intensive remedial actions being considered in the RI/FS (ThermoRetec Consulting and Natural Resource Technology, 2000).

2. *Intermediate remediation*. This scenario assumes that losses continue largely unabated during a remediation period (Area B), then linearly decline to baseline over another 30 years (Areas C + D) for a total of 40 years on ongoing losses. This scenario is similar to the intermediate remediation scenarios in the RI/FS.

3. *Little or no additional remediation*. These scenarios consider limited remediation over 10 years (Area B), resulting in declining losses over an additional 60 years (Areas C + D + E) for a 70 year total, or resulting in declining losses over an additional 90 years (Areas C + D + E + F) for a 100 year total.

The TVE study design allows the calculation of the scale of restoration that provides services of equal value to the value of PCB-caused losses within any time period shown in Figure 3.3.

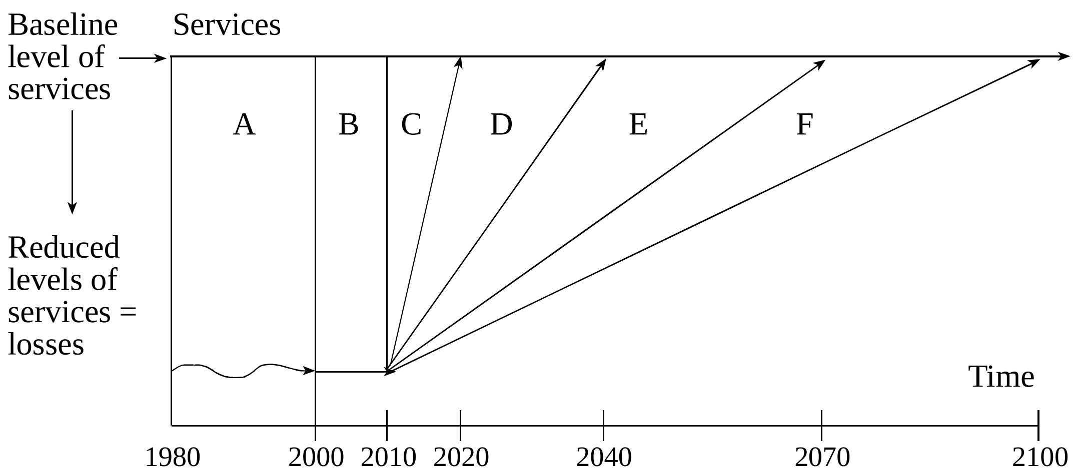


Figure 3.3. Interim losses under alternative time paths for a return to baseline.

Summary of results

Awareness and preferences

Respondents were asked how aware they were of each of the four natural resource topics presented (wetlands, PCBs, outdoor recreation, and runoff control) before receiving the survey. Respondents reported being moderately to highly aware of the topics, with over 80% reporting they were somewhat to very aware of each topic. The literature identifies that higher awareness can be expected to enhance the reliability of responses and to reduce the burden of communication in survey design. High levels of awareness of a topic most likely reflect personal interest in the topics and increased preference for, and values for, natural resource restoration.

Various questions address respondent concerns and preferences for the four programs and the service flow benefits they provide. There is a strong and consistent preference for PCB removal over other natural resource enhancement programs (see Appendix A). Relative to PCB removal, runoff control and wetland enhancements have modest interest and values. Limited interest is expressed in enhancing 120 regional parks, and almost no interest is expressed in adding new regional parks. Table 3.6 summarizes the importance ratings for the benefits from each program. Table 3.7 summarizes preferences in terms of doing and spending less, the same, or more, compared to current levels, for each program in the future.

Table 3.6. Importance of natural resource action benefits (1 = not at all important to 5 = very important).

Benefits[a]	Mean importance ranking (SE of mean)
Remove PCBs to reduce risks to birds, fish, and other wildlife	4.3 (0.05)
Remove PCBs so that it is safe to each fish and waterfowl	4.3 (0.05)
Reduce runoff to improve water clarity	4.0 (0.05)
Increase wetland acreage to support birds, fish, and other wildlife	3.9 (0.05)
Reduce runoff to reduce algae blooms	3.8 (0.05)
Add facilities at existing parks	3.6 (0.05)
Add new parks	3.3 (0.06)

a. Listed in order of mean importance score, not in the order they appear in the survey.

Table 3.7. Preferred actions for natural resource programs.

Natural resource programs[a]	Do less and spend less[b]	Do and spend the same	Do more and spend more
PCB investigations and removal	NA[c]	17%	83%
Runoff reduction	2%	34%	65%
Wetlands maintenance and/or restoration	3%	42%	56%
New facilities at existing parks and/or opening new parks	2%	51%	47%

a. Listed in order of mean importance score, not in the order they appear in the survey.
b. Percentages are adjusted to remove missing responses, which amount to less than 2.4% for all questions and may not sum to 100% due to rounding.
c. Not applicable: “Do less and spend less” was not offered as an option for PCBs.

The reported preferences vary by household characteristics. For example, households report higher importance for the benefits of a program, and interest in doing more and spending more, if they have anglers active in fishing the waters of Green Bay, if they live very near Green Bay, and if they were previously very aware of the natural resource topic.

Scaling restoration

The results of the choice questions, which trade off enhancements in natural resource programs, demonstrate that respondents predominately answer in a manner consistent with our expectations: more enhancements are preferred to fewer enhancements, and lower costs are preferred to higher costs and the trade-offs are consistent with the results in Tables 3.6 and 3.7. These results support the reliability of the results.

The resource trade-off questions are used to scale combinations of resource restoration programs that would provide services that the public considers to be equivalent in value (measured in utility) to eliminating the continuing PCB-caused losses. While the final mix and scale of restoration programs will be determined later, the model presented here provides a basis upon which to scale alternative restoration programs. The composition and costs for alternative restoration programs are discussed in Section 3.2.9.

Table 3.8 provides examples of the scale of sample mixes of restoration projects that provide services with value equal to the ongoing PCB-caused losses for selected scenarios. Each line represents one possible mix of restoration projects. The listed examples are but a few of the infinite number of possible combinations that the Co-trustees and potentially responsible parties could develop to provide services of equal value to the PCB caused losses. The first three lines provide example combinations for the scale of restoration providing services of value equal to the PCB-caused losses from 2000 until a return to baseline if an intensive level of remediation returns services to baseline by 2020:

- a combination of 3,100 acres of wetlands restoration, plus a 10% enhancement in existing park facilities, plus an additional 14 inches of Green Bay water clarity from a runoff control program
- a combination of 5,500 acres of wetlands restoration, plus an 8% increase in existing park facilities, plus an additional 12 inches of Green Bay water clarity from a runoff control program
- 11,000 acres of wetlands restoration, plus an additional 12 inches of Green Bay water clarity from a runoff control program.

The second block provides examples for the 40 year intermediate level of remediation. The third block provides examples of the scale of restoration that provides services of value equal to a

Table 3.8. Compensatory restoration scaling: Illustrative example combinations.

	Example restoration combinations		
Years until clean from PCBs	**Wetland acres[a]**	**Existing park enhancement**	**Runoff control[b]**
PCB remediation scenarios[c]			
Intensive: (0 to 20 years)	3,100	10%	14”/50%
	5,500	8%	12”/45%
	11,000	0%	12”/45%
Intermediate: (0 to 40 years)[d]	24,100	10%	16”/55%
	16,000	20%	16”/55%
Partial restoration:	2,900	2%	4”/25%
(20 to 40 years)	5,000	3%	2”/13%
	2,400	0%	7”/33%

a. Rounded to nearest 100 acres.
b. Additional inches of water clarity/percentage decrease in number of excess algae days.
c. Restoration is for PCB-related losses during the period indicated.
d. Requires extrapolating beyond the range of actions considered for some or all programs.

portion of the PCB-caused losses corresponding to the differences between a 20 and 40 year remediation.

These illustrations do not include additional acres of new parks as a restoration approach because this approach was found to have a near-zero value in the 10 county area. A few key findings emerge as applicable to the ultimate selection and scaling of restoration alternatives within the identified three project types (wetlands, runoff control, and outdoor recreational facilities):

- Wetland (and likely other wildlife habitat) restoration programs and runoff control programs are preferred to, and more highly valued than, programs to enhance outdoor recreation in the assessment area. While specific outdoor recreation enhancements would benefits some residents, the majority of residents indicated limited interest in additional facilities and parks.

- Continued increases in the levels of wetland restoration programs increase benefits, but at a declining rate. That is to say, there are diminishing marginal utility gains as more wetlands are restored. As a result, increased restoration well beyond the levels addressed in the study will most likely result in limited additional benefits to the public.

- The value of PCB-caused losses is so substantially larger than the value of service flow benefits from the restoration programs that it is difficult to generate benefits equivalent in value to the PCB-caused losses with just improvements in one program. For instance, a widespread improvement in regional parks provides services that are equal in value to the value of the first few years of PCB-caused losses, a 20% increase in wetland acres provides services with value equal to about the first seven years of PCB-caused losses, and runoff control that results in an additional 14 inches of water clarity provides services with value equal to about the first 15 years of PCB-caused losses. Therefore, to provide sufficient restoration with value equal to the value of ongoing PCB-caused losses until a return to baseline will most likely require a combination of several programs.

- The restoration combinations presented in Table 3.8 consider up to a 40 year time horizon for eliminating PCB injuries because even the maximum combination of the wetlands, outdoor recreation, and runoff control programs considered do not provide enough service flow benefits to be equivalent to eliminating PCB losses more than 40 years more quickly. To provide services flow benefits for PCB-caused losses beyond 40 years would require additional co-variations on these four natural resource programs.

Comparison to other studies

The TVE study differs from, but necessarily partially overlaps, the Co-trustees' recreational damage determination (U.S. FWS and Stratus Consulting, 1999f) because both include a portion of the recreational fishing losses due to PCB-caused fish consumption advisories. The WTP results of the TVE and recreational fishing studies can be compared for those households with Green Bay anglers in the 10 nearby Wisconsin counties. For this comparison population, the WTP values in this TVE study are comparable to or slightly larger than the WTP values in the recreational fishing study. This is as expected because this study values a larger set of losses than does the recreational fishing study, although for households with Green Bay anglers, fishing losses may well be the dominant component of PCB-caused losses. The comparability of the results supports the estimated magnitude of damages in each study.

The results of the TVE study are also consistent with other existing literature specifically addressing social preferences and values for PCBs and other natural resource management programs in northeastern Wisconsin (see Appendix A). Existing literature consistently identifies that regional residents are aware of and concerned about water pollution issues, and place a high priority and value on cleaning up contaminated water resources. While the existing literature does not address the same scenarios as the TVE study, allowing for differences in the scenarios, the preferences and compensable values from the TVE study are of a magnitude consistent with those in the literature.

3.2.6 Strategies for implementing the preferred alternative

This section describes the Co-trustees' strategies for implementing the different elements of the preferred restoration alternative (wetland restoration, wetland preservation, installation of vegetated buffer strips, and improvements in agricultural practices to reduce nonpoint source runoff). In developing their preferred restoration approach, the Co-trustees have considered issues such as:

- consideration of the approximate number and spatial distribution of sites that provide opportunities for these types of restoration actions
- consideration of the types of wetlands that should be targeted for restoration or preservation, and the potential locations of wetland restoration and improvement actions
- consideration of the specific nature of the actions that would be required to implement different restoration components.

The Co-trustees emphasize that identification of the specific parcels of land that will be restored, enhanced, or acquired, and development of the specific actions that will be undertaken at each of these parcels, will be undertaken as part of the Co-trustees' post-award restoration plan. The strategy presented here provides the general framework within which the more specific work of developing the post-award restoration plan can be conducted. The strategy is intended to provide the flexibility necessary to incorporate the specific issues and constraints that will arise in continued restoration planning and implementation, yet provide enough specificity to allow for public comment on the strategy. In addition, the strategy will be used to help develop the cost estimate for implementing the preferred restoration alternative.

Strategy for wetland restoration and preservation

Background

Wetlands are an integral part of the Green Bay ecosystem. They provide valuable habitat for many plants, birds, fish, and other wildlife that are dependent on wetlands for their survival. They are highly productive areas, and help reduce wave erosion, contain nonpoint source runoff, provide groundwater recharge and discharge, and recycle nutrients. Many fish species of Green Bay rely on coastal wetlands for breeding and rearing, including yellow perch, northern pike, and largemouth bass, as well as shiners and minnows, which are essential prey items for many birds and larger fish. Many bird species also rely on wetlands for breeding and feeding, such as herons, rails, eagles, and terns. Since wetlands provide essential ecological services and habitat for so many fish, bird, and other biota species, preserving and restoring wetlands provides a means of bettering the ecological and human use services of the Lower Fox River and Green Bay Environment and thereby compensate for the losses caused by PCBs.

As part of their restoration planning process, the Co-trustees conducted an in-depth evaluation of the current status of wetlands in the Lower Fox River and Green Bay Environment to assist in development of a wetland restoration and preservation strategy. The analysis was conducted for the Co-trustees by Hey and Associates, a firm with extensive expertise in wetland ecology and restoration in the Great Lakes. The analysis is based on a review of documents and data sources related to wetlands in the area (e.g., the Green Bay Special Wetlands Inventory Study conducted by the Service in 1993), interviews with wetland resource experts from public and private organizations, information obtained from the U.S. Army Corps of Engineers, and a limited field survey of wetlands in the area. The evaluation examined such issues as the spatial distribution of current wetland types and historical wetland losses, the types of wetlands in the area with high ecological values, current and future pressures on wetlands in the area, the effectiveness of current wetland protection programs, and opportunities and methods for preservation and restoration activities. The results of the analysis are summarized here, and the full report on the analysis is included as Appendix E.

Wetlands historically were drained or filled for development as agricultural lands, urban use, or navigation projects, or simply to "reclaim" them. It has been estimated that approximately 90% of the original wetlands in the Green Bay area have been lost (WDNR, 1988). Most of the Green Bay wetlands are along the bay's western shore and comprise primarily emergent marsh, shrub/scrub, or forested habitat. In the Green Bay system, the coastal, floodplain, and headwater wetlands are particularly valuable because they can have substantial impacts on improving water quality and providing valuable habitat for a wide variety of plant and animal species.

In the last few decades, as awareness of the ecological importance of wetlands has increased, so have efforts to maintain the remaining wetlands. The regulatory system now in place requires authorization from the Army Corps of Engineers and compliance with state water quality certification programs and water quality standards for activities such as wetland filling. Additional protection is provided by shoreland-wetland zoning minimum standards, other coastal management requirements, and wetland restoration and preservation incentive programs such as the U.S. Department of Agriculture's "Swampbuster" program. Potential impacts to wetlands typically must be permitted, which usually requires delineation and characterization of the wetland and minimization of impacts. Mitigation is usually required for projects that cause impacts above a certain acreage threshold, typically 0.25 acre. The combined effect of these requirements has been to reduce the extent of wetland loss in the Green Bay ecosystem. Army Corps of Engineers data show that impacts to a total of 168 acres of wetlands were permitted by the Corps from 1991 through 1999 in the five Wisconsin counties that border Green Bay (Appendix E).

However, the current regulations do not prevent all wetland loss. Army Corps of Engineers permits are required only for wetland filling and not for wetland draining or excavation [40 CFR § 232]. Wetlands can be excavated to create ponds as part of residential or industrial development. Wetlands may be drained if draining alone allows for more intensive land uses, or if draining allows for future development of the area when it no longer meets the technical definition of a wetland. Furthermore, many small projects (e.g., culvert crossings, minor fill for driveway or roadway crossings, and dredging for docks) can have substantial indirect effects on wetlands through land use changes and edge disturbances. These types of indirect effects are particularly common along the west shore of Green Bay.

Wetland restoration strategy

Wetland restoration would help replace wetlands that have been lost. The ecological benefits of wetland restoration projects would begin immediately after project completion. Wetland restoration, which seeks to restore wetlands in areas where hydrological alterations have eliminated former wetlands, is generally much more effective than wetland creation, which seeks to create wetlands in areas that were not previously wetlands (Appendix E). Restoration is typically most effective when it is based on re-establishing the hydrological characteristics that had been eliminated (Appendix E). Therefore, the Co-trustees' wetland restoration strategy will target agricultural lands that are converted wetlands. Wetland restoration of agricultural fields typically involve plugging ditches, disrupting drain tile systems, and re-establishing wetland plants (Appendix E).

Agricultural lands in bay coastal areas or in river or stream floodplains are particularly desirable for restoration actions, as are lands that are adjacent to existing large or valuable wetlands. Restoration of these areas would provide particularly valuable wetlands and a significant enhancement of natural resources in the area. A preliminary analysis of land uses, soil types, surface hydrology, and land cover was conducted using a geographic information system (GIS) to help identify the potential amount and distribution of such lands in the Green Bay area. The results of the analysis, which are detailed in Appendix F, show that approximately 125,000 acres of agricultural lands in the counties bordering Green Bay lie on hydric soils and therefore may provide opportunities for wetland restoration. Although not all of these lands have the potential for restoration to wetlands, the analysis indicates that wetland restoration opportunities are plentiful. Areas within floodplains, within coastal areas, or adjacent to valuable natural areas will be targeted by the Co-trustees for restoration to wetlands.

Wetland preservation strategy

Wetland preservation is another important component of the Co-trustees' restoration strategy. Despite the existence of regulations designed to minimize additional wetland loss and impacts, such regulations typically do not address such threats as indirect impacts, cumulative small-scale impacts, surrounding land use changes, or wetland draining. Furthermore, reliance on regulations and policies does not necessarily provide for long-term preservation of valuable wetland habitat. As a result, wetland preservation offers a potentially effective approach for providing long-term ecological benefits in the Green Bay environment.

The Co-trustees' strategy for wetland preservation targets the following types of wetlands:

- *Coastal wetlands*. The Service's detailed survey of Green Bay coastal wetlands defines coastal wetlands as wetlands with water levels that are directly linked to the water level in the bay (U.S. FWS, 1993). These wetlands are important to the water quality and habitat of Green Bay, providing spawning and rearing habitat for fish, nesting and feeding habitat for birds, and many other functions such as wave energy dissipation, groundwater/surface water interaction, and suspended sediment and nutrient retention (Figure 3.4). These wetlands are under threats from the continued development of coastal areas. Of the remaining coastal wetlands, those that are relatively undisturbed or particularly valuable will be targeted for preservation. According to the detailed survey, there are approximately 14,300 acres of relatively undisturbed coastal wetlands and approximately 18,300 acres of disturbed coastal wetlands remaining (U.S. FWS, 1993). Surveys of fish communities show that the undisturbed coastal wetlands of Green Bay support more fish and a more diverse species assemblage than those wetlands that are disturbed (Brazner, 1997).

- *Wetlands in areas closer to more populated areas*. Preservation of wetlands in and around more populated areas can provide the greatest incremental benefit since they are the wetlands most likely to be impacted in the near future, and preserving them can provide direct use services to more people. Wetland preservation in these areas receives considerable attention from local and regional planning commissions. Based on an analysis of population density changes for the 1990s from U.S. Census data, areas of highest population changes are centered on the southern end of Green Bay (Appendix F). A total of approximately 58,600 acres of wetlands are found within the areas that contain the top 50% of population density growth rates, indicating the potential for wetland preservation in these areas. Specific types of wetlands in these areas, such as floodplain wetlands, may be targeted. More detailed delineations of wetlands under immediate or pending development pressure are available from regional, county, and municipal planning departments, and this information will be used by the Co-trustees in developing the post-award restoration plan.

- *Wetlands with high ecological value habitat or that support rare species.* Despite the tremendous loss of wetlands that has occurred around Green Bay, the area still contains wetland habitat of regional significance. Numerous ecologically valuable areas around the bay have been identified for priority conservation efforts. For example, The Nature Conservancy, in conjunction with federal, state, and local governments, nongovernmental organizations, and academic institutions, recently completed a comprehensive, scientifically based analysis of habitats and species within the Great Lakes Ecoregion, which stretches from Minnesota to southern Quebec (The Nature Conservancy, 1999).

Figure 3.4. Coastal wetlands along the western shore of Green Bay between Oak Orchard and Thomas Slough in the southern part of the bay. Photo credit: Ken Stromborg, U.S. Fish and Wildlife Service.

> This evaluation identified "portfolio sites" across the region as the focus of the organization's conservation efforts. A subset of the sites, the "priority portfolio sites," are those sites that are particularly important for conservation efforts because of the rarity or ecological value of the habitat and/or species at the sites. Several portfolio and priority portfolio sites within the Great Lakes Ecoregion are located in the Green Bay area, as shown in Figure 3.5. Many of these areas, which are primarily on the Door Peninsula in Wisconsin, Garden Peninsula in Michigan, and along the western and southern shores of Green Bay, include wetlands, placing them within the scope of the Co-trustees preservation targets (personal communication, M. Grimm, The Nature Conservancy, September 2000). These same general areas were identified as "critical coast wetland problem areas" that require conservation efforts in a study by the U.S. Geological Survey (Shideler, 1992). When the Co-trustees develop the post-award restoration plan, they will coordinate with organizations such as The Nature Conservancy and its partners to make use of the extensive work that has been conducted in identifying those sites in the Green Bay area that have high ecological value.

The primary methods that will be used for wetland preservation are land acquisition and land management for ecological objectives. These methods were identified by The Nature Conservancy and its partners as the most effective tools for wetland preservation. In addition to purchasing targeted wetland areas, land surrounding targeted wetland areas may also be purchased to minimize indirect impacts from adjacent development pressure. The Co-trustees will coordinate with local land conservation agencies and groups in conducting the land purchases, and anticipate that any lands purchased for preservation will be under the ownership of the local agencies or organizations. The Co-trustees emphasize that they are not seeking to be the owners of the lands purchased for preservation if ownership is possible through state or local governments, land trusts, or appropriate nongovernmental organizations. Land easements to allow for land management for ecological objectives may also be used, but easements may not always be successful, and the scope of the easements required for ecological management typically makes the easements nearly as expensive as outright land purchase (B. Bryant, U.S. Fish and Wildlife Service, personal communication, 2000).

In summary, the Co-trustees' strategy for wetland preservation will focus on coordinating with local agencies and organizations in acquiring and managing coastal wetlands, wetlands in areas of higher population growth, and wetlands of high natural quality. A preliminary analysis indicates that potentially tens of thousands of acres of these wetland types are available for preservation. Final selection of specific wetlands that would be preserved in the post-award restoration plan will include consideration of the ecological value of the wetland habitats, ownership/protection opportunities, geographic/ecological diversity, and local/regional planning and citizens' concerns.

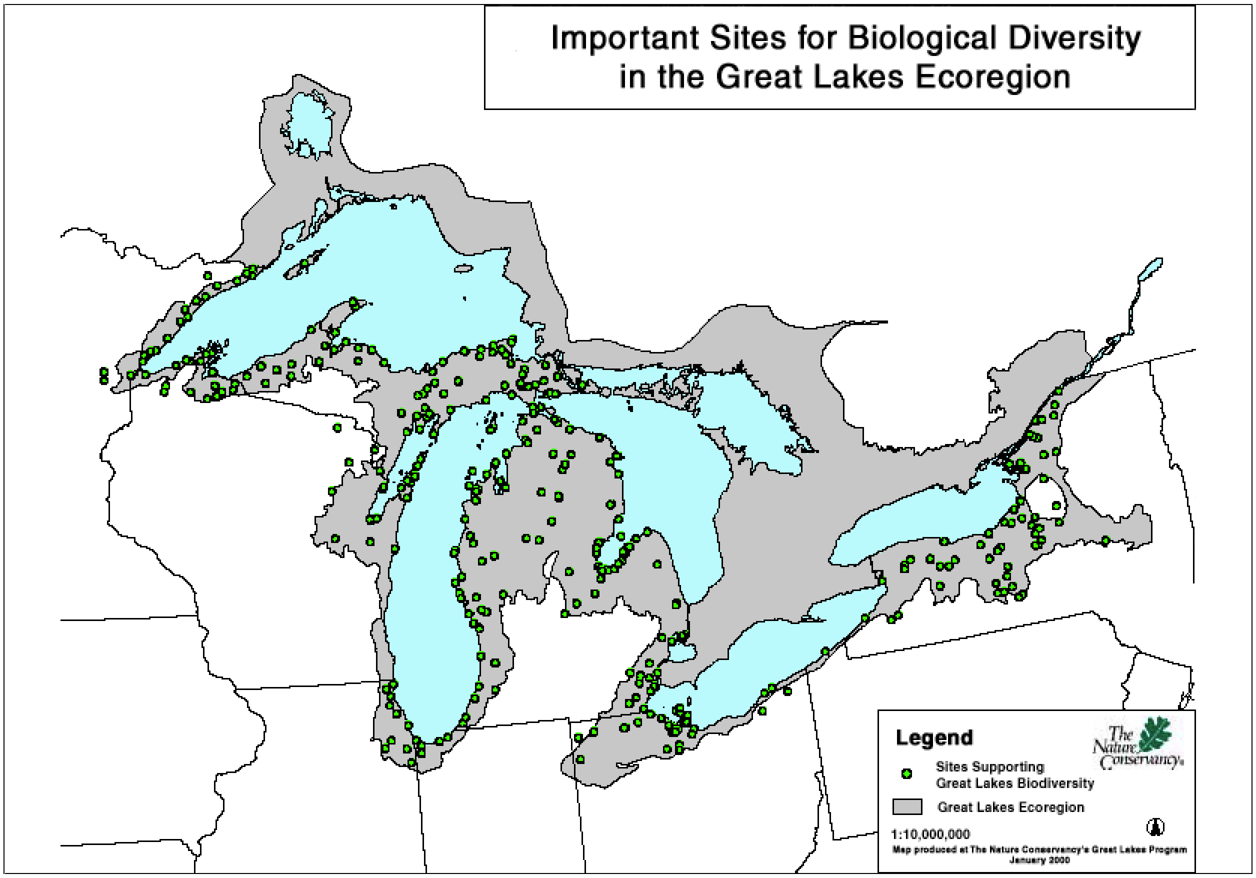


Figure 3.5. Locations of sites within the Great Lakes Ecoregion identified by The Nature Conservancy and its partners as being important for preserving biological diversity in the region. Note the density of sites around Green Bay, including on Door Peninsula and along the northern edge of the bay. Figure courtesy of The Nature Conservancy.

Strategy for a mixture of wetlands preservation and restoration projects

A final component of the Co-trustees' strategy for wetland preservation and restoration is how to combine the different possible actions into an overall restoration approach to estimate benefits and costs. Table 3.9 provides a general framework for how the Co-trustees will combine the different actions that constitute wetland preservation and restoration into an overall wetlands strategy. The final mixes of types of lands preserved, areas restored, and locations addressed will depend on how the wetland restoration and preservation actions are actually implemented in the field. The strategy described here is intended to provide guidance for the post-award restoration

Table 3.9. Co-trustees' general approach toward combining different components of wetlands actions.

Restoration project type	Approach for developing project mixes
Wetland restoration and preservation	3:1 ratio between acres of wetlands preserved and acres of wetlands restored
Wetland preservation	2:2:1 ratio between acres of coastal wetlands, acres of other high-quality wetlands, and acres of wetlands in more populated areas preserved
Coastal upland preservation (to help protect neighboring coastal wetlands)	9:1 ratio between acres of coastal wetlands and acres of coastal uplands preserved

plan, which will be more specific in how the actions will be implemented, and to provide a reasonable basis for estimating the benefits and costs of the actions.

One important aspect of the approach to wetlands actions is the relative emphasis on preservation of existing wetlands versus restoration of former wetlands. Several factors play a role in determining this relationship, including the types and timeframes of the ecological benefits that are likely to be provided by each type of action, the overall net benefits provided by each, the need and opportunities for each, and the degree to which the actions adequately address resource service losses caused by PCB injuries. On the one hand, the ecological services provided through wetland preservation may be greater than those provided by wetland restoration, since wetlands of high ecological services are being selected specifically for preservation. In general, restored wetlands are unlikely to provide this same level of service. Furthermore, the Co-trustees recognize that a sound overall wetland strategy for the Lower Fox River and Green Bay Environment should be based on wetland preservation, for if wetland losses are occurring, restoration without preservation of existing wetlands achieves little net benefit. On the other hand, the actual benefits of wetland preservation will not begin until the point in the future when the wetlands would have been lost had they not been preserved, whereas the benefits of wetland restoration begin much sooner. In addition, only through wetland restoration can the amount of wetlands, and therefore the total ecological benefits provided by wetlands, be increased over current levels. Given these factors, an acreage ratio of wetland preservation to wetland restoration of 3:1 will be used by the Co-trustees as guidance for the post-award restoration plan and for estimating benefits and costs. To compute the scale of benefits provided by wetlands preservation, we use the TVE result of diminishing marginal utility for added wetlands and apply the valuation functional form to wetlands preservation. As a result, the value of preservation of wetland acres at risk is substantially larger than the value of restoration of lost wetland acres, consistent with the Co-trustee preference for preservation.

For wetland preservation, a distribution of acres across the three types of wetlands that the Co-trustees will target for preservation (coastal wetlands, wetlands of high natural quality, and wetlands in more populated areas) must be selected. Based on the availability of the different types of wetlands around Green Bay and the relative importance of the ecological services provided, the Co-trustees will use an acreage ratio of 2:2:1 for coastal wetlands to other wetlands of high natural quality to wetlands in more populated areas as the general target for wetland preservation. In addition, in some cases the preservation of coastal wetlands will include the preservation of adjacent coastal uplands. The Co-trustees will target 1 acre of coastal uplands for preservation for every 9 acres of coastal wetlands that are preserved.

By combining wetland preservation with restoration, the Co-trustees' restoration will provide direct benefits to the fish, bird, and other natural resources of the Lower Fox River and Green Bay Environment that have been injured by PCBs.

Strategy for vegetated buffer strip installation and alterations in land-use practices to reduce nonpoint source runoff

Reducing the loadings of sediment and nutrients into Green Bay has long been the focus of environmental planning efforts in the area. Green Bay is under stress from excess sediment and nutrient loads (WDNR, 1988). High phosphorus loads stimulate the growth of blue-green algae, which causes the periodic algae blooms in inner Green Bay. When the blue-green algae die off, the decomposition process consumes oxygen and produces ammonia, making the water less habitable for some native fish species and more hospitable to species such as carp, which can survive in low-oxygen, high-ammonia waters. Furthermore, zooplankton, which are a primary food source of several fish species in Green Bay, prefer green algae over blue-green algae, so the stimulated algae growth does not fully contribute to the aquatic food chain. The excess algae growth and the total suspended solids (TSS) loads to the bay reduce water clarity and light penetration. Reduced light penetration means that submerged aquatic vegetation, which provides important habitat for many fish and waterfowl species, is unable to grow except in the most shallow waters. The lack of submerged vegetation in the inner bay has been cited as the cause for a decline in waterfowl use of the lower bay during spring and fall migration (WDNR, 1993). Decreased light penetration can also reduce the feeding success of sight-feeding fish such as sport fish like walleye and northern pike. Algae blooms can also reduce recreational services because the blue-green algae release a chemical when they die that can irritate people's skin and eyes on contact, and because of the foul odor produced during die-off.

Overall, these effects combine to reduce both the level and quality of the natural resource service flows provided by the waters of Green Bay. Thus, reducing nonpoint source loads is a means of enhancing natural resources that have been injured by PCBs through improving the ecological habitat and human use services of the bay.

Strategy for improving agricultural practices

Nonpoint source loadings of sediment and nutrients (particularly phosphorus) into Green Bay originate largely from agricultural fields around the bay (WDNR, 1988). For example, in the Duck, Apple, and Ashwaubenon Creek watersheds, approximately 95% of the total sediment load to watershed streams comes from cropland runoff (WDNR et al., 1997). Both Wisconsin and Michigan have well-established programs to improve agricultural practices to reduce nonpoint source pollution from rural areas. These programs have identified Best Management Practices (BMPs) which include cropland management practices that reduce loadings into adjacent streams and waterways. BMPs include actions such as contour farming, stripcropping, cropland protection cover, and conservation tillage. Of these BMPs, the Co-trustees will focus on conservation tillage to represent BMP improvements in cropland management to reduce nonpoint source pollution. Although other BMPs may be targeted as part of the post-award restoration plan, conservation tillage is used here to represent the benefits and costs associated with improvements in agricultural practices to reduce cropland erosion. Conservation tillage programs are a fundamental component of plans and efforts to reduce nonpoint source pollution into Green Bay (WDNR et al., 1993, 1997). Moreover, conservation tillage can provide collateral ecological benefits by providing cover for birds and small mammals and improved habitat quality for soil invertebrates (which, in turn, are fed upon by small mammals and birds).

In conservation tillage (also known as high residue management), tilling before planting is reduced or modified such that at least 30% of the field is covered with residue from previous crops (Figure 3.6). The most complete form is no-till, in which no tilling is conducted before planting. Other forms vary by the tilling practice and amount of residue left on the field. Conservation tillage can reduce TSS and phosphorus loadings from cropland by up to approximately 70% (Appendix G). Conservation tillage is commonly used on farms across the country, and it can provide other direct benefits to farmers such as reduced labor, tractor trips, and fuel consumption (R. Burton, Outagamie Land Conservation Department, personal communication, 2000).

Although programs to encourage or induce farmers to adopt conservation tillage have been in place in several counties around Green Bay for several years, many croplands in the area remain under conventional tillage. For example, 73% of the cornfield acres within the Wisconsin portion of the Green Bay drainage are still under conventional tillage, according to a 1999 survey (see Appendix H). Thus there are many opportunities to expand the existing conservation tillage programs, which exist for only a few of the watersheds.

The strategy for inducing farmers to adopt conservation tillage is to provide incentive payments for converting conventional tillage land to low tillage. This strategy is the same as the strategy that has been employed by county and tribal land conservation departments with success. Typically, incentive payments are required for a limited number of years initially, and once

Figure 3.6. Example of a farm field under conservation tillage practice. Note the crop residue remaining on the field. Photo from http://www.purdue.edu/UNS/html4ever/9802.Evans.notill.html.

farmers have adopted and become accustomed to conservation tillage practices, the need for continuing incentive payments is reduced (R. Burton, Outagamie Land Conservation Department, personal communication, 2000). Education and outreach to farmers are also seen as significant components of a successful conservation tillage program (R. Burton, Outagamie Land Conservation Department, personal communication, 2000).

The Co-trustees will coordinate closely with county and tribal land conservation departments in implementing a program to increase conservation tillage. Some of these departments, particularly those of Brown County, Outagamie County, Winnebago County, and the Oneida Reservation, have active programs already in place. The Co-trustees will work with these departments to make full use of their experience and institutional knowledge. In this way, a conservation tillage program can provide a coordinated and cost-effective means of reducing TSS and phosphorus loadings into Green Bay, thereby improving the ecological and human use services provided by the bay's resources.

Strategy for vegetated buffer strips

In many areas around Green Bay, fields are tilled and planted right up to stream edges, or right across ephemeral drainageways that run through fields. As a result, runoff generated from the fields has a direct route into the stream or drainageway. The installation of buffer strips along streams that run through agricultural areas has been shown to be an effective means of reducing the loadings of sediment and nutrients to streams (Appendix I). These strips can capture sediment and nutrients coming from the fields before they reach the streams, and can reduce erosion of streambanks. Figure 3.7 shows an example of a field before and after installation of a vegetated buffer strip, and Figure 3.8 provides another example of an installed buffer strip.

In addition to reducing nonpoint source pollution loadings from cropland, buffer strips can also provide valuable direct habitat benefits. The streambank stabilization caused by the roots of the vegetation used in the buffer strip helps to decrease the formation of erosion gullies (Kittle, 1999) and to maintain stream geometry, thereby enhancing stream habitat for fish and macroinvertebrates (Gilliam et al., 1997). The vegetative cover of the buffer strip can provide wildlife nesting and feeding habitat (U.S. EPA, 1993). Buffer strips may also provide connecting corridors that enable wildlife to move safely from one habitat to another (NRCS, 2000). These collateral benefits provided by vegetated buffer strips are consistent with the overall Co-trustee restoration criteria and goals.

The Co-trustees' strategy for buffer strip installation is based on the strategy currently being used by the Brown County Land Conservation Department to implement their buffer strip program (W. Hafs, Brown County Land Conservation Department, personal communication, 2000). Brown County pays landowners a fee of $500 per converted acre as an incentive for converting plowed land to buffer strips. Because of Brown County's buffer strip ordinance, the conversion to a buffer strip is perpetual and runs with the land deed (W. Hafs, Brown County Land Conservation Department, personal communication, 2000). Thus the incentive fee acts similarly to the purchase of a land easement from farmers for the areas converted from agriculture to buffer strip. Active restoration is then conducted, which typically consists of planting and maintaining natural vegetation in the strip.

3.2.7 Estimating benefits of the preferred alternative for scaling purposes

As described in Section 3.2.5, scaling the preferred restoration alternative is accomplished through value-to-value equivalency, which determines the level of restoration required to compensate the public for the injuries to natural resources by determining the value to the public of the environmental services gained through restoration. Thus, a key component of the scaling process is estimating the environmental benefits that will be achieved through restoration for use

Figure 3.7. Example of a drainageway before (top) and after (bottom) installation of a vegetated buffer strip. Photo courtesy of William Hafs, Brown County Land Conservation Department.

Figure 3.8. **Example of an installed buffer strip.** Photo courtesy of William Hafs, Brown County Land Conservation Department.

in conjunction with the TVE study results. This section describes how the environmental benefits of the preferred alternative components (wetland restoration, wetland preservation, and nonpoint source pollution control through conservation tillage and vegetated buffer strips) will be estimated for the purposes of restoration action scaling.

Estimating benefits of wetland restoration and preservation

The environmental benefits provided by both wetland restoration and wetland preservation will be expressed as acres of wetlands restored or preserved. However, there are two underlying factors that require consideration and may influence the total amount of wetland actions taken: differences in the environmental services provided by different wetlands, and the time span over which the benefits of wetland preservation accrue.

Different wetlands can vary dramatically in the levels of environmental benefits they provide, such as floodwater retention, sediment and nutrient trapping, energy and carbon cycling, and plant and wildlife habitat. The TVE study (Section 3.2.5) is based on the assumption that the types and magnitude of environmental benefits provided by restoration actions are at least similar to those provided by wetlands that exist today or have been lost in the past. Several methods are available for quantifying these services which could be used to provide a metric for comparing the benefits provided by different wetlands. Such methods include those for quantifying functional benefits, such as the U.S. Army Corps of Engineer's hydrogeomorphic classification system (Brinson, 1993); those for quantifying benefits for particular fish or wildlife species, such as the Service's Habitat Evaluation Procedures (U.S. FWS, 1980); and those for quantifying economic benefits (Bardecki, 1998). The Co-trustees may use these or other procedures as part of the post-award restoration plan to assist in identifying specific targets or priorities for wetland restoration or preservation beyond those developed in the previous section. However, at this point in the restoration planning process the Co-trustees are not including a quantitative estimation of wetlands benefits as part of the scaling process, and wetland benefits will be expressed simply as acres restored or preserved. The Co-trustees recognize that restored wetlands may not provide the same level of ecological services as do the wetlands that would be targeted for preservation. This fact is taken into account in how the Co-trustees may combine wetland preservation and restoration in the preferred restoration alternative.

A second factor to consider in estimating the benefits provided by wetland restoration or preservation is the timeframe over which the benefits accrue. The benefits provided by wetland restoration would begin soon after restoration actions are completed. The flow of benefits would follow the development of the restored wetland into a fully functional system, which, if the restoration effort is successful, can take from several years to several decades (D'Avanso, 1990). In contrast, the benefits of wetland preservation do not begin until the time at which the wetland would have been lost or degraded had preservation not taken place. Since the wetlands being preserved already exist, preservation provides additional benefits only if and when the wetland benefits would have been otherwise lost. Estimating the time period over which preservation benefits accrue is difficult given the general success of existing regulation in at least slowing down wetland loss. However, it is probable that many wetlands would not face significant human impacts for decades to come, and certainly at a time much farther into the future than when the benefits of wetland restoration begin. Since benefits that occur in the future are discounted to convert to present-value amounts, this means that a higher quantity of wetland preservation is required than wetland restoration to provide the same level of benefits (assuming that restored wetlands are of equal ecological value). For example, using a discount rate of 3% to convert future to present-value benefits, if it is assumed that wetland restoration benefits begin in 5 years and wetland preservation benefits begin in 20 years, then 15,600 acres of wetland preservation would be required to yield the benefits provided by 10,000 acres of wetland restoration (all other factors being equal).

In conclusion, the benefits of wetland restoration and preservation will be quantified in terms of acres restored or preserved. Measures of wetland benefits may be used as part of the post-award restoration plan to rank or compare different wetlands. Finally, more acres of wetland preservation may be required to provide the same level of benefits as wetland restoration, since the benefits of wetland restoration begin soon after project completion whereas the benefits of preservation do not begin until the time when the wetlands would have been lost or degraded.

Estimating loadings reductions from conservation tillage and buffer strips

The environmental benefits provided by conservation tillage and vegetated buffer strips can be expressed as the estimated reduction in TSS and phosphorus loads to Green Bay. These reductions in loads can also be translated into corresponding increases in water clarity and reductions in algae growth, which are the two parameters used in the TVE study to express the benefits of controlling nonpoint source pollution. A GIS-based modeling approach was used to provide an initial estimate of the reductions in loads that would result from improving tillage practices and installing riparian buffer strips in the Green Bay basin (Appendix H). The approach presented here represents a reasonable and reliable approach for the purposes of the RCDP. In developing the post-award restoration plan, the Co-trustees may work with state and local experts and land conservation personnel to develop alternative approaches that can provide better input into identifying specific parcels of land or restoration actions and more precise estimates of the benefits that can be achieved.

Estimating current loads of TSS and phosphorus to Green Bay

The first step in evaluating the effectiveness of nonpoint source pollution reduction programs is to model the loads of TSS and phosphorus into Green Bay under current land management practices. Estimates of load reductions under altered land management practices (conservation tillage, riparian buffer strips) can then be estimated by altering the model.

A model of current loads was developed for the Co-trustees by Fox Wolf Basin 2000, and is described in detail in Appendix G. The model takes into account such factors as land cover type, soil characteristics, climate, topography, and current tillage practices to estimate loadings to Green Bay from each of the watersheds shown in Figure 3.9. Only watersheds within Wisconsin were included because the GIS data layers for conducting the analysis are only available for Wisconsin, and because the Wisconsin Green Bay tributaries contribute the large majority of the nonpoint pollution loadings into Green Bay. For example, 90% of total organic phosphorus loading into Green Bay in 1989 from major tributaries was from Wisconsin tributaries, compared to just 10% from Michigan tributaries (Fitzpatrick and Myers, 2000).

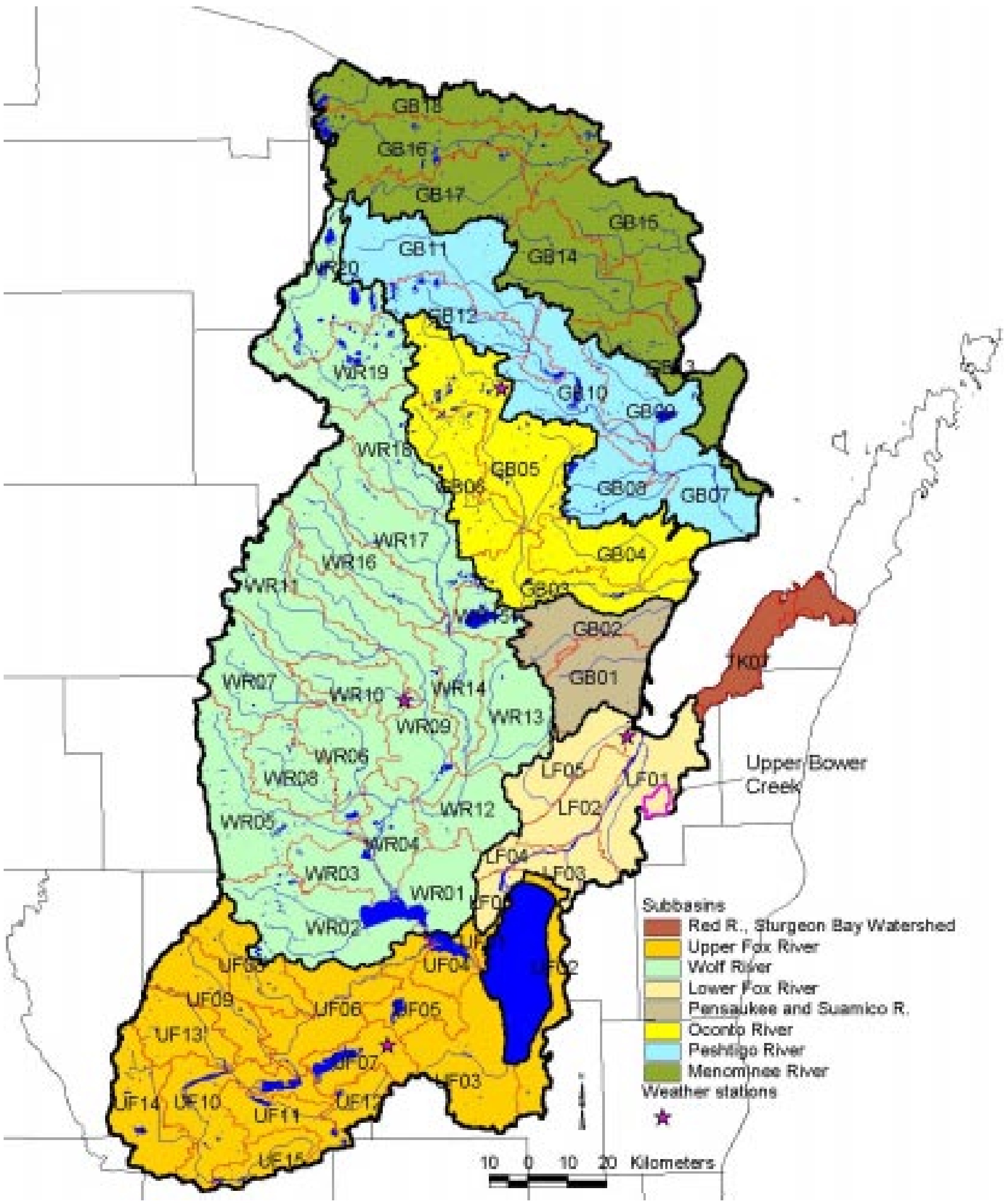


Figure 3.9. Watersheds included in the analysis of TSS and phosphorus loadings to Green Bay.

The results of the analysis of current runoff loads are presented and discussed in detail in Appendix G. Nonpoint source runoff delivers approximately 136,000 metric tons of sediment per year and 643,000 kg of phosphorus per year to Green Bay. The watersheds that produce the highest runoff loadings tend to be those in the Lower Fox River and lower part of the Upper Fox River drainages, such as the East River watershed, the Plum and Kankapot creeks watershed, the Lake Winnebago East watershed, the Fond du Lac River watershed, and the Duck Creek watershed. These results are used as the starting point from which reductions in loadings that result from conservation tillage practices and riparian buffer strips can be estimated.

Estimating reductions in loadings from conservation tillage practices

Appendix H describes the methods used to estimate the reductions in loadings from a basin-wide conservation tillage program. The method is based on the relative effectiveness of different tillage practices to lower the amount of TSS and phosphorus runoff generated from croplands, applied to the acres within each watershed that would fall into cropland tillage categories after implementation of a program to improve tillage practices. The method incorporates an assumption of a less than complete level of farmer participation in the program.

The results are shown in Table 3.10 for phosphorus load reductions under different levels of implementation and for different numbers of watersheds in which a conservation tillage program is enacted (results for TSS reductions are similar). If conservation tillage is adopted within all watersheds and farmer participation is 75%, then approximately 910,000 acres of cropland within the Green Bay basin would be converted from more conventional tillage practices to conservation tillage. This would result in an approximately 26% reduction in phosphorus loads to Green Bay. A slightly higher number of acres converted (997,000) and percent phosphorus load reduction (29%) can be achieved if 85% farmer participation is assumed. By applying conservation tillage practices across watersheds according to the amount of reduction achieved per acre converted, implementation on only 303,000 acres achieves a phosphorus loading reduction of 15%.

Estimating reductions in loadings from installing vegetated buffer strips

Appendix H describes how the loadings reductions from installing vegetated buffer strips along streams are estimated. In general, buffer strips are assumed to be installed in areas that are currently under agricultural production within 15 m of waterways. Buffer strips reduce watershed loadings into Green Bay by both capturing a portion of the loadings in runoff that enter the buffer strip and by generating much less loadings than active agricultural fields. The analysis assumes that buffer strips are effective at capturing only the loadings that are generated within 90 m of the upgradient edge of the strip, since loadings generated from farther away are assumed to reach a buffer strip as channelized flow (Appendix I). For the loadings generated

Table 3.10. Estimated reductions in phosphorus loadings to Green Bay under different implementation levels of conservation tillage.

Acres converted to conservation tillage[a]	Estimated percent reduction in phosphorus loadings to Green bay
997,000[b,c]	29.0
910,000[c,d]	26.0
501,000[d]	20.0
303,000[d]	15.0
169,000[d]	10.0

a. Conservation tillage is defined as mulch till or no till/ridge till; total includes corn and soybean crops.

b. Assumes maximum of 85% of lands in conventional till are converted to conservation tillage.

c. Conservation tillage scenario is applied to all Green Bay watersheds.

d. Assumes maximum of 75% of lands in conventional till are converted to conservation tillage.

from within 90 m of buffer strips, buffer strips are assumed to be 35% effective at reducing phosphorus loads (Appendix I).

The estimated reductions in phosphorus loadings to Green Bay under different levels of buffer strip installation are shown in Table 3.11. At levels of implementation that are less than 100%, we assume that buffer strips are installed in only the watersheds where the highest level of reduction is achieved per acre of buffer strip installed. Thus, for example, to achieve 50% of the phosphorus reduction that is achieved at a full implementation level, only 23% of the potential buffer strip acres need be converted. This approach allows for a cost-effective way of combining different levels of buffer strip installation with different levels of conservation tillage programs to achieve a given level of loadings reduction.

Estimating increases in Green Bay water clarity

The Co-trustees' TVE study is based on expressing the benefits of nonpoint source pollution reductions in terms of increases in Green Bay water clarity and reduction in algae. Reductions in nonpoint source loadings to Green Bay are translated to corresponding increases in water clarity using the relationship between phosphorus and water clarity that has been measured in Green Bay (Appendix H). Table 3.12 shows the relationship between percent reduction in phosphorus to Green Bay and number of inches of increased water clarity that will be used to express nonpoint source pollution reduction benefits. The method being used is based on (1) the relationship between phosphorus concentrations and water clarity in Green Bay that has been measured from 1991 through 1997 by the Green Bay Metropolitan Sewerage District, and (2) the

Table 3.11. Percent reductions in phosphorus loadings to Green Bay under different levels of buffer strip implementation.

Acres converted to vegetated buffer strips[a]	Percentage of potential Green Bay watershed acres converted	Estimated percent reduction in phosphorus loads to Green Bay
52,745	100	4.1
32,900	62	3.5
23,900	45	3.0
17,300	33	2.5
12,300	23	2.0
8,500	16	1.5
5,250	10	1.0

a. Assuming that conversion is conducted in the most cost-effective watersheds first.

Source: Appendix H.

Table 3.12. Increases in Green Bay water clarity with reductions in phosphorus loadings.

Percent reduction in phosphorus runoff loadings into Green Bay	Resulting water clarity[a] (inches)
4.0	21.0
8.0	22.0
12.0	23.0
16.0	24.2
20.0	25.3
24.0	26.5
28.0	27.8
32.0	29.1

a. Initially 20 inches.

relationship between changes in Green Bay phosphorus loadings and water concentrations used in the Green Bay Mass Balance Study (Bierman et al., 1992; DePinto et al., 1994; Fitzpatrick and Meyers, 2000; Hydroqual, 1999; LTI Environmental Engineering, 1999). More detailed and comprehensive analyses may be conducted as part of the post-award restoration plan, depending on the scale of nonpoint source pollution reduction programs actually implemented and the need for additional precision.

3.2.8 Costing methods

The final claim for damages that will be prepared by the Co-trustees will include the cost of implementing the preferred restoration alternative as one of its components. This section describes the different cost elements of the preferred restoration alternative.

Each component of the preferred restoration alternative has multiple cost elements. These elements include direct costs (costs that are attributable to the specific restoration action) and indirect costs (costs that cannot be attributed to the actions themselves, such as overhead) [43 CFR §11.83(b)(1)]. The direct and indirect cost elements for each type of restoration action are summarized in Table 3.13.

Table 3.13. Cost elements for each selected restoration action.

	Direct costs						Indirect costs
	Land acquisition/easements						
Restoration action	Land value	Transaction costs	Restoration actions	Project maintenance	Contingency	Monitoring	Co-trustee overhead
Wetland restoration	X	X	X	X	X	X	X
Wetland preservation	X	X				X	X
Conservation tillage practices			X			X	X
Riparian buffer strip installation	X	X	X	X	X	X	X

Table 3.14 lists the different costing methodologies specified in 43 CFR § 11.83(b)(2) that will be used by the Co-trustees for each of the cost elements. The goal of applying the various cost estimating methods is to develop a reasonable estimate of how much it will cost to implement the preferred alternative.

Land acquisition costs

Land acquisition costs include two direct cost components: the land purchase price and the costs associated with planning, negotiating, and conducting the land transaction (transaction costs). Transaction costs are estimated as a percentage of the land acquisition costs. Based on the Service’s experience with land acquisition programs, transaction costs are typically 20% of the

Table 3.14. Costing methodologies for the different cost elements.

	Direct costs						Indirect costs
	Land acquisition						
Costing methodology	Land value	Transaction costs	Restoration actions	Project maintenance	Contingency	Monitoring	Co-trustee overhead
Unit methodology	X		X	X			
Standard time data methodology			X				
Factor methodology		X			X	X	
Indirect rate application							X

purchase price (B. Bryant, U.S. FWS — Great Lakes Regional Office: Land Acquisition Supervisor, personal communication, 2000).

The Co-trustees generated a general cost estimate of land prices to derive land value cost estimates for different types of land in the counties surrounding Green Bay. The general cost estimate, produced by Ritter Appraisals, Inc., is based on three sources of information: (1) a detailed review of 1998 and 1999 transaction records and listed prices for parcels greater than 40 acres in the following five counties: Brown, Door, Marinette, Oconto, and Outagamie; (2) 1998 sales summary data organized by land use class from the Wisconsin Department of Revenue; and (3) conversations with local realtors. A copy of the general cost estimate report is included as Appendix J. Although the general land cost estimate was conducted based on data for only five counties in Wisconsin, the counties included in the analysis represent a mix of urban and rural areas that border or are near Green Bay. Therefore, the average land price estimates developed from these five counties are assumed to be representative of the other Wisconsin and Michigan counties where restoration actions may take place.

Land cost estimates were developed on a per acre basis for the following types of land:

- agricultural lands, with separate estimates for lands sold for continued use as agricultural land and for lands sold for diverting use

- wetlands, including separate estimates for inland wetlands, bay/coastal wetlands, and inland wetlands along stream or river waterfronts

- bay coastal uplands and uplands along stream or river waterfronts.

In addition, the general cost estimate includes a qualitative analysis of how factors such as parcel size, road access, and location within a county influence the average land value.

Table 3.15 shows the results of the general cost estimate for the types of lands relevant to the RCDP cost analysis. The results shown are the per acre cost for each type of land, weighted across Green Bay counties by the amount of available land with the potential for restoration or preservation within each county. For example, to obtain the value of $3,000 for agricultural land on hydric soils, the average value within each county was weighted by the acres of agricultural land on hydric soil within that county, relative to the total number of such acres across all the counties. Table 3.15 includes the underlying basis used to calculate the weighted average for each of the land types.

Table 3.15. Estimated overall average land purchase prices based on weighting individual county average prices.

Type of land	Basis for weighting costs across counties	Weighted average cost (per acre)
Agricultural land for restoration to wetlands	Distribution of agricultural land on hydric soils (Appendix F)	$3,000
Coastal wetlands for preservation	Distribution of coastal wetlands (Appendix F)	$1,300
Uplands (as a buffer for coastal wetlands)	Distribution of coastal wetlands (Appendix F)	$1,600
Natural area wetlands for preservation	Distribution of The Nature Conservancy portfolio sites[a]	$1,000
Inland wetlands for preservation around urban areas	Distribution of population density growth (Appendix F)	$1,300

a. Assumed to be 50% in Door County and 50% in Marinette and Delta counties, based on Figure 3.5.

Again, the Co-trustees wish to emphasize that they are not seeking to be the owners of any purchased land, and anticipate that such land would be under the ownership of local land conservation groups and/or agencies.

Active restoration costs

Active restoration costs include costs for restoring wetlands, converting farmland to conservation tillage, and installing vegetated buffer strips. The active restoration costs that will be used in developing the overall cost estimate are shown in Table 3.16. Descriptions are provided below, and details are provided in Appendix K.

Table 3.16. Active restoration costs.

Type of restoration action	Unit cost
Restoration of farmland to wetland	$2,600/acre
Conservation tillage	$90/acre
Riparian buffer strip installation	$240/acre
Source: Appendix K.	

Restoring farmland to wetlands typically requires active restoration work such as plugging ditches, destroying drain tile, and seeding or planting wetland plants. The cost estimates for wetland restoration are based on unit cost estimates for the types of activities typically required. An average cost of $2,600 per acre of agricultural land restored to wetlands is used to estimate the direct cost of wetland restoration.

The direct restoration costs for implementing conservation tillage practices include two components: incentive payments to farmers to adopt the new tillage practices, and transaction costs associated with contacting, educating, and negotiating with farmers. Incentive payment costs and transaction costs are based on the current programs of Winnebago and Outagamie counties. Typical total costs for the conservation tillage program are approximately $90 per acre converted to conservation tillage, assuming that four years of performance-based payments are required for farmers to permanently adopt conservation tillage practices.

The cost element estimates for the installation of vegetative buffer strips are based on unit cost estimates from the Brown County Land Conservation Department, which has experience in installing vegetated buffer strips. The types of activities typically required to install buffer strips include removing stones, plowing, harrowing, and seeding. A value of $240 per acre of buffer strip is used to estimate these costs.

Project maintenance costs

Restored wetlands and vegetated buffer strips typically require a limited amount of ongoing maintenance. Restored wetlands typically require activities such as prescribed burning and/or mowing to maintain a dominance of desirable wetland plant species. Assuming that maintenance activities are required every 3 years, $590 per acre is required to fund the maintenance for 25 years (Appendix K).

Vegetated buffer strip maintenance activities generally consist of annual mowing, occasionally reseeding the buffer strip, and filling in gullies and other concentrated flow paths that have developed over time. Assuming that some of these activities (e.g., mowing) are conducted every year and others are conducted every 5 years, $1,100 per acre is required to fund maintenance for 25 years (Appendix K).

Contingency

Contingency costs are included to cover unexpected costs not incorporated in the other cost element estimates. Contingency costs will be estimated as a percentage of the total of the other direct costs and will be applied only to wetland restoration and vegetated buffer strip installation, the activities that require engineering and construction related work. The Co-trustees anticipate using a contingency cost rate of 10%, based on standard contingency rates (U.S. Army Corps of Engineers and U.S. EPA, 2000).

Restoration monitoring

A direct cost element that is associated with all of the components of the preferred restoration alternative is monitoring. The restoration actions that will be conducted by the Co-trustees must be monitored to determine the degree to which the actions achieve the restoration scaling goals. In addition, monitoring will provide ongoing evaluation of any maintenance activities that should be added or modified for the projects to achieve their goals. Monitoring will be conducted according to a monitoring plan developed by the Co-trustees as part of the post-award restoration plan.

Monitoring costs will be estimated as a percentage of the total restoration costs. Based on general experience, the Co-trustees estimate that monitoring costs will be approximately 5% of the total of land value, land transaction, restoration action, and project maintenance costs.

Improvement to park facilities

In addition to the four preferred types of restoration actions (wetland restoration, wetland preservation, conservation tillage, and vegetated buffer strip installation), the Co-trustees have also developed cost estimates for improving existing park facilities in the Green Bay area (Appendix K). Improvements to existing park facilities is one of the types of restoration actions considered in the Co-trustees' TVE assessment and for which scaling measurements are available. Although the results of the TVE assessment demonstrate that improvements to existing parks are not highly valued by the public compared to the other potential restoration actions, cost estimates for park improvements are developed to allow the Co-trustees flexibility in the selection of restoration components.

The cost of improving existing park facilities is estimated based on an incremental increase in the current costs allocated to existing park facilities in the Green Bay area. The current annual budgets for the county Parks and Recreation Departments and the specific state parks in the area were compiled to provide an estimate of current costs for these parks. The results are shown in

Table 3.17. A total of approximately $9.4 million is currently spent annually on county and state park facilities within the area. The cost of improving these parks will be estimated based on a percentage increase in this annual amount spent on the parks. For example, the cost of a 10% improvement in existing park facilities (one of the restoration levels assessed in the TVE study) is estimated as $940,000 annually, not accounting for inflation. Over 25 years this amounts to a total estimated cost of $24.0 million.

Table 3.17. Estimated current average annual costs for county and state parks in the Green Bay area.

Type of park	Estimated annual costs for provision of baseline recreational services (millions 2000$)
County	$7.2
State	$2.2
Total	**$9.4**

Indirect costs

Indirect costs include Co-trustee agency overhead costs associated with implementing the preferred restoration alternative. Indirect costs will be estimated using an indirect cost rate for overhead costs [43 CFR §11.83(b)(1)(iii)]. The Co-trustees will use the standard indirect rates of the Service and the Department for projects of a nature similar to the preferred alternative. The standard indirect rates for the Service and Department are:

- 22% Service overhead for project costs incurred within Region 3 of the Service, which includes Wisconsin and Michigan (Blankenship, 1992)
- 16.84% Department overhead for project costs incurred within the Service's regions (Frank Horvath, U.S. FWS, personal communication, 2000).

Therefore, a total overhead rate of 38.84% is used by the Co-trustees to estimate indirect costs.

Summary

Table 3.18 presents an example of the estimated overall average unit costs for each cost component of the four types of restoration actions. Many factors may affect the actual unit costs at the time of final plan implementation, including exact project location, attitudes of current landowners, and the specific restoration and maintenance actions required. The values shown in Table 3.18 are intended to represent reasonable estimates of the overall average costs for each of the cost elements.

Table 3.18. Examples of estimated overall average unit costs.

	Direct costs ($/acre)						Indirect costs ($/acre)	
	Land acquisition (per acre)							
Restoration action	Land value	Transaction costs (20%)	Restoration actions	Project maintenance (present value)	Contingency on restoration actions (10%)	Monitoring (5%)	Co-trustee overhead (38.84%)	Total costs ($/acre)
Wetland restoration	3,000	600	2,600	590	260	340	2,900	$10,300
Wetland preservation — coastal wetlands	1,300	260	n/a	590	n/a	110	880	$3,100
Wetland preservation — coastal uplands	1,600	320	n/a	n/a	n/a	100	780	$2,800
Wetland preservation — other high quality natural areas	1,000	200	n/a	590	n/a	90	730	$2,600
Wetland preservation — wetlands in more populated areas	1,300	260	n/a	590	n/a	110	880	$3,100
Conservation tillage	n/a	n/a	90	n/a	n/a	5	40	$140
Vegetated buffer strips	500	100	240	1,100	20	100	800	$2,900

3.2.9 Combining restoration projects in the preferred alternative

The final component of the Co-trustees' restoration plan is defining the amounts of the different general classes of restoration actions that will, together, constitute the preferred alternative. This section describes the Co-trustees' overall approach to defining the preferred mix of project types, and provides representative examples of total restoration costs for different possible combinations. The final mix of project types will be defined in the post-award restoration plan.

The Co-trustees' TVE study is used to assist in defining the scale of restoration required to compensate the public for natural resource injuries and service losses through different possible combinations of the three general project categories (increasing wetland acreage, reducing nonpoint source pollution, and improving existing park facilities). Through these three types of restoration actions, the public can be made whole for the continuing and future PCB injuries to natural resources. The Co-trustees considered the following factors in determining the relative amount of the three restoration project types that constitute the preferred alternative:

- *Natural resource restoration is preferred over outdoor recreational facility improvements.* Park improvements scored much lower against the Co-trustees' criteria than resource-based actions of wetlands preservation/restoration and nonpoint source pollution reduction. This preference is also supported by the results of the TVE study, which demonstrate the public's preference for natural resource actions over outdoor recreational enhancements.

- *A mix of project types is preferred*. Co-trustees prefer a mix of natural resource restoration actions to provide a broad array of natural resource services throughout the Lower Fox River and Green Bay Environment and to enhance a select group of outdoor recreational activities that have benefits to local communities. Thus, a variety of natural resource and public goals are supported, rather than just one type of goal. Selecting a mix of project types allows for more flexibility to develop a cost-effective restoration plan, and may be necessary to provide the full amount of services of equal value to those lost under some PCB remediation scenarios.

- *There are technical limitations on the maximum amount of each restoration type that is reasonably possible to implement.* The preceding sections describe the limits on the maximum amount of TSS and phosphorus loading reductions that are possible through conservation tillage and buffer strip installation. There are also limits on the total wetland acreage available for preservation, and on the extent to which existing park facilities can be improved.

- *The scale of restoration required affects the project mix.* The less extensive the response agencies' PCB cleanup, the larger the magnitude of restoration required to compensate the public for losses (because service flow losses will continue longer). The relative mix of project types selected may change as the overall amount of restoration changes, because of practical limits on implementation of specific project types or because of cost considerations.

- *Cost-effectiveness.* The TVE study observed diminishing marginal value with increasing levels of any one type of restoration (other than PCB removal), indicating that a mix of actions is preferred to cost-effectively produce service flow benefits. Furthermore, the cost-effectiveness of actions to reduce nonpoint source runoff may decrease as the amount of the actions increases (since the most cost-effective watersheds and sites will be addressed first).

Table 3.19 lists illustrative examples of mixes of restoration actions, including different combinations of preserving and restoring wetlands, increasing water clarity through conservation tillage and buffer strips, and improving existing park facilities. These examples illustrate the types of combinations that will be considered by the Co-trustees under different possible remediation scenarios and timeframe of continuing injury. Estimated costs for each of the combinations are also provided. The table shows that if intensive remediation is conducted and baseline levels are achieved within 20 years, restoration costs are less than if intermediate remediation is conducted and PCB injuries continue for 40 years. The examples shown in the table are illustrative only to demonstrate the types of project mixes and associated costs that will be considered by the Co-trustees as part of the post-award restoration plan. However, as described previously, cost is not the only factor in selecting the mix of project types to be implemented.

The combinations of wetland preservation, wetland restoration, reduced nonpoint source runoff through improved tillage practices and riparian buffer strips, and improved park facilities will provide a broad array of environmental benefits, from improving habitat for birds, fish, and other biota to increasing bay water clarity to enhancing recreational opportunities. These actions will compensate for the resources and services lost because of PCB injuries by providing valuable environmental benefits to the Lower Fox River and Green Bay Environment.

Table 3.19. Illustrative examples of project mixes and total restoration costs under different time periods of injury.

Nonpoint source runoff reduction			Wetlands			
Vegetated buffer strip (acres)	Cropland converted to conservation tillage (acres)	Resulting water clarity (inches, from 20 inches initially)	Acres preserved	Acres restored	Percent improvement in park facilities	Total cost (millions)
For PCB injuries from 0 to 20 years into the future (intensive remediation)						
5,500	106,000	22.0	8,700	2,900	10	$111
12,000	254,000	24.0	7,800	2,600	5	$133
23,500	477,000	26.0	6,900	2,300	5	$191
For PCB injuries from 0 to 40 years into the future (intermediate remediation)						
12,000	254,000	24.0	9,900	3,300	10	$158
23,500	477,000	26.0	9,000	3,000	10	$216
23,500	852,000	28.0	8,700	2,900	10	$268

3.3 Compensable Value Determination

The Co-trustees conducted an assessment of the compensable values of recreational fishing service flow losses to the public (referred to as recreational fishing damages) as a result of releases of PCBs into the waters of Green Bay. The assessment was based on existing literature and data, as well as data from a new survey of recreational anglers, to identify and quantify impacts of the PCB contamination on recreational fishing through time. A report detailing the approach, methods, results, and conclusions of the assessment was published in November 1999 (U.S. FWS and Stratus Consulting, 1999f). A summary of the report is provided here.

The assessment determines total recreational fishing damages, including damages for both past interim losses and current and future losses. However, as described in Section 3.1 of this RCDP, the Co-trustees have selected the compensable values from recreational fishing losses for use in calculating only the past interim damages, and current and future damages will be calculated as restoration costs. Nevertheless, the current and future damages for recreational fishing losses that were determined in the Co-trustees' assessment are included here to provide a comparison with the results of the TVE study that addresses current and future losses of all services (Appendix A).

3.3.1 Methods

Area addressed

The recreational fishing damages assessment assessed losses for all waters of Green Bay, including the bays within Green Bay (e.g., Little and Big Bays de Noc, Sturgeon Bay), and all rivers feeding into Green Bay up to the first dam or obstruction, including the Lower Fox River from the dam at De Pere to Green Bay. The entire waters of Green Bay are included because there are PCB fish consumption advisories (FCAs) for the entirety of Green Bay, including its tributaries. Thus, the PCBs released into the Lower Fox River result in service losses, and therefore damages, throughout the waters of Green Bay. While PCBs from the Lower Fox River are transported to the waters, sediments, and natural resources of Lake Michigan, this assessment does not address any recreational fishing service flow losses from the release of PCBs into Lake Michigan outside of the waters of Green Bay.

Types and measures of service flow losses considered

The assessment estimates the value of recreational service flow losses (e.g., damages) resulting from the imposition of FCAs in response to PCB contamination in the assessment area. While fish populations may be injured by PCBs, resulting in recreational fishing service flow losses through reduced catch rates, these injuries have not been quantified and are not included in the valuation of recreational service losses. However, the assessment methods and results are designed to compute the value of service flow benefits from increased catch rates if increasing catch rates is part of a restoration package.

The recreational fishing service flow losses from FCAs can be classified into the following four categories:

1. ***Reduced enjoyment from current Green Bay fishing days.*** Anglers active at the assessment site may enjoy their days at the site less because of concerns about health, and safety and displeasure with catching contaminated fish. These concerns can result in changes in fishing locations within the waters of Green Bay, changes in target species type and size, and changes in behavior regarding keeping, preparing, and consuming fish.

2. ***Losses by Green Bay anglers from fishing at substitute sites.*** Because of FCAs, anglers who fish the waters of Green Bay may substitute some of their fishing days from the waters of Green Bay to other fishing sites that, in the absence of FCAs in the waters of Green Bay, would be less preferred sites.

3. ***Losses by Green Bay anglers who take fewer total fishing days.*** Because of FCAs, anglers who fish the waters of Green Bay may take fewer total fishing days than they would otherwise. For example, an angler may still take the same number of days to other sites, but take fewer days to the waters of Green Bay to avoid the FCAs.

4. ***Losses by other anglers and nonanglers.*** Because of FCAs, some anglers may completely forego fishing the waters of Green Bay, in one year or many years. Other individuals who would fish the waters of Green Bay if it did not have FCAs may completely forego fishing.

The approach employed in the Co-trustees' assessment measures the value of service losses in categories 1 and 2, but not in categories 3 and 4. As a result, the calculations understate recreational fishing damages. The magnitude of this omission is unknown, although survey results indicate that losses in category 4 are not inconsequential, because the number of anglers who would be active in Green Bay fishing in the absence of FCAs may be as much as 30% larger than occurs with the current FCAs.

Consistent with the Department regulations for conducting NRDAs, the assessment measures the value of service flow losses through measuring recreational WTP for changes in FCA levels [43 CFR § 11.83 (c)].

Time period

Compensable damages are computed for interim services lost to the public resulting from PCB contamination from the date of CERCLA enactment (December 1980) or CWA amendments (1976) until the service flows are restored to baseline [43 CFR § 11.80 (b)]. For purposes of this determination, which concerns the value of losses to recreational anglers, the service flows are considered to be returned to baseline when there are no longer FCAs. Interim damages thus include: (1) damages for past service flow losses starting in 1981 or 1976 through 1999, and (2) damages for future service flow losses beginning in 2000 until FCAs are removed. Future damages are computed under alternative remediation and restoration scenarios.

Primary data collection and benefits transfer

The assessment focuses on primary data collection and analysis to estimate open-water recreational fishing damages for a target population of anglers who purchase Wisconsin fishing licenses in eight Wisconsin counties near Green Bay and who fish in Green Bay. Data collection focuses on the Wisconsin waters of Green Bay because PCB loadings and the resultant FCAs are more severe for the Wisconsin waters of Green Bay than for the Michigan waters of Green Bay, and because the recreational fishing activity in the Wisconsin waters of Green Bay is much larger than in the Michigan waters of Green Bay. Therefore, recreational fishing losses are expected to be greater in the Wisconsin waters than in the Michigan waters. The population of anglers who purchase licenses in eight counties near Green Bay was targeted because they account for most of the anglers and fishing days in the Wisconsin waters. Thus, damages associated with many, but not all, Green Bay anglers who live out of state are included. Data collection focuses on open-water fishing (e.g., non-ice fishing) because it accounts for almost 90% of all fishing on the waters of Green Bay.

The assessment was designed to collect and combine data on actual fishing activities under current conditions (e.g., days fishing in the Wisconsin waters of Green Bay and elsewhere), referred to as revealed preference data, with stated preference data on how anglers would be willing to trade off changes in fishing characteristics, including catch rates, FCAs, and costs, and on how many days anglers would fish Green Bay under alternative conditions for the waters of Green Bay. This combination of data allows the benefits of both types of data to be realized. For example, Green Bay is a unique resource, and substitute sites similar to Green Bay without FCAs do not exist. Therefore, stated preference data were necessary to assist in determining angler preferences for resource characteristics that do not currently exist.

Stated preference data were collected using choice questions, which is a method related to conjoint analysis. The revealed preference and stated preference data, along with site-specific and individual-specific data, were combined in random utility models of recreation demand to estimate damages. These economic methods are recognized in the NRDA regulations at 43 CFR § 11.83 and at 15 CFR Part 990 Preamble Appendix G, and are well established in the literature.

Based on the damages in the Wisconsin waters of Green Bay, we employ benefits transfer methods [43 CFR § 11.83 (c)(2)(vi)] to compute damages for fishing days in the Michigan waters of Green Bay, and for ice-fishing days in the Wisconsin waters of Green Bay. This provides a high-quality benefits transfer because it applies to the same water body, and to the same or similar fish species and fishing activities.

Focus on Green Bay fishing by Green Bay anglers

The primary data collection is from a sample of the target population of anglers who currently fish the Wisconsin waters of Green Bay and focuses on the valuation of changes in fishing conditions in the Wisconsin waters of Green Bay. Through this approach, the extent and value of service flow losses with a large sample of anglers who are specifically knowledgeable of the resources and injuries of interest are estimated, and the survey is designed so that the valuation questions are relevant to respondents. Respondent familiarity and relevant questions specific to the site and conditions of interest, combined with the real world nature of the questions, enhance response accuracy and the applicability of the results to the valuation of service flow losses and the determination of compensable values.

A three-step procedure was used to collect data from a random sample of individuals in the target population of anglers who purchased licenses in eight counties near Green Bay and who are active in fishing the Wisconsin waters of Green Bay. First, a random sample of anglers was drawn from lists of 1997 license holders in the county courthouses in the eight counties near the Bay of Green Bay: Brown, Door, Kewaunee, Manitowoc, Marinette, Oconto, Outagamie, and Winnebago. This population includes residents of these counties, residents of other Wisconsin counties, and nonresidents who purchased their Wisconsin fishing licenses in these eight counties.

Second, a telephone survey was completed in late 1998 and early 1999. The telephone numbers were obtained from the courthouse sample, and a telephone contact was attempted for a 69% response rate. The telephone survey collected data on the number of total days fished in 1998, how many days were in the waters of Green Bay, and attitudes about actions to improve fishing. Anglers who participated in open-water fishing in the Wisconsin waters of Green Bay in 1998 were recruited for a followup mail survey: 92% of the recruited anglers agreed to participate. Data from the telephone survey allow comparisons of anglers who were and were not active in fishing the Wisconsin waters of Green Bay, as well as a comparison of those anglers who completed the mail survey versus anglers who did not complete the mail survey.

Third, a mail survey was used to collect data for estimating damages associated with PCB contamination and the resultant FCAs. The survey focuses on FCAs and catch rates for four species that account for about 90% of the Green Bay fishing activity, and on fishing costs. Interviews with anglers indicate that they are most concerned with changes in these site characteristics, and much less concerned with changes in most other site characteristics such as improving recreational facilities. By focusing on the key target species and key site characteristics, site conditions were efficiently presented, resulting in a cost-effective assessment that had limited cognitive burden on survey respondents.

The core of this mail survey is a series of eight choice questions used to assess damages for reductions in enjoyment for current open-water fishing days in the Wisconsin waters of Green Bay. In each question, respondents are provided two alternatives (A and B), each with different levels of fishing characteristics for the waters of Green Bay, and asked to choose Alternative A or Alternative B. Fishing characteristics include catch rates and FCA levels for yellow perch, trout and salmon, walleye, and smallmouth bass, and an angler's share of a daily fee. By varying the levels of the characteristics across alternatives and questions, the survey provides input data for computing the amount of money the anglers would be willing to pay (or the increases in fish catch rates the anglers would be willing to give up) to reduce or eliminate FCAs, as well as the amount of money the anglers would be willing to pay for increased catch rates.

After each choice question, a followup question asks how often the respondent would fish the Wisconsin waters of Green Bay under the alternative they select. This followup question allows the estimation of damages associated with substituting days from the waters of Green Bay to other fishing sites because of FCAs. The mail survey also updates the angler's fishing activity profile for 1998 by asking how many fishing days occurred since the telephone survey; collects attitude, opinion, and socioeconomic data; and collects additional data to evaluate the choice question responses. Of the 820 anglers mailed the survey, 647 (79%) completed and returned the survey.

Based on an evaluation of the sampling plan and available data, adjustments to the sample estimate of average days fished per angler are made to obtain a target population estimate accounting for potential recall, sampling, and nonresponse biases. Further, the sample can be expected to account for on the order of 90% of recreational fishing days on the Wisconsin waters of Green Bay and to be reasonably representative of the mix of resident and nonresident anglers.

3.3.2 Results

Advisory awareness

Eighty-five percent of the anglers active in the Wisconsin waters of Green Bay had heard or read about the FCAs. Generally, the anglers' perceptions of the specific advisory levels (i.e., how often one could eat fish of each species) are generally consistent with the published FCAs, although perceptions tend to understate the actual FCA severity for smallmouth bass.

The majority of the anglers rate the advisories as somewhat to very bothersome to their Green Bay fishing. Seventy-seven percent of the anglers identify behavioral responses to the FCAs, and 30% of active anglers report that they spend fewer days fishing the Wisconsin waters of Green Bay because of the FCAs. Over half the anglers have changed the species or size of fish they keep to eat, and over half have changed the way the fish they keep are cleaned, prepared, or cooked. For most anglers, improving catch rates is rated as less important than removing PCB contamination from Green Bay.

Total recreational fishing damages

The present value of all interim recreational fishing losses are summarized in Table 3.20. Damage estimates were found to be robust and highly statistically significant over different specifications of the statistical model.

Damages for past service flow losses are computed from 1981 or 1976 and are continued through 1999. Fishing activity through time is based on WDNR and MDNR estimates for the waters of Green Bay. Damages are scaled through time to reflect changes in FCAs through time. Generally, the FCA levels were the same or less in the past (as a result, anglers may have experienced the same or less loss of enjoyment but experienced increased health risks in the past, which is not included in the damage estimates). In Michigan, however, the FCAs were more restrictive in some past years. Also note that the number of fishing days in the past was often larger than in 1998. Total damages for past service flow losses starting in 1981 are estimated to be about $64.5 million, with about 69% of these damages in the Wisconsin waters of Green Bay.

Damages for future recreational fishing service flow losses are computed starting in 2000. The duration and levels of the FCAs depend on the level of remediation efforts to address PCB contaminated sediments, which have not been selected. The assumed levels of remedial efforts used to calculate the numbers shown in Table 3.20 are the same as those used to report the results of the Co-trustees' TVE study (Appendix A). For all future years we assume that fishing effort remains constant at 1998 levels for all fishing considered. The assumption of current fishing activity levels into the future may or may not be conservative because fishing effort in the waters of Green Bay was at a decade low level in 1997 and 1998. Fishing effort may or may not

Table 3.20. Present values for recreational fishing service losses for the waters of Green Bay resulting from fish consumption advisories for PCBs (millions 1998$, present value to 2000).[a,b]

	(A) Wisconsin waters of Green Bay		(B) Michigan waters of Green Bay	(C) All waters of Green Bay (A + B)
	Open-water fishing	Open-water plus ice	All fishing	All fishing
Damage category	**Primary study**	**Primary + transfer**	**Benefits transfer**	**Primary + transfer**
1. Present value of past losses:				
a. 1981-1999	37.8	44.3	20.2	64.5
b. 1976-1981	5.4	6.3	5.8	12.1
2. Present value of future losses[c]				
a. intensive remediation[d]	30.7	36.2	5.3	41.5
b. intermediate remediation[e]	43.2	51.0	7.5	58.5
c. no additional remediation[f]	62.3	72.9	10.2	83.2
3. Present value of total damages from 1976 to baseline (1+2)				
a. intensive remediation	68.5	80.5	25.5	106.0
b. intermediate remediation	81.0	95.3	27.7	123.0
c. no additional remediation	100.2	117.3	30.4	147.7

a. Rounded to the nearest $100,000. Totals may not equal sum of elements due to rounding.

b. Values for Wisconsin open-water fishing include reduced quality of current days plus substitution of days to other sites. Values for Wisconsin ice fishing and Michigan fishing include only reduced quality of current days.

c. Present values computed adjusting for changes in FCAs through time, assuming an average fishing activity at 1998 levels, and a 3% discount rate.

d. 20 years of damages = 10 years sediment removal plus 10 years of declining FCAs.

e. 40 years of damages = 10 years sediment removal plus 30 years of declining FCAs.

f. FCAs decline to zero over 100 years due to natural recovery.

remain depressed, most likely depending on the future catch rates, changes in FCAs and other water quality measures, and changes in the population of northeast Wisconsin.

Damages for future recreational fishing service losses range from $41.5 million (with intensive remediation) to $83.2 million (with no additional remediation). Total damages for past and future service losses range from $108 million (with intensive remediation) to $148 million (with no additional remediation).

A 3% discount rate is used to escalate past damages and to discount future damages to the year 2000. A 3% discount rate is consistent with the average real 3-month Treasury bill rates over the last 15 years (Bureau of Economic Analysis, 1998; Federal Reserve, 1998) and is consistent with Department recommendations (U.S. DOI, 1995) for NRDAs under CFR § 11.84(e). The present value of past and future service flow losses varies with the discount rate. For example, increasing the discount rate to 6% increases the value of past service flow losses but decreases the value of future service flow losses. The value of the total of past and future service flow losses would increase by about 15% under Scenario 1, increase by about 7% under Scenario 2, and decrease by about 6% under Scenario 3. Decreasing the discount rate to 2% would decrease the value of past and future service flow losses in Scenario 1 by about 3%, increase the value in Scenario 2 by less than 1%, and increase the value in Scenario 3 by about 9%.

3.3.3 Conservative design features

These compensable value estimates are conservative. The computations exclude:

- damages to anglers and nonanglers who do not fish Green Bay at all because of the FCAs
- damages from reduced total fishing days by Green Bay anglers
- damages due to injuries to Oneida tribal waters
- damages that could result from potential fish population injuries.

The understatement of estimates may be caused by other factors as well. For example, the computations use very conservative assumptions about FCA levels in Green Bay; that is, the damages are based on FCA levels that understate current FCA levels for every one of the species. Additionally, damages for other fishing categories, such as subsistence fishing, have been omitted or limited.

3.4 Preparing a Final Claim

The Co-trustees' final claim for damages includes the following components [43 CFR § 11.15(a); 43 CFR § 11.80(b)]:

- the cost of resource restoration, as described in Section 3.2

- the compensable value of lost recreational fishing services because of PCB fish consumption advisories, as described in Section 3.3

- the reasonable and necessary costs of the Co-trustees' assessment.

Section 3.1 described how, to avoid possible double counting, compensable values from recreational fishing losses and restoration costs may be combined in the final claim. The Co-trustees will apply the recreational fishing damages determination to quantify compensable values for past interim loss damages, whereas the restoration planning analysis is applied to current and future losses. All recovered damages will be applied to resource restoration, with the compensable value damages being applied to conduct restoration that directly enhances recreational fishing services and/or provides additional restoration similar to that being conducted to address future injuries.

The magnitude of future losses, and therefore the amount and cost of restoration that may be required, is dependent on the extent of PCB cleanup that will be conducted under the response agencies' remedial action. The more extensive the PCB cleanup, the less resource restoration is necessary. The exact mixture of projects that will constitute restoration may also be affected by the extent of PCB cleanup that will be conducted, as described in Section 3.2.9. Therefore, the final claim will be prepared following selection of a remedy.

Table 3.21 presents the claim components of compensable values for past interim loss damages and potential restoration costs for present and future losses under several different assumed PCB cleanup scenarios and combinations of restoration projects. The values shown in the table do not include the reasonable and necessary costs of the Co-trustees' assessment. The restoration costs shown in the table are from several illustrative examples of different mixes of restoration project types that the Co-trustees may consider. The costs are not intended to serve as the costs that will be used in the final claim.

Table 3.21. Potential damages under different remediation scenarios[a] (millions).

Remediation scenario	Past interim damages (recreational fishing losses)[b]	Present and future damages (restoration costs)[c]	Total
Intensive PCB cleanup (baseline achieved in 20 years)	$65	$111-191	$176-256
Intermediate PCB cleanup (baseline achieved in 40 years)	$65	$158-268	$223-333

a. Table does not include the reasonable and necessary costs of conducting the assessment, which will be included in the final claim.

b. From column C of Table 3.20 (all waters of Green Bay, open-water plus ice fishing, 1981-1999).

c. From Table 3.19. Values are from illustrative mixes of restoration project types and are not intended to represent the costs that will be used in the final claim.

Through compensable damages for past interim losses (which will be applied to resource restoration) and restoration actions to address continuing and future injuries, the public will be compensated for the injuries to natural resources caused by PCB releases into the Lower Fox River.

4. Assessment Planning and Coordination

4.1 Coordination of the Co-trustees' Assessment with the Public

The Co-trustees place a high priority on public values and attitudes, public access to the assessment, and transparency of the assessment to ensure that the assessment is credible, understandable, and in the public interest. Therefore, the Co-trustees have endeavored to ensure public input on the NRDA and provide full disclosure of all assessment results. The Service maintains a public reading room in Green Bay (1015 Challenger Court, Green Bay, WI 54311, 920-465-7407) and an Internet site of assessment plans, assessment determinations, and indexes (http://www.fws.gov/r3pao/nrda). The Co-trustees hold formal public comment periods and formal public meetings. The Co-trustees meet with local agencies and organizations that have expertise or represent the public, coordinate with other potential trustees and response agencies, and are members of the Intergovernmental Partnership. Finally, the Co-trustees coordinate and negotiate with the potentially responsible parties. These efforts are described in greater detail below.

4.1.1 Public comment periods and meetings

In addition to the 45-day public comment period for this RCDP, the Co-trustees have conducted four formal public comment periods for all of the administrative assessment planning documents used in the Fox River/Green Bay NRDA (Appendix B). These public comment periods ensure that the public can express its preferences on how the site should be assessed, and provide relevant information that may not have been considered by the Co-trustees.

In addition, including the public meeting for this RCDP, the Co-trustees have held five formal public meetings to present the results of the assessment as they become available (Appendix B). These public meetings ensure that the public is aware of the results of the assessment being conducted on their behalf. It also provides the public, including the scientific community, an opportunity to react and provide additional relevant information and input to the Co-trustees.

4.1.2 Public surveys

Public surveys provide information of direct relevance to determining the appropriate type and scale of restoration required to make the public whole. In addition, these surveys provide information about public preferences and values which would not be available through public meetings and the Co-trustees' normal coordination with the public.

The Co-trustees have conducted three economic studies that surveyed the public to determine public values relevant to the assessment. The first was a limited pilot study of subsistence fishing along the Lower Fox River. This study was not completed, but the preliminary results (Hutchison, 1999) were forwarded to the WDNR and the EPA for potential use in the human health risk assessment. This study showed that subsistence fishing is a significant consideration for cleanup and restoration of the Lower Fox River. The second study was a valuation of recreational fishing damages due to fish consumption advisories (see Section 3.3 and U.S. FWS and Stratus Consulting, 1999f). The third survey was part of a total value equivalency study, which is described in Section 3.2.4 and Appendix A of this RCDP. This study showed that cleanup is the most important environmental program for the Lower Fox River and Green Bay Environment, followed by habitat and nonpoint source control. The study also determined the appropriate scale of these programs to make the public whole.

Several other studies have been conducted for Green Bay to determine the importance and value of environmental resources to the general public. While none of this literature is as applicable as the Co-trustees' studies for selecting and scaling restoration options, the literature shows considerable consistency in that residents are aware of and concerned about environmental programs and place a high priority and value on cleaning up contaminated water resources, and cleanup of pollution is a high priority among alternative natural resource management actions that may be taken. Stoll (1999) conducted a 1997 repeat mail survey of the general population to estimate benefits of contaminated sediment remediation in the Fox-Wolf River basin. Johnsen et al. (1992) also examined public perceptions and attitudes toward environmental rehabilitation of the lower Green Bay watershed. Further, the St. Norbert College Survey Center conducted a 1999 survey (Campbell, 1999; St. Norbert College Survey Center, 1999) that summarizes current attitudes of nearby Brown County residents about Fox River health concerns.

Other studies have focused on Great Lakes areas outside of the assessment area. Katz and Schuler (1995) surveyed public knowledge and opinions about Great Lakes issues in general. Finally, a study was done to learn about environmental awareness and attitudes about Lake Erie and the Ashtabula River by surveying random samples of Ashtabula County voters in Ohio (Lichtkoppler and Blaine, 1999). All of these surveys and studies are described in greater detail in Appendix A.

4.1.3 Coordination with agencies and groups with expertise relevant to the NRDA

In addition to formal public comment periods, formal public meetings, and scientific public surveys, the Co-trustees have also conducted extensive public outreach with key constituents and expert agencies relevant to the Lower Fox River and Green Bay Environment. Since 1992, the Service has led presentations and discussions relevant to the Fox River and Green Bay at

43 meetings with key constituents and agencies with important expertise. A complete listing of these meetings is provided in Appendix B.

4.1.4 Coordination with the WDNR experts

The Service has been coordinating its NRDA program and/or the Fox River/Green Bay NRDA with the WDNR since 1989 (Appendix B). In addition, the Co-trustees have consulted directly with WDNR experts on all aspects of the Fox River/Green Bay NRDA. WDNR experts that have collaborated with the Co-trustees include aquatic toxicologists, terrestrial toxicologists, ecologists, fishery managers, wildlife managers, economists, PCB fate and transport modelers, chemists, data managers, NRDA experts, real estate experts, park managers, endangered species experts, water quality experts, and engineers from divisions and offices throughout the WDNR.

4.2 Co-Trustee Coordination with the Response Agencies for the Lower Fox River and Green Bay Environment

4.2.1 Intergovernmental Partnership Memorandum of Agreement purpose and summary

On July 11, 1997, the Co-trustees, the EPA, and the WDNR, collectively the Intergovernmental Partnership (IGP), entered into a Memorandum of Agreement (MOA). The MOA was designed to coordinate response and restoration activities undertaken by the IGP. The MOA was also designed to coordinate negotiations by the IGP with the potentially responsible parties. Since the signing of the MOA, the Co-trustees have participated in all of EPA's and WDNR's deliberations on the RI/FS, have sought Co-trusteeship with the WDNR, and have refrained from unilateral settlement negotiations with the potentially responsible parties. In addition, the Co-trustees have participated in IGP public relations efforts through the Fox River Current and IGP public meetings.

4.2.2 Formal comments

To ensure consistency between the Co-trustees' NRDA and the response agencies RI/FS, the Co-trustees are members of EPA's Biological Technical Advisory Group for the Fox River and Green Bay NRDA. In addition, the Co-trustees have provided data, analyses, draft language, and written comments to the EPA, the WDNR, and the WDNR's consultants on 38 occasions since February 1998. Examples of key changes made in the RI/FS based on the Co-trustees' information and comments include 1) incorporation of Green Bay into the RI/FS; 2) inclusion of ecological risk endpoints other than population endpoints; 3) incorporation of assessment data, analyses, and determinations into the RI/FS; and 4) incorporation of PCB fate and transport model documentation into the RI/FS.

4.3 Coordination of the Co-Trustees' Assessment with the Potentially Responsible Parties

In addition to coordinating with processes influenced by the potentially responsible parties, such as the Fox River Coalition and the State/Company Agreement, the Co-trustees have sought meaningful coordination with the potentially responsible parties directly. Therefore, the Co-trustees invited the potentially responsible parties to participate in a collaborative assessment in 1994 when the assessment was launched, and again in 1996 when the assessment plan was published. However, the PRPs elected to enter into an agreement for a collaborative assessment with WDNR.

Even though the potentially responsible parties have neither funded nor participated in the Co-trustees' assessment, the Co-trustees have sought input from the potentially responsible parties. The Co-trustees have received multiple comments on the assessment from the potentially responsible parties, and the Co-trustees will provide a responsiveness summary of all formal comments in the Report of Assessment soon after the EPA issues its cleanup decision in the ROD. Furthermore, the Co-trustees have participated in the potentially responsible parties' RI/FS peer reviews and have analyzed and used data produced by the potentially responsible parties, including chemical data, habitat data, and economics data.

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Appendix A — Total Value Equivalency Study

RESTORATION SCALING BASED ON TOTAL VALUE EQUIVALENCY: GREEN BAY NATURAL RESOURCE DAMAGE ASSESSMENT

Final Report

Prepared for:

U.S. Fish and Wildlife Service
U.S. Department of Interior
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October 25, 2000

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Acronyms

CERCLA	Comprehensive Environmental Reponses, Compensation, and Liability Act
CVM	contingent valuation method
EPA	U.S. Environmental Protection Agency
FCAs	fish consumption advisories
FRGS	Fox River Global Meeting Goal Statement
iRCDP	Initial Restoration and Compensation Determination Plan
NRDA	natural resource damage assessment
PCBs	polychlorinated biphenyls
RAP	Remedial Action Plan
RCDP	Restoration and Compensation Determination Plan
RI/FS	Remedial Investigation and Feasibility Study
RV	revealed preference
SP	stated preference
TVE	total value equivalency
WTP	willingness to pay

Figures

Tables

1. Introduction

1.1 Purpose of the Study

This study was prepared as part of the Lower Fox River/Green Bay natural resource damage assessment (NRDA) by the U.S. Fish and Wildlife Service (the Service), the National Oceanic and Atmospheric Administration, the Oneida Tribe of Indians of Wisconsin, the Menominee Tribe of Indians of Wisconsin, the Michigan Attorney-General, and the Little Traverse Bay Board of Odawa Indians (collectively referred to as the Co-trustees) in accordance with the regulations at 43 CFR §§ 11.81-11.84, the Assessment Plan: Lower Fox River/Green Bay NRDA at 61 FR 43,558 (August 2, 1996), and the Lower Fox River/Green Bay NRDA: Initial Restoration and Compensation Determination Plan (iRCDP) at 63 FR 50,254 (September 21, 1998).

Releases of polychlorinated biphenyls (PCBs) into the Lower Fox River and Green Bay have resulted in, and continue to result in, injuries to natural resources and related ecologic and human use service flow losses at these sites. The objective of this total value equivalency (TVE) study is to support the restoration planning portion of the Co-trustees' damage determination by (1) obtaining public preferences for the types and mix of restoration alternatives, and (2) providing value-based methods to scale resource restoration projects to provide services of *equivalent* societal value to the *total value* of all PCB-caused service flow losses from 2000 until service flows are returned to baseline (*PCB-caused service flow losses* are also referred to as *PCB-caused losses*, or as *losses*).

This study considers PCB-caused losses based on remedial scenarios proposed in the draft remedial investigation/feasibility study (ThermoRetec Consulting, 2000a,b). The results herein may be revised and the revisions incorporated into the Co-trustees restoration determination after the U.S. Environmental Protection Agency (EPA) issues a Record of Decision.

The remainder of this introduction provides background on the case, explains how this study supports the Co-trustees damage determination, and provides a summary of key results. This study uses a survey to obtain preferences and to scale restoration. Chapters 2 and 3 provide a summary of the survey instrument design and implementation. Chapter 4 provides a summary of survey results, focusing on the public's preferences across different types of restoration alternatives. Chapter 5 provides the economic model used, and Chapter 6 reports the results for the scaling of alternative restoration actions to provide services equivalent in value to the ongoing PCB-caused losses. Chapter 6 also addresses the comparability and overlap between this study and the Co-trustees' recreational fishing damage determination (Breffle et al., 1999), and provides additional study conclusions. The appendices provide copies of survey materials, supporting economic model details, and a summary of related literature concerning area residents' preferences and values regarding natural resource injuries and restoration programs.

While not the focus of this study, the study survey design also provides information that can be used to compute willingness-to-pay (WTP) monetary measures for interim losses from 2000 until a return to baseline, which can be used as a measure of compensable values. The methods to compute these values are presented in Chapter 5 and the results are presented in Chapter 6.

1.2 Background

PCBs are hazardous substances that were released into the Lower Fox River of Wisconsin, primarily by paper company facilities as part of the manufacturing, deinking, and repulping of carbonless copy paper that contained PCBs (Sullivan et al., 1983; WDNR, 1998; Stratus Consulting, 1999c), primarily between the late 1950s and mid-1970s.[1] Through time, PCBs have been and continue to be redistributed into the sediments and natural resources of the Lower Fox River and Green Bay (Stratus Consulting, 1999c).

Fish and wildlife throughout the Lower Fox River and the waters of Green Bay are exposed to PCBs, primarily through the food chain process (Stratus Consulting, 1999c). As a result of elevated PCB concentrations in fish, in 1976 the Wisconsin Department of Health and Human Services issued fish consumption advisories (FCAs) for sport-caught fish in the Wisconsin waters of Green Bay (including the Lower Fox River), and in 1977 Michigan issued FCAs for the Michigan waters of Green Bay (Stratus Consulting, 1999b). These FCAs continue today and are expected to continue for decades into the future, depending on the level of remediation and restoration at the site (Thermoretec Consulting, 2000a,b). Past and future recreational fishing active use losses from PCB-caused FCAs in these waters were addressed by the Co-trustees in Breffle et al. (1999). Similar to FCAs, waterfowl consumption advisories have been issued since 1987 in the Lower Fox River area because of elevated concentrations of PCBs (WDNR, 1987).

PCBs have caused injuries to fish and wildlife in the area, causing ecologic and human use service flow losses. Walleye have higher rates of tumors and pre-tumors than do walleye from comparable reference areas, and the difference has been attributed to PCBs (Stratus Consulting, 1999b; Barron et al., 2000). PCB injuries to bald eagles, double-crested cormorants, and common and forster's terns (both identified as endangered species by the State of Wisconsin) in the area include decreased egg hatching success. Forster's terns are also injured as a result of

1. PCBs are a hazardous substance under 40 CFR § 301.4 pursuant to Section 102(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Section 311 of the Federal Water Pollution Control Act.

increased deformity rates (Stratus Consulting, 1999a). In addition, PCB concentrations pose risks of adverse effects on piscivorous mammals in the area, such as mink (ThermoRetec Consulting, 2000c).

The assessment area includes the *waters of Green Bay*[2] and the surrounding land and wildlife resources directly or indirectly impacted by the PCB contamination in the waters of Green Bay, plus a part of northeast Lake Michigan (Figure 1.1).

1.3 Objectives

The purpose of the Co-trustee's damage determination is to "establish the amount of money to be sought in compensation for injuries to natural resources resulting from a release of a hazardous substance" [43 CFR §11.80(b)]. The measure of damages is defined as *restoration costs* plus, at the discretion of the Co-trustees, *compensable values for interim losses* [43 CFR §11.80(b)]. In addition, damages include the Co-trustees' reasonable assessment costs [42 USC § 9607(a)(4)(C)]. The term *interim losses* refers to losses from the time of release to when resources and services are returned to baseline and encompasses *past losses* up to the present, and *ongoing losses* during and after remediation and restoration actions until services flows are returned to baseline [43 CFR §11.80(b)]. The primary focus of this study is to support restoration planning.

Restoration refers to actions undertaken to return an injured resource to its baseline condition as measured by the services provided by that resource [43 CFR § 11.14(ll)]. *Baseline* refers to the conditions that would have existed in the assessment area had the release of hazardous substances not occurred [43 CFR § 11.14(e)] and *services* are defined as the "physical and biological functions performed by the resource, including the human use of those functions" [43 CFR § 11.14 (nn)]. Restoration can be accomplished by restoring or rehabilitating resources or by replacing or acquiring the *equivalent* of the injured natural resources, as measured by the services those resources provide [43 CFR § 11.82(a)]. In restoration planning, Trustees evaluate restoration alternatives and select and determine the scale of the preferred alternative based on the magnitude of service flow losses the releases cause over time.[3] The costs to perform the preferred alternative become the restoration cost component of the damage determination.

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2. The waters of Green Bay are defined to include the Bay of Green Bay, all bays within Green Bay (e.g., Little and Big Bay de Noc, Sturgeon Bay), and all rivers feeding into Green Bay up to the first dam or obstruction, including the Lower Fox River starting at Little Lake Buttes des Morts to the Bay of Green Bay.

3. An alternative can consist of single actions or combinations of actions [43 CFR § 11.82(b)(1)].

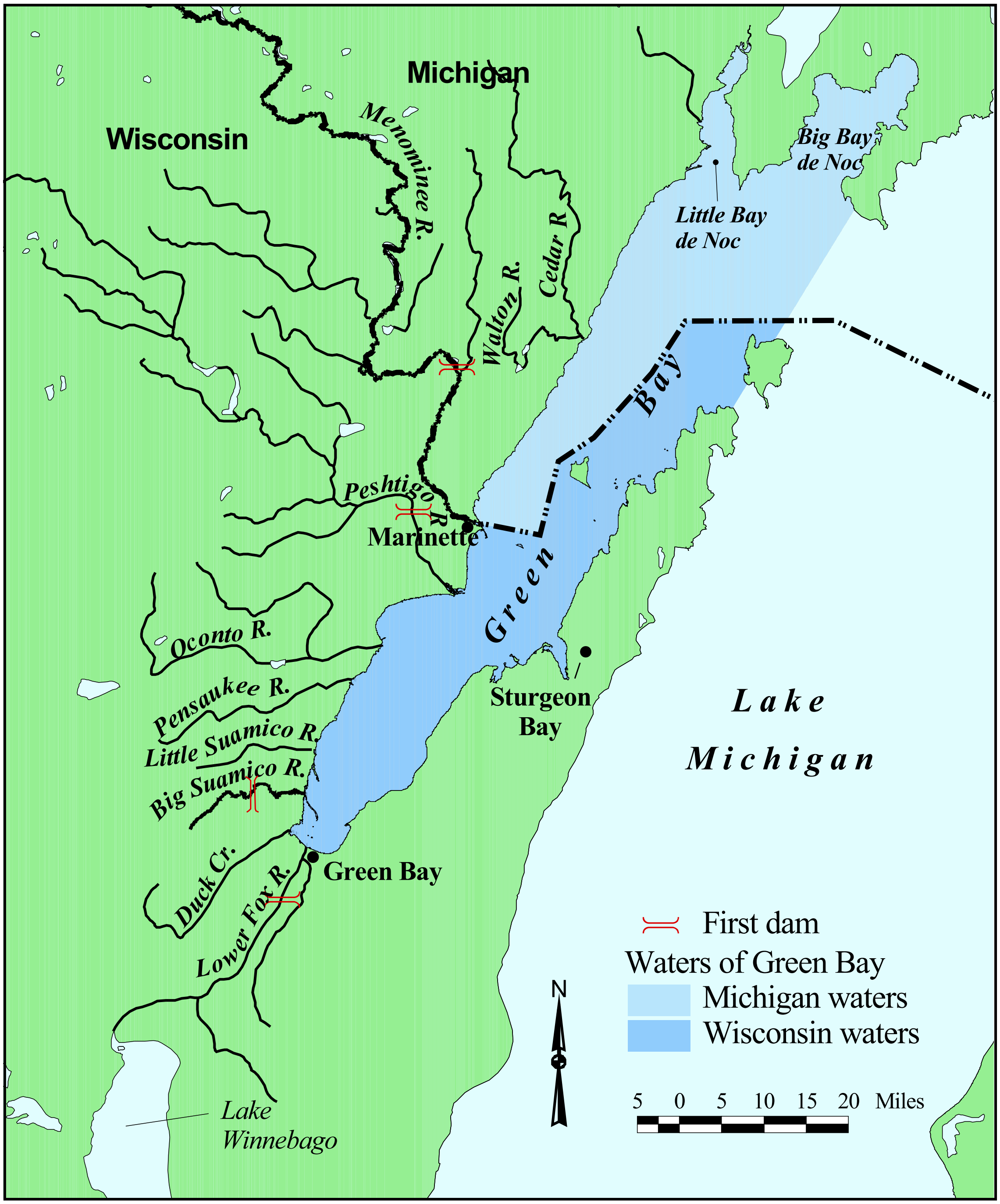

Figure 1.1. Wisconsin and Michigan waters of Green Bay.

This TVE study supports restoration planning in two ways. First, the study explicitly obtains public input regarding the preferences and values for alternative types of restoration projects, which aids the Co-trustees in evaluating the benefits of alternatives [43 CFR § 11.82(d)(2)], and ensures that the public has input on the selection of alternatives [43 CFR § 11.90].

Second, the study provides value-based methods to determine the appropriate scale of potential restoration actions. In some cases, restoration can be obtained by actions that restore, rehabilitate, or acquire the same amount of the same services at the same or very similar locations as those that were lost. For example, if an oil spill causes a boat launch to be closed, opening access to a comparable new boat launch nearby may provide the same services of the same scale as the losses, and thus the replacement services are equivalent (in type, level, and value) to the service flow losses. The amounts of services to be restored depend on the injuries through time, which may vary with the contamination and with the remediation efforts through time. For example, if contamination reduces mink populations, restoration might include habitat enhancements to support the population, combined with periodic mink stocking at varying levels to return the stocks to baseline levels through time. Scaling restoration programs that provide the same or very similar services is sometimes referred to as *service-to-service* scaling, where the amount of restored services are scaled to be equal to the amount of lost services now and through time.

For a large share of the PCB-caused service flow losses in the assessment area, particularly within Green Bay, where most of the PCBs have come to be located, providing restoration with the same or very similar services may not be technically feasible (i.e., the Co-trustees may be unable to find or develop resources that are sufficiently extensive to be developed in sufficient quantities), may be undesirable (e.g., increasing the population of fish or birds that may continue to experience injuries from PCB exposure), or may be too expensive. For this and other reasons, it may be preferable to select restoration actions that provide resources and services of a similar but different type or quality than those injured. Because such restoration may not provide the same services, it may not be possible to apply *service-to-service scaling*. In these cases, value-based scaling methods provide a basis for selecting and scaling restoration activities.

Value-to-value scaling is used in this study to scale restoration projects that provide services similar to, but not the same as, those lost.[4] Scaling is computed such that the societal value of the services gained through restoration equals the societal value of PCB-caused losses. Value is measured by the utility (benefits or satisfaction) that people derive from all active and passive uses of the resources. Dollar measures of value are not required for value-to-value scaling.

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4. See also 15 CFR § 990.53(d) for additional discussion of value-based scaling concepts and methods.

In this study we focus on restoring all human use losses, including *active use losses* related to well-identified active, and often on-site, resource uses such as recreational fishing, and *passive use losses* arising from services individuals receive from resources apart from their own readily identified and measured active uses. [5]

Certain active use losses may be cost-effectively and readily individually measured and valued, as the Co-trustees have done for recreational fishing active use losses (see Breffle et al., 1999). However, focusing solely on these losses omits consideration of other potentially significant losses, thus understating the services to be restored. This TVE study is a total value assessment because it addresses most or all PCB-caused service flow losses, including but not limited to recreational fishing and other recreational losses such as waterfowl hunting and wildlife viewing; casual or indirect losses such as reduced enjoyment while driving or walking by or working near a site, and when hearing about, reading about, or seeing photographs of a site; and option and bequest losses tied to preserving resource services for future use for oneself or for others.

Value-to-cost scaling can be used to select the type and scale of restoration projects such that their cost equals the value of the lost services. This is the same as computing compensable values [CFR 43 § 11.83-11.84] and applying the recovered damages to selected restoration projects [43 CFR § 11.93 (b)]. This study supports the selection of the mix and scale of restoration projects once damages are recovered by identifying project preferences and the relative value of alternative mixes of projects. While not the primary focus of this study, the study can provide a measures of *compensable values* for interim losses from 2000 until services are returned to baseline using a WTP measure [43 CFR §11.83(c)(2)].[6,7]

5. Some authors use different terms to refer to these concepts, or define the terms slightly differently. These differences generally have little substantive impact when the focus is on restoring all human use losses. These terms are consistent with the DOI regulations, where passive use losses include nonuse losses such as bequest and existence losses.

6. *Compensable values* include “the value of lost public use of the services provided by the injured resources, plus lost nonuse values such as existence and bequest values” [43 CFR § 11.83(c)(1)].

7. The values provided in this study could also be used to support value-to-value scaling of the compensable values for the total interim recreational fishing losses (Breffle et al., 1999) to the value of the restoration programs addressed here.

1.4 Approach

Survey of preferences and values

To obtain public preferences and values, a survey was conducted with residents of 10 Wisconsin counties surrounding the Wisconsin waters of Green Bay. The survey focuses on four groups of natural resource restoration programs for the Green Bay area. Over 600 restoration projects for the assessment area were compiled and analyzed, with a large majority of the proposed projects falling into one of these groups (see Chapter 2). The levels of restoration considered for each of the four program groups were selected reflecting relevant technical options and responses from respondents in survey focus groups and pretests.

1. *Restore wetlands* near the waters of Green Bay. Wetlands restoration will provide increased spawning and nursery habitat and increased food for a wide variety of fish, birds, and other wildlife. This provides wildlife services similar to, but not the same as, those injured by PCBs. Preferences and values for restoration of wetlands can also be applied as an indicator of the preferences and values for preventing further wetland loss and for other habitat enhancement projects. Restoration levels range from taking no action up to a 20% increase in wetlands within five miles of Green Bay within Wisconsin (although selected wetlands for restoration could also be located in Michigan).

2. *Remove PCBs* in the sediments of the assessment area. Removal of PCBs will reduce the number of years until FCAs and the injuries to wildlife are eliminated. The levels of removal considered result in the number of years until PCBs are at safe levels (i.e., a return to baseline conditions) ranging from 100 years (no additional removal) to 20 years with intensive remediation.

3. *Enhance outdoor recreation* in 10 counties surrounding Green Bay. Enhanced recreation includes increasing facilities at existing parks such as adding picnic grounds, boat ramps, and biking and hiking trails, and developing new parks. These facilities provide recreation services, although not the same services as those affected by the PCB-caused losses. The levels of recreation enhancements considered range from no improvements up to a 10% increase in facilities at existing parks and a 10% increase in new park acreage.

4. *Reduce runoff* that contributes to pollution of the waters of Green Bay. Controlling runoff improves water quality by lessening algae growth and improving water clarity, especially in the lower bay. This improves aquatic vegetation and habitat for fish and some birds and improves recreation. Runoff control in this case provides similar, but not the same, services as those injured by PCBs. The runoff control levels considered range from no change in the amount of runoff up to a 50% reduction, reflected by changes in water quality measures.

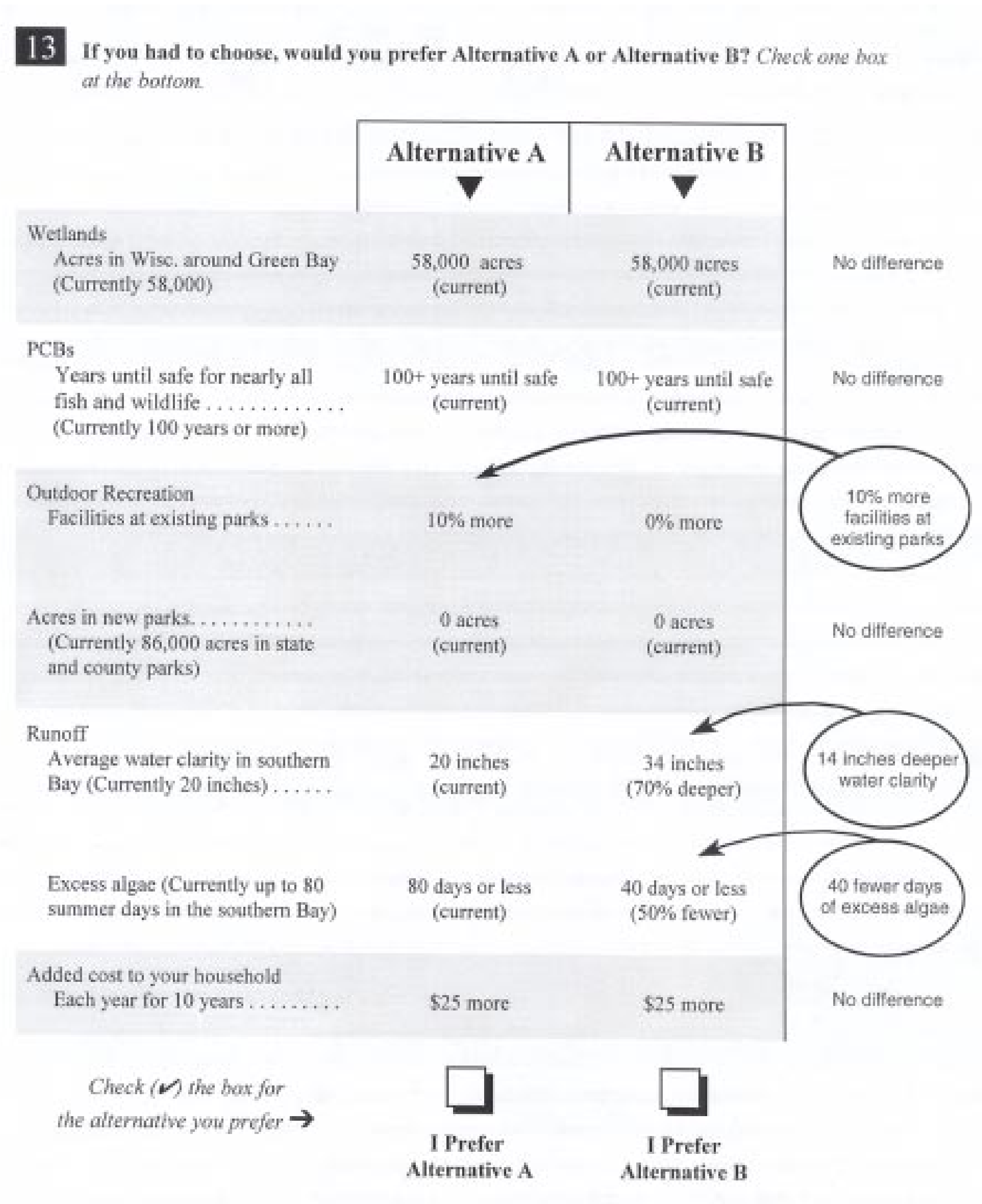
This TVE study is designed to support restoration planning by providing a large-scale perspective of public preferences across alternative types of restoration programs, and providing a method to scale programs that provide equivalent value to the service flow losses. The study is not intended to provide a selection of individual projects such as specific wetland acres or specific recreational facilities. That task is left to Co-trustees and regional planners who have a detailed knowledge of needs, technical effectiveness, and cost-effectiveness.

The survey describes each of the four natural resource restoration programs and asks a variety of questions to elicit preferences about the programs and the program levels. Next, the survey includes six stated preference choice questions, where respondents state their preferences by choosing which of two alternatives (A or B) they prefer, where each alternative has a specified level for each of the four restoration programs.

Figure 1.2 provides an illustration of the choice questions presented to respondents. In this question respondents are making a choice between enhanced outdoor recreational facilities at existing parks and increased levels of runoff control. By varying the program mixes and levels across questions and examining the choices made, mathematical methods (knows as random utility models) are used to determine how much of one kind of restoration has equivalent value to different amounts of other kinds of restoration.

The alternatives, and the choice between alternatives, are designed to reflect realistic and meaningful options for natural resource management in the study area. To present realistic choices, each of the alternatives includes a dollar cost to the household associated with the alternative. The dollar values presented differ across choice pair, and across survey versions, which allows for calculation of the public's WTP for the value of PCB-caused losses, or compensable values (see Chapter 5), and for the natural resource enhancements considered.

The TVE survey was implemented through a mail survey of a stratified random sample of households in 10 counties near Green Bay. Of the 650 eligible respondent households, 470 responded, resulting in a 72% response rate. An evaluation of the sampling plan and responses indicates that any potential sampling and response biases are likely to be small and thus have a minimal impact on the results (see Chapter 3 for further discussion of potential sampling and response biases).



13 **If you had to choose, would you prefer Alternative A or Alternative B?** *Check one box at the bottom.*

	Alternative A	Alternative B	
Wetlands Acres in Wisc. around Green Bay (Currently 58,000)	58,000 acres (current)	58,000 acres (current)	No difference
PCBs Years until safe for nearly all fish and wildlife . . . . (Currently 100 years or more)	100+ years until safe (current)	100+ years until safe (current)	No difference
Outdoor Recreation Facilities at existing parks	10% more	0% more	10% more facilities at existing parks
Acres in new parks. . . . . (Currently 86,000 acres in state and county parks)	0 acres (current)	0 acres (current)	No difference
Runoff Average water clarity in southern Bay (Currently 20 inches)	20 inches (current)	34 inches (70% deeper)	14 inches deeper water clarity
Excess algae (Currently up to 80 summer days in the southern Bay)	80 days or less (current)	40 days or less (50% fewer)	40 fewer days of excess algae
Added cost to your household Each year for 10 years	$25 more	$25 more	No difference

Check (✔) the box for the alternative you prefer → ☐ **I Prefer Alternative A** ☐ **I Prefer Alternative B**

Figure 1.2. Sample choice question.

Remediation scenarios

This TVE study determines what level of enhancements in the selected natural resource programs has a value that is equivalent to the value of PCB-caused losses over various time periods for alternative remediation scenarios. Figure 1.3 illustrates how ongoing PCB-caused losses depend on the rate of remediation f services. In the figure, Area A represents past losses experienced before remediation begins at the site (assumed to be 2000); these losses are not addressed in this TVE study. Area B reflects an assumption of a 10 year period (2000-2009) for remediation actions during which time limited, if any, recovery may occur. Areas C-F are ongoing losses after remediation (if any), depending on the level of remediation. We consider several scenarios:

1. *Intensive remediation.* This scenario assumes that losses continue largely unabated during the remediation period (Area B), then linearly decline to baseline over another 10 years (Area C) for a total of 20 years of ongoing losses. This scenario reflects the Fox River Global Meeting Goal Statement (FRGS-97) by the Fox River Global Meeting Participants (1997), and is similar to the more intensive remedial actions being considered in the Remediation Investigation and Feasibility Study (RI/FS, ThermoRetec Consulting, 2000a,b).

2. *Intermediate remediation*. This scenario assumes that losses continue largely unabated during a 10 year remediation period (Area B), then linearly decline to baseline over another 30 years (Areas C + D) for a total of 40 years on ongoing losses (10 + 30). This scenario is similar to the intermediate remediation scenarios in the RI/FS.

3. *Little or no additional remediation*. These scenarios consider limited remediation over 10 years (Area B), resulting in declining losses over either (a) an additional 60 years (Areas C + D + E) for a 70 year total (10 + 60), or (b) an additional 90 years (Areas C + D + E + F) for a 100 year total (10 + 90).

The TVE study design allows the calculation of the scale of restoration to provide services of equal value to the value of PCB-caused losses through time, or to a portion of the losses through time, such as between a 20 year intensive remediation and a 40 year intermediate remediation (Area D in Figure 1.3).

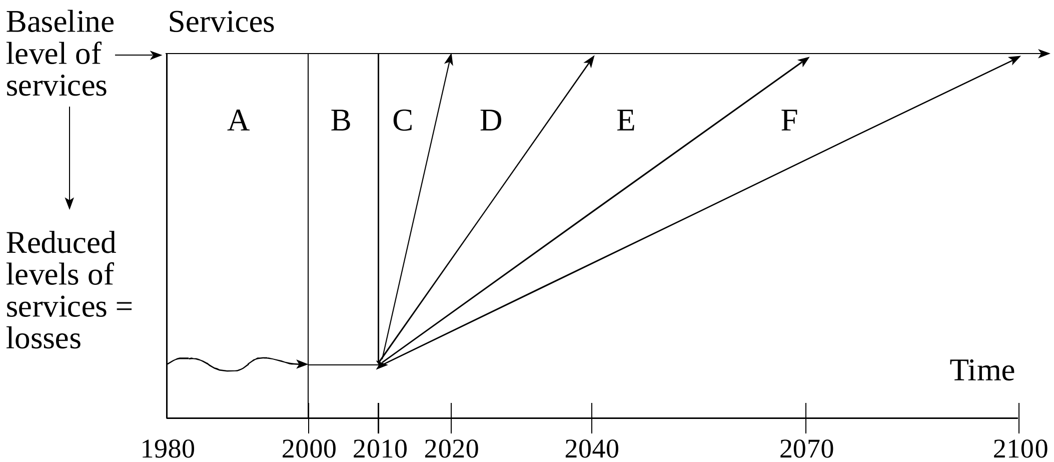


Figure 1.3. PCB-caused service flow losses under alternative time paths for a return to baseline.

1.5 Summary of Results

Awareness and preferences

Respondents were asked how aware they were of each of the four natural resource topics presented (wetlands, PCBs, outdoor recreation, and runoff control) before receiving the survey. Respondents reported being moderately to highly aware of the topics, with over 80% reporting they were somewhat to very aware of each topic. The literature identifies that higher awareness can be expected to enhance the reliability of responses and to reduce the burden of communication in survey design. High levels of awareness of a topic most likely reflect personal interest in the topics and increased preference for, and values for, natural resource restoration.

Various questions address respondent concerns and preferences for the four programs and the service flow benefits they provide. There is a strong and statistically significant preference for PCB removal over other natural resource enhancement programs, even though efforts were taken to ensure that PCB removal was treated in the survey on an equal basis with the other natural resource restoration programs (see Chapter 2). Relative to PCB removal, runoff control and wetland enhancements have modest interest and values. Limited interest is expressed in enhancing 120 regional parks, and almost no interest is expressed in adding new regional parks. Table 1.1 summarizes the importance ratings for the benefits from each program. Table 1.2 summarizes preferences in terms of doing and spending less, the same, or more, compared to current levels, for each program in the future.

Table 1.1. Importance of natural resource action benefits (1 = not at all important to 5 = very important).

Benefits[a]	Mean importance ranking (SE of mean)
Remove PCBs to reduce risks to birds, fish, and other wildlife	4.3 (0.05)
Remove PCBs so that it is safe to eat fish, and waterfowl	4.3 (0.05)
Reduce runoff to improve water clarity	4.0 (0.05)
Increase wetland acreage to support birds, fish, and other wildlife	3.9 (0.05)
Reduce runoff to reduce algae blooms	3.8 (0.05)
Add facilities at existing parks	3.6 (0.05)
Add new parks	3.3 (0.06)

a. Listed in order of mean importance score, not in the order they appear in the survey.

Table 1.2. Preferred actions for natural resource programs.

Natural resource programs[a]	Do less and spend less[b]	Do and spend the same	Do more and spend more
PCB investigations and removal	NA[c]	17%	83%
Runoff reduction	2%	34%	65%
Wetlands maintenance and/or restoration	3%	42%	56%
New facilities at existing parks and/or opening new parks	2%	51%	47%

a. Listed in order of mean importance score, not in the order they appear in the survey.
b. Percentages are adjusted to remove missing responses, which amount to less than 2.4% for all questions and may not sum to 100% due to rounding.
c. Not applicable: “Do less and spend less” was not offered as an option for PCBs.

The reported preferences vary by household characteristics. For example, households report higher importance for the benefits of a program, and interest in doing more and spending more, if they have anglers active in fishing the waters of Green Bay, if they live very near Green Bay, and if they were previously very aware of the natural resource topic.

Scaling restoration

The results of the choice questions, which trade off enhancements in natural resource programs, demonstrate that respondents predominately answer in a manner consistent with our expectations: more enhancements are preferred to fewer enhancements, and lower costs are preferred to higher costs. These results support the reliability of the results.

The resource trade-off questions are used to scale combinations of resource restoration programs that would provide services that the public considers to be equivalent in value (measured in utility) to eliminating the continuing PCB-caused losses. While the final mix and scale of restoration programs will be determined later, the model presented here provides a basis upon which to scale alternative restoration programs. The costs for the selected restoration programs are addressed in the Co-trustees' Restoration Compensation Determination Plan (RCDP).

Table 1.3 provides examples of the scale of sample mixes of restoration projects that provide services with value equal to the ongoing PCB-caused losses for selected scenarios. Each line represents one possible mix of restoration projects. The listed examples are but a few of the infinite number of possible combinations that the Co-trustee Council and potentially responsible parties could develop to provide services of equal value to the PCB-caused losses. The first three lines provide example combinations for the scale of restoration providing services of value equal to the PCB-caused losses from 2000 until a return to baseline if an intensive level of remediation returns services to baseline by 2020:

- A combination of 3,100 acres of wetlands restoration, plus a 10% enhancement in existing park facilities, plus a 50% runoff control program
- A combination of 5,500 acres of wetlands restoration, plus an 8% increase in existing park facilities, plus a 45% runoff control program
- 11,000 acres of wetlands restoration, plus a 45% runoff control program.

The second block provides examples for the 40 year intermediate level of remediation. The third and fourth blocks provide examples of the scale of restoration that provides services of value equal to a portion of the PCB-caused losses corresponding to the differences between a 20 and 40 year remediation and between a 20 and 70 year remediation.

Table 1.3. Illustration of restoration scaling.

	Example mixes of restoration programs		
Scenario	**Wetland restoration acres[a]**	**Existing park enhancement**	**Runoff control[b]**
PCB remediation scenarios[c]			
Intensive: (0 to 20 years)	3,100	10%	14”/50%
	5,500	8%	12”/45%
	11,000	0%	12”/45%
Intermediate: (0 to 40 years)[d]	24,100	10%	16”/55%
	16,000	20%	16”/55%
Partial restoration			
Intensive vs. 40 year Intermediate (20 to 40 years)	2,900	2%	4”/25%
	5,000	3%	2”/13%
	2,400	0%	7”/33%
Intensive vs. 70 year Intermediate (20 to 70 years)	5,700	0%	14”/50%
	13,000	10%	10”/40%

a. Rounded to nearest 100 acres.

b. Additional inches of water clarity/percentage decrease in number of excess algae days.

c. Restoration is for PCB-caused losses during the period indicated.

d. Requires extrapolating beyond the range of actions considered for some or all programs.

These illustrations do not include additional acres of new parks as a restoration approach because acres of new parks in the 10 county area was found to have a near-zero value. A few key findings emerge as applicable to the ultimate selection and scaling of restoration alternatives within the identified three project types (wetlands, outdoor recreational facilities, and runoff control):

- Wetland (and likely other wildlife habitat) restoration programs and runoff control programs are preferred to, and more highly valued than, programs to enhance outdoor recreation in the assessment area. While specific outdoor recreation enhancements would benefit some residents, the majority of residents indicated limited interest in additional facilities and parks.

- Continued increases in the levels of wetland restoration programs increase benefits, but at a declining rate. That is to say, there are diminishing marginal utility gains as more wetlands are restored. As a result, increased restoration well beyond the levels addressed in the study will most likely result in limited additional benefits to the public.

- The value of PCB-caused losses is so substantially larger than the value of service flow benefits from the restoration programs that it is difficult to generate benefits equivalent in value to the PCB-caused losses with just improvements in one program. For instance, a widespread improvement in regional parks provides services that are equal in value to value of the first few years of PCB-caused losses, a 20% increase in wetland acres provides services with value equal to about the first seven years of PCB-caused losses, and a 50% additional runoff control provides services with value equal to about the first 15 years of PCB-caused losses. Therefore, to provide sufficient restoration with value equal to the value of ongoing PCB-caused losses until a return to baseline will likely require a combination of several programs.

- The restoration combinations presented in Table 1.3 consider up to a 40 year time horizon for eliminating PCB injuries because even the maximum combination of the wetlands, outdoor recreation, and runoff control programs considered do not provide enough service flow benefits to be equivalent to eliminating PCB losses more than 40 years more quickly. To provide services flow benefits for PCB-caused losses beyond 40 years would required additional natural resource programs, or variations on the programs addressed herein.

Double counting and comparison to other studies

The WTP value measures for interim losses estimated in this TVE study can be used to eliminate double counting in the final damage determination and to compare the results here with other existing literature.

This TVE study differs from, but necessarily partially overlaps, the Co-trustees' recreational damage determination (Breffle et al., 1999) because both include a portion of the recreational fishing losses due to PCB-caused fish consumption advisories. The WTP results of the TVE and recreational fishing studies can be compared for those households with Green Bay anglers in the 10 nearby Wisconsin counties. For this comparison population, the WTP values in this TVE study are comparable to or slightly larger than the WTP values in the recreational fishing study. This is as expected because this study values a larger set of losses than does the recreational fishing study, although for households with Green Bay anglers, fishing losses may well be the dominant component of PCB-caused losses. The comparability of the results supports the estimated magnitude of damages in each study, and allows double counting between the studies to be readily addressed (see Section 6.3.3).

The results of this study are also consistent with other existing literature specifically addressing social preferences and values for PCBs and other natural resource management programs in northeastern Wisconsin (see Appendix D). Existing literature consistently identifies that regional residents are aware of and concerned about water pollution issues, and place a high priority and value on cleaning up contaminated water resources. While the existing literature does not address the same scenarios as in this TVE study, allowing for differences in the scenarios, the preferences and WTP values calculated in this TVE study are of a consistent magnitude with those found in the literature.

2. Survey Design

Section 2.1 provides an overview of the survey instrument, key survey design considerations influencing why we selected the stated preference choice-question approach, and how we designed the survey. Section 2.2 provided a detailed discussion of the individual elements of the survey.

2.1 Survey Design Overview

2.1.1 Background

To support the restoration planning objectives of this study, the survey needed to address the range of the most relevant restoration alternatives. Therefore, we first developed a database of potential restoration projects, drawing on work completed by many groups in the Green Bay area (Hagler Bailly Services, 1998). The database merged the specific project recommendations made in the 1988 Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern (WDNR, 1988), projects from the 1994 Green Bay Habitat Restoration Workshop Summary (WDNR, 1994), and projects that in various documents were developed, gathered by, and presented to the WDNR Habitat Restoration Workgroup (the Boronow Group), which worked during 1997 and 1998. The Potential Restoration Projects Database contains over 600 individual projects or ideas.

Most of the identified restoration projects could be placed into one of four broad natural resource topic areas. Working with scientists, for each topic area we next developed technical information about current conditions, and about the types of benefits that could be obtained from restoration projects. The levels of restoration to be considered in the survey for each topic area were selected reflecting technical options and responses from respondents in survey focus groups and pretests (see Section 2.2.2). The four natural resource restoration topics, along with their related service flows and range of restoration levels are as follows:

1. *Restoration of wetlands* near the waters of Green Bay. Wetlands restoration will provide increased spawning and nursery habitat and increased food for a wide variety of fish, birds, and other wildlife. This provides wildlife services similar to, but not the same as, those injured by PCBs. Preferences and values for restoration of wetlands can also be applied as an indicator of the preferences and values for preventing further wetland loss and for other nonwetland habitat enhancement projects. Restoration levels range from taking no action up to a 20% increase in wetlands within five miles of Green Bay in Wisconsin (although selected wetlands could also be located in Michigan).

2. *Removal of PCBs* in the sediments of the assessment area. Removal of PCBs will reduce the number of years until FCAs and the injuries to wildlife are eliminated. The levels of removal considered result in the number of years until PCBs are at safe levels (i.e., a return to baseline conditions), ranging from 100 years (no additional removal) to 20 years.

3. *Enhance outdoor recreation* in 10 counties surrounding Green Bay. Enhanced recreation includes increasing facilities at existing parks such as adding picnic grounds, boat ramps, and biking and hiking trails, and developing new parks. These facilities provide recreation services, although not the same services as those affected by the PCB-caused losses. The levels of recreation enhancements considered range from no improvements up to a 10% increase in facilities at existing parks and a 10% increase in new park acreage.

4. *Reduce runoff* that contributes to pollution of the waters of Green Bay. Controlling runoff improves water quality by lessening algae growth and improving water clarity, especially in the lower bay. This improves aquatic vegetation and habitat for fish and some birds and improves recreation. Runoff control in this case provides similar, but not the same, services as those injured by PCBs. The runoff control levels considered range from no change in runoff up to a 50% reduction, reflected by changes in water quality measures.

After describing the topics and restoration program levels, the survey included six stated preference choice questions, where respondents stated their preferences across restoration types and levels. Figures 1.2 and 2.1 provide illustrations of two examples of choice questions.

- In Figure 1.2, respondents were asked to make a choice between two restoration alternatives: enhanced outdoor recreational facilities at existing parks in Alternative A or increased levels of runoff control in Alternative B. In both alternatives, household costs increase by $25 per year for 10 years.

- In Figure 2.1, respondents were asked to make a choice between a restoration alternative or remaining with the status quo: PCB removal resulting in a reduction to 40 years until PCBs are safe, at a per household cost increase of $200, in Alternative A, or no additional resource enhancements and no additional household costs in Alternative B.

The restoration levels for the four programs and the associated household costs are varied across the alternatives in each question and across the questions. By examining the choices made, mathematical methods (knows as random utility models) are used to determine how much of one kind of restoration has equivalent value to different amounts of other kinds of restoration, and to compute the WTP value of ongoing PCB-caused losses and of the restoration alternatives**.**

14 **If you had to choose, would you prefer Alternative A or Alternative B?** *Check one box at the bottom.*

	Alternative A ▼	**Alternative B** ▼
Wetlands Acres	58,000 acres (current)	58,000 acres (current)
PCBs Years until safe for nearly all fish and wildlife	40 years until safe (60% faster)	100+ years until safe (current)
Outdoor Recreation Facilities at existing parks.	0% more	0% more
Acres in new parks	0 acres (current)	0 acres (current)
Runoff Average water clarity in the southern Bay	20 inches (current)	20 inches (current)
Excess algae days in lower Bay . .	80 days or less (current)	80 days or less (current)
Added cost to your household Each year for 10 years	$200 more	$0 more
Check (✔) the box for the alternative you prefer ➔	❑	❑

Figure 2.1. Typical choice question.

2.1.2 Selection of the stated preference choice-question survey approach

Generally, two broad classes of approaches are often used to evaluate preferences and values for natural resource changes: stated preference (SP) approaches and revealed preference (RP) approaches.[1] SP approaches use survey questions to have respondents explicitly or implicitly state their preferences and value. In a very simple SP approach, respondents could be asked, "When fishing in this area do you prefer fishing for perch, or fishing for catfish?" or "Would you pay $5 to launch your boat in these waters?" In contrast, an RP approach examines behavioral choices that have been made, and which are observed in markets or reported by respondents in surveys, to infer preferences and values. In our simple example, RP data might find that most anglers in the area fish for perch and few fish for catfish, and thus we reveal that for the current conditions there is a preference for perch fishing; and RP data might find that most boat anglers will pay $5 to launch their boat at the site rather than fish elsewhere, or would fish elsewhere.

We selected the SP approach because it would cost-effectively provide the most comprehensive, valid, and accurate information to support the restoration planning objectives of the study.[2] A stated preference survey can be more comprehensive because it can measure preferences and values (in utility or dollars) for more PCB-caused service flow losses, and for most or all of the service flow gains from a restoration alternative. Another strength of the SP approach is that the researcher can measure public preferences and values directly relevant to all levels of all four restoration alternatives being considered for the site of interest, including restoration providing service levels that do not currently exist, thus obtaining valid and accurate information (Morikawa et al., 1990; Louviere, 1996).

We judged that using RP approaches would not sufficiently serve the study objectives. RP approaches could be cost-effectively applied, or applied at all, for only a limited number of PCB-caused losses, such as for recreational fishing (such as in Chen and Cosslett, 1998; Herriges et al., 1999; and Breffle and Morey, 2000), and for only a limited number of the service flow benefits for a few of the restoration alternatives of interest (such as for selected recreational activities). RP approaches would not be cost-effective for many types of active uses related to enjoying a site and generally could not be used to reveal values for some service flows, including passive uses and cultural uses.

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1. See, for example, Kopp and Smith (1993), Freeman (1993), Adamowicz et al. (1994), Breffle et al. (1999), and the U.S. DOI NRDA regulations at 43 CFR § 11.83(c). Some authors use different terms to refer to these methods.

2. *Comprehensive* refers to covering all or a large set of the service flow losses and gains, for all or a large set of the restoration options of interest. *Valid* refers to measuring the specific variable of interest, without bias, rather than measuring a close but different variable or measuring the variable with bias. A*ccuracy* refers to measuring the variable with reasonable precision.

Even for the service flows that RP approaches could cost-effectively measure, RP approaches would not be able to reliably and accurately measure values for many of the restoration alternatives of interest because some alternatives enhance natural resources in ways that do not currently exist in the assessment area. Therefore, relevant behavioral data for the assessment area to measure preferences and values does not exist. In some cases, RP information can be used from other comparable sites, or the same site in prior years, to learn about preferences and values for some of the service flows of interest, but generally the ability to comprehensively, reliably, and accurately measure current preferences and values relevant to the unique assessment area is limited.

Using RP data as the primary approach would have the undesirable effect of understating PCB-caused losses and limiting the evaluation to the types and levels of restoration alternatives to those that may not be of the most interest and value. Thus, for a comprehensive assessment, SP studies would be required. Conducting additional RP studies, beyond the recreational fishing damage determination and in addition to the required SP study, would not be cost-effective because of the limited coverage of restoration alternatives and service flows that RP studies could provide.

2.1.3 Choice-question method as an established method

We selected a choice-question method because the method is established in the literature, and can be designed to cost-effectively and directly assess the study objectives for the specific types and levels of PCB-caused losses and restoration alternatives of relevance.

Choice questions evolved from conjoint analysis, which has been extensively used in marketing and transportation research.[3] Choice questions have come into widespread use in environmental economics. For example, Magat et al. (1988) and Viscusi et al. (1991) applied SP data to estimate the value of reducing health risks; Adamowicz et al. (1994, 1997) and Morey et al. (1999a) applied it to estimate recreational site choice models for fishing, moose hunting, and mountain biking, respectively; Breffle et al. (1999) used it to value changes in recreational fishing; Adamowicz et al. (1998) used it to estimate the value of enhancing the population of a threatened species; Layton and Brown (1998) used it to estimate the value of mitigating forest loss resulting from global climate change; Morey et al. (1999b) applied SP data to estimate WTP for monument preservation in Washington, DC; Swait et al. (1998) compared prevention versus compensation programs for oil spills; and Mathews et al. (1997) and Ruby et al. (1998) asked anglers to choose between two saltwater fishing sites as a function of their characteristics. Breffle et al. and Mathews et al. were NRDA applications.

3. For survey articles and reviews related to use in marketing, see Louviere (1988, 1992, 1994), Green and Srinivasan (1990) Batsell and Louviere (1991); and for use in transportation planning, see Hensher (1994).

A number of additional applications to environmental topics have used a rating variation of choice questions, in which survey respondents rate the degree to which they prefer one alternative over the other. For example, Opaluch et al. (1993) and Kline and Wichelns (1996) develop a utility index of the characteristics associated with potential noxious facility sites and farm land preservation. Johnson and Desvousges (1997) estimate preferences and WTP for various electricity generation scenarios and related environmental and social impacts.[4]

We chose to use choice questions rather than the rating variation of choice questions and to limit the choice to two alternatives. Choice questions mimic the real choices individuals continuously make, whereas individuals rank and rate much less often.[5] And choice questions among two options are easier, thus reducing the burden on our respondents while still providing information sufficient for the study objectives.

The use of the choice-question method in this natural resource damage assessment is consistent with U.S. DOI NRDA regulations [43 CFR § 11.83(c)(3)]. The choice-question methods used here combine elements of random utility models used in recreation assessment and stated preference methods, which are identified as acceptable methods in the U.S. DOI regulations [43 CFR § 11.83(c)(3)]. Choice-question methods are explicitly identified (under the name "conjoint methods") in the NOAA NRDA regulations for use in value-to-value scaling of restoration alternatives (15 CFR Part 990, preamble Appendix B, part G), which is supported in Mathews et al. (1995, 1997).

2.1.4 Key design considerations

Once we had chosen a survey based choice-question approach, our attention turned to strategies to design and implement a state-of-the-art application. To provide valid and accurate preferences and values, our SP survey incorporates general survey design considerations as described in several standard works, including Dillman (1978, 2000), Shuman and Presser (1996), and Tourangeau et al. (2000). In addition, we addressed survey design considerations that are specific to all SP surveys (Mitchell and Carson, 1989; Kopp et al., 1997) and to choice-question application of SP surveys. In this section we discuss selected key survey design considerations.

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4. Other examples include Rae (1983), Lareau and Rae (1998), Krupnick and Cropper (1992), Gan and Luzar (1993), and Mackenzie (1993). Adamowicz et al. (1997) provide an overview of environmental valuation choice and ranking studies up to 1996. Dozens of new environmental economic applications are now occurring each year.

5. See, for example, Louviere and Woodward (1983), Louviere (1988), and Elrod et al. (1992).

Accurate, neutral, and accessible information

An important consideration to our design was to present accurate information in a neutral and accessible manner. Throughout the survey design we consulted with scientists and public officials to assure and document that all of the information presented in the survey provided accurate and balanced perspectives of the natural resource topics of interest.

Beyond accuracy in the scientific information, several actions were taken to assure the survey made a neutral presentation. These included not identifying the sponsor, but rather noting the usefulness of the results to government, industry, and citizen groups; assuring there was a consistent and equal presentation of each of the four natural resource topics addressed; and repeatedly recognizing that respondents may not place importance on the identified resource enhancements (e.g., "how important, if at all, . . ." and rather than assuming restoration would be preferred, including options such as "do less and spend less" and "do and spend the same").

In pretests, when respondents were asked for whom and why they thought the survey was being conducted, the most frequent answer was they did not know, second was that it involved the State of Wisconsin in its efforts to help evaluate what to do in the Green Bay area, and some respondents indicated that they thought the paper companies were sponsoring the research. While our focus was on restoration preferences and scaling for PCB-caused losses, focus group and pretest respondents indicated they thought that the survey had to do with all four resource topics and was not motivated by, or oriented to, consideration of PCBs or any of the other topics. When asked if they felt that the survey contained any bias for or against any particular issue, focus group and pretest respondents overwhelmingly indicated that they did not feel the survey was biased.

An important design consideration is to present the required information in a manner that is accessible to, and not a burden to, respondents; otherwise respondents may not complete any or all of the survey, and may be confused by information and provide unreliable and/or inaccurate information. In this survey, wherever possible, we present information at a basic level, and to facilitate reading the survey we carefully structured the information in consistent formats for each resource topic and in the choice questions. While considerable information is presented, simple questions and maps, graphs, and tables are interspersed among the text to break up the information, to be visually interesting, and to help the respondent think about the information as he or she progresses through the survey. The simple questions also provide useful attitudinal and demographic information. Again, focus groups and pretests were used to work on survey language and respondent ability to understand the survey and provide valid and accurate answers.

Context

A standard tenet of SP design is that if the SP context of the presentation and questions simulates real choices, and if the responses could have a real impact on the respondents, there is incentive for the respondents to provide answers that are a valid and accurate reflection of their preferences. In this survey, we present a realistic context that government, industry, and citizen group planners are examining options for natural resources in northeast Wisconsin. These issues have long and frequently received a high level of attention in the news in the assessment area. In fact, a large portion of respondents in the focus groups, pretests, and final instrument expressed awareness of, and concern about, the various natural resource topics being addressed. A large share of the residents in the area enjoy the natural resources of interest in one way or another, and thus changes in the resources would affect them. Often there are public meetings on these natural resource topics, and it is reasonable for citizens to accept that decision makers seek public input through a survey of this type, and that results will influence the selection of the types and levels of actions to be taken.

In most SP studies, the context of who will pay, and how, is a key design feature. While our study focused on restoration priorities and scaling of restoration, which did not require that we specify the costs, participants in focus groups quickly identified that consideration of who will pay and how was important to set a realistic context for the choices they were presented with: "Who is going to pay," or "I know we will have to pay some for these natural resource improvements, but industry, users, and farmers should pay their share" typify the types of comments received. These types of concerns also identify that respondents took the survey seriously.

Reflecting the concern about who pays and how, we included dollar costs to the household associated with each alternative. Dollar costs would be paid through a combination of federal, state, and local taxes, as most often occurs for these types of major natural resource programs. Dollar costs would be paid over a 10 year period, matching the implementation period identified for the projects. With these aspects added to the context, most respondents in focus groups and the pretest identified the choice questions as reasonable and meaningful. While the inclusion of dollar costs adds realism to the context of the presentation, by varying the costs across choice pairs and across survey versions, it also allows for calculation of the public's WTP for the value of PCB-caused losses (see Chapter 5), and for the natural resource enhancements considered.

Information presentation

Another consideration in any SP survey is that respondents have the information necessary for them to make informed choices (Fischoff and Furby, 1988). Choices that are poorly informed may result in inaccurate and potentially biased reflections of preferences. We addressed this consideration in two ways: by carefully selecting the information to be presented (and making sure it is accurate), and by limiting the population surveyed to those households near the site (see the section below on the choice of population to be surveyed).

One of the most important peculiarities of SP surveys, compared to surveys used for other purposes, is the amount of information that must be conveyed to, and understood by, respondents. Ideally, to make the best choices, people should be fully informed, but a goal of full information is impractical, would create an unnecessary respondent burden, and may even worsen the response rates and the quality of response. As identified by Fischoff and Furby (1988):

> Simply telling people everything provides no guarantee that they have understood everything. Such a strategy might even impede understanding if attention to critical features of the contingent market is diverted by a deluge of details about features that could have gone without saying because they have little practical effect on decisions.

What we strive for in designing SP surveys (and often in life) is information that is fundamental to the choice process; that is accurate, neutral, and realistic; and that is simple and straightforward to understand. In this specific SP instrument, we specifically identify the natural resource topics of interest and identify characteristics of current conditions, and changes in current conditions if natural resource programs are undertaken. Thus, we have specified the goods to be compared in the choice questions and, as discussed above, the context under which changes would occur.

A related informational consideration is the number of restoration alternatives, and their characteristics, to present. Clearly, as the number of details about restoration alternatives increase, it becomes more challenging for the respondent to understand, track, and trade off many characteristics, which increases the chance of confusion or focusing on only one or a few of the attributes (reducing accuracy), or dropping out (resulting in low response rates).

We chose to present four types of restoration program characteristics by seven index variables, as illustrated in Figures 1.2 and 2.1. Generally, a small number of characteristics is included so as not to overwhelm the respondent.[6] The respondent must understand each of the characteristics (in our case, programs and their benefits) and keep track of changes in each of the characteristics in both alternatives of a choice question.

6. For example, Opaluch et al. (1993) characterize noxious facilities in terms of seven characteristics; Adamowicz et al. (1997) use six characteristics to describe recreational hunting sites; Johnson and Desvousges (1997) use nine characteristics to describe social and environmental impacts of electricity-generation scenarios; and Mathews et al. (1997) use seven characteristics to describe fishing sites.

Our design asks respondents meaningful questions that support restoration planning by providing a large-scale perspective of public preferences across alternative types of restoration programs, and by providing information to scale programs that provide equivalent value to the PCB-caused losses. The study is not intended to provide a selection of individual projects such as which specific wetland acres to restore or specific recreational facilities to build. That task is left to Co-trustees and regional planners who have a detailed knowledge of needs, technical effectiveness, and cost-effectiveness.

The choice of the population to be surveyed

We limited the study to a "target population" of residents from a 10-county area near Green Bay and the Lower Fox River (Figure 2.2) and sampled from this population. Each county is located nearly entirely within 60 miles of Green Bay. Because of their proximity to the bay, individuals from these counties could be expected to be more active users of, and more familiar with, the natural resources in the Green Bay area than individuals from outside of the target population. For example, approximately 90% of all recreational fishing days in the waters of Green Bay (including the Lower Fox River and other tributaries up to the first obstruction) by Wisconsin residents are by anglers who reside in the 10 counties (Breffle et al., 1999). Respondent familiarity with the resources increases saliency and thus response rates and reduces the amount of information that must be presented in the survey. In addition, Shuman and Presser (1996) have argued that the more crystallized respondent attitudes and values are (which familiarity should support), the less important small context changes are likely to be in survey design.

Of course, people farther from Green Bay may have suffered damages from PCBs. Restricting our study to the 10 counties represented a compromise. Some losses would probably remain uncounted for the sake of greater accuracy of the losses that would be addressed (see Section 6.4 for additional discussion).

Choice of survey mode

The survey was designed to be conducted by mail, with a telephone survey of nonrespondents (see Chapter 3). On a general level there are three major modes for administering surveys: personal interview, telephone interview, and mail (Dillman, 2000; Tourangeau et al., 2000). Telephone interviews were rejected as the main survey mode because we concluded that we needed to present too much information to effectively convey over the phone without also mailing information to respondents, and thus increasing costs with limited demonstrated gain in the response rates and quality over a mail survey. Personal interviews with visual aids can be effective in communicating information for these types of surveys (Carson et al., 1992), but are very labor intensive to obtain the desired response rates and generally cost hundreds of dollars per completed interview. Both telephone and personal interview surveys can be beneficial when there is a need for interaction between an interviewer and respondent, such as to explain complex

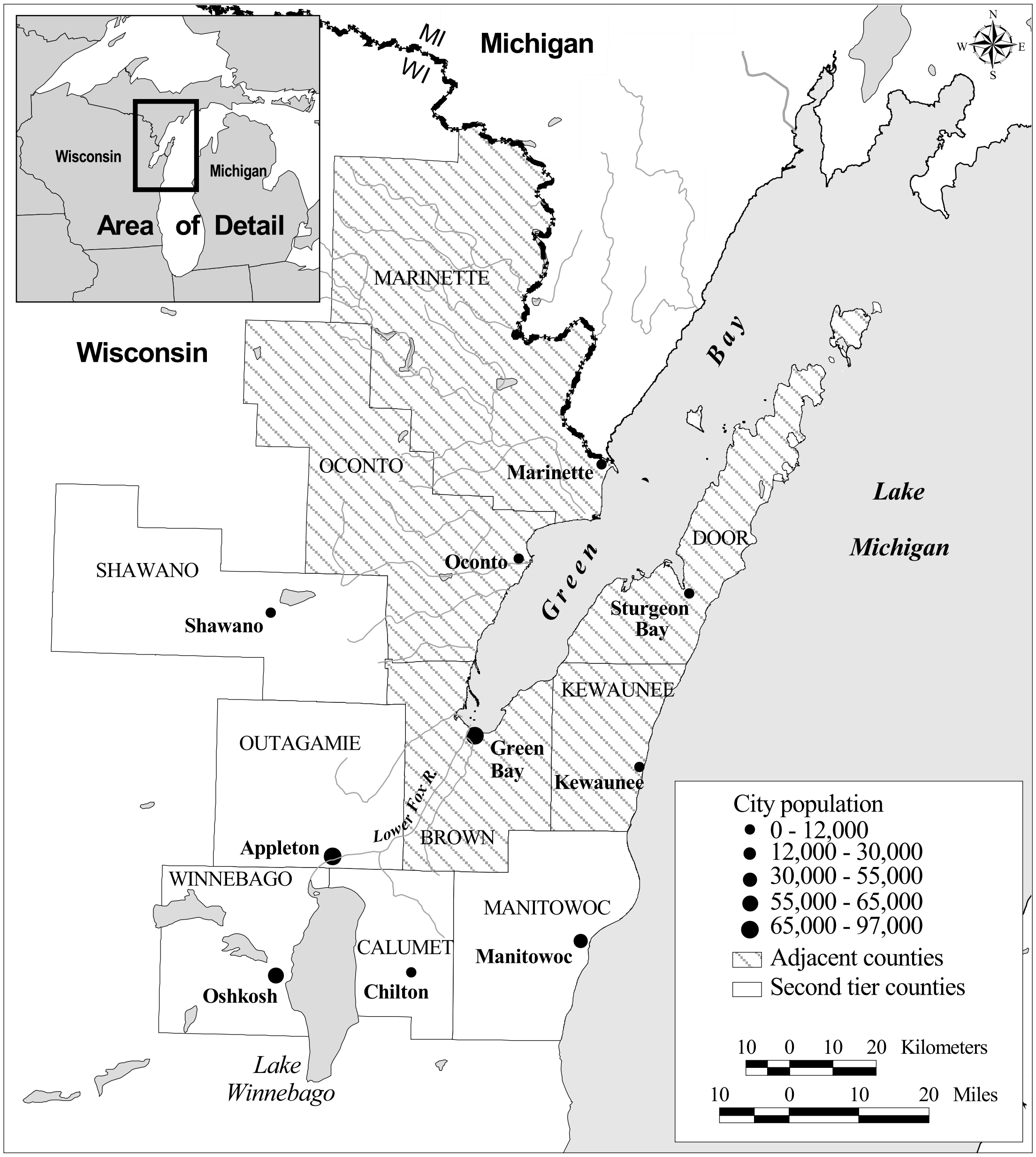

Figure 2.2. Target population counties.

information, or when the series of questions to be asked varies depending on the answers received as the survey progresses. However, the interpersonal communication in telephone and personal interviews is more likely to result in potential *social desirability biases,* wherein the respondents are more likely to provide what they consider to be socially desirable responses (Dillman and Tarnai, 1991; Whittaker et al., 1998; Ethier et al., 2000).

By limiting the sample to people in the 10-county area, and by careful design and pretesting, we reduced the burden of information communication substantially. Our statistical design for the key questions did not require the questions to be asked to vary depending on the responses to prior questions. Based on experience, and on repeated pretesting, we concluded that the required information could be successfully presented in a mail survey approach with high quality responses and high response rates, so long as respondents were provided a modest completion incentive of $15. As such, the mail survey approach was the most cost-effective approach to obtain high quality data.

Focus groups, pretesting, and peer review

An important aspect of survey design is to use focus groups and pretests to ensure that all material in the survey was clear and readable by members of the general public, that the information was presented so the context was meaningful and realistic to ensure neutrality of the survey, and that respondents are providing the information that researchers seek (e.g., the survey obtains valid information for the study objectives). The TVE survey instrument was developed and pretested through a series of eight focus groups and three rounds of in-person pretest interviews conducted in northeast Wisconsin with 182 subjects. The focus groups generally included 8 to 12 people in semi-structured discussions. In the pretests, the respondents completed draft survey instruments, and a research team member debriefed the respondent on the survey instrument and their answers. Table 2.1 indicates the date, site, activity, number of participants, and focus of the various survey development and pretesting steps.

To further assure that the survey reflected professional standards, the survey instrument was peer reviewed at various stages by Vic Adamowicz, Professor, Department of Rural Economics, University of Alberta; Don A. Dillman, Professor of Sociology and Rural Sociology and Deputy Director for Research of the Social and Economic Sciences Research Center at Washington State University in Pullman; and Roger Tourangeau, Senior Research Scientist at the Survey Research Center at the University of Michigan and Research Professor at the Joint Program in Survey Methodology at the University of Maryland.

Table 2.1. Green Bay total value equivalency survey focus groups and pretests.

Date	Site	Activity	Number of participants	Type of respondents	Focus	Investigators
4/29/98 and 4/20/98	Green Bay, Wisconsin	Four focus groups	34	General public	Assess familiarity with and terminology used to describe natural resource issues in NE Wisconsin	Jeff Lazo, Mike Welsh
9/22/98 and 9/23/98	Green Bay, Wisconsin	Four focus groups	42	General public	Explore strategies for using stated preference questions and to better understand the amount and type of information that was needed and could be provided	Jeff Lazo, Mike Welsh
6/9/99 and 6/10/99	Green Bay, Wisconsin	Self-administered w/debriefing	56	General public	Explore stated preference strategies and ways of describing the resource management options	Rich Bishop, Jeff Lazo, Sonya Wytinck
8/4/99	Green Bay, Wisconsin	Self-administered w/debriefing	36	General public	Pretest final survey instrument	Rich Bishop, Jeff Lazo
8/5/99	Oshkosh, Wisconsin	Self-administered w/debriefing	14	General public	Pretest final survey instrument	Rich Bishop, Jeff Lazo

2.2 Detailed Design

In this section we discuss the details of the four major sections of the survey:

1. introductory materials
2. introduction of the four natural resource management topics and programs
3. choice questions
4. follow-up questions including sociodemographic questions.

Table 2.2 outlines the final survey instrument and the general purposes of the questions. A copy of one version of the survey instrument is provided in Appendix A (the versions vary only by the levels of programs and costs in the choice questions, which is discussed below).

2.2.1 Introductory materials

Along with the survey instrument, respondents received a personalized cover letter. The sponsor(s) of the survey and the intended use of the results for restoration planning and damage assessment were not identified. The cover letter stated that the survey would help "representatives from government, industry, and citizen groups" determine "what should the priorities be for natural resource programs in Northeast Wisconsin?" This approach was adopted as part of our strategy to make the survey neutral with respect to the natural resource alternatives.

The introductory material identified the study area as northeast Wisconsin. This was reemphasized on the cover page with the title, "What Are Your Opinions About the Future of Natural Resources in Northeast Wisconsin," and a color map of the study area on the front page. When respondents opened the survey booklet, they found an introductory sentence stating that "Decision makers are examining options for natural resources in northeast Wisconsin." The inside front cover provided the definition of the "Bay of Green Bay" as "the waters of the Bay of Green Bay and all tributaries up to the first dam or obstruction" to focus respondents on resources issues related to the Bay.

Question 1 asked respondents how often they personally participate in activities related to the use of the resources on the waters and shorelines of the Bay of Green Bay. This question served as a simple beginning question, reinforced the location of interest, and elicited information on the respondents' natural resource uses to begin the cognitive process of thinking about how the resources relate to the respondent through their activities.

Table 2.2. Outline of Green Bay total value equivalency survey.

Section	Item or question	Purpose
Introductory materials	Cover letter	Provide information on the purpose and importance of the study.
	Cover page — map	Show the location of Green Bay, major cities and towns, tributaries, and first dam or obstruction. Identify the study area and indicate the general purpose of the survey to seek their opinions about the future of natural resources in the area.
	Inside cover	Define the term "Bay of Green Bay."
	Question 1	Elicit information on participation in outdoor activities. Have individuals consider their uses of the natural resources around the Bay. Introduce the four natural resource topics addressed in the remainder of the survey.
Introduction to natural resource programs	Questions 2-3	Provide information on wetlands and the benefits from increased wetlands. Elicit the importance on increased wetlands benefits. Introduce levels of program options in terms of restoring wetlands.
	Questions 4-6	Provide information on PCBs and the benefits from PCB removal. Elicit the importance of PCB removal benefits. Introduce levels of removal, safe levels, and years of injury.
	Questions 7-9	Provide information on state and county parks and their facilities. Identify levels of enhancements and elicit importance of improved facilities and new park benefits. Introduce concepts and levels of programs for enhancing and enlarging state and county parks.
	Questions 10-12	Provide information on runoff (nonpoint source pollution) and the benefits from increased runoff control. Elicit importance of the benefits of runoff control. Introduce levels of programs to reduce runoff and its impacts in terms of water quality variables.
Choice questions	What alternatives do you prefer	Introduce the choice questions. Introduce and define the payment vehicle. Reiterate key information about each of the four resource topics.
	Questions 13-18	Implement the choice questions.
Follow-up and socio-demographics	Questions 19-22	Obtain information to assist in analyzing individuals' responses to the choice questions.
	Questions 23-35	Obtain sociodemographic information.
	Question 36	Elicit additional open-ended comments on the survey.

2.2.2 Natural resource topics

The next section of the survey introduced each of the four natural resource topics in four separate two-page sections. Each natural resource topic was given consistent treatment so that none of the four topics stood out as being presented as more or less important than the others. The four sections followed a similar presentation, as outlined in Table 2.3 and discussed below.

Table 2.3. Format of the natural resource topic sections.

Natural resource topic	Define topic and related benefits	Describe historical trends and current status of resources for the topic, and elicit respondents' opinions on importance of enhancement benefits	Introduce possible levels of enhancement and respondents' attitudes on action	Provide supporting table or diagram on the natural resource topic and service flows
Wetlands	Introduction	Question 2	Question 3	Map of WI wetlands within 5 miles of the Bay of Green Bay
PCBs	Introduction	Questions 4 & 5	Question 6	Table of GB/LFR FCAs
Outdoor recreation	Introduction	Questions 7 & 8	Question 9	Map of state and county recreation areas
Runoff	Introduction	Questions 10 & 11	Question 12	Figure of water pollution from runoff

For each natural resource topic, the presentation began with information defining the resources in the topic area and other information found to be useful to respondents, such as historical trends and current status. The next questions identified the benefits associated with resource enhancements (or correspondingly the impacts of current conditions) and asked how important it was to the respondent, if at all, to undertake resource programs that would obtain these benefits. These questions again have respondents consider how the benefits relate, if at all, to their own interests. Each presentation was accompanied by diagrams or tables, which provided supporting information, and helped to sustain respondent interest and attention.

The last section for each topic gave more information about potential enhancement programs and program levels, identified a 10 year implementation period (which matches the subsequent 10 year payment period), and provided other program information. The questions then asked respondents if they felt that less, the same, or more should be done and spent on the resource enhancement programs. These questions continue the process of considering program benefits, especially relative to the added costs to undertake the programs.

In addition to providing useful information on their own, the responses to the importance and action questions in these sections also provide consistency checks against the results of the choice questions. We expected when we designed these questions that the relative importance of benefits from the natural resource programs, and desire to do or spend less, the same, or more on these types of programs, would be highly correlated with the results to the choice questions for all respondents as a whole and generally for each individual respondent.

Wetlands

The resource description focused on wetlands within 5 miles of the Bay of Green Bay and historical trends in wetland losses and related policies (Harris et al., 1977; Bosley, 1978; WDNR, 1988; Shideler, 1992). A distance of five miles was used to include the primary feeding range of bald eagles and other species living near the bay, and as an approximation of the distance up the tributaries where Green Bay fish spawn most often, thus making a strong connection to the injured natural resources and services. These wetlands were identified using GIS techniques (ESRI, 1998; WDNR, 1999a). It was stated that regulations now in place will effectively prevent further reductions in wetland acres (NRCS, 1990; USGS, 1996; WDNR, 1999c) to focus on the benefits of wetland restoration.

Question 2 identified wetland services such as habitats for fish, birds, and mammals and described the expected changes in wetland-dependent species if the quantity of wetlands increased (WDNR, 1979; Christie and Meyers, 1987; Brazner, 1997; Stratus Consulting, 1999a). Respondents were asked to indicate how important they felt it was to increase wetland acreage to support birds, fish, and other wildlife (e.g., to obtain program benefits).

Question 3 asked respondents whether they would prefer that less or the same be done and spent to maintain wetlands, or more be done and spent to restore wetlands. The “do more” option introduces information on options to restore wetlands and indicates that up to 11,600 acres could be restored. Based on a review of proposed restoration options, it seemed unlikely that significantly more than a 20% to 30% increase in wetland acreage would be likely. In addition, in focus groups and survey pretests, there was significantly diminishing interest in more than a 20% increase in wetlands.

PCBs

The industrial sources of PCBs in the Lower Fox River were identified (U.S. EPA, 1997) and it was pointed out that PCBs were banned from industrial use in the mid-1970s, which makes it clear that the issue is not one of stopping continued industrial releases (U.S. EPA, 1998). To identify how PCBs affect the environment and people, the survey identifies that PCBs have accumulated in the sediments of the Lower Fox River and the Bay of Green Bay and that birds, fish, and wildlife ingest PCBs through the food chain (WDNR, 1999b). Injuries were then described in terms of (1) FCAs, including an FCA summary table (U.S. EPA, 1996, 1999; WDNR, 1999b), and (2) harm to wildlife in and around Green Bay. The indicated magnitudes of risks to birds, fish, and other wildlife were based on several sources (Christie and Meyers, 1987; Matteson, 1988; Mossman, 1988; Matteson and Erdman, 1992; U.S. EPA, 1998; Stratus Consulting, 1999a, 1999b; ThermoRetec Consulting, 1999).

Questions 4 and 5 discussed the impact of PCBs on wildlife and potential human health impacts and asked respondents to tell us how important they felt PCB removal was, if at all, to them so that it is safe to eat fish and waterfowl, and to reduce harm to birds, fish, and other wildlife. Question 6 then asked them whether they would prefer that no further efforts go into PCB investigations and removal, or that more should be done to remove PCBs. To provide a single index of PCB injuries (or benefits from removal), the concept of years until PCBs are at safe levels was identified and defined: "By safe levels we mean there are no consumption advisories for, and no harm to, nearly all fish and wildlife." The question introduction and responses identified how long it will be until safe levels under alternative options, ranging from 100 years under the do-no-more options to between 20 and 70 years with some PCB removal (Stratus Consulting, 1999a). Also introduced are the 10 year removal implementation period and that damages would decline through time thereafter. " No "do less" option was offered since doing less removal (other than completing the demonstration projects) is not feasible.

Outdoor recreation

The quantity and distribution of state parks and natural areas and county parks (there are no national parks) in the 10 county region were described in the introduction and on the accompanying map in this section of the survey (ESRI, 1998; WDNR/GEO, 1998). Recreational sites throughout the 10 counties are widely accessible to residents, and many of these sites provide services similar to the types of recreational services affected by PCB contamination. We included all 10 counties to increase the likelihood that a respondent (from any of the 10 counties) would expect to experience benefits from the proposed enhancements (e.g., focus groups suggested that if only parks within two miles of the bay were included, many respondents from greater distances would have a lower likelihood of using the enhancements, and would most likely report lower importance and values for such a recreation program). We excluded city parks as many of these provide services (e.g., ball parks, playgrounds) dissimilar to the affected recreational services. Facilities offered at outdoor recreation sites were described (WLRB, 1997) as was the potential need for more facilities to meet future needs.

Questions 7 and 8 introduced the possibility of adding facilities at existing parks and opening new parks throughout the 10 county area, with the 10% enhancement level illustrated. Respondents were asked how important it was to them to improve existing parks and to add new parks. In Question 9, the 10 year implementation period was defined, and respondents were asked if they prefer less or the same be done and spent to maintain existing facilities, or more be done to add facilities and new parks. Note that only a 10% enhancement was considered because, in focus groups and pretests, most respondents expressed significantly diminishing and even zero interest in more than a 10% increase in recreational facilities.

Runoff

Sources of runoff to the Green Bay watershed, and the impacts of runoff on bay resources, were explained next (WDNR, 1988, 1993a, 1993b, 1996a, 1996b, 1997a, 1997b, 1997c; Harris, 1993). In response to what we heard in focus groups and pretest interviews, we identified how runoff can be reduced; pointed out that invasion of zebra mussels was leading to some improvements in water clarity, but that the future effects of the zebra mussel invasion were uncertain (Harris, 1993); and identified that runoff is not a source of PCBs and does not affect drinking water quality (Bierman et al., 1992). To improve respondents' understanding of runoff, an illustration provided a stylized river cross-section showing sources, transport, and impacts.

Question 10 discussed how, how much, and where nutrients in runoff lead to excess algae in Green Bay (Harris and Christie, 1987; Harris, 1993; Sachs, 1999), and asked respondents how important it is to them to reduce the number of days with excess algae in Green Bay. Question 11 discussed the impacts of sediments and algae on water quality, and the resulting impacts on aquatic habitat, fish, and birds (Sager et al., 1996). Because not all these effects could be quantified, water clarity was used as an index for these effects when asking how important it would be to reduce runoff to improve water clarity (and used in subsequent survey questions).

Question 12 stated that runoff control options would take 10 years to reach their goals and asked individuals if they prefer less, the same, or more be done and spent to control runoff. The "do the same" option reminded respondents that current water clarity averages about 20 inches in the summer and that there are currently about 80 days a year of excess algae in the southern Bay of Green Bay. The "do more" option specifies that potential control programs could lead to up to a 50% reduction in runoff, resulting in water clarity of 34 inches and 40 days a year of excess algae. The days of excess algae and inches of water clarity were estimated based on regression models of phosphorus and water quality in lower Green Bay using data provided by Dr. Paul Sager, University of Wisconsin-Green Bay, and summarized in Harris (1993).

2.2.3 Choice questions

Introduction

The choice questions were preceded by an introductory page "What Alternatives Do You Prefer?" which set the context for the choices to be made. The context included making choices among alternatives that enhance natural resources and that will cost more for the respondents' households beyond what they are now paying. To provide a credible scenario and to reduce scenario rejection since respondents often indicated that the responsible parties (industry, farmers) and specific/interest user groups should pay for these improvements, the survey indicated that "some costs will be paid by industry, farmers, and conservation organizations. But taxpayers may have to pay something as well." Household payments would be made through increases in local, state, and federal taxes. Consistent with the 10 year time period for each of the natural resource options to be implemented, a 10 year payment period was specified. Based on the focus groups and pretest interviews, we judged that this represented an acceptable and realistic payment vehicle and time frame to respondents.

To ensure that key features of the trade-off scenarios were clear, the choice section introduction reiterated key items of the natural resource programs, and the choice questions further identified how the proposed program levels compared to existing conditions. The first choice question also provided extended information, including describing the baseline conditions and identifying the specific differences between the two alternatives to aid in successfully working through the first question.

Choice question design

Each choice question includes a pair of alternatives, or a choice pair. Each alternative contains a specific combination of the levels of the four natural resource programs and costs to the respondent's household. The levels considered for each natural resource program, and household costs, are summarized in Table 2.4. The levels considered ranged from the current conditions to varying levels of improvement to current conditions (discussed above for each program). This reflects the objective of determining the level of restoration program enhancements that will provide services of equivalent value to the value of an enhanced PCB removal program. Further, we found in pretesting, as well as in the final results, that very few respondents preferred to do less and spend less on any one of the natural resource programs (typically less than 3%). If fact, except for increased recreational facilities and parks, the majority of respondents supported doing more and spending more on each of the programs (between 55% and 81%). However, for some or all programs, some respondents may prefer the status quo level of effort, spending, and benefits as compared to program improvements that cost them money. This potential is accommodated in the design of the questions (see "referendum pairs" below). The annual household costs ranged from $0 to $200. This range reflected focus group and pretest results and a desire to have a range that covered a substantial share of the likely range of values that households may have so as to reduce potential truncation bias that could bias downward the valuation results (Rowe et al., 1996).

Table 2.4. Green Bay equivalency value survey — attribute levels.

Attribute	Level 1	Level 2	Level 3	Level 4	Level 5
Wetlands					
Acres in Wisc. around Green Bay (currently 58,000)	58,000 acres (current)	60,900 acres (5% more)	63,800 acres (10% more)	69,600 acres (20% more)	n.a.
PCBs					
Years until safe (currently more than 100 years)	100 or more years (current)	70 years (30% faster)	40 years (60% faster)	20 years (80% faster)	n.a.
Outdoor recreation					
Facilities at existing parks	0% more (current)	10% more	n.a.	n.a.	n.a.
Outdoor recreation					
Acres in new parks (currently about 86,000 acres in state and county parks)	0 (current)	4,300 (5% more)	8,600 (10% more)	n.a.	n.a.
Runoff					
Average water clarity in southern Bay (currently 20 inches)	20 inches (current)	24 inches (20% deeper)	34 inches (70% deeper)	n.a.	n.a.
Excess algae (currently up to 80 summer days in the southern Bay)	80 days or less (current)	60 days or less (25% fewer)	40 days or less (50% fewer)	n.a.	n.a.
Added cost to your household					
Each year for 10 years	$0	$25	$50	$100	$200

The alternatives were designed and combined into choice pairs to obtain sufficient independent variation in the attributes to statistically identify the separate influence of each attribute on the choice of Alternative A or Alternative B. The survey was designed to include six choice pairs to limit potential respondent fatigue associated with answering repetitive questions. Ten sets of choice pairs (i.e., 10 survey versions) were designed to obtain sufficient variation in choice pairs for statistical analysis. Thus, a total of 60 alternatives were designed (10 sets with 6 pairs each).

Given the number of characteristics and the levels they can take, there were over 1,400 possible alternatives and an extremely large number of possible pairs of alternatives. Several software packages are available to select choice pairs to meet statistical design objectives, and in many packages constraints may be imposed to eliminate certain types of inappropriate pairs. We used SAS Proc Factex and Proc Optex to help design the pairs. However, one quickly finds that, even with multiple constraints imposed on the selected pairs, the software package results are not entirely satisfactory. Therefore, we further designed the selected choice pairs to reflect additional considerations related to the complexity of the pairs and to ensure realism and consistency in the pairs presented to any one respondent, as discussed below. The final survey pairs are summarized in Appendix A, Table A.1.

Using randomly generated pairs results in many, or even most, pairs involving varying levels of many attributes in each alternative. Thus, respondents are presented with the task of comprehending and selecting between mixes of multiple programs changes in each alternative in most or all of the questions. This may be a complex task for some respondents, especially if there are limited practice questions, and may result in respondents choosing to focus only on a subset of attributes as the basis for decision making, thus increasing the variance in the estimation of preferences. One way to try to partially address this would be to provide simplified practice questions to make respondents accustomed to the format. However, a lot of space and respondent time would go into practice questions that would not generate useful data.

Instead of practice questions, we selected a design to graduate respondents from simple to more complex choice pairs as they progressed through the survey instrument, thus reducing the cognitive burden at the outset. This would have the additional benefit of allowing us to do selected statistical comparisons of the responses across different types of choice pairs and, early in the question sequence, to address potential preferences for the status quo (see Section 4.7 and Chapter 5). Three types of choice questions were used:

- **Simple resource-to-resource pairs.** The first paired comparison question in each version of the survey (see Figure 1.2 and Question 13 in all of the survey versions) presented a choice between an improvement in one attribute in Alternative A and an improvement in a second attribute in Alternative B.[7] Other program levels (attributes) were held at current levels in both alternatives, and the same dollar cost was presented in both alternatives (see Question 13 in the sample survey in Appendix A). The programs and levels of changes were varied across the survey versions, and across Alternatives A and B, to cover all the resources, with slightly more cases with PCBs as one of the alternatives. This design provided several benefits. First, respondents began the paired comparisons with a relatively simple question that was expected to be more easily answered, leading them to continue the survey. Second, the results provided simple tradeoff results between program levels that did not require a complex statistical model to begin to evaluate the results.

7. A few simple resource-to-resource questions were added or randomly occur in subsequent questions.

- **Referendum pairs.** The second question in each survey version (Question 14) presented a choice between an improvement in one attribute and the associated increased costs versus no change in the attributes from current levels and costs (e.g., the status quo, see Figure 2.1 from survey version 1 where Alternative A reduces the years until PCBs are at safe levels from 100 years to 40 years at a cost of $200, and no other changes occurring, compared to Alternative B of the status quo and no increase in household costs). For the referendum questions, the attribute levels and dollar costs were varied across the survey versions, and across Alternatives A and B, to cover a broad range of the resources, with slightly more cases with PCB as one of the alternatives. These questions provided a relatively simple trade-off early in the question sequence to aid respondents' progress through the choice questions, and provided an early question in which respondents may demonstrate a preference for the status quo as opposed to program enhancements at added costs to their household. This type of question is similar to a traditional contingent valuation referendum question and provided evidence on the relative merits of resource-to-resource trade-offs versus resource-to-money trade-off questions.

- **Complex choice pairs.** The third type of questions are ones in which either or both Alternative A and Alternative B may have changes in more than one resource program and costs as compared to current conditions, generally resulting in complex comparisons that we expect may result in increased noise in the estimation of preferences.

The pairs in Questions 15 through 18 were allowed to be of any of the above question types, and generally are complex choice pairs. The starting point for selecting these pairs was obtained by applying the pair-design software programs to generate more pairs than needed. To retain realism, dominant choice pairs were eliminated. These were cases where one alternative was clearly an improvement over the second alternative. For example, Alternative A would have the same or increased levels of each natural resource program at the same or reduced cost compared to Alternative B. Respondents reported such questions as unrealistic choices (e.g., "How can you get more environmental benefits at the same or lower costs?"). Furthermore, such choices provide little statistical benefit.

Next, the selection and assignment of pairs to survey versions was considered. Sequencing conflicts within a survey version were evaluated and limited. For example, assume Question 14 proposed a small change in wetlands (e.g., 5,800 acres) at a high cost (e.g., $100 per year per household). If a subsequent question traded off a much larger change in wetlands (or the same small change in wetlands plus enhancements in other resource programs) at a much lower cost (e.g., $25 per year per household), participants in focus groups and pretests questioned the realism of the question set and its policy relevance. Sequencing was also evaluated in terms of avoiding a string of questions in any survey version focusing on one of the four resource programs, to avoid emphasizing any one topic in any survey version. The assignment of pairs to survey versions also considered the ability to compare results across survey versions, as well as within survey versions.

These steps increased the realism of the choices for respondents. There are some nonzero correlations between the various attribute levels across the alternatives (see Table 2.5), but this is not uncommon and the correlations here are sufficiently orthogonal to support the accurate estimation of parameters.

2.2.4 Follow-up questions and demographics

The remaining survey questions help us analyze responses to the choice questions and other survey questions. Question 19 asked how important each attribute in the choice questions (i.e., acres of wetland, years until safe levels of PCBs) was in the choices made by the respondent. We expect a strong correlation between the choice question results and the ratings in this question, reflecting that respondent answers to the choice questions are consistent with their intended rating of importance of the various factors to be considered, and we further expect both of these results to be correlated with the importance assigned to the benefits of the natural resource programs, and desired actions for less, the same, or more of these programs as reported in Questions 2 through 12.

Question 20 asked how confident respondents were in their answers to the choice questions, and Question 21 asked whether their responses to the choice questions should be considered by decision makers. Recognizing that the choice questions may be difficult for some respondents, these questions are intended to give an indication of the quality that respondents assign to their responses. Question 22 asked about pre-survey awareness of natural resource issues. We expected that awareness of the issues would be related to increased interest in and value for these programs, and that increased awareness would result in improved response quality (Cameron and Englin, 1997).

Because we expected that whether or not individuals from a household fish in Green Bay may be a significant explanatory variable, and to address potential double counting between the recreational damage determination (Breffle et al., 1999), Question 23 asked whether the respondent or anyone else in the household had fished in Green Bay or its tributaries up to the first dam in the last 12 months. This question is more specific than Question 1, which asks about the typical activity levels. We treat this question as an improved measure of interest in Green Bay fishing compared to Question 1, rather than as a specific estimate of such activity because the survey does not focus on fishing and asks for a full year recall (see Breffle et al., for

Table 2.5. Correlation between choice set attribute levels.

	Wetlands A	PCBs A	Recreation A	New parks A	Runoff A	Cost A	Wetlands B	PCBs B	Recreation B	New parks B	Runoff B	Cost B
Wetlands A	1.000											
PCBs A	-0.104	1.000										
Recreation A	0.205	0.078	1.000									
New Parks A	0.386	0.121	0.080	1.000								
Runoff A	0.313	-0.167	0.097	0.186	1.000							
Cost A	0.337	-0.298	0.101	0.330	0.206	1.000						
Wetlands B	0.163	-0.071	0.008	0.140	0.115	0.094	1.000					
PCBs B	-0.474	0.107	-0.361	-0.142	-0.123	-0.042	0.076	1.000				
Recreation B	0.304	-0.149	-0.045	0.116	0.178	0.102	0.122	-0.114	1.000			
New Parks B	0.294	-0.319	-0.053	0.170	0.191	0.077	0.126	-0.122	0.141	1.000		
Runoff B	0.194	-0.141	0.026	0.150	0.013	0.144	0.162	0.003	0.156	0.105	1.000	
Cost B	0.388	0.053	0.263	0.262	0.194	0.030	0.171	-0.412	0.191	0.309	0.257	1.000

estimates of Green Bay fishing activities and for discussions of recall bias in reported fishing activity levels).

Questions 24 through 35 asked background sociodemographic questions. Question 36 allowed respondents to provide additional comments about the survey and topics addressed.

3. Survey Implementation

3.1 Sample Selection

Our goal was to obtain 400 to 450 completed surveys, which would provide sufficient sample size to evaluate preferences with statistical confidence based on experience with similar studies (Breffle et al., 1999). With 6 choice questions per respondent, such a sample size would provide a minimum of 2,400 choice question responses (6 × 400). Based on experience with rates of ineligible addresses from mailing lists (10% to 20%) and expected response rates from eligible households (60% to 75%), a total starting sample of 750 was selected.

A stratified random sample was drawn from the 10-county area based on two sampling strata, as identified in Figure 2.1 and Table 3.1. The two strata radiate out from the Bay of Green Bay, reflecting the focus on the natural resource programs presented:

1. The "adjacent" stratum of five counties with shoreline on the Bay of Green Bay, the population of which is predominately located within about 20 miles of the bay.

2. The "second tier" stratum of five counties that border the "adjacent" counties.[1] These counties are located 10 to 60 miles from the bay, with the largest cities in these counties generally 30 or more miles from the bay.

The sample was weighted to emphasize households in the first stratum, since these households were likely to be the most familiar with the resources in question, and have the highest PCB-caused service flow losses and the highest potential benefits from natural resource restoration projects. However, we judged that people in the second tier counties were close enough to the assessment area to be familiar with the resources in question and potentially to have PCB-caused service flow losses. Furthermore, including the second tier would allow us to investigate how the scaling of restoration and WTP vary with distance within 60 miles of the site. The strata were weighted to achieve a minimum of 300 responses from the adjacent stratum and a minimum of 125 responses from the second tier stratum. Within each stratum, the sample was divided among counties based on the estimated 1998 population in the county, assuming the number of individuals per household was consistent across counties.

1. Three potential second tier counties (Forest, Menominee, and Langlade) were excluded because all or nearly all of Forest and Langlade are more than 60 miles from the site, and Menominee has a small population.

Table 3.1. Green Bay total value equivalency survey sample plan.

County	City	County touches bay	Approx. county distance to bay	Approx. largest city distance to bay	1998[a] population	% of total	Sample[b]	Target number of completed surveys
Adjacent strata					**Strata weight**	**1.600**		
Brown	Green Bay	Yes	<20	<10	218,149	26.87%	320	
Door	Sturgeon Bay	Yes	<20	<10	26,537	3.27%	40	
Kewaunee	Kewaunee	Yes	<25	<20	19,904	2.45%	30	
Marinette	Marinette	Yes	<60	<10	42,523	5.24%	65	
Oconto	Oconto	Yes	<60	<10	33,089	4.07%	50	
Adjacent strata subtotal					340,202	41.90%	505	300
Second tier strata					**Strata weight**	**0.570**		
Calumet	Chilton	No	25-40	35	38,760	4.77%	20	
Manitowoc	Manitowoc	No	15-50	35	84,434	10.40%	45	
Outagamie	Appleton	No	10-40	30	155,953	19.21%	80	
Shawano	Shawano	No	10-60	30	38,730	4.77%	20	
Winnebago	Oshkosh	No	30-60	45	153,937	18.96%	80	
Second tier subtotal					471,814	58.10%	245	125
Totals					812,016	100%	750	425

a. Wisconsin Official Population Estimates, County Estimates (1998).

b. Sample by county = 750 × % of total × strata weight, rounded to nearest 5. Ten survey versions randomized across each county.

Households within a county were randomly selected by Genesys Sampling Systems from households with listed telephone numbers and available addresses. In northeast Wisconsin this provided coverage of more than 77% of all households in the target population, as measured by the ratio of households with listed telephone numbers to total households (Table 3.2). The percentage of listed households varies by county, but is consistent across the aggregate of all counties in the two sampling strata (76.9% and 78.4%).

Table 3.2. Households with listed telephone numbers.[a]

Strata/county	Households	Number listed	Listed %
Adjacent strata			
- Brown	88,228	71,350	81%
- Door	17,593	14,050	80%
- Kewaunee	7,453	6,074	81%
- Marinette	26,455	19,125	73%
- Oconto	17,896	10,555	59%
Subtotal	157,625	121,244	76.9%
Second tier strata			
- Calumet	14,140	6,745	48%
- Manitowoc	31,570	25,179	80%
- Outagamie	68,238	57,155	84%
- Shawano	16,227	12,077	74%
- Winnebago	58,971	47,081	80%
Subtotal	189,146	148,237	78.4%
Total			
- Unweighted			77.8%
- Weighted[b]			77.3%

a. Source — Genesys Sampling Systems.

b. Weighted by sample size for each strata; see Table 3.1.

Because the survey was designed to obtain head of household attitudes and values, the design allowed for either a male or a female head of household to complete the survey.

3.2 Implementation

The survey was implemented by the Hagler Bailly Survey Center in Madison, Wisconsin. As noted above, ten versions of the mail survey were prepared. Sampled households were randomly assigned a version number before implementation. Standard procedures for repeat-contact mail surveys (Dillman, 2000) were followed, except that we added an attempt to contact nonrespondents by telephone.

1. **Initial mail survey package.** This package consisted of a cover letter from the Hagler Bailly Survey Research Center explaining the study, a 21-page mail survey booklet, and a postage-paid return envelope. The cover letter stated that a $15 check would be sent to respondents if they completed the survey by September 30. The surveys were mailed on September 10.

2. **Thank you/reminder postcard.** All sampled individuals were mailed a postcard 5 days after the initial mailing (September 15). The postcard thanked those who had responded to the survey and reminded those who had not yet responded to please do so.

3. **Combination telephone and mail follow-up.** Between October 5 and October 12, 1999, we tried follow-up telephone calls with all sample households that had remained potentially eligible and that had not returned the survey up to that point. Those we reached were told that the study deadline had been extended. They were asked whether they had received the survey and whether they had returned it. Those who had not returned the survey were asked to please complete it by October 18 and return it. If they needed another copy of the survey, it was mailed the day after the telephone call. Respondents reached by telephone who recalled receiving the mail survey, and who indicated they would not be returning it, were asked to complete a short telephone survey. Households that were not reached by phone by October 13 were sent another mail survey.

The cutoff date for accepting completed mail surveys was November 5, 1999.

Table 3.3 shows the response rates for the mail survey, by county, stratum, and in total. Overall, we received completed mail surveys from 72% of the eligible (adjusted) sample. The eligible sample did not include those who were known to be deceased, those for whom the mailings were undeliverable, those who had disconnected telephone numbers, those where the telephone was no longer a residential phone, and one individual identified as a U.S. Fish and Wildlife Service employee.[2] Four surveys were returned less than half completed and were treated as nonresponses.

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2. Of the starting sample, 87% remained in the eligible sample (13% were removed from the sample based on the above criteria). While this varied somewhat by county, the eligible sample proportion of the starting sample was quite consistent across the aggregate of all counties in each of the two sampling strata (86.5% and 87.1%). The completion rate varied by county, but was consistent across the aggregate of all counties in each sampling strata (72.3% and 71.3%).

Table 3.3. Mail survey response rates.

	Total	Brown	Calumet	Door	Kewaunee	Manitowoc	Marinette	Oconto	Outagamie	Shawano	Winnebago
Starting sample size	750	320	20	40	30	45	65	50	80	20	80
Undeliverable	53	15	1	9	3	1	8	5	2	2	7
Deceased	4	2	0	0	0	0	1	1	0	0	0
Out of sample	43	19	1	2	2	5	3	0	5	0	6
Service employee	1	0	0	0	1	0	0	0	0	0	0
Disconnected phone number	39	19	1	1	1	4	3	0	5	0	5
Non-household	3	0	0	1	0	1	0	0	0	0	1
Adjusted sample size	650	284	18	29	25	39	53	44	73	18	67
Refused	51	22	1	1	3	4	7	1	6	1	5
Mail refusals	5	0	0	0	1	1	0	0	2	0	1
Phone refusals	39	19	1	1	2	2	4	1	4	1	4
Elderly/unable to comprehend	7	3	0	0	0	1	3	0	0	0	0
Partially completed survey (less than half completed)	4	1	0	0	0	0	2	0	0	1	0
Number of completed surveys	470	214	13	20	17	25	33	32	52	13	51
Response rate to mail survey[a]	72%	75%	72%	69%	68%	64%	62%	73%	71%	72%	76%

a. Computed as the number of completed surveys/adjusted sample size.

We tried to call 327 members of the sample, reached 217 and 136 said that they intended to return the survey. Of these 136, 83 (61%) did return the survey by the cutoff date. The remaining 81 respondents reached by telephone either refused to complete the mail survey or were incapable of returning the survey (e.g., language barrier or age), including 13 who completed the brief telephone survey (these 81 nonrespondents remained in the sample for response rate calculations).

We could not reach 110 members of the sample. Of these, 42 were deleted from the sample because of bad or disconnected telephone numbers (the sample was of households with listed phone numbers). Of the remaining 68 subjects, 60 were sent a second mail survey and cover letter extending the response deadline (a few respondents were deleted from this mailing reflecting households where an individual was reached but where there was a potential language barrier). All 68 respondents with potentially valid phone numbers, but where contact could not be made, were left in the sample for the response rate calculations.

Of the 60 people who were sent a second survey after we could not reach them by telephone, 24 (40%) returned it before the cutoff date. The lower response rate for these households most likely reflected a combination of factors: more resistant sample members, additional bad addresses in the sample, and seasonal residences where respondents may not have received any of the mail or phone contacts. The 1990 Census (Census of Population and Housing, STF1A) for Door and Marinette counties (two counties with lower response rates) indicated that about one-third of the housing units were for "seasonal, recreational or occasional use," compared to an average of about 7% for the other eight counties.

The response rate to individual survey questions was high. For all questions other than the 11 parts of Question 1 and Question 35, item nonresponse was less than 2.5%. Item nonresponse for Question 35, the income question, was 4.7%. The rate of "don't know" responses was also very low, less than 3.0% for every question in the survey.

3.3 Evaluation of Potential Sample and Nonresponse Biases

3.3.1 Introduction

To summarize the results at the outset, while we find some differences in the characteristics of the survey respondents compared to the target population, statistical analyses in Chapters 4 and 5 indicate that these differences are not likely to result in any significant biases to the results.

Sampling bias refers to possible differences between the sample selected and the target population. The target population was all households in the 10 counties neighboring the Bay of Green Bay and the Lower Fox River, with responses sought from a head of the selected household. Given the sample was selected from households with listed telephone numbers, the most likely source of sampling bias, if any, would be differences between those households with and without telephone numbers. Given that about 77% of the households in both sampling strata of the target population have listed phone numbers (Table 3.2), households without listed telephones would need to be dramatically different from those with listed phones for there to be a substantial sampling bias in the results of this study.

Research by Piekarski (1989) indicates that households with unlisted telephone numbers are more likely to be multifamily housing units and renter occupied than are listed households (which are more likely to own their residences). Younger persons (both female and male) and single, divorced, and separated householders (with and without children) are more likely to be unlisted than are other types of households. Finally, retired householders are more likely to be listed than employed householders. We examine the impact of these potential differences later in this section.

Nonresponse biases potentially result from the differences between the respondents and the nonrespondents in the sample. In some valuation assessments, analysts are concerned that individuals who are less interested in (and have lower awareness of) the topics addressed in the survey are less likely to respond. Such individuals would be likely to have lower benefits from natural resource improvements. This difference could lead to an upward bias in the estimated WTP values. However, for restoration scaling this potential bias would be minimal if nonrespondents have proportionately lower values for both PCB injuries and for the benefits from other restoration projects. In any case, the mail survey had a high response rate of 72%, which can be expected to significantly limit the magnitude of any potential nonresponse bias on the overall assessment.

3.3.2 Comparison of phone survey and mail survey respondents

In the phone survey, we completed comparison questions with 13 individuals who said they would not return the mail survey. While the telephone follow-up sample size of 13 for this comparison is very small, the results are suggestive. The telephone survey covered demographic characteristics, participation rates in fishing and other outdoor activities, and streamlined versions of the importance ratings for increased wetlands, PCB removal, and increasing facilities at existing parks in questions that closely parallel the mail survey questions 2, 4, 5, and 7. (To streamline the telephone survey, a runoff question was omitted.) The 13 nonrespondents were much less likely to report that they or household members are Green Bay anglers than the mail survey respondents (1 of 13 versus 30% in the mail survey**)**. As described in Chapter 5, Green Bay anglers have PCB values approximately 20% larger than for those who were not Green Bay anglers, and similar relative values for the other natural resource programs. Thus, nonrespondents may require slightly less restoration to provide services of equal value to PCB injuries than do respondents, but we would not expect the effects to be large. In addition, we found the following:

- The 13 nonrespondents reported lower participation rates than did mail survey respondents for each of the outdoor recreational activities asked.

- The importance ratings for each of the natural resource benefits are not statistically different between the 13 nonrespondents and mail survey respondents (Table 3.4). As in the mail survey, the rating for outdoor recreation facilities is much lower than for the other programs, and the ratio of importance for PCBs and wetlands to outdoor recreation is larger for the 13 nonrespondents than in the mail survey. The relative significance of wetlands to PCBs is slightly higher in the phone follow-up than in the mail survey, but the sample size is insufficient to place much emphasis on this.

- The 13 nonrespondents are slightly, but not statistically significantly, older (58.6 years versus 50.8 years), have smaller household sizes (1.7 versus 2.7), and are more likely to be female (46% versus 29%). The sample size in the telephone survey is insufficient to conclude that these are meaningful differences, and thus any differences are expected to have at most a negligible impact on the assessment.

Table 3.4. Comparison of importance ratings from phone and mail surveys.

	Telephone survey		**Mail survey**		**Z value for difference**
	Net of don't knows		**Net of missing/don't knows**		
Importance to . . .	**Mean**	**SE**	**Mean**	**SE**	
Increase wetland to support increased populations of wildlife	4.16	0.37	3.9	0.05	0.70
Remove PCBs so it is safe to eat fish and waterfowl	4.08	0.38	4.3	0.05	0.58
Remove PCBs to reduce risks to wildlife	4.16	0.37	4.3	0.05	0.38
Add new facilities at existing state and county parks	3.00	0.51	3.6	0.05	1.18

In summary, the results for the 13 nonrespondents who completed the phone comparison questions suggest that while modest differences in restoration scaling might occur because of differences between respondents and nonrespondents, the evidence from within the study does not support concluding that any resulting biases would be substantial.

3.3.3 Comparison of Census information and mail survey respondents

Another way to consider sampling and nonresponse bias is to look outside the study by comparing the characteristics of the sample and the target population based on Census data, and then consider how these differences may affect the assessment based on the analyses in Chapters 4 and 5. However, the mail survey sample is of heads of households, and for most socioeconomic characteristics the most similar readily available Census data are for all adults age 18 and older. This provides a somewhat misleading comparison because many younger adults are less likely to be heads of households.

The analyses in Chapters 4 and 5 show that higher levels of participation in outdoor recreation (especially whether respondents are Green Bay anglers) and higher levels of awareness of the four resource issues are key variables in explaining how much restoration is of equal value to the value of PCB-caused losses, and the magnitude of WTP values, per household. Therefore, we consider here how demographic characteristics of the survey respondents might be different from the population and how the differences might, if at all, affect the assessment.

Table 3.5 shows that more survey respondents own their residences than do members of the 1990 adult population (84% versus 71%). In part, this most likely reflects that some young adults in the Census data are not heads of households and are less likely to own their residence than are heads of households. This is also consistent with the Piekarski (1989) evidence that samples based on listed telephones may over-represent households that own their residences. Simple Pearson correlations suggest that residence ownership is positively and significantly correlated with awareness for three of the four natural resource topics (with outdoor recreation being the exception) and with increased levels of recreation, but not with increased participation in Green Bay fishing. However, the strength of the relationships between residence ownership and these variables, or on choices made in Questions 13 through 18, is either small or insignificant.

Table 3.5. Ownership of residence (Question 24).

Tenure	Number of observations	Percent of respondents	Percent of occupied housing units in 10 county area[a]
Own	395	84.0%	71.2%
Rent	73	15.5%	28.8%
Missing	2	0.4%	NA

a. Source: U.S. Census Bureau (1990).

About 71% of the mail survey respondents were males, which exceeds the population proportion among adults (Table 3.6). The fact that listed telephones are more likely to be in the male head of household name than the female head of household name explains this result. Further, any adult head of household could complete the survey to reflect the household attitudes and values, so it

Table 3.6. Gender of respondents (Question 26).

	Number of observations	Percent of respondents	Percent of population in 10 county area[a]
Male	335	71.3%	49.2%
Female	135	28.7%	50.8%
Missing	0	0.0%	NA

a. Source: U.S. Census Bureau (1990).

is valid for female heads of household to have their male counterparts complete the survey. While we do not consider the sample gender ratio to be a source of bias, we note that males reported higher rates of outdoor participation (including Green Bay fishing) and were more aware of all four resource issues than females. This also may be part of the reason why the male head of household chose to complete the survey.

The average age of survey respondents is about 51 years (ranging from 21 to 96 with a standard error of 0.73). The Census population average is 44.3 years old for adults over 18 years of age. That retired individuals are more likely to have listed telephones may be part of the reason. However, the Census population average includes young adults who are living with others (e.g., parents, older relatives), and who are not a head of the household. Thus, heads of households are expected to be older than the average adult age 18 and older. Further, male heads of household, who more frequently completed the survey, on average are older than female heads of household. Finally, while recreational participation (other than fishing) increased with age, the rate of participation in Green Bay fishing decreased. Overall, we do not anticipate that difference between the age distribution of our respondents and the age distribution of all adults in the population had a biasing effect on the analysis in the next chapters.

Table 3.7 shows that the sample mean family size of 2.7 individuals is comparable to the population mean family size (also 2.7 people per household). Table 3.8 shows that the racial and ethnic compositions of the sample and the population also are very comparable. For these two characteristics, the Census variable is directly comparable to its counterpart sample variable, and the results are very similar.

Table 3.9 shows that the sample tends to have a higher level of educational attainment than the population of all adults. Here again, the Census statistics may not be strictly comparable to our population of heads of households. Many adults 18 and older in the Census figures are younger adults who may not have completed their schooling. There may also be some effect due to households with unlisted telephone numbers being more likely to be renters rather than homeowners. Presumably homeowners tend to have higher levels of educational attainment and income.

Table 3.7. Household and family size (Questions 28, 29, 30, 31).

Question	Net of missing: Number of observations	Net of missing: Mean	Net of missing: SE	Missing
How many people are there in your household, including yourself?	468	2.7	0.06	0.4%
How many children do you have, whether living with you or not?	467	2.3	0.08	0.6%
How many grandchildren do you have, whether living with you or not?	464	2.0	0.18	1.3%
How many listed telephone numbers does your household have?	465	1.1	0.02	1.1%
Census estimate of average household size for 10 counties [a]	NA	2.7	NA	NA

a. Source: U.S. Census Bureau (1990).

Table 3.8. Racial or ethnic background (Question 34).

Racial or ethnic background	Percent of respondents	Percent of population in 10 county area[a]
White or Caucasian	97.9%	97.3%
Black or African American	0.2%	0.3%
Hispanic or Mexican American	0.2%	0.7%
Asian or Pacific Islander	0.4%	1.0%
Native American Indian	0.9%	1.2%
Other	0.0%	0.2%
Missing	0.4%	NA

a. Source: U.S. Census Bureau (1990).

Table 3.9. Highest level of schooling attained (Question 32).

Level of schooling	Percent of respondents	Percent of population age 18 and older in 10 county area[a]
Did not complete high school	5.1%	21.0%
High school diploma or equivalent	38.1%	40.0%
Some college, two year college degree (AS) or technical school	31.7%	17.3%
Four year college graduate (BA, BS)	12.3%	10.6%
Some graduate work but did not receive a graduate degree	4.3%	NA
Graduate degree (MA, MS, MBA, PhD, JD, MD, etc.)	7.7%	3.7%
Missing	0.9%	

a. Source: U.S. Census Bureau (1990).

Table 3.10 shows that the sample has fewer employed individuals and more retired individuals than the population. Education levels and employment status were found to have little influence on the key assessment variables.

Table 3.10. Employment status (Question 33).

Employment category	Percent of respondents	Percent of 10 county population[a]
Employed full time	64.7%	77.4%
Employed part time	5.5%	(employed full or part time)
Retired	25.7%	
Homemaker	2.1%	19.8% (not in labor force)
Student	0.6%	
Unemployed	1.1%	2.8%
Missing	0.2%	NA

a. Percent of labor force aged population (i.e., 16 years and older) for 1997.

Source: Wisconsin Department of Workforce Development (2000).

Table 3.11 summarizes the 1998 household income levels reported by the mail survey respondents. The median household income is in the $40,000 to $49,999 bracket. We compute the population median income as approximately $43,000 based on Census data.[3] These figures are for the same variable and the results are very comparable and do not suggest any source for substantive sampling and nonresponse bias.

3. Specifically, we computed the median household income for each county based on 1995 Census data (U.S. Census Bureau, 1998), escalated by the CPI from 1995 to 1998 dollars (1.0696), and weighed the county estimates by county population to compute a 10 county median.

Table 3.11. Household income.

Mail survey income categories	% of survey respondents (omitting missing)[a]
Less than $10,000	4.5%
$10,000 to $19,999	11.8%
$20,000 to $29,999	12.9%
$30,000 to $39,999	15.6%
$40,000 to $49,999	14.5%
$50,000 to $59,999	10.7%
$60,000 to $79,999	16.5%
$80,000 to $99,999	6.3%
$100,000 to $149,999	3.8%
$150,000 or more	3.3%
10 county sample median	$40,000 to $49,999
10 county Census median[b]	about $43,000

a. 4.7% missing. Percents may not total 100% due to rounding.

b. Based on 1995 median household income by county (U.S. Census Bureau, 1998), inflated to 1998 with the CPI, and weighted by county population.

3.4 Summary

The above evaluation indicates that any sampling and nonresponse biases will have limited impact on the assessment. First, the differences between the measurable sample and population characteristics are generally small, and these differences are not associated with strong influences on the assessment. Second, the high sample coverage rates and response rates reduce the potential for these biases and reduce the influence of these biases, if any, on the overall assessment. Finally, the influence of any potential sampling and nonresponse bias is further minimized in the scaling of restoration because the potential biases typically would be in the same direction for all of the resource programs. Thus some of the potential bias may largely cancel out when computing the scale of restoration of equivalent value to PCB losses.

4. Survey Results

4.1 Introduction

This chapter provides results on respondent activities, attitudes, awareness, and evaluations of the four natural resource topics and programs. Responses to choice Questions 13 through 18 are addressed in Section 4.6 and in Chapter 5. Responses to sociodemographic questions were summarized in Section 3.3 (see also Appendix C).

A respondent's awareness of the four natural resource topics before receiving the survey (from Question 22) is found to be an important indicator of responses to opinion and attitude questions (reported in this chapter), and to preferences and values for natural resource restoration options (as reported in the next chapter). We begin by reporting on respondent awareness of the four topics, and note throughout the presentation how the results are related to respondent awareness. Then, we report the results on respondent activity levels in potentially related recreation, and respondents' ratings of the importance of natural resource topics. We conclude by simple evaluations of the choice pair results that do not require models such as used in Chapter 5.

4.2 Topic Awareness

Question 22 asked respondents, "Prior to receiving this survey, how aware were you of each of the four natural resource topics we addressed?" Each topic was rated from 1 = "I was not aware of this topic" to 5 = "I was very aware of this topic." Respondents with more awareness, or familiarity, generally have more crystallized attitudes and values regarding the natural resource, and thus responses may have greater validity and accuracy. Increased awareness probably reflects respondents' interests, and in general increased awareness may be associated with increased preferences for natural resource enhancements.

Results for the awareness question are presented in Table 4.1. These results indicate that respondents have a moderate to high level of awareness of the topics, especially of PCBs: approximately 70% of respondents report awareness scores of 4 or 5 for PCBs, and over 90% reporting scores of 3 or greater. For the other three topics, about 45% to 50% report scores of 4 or 5, and over 80% report scores of 3 or greater. Topic awareness is correlated with participation in recreational activities, especially fishing in the waters of Green Bay, and with several sociodemographic variables (Table 4.2). Awareness is also highly correlated with several policy variables and with responses to questions in which respondents evaluate their own responses to the program choice questions (discussed below).

Table 4.1. Awareness of natural resource topics before receiving the survey[a] (Question 22: 1 = was not aware of this topic to 5 = very aware of this topic).

							Net of missing		
Natural resource topic	**Not at all aware 1**	**2**	**Somewhat aware 3**	**4**	**Very aware 5**	**Missing**	**Number of observations**	**Mean awareness rating**	**SE**
Wetlands	8.7%	9.8%	36.6%	24.7%	20.0%	0.2%	469	3.4	0.05
PCBs	4.3%	2.6%	21.7%	29.2%	40.6%	1.7%	462	4.0	0.05
Outdoor recreation	6.4%	12.6%	35.1%	25.3%	19.4%	1.3%	464	3.4	0.05
Runoff	7.9%	10.9%	30.0%	27.5%	22.6%	1.3%	464	3.5	0.06

a. Totals may not sum to 100% because of rounding.

4.3 Outdoor Recreational Activity in and around the Waters of Green Bay Area

Question 1 examines the level of outdoor recreation participation for many activities on the waters and shoreline of the Bay of Green Bay. It reiterates the geographic focus of the survey, motivates respondents to think about if and how the natural resource enhancements might affect them, and provides potentially useful explanatory variables for evaluation of subsequent responses, such as the types and levels of recreational activity. Question 1 is not intended to provide precise estimates, but indicators of relative activity levels across respondents.

The most popular outdoor activities are ones that do not require a lot of equipment or time, such as enjoying outdoor scenery, viewing wildlife, camping or picnicking, and hiking, walking, or jogging. More than 50% of respondents report participating in those activities at least once a year. Other activities have smaller groups of avid participants, but more than 50% of respondents never participate or participate less than once a year. Fishing, biking, swimming, and boating attract about 40% of the respondents at least once a year. The least popular activities are waterskiing or jetskiing, and canoeing or kayaking; only about 12% indicated they do these activities at least once a year. Hunting is also a less common activity, with only 26% participating at least once a year.

Proximity to the Bay of Green Bay influences participation. As would be expected, respondents who live closer to the bay participate more frequently in many of the activities on the bay (Table 4.3). The only activities that did not show a significant difference in participation by those who live near Green Bay (about 50% live within 8.8 miles) and those who live farther away (more than 8.8 miles, but still within the 10 neighboring counties) were camping or picnicking, fishing, hunting, and canoeing or kayaking.

Table 4.2. Correlations between topic awareness (Question 22) and other variables.

Correlation variables	**Natural resource topic awareness**[a]			
	Wetlands	**PCBs**	**Outdoor recreation**	**Runoff**
Recreation variables	Question 1 none[b] **Question 23 fish Green Bay**	Question 1 *fishing, boating, skiing, canoeing, swimming, hunting, hiking/walking,* hunting, wildlife viewing, enjoying scenery **Question 23 fish Green Bay**	Question 1 **enjoying scenery**, *boating, skiing, swimming, wildlife viewing, hiking/walking,* canoeing, hunting, biking **Question 23 fish Green Bay**	Question 1 none **Question 23 fish Green Bay**
Policy variables	**Question 2 wetland acres** Question 6 PCB spending	**Question 2 wetland acres** *Question 4 PCBs FCAs*	*Question 2 wetland acres* Question 6 PCB spending **Question 7 enhance facilities** **Question 8 add facilities**	**Question 2 wetland acres** Question 10 excess algae Question 11 water clarity
Evaluation variables	Question 19 **wetlands**, *algae, costs* **Question 20 confidence** **Question 21 use of results** **Question 22 awareness — all issues** **Made a comment**	Question 19 **wetlands, PCBs** **Question 20 confidence** **Question 21 use of results** **Question 22 awareness — all issues** **Made a comment**	Question 19 *wetlands,* **enhance facilities, new parks,** *excess algae* **Question 20 confidence** **Question 21 use of results** **Question 22 awareness — all issues** Made a comment	Question 19 **wetlands,** PCBs, new parks, **water clarity, excess algae** **Question 20 confidence** **Question 21 use of results** **Question 22 awareness — all issues** **Made a comment**
Socio-demographic variables	**Question 24 own residence** **Question 26 male** *Question 34 ethnic background*	**Question 24 own residence** *Question 26 male* Question 28 # in household	Question 26 male	*Question 24 own residence* **Question 26 male** *Question 29 # children*

a. **Bold** = correlation at 99% confidence or higher, *italics* = correlation at 95% to 99% confidence, regular = correlation at 90% to 95% confidence.
b. Correlated with "enjoying outdoor scenery" at 10.4% level.

Table 4.3. Average participation level[a] in outdoor activities on the waters and shorelines of the Bay of Green Bay by distance of residence to Green Bay (Question 1).

Location of residence		Enjoying outdoor scenery	Wildlife viewing	Hiking, walking, or jogging	Camping or picnicking	Fishing	Biking	Swimming	Boating (nonfishing)	Hunting	Canoeing or kayaking	Waterskiing or jetskiing
Near Green Bay[b]	Mean	3.04[d]	2.49[d]	2.41[d]	1.92	1.81	1.83[d]	1.79[d]	1.70[d]	1.50	1.22	1.21[d]
	SE	0.065	0.072	0.077	0.063	0.065	0.074	0.067	0.058	0.062	0.038	0.038
	Nobs	232	229	229	222	229	225	223	222	221	217	218
Farther from Green Bay[c]	Mean	2.73[d]	2.22[d]	2.23[d]	1.87	1.76	1.55[d]	1.54[d]	1.45[d]	1.51	1.17	1.13[d]
	SE	0.077	0.076	0.082	0.066	0.073	0.063	0.058	0.051	0.066	0.036	0.033
	Nobs	212	213	209	209	217	207	210	209	210	206	205
All respondents	Mean	2.89	2.36	2.32	1.90	1.78	1.69	1.67	1.58	1.50	1.20	1.17
	SE	0.051	0.053	0.056	0.046	0.048	0.049	0.045	0.039	0.045	0.026	0.025
	Nobs	444	442	438	431	446	432	433	431	431	423	423

Nobs = Number of observations.

a. Where 1 = less than once a year or never, 2 = 1 to 5 times a year, 3 = 6 to 10 times a year, and 4 = more than 10 times a year.

b. Respondents are near Green Bay if their residence is less than 8.8 miles from Green Bay (about half the respondents).

c. Respondents are farther from Green Bay if their residence is 8.8 miles or more from Green Bay (about half the respondents).

d. Indicates activity level of those who live near Green Bay is significantly different from those who live farther from Green Bay at the 95% level.

Those who were very aware of the natural resource topics addressed in the survey tended to be more avid participants in recreational activities in the Green Bay area than those who were only somewhat or not at all aware. Table 4.4 shows the mean activity levels for respondents who indicated that they were more aware of all the natural resource programs presented (i.e., a rating of 4 or 5 in Question 22 for all four issues) and for those respondents who indicated they were less aware of the natural resource programs presented (i.e., a rating of 1, 2, or 3 in Question 22 for all four issues). The only activity that did not have a statistically significant difference in participation levels between more aware and less aware respondents was waterskiing or jetskiing. For all other activities named in Question 1, the respondents who were more aware of

Table 4.4. Participation level by awareness of issue (Question 1 by Question 22).

Activity	Awareness level	Number of observations	Mean frequency of activity[c]	SE
Fishing	less aware[a]	86	1.52[d]	0.093
	more aware[b]	112	1.93[d]	0.101
Boating (nonfishing)	less aware[a]	83	1.45[d]	0.084
	more aware[b]	106	1.76[d]	0.086
Waterskiing or jetskiing	less aware[a]	83	1.12	0.049
	more aware[b]	100	1.21	0.052
Canoeing or kayaking	less aware[a]	82	1.09[d]	0.036
	more aware[b]	104	1.38[d]	0.070
Swimming	less aware[a]	83	1.49[d]	0.079
	more aware[b]	107	1.80[d]	0.105
Hunting	less aware[a]	84	1.31[d]	0.079
	more aware[b]	104	1.66[d]	0.101
Wildlife viewing	less aware[a]	84	1.96[d]	0.104
	more aware[b]	111	2.77[d]	0.108
Enjoying outdoor scenery	less aware[a]	85	2.49[d]	0.111
	more aware[b]	110	3.21[d]	0.096
Camping or picnicking	less aware[a]	81	1.73[d]	0.102
	more aware[b]	107	1.99[d]	0.092
Biking	less aware[a]	82	1.54[d]	0.095
	more aware[b]	108	1.86[d]	0.104
Hiking, walking, or jogging	less aware[a]	85	2.11[d]	0.125
	more aware[b]	109	2.53[d]	0.115

a. In Question 22 for each of the four natural resource topics, respondent indicated a 1, 2, 3 for how aware they were of the topic before receiving the survey (1 = not at all aware, 3 = somewhat aware, 5 = very aware).
b. In Question 22 for each of the four natural resource topics, respondent indicated a 4 or 5 for how aware they were of the topic before receiving the survey (1 = not at all aware, 3 = somewhat aware, 5 = very aware).
c. 1 = less than once a year or never, 2 = 1 to 5 times a year, 3 = 6 to 10 times a year, 4 = more than 10 times a year.
d. Indicates activity level of those who are more aware is significantly different from those who are less aware at the 95% level.

the natural resource programs in the region were also more avid participants. This result is intuitive: people who use the resource are more aware of topics related to the resource.

Question 23 asks how many days the respondent fished in the last 12 months. The intent of this question was to obtain an indication of interest in Green Bay fishing for respondent households rather than a precise estimate of participation in the sample counties, which is available elsewhere (Breffle et al., 1999). The Green Bay fishing participation rate reported in Question 23 is about 30.4%, and just over double the participation rates determined in Breffle et al. (1999). Two reasons explain this result. First, the sample is weighted to more heavily sample respondents in counties adjacent to Green Bay, who would fish these waters more often (Stratum 1, see Section 3.1). Reweighting the results to the population in the 10 study counties results in an estimate of about 26.5%. Second, because this question asks for one year recall, we can expect some telescoping in the response, e.g., respondents who fished in the prior year, but not the last 12 months, may report the event in the past 12 months because of telescoping and/or to indicate they generally fish the site (Westat, 1989; Tourangeau et al., 2000).

Question 23 also asked for the number of days fished in the waters of Green Bay by those who had fished on Green Bay. These anglers reported fishing Green Bay an average of 10.5 days (SE = 1.14) in the prior 12 months. This level is similar to that found in Breffle et al. (1999), where anglers who fished Green Bay reported fishing 9.95 days (SE = 0.55) per year. In both instances the anglers were asked to recall their fishing activities over a 12 month period, which may be subject to recall bias. A discussion of potential biases and adjustments for bias can be found in Breffle et al. (1999, pp. 3-29 to 3-32). With adjustments for recall bias, it was estimated that anglers in the 1999 study had spent an average of 6.19 days of open water plus ice fishing the Bay of Green Bay in that 12 month period.

4.4 Importance and Action Scores

Questions 2 through 12 are part of the presentation of the four natural resource topics considered in this survey. Each presentation has a description of the current state of the resource followed by one or two importance questions and then one action question. The importance questions ask how important the benefits from potential programs are to the respondent. The action questions ask whether the respondent feels that less, the same, or more should be done and spent on each of these topics.

4.4.1 Benefits importance scores

Respondents were asked to rate the importance of the environmental and human use service flow benefits for each of the four general programs (Question 2 for wetlands, Questions 4, 5 for PCBs, Questions 7, 8 for outdoor recreation, Questions 10, 11 for runoff). Table 4.5 shows the ratings of the importance questions. From the responses we see that residents of this area are concerned about natural resource issues in and around Green Bay. Of the four programs considered, removing PCBs is rated most important (with statistical significance), reducing runoff and increasing wetlands are next (their ratings are not significantly different from each other at the 95% level), and improving outdoor recreation is rated least important (with statistical significance).

Table 4.5. Importance of all natural resource action benefits (Questions 2, 4, 5, 7, 8, 10, 11: 1 = not at all important to 5 = very important).

	Net of missing/don't know				
Benefits[a]	**Number of observations**	**Mean importance rating**	**SE**	**Don't know**	**Missing**
Remove PCBs so that it is safe to eat fish and waterfowl (Question 4)	458	4.3	0.05	1.7%	0.9%
Remove PCBs to reduce risks to birds, fish and other wildlife (Question 5)	462	4.3	0.05	1.3%	0.4%
Reduce runoff to improve water clarity (Question 11)	461	4.0	0.05	1.9%	0.0%
Increase wetland acreage to support birds, fish and other wildlife (Question 2)	460	3.9	0.05	1.7%	0.4%
Reduce runoff to reduce algae blooms (Question 10)	457	3.8	0.05	2.8%	0.0%
Add facilities at existing parks (Question 7)	467	3.6	0.05	0.6%	0.0%
Add new parks (Question 8)	466	3.3	0.06	0.9%	0.0%

a. Listed in order of mean importance, not in the order they appeared in the survey.

Respondents' levels of awareness of the different resource topics before receiving the survey often affects their benefits importance scores. Those who are more aware had higher benefits importance scores for each of the natural resource topics than those who are less aware (Table 4.6). Benefits from removing PCBs are rated on average as 4.3 on the 5 point scale by all those who are more aware of any individual topic, and 4.1 to 4.2 by those who were less aware of individual topics. Outdoor recreation parks and facilities receive the highest scores from those who are more aware of outdoor recreation in the area, but they still have the lowest action score even by this group.

While scores change with awareness, the rankings of the different benefits from natural resource actions remain nearly the same. Removing PCBs always rank first, and enhancing outdoor recreation (adding facilities or new parks) always rank last. The only difference is that the rankings of wetlands programs and runoff programs sometimes switch, although the difference in scores generally are not large.

Thus, while awareness is correlated with benefit importance scores (higher awareness scores generally resulting in somewhat higher benefit importance scores), awareness has a relatively limited impact on the average rankings across the four programs (e.g., PCBs always ranked first and outdoor recreation always ranked last).

Table 4.6. Mean (SE) importance of all natural resource action benefits by awareness of issues (Questions 2, 4, 5, 7, 8, 10, 11: 1 = not at all important to 5 = very important).

Natural resource action benefits[a]	More aware all[a]	Less aware all[a]	More aware wetlands[b]	Less aware wetlands[b]	More aware PCBs[b]	Less aware PCBs[b]	More aware recreation[b]	Less aware recreation[b]	More aware runoff[b]	Less aware runoff[b]
Number of observations	117	92	210	258	327	140	209	259	234	234
Remove PCBs so that it is safe to eat fish and waterfowl (Question 4)	4.4 (0.10)	4.0 (0.13)	4.3 (0.07)	4.2 (0.07)	4.3 (0.06)	4.1 (0.10)	4.3 (0.07)	4.2 (0.07)	4.3 (0.07)	4.2 (0.07)
Remove PCBs to reduce risks to birds, fish, and other wildlife (Question 5)	4.4 (0.10)	4.0 (0.13)	4.3 (0.07)	4.2 (0.07)	4.3 (0.06)	4.2 (0.09)	4.3 (0.07)	4.2 (0.07)	4.4 (0.07)	4.2 (0.07)
Reduce runoff to improve water clarity (Question 11)	4.1 (0.10)	3.8 (0.11)	4.1 (0.07)	3.9 (0.06)	4.0 (0.06)	3.9 (0.09)	4.0 (0.07)	3.9 (0.06)	4.1 (0.07)	3.8 (0.07)
Increase wetland acreage to support birds, fish, and other wildlife (Question 2)	4.3 (0.11)	3.5 (0.13)	4.3 (0.08)	3.6 (0.07)	4.1 (0.06)	3.7 (0.10)	4.1 (0.08)	3.8 (0.08)	4.2 (0.07)	3.7 (0.08)
Reduce runoff to reduce algae blooms (Question 10)	4.0 (0.10)	3.6 (0.12)	3.9 (0.08)	3.7 (0.07)	3.8 (0.06)	3.7 (0.09)	3.9 (0.07)	3.7 (0.07)	4.0 (0.07)	3.6 (0.07)
Add facilities at existing parks (Question 7)	3.7 (0.12)	3.5 (0.12)	3.6 (0.08)	3.6 (0.07)	3.6 (0.06)	3.7 (0.09)	3.8 (0.08)	3.4 (0.07)	3.6 (0.08)	3.6 (0.07)
Add new parks (Question 8)	3.5 (0.12)	3.2 (0.14)	3.3 (0.09)	3.3 (0.07)	3.3 (0.07)	3.3 (0.11)	3.6 (0.09)	3.1 (0.07)	3.3 (0.08)	3.3 (0.08)

a. If respondents chose 4 or 5 for awareness of all four topics in Question 22, they fall in the "more aware all" category. If respondent chose 1, 2 or 3 for all four topics in Question 22, they fall in the "less aware all" category.
b. If respondents chose 4 or 5 for awareness of the *topic* in Question 22, they fall in the "more aware *topic*" category, otherwise they are in the "less aware *topic*" category.

4.4.2 Action scores

Action scores refers to the questions about whether respondents prefer doing and spending less, the same, or more than currently occurs for each resource topic (Question 3, Question 6, Question 9, Question 12). Table 4.7 shows the level of action respondents would like to see implemented to improve these resources. The greatest support is for actions to remove PCBs, there is moderate support for wetlands and runoff programs, and the lowest support is for actions to improve outdoor recreation. Respondents who are more aware tend to want more done and spent than respondents who are less aware of the resource topic, except for PCBs, where even respondents who indicated they were less aware also feel it is important to do more and spend more.

Table 4.7. Preferred level of action for natural resource programs (Questions 3, 6, 9, 12).

Natural resource program[a]		Do less and spend less	Do the same	Do more and spend more	Missing[d]
PCB investigations and removal (Question 6)	All	NA[c]	16.4%	81.3%	2.3%
	More aware of PCBs[b]	NA	16.2%	81.7%	2.1%
	Less aware of PCBs[b]	NA	16.9%	80.3%	2.8%
Runoff reduction (Question 12)	All	1.5%	33.4%	63.6%	1.5%
	More aware of runoff[b]	0.9%	23.8%	74.5%	0.8%
	Less aware of runoff[b]	2.1%	43.0%	52.8%	2.1%
Wetlands maintenance and/or restoration (Question 3)	All	2.6%	40.9%	54.7%	1.9%
	More aware of wetlands[b]	1.9%	26.7%	70.0%	1.4%
	Less aware of wetlands[b]	3.1%	52.3%	42.3%	2.3%
New facilities at existing parks and/or opening new parks (Question 9)	All	1.9%	50.9%	46.8%	0.4%
	More aware of recreation[b]	1.9%	40.0%	58.1%	0.0%
	Less aware of recreation[b]	1.9%	59.6%	37.7%	0.8%

a. Listed in order of preference for more action, not in the order they appeared in the survey.
b. If respondents chose 4 or 5 for awareness of the *topic* in Question 22, they fall in the "more aware of *topic*" category, otherwise they are in the "less aware of *topic*" category.
c. Not applicable: "Do less and spend less" was not offered an option for PCBs, as discussed in Section 2.2.2.
d. Percentage may not total to 100% because of rounding.

These measures are correlated with the benefits importance scores. For instance, in Table 4.5 we see that removing PCBs receives the highest importance rating of all the issues, and in Table 4.7 we see that most respondents would like to see more done and more spent to remove the PCBs.

4.5 Evaluation Scores

This section provides results for Questions 19 through 21, to which respondents provide follow-up evaluation of their own responses to the choice questions, Question 13 through Question 18.

Question 19 is again asking about the importance of various natural resource program benefits, but the context is slightly different. Here the question relates to the tradeoffs that respondents made in the set of choice questions. In these tradeoffs the respondent is constrained by the cost of the sets of programs. The cost is an important factor for respondents (rated second to PCB removal) and as such has an effect on the ratings of all the programs. Comparing results reported in Table 4.5 to those in Table 4.8, we see that adding a monetary dimension reduces the average rating of each of the issues, but does not change their relative ranking.

Table 4.8. Importance of program attributes in making choices between alternatives (Question 19: 1 = not at all important to 5 = very important).

	Net of missing			
Program attribute[a]	**Number of observations**	**Mean importance rating**	**SE**	**Missing**
Years until safe levels of PCBs	468	3.9	0.05	0.4%
Annual cost to your household	466	3.8	0.05	0.9%
Inches of water clarity	465	3.5	0.05	1.1%
Days of excess algae each summer	467	3.3	0.05	0.6%
Acres of wetlands	468	3.3	0.05	0.4%
Facilities at existing parks	464	3.1	0.05	1.3%
Acres of new parks	466	2.9	0.06	0.9%

a. Listed in order of mean importance, not in the order they appeared in the survey.

For example, PCB removal remains the most important action, but while the benefits of PCB removal are rated an average of 4.3 on a scale of 5 (1 = not at all important, 5 = very important) with no consideration of cost, they are rated an average of 3.9 on the same scale when a monetary constraint is introduced. Cost is the next most important consideration. Recreation remains the lowest ranked resource topic. In the benefits importance questions, adding facilities was rated 3.6 and new parks 3.3, but with the addition of a monetary constraint in Question 19, they are rated 3.1 and 2.9 on a scale of 1 to 5.

In their responses to Question 19, the more aware and less aware groups have the same relative rankings for the benefits of natural resource programs that we saw in the benefits importance scores (Table 4.6). When the benefits of the resource programs are ranked along with cost in

Question 19, cost is ranked the most important factor for those who are less aware of all of the topics and the second most important factor (after PCBs) for those who are more aware of all the topics, suggesting that values will be lower for those who are less aware than for those who are more aware.

Questions 20 and 21 provide two perspectives on respondents' evaluations of their responses to the choice questions, and these are summarized in Tables 4.9 and 4.10. Question 20 asks respondents to consider their confidence in their choices between the alternatives in Questions 13 through 18. Question 21 takes a pragmatic perspective and tells the respondent to consider that "Questions 13 to 18 were asked to provide citizen input for decisions makers to consider along with scientists and planners," and then asks, "With this in mind how much should public officials consider your responses to Questions 13 through 18?"

Table 4.9. Confidence in choices between alternatives (Question 20: 1 = not at all confident to 5 = very confident).

							Net of missing		
Category[a]	Not at all confident 1	2	Somewhat confident 3	4	Very confident 5	Missing	Nobs	Mean confidence rating	SE
All	1.3%	4.9%	40.0%	37.9%	15.5%	0.4%	468	3.6	0.04
More aware	0.9%	3.4%	23.9%	46.2%	24.8%	0.9%	116	3.9	0.08
Less aware	2.2%	12.9%	49.5%	29.0%	6.5%	0%	93	3.2	0.09

Nobs = Number of observations.

a. If respondents chose 4 or 5 for awareness of all four topics in Question 22, they fall in the "more aware" category. If respondents chose 1, 2 or 3 for all four topics in Question 22, they fall in the "less aware" category.

Respondents were generally confident about the choices in the paired comparison questions: 93% indicated they were somewhat to very confident in the choices they made. And 95% felt that their responses should be somewhat or completely considered (along with other information from scientists and planners) in decisions made by public officials concerning these natural resource issues. Respondents who were more aware of the natural resource issues before receiving the survey tended to be more confident in their answers and more certain that their responses to the choice questions should be considered by public officials. Most all of those who are least confident in their responses (value = 1 or 2 in both Question 20 and Question 21) are individuals with lower awareness for several or all of the response topics and who report lower preference for, and values for, the restoration programs.

Table 4.10. Extent to which public officials should consider your responses to choice questions (Question 21: 1 = should not consider my responses at all to 5 = should completely consider my responses).

Category[a]	Should not consider my responses at all 1	2	Should somewhat consider my responses 3	4	Should completely consider my responses 5	Missing	Net of missing: Nobs	Net of missing: Mean confidence rating	Net of missing: SE
All	0.6%	3.4%	27.2%	39.4%	28.9%	0.4%	468	3.9	0.04
More aware	0.0%	0.9%	11.1%	42.7%	44.4%	0.0%	116	4.3	0.07
Less aware	1.1%	12.9%	40.9%	29.0%	16.1%	0%	93	3.5	0.10

Nobs = Number of observations.

a. If respondent chose 4 or 5 for awareness of all four topics in Question 22, they fall in the "more aware" category. If respondent chose 1, 2 or 3 for all four topics in Question 22, they fall in the "less aware" category.

4.6 Comments

In response to Question 36, 125 (27%) of the respondents provided written comments on the survey. Table 4.11 provides a summary of their 181 comments. A total of 37 respondents (7.9% of all respondents) made one or more comments that might indicate scenario rejection.[1]

When considering the impact of potential scenario rejection on the scaling of restoration to be of equivalent value to PCB-caused service flow losses, what would matter is if there were a disproportionate level of rejection tied to PCBs versus the other topics. This is in fact the case. A total of 29 respondents made comments suggesting potential rejection of paying for PCB removal, 4 respondents made comments suggesting potential rejection of paying for runoff programs, 3 respondents made comments suggesting potential rejection of paying for outdoor recreation programs, and 6 respondents made comments suggesting potential rejection of implementing it through the government bureaucracy. Thus, this suggests that a bias, if any, would be toward understating the required level of restoration to be of equivalent value to PCB-caused service flow losses.

1. Scenario rejection occurs when an individual's preference statement does not reflect his value for a commodity but rather is in response to some component of the choice pair scenario, such as the payment vehicle or the timing of commodity provision.

Table 4.11. General comments made at end of survey, coded into categories.

Comment number[a]	Comment category	Number making comment[b]	Percent of those with comments	Percent of all respondents
11	Industry should pay / is liable for PCBs	21	16.8%	4.5%
12	Farmers should pay for runoff	4	3.2%	0.9%
13	User should pay	3	2.4%	0.6%
14	Use other funding source / taxes already too high	5	4.0%	1.1%
15	Bureaucracy / government wastes money	6	4.8%	1.3%
16	Amount must be reasonable / don't raise it too much	4	3.2%	0.9%
23	PCB removal is very important	11	8.8%	2.3%
24	Concerns about PCB removal — process, efficiency, effectiveness	11	8.8%	2.3%
25	Quit fishing because of PCBs / want safer fish	7	5.6%	1.5%
30	Parks — general	1	0.8%	0.2%
31	Need more info about parks	1	0.8%	0.2%
33	Improve current parks / stop decline / current conditions poor	6	4.8%	1.3%
34	Don't expand / add facilities / add more parks	2	1.6%	0.4%
35	I don't use parks	1	0.8%	0.2%
36	I do use, or have used parks	2	1.6%	0.4%
40	Wetlands — general	2	1.6%	0.4%
41	Need more info about wetlands	2	1.6%	0.4%
42	Wetlands are important for future generations	1	0.8%	0.2%
43	Wetlands are a very important resource	8	6.4%	1.7%
44	Don't spend more on wetlands	1	0.8%	0.2%
50	Runoff — general	1	0.8%	0.2%
51	Need more info about runoff	1	0.8%	0.2%
53	Runoff is an important issue	1	0.8%	0.2%
60	Survey issues — general	3	2.4%	0.6%
61	Support for survey (compliment, thanks)	19	15.2%	4.0%
62	Survey biased	6	4.8%	1.3%
63	Didn't like tradeoffs (wanted a spend no more option, didn't want to trade recreation for environment)	3	2.4%	0.6%
70	Other — general	11	8.8%	2.3%
71	Mention other environmental issues	22	17.6%	4.7%
72	Enforce current regulations	6	4.8%	1.3%
73	Environment is important / general support for environment	9	7.2%	1.9%

a. Comment number as coded.
b. Sum is greater than 125 because some respondents brought up several topics in their comments.

4.7 Choice Pair Evaluation Using Simple Comparisons

In Chapter 5 we apply a sophisticated statistical model to evaluate the responses to the choice questions accounting for characteristics of the respondents. However, simple evaluations of a subset of the choice pairs provide straightforward insight into respondent preferences and into whether respondents are responsive to the natural resource changes being presented. These simple comparisons are based on the percentage of respondents to a choice pair that selects one or the other of the two alternatives in the choice pair. They do not consider respondent characteristics and are based on small sample sizes.

Table 4.12 summarizes the eight simple resource-to-resource pairs (i.e., costs are held constant across the two alternatives) involving PCB removal, measured as years until safe levels of PCBs are reached, versus other enhancements in one of the other three resource programs. The table lists the version and question number (e.g., the pair of alternatives) and sample size, the change in years until PCBs are safe and the changes in the other resource topics that are compared in the two alternatives, the dollar amount that was held constant in both alternatives, and the percent choosing the alternative with fewer years until PCBs are at safe levels.

Table 4.12. Pairs with PCB removal versus other single resource programs.

V#/Q#[a]	Number of observations	Years until PCB levels are safe	Versus	Fixed $ value	Percent choosing reduced PCBs
9/13	48	100 to 70 years	Runoff: 0% to 25% control	$25	57%
9/17	49	100 to 70 years	Wetlands: 0% to 10% increase in acres	$25	76%[b]
10/13	40	100 to 40 years	Runoff: 0% to 50% control	$50	58%
8/13	44	100 to 40 years	Wetlands: 0% to 20% increase in acres	$50	69%[b]
6/13	32	100 to 20 years	Wetlands: 0% to 20% increase in acres	$50	82%[b]
3/16	42	70 to 40 years	Parks: 0% to 5% increase in new acres and 0% to 10% enhancements at existing parks	$100	69%[b]
10/17	48	70 to 20 years	Recreation: 0% to 10% enhancements at existing parks	$50	92%[b]
5/15	50	40 to 20 years	Recreation: 0% to 10% enhancements at existing parks	$50	60%

a. V# =Version number, Q# = question.
b. Statistically significant at 10% or higher levels.

The results in Table 4.12 highlight a consistent preference for PCB removal when directly compared to enhancements in other programs. In each such direct comparison, PCB removal is preferred. Even with the small sample sizes in the individual choice questions, the preference is statistically significant at a 10% level for most of the comparisons (falling just short of statistical significance in the other cases, which involve either smaller PCB changes and/or runoff control). For other simple resource-to-resource comparisons, we find certain runoff control programs are preferred to outdoor recreational enhancements and to certain wetland programs, and statistically significantly so in three of four such comparisons. These simple comparisons identify that PCB removal and runoff control are, respectively, the first and second most preferred restoration actions. These results are consistent with the attitude scores provided earlier in this chapter and with the model presented in Chapter 5 that incorporate all of the choice pairs and important respondent attributes (and thus has more statistical power).

Comparing results for choice pairs from different survey versions can be used as "between-sample" tests of if and how respondents respond to changes in the level of resource changes and costs presented. One would expect that a program providing more benefits (e.g., more acres of wetlands or less years of PCB contamination) would be valued the same as or more than a program providing a lesser level of benefits. Such "scope tests" have sometimes been suggested as a validity test for contingent valuation studies (Carson, 1997). The choices respondents make indicate that respondents are responding to different levels of natural resource attributes presented to them — the support for programs varies with the level of change in the program results.

Table 4.13 compares the results of resource-to-resource choice pairs that provide scope test type comparisons. Using the first row as an example, pair 5/15 (Version 5, Question 15, which has 50 observations) asks for a choice between a 10% increase in existing recreational facilities (resource change 1) and reducing the years until PCBs are at safe levels from 40 years to 20 years. In this choice, the dollar cost presented to respondents for both alternatives is the same at $50. Pair 10/17 calls for a choice between the same change in existing recreational facilities (10% increase) and reducing the years until PCBs are at safe levels from 70 years to 20 years (in this question, the cost of both programs was $50). In both choice pairs (5/15 and 10/17), one resource change was a 10% increase in existing recreational facilities. In the second choice pair listed, this change in recreation was compared to a larger change in PCBs than in the first choice pair (70 to 20 years versus 40 to 20 years). One would expect that the preference for the recreational enhancement in the second pair (10/17) would be less than in the first pair because the PCB change is even larger, and this is what is found. In this case, the preference for the recreational enhancement program drops from 40% to 8%, which is a statistically significant change. The dollar levels are not expected to influence the choices because, except in the seventh

Table 4.13. Simple comparison of choice pairs: Resource comparisons.

Comparison	V#/Q#	Number of observations	Resource change 1	Resource change 2	$	% select change 1	Expected result
1	5/15	50	Rec: 0% to 10% ↑	PCBs: 40 to 20 yrs	50	40%	Yes[a]
	10/17	48	Rec: 0% to 10% ↑	PCBs: 70 to 20 yrs	50	8%	
2	8/13	44	Wetland: 0% to 20% ↑	PCBs: 100 to 40 yrs.	50	32%	Yes[a]
	6/13	44	Wetland: 0% to 20% ↑	PCBs: 100 to 20 yrs	50	18%	
3	10/17	48	PCBs: 70 to 20 years	Rec: 0% to 10% ↑	50	92%	Yes[a]
	5/18	49	PCBs: 70 to 20 years	Rec: 0% to 10% ↑ and Wetlands: 0% to 10% ↑	50	67%	
4	10/13	48	PCBs: 100 to 40 yrs	Rec: 0% to 10% ↑	50	58%	Yes
	1/16	38	PCBs: 100 to 40 yrs	Rec: 0% to 10% ↑ and Runoff control: 0% to 50% ↑	50	53%	
5	5/15	50	PCBs: 40 to 20 yrs	Rec: 0% to 10% ↑	50	60%	(vs 5/15)
	8/15	45	PCBs: 40 to 20 yrs	Rec: 0% to 10% ↑ and Wetlands: 0% to 5% ↑	50	51%	Yes
6	9/16	49	PCBs: 40 to 20 yrs	Rec: 0% to 10% ↑ and Runoff control: 0% to 25% ↑	50	41%	(vs 5/15) Yes[a]
7	2/13	48	Wetlands: 0% to 5% ↑	Parks: 0% to 5% ↑	25	44%	Yes[a]
	4/15	47	Wetlands: 0% to 5% ↑	Parks: 0% to 10% plus other improvements and cost decreases	NA	9%	
8	5/15	50	Rec: 0% to 10% ↑	PCBs: 40 to 20 years	50	40%	Yes
	2/17	48	Rec: 0% to 10% ↑	PCBs: 40 to 20 years and Wetlands: 10% to 20% ↑	100	31%	

Notes: V# = version number, Q# = question number. $ = fixed dollar amount in both alternatives of a pair. Pairs are ordered in each block such that the probability of choosing resource change 1 would be expected to decrease with the second pair compared to the first pair. ↑ = enhancements/increases.

a. Statically significant difference a 10% one-tailed test level.

comparison in this table, they are the same for both alternatives in a choice pair, but are presented for perspective on the questions.[2]

The remainder of Table 4.13 lists seven additional comparisons (note that 5/15 is compared to both 8/15 and 9/16). The table is presented so that the expected probability of selecting the enhancements listed as "resource change 1" as compared to "resource change 2" decreases with the second pair because the improvements in resource change 2 are larger in the second pair than in the first pair.[3] Limited pairs can be compared in this manner because in many pairs not listed here some resources or costs increase while other decrease, or the pairs compare increases in one or many programs with increases in one or many programs. The pairs listed provide comparisons where the expected change in preferences is clear so long as one assumes zero or increasing utility with increasing program levels and with decreasing costs.

In all cases in Table 4.13, the results are as expected, and in many cases the differences are statistically significant. This is important because the sample sizes are small for such between-sample comparisons that do not control for other variables (resident location, awareness, angler). Given these considerations, the results provide strong evidence for between-sample scope responsiveness for the accuracy of the resource-to-resource comparison question responses.

Table 4.14 makes similar comparisons using the referendum style questions (Question 14 in all 10 survey versions). Again, in each comparison the data are presented so that the probability of selecting resource change 1 is expected to be less for the second choice pair than for the first choice pair. The results here also support that respondents are responding to scope, but in two comparisons the results do not support expectations. Both cases involve responses to Version 2, Question 14. The reasons why the results to Version 2, Question 14 provide contradictory results are unclear, and may be the small sample size and varying sample characteristics. For example, respondents to Version 2 rated the importance of costs, in Question 19, higher than did respondents in any other survey version, which is consistent with the results reported in Table 4.14. Given the sample sizes, respondent characteristics, and other potential influences, are not controlled in these simple comparisons, it is not surprising or unreasonable that one of the pairs, and 2 of 14 comparisons in Tables 4.13 and 4.14, would result in unexpected results from simple comparisons.

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2. The dollar values are also the same for both choice pairs in most of the comparisons in Table 4.13. In many utility function specification (e.g., utility linear in program levels and income, utility linear in program levels and program levels all consistently interacting with income), the dollar level would not affect the choice between alternatives. Other utility specifications may exist where the dollar value could affect the choice between alternatives, but the results in Tables 4.12 and 4.13, and in Chapter 5, do not suggest cause for concern that the dollar levels are substantially, if at all, influencing the preference and scope test conclusions reported here.

3. The pairs are presented in this manner to facilitate comparisons. Resource change 1 and resource change 2 may be either Alternative A or Alternative B in the actual question.

Table 4.14. Simple comparison of choice pairs: Referendum comparisons.

Comparison	V#/Q#	Number of observations	Resource change 1	Resource change 2 (or $ cost change)	$	% select change 1	Expected result
1	4/14	47	PCBs: 100 to 20 yrs	$0 to $200	NA	57%	Yes[a]
	1/14	38	PCBs: 100 to 40 yrs	$0 to $200	NA	39%	
2	5/14	51	PCBs: 100 to 40 yrs	$0 to $50	NA	67%	Yes[a]
	1/14	38	PCBs: 100 to 40 yrs	$0 to $200	NA	39%	
3	2/14	48	PCBs: 100 to 20 yrs	$0 to $50	NA	44%	Yes
	1/14	38	PCBs: 100 to 40 yrs	$0 to $200	NA	39%	
4	2/14	48	PCBs: 100 to 20 yrs	$0 to $50	NA	44%	No
	4/14	47	PCBs: 100 to 20 yrs	$0 to $200	NA	57%	
5	2/14	48	PCBs: 100 to 20 yrs	$0 to $50	NA	44%	No[a]
	5/14	51	PCBs: 100 to 40 yrs	$0 to $50	NA	67%	
6	9/14	49	Parks: 0% to 10% ↑	$0 to $50	NA	43%	Yes[a]
	8/14	45	Parks: 0% to 5% ↑	$0 to $100	NA	22%	

Notes: V# = version number, Q# = question number. $ = fixed dollar amount in both alternatives of a pair. Pairs are ordered in each block such that the probability of choosing resource change 1 would be expected to decrease with the second pair compared to the first pair. ↑ = enhancements/increases.

a = Statically significant difference a 10% one-tailed test level.

5. A Model of Preferences for Resource Alternatives

5.1 Introduction

In this chapter we present the choice-question model used to estimate preferences for resource enhancement projects in and around the Bay of Green Bay. This model can be used to examine how individuals trade off different levels of the four programs, such as wetlands acres and years until PCBs are at safe levels. It can also show how individuals value changes in program levels in monetary terms, such as the WTP for program enhancements.

The choice-question model seeks to explain statistically each respondent's six choices from the choice pairs as a function of a number of program and individual characteristics. The model parameters represent a quantitative measure of the relative importance of the program characteristics in determining the benefits individuals receive from their availability. For example, the parameter on a variable for the number of years until no PCB-caused losses remain indicates the decrease in benefits if the number of years increases by that much.

We assume in the model that survey respondents chose the alternative (Alternative A or Alternative B) in each pair that would provide them with the largest net benefit. The technical logic of pairwise choice-question models is presented in Appendix B.

Sections 5.2 and 5.3 present variables affecting utility and discuss model features. Section 5.4 constructs the utility function for the natural resource program benefits and discusses the parameters. Section 5.5 discusses the computation of WTP for environmental changes; Section 5.6 describes the estimation method; and Section 5.7 presents the estimated parameters and assesses model performance.

5.2 Factors Affecting Utility from Green Bay Resources

Our choice questions are "binary" choices (i.e., they are choices between two alternatives). Economists assume respondents choose one of the alternatives over the other because the respondents believe that they would receive more satisfaction, or "utility," from the chosen alternative than from the rejected one. To analyze the survey responses, it is necessary to assume that the "utility function" takes on a specific mathematical form. Utility is assumed to be a function of the characteristics of the alternatives. Here we followed the common practice of assuming that utility is a linear function of the utility parameters as shown in Equation B-1 of Appendix B.

In our choice pairs, the levels of the characteristics take on a limited number of discrete values (see Table 2.4). For example, the number of years until no PCB-caused losses remain takes on a value of 100, 70, 40, or 20; wetlands variables also take on four values. Rather than assume that these variables are continuous variables, and then impose a functional form on the data, we have chosen to treat each of the resource levels as separate "dummy variables," which take on a value of one if a particular resource level occurs in the choice alternative, and zero otherwise. This method allows the greatest degree of flexibility in the model because the utility from each level of a characteristic is estimated independently from other levels. Therefore, the model is not linear in the characteristics; that is, marginal utilities (benefits) for increasing amounts of a type of resource action are not constant. There are 11 different dummy variables for the five resource groups (not counting the base case in each group that does not have a dummy variable, for identification of the model). The cost of the alternative is also a determinant of utility.[1]

The model also incorporates preference heterogeneity; that is, marginal utilities for changes in characteristics are allowed to vary over different types of people. Preferences typically vary across individuals, although assuming preferences are the same across individuals is a common assumption in models of this kind. The classic way of including heterogeneity is to let effects on utility from changes in site characteristics vary as a function of individual socioeconomic and demographic characteristics. This traditional method, which we use in this study, has been employed for many years, and a summary discussion can be found in Pollack and Wales (1992).

To reduce greatly the number of parameters introduced into the model by incorporating preference heterogeneity, a restriction was imposed to add structure within each resource group. As noted above, for example, the model contains three dummy variables for four PCB characteristics.[2] It is assumed that the set of PCB parameters, or parameters for any of the other resource groups, varies across different types of respondents proportionately. For example, the PCB parameters for anglers (based on Question 23) are all higher than for non-anglers by the same percentage.

1. Because our model is linear in income, it does not have income effects, and the income variable does not affect estimation. When computing the utility difference between the alternatives, income drops out when utility from one alternative is subtracted from utility in the other alternative, because income is the same in both.

2. The fourth level serves as the current level and thus does not require a dummy variable. Its utility is simply the level of utility when the other three dummy variables are set at zero.

Recreational anglers and those living close to Green Bay are allowed to have different preferences for reductions in PCB years. Further, those who have a high self-reported level of awareness for a given resource group are allowed to have different preferences for that particular resource group than those less aware.[3] Prior respondent experience with environmental commodities tends to increase values, which should be addressed in the econometric model, and awareness is an effective means to proxy that experience (see Cameron and Englin, 1997). The awareness variable is an index or conglomeration reflecting past experience and behavior as well as exogenous characteristics of the individual, as discussed in Chapter 4. Including awareness also captures respondent confidence in their reported results (Section 4.5).

In preliminary analyses, other individual-specific variables including gender and involvement in other types of recreation, were found not to be statistically significant. Any variables found not to be significant were omitted from the final specification of the model to: 1) increase the accuracy (efficiency) of the estimates by reducing unnecessary noise, and 2) make the estimated model parameters more straightforward to interpret by removing needless complications.

5.3 Other Model Features

5.3.1 Positioning effects

Positioning effects occur when respondents have a tendency to choose one of the alternatives (usually the first one, Alternative A in this case) more frequently than the other after controlling for all other relevant variables (here, the six attributes). Positioning may occur because the survey process may be difficult or tiring for some individuals, or their preferences for the resource program may not be well defined. In such cases, respondents may tend to select the first alternative repeatedly to reduce their cognitive burden. In the final sample of 470 respondents, 32 chose Alternative A in all six choices and 8 chose Alternative B in all choices. To evaluate the impact of positioning effects on our results, if any, a dummy variable equal to one was included for A alternatives.

5.3.2 Varying difficulty of choice

Using randomly generated levels of changes in natural resource programs will result in many, or even most, pairs involving varying levels for multiple programs in each choice pair. Thus, respondents would be presented with the challenging task of comprehending multiple changes

3. Awareness interactions were included for all resource groups except new parks, because that resource action was not found to yield significantly positive benefits in preliminary specifications.

each time they compare a pair of alternatives. The choice task may be daunting for some respondents and, if so, they may tend to focus only on a subset of the characteristics as the basis for decision-making, thus increasing the variance in the parameter estimates.

The choice pairs throughout the 10 different versions of the survey were designed to be of distinctly different types, some which may be more difficult for respondents to rank than others. These are described in detail in Section 2.2.3:

- *Simple resource-to-resource pairs:* These choice questions present a simple one resource versus one resource tradeoff: for example, an improvement in wetlands in one alternative versus an improvement in recreational facilities in the second alternative, with the levels of other programs and taxes paid the same in both alternatives.

- *Referendum pairs:* These choice questions mimic standard referendum questions developed in the contingent valuation literature: for example, an improvement in wetlands with an increase in taxes in one alternative versus the status quo in the other alternative.

- *Complex pairs:* These choice questions present complex mixes of multiple changes in natural resource levels and taxes paid in either or both alternatives of a choice pair.

The ability of respondents to reveal preferences may vary across these different types of questions, which exhibits itself in varying degrees of randomness in decision-making. The magnitude of this randomness can be examined using scale parameters, that differ by type of choice question, that make all of the model parameters larger or smaller relative to the variance of the random component of preferences. Therefore, we model not only heterogeneity of preferences across individuals but also heterogeneity in the variance of the stochastic component across pair types for a given individual. Two dummy variables were added to scale the parameters to account for the fact that results may be statistically “noisier” across the three different types of questions.[4]

4. Estimating separate scale factors for different choice questions in the estimation of environmental preferences has been done to test for learning and fatigue effects (see, for example, Breffle et al., 1999 and Adamowicz et al., 1998). With learning, randomness may decrease; and with fatigue, randomness may increase. Swait and Adamowicz (2000) allowed for the level of unexplained noise in choices to vary over choices and individuals using stated preference choices, and combining stated preference and revealed preference data. Scale parameters were allowed to vary with complexity, where complexity was represented by an endogenously-determined overall measure of uncertainty called entropy (which increases in the number of alternatives and correlations between attributes), rather than using prespecified complexity categories as we have done. Mazzotta and Opaluch (1995) present results supporting the hypothesis that increasing complexity in the choice task increases the associated noise in the choice.

5.4 The Utility Function

The following equation presents the utility function for individual *i*; all of the variables in this function are defined in Table 5.1:

$$
\begin{aligned}
U_i &= \beta_y (y_i - COST_i) \\
&+ \sum_{l=1}^{3} (1+\beta_{weta} D_{weta_i})(\beta_{wet_l} D_{wet_l}) \\
&+ \sum_{m=1}^{3} [(1+\beta_{pa} D_{pa_i} + \beta_n D_{n_i} + \beta_f D_{f_i})\beta_{p_m} D_{p_m}] \\
&+ (1+\beta_{pea} D_{pea_i})\beta_{pe} D_{pe} + \sum_{q=1}^{2} \beta_{pn_q} D_{pn_q} \\
&+ \sum_{r=1}^{2} (1+\beta_{roa} D_{roa_i})\beta_{ro_r} D_{ro\,r} + \beta_A D_A + \varepsilon_i \ ,
\end{aligned}
\tag{5-1}
$$

where $\varepsilon_i \sim N(0, \frac{\sigma_\varepsilon^2}{(1+s_s D_s + s_r D_r)^2})$, and σ_ε is not identified and so is set to $\sqrt{1/2}$.

Parameter β_y indicates the increase in utility if the cost decreases by $1 and is typically referred to as the marginal utility of money. It is assumed to be a constant. This parameter is expected to have a positive sign, which also implies that the individual prefers to pay a lower cost. Downward sloping demand (i.e., demand is a decreasing function of price) is a standard tenet of consumer economic theory and is very often observed in practice.

The other site-characteristic parameters, $\beta_{wet_l}, \beta_{p_m}, \beta_{pe}, \beta_{pm_q}$, and β_{ro_r} represent the change in utility from a change in each of the respective resource characteristics. The expected signs of the elements of β_{ro} are positive for all levels and increasing for better runoff quality; individuals are expected to prefer better water clarity and fewer excess algae days. The expected signs of the elements of β_p are expected to be negative for all levels and getting larger in absolute values as the number of years increases; individuals prefer PCB-caused losses to last a shorter period. Finally, we expect wetlands and parks to provide increasing benefits as more of the resources are provided.

Individual characteristic dummies are defined such that the base parameter (where the dummy equals zero) is for the type of individual with the largest expected parameter. For example, anglers may have larger marginal utilities (in absolute value) than non-anglers, and anglers are given a value of zero for the dummy. The parameters on the dummy variables are then used to scale (down) the base parameters multiplicatively (see Equation 5-1) for the types of individuals

Table 5.1. Model variables.

Variable	Definition
Green Bay characteristics	
COST	Cost per year for 10 years
$D_{wet_l}, l \in [1,3]$	= 1 if acres of preserved wetlands increased to amount in level *l* = 0 otherwise baseline level: 58,000 acres; increased levels: 60,900 acres, 63,800 acres, 69,600 acres
$D_{p_m}, m \in [1,3]$	= 1 if years until safe from PCBs is decreased to time in level *m* = 0 otherwise baseline level: 100 years; decreased levels: 70 years, 40 years, 20 years
D_{pe}	= 1 if facilities at existing parks are increased by 10% = 0 otherwise
$D_{pn_q}, q \in [1,2]$	= 1 if acres of new parks increased by the amount in level *q* = 0 otherwise increased levels: 5%, 10%
$D_{ro_r}, r \in [1,2]$	= 1 if runoff improves water quality level to level *r* = 0 otherwise baseline level: 20" of water clarity and 80 excess algae days or less; improved levels: 24" (20% improvement) and 60 days or fewer (25% reduction), 34" (70% improvement) and 40 days or fewer (50% reduction)[a]
Individual characteristics[b]	
y_i	Income of respondent *i*
D_{weta_i}, D_{pa_i}, D_{pea_i}, D_{roa_i}	= 0 if respondent *i* is highly aware of issues related to wetlands, PCBs, existing parks, and runoff, respectively (Question 22 = 4 or 5) = 1 otherwise
D_{n_i}	= 0 if respondent *i* lives near Green Bay (within two miles based on zip code) = 1 otherwise
D_{f_i}	= 0 if respondent *i* is a Green Bay recreational angler (Question 23) = 1 otherwise
Pair- and alternative-specific variables	
D_A	= 1 if alternative is A alternative = 0 otherwise
D_s	= 1 if pair compares two alternatives in which only one resource characteristic varies in each alternative (*single v. single*) = 0 otherwise
D_r	= 1 if pair contains resource improvement(s) with positive cost compared to baseline conditions with no cost (*referendum*) = 0 otherwise

a. Note that changes in water clarity and excess algae days are perfectly correlated in the choice pairs.
b. Note that the dummy variable definitions for individual characteristics are opposite the usual convention: those *with* a characteristic get a value of zero instead of one. The base case with all dummies equal to zero is the type expected to have the highest value for PCBs and other resources (i.e., angler, lives near, higher awareness). Given the form of the utility function, estimation was easier by scaling *down* the marginal utilities of other, lower-value types of individuals with dummies set to one.

with dummies equal to one (e.g., non-anglers). It is easier for the estimation program to scale down larger parameters than to scale up smaller parameters (the latter of which may effectively equal zero). To clarify, suppose that some type of individual has a marginal utility that is effectively zero. For example, those less aware of wetland resources may have no value for more wetlands, and an associated zero marginal utility. It would be impossible for the estimation program to scale up the zero parameter for the less aware group to anything positive for another type of individual (e.g., more aware). Conversely, it is easy for the program to scale down a positive marginal utility, even to zero.

The awareness parameters, $\beta_{weta}, \beta_{pa}, \beta_{pea},$ and β_{roa}, are expected to be negative, because those with a higher awareness are expected to have a higher value for resource quality than those with a lower awareness. Likewise, those living near Green Bay, and those who fish Green Bay recreationally, are expected to value PCB cleanup more than those who live far and those who do not fish; β_n and β_f are expected to be negative for those who do not fish and live at a distance.

5.5 Willingness to Pay per Household

For a model with no income effects and only one alternative in each state, such as this model, the computation of WTP for a resource program (such as to avoid years of PCB-caused losses) per household, measured as the compensating variation (CV_i), is straightforward. It can be computed as the difference between utility in the two states divided by the marginal utility of money. Because utility is linear in the vector of marginal utilities β_i, the formula for CV_i is:

$$CV_i = \frac{1}{\beta_y}[\beta_i'(x_i^1 - x_i^0)], \tag{5-2}$$

where x is the vector of the resource characteristics and β_i varies across individuals as a function of individual characteristics.

Because all of the resource (and respondent) characteristics are incorporated as dummy variables with values of zero or one, the formula for CV_i for a given resource characteristic is simply the marginal utility for that characteristic as represented by a model parameter(s) divided by the marginal utility of money. Also note that the stochastic component cancels out of Equation 5-2, so E(CV_i) = CV_i $\forall$ i. Estimated values are reported in Chapter 6.

5.6 Model Estimation

In the empirical model, parameters are estimated using a mathematical search algorithm that makes the individuals' observed choices most likely. In other words, the estimated parameters maximize the likelihood of collectively observing the chosen alternatives from the choice pairs. The parameter estimates are called *maximum likelihood* estimates because they are estimates of the population parameters that maximize the likelihood of drawing the sample of the observed choices.

The Gauss application module "Maxlik" was used to maximize the likelihood function (Equation B-4 in Appendix B). Convergence was achieved for a variety of starting values, and always at the same point. The model was estimated using a personal computer with a 400 MHz Pentium II chip and 128 MB of RAM and took approximately 12 minutes to converge.

The *likelihood function* that is maximized is derived and presented in detail in Appendix B. In short, it is a joint probability over all of the individuals in the data set. For a single individual it is computed as the product of the probabilities of the chosen Green Bay alternatives over the six choice-occasion pairs. Maximizing the likelihood function is equivalent to maximizing the joint probability of observing the collective angler choices. Parameters estimated by maximum likelihood have desirable statistical properties. For example, the estimates get closer to their actual values as the sample size grows larger. Under some additional assumptions, these are also the most precise estimates.

5.7 The Estimated Model

This section presents an overview of the estimation of the model described above. The estimated parameters of the utility function in Equation 5-1 are discussed qualitatively here, and the specific parameter estimates are reported in Table 5.2. In the next chapter, these parameters are used to compute the rates at which individuals trade off PCB-caused losses with other site characteristics, and to value in WTP the changes in site characteristics. Major conclusions that can be drawn from this section are that model parameters are estimated with accuracy, and that the model accurately predicts the choices.

5.7.1 Signs and significance of the parameter estimates

An important result from this estimation is that all of the estimated parameters with expected signs do in fact have the expected signs, and within resource groups, parameters have reasonable relative magnitudes. As expected, the cost of an alternative has a highly significant negative effect on utility.

Table 5.2. Parameter estimates.

Parameter	Estimate[a] (asymptotic *t* statistic)
β_y (marginal utility of money)	0.0060 (13.286)
β_{wet_l} (wetlands)	
l = 60,900 acres	0.1873 (2.264)
l = 63,800 acres	0.3420 (3.780)
l = 69,600 acres	0.4187 (5.000)
β_{p_m} (PCBs)	
m = 20 years	1.2172 (7.253)
m = 40 years	0.8477 (6.735)
m = 70 years	0.3273 (3.871)
β_{pe} (existing parks)	0.1077 (1.918)
β_{pn_q} (new parks)	
q = 5%	0.0236 (0.438)
q = 10%	-0.1030 (-1.856)
β_{ro_r} (runoff/water quality)	
r = 24” clarity and < 60 excess algae days	0.1838 (2.856)
r = 34” clarity and < 80 excess algae days	0.4817 (7.465)
β_{weta} (wetlands awareness)[b]	-1.0879 (-5.527)
β_{pa} (PCBs awareness)[b]	-0.3387 (-3.729)
β_{pea} (existing parks awareness)[b]	-1.0780 (-2.234)
β_{roa} (runoff/water quality awareness)[b]	-0.4599 (-3.202)
β_n (PCBs for group not living near)	-0.1618 (-1.708)
β_f (PCBs for non-angler group)	-0.1958 (-2.498)
β_A (position dummy)	0.1244 (4.456)
s_s (scale for resource-to-resource pairs)	0.5897 (2.363)
s_r (scale for referendum pairs)	-0.4422 (-3.932)

a. Parameters can be interpreted as the change in utility for the specified change in the characteristics, as compared to current levels.
b. Awareness = 1 if less aware of this specific resource topic.

The signs on the wetlands improvements parameters are significant at a 5% level, and positive and increasing at a decreasing rate with greater numbers of acres restored, suggesting diminishing marginal utility. The second 5,800 additional acres is only valued about one-fifth as much as the first 5,800 acres. Utility from improvements in runoff is also increasing and significant at a 5% level; inches of water clarity also exhibit diminishing marginal utility. The first 4 additional inches of water clarity are valued about 54% more per inch compared to subsequent inches.

Increasing facilities at existing parks is significant at a 10% (and almost 5%) level using a two-tailed test. A 5% increase in new parks has a positive parameter, and a 10% increase has a negative parameter, indicating that respondents do not value more parks. Individuals may think land designation for a significant increase in parks is a waste of government funds, or that better uses of land exist.

Parameters on the PCB variables are highly significant, show sensitivity to scope (i.e., a greater number of years until PCB-caused losses no longer remain reduces utility more), and indicate that individuals discount the future. For example, a change in the number of years until PCBs are at safe levels from 100 years to 70 years increases utility 41% less per year of change than a change from 40 to 20 years.

Awareness was found to be a highly significant variable. Those who are less aware of recreational parks and wetlands essentially derive no utility from changes in the levels of these resources. Those less aware of PCBs have benefits that would be about 34% less for their removal, and those less aware of runoff and water quality issues get about one-half the utility.

Anglers and those living in close proximity also would get more utility from the reduction in the years until PCBs are at safe levels: the parameter for non-anglers is approximately 20% lower, and the parameter for those living beyond two miles is approximately 16% lower.[5] Distance and angler status were found not to be significant for other resource groups. This result makes sense because the other programs have a wider geographic impact than just the waters of Green Bay.

The parameter for positioning is significant and positive, meaning that A is selected more frequently than B, controlling for other variables. This parameter is retained in the model to eliminate positioning bias in the assessment; the utility from a program alternative (and subsequently tradeoffs and WTP) is then computed using the estimated parameters but excluding the positioning parameter, because the positioning parameter is used to calibrate for survey

5. Two miles from the Bay of Green Bay, where the large majority of recreational fishing occurs in the “waters of Green Bay” (Breffle et al., 1999), was chosen to define the distance variable in the econometric analysis because that is the farthest distance for which we found a statistically significant difference between the two distance groups.

design effects but is not a demand parameter. The significance of the positioning parameter is caused largely by a small number of respondents (28) who chose Alternative A in all six pairs, which may happen for some respondents because of the complexity of the choices. Furthermore, some choices of A are expected for these individuals, and their choices are generally consistent with other survey responses. For example, in the group who chose Alternative A in every case, PCBs and cost were generally ranked as most important, and alternatives with better PCB and cost characteristics were generally chosen. Theory cannot predict what effect the omission of the positioning parameter would have on the estimated relative importance of PCBs and other parameters; it was included as a precautionary measure, and its inclusion is econometrically preferred.

The simple resource-to-resource comparisons have the smallest variance in the random component.[6] The variance for simple resource-to-resource pairs is about 0.4 times the variance of the complex pairs (60% smaller). It is not surprising that these pairs have less noise than the complex pairs because the comparison of alternatives is more straightforward. The referendum-style questions have the greatest variance, suggesting that individuals can make tradeoffs between different resource improvements more easily than they can trade off site characteristics for money; the variance for referendum pairs is about 3.21 times the variance for complex pairs (221% larger), and about 8.11 times the variance for simple resource-to-resource pairs (or the variance for simple resource-to-resource pairs is about 12% as large as the variance for referendum pairs). The greater noise with referendum pairs may also suggest some degree of scenario rejection when the respondent is essentially asked for a WTP in money. This referendum result is supported by the data in Tables 4.13 and 4.14 which also suggest that sensitivity to scope is manifested less in the referendum pairs.

By allowing only the variances to differ across question types (and not the means of the parameters), we are imposing *parameter proportionality* across question types, where the relative magnitude of different demand parameters remains the same. With parameter proportionality, expected choices across the types of choice questions will be the same; only the level of randomness varies.[7] Louviere (1996) notes that parameter proportionality is often not

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6. It is important here not to confuse estimated variances of the random components (which are maximum likelihood parameter estimates that are not expected to change in any particular direction as sample size grows) with the estimated variances for those parameter estimates (which do shrink with sample size). The statistical significance of the estimated variance parameters is notable, given the smaller sample sizes for the referendum and single versus single type choice pairs (about one-quarter the sample size each as compared to the number of observations with complex pairs).

7. The reader should be clear that smaller estimated scales for certain types of choice questions mean that responses to those types receive less weight in estimation of the model parameters (i.e., less weight in the likelihood function discussed in Appendix B) than other types with higher scales. The demand parameter estimates would be different if the scale were the same for every pair.

rejected across different types of data sets in numerous studies. However, even in cases where parameter proportionality is statistically rejected, Louviere suggests that modeling only error variability will account for most of the heterogeneity. Estimating separate models by choice type to test for parameter proportionality was not possible. Sample sizes were not large enough and the variation in attribute levels too limited for some choice types and variables. Several parameters were not identified in the models separated by choice type.

5.7.2 Measures of model fit

Statistical procedures were implemented to show how well the model explains the data. First, an intuitively appealing test of fit is to examine the proportion of choices from choice pairs that are accurately predicted by the model. To determine which alternative the model predicts would be chosen from a pair, the estimated parameter values are put into Equation 5-1, along with the resource characteristics and costs from the two alternatives. Whichever alternative gives the highest value for estimated expected utility is the alternative the model predicts will be chosen. The model correctly predicts about 66% of the 2,784 choices in the data.

A pseudo-R^2 for the choice pairs is approximately 0.12. It is akin to a measure of fit for a simple linear regression model where the value ranges from zero to one and indicates the percentage of variation in the data that is explained by the model. A value of 0.12 is typical for cross-sectional data.

6. Restoration Scaling and Valuation Results

6.1 Introduction

Section 6.2 addresses the scale of restoration of equal value to the ongoing PCB-caused losses in terms of the three types of programs evaluated: wetlands enhancements, recreational enhancement, and runoff control. The selection and cost of preferred restoration is addressed in the RCDP. WTP measures for ongoing PCB-caused losses from 2000 until a return to baseline, as well as WTP measures for the restoration alternatives, are presented in Section 6.3. The WTP results provide additional perspective on the values used to scale restoration, as the underlying utility measures and WTP measures are linearly related. The WTP results for PCB-caused losses are also compared with those in the recreational fishing damage determination (Breffle et al., 1999) to avoid double counting [43 CFR § 11.84 (c)]. Section 6.4 provides conclusions, including a summary of study design features that indicates the estimates are likely to understate the required amounts of restoration and understate the WTP value measures (or ongoing PCB-caused losses).

For this assessment we assume that the regional population remains constant over the scenario time period. This assumption has limited impact on the scaling of restoration so long as the relative preferences between PCB removal and other restoration programs considered remain relatively stable in the future. However, this assumption will likely understate the WTP value measures if there will be population growth in the future because this growth is not factored into the computations.

6.2 Restoration Scaling

We use the model results in Chapter 5 to scale the wetlands, runoff, and recreation enhancement restoration programs to provide services of equal value to the PCB-caused service flow losses, and to compute WTP values. Because there are many possible combinations of the mix and levels of restoration programs, we illustrate the scale of restoration for a sample of program combinations for selected scenarios.

The scale of restoration for PCB-caused losses is computed such that the marginal disutility from continued PCB-caused losses is just offset by the marginal utility gained from enhancements in other natural resource restoration programs. For example, if the estimated marginal disutility for 10 more (or utility from 10 fewer) years of PCB-caused losses is estimated to be 4, and the marginal utility for a 25% increase in runoff control in Green Bay is estimated to be 4, then a 25% increase in runoff control would provide restoration of equal value to 10 more years of

PCB-caused losses. As a further example, if preserving an additional 5,000 acres of wetlands (above the current amounts) generates a marginal utility of 4 and an additional 10,000 acres has a marginal utility of 6, and the marginal utility for a 20-year reduction in PCB-caused losses is 5, we use linear interpolation. We infer that a 7,500-acre increase in wetlands would provide restoration of equivalent value to 20 more years of PCB-caused losses.

To scale restoration (and subsequently to compute WTP value measures), we first need to weight the sample results to reflect the differences between the sample and the population in the 10 sample counties. The sample was made comparable to the population using weights for distance (counties closer to Green Bay were sampled more heavily than counties farther away, and some living near Green Bay have higher PCB-caused losses) and recreational angler status (the sample has a disproportionately high number of anglers, who value PCB removal more).[1]

Weighting did not have a large impact on results. For example, average WTP values for PCB removal (and therefore for PCB-caused losses) per household fell by about 9% when the weights were used. For restoration scaling the effect was even smaller. Those who value a reduction in the number of years until PCBs are at safe levels less also tend to have lower values for other resource programs, so the effects of sample adjustments on the computation of the scale of restoration are largely offsetting.

Individuals differ in terms of how they trade off different resource programs for reductions in PCB-caused losses. We determine the level of restoration that is necessary for the population as a whole. For each scenario, for each individual in the weighted sample we use the model parameters to compute the utils associated with the PCB-caused losses and to compute the utils associated with the varying levels of the restoration programs. The individual utils are added up across all individuals in the weighted sample and the appropriate scale of restoration is determined so it yields the same total utils as the PCB-caused losses.

We consider the scale of restoration, and the WTP measures of ongoing PCB-caused losses, for a range of remediation scenarios (see Section 1.4). Estimates of the scale of restoration of equivalent value to PCB losses, and WTP measures for PCB-caused losses, between now (2000) and 20 years from now are computed by annualizing the utility and WTP for changes in losses

1. The proportion of angler households in the population was determined using data from the recreational damage determination (Breffle et al., 1999). Green Bay angler households were identified in the current study using Question 23 about fishing Green Bay in the last 12 months. However, this question may simply reflect interest in fishing, and weighting on the basis of this response compared to population data about anglers who actually did fish the waters of Green Bay may result in an overcorrection. Because households with interest in Green Bay angling have higher WTP and value the reduction of PCB years more relative to other resource actions, this overcorrection will lead to an understatement of the scale of restoration and of WTP values for the public as a whole.

between remediation lasting 20 years and remediation lasting 40 years, and using a discount rate of 3% to compute the present value of losses from period 2000 to 2020 based on Figure 1.3. A 3% discount rate is selected to be consistent with regulatory guidance (Section 6.3.2) and consistent with all other present value calculations in the Co-trustee damage determination.

Potential natural recovery during the assumed 10 year period of remediation is not considered. After remediation is selected, the damage estimates can be revised to account for natural recovery. However, unless the rate of natural recovery is rapid, such revisions would be minimal.

Table 6.1 provides examples of the scale of sample mixes of restoration projects that provide services with value equal to the ongoing PCB-caused losses over specified time periods. For instance, the first three lines provides three examples of restoration providing services of value equal to the PCB-caused losses from 2000 until a return to baseline if an intensive level of remediation returns services to baseline in 2020. The second block provides examples for the 40 year intermediate level of remediation and the third block provides examples of the scale of restoration that provides services of value equal to a portion of the PCB-caused losses corresponding to differences between a 20 year and 40 year remediation, and between a 20 year and 70 year remediation. The examples include a combination of wetland acreage, park enhancements, and runoff control to provide sufficient restoration. Additional acreage of new parks was not found to be valued, so this program is not included in constructing restoration combinations.

For some scenarios, single resource programs using wetlands only or runoff control only, or combinations of these two actions, provide a sufficient scale of restoration. However, even a substantial recreation program of enhancements at 120 regional parks, for example, provides restoration benefits equivalent to only a few years of PCB-caused losses. In some cases, more of a program is required than considered in the survey. In these cases we extrapolate at the same marginal utility as for the last program units added, which likely understates the scale of restoration due to diminishing marginal utility of increasing program units (wetland acres, % control of runoff, % improvement in existing parks).

For two reasons, it may be economically more efficient to pursue combinations of programs rather than a single-resource program to provide properly scaled restoration. First, diminishing marginal utility at increasingly high levels for wetlands and runoff control means that the benefits do not increase at the same rate as the size of these programs are increased. Second, very high quantities of a given program may result in increasing marginal costs, to the point where some large programs may be technically infeasible.

Table 6.1. Illustration of restoration scaling.

Scenario	Example mixes of restoration programs		
	Wetland restoration acres[a]	Existing park enhancement	Runoff control[b]
PCB remediation scenarios[c]			
Intensive: (0 to 20 years)	3,100	10%	14”/50%
	5,500	8%	12”/45%
	11,000	0%	12”/45%
Intermediate: (0 to 40 years)[d]	24,100	10%	16”/55%
	16,000	20%	16”/55%
Partial restoration			
Intensive vs. 40 year Intermediate (20 to 40 years)	2,900	2%	4”/25%
	5,000	3%	2”/13%
	2,400	0%	7”/33%
Intensive vs. 70 year Intermediate (20 to 70 years)	5,700	0%	14”/50%
	13,000	10%	10”/40%

a. Rounded to nearest 100 acres.

b. Additional inches of water clarity/percentage decrease in number of excess algae days.

c. Restoration is for PCB-caused losses during the period indicated.

d. Requires extrapolating beyond the range of actions considered for some or all programs.

The scenarios in Table 6.1 do not include ongoing damages from 2000 that continue beyond 2040. This is because the levels considered for increased wetlands acres plus runoff control plus recreational enhancements do not provide benefits sufficient for ongoing PCB-caused losses starting in 2000 and continuing beyond 2040 without extrapolating well beyond the levels considered, and because the diminishing marginal utility reflected in the results suggests that the incremental value may be close to zero for additional enhancements well beyond the range considered. Therefore, for remediation that takes longer than 40 years, additional restoration actions beyond (or variations to) the three programs considered here may also be required.

Table 6.1 also provides scales of restoration for a portion of ongoing losses. These measures may be combined with other damage measures as an alternative approach to assess damages for all losses through time, such as using a combination of recreational fishing damages, total compensable damages, or habitat restoration programs for past damages and interim damages up to 2020, and then using Table 6.1 to scale restoration for ongoing losses after 2020.

6.3 WTP Measures of Values

6.3.1 Population-weighted annual measures of WTP per household

By asking respondents to consider tradeoffs between resource programs and monetary costs their household pays, we are also able to derive WTP for the programs, which for PCBs is a measure of total compensable values for ongoing PCB-caused losses. To obtain population based WTP measures, as for restoration scaling, the sample WTP values are weighted to reflect the population in the 10 county assessment area. To obtain present value measures, the stream of 10 year payments is discounted to 2000.

Table 6.2 presents the annual WTP estimates over 10 years based on CV_i from Equation 5-2. The values reported in Table 6.2 are population means, obtained by weighting the sample results to the population as described in Section 6.2. The 95% confidence intervals are approximated using the Krinsky-Robb procedure using 500 draws.

Figure 6.1 graphically presents the mean WTP results for each level of the four programs. Table 6.2 and Figure 6.1[2] demonstrate that PCB removal is generally much more highly valued than any other resource program, reflecting the results in the previous section that large quantities of multiple programs would be necessary to compensate for some injury scenarios. Diminishing marginal utility for a single program is reflected in the values for wetlands and runoff control (i.e., total values for these resource programs increase at a decreasing rate as more of the action is undertaken). The values for PCB removal increase as the years decrease until safe levels are reached. This reflects that near-term losses (e.g., between 0 and 20 years from now) are valued more highly by respondents than losses in the more distant future (e.g., between 100 and 70 years). Note that the mean WTP values for all resource changes and scenarios is less than 1% of the typical household's budget.

The mean WTP values per household for PCB-caused losses in the intensive remediation scenario (constant losses between 2000 and 2009, then linearly declining losses to zero at the end of 2019) averages to about $36 per year (the present value of 10 payments of $83.42 = $733, divided by 20 years of losses). The present value of annual losses ranges from about $52 per year in the first 10 years prior to remediation reducing losses, then declining to zero at the end of the 20th year. These values are of a similar size as those reported in the literature for other significant natural resource programs in the assessment area and Great Lakes area (Appendix D).

2. Figure 6.1 omits values for outdoor recreation enhancements through additional acres of park, which are not statistically different from zero for all respondents or for the more aware respondents.

Table 6.2. Mean population-weighted household willingness to pay for resource programs (dollars per year for 10 years, in 1999 dollars).

Resource program	Mean E(*CV*)[a]
PCB remediation scenarios	
Intensive: (0 to 20 years)	\$83.42 [\$47.04, \$116.99]
Intermediate: (0 to 40 years)	\$118.92 [\$67.06, \$166.77]
No additional remediation: (0 to 100 years)	\$200.37 [\$146.10, \$251.59]
Other PCB scenarios[b]	
20 to 100 years	\$116.95 [\$91.09, \$139.97]
40 to 100 years	\$81.45 [\$61.52, \$102.27]
70 to 100	\$31.44 [\$17.17, \$47.26]
0 to 70 years	\$168.93 [\$114.61, \$217.11]
20 to 70 years	\$85.50 [\$64.95, \$106.63]
40 to 70 years	\$50.00 [\$33.76, \$68.21]
20 to 40 years	\$35.50 [\$20.02, \$49.78]
Other resource programs	
Wetlands	
58,000 → 60,900 acres	\$13.48 [\$2.60, \$24.76]
58,000 → 63,800 acres	\$24.61 [\$10.76, \$38.30]
58,000 → 69,600 acres	\$30.12 [\$18.58, \$42.89]
Existing parks (10% increase)	\$7.73 [-\$0.15, \$15.83]
New parks	
5% increase	\$0[c]
10% increase	\$0[c]
Runoff control	
Clarity: 20” → 24”; reduction in algae days: 25%	\$23.50 [\$7.54, \$42.24]
Clarity: 20” → 34”; reduction in algae days: 50%	\$61.60 [\$46.92, \$78.65]

a. Simulated 95% confidence interval in brackets.
b. WTP is for avoidance of PCB-caused losses during the period indicated.
c. Not significantly different from \$0 for all respondents or even for the more aware respondents (Table 6.3).

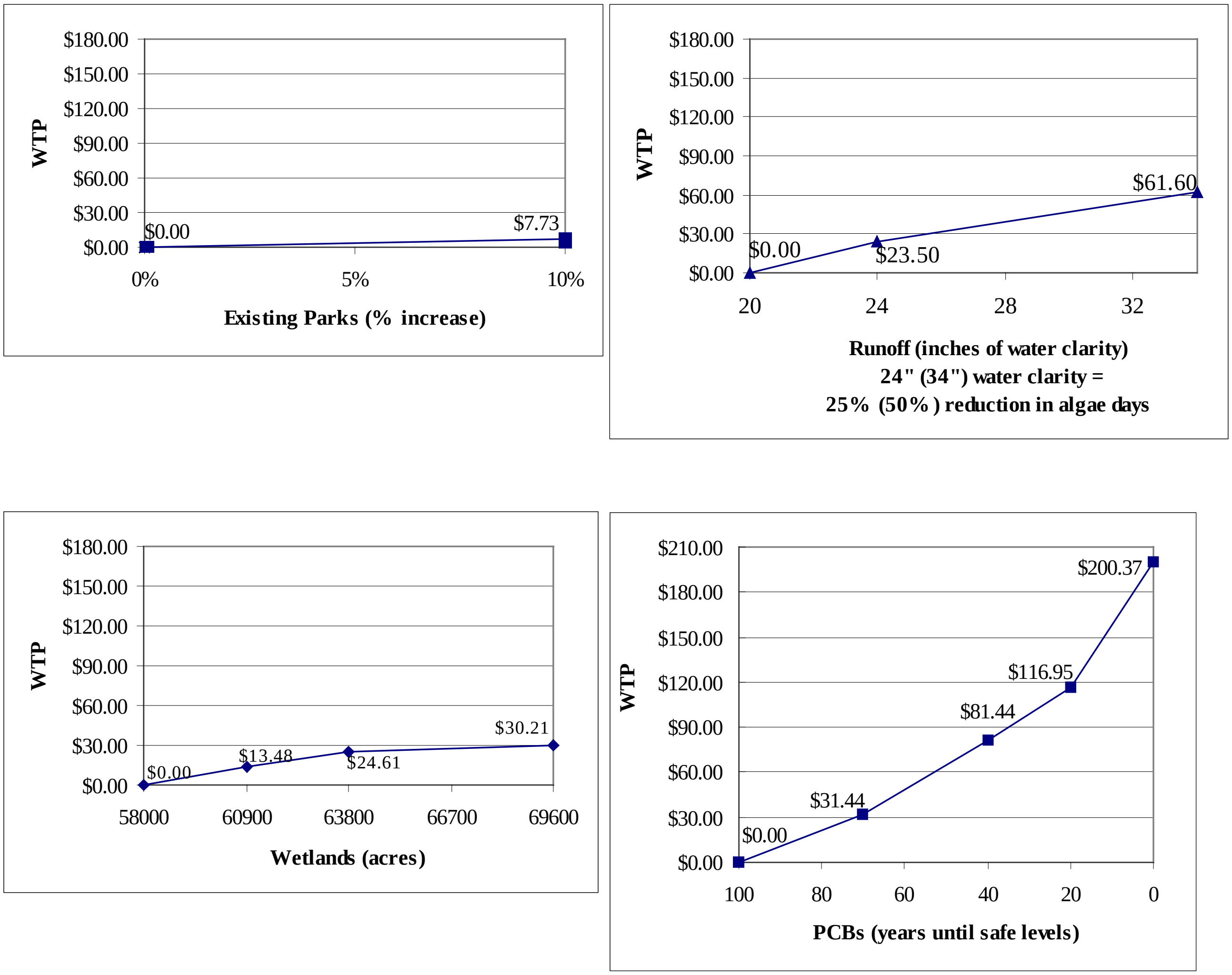

Figure 6.1. Population-weighted willingness to pay estimates for resource programs (household WTP per year for 10 years, $1999).

Heterogeneity of preferences was incorporated into the model to allow different types of respondents to report different household WTP values. As illustrated in Table 6.3, values vary in plausible ways; e.g., households closer to the site and with recreational anglers have higher PCB values. For each natural resource program and scenario, the values are reported by households that are more aware of the natural resource topic (topic awareness = 4 or 5) and by households that are less aware of the natural resource topic (topic awareness = 1, 2, or 3). Note that the WTP values decrease with awareness for each of the topics except the addition of new parks, for which the values are not statistically different from zero for either the more aware or less aware group. For PCB removal, the values are lower for the less aware group, compared to the more aware group (by 34% to 53% depending on household location and angler status), but are still statistically significantly larger than zero. Similarly, the runoff control values decrease by nearly half for the less aware group as compared to the more aware group. The wetlands and existing parks values decrease to $0 for the less aware group.

6.3.2 Aggregate present values of PCB-caused losses

In this section, the present values of interim WTP for PCB-caused losses between 2000 and a return to baseline are presented for alternative scenarios based on the population-weighted estimates of WTP. The aggregate values represent losses to the 346,700 households in the 10 county area; we assume the population remains constant into the future. The aggregate values are computed using a 3% discount rate (with no discounting in the first year of payment and then discounting the subsequent nine years of payment). A 3% discount rate is consistent with the average real three-month Treasury bill rates over the last 15 years (Bureau of Economic Analysis, 1998; Federal Reserve, 1998) and is consistent with the U.S. DOI implementation guidelines (U.S. DOI, 1995) for NRDAs under 43 CFR § 11.84 (e)(2). Using a 3% discount rate, the present value multiplier for 10 years of payments is 8.786. Using a 2% discount rate on the 10 years of payments would result in a 4.3% increase in the aggregate present value, and using a 6% discount rate would result in an 11.2% decrease in the aggregate present value. The total values for key remediation scenarios, and differences between remediation scenarios, are reported in Table 6.4 and range from $254 million for ongoing losses with a 20 year return to baseline, to $610 million for ongoing losses if there is little or no PCB removal.

Aggregate WTP values for interim PCB-caused losses from 2000 until a return to baseline may be larger than, similar to, or smaller than the costs of the appropriately scaled restoration programs to provide services of equal value to PCB-caused losses. Differences can be attributed to the degree of cost and technical feasibility of restoration programs, and the degree to which resource enhancement programs provide multiple benefits, including both active and passive use benefits, such that the values of these programs exceed the costs of these programs.

Table 6.3. Household WTP estimates by respondent type (dollars per year for 10 years, in 1999 dollars).

	Mean WTP	
Resource change	**More aware[a]**	**Less aware**
PCB remediation scenarios[b]		
Intensive: (0-20 years)		
all respondents	$118.96	$65.90
angler, near (within two miles)	$145.32	$96.09
angler, not near	$121.80	$72.57
non-angler, near (within two miles)	$116.86	$67.64
non-angler, non near	$93.34	$44.12
Intermediate: (0-40 years)		
all respondents	$169.58	$93.94
angler, near (within two miles)	$207.16	$136.98
angler, not near	$173.63	$103.45
non-angler, near (within two miles)	$166.59	$96.42
non-angler, non near	$133.06	$62.89
No additional remediation: (0-100 years)		
all respondents	$285.72	$158.28
angler, near (within two miles)	$349.03	$230.80
angler, not near	$292.52	$174.31
non-angler, near (within two miles)	$280.68	$162.46
non-angler, non near	$224.19	$105.97
Other resource programs		
Wetlands		
58,000 → 60,900 acres	$31.34	$0[c]
58,000 → 63,800 acres	$57.24	$0[c]
58,000 → 69,600 acres	$70.07	$0[c]
Existing parks (10% increase)	$18.02	$0[c]
New parks		
5% increase	$0[c]	$0[c]
10% increase	$0[c]	$0[c]
Runoff control		
Clarity: 20” → 24”; reduction in algae days: 25%	$30.75	$16.61
Clarity: 20” → 34”; reduction in algae days: 50%	$80.61	$43.54

a. If respondents chose 4 or 5 for awareness of the relevant topic in Question 22, they fall in the “more aware” category, otherwise they are in the “less aware” category.
b. WTP is for avoidance of PCB-caused losses during the period indicated.
c. Estimated values were not statistically different from zero. To estimate population-weighted means, individual values were set to $0.

Table 6.4. Present value of total WTP for ongoing PCB-caused losses: Residents of 10 Wisconsin counties (millions of 1999 dollars).

Scenario	Mean (range[a])
PCB remediation scenarios	
Intensive (20 years)	$254 ($143-$356)
Intermediate (40 years)	$362 ($204-$508)
Intermediate (70 years)	$515 ($349-$661)
Limited or none (100 years)	$610 ($445-$766)
Changes in remediation scenarios	
20 rather than 40 years	$108 ($ 61-$75)
20 rather than 70 years	$260 ($198-$325)
20 rather than 100 years	$356 ($276-$426)
40 rather than 70 years	$152 ($103-$208)
40 rather than 100 years	$248 ($187-$312)
70 rather than 100 years	$96 ($52-$144)

a. 95% confidence interval.

6.3.3 Comparison to recreational fishing damage determination

Introduction

The PCB-caused losses considered in this TVE assessment differ from, and only partially overlap, the PCB-caused losses considered in the Co-trustee's recreational fishing damage determination (Breffle et al., 1999).

- *Time periods*. The recreational fishing assessment considers losses from 1980 until a return to baseline. This TVE assessment considers losses from 2000 until a return to baseline, or a subset of the time period in the recreational fishing assessment.

- *Affected populations*. The recreational fishing assessment considers losses to Wisconsin resident and non-resident anglers who purchased licenses in an 8 county area of Wisconsin surrounding the Bay of Green Bay to fish the Wisconsin waters of Green Bay, plus losses experienced by anglers who fished the Michigan waters of Green Bay. This TVE assessment considers losses to all residents of a 10 county area of Wisconsin. This population includes the anglers from these counties, but does not include other anglers from outside of these counties (e.g., from anglers from other Wisconsin counties, or from out-of-state).

- *Losses considered*. The recreational fishing assessment considers only active use losses resulting from fish consumption advisories. This TVE assessment considers these losses and all other PCB-caused losses.

The results of this TVE assessment and the recreational fishing assessment can be compared for a comparison population of households with Green Bay anglers in the 10 Wisconsin counties near the Bay of Green Bay. For this comparison population, and for ongoing damages from 2000 until a return to baseline, the WTP measures of compensable values in this TVE assessment are slightly larger than the WTP measure of compensable values in the recreational fishing assessment. This is as expected as this assessment values a larger set of losses than in the recreational fishing assessment, although for households with Green Bay anglers, the active use fishing losses may well be the dominant component of PCB-caused losses. While the two assessments take different approaches to measure compensable values, the comparability of the results for a comparison population supports the estimated magnitude of damages in each assessment, and allows double counting between the assessments to be readily addressed.

Comparison

The recreational fishing assessment computed annual WTP per angler for losses in 2000. The present value of all losses was then computed reflecting an assumed 10-year remediation period with minimal recovery, followed by a recovery period of varying lengths (10, 20, and 90 years for a total time period for return to baseline of 20, 40, and 100 years), and discounted to a present value using a 3% discount rate (which is used in all subsequent comparisons). In contrast, the estimation of WTP damages in this TVE assessment is based on the respondent WTP per year for 10 years to obtain changes in future PCB-caused losses, including recreational fishing and other losses. For comparison purposes, for each remediation scenario we assume that the time stream of losses corresponding to the TVE values is the same as in the recreational fishing study. We also use a 3% discount rate for all present value calculations.

We make the following adjustments to the total values from each assessment to make them comparable for households in the 10 counties who have Green Bay anglers. For the TVE assessment, we multiply the total values reported in Table 6.4 by 11.46% (the percent of households with Green Bay anglers)[3] and by 1.1703 (the ratio of WTP per household for households with Green Bay anglers to the WTP per household for all households in the sample). These numbers are reported in the first data column of Table 6.5. For the recreation assessment we take the total damages for Wisconsin waters of Green Bay, which were computed for anglers who purchase licenses in 8 neighboring counties. These values are reduced reflecting that only 76% of the anglers resided in these counties (Breffle et al., 1999; Table 3.18), and escalated by

3. In 1998 there were about 48,600 Green Bay anglers who purchased their Wisconsin fishing license in 8 nearby counties (Breffle et al., 1999; page 8-6). Approximately 76% of these anglers resided in these 8 counties. Allowing for 5% of households to have more than one Green Bay angler results in 35,117 households with Green Bay anglers, or 11.12%). We assume the same percent for Shawano and Calumet counties, which are also included in the TVE assessment, resulting in 38,553 households and 40,480 Green Bay anglers.

Table 6.5. Comparison of total future damages in the recreational fishing and total value equivalency assessments.

Scenario	Total values for comparison population of households in 10 county region with Green Bay anglers (millions, 1999$)		Ratio of total values to recreational fishing values
	Total value equivalency study	Recreational fishing study	
Intensive restoration (0-20 years)	$33.1	$30.7	1.08
Intermediate restoration (0-40 years)	$47.1	$43.1	1.09
No restoration (100+ years)	$79.4	$61.9	1.28
Intensive — intermediate restoration (20-40 years)	$14.1	$12.6	1.12

1.02 for inflation and by 1.096 to reflect the number of households in the 10 counties in the TVE assessment as compared to households in the 8 counties in the recreational fishing assessment (see Table 3.2). These values are reported in the second data column of Table 6.5.

The ratios of the TVE total values to the recreational fishing compensable values (for the comparison population) are reported in the last column of Table 6.4 and range from 1.07 to 1.28, with the variation in the ratio most likely reflecting differences in the assumptions and actual values for discount rates and other computation variables, and normal imprecision in the underlying estimates.

A similar comparison can be made based on individual angler household damages. For simplicity, consider the WTP for reducing the period of recovery from 40 years to 20 years (from intermediate to intensive remediation), a value directly reported in this TVE study (reducing required assumptions for comparison) and estimated to be $364 ($41.4 per year for Green Bay angling households) for 10 years discounted at 3%, where the first payment is not discounted. The recreation study reports average angler values of approximately $51 per angler per year for current damages for open water fishing ($1998 from Table 1.1 in Breffle et al., 1999). Adding ice fishing (+18%), updating to 1999 dollars (+2%), and allowing for multiple Green Bay anglers per Green Bay household results in values of $65 per year per household with Green Bay anglers. Computing these damages for the period 20 to 40 years hence, with damages declining from baseline levels to zero over this period (2020 to 2040), and discounting to a present value at 3% discount rate, results in a present value of $335 per household with Green Bay anglers, or about 9% less than the comparable $364 from this assessment.

Double counting

If both the Co-trustees' recreational fishing damage assessment and this TVE assessment are to be used to assess damages, double counting should be eliminated. The overlap between the studies is for future losses from 2000 until injuries and losses are eliminated, limited to Wisconsin households in the 10 neighboring counties with Green Bay anglers. There is no double counting for past damages, for Wisconsin resident anglers from outside of the 10 counties, for nonresident anglers, or for any damages associated with fishing in Michigan waters of Green Bay.

Double counting can be addressed in several ways. First, in this TVE assessment we compute the WTP values for ongoing PCB-caused losses to households with Green Bay anglers (anglers who fish the waters of Green Bay) in the 10-county area to be about 13% of the total value of losses to all households in the study. Thus, one could add the recreational fishing study damages (in total) to 87% of the values from this study and remove double counting. Alternatively, one could add the total damages from this study to the non-overlapping portions of the recreational fishing assessment (past damages, damages in Michigan waters of Green Bay), and to 17% of the future losses in Wisconsin waters of Green Bay (from non-residents and from residents from outside of the 10 county area).[4]

6.4 Conclusions

This TVE assessment identifies that the scale of restoration of equivalent value to, and the WTP values for, PCB-caused losses in the Lower Fox River and Green Bay area are substantial. It is possible for combinations of natural resource restoration programs, including wetlands restoration, improvements to outdoor recreational facilities, and runoff control, to provide sufficient benefits with value equal to PCB-caused losses during a limited time frame (less than 40 years) if the programs are sufficiently comprehensive and extensive.

The overall assessment results are consistent with the literature identified in Appendix D, and the estimated values for anglers in the population are consistent with the more specific recreational fishing damages assessment — the damages are larger here because this assessment considers all injuries rather than just reduced enjoyment of fishing because of fish consumption advisories considered in the recreational fishing assessment (Breffle et al., 1999).

4. 48,600 individuals purchasing licenses in the 8 counties minus 40,480 Green Bay anglers from the 10 counties accounting for in the TVE study leaves 8,180, or 17%.

The key biases and omissions in the assessment are summarized below and in Table 6.6. Overall, the estimated scale of restoration and WTP values are expected to be conservative (i.e., the level or restoration, and the WTP estimates, are understated).

Table 6.6. Omissions, biases, and uncertainties resulting in conservative estimates.

Method or assumption	Effect on scale of restoration	Effect on WTP values for PCB losses
Past damages were omitted	-	-
Only about 15% of the Wisconsin households were considered (10 counties)	unknown, small	-
Michigan household losses are not considered	unknown, small	-
Tribal resource losses are not considered	-	-
Unknown period for return to baseline	unknown	unknown
Sampling and non-response bias	unknown, small	+, small
Population growth not incorporated	no effect	-
Increasing environmental preferences not considered	unknown	-

A "-" ("+") indicates that the effect of the omission, bias, or uncertainty on the scale of restoration or WTP value measures is to understate (overstate) the true level or value.

1. *Omission of past damages*. Past damages are omitted and potentially substantial. In the recreational fishing report past damages accounted for between 44% and 60% of total damages, depending on the remediation scenario. The significance of the omission in this study is unknown but could be expected to be important compared to ongoing losses.

2. *Omission of Wisconsin residents outside of the neighboring 10 counties and of Michigan residents*. This TVE assessment focused on residents in 10 Wisconsin counties. Distance was found to have little effect on values except for the existence of higher values for PCB-caused losses for a minority of respondents living very close to Green Bay.

   The effect of omitting more distant residents on the scale of restoration is unknown; however, the effect may be small because study results do not show distance as having a great effect on tradeoffs. The effect on WTP values for PCB losses is to have a clear downward bias that results in understated aggregate values. For example, because there are over five times as many Wisconsin households outside of the 10 county region, even if the average value for PCB losses by residents from outside the 10 county region were 10% of the values for households within the 10 county region, the omitted values would be as much as 50% of the measured aggregate values.

3. *Omitted losses to Michigan households*. Also omitted are preferences and values for Michigan residents in the region. In 1990 there were about 24,000 households in two Michigan counties adjacent to the upper portion of the waters of Green Bay (Delta and Menominee), and another 44,000 in the next four adjacent counties (Alger, Dickinson, Marquette, and Schoolcraft). All totaled this amounts to slightly less than 20% as many households as in the 10 Wisconsin counties considered. Because of their proximity to the injured natural resources, one might also expect these households to experience losses, although potentially less than for Wisconsin households because the degree of some (but not all) injuries is less in the upper bay. As above, the scale of restoration (largely located in Wisconsin) may not be substantially altered, but the WTP value measures of PCB-caused losses are understated.

4. *Omitted losses associated with Tribal resources*. Estimates of PCB losses focused on the Lower Fox River and Green Bay and did not include detail on injuries to Tribal lands and waters, and to the associated Tribal, cultural, and other losses. Neither the scale of restoration nor the WTP value measures account for Tribal resources, and thus are understated.

5. *Unknown period for a return to baseline*. The time period for remediation, and the resulting time period until a return to baseline, is uncertain until the Record of Decision is completed. Therefore, the assessment scales restoration, and computes WTP value measures of ongoing losses, for a range of scenarios.

6. *Sampling and nonresponse biases.* As identified in Sections 3.3 and 3.4, any such biases are expected to be small due to the comparability of the sample and the population, and the high response rates. Any such bias would likely similarly influence the value of all natural resource enhancement programs and thus largely cancel out for the restoration scaling resulting in minimal impact. The impact of sampling and nonresponse biases on the WTP values would likely be to increase the computed values, although the analysis suggests any such biases would be small, if they existed at all.

7. *Constant population*. The population is expected grow over time. This is not expected to have any effect on the scale of restoration so long as relative preferences and values remain constant for PCB removal and for other restoration programs, but aggregate WTP will be understated by the amount the population grows.

8. *Constant preferences.* Preferences for environmental commodities may change over time. How PCB losses vis-à-vis benefits from other resource enhancement programs will change is not clear, so the effect on the scale of restoration is unknown. However, increased environmental preferences would have a tendency to increase WTP, and therefore WTP value measures for PCB-caused losses.

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Appendix A — Survey Materials

A.1 Introduction

This appendix includes survey materials, including:

- Initial letter with first mailing
- Mail survey instrument. Note: Only Version 1 is included. All other versions are the same except that the choice pairs vary across versions.
- Table of choice pairs by survey version
- Follow-up postcard
- Follow-up phone survey script
- Follow-up letters for those reached by phone
- Follow-up letters for those not reached by phone
- Thank you letter

The letters included here do not show the letterhead. For the final hard copy report the letters with letterhead will be copied and included.

The mail survey included here does not have all the pictures. For the final hard copy report the mail survey with the pictures will be copied and included.

Initial letter with first mailing

CASEID

<Address>

Dear <Address>:

What should the priorities be for natural resource programs in Northeast Wisconsin? Representatives from government, industry, and citizen groups are addressing this question right now in order to develop regional action plans. Informed decisions can only be made if these decision makers know how citizens like you think about natural resource issues in your area.

The questionnaire included with this letter asks for your household's opinions on natural resource issues in Northeast Wisconsin. It should be answered by either the male or female head of household. **Your opinion matters!** Your household is part of a small sample of households in Northeast Wisconsin that were scientifically selected to provide citizen opinions. Because the sample size is small, it is important that we hear from you. The survey does not require any special knowledge--we just ask that you consider each question and respond with your own opinion.

We realize this questionnaire takes time to answer and that your time is valuable. **If you return the survey by September 30 and complete all the questions, we will send you a $15 "Thank You" check.** A postage-paid envelope has been provided. As a further thank you for returning a completed survey, we will also send you a summary of the results later this year.

All of your answers are confidential; your name will never be revealed to anyone. A code number has been put on the questionnaire so we can send you the $15 check for completing and returning it. If you have any questions, please call me toll-free at 1-800-935-4277. Thank you for your help, and please remember to complete all questions.

Sincerely,

Pam Rathbun, Manager
Survey Research Center

WHAT ARE YOUR OPINIONS ABOUT THE FUTURE OF NATURAL RESOURCES IN NORTHEAST WISCONSIN?

Important Definition

In this survey "the Bay of Green Bay" means the waters of the Bay of Green Bay and all tributaries up to the first dam or obstruction.

Introduction

Decision makers are examining options for natural resources in northeast Wisconsin. Your responses to this survey will help in making decisions about which options are best.

1 **How often do <u>you</u> personally participate in each of the following activities in Wisconsin on the waters and shorelines of the <u>Bay of Green Bay</u>?** *Circle the letter of your answer for each activity.*

	Less than once a year or never	1 to 5 times a year	6 to 10 times a year	More than 10 times a year
Fishing	A	B	C	D
Boating (non-fishing)	A	B	C	D
Waterskiing or jetskiing . . .	A	B	C	D
Canoeing or kayaking	A	B	C	D
Swimming	A	B	C	D
Hunting	A	B	C	D
Wildlife viewing	A	B	C	D
Enjoying outdoor scenery . .	A	B	C	D
Camping or picnicking	A	B	C	D
Biking	A	B	C	D
Hiking, walking, or jogging	A	B	C	D

This survey addresses four natural resource topics. The information provided reflects the most recent scientific reports about these topics.

- **Wetlands**
- **PCBs**
- **Outdoor recreation**
- **Runoff**

Wetlands

Within 5 miles of the Bay of Green Bay there are about 58,000 acres of wetlands in Wisconsin (see map on the facing page), and another 86,000 acres in Michigan. These nearby wetlands are very important to the fish and wildlife of the Bay of Green Bay.

- **Farming, cutting forests, and developing residential and urban areas have reduced wetlands in this area by more than half in the past 100 years.**
- **Current regulations are designed to prevent further loss of wetlands in this area.**
- **Programs have been proposed to restore wetlands in this area. Any wetlands restoration would take about 10 years.**

2 **Wetlands around the Bay of Green Bay provide spawning and nursery habitats for a majority of the fish species in the Bay, including yellow perch, bluegill, largemouth bass, northern pike, and over 35 other species. These wetlands also provide necessary habitat and food for many bird species in the Bay area, including terns, many species of ducks and geese, shorebirds, bald eagles, several species of hawks, coots, and others. Other wildlife such as deer, muskrat, and mink also use wetlands for habitat.**

Increases in wetlands would support nearly proportional increases in the populations of those bird and fish species that depend on wetlands. For example, increasing wetland acres by 10% would increase the numbers of those birds and fish that rely on wetlands by about 10%.

How important to you, if at all, is it to increase wetland acreage near to the Bay of Green Bay to support birds, fish, and other wildlife? *Circle the number of your answer.*

Not at all important		Somewhat important		Very important	Don't know
1	2	3	4	5	8

3 **Which of the following options do you prefer for Wisconsin wetlands near to the Bay of Green Bay?** *Circle the number of your answer***.**

1 Do less and spend less to maintain wetlands, resulting in a loss of wetlands.
2 Do and spend about the same to maintain the current wetland acreage (about 58,000 acres).
3 Do more and spend more to restore wetlands. Options to restore wetlands range from restoring 2,900 acres (5% more than now) to restoring 11,600 acres (20% more than now).

V1

Wisconsin Wetlands Within 5 Miles of the Bay of Green Bay

PCBs

PCBs are substances that were used by industry until the mid-1970s, when they were banned.

- **PCBs released into the Lower Fox River have accumulated in the sediments at the bottom of the Lower Fox River and Green Bay.**
- **PCBs get into fish, birds, and other wildlife through the food chain.**

4 **Because of PCBs, consumption advisories have been issued for all sport-caught fish in Green Bay (including all tributaries up to the first dam) and for some waterfowl in the area. The fish consumption advisories tell how often a meal of fish may be safely eaten (see table on the facing page). Eating more fish than is recommended may increase a woman's risk of bearing children with learning disabilities and slow development, and for everyone may increase the risk of cancer.**

Programs have been proposed to remove PCBs in this area. How important to you, if at all, is it to remove PCBs so that it will be safe to eat fish and waterfowl? *Circle the number of your answer.*

Not at all important		Somewhat important		Very important	Don't know
1	2	3	4	5	8

5 **PCBs cause harm to wildlife in and near the Bay of Green Bay.**

Birds **Forester's terns and common terns in the area reproduce at rates that are about half of the rate elsewhere in Wisconsin. Both are listed as Wisconsin endangered species.**

Bald eagles in the area also reproduce at about half the normal rate for Wisconsin. PCBs contribute to this problem. Bald eagles are no longer listed as endangered.

A small percentage of cormorants experience deformities such as crossed bills.

Fish **About 25% of walleye have abnormalities that can become cancerous liver tumors.**

Other Wildlife **Some sensitive fish-eating wildlife, like mink, may be harmed.**

Even though PCBs harm wildlife, it is unclear whether the total numbers of terns, eagles, cormorants, walleye, mink and other species in the area are less than if there were no PCBs. This is because wildlife migrates into and out of the area, because there is limited habitat in the area for some species, and because other factors influence wildlife populations.

How important to you, if at all, is it to remove PCBs in the Bay of Green Bay area to reduce harm to birds, fish, and other wildlife? *Circle the number of your answer.*

Not at all important		Somewhat important		Very important	Don't know
1	2	3	4	5	8

V1

6 **PCB removal would take about 10 years. Any PCB removal would use the best available technology to minimize stirring up PCBs, and the PCBs that are removed would be disposed of in a manner that would prevent future risks to humans and wildlife.**

Not all PCBs can be removed. The PCBs that are not removed may continue to harm some fish and wildlife. For example, with extensive PCB removal, fish consumption advisories for yellow perch and some impacts to wildlife would be eliminated shortly after PCB removal, but it would be 20 years total (10 years for removal plus 10 more years for nature to recover)

before PCBs are at safe levels. By safe levels we mean there are no consumption advisories for, and no harm to, nearly all fish and wildlife.

Which of the following options do you prefer for PCBs in the Green Bay area of Wisconsin?
Circle the number of your answer.

1 No further PCB investigations or removal. With no further removal it will be 100 years or more until PCBs are at safe levels.
2 Do more and spend more to remove PCBs. Depending on how many PCBs are removed, the time until PCBs are at safe levels would range from 20 years up to 70 years.

Wisconsin Department of Natural Resources

Fish Consumption Advisories for PCBs

V1

Outdoor Recreation

In 10 Wisconsin counties around the Bay of Green Bay, there are over 120 state parks, natural areas, and county parks covering more than 86,000 acres (see map on the facing page).

- **These parks include a variety of facilities such as picnic grounds, beaches, scenic sites, piers, boat ramps, biking and hiking trails, and interpretive centers.**
- **To meet the current and future needs of area residents, programs have been proposed to add facilities at existing parks and to open new parks.**

7 **Adding facilities at existing parks can improve recreational opportunities in these parks. For example, 10% more facilities would mean that most parks would see improvements. Some parks would add hiking or biking trails, some parks would add picnic areas, some parks would add a boat ramp, some parks would add adjacent land, and so forth.**

How important to you, if at all, is adding facilities at existing parks throughout the area to enhance recreational opportunities? *Circle the number of your answer.*

Not at all important		Somewhat important		Very important	Don't know
1	2	3	4	5	8

8 **New parks can be opened throughout the area to increase recreational opportunities. How important to you, if at all, is opening new parks to enhance outdoor recreational opportunities?** *Circle the number of your answer.*

Not at all important		Somewhat important		Very important	Don't know
1	2	3	4	5	8

9 **Any new facilities at existing parks, and any new parks, would be located throughout the area to best meet the needs of residents and would take up to 10 years to accomplish. Which of the following options do you prefer for state and county parks in northeast Wisconsin?** *Circle the number of your answer.*

1 Do less and spend less to maintain existing outdoor recreation parks.
2 Do and spend about the same to maintain existing park conditions and facilities.
3 Do more and spend more to add facilities at existing parks and/or to open new parks.

V1

State and County Recreation Areas

Runoff

Runoff from farms, highways, construction sites, and residential and urban neighborhoods carries plant nutrients and sediments into the Bay of Green Bay and its tributaries, causing algae growth, muddy water, and changes in aquatic habitat (see figure on the facing page).

- **Runoff pollution can be reduced by decreasing erosion; controlling farm, urban, and residential wastes; fencing livestock away from streams; and other measures.**
- **Zebra mussels (small shellfish) have invaded Green Bay. They filter the water, making it clearer. However, scientists say we <u>cannot</u> count on zebra mussels to improve water clarity in the future.**
- **Runoff is <u>not</u> a significant source of the PCBs in the Lower Fox River and Green Bay and does not affect the quality of your drinking water.**

10 **When too many plant nutrients are present, excess algae coats the surface of the water with decaying plants and causes a foul odor. The frequency of excess algae varies by location in the Bay of Green Bay from seldom in the central and northern Bay to up to 80 days a summer in the southern Bay. Most excess algae occurs from mid-June to mid-September.**

How important to you, if at all, is it to control runoff to reduce the number of days with excess algae in Green Bay? *Circle the number of your answer.*

Not at all important		Somewhat important		Very important	Don't know
1	2	3	4	5	8

11 **Because of sediments and algae, you can only see down into the water about 20 inches on average in southern Green Bay, with clearer water to the north. This not only makes the water look less appealing but also reduces the light that reaches underwater plants and thus reduces aquatic habitat. Populations of desirable fish and birds are smaller and carp populations are larger than they would be otherwise, but scientists cannot yet put numbers on the vegetation and wildlife effects.**

How important to you, if at all, is it to control runoff to improve water clarity? *Circle the number of your answer.*

Not at all important		Somewhat important		Very important	Don't know
1	2	3	4	5	8

12 **Any actions to reduce runoff would take up to 10 years to reach their goals. Which of the following options do you prefer for controlling runoff around the Bay of Green Bay?**
Circle the number of your answer.

1 Do less and spend less, resulting in reduced water clarity, increased days of excess algae, and less aquatic habitat in Green Bay and its tributaries.
2 Do and spend about the same. In the southern parts of Green Bay, average summer water clarity would remain about 20 inches, excess algae would occur up to 80 days a summer, and aquatic habitat would remain the same.
3 Do more and spend more to control runoff. Options range up to a 50% reduction in runoff. In the southern parts of Green Bay, this would result in about 34 inches of water clarity, excess algae up to 40 days per year, and increased aquatic habitat.

Water Pollution from Runoff

What Alternatives Do You Prefer?

In each of the next questions there are two alternatives, labeled A and B (see Question 13).

- **Each alternative describes a possible combination of options for natural resources in and around the Bay of Green Bay and the additional costs to your household beyond what you are now paying.**
- **Depending on the options, some costs will be paid by industry, farmers, and conservation organizations. But taxpayers may have to pay something as well. Assume <u>your household pays</u> its share of any added costs through a combination of federal, state, and local taxes <u>each year for the next 10 years.</u>**
- **Since we do not yet know how much each alternative will actually cost you or others, we are asking about a range of costs.**
- **For each question, even if you do not view either Alternative A or B as ideal, still tell us which of the two alternatives you would prefer.**
- **To help you get started, for Question 13 we have provided information on the right-hand side indicating the differences, if any, between Alternatives A and B.**

REMEMBER

1. **The goal of wetlands restoration is to provide additional habitat for fish and wildlife.**

2. **For PCBs, the "years until safe" is the number of years until there are no consumption advisories for, and no harm to, nearly all fish and wildlife. Many advisories and effects will end sooner, but a few advisories and effects may last longer.**

3. **New recreation facilities at existing parks could include rest rooms, trails, boat ramps, and picnicking and camping facilities. Any new facilities at existing parks and any new parks would be located to best meet the needs of area residents.**

4. **Pollution from runoff creates excess algae, reduces water clarity, and causes the loss of aquatic habitat, all of which occur most often in the southern Bay.**

13 **If you had to choose, would you prefer Alternative A or Alternative B?** *Check one box at the bottom.*

	Alternative A ▼	**Alternative B** ▼	
Wetlands Acres in Wisc. around Green Bay. (Currently 58,000)	58,000 acres (current)	69,600 acres (20% more)	11,600 more acres in wetlands
PCBs Years until safe for nearly all fish and wildlife . . . . (Currently 100 years or more)	100+ years until safe (current)	100+ years until safe (current)	No difference
Outdoor Recreation Facilities at existing parks	10% more	0% more	10% more facilities at existing parks
Acres in new parks. . . . . (Currently 86,000 acres in state and county parks)	0 acres (current)	0 acres (current)	No difference
Runoff Average water clarity in southern Bay (Currently 20 inches)	20 inches (current)	20 inches (current)	No difference
Excess algae (Currently up to 80 summer days in the southern Bay)	80 days or less (current)	80 days or less (current)	No difference
Added cost to your household Each year for 10 years.	$25 more	$25 more	No difference

Check (✔) the box for the alternative you prefer ➔

☐ **I Prefer Alternative A**

☐ **I Prefer Alternative B**

V1

14 **If you had to choose, would you prefer Alternative A or Alternative B?** *Check one box at the bottom.*

	Alternative A	Alternative B
Wetlands Acres	58,000 acres (current)	58,000 acres (current)
PCBs Years until safe for nearly all fish and wildlife	40 years until safe (60% faster)	100+ years until safe (current)
Outdoor Recreation Facilities at existing parks.	0% more	0% more
Acres in new parks	0 acres (current)	0 acres (current)
Runoff Average water clarity in the southern Bay	20 inches (current)	20 inches (current)
Excess algae days in lower Bay . .	80 days or less (current)	80 days or less (current)
Added cost to your household Each year for 10 years	$200 more	$0 more
Check (✔) the box for the alternative you prefer ➔	☐	☐

15 **If you had to choose, would you prefer Alternative A or Alternative B?** *Check one box at the bottom.*

	Alternative A ▼	**Alternative B** ▼
Wetlands		
Acres	60,900 acres (5% more)	63,800 acres (10% more)
PCBs		
Years until safe for nearly all fish and wildlife	100+ years until safe (current)	20 years until safe (80% faster)
Outdoor Recreation		
Facilities at existing parks	0% more	10% more
Acres in new parks	0 acres (current)	8,600 acres (10% more)
Runoff		
Average water clarity in the southern Bay	20 inches (current)	24 inches (20% deeper)
Excess algae days in lower Bay. .	80 days or less (current)	60 days or less (25% fewer)
Added cost to your household		
Each year for 10 years	$50 more	$200 more
Check (✔) the box for the alternative you prefer ➔	☐	☐

V1

16 **If you had to choose, would you prefer Alternative A or Alternative B?** *Check one box at the bottom.*

	Alternative A ▼	**Alternative B** ▼
Wetlands		
Acres	58,000 acres (current)	58,000 acres (current)
PCBs		
Years until safe for nearly all fish and wildlife	100+ years until safe (current)	40 years until safe (60% faster)
Outdoor Recreation		
Facilities at existing parks	10% more	0% more
Acres in new parks	0 acres (current)	0 acres (current)
Runoff		
Average water clarity in the southern Bay	34 inches (70% deeper)	20 inches (current)
Excess algae days in lower Bay .	40 days or less (50% fewer)	80 days or less (current)
Added cost to your household		
Each year for 10 years	$50 more	$50 more
Check (✔) the box for the alternative you prefer ➔	❑	❑

17 **If you had to choose, would you prefer Alternative A or Alternative B?** *Check one box at the bottom.*

	Alternative A ▼	**Alternative B** ▼
Wetlands Acres	69,600 acres (20% more)	69,600 acres (20% more)
PCBs Years until safe for nearly all fish and wildlife	40 years until safe (60% faster)	100+ years until safe (current)
Outdoor Recreation Facilities at existing parks	0% more	10% more
Acres in new parks	4,300 acres (5% more)	4,300 acres (5% more)
Runoff Average water clarity in the southern Bay	34 inches (70% deeper)	24 inches (20% deeper)
Excess algae days in lower Bay .	40 days or less (50% fewer)	60 days or less (25% fewer)
Added cost to your household Each year for 10 years	$100 more	$50 more
Check (✔) the box for the alternative you prefer ➔	☐	☐

18 **If you had to choose, would you prefer Alternative A or Alternative B?** *Check one box at the bottom.*

	Alternative A ▼	**Alternative B** ▼
Wetlands Acres	63,800 acres (10% more)	60,900 acres (5% more)
PCBs Years until safe for nearly all fish and wildlife	20 years until safe (80% faster)	70 years until safe (30% faster)
Outdoor Recreation Facilities at existing parks	0% more	0% more
Acres in new parks	4,300 acres (5% more)	8,600 acres (10% more)
Runoff Average water clarity in the southern Bay	20 inches (current)	34 inches (70% deeper)
Excess algae days in lower Bay. .	80 days or less (current)	40 days or less (50% fewer)
Added cost to your household Each year for 10 years	$50 more	$25 more
Check (✔) the box for the alternative you prefer ➔	❑	❑

19 **When you were making your choices between alternatives A and B in Questions 13 through 18, how important were each of the following?** *Circle the number of your answer for each item.*

	Not at all important		Average importance		Very important
Acres of wetland	1	2	3	4	5
Years until safe levels of PCBs	1	2	3	4	5
Facilities at existing parks	1	2	3	4	5
Acres of new parks	1	2	3	4	5
Inches of water clarity	1	2	3	4	5
Days of excess algae each summer. . .	1	2	3	4	5
Annual cost to your household	1	2	3	4	5

20 **Overall, how confident do you feel about your choices between the alternatives in Questions 13 through 18?** *Circle the number of your answer.*

Not at all confident		Somewhat confident		Very confident
1	2	3	4	5

21 **Questions 13 through 18 were asked to provide citizen input for decision makers to consider along with other information from scientists and planners. With this in mind, how much should public officials consider <u>your responses</u> to Questions 13 through 18?** *Circle the number of your answer.*

Should not consider my responses at all		Should somewhat consider my responses		Should completely consider my responses
1	2	3	4	5

22 **Prior to receiving this survey, how aware were you of each of the four natural resource topics we addressed?** *Circle the number of your answer for each topic.*

	I was not aware of this topic		I was somewhat aware of this topic		I was very aware of this topic
Wetlands	1	2	3	4	5
PCBs	1	2	3	4	5
Outdoor recreation	1	2	3	4	5
Runoff	1	2	3	4	5

About You and Your Household

This information is used to help group your responses with responses of other households. Your individual responses and your name will not be released.

23 **In the last 12 months, have you fished in Green Bay or its tributaries up to the first dam (see map on the cover)?** *Circle the number of your answer.*

1 No

(If no) in the last 12 months, have *other* household members fished in Green Bay or its tributaries up to the first dam? *Circle the number of your answer.*

1 No

2 Yes

3 Don't know/Uncertain

2 Yes

(If yes) in the last 12 months, on about how many days have you fished in Green Bay or its tributaries up to the first dam?

________ Days

24 **Do you own or rent your residence?** *Circle the number of your answer.*

1 Own

2 Rent

25 **Do you have a vacation home or cabin in northeast Wisconsin?** *Circle the number of your answer.*

1 Yes

(If yes) about how many miles is it from your vacation home or cabin to the Bay of Green Bay?

_______ Miles to Green Bay

2 No

26 **Your gender:**

1 Female
2 Male

27 **Your age:** ______ Years old

28 **How many people are there in your household, including yourself?**

number

29 **How many children do you have, whether living with you or not?**

number

30 **How many grandchildren do you have, whether living with you or not?**

_____ number

31 **How many listed telephone numbers does your household have?**

_____ listed telephone numbers

V1

32 **What is the highest level of schooling you have completed?** *Circle the number of your answer.*

1 Did not complete high school
2 High school diploma or equivalent
3 Some college, two year college degree (AS) or technical school
4 Four year college graduate (BA, BS)
5 Some graduate work but did not receive a graduate degree
6 Graduate degree (MA, MS, MBA, PhD, JD, MD, etc.)

33 **What is you present employment status?** *Circle the number of your answer.*

1	Employed full time	4	Homemaker
2	Employed part time	5	Student
3	Retired	6	Unemployed

34 **Which of the following categories best describes your racial or ethnic background?** *Circle the number of your answer.*

1	White or Caucasian	4	Asian or Pacific Islander
2	Black or African American	5	Native American Indian
3	Hispanic or Mexican American	6	Other: _______

35 **What was your household income (before taxes) in 1998?** *Circle the number of your answer.*

1	less than $10,000	6	$50,000 to $59,999
2	$10,000 to $19,999	7	$60,000 to $79,999
3	$20,000 to $29,999	8	$80,000 to $99,999
4	$30,000 to $39,999	9	$100,000 to $149,999
5	$40,000 to $49,999	10	$150,000 or more

36 **Is there anything we have overlooked? Please use this space for any additional comments you would like to make.**

Your Participation Is Greatly Appreciated!

Please return the survey in the enclosed envelope to:

Hagler Bailly Services
University Research Park
455 Science Drive
Madison, Wisconsin 53711

Table of choice pairs by survey version

Table A-1 Version 1 Choice Sets				
	Question 13		Question 14	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	58000	69600	58000	58000
Change in Wetlands	current	20 % more	current	current
PCBs - Years Until Safe	100+	100+	40	100+
Percent Increase in Facilities at Existing Parks	10	0	0	0
Acres in New Parks	0	0	0	0
Change in Acres in Parks	current	current	current	current
Inches of Average Water Clarity	20	20	20	20
Change in Water Clarity	current	current	current	current
Excess Algae Days in Lower bay	80	80	80	80
Change in Excess Algae Days	current	current	current	current
Added Cost to Household for 10 Years	25	25	200	0
	Question 15		Question 16	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	60900	63800	58000	58000
Change in Wetlands	5% more	10% more	current	current
PCBs - Years Until Safe	100+	20	100+	40
Percent Increase in Facilities at Existing Parks	0	10	10	0
Acres in New Parks	0	8600	0	0
Change in Acres in Parks	current	10% more	current	current
Inches of Average Water Clarity	20	24	34	20
Change in Water Clarity	current	20% deeper	70% deeper	current
Excess Algae Days in Lower bay	80	60	40	80
Change in Excess Algae Days	current	25% fewer	50% fewer	current
Added Cost to Household for 10 Years	50	200	50	50
	Question 17		Question 18	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	69600	69600	63800	60900
Change in Wetlands	20 % more	20 % more	10% more	5% more
PCBs - Years Until Safe	40	100+	20	70
Percent Increase in Facilities at Existing Parks	0	10	0	0
Acres in New Parks	4300	4300	4300	8600
Change in Acres in Parks	5% more	5% more	5% more	10% more
Inches of Average Water Clarity	34	24	20	34
Change in Water Clarity	70% deeper	20% deeper	current	70% deeper
Excess Algae Days in Lower bay	40	60	80	40
Change in Excess Algae Days	50% fewer	25% fewer	current	50% fewer
Added Cost to Household for 10 Years	100	50	50	25

Table A-2 Version 2 Choice Sets				
	Question 13		Question 14	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	58000	60900	58000	58000
Change in Wetlands	current	5% more	current	current
PCBs - Years Until Safe	100+	100+	100+	20
Percent Increase in Facilities at Existing Parks	0	0	0	0
Acres in New Parks	4300	0	0	0
Change in Acres in Parks	5% more	current	current	current
Inches of Average Water Clarity	20	20	20	20
Change in Water Clarity	current	current	current	current
Excess Algae Days in Lower bay	80	80	80	80
Change in Excess Algae Days	current	current	current	current
Added Cost to Household for 10 Years	25	25	0	50
	Question 15		Question 16	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	58000	63800	63800	63800
Change in Wetlands	current	10% more	10% more	10% more
PCBs - Years Until Safe	70	70	100+	70
Percent Increase in Facilities at Existing Parks	10	0	10	0
Acres in New Parks	4300	8600	8600	4300
Change in Acres in Parks	5% more	10% more	10% more	5% more
Inches of Average Water Clarity	24	20	20	24
Change in Water Clarity	20% deeper	current	current	20% deeper
Excess Algae Days in Lower bay	60	80	80	60
Change in Excess Algae Days	25% fewer	current	current	25% fewer
Added Cost to Household for 10 Years	25	200	200	50
	Question 17		Question 18	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	69600	63800	63800	60900
Change in Wetlands	20 % more	10% more	10% more	5% more
PCBs - Years Until Safe	20	40	40	20
Percent Increase in Facilities at Existing Parks	0	10	10	10
Acres in New Parks	4300	4300	0	0
Change in Acres in Parks	5% more	5% more	current	current
Inches of Average Water Clarity	34	34	34	34
Change in Water Clarity	70% deeper	70% deeper	70% deeper	70% deeper
Excess Algae Days in Lower bay	40	40	40	40
Change in Excess Algae Days	50% fewer	50% fewer	50% fewer	50% fewer
Added Cost to Household for 10 Years	100	100	100	200

Table A-3
Version 3 Choice Sets

	Question 13		Question 14	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	58000	58000	58000	69600
Change in Wetlands	current	current	current	20 % more
PCBs - Years Until Safe	100+	100+	100+	100+
Percent Increase in Facilities at Existing Parks	0	10	0	0
Acres in New Parks	8600	0	0	0
Change in Acres in Parks	10% more	current	current	current
Inches of Average Water Clarity	20	20	20	20
Change in Water Clarity	current	current	current	current
Excess Algae Days in Lower bay	80	80	80	80
Change in Excess Algae Days	current	current	current	current
Added Cost to Household for 10 Years	25	25	0	50
	Question 15		Question 16	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	69600	69600	63800	63800
Change in Wetlands	20 % more	20 % more	10% more	10% more
PCBs - Years Until Safe	100+	20	70	40
Percent Increase in Facilities at Existing Parks	10	0	10	10
Acres in New Parks	8600	8600	4300	0
Change in Acres in Parks	10% more	10% more	5% more	current
Inches of Average Water Clarity	24	34	20	20
Change in Water Clarity	20% deeper	70% deeper	current	current
Excess Algae Days in Lower bay	60	40	80	80
Change in Excess Algae Days	25% fewer	50% fewer	current	current
Added Cost to Household for 10 Years	50	200	100	100
	Question 17		Question 18	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	60900	60900	58000	69600
Change in Wetlands	5% more	5% more	current	20 % more
PCBs - Years Until Safe	20	40	40	70
Percent Increase in Facilities at Existing Parks	0	0	0	10
Acres in New Parks	0	8600	8600	0
Change in Acres in Parks	current	10% more	10% more	current
Inches of Average Water Clarity	34	24	24	34
Change in Water Clarity	70% deeper	20% deeper	20% deeper	70% deeper
Excess Algae Days in Lower bay	40	60	60	40
Change in Excess Algae Days	50% fewer	25% fewer	25% fewer	50% fewer
Added Cost to Household for 10 Years	25	100	200	100

Table A-4
Version 4 Choice Sets

	Question 13		Question 14	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	58000	58000	58000	58000
Change in Wetlands	current	current	current	current
PCBs - Years Until Safe	100+	100+	20	100+
Percent Increase in Facilities at Existing Parks	10	0	0	0
Acres in New Parks	0	0	0	0
Change in Acres in Parks	current	current	current	current
Inches of Average Water Clarity	20	34	20	20
Change in Water Clarity	current	70% deeper	current	current
Excess Algae Days in Lower bay	80	40	80	80
Change in Excess Algae Days	current	50% fewer	current	current
Added Cost to Household for 10 Years	25	25	200	0

	Question 15		Question 16	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	58000	60900	63800	69600
Change in Wetlands	current	5% more	10% more	20 % more
PCBs - Years Until Safe	70	100+	20	70
Percent Increase in Facilities at Existing Parks	10	0	0	0
Acres in New Parks	8600	4300	4300	8600
Change in Acres in Parks	10% more	5% more	5% more	10% more
Inches of Average Water Clarity	34	24	34	24
Change in Water Clarity	70% deeper	20% deeper	70% deeper	20% deeper
Excess Algae Days in Lower bay	40	60	40	60
Change in Excess Algae Days	50% fewer	25% fewer	50% fewer	25% fewer
Added Cost to Household for 10 Years	50	200	200	25

	Question 17		Question 18	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	69600	60900	60900	69600
Change in Wetlands	20 % more	5% more	5% more	20 % more
PCBs - Years Until Safe	70	40	70	70
Percent Increase in Facilities at Existing Parks	0	10	10	10
Acres in New Parks	8600	8600	0	0
Change in Acres in Parks	10% more	10% more	current	current
Inches of Average Water Clarity	20	20	34	24
Change in Water Clarity	current	current	70% deeper	20% deeper
Excess Algae Days in Lower bay	80	80	40	60
Change in Excess Algae Days	current	current	50% fewer	25% fewer
Added Cost to Household for 10 Years	200	50	50	50

Table A-5
Version 5 Choice Sets

	Question 13		Question 14	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	58000	58000	58000	58000
Change in Wetlands	current	current	current	current
PCBs - Years Until Safe	100+	100+	40	100+
Percent Increase in Facilities at Existing Parks	0	0	0	0
Acres in New Parks	8600	0	0	0
Change in Acres in Parks	10% more	current	current	current
Inches of Average Water Clarity	20	24	20	20
Change in Water Clarity	current	20% deeper	current	current
Excess Algae Days in Lower bay	80	60	80	80
Change in Excess Algae Days	current	25% fewer	current	current
Added Cost to Household for 10 Years	25	25	50	0
	Question 15		Question 16	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	58000	58000	60900	58000
Change in Wetlands	current	current	5% more	current
PCBs - Years Until Safe	40	20	70	40
Percent Increase in Facilities at Existing Parks	10	0	0	0
Acres in New Parks	0	0	8600	0
Change in Acres in Parks	current	current	10% more	current
Inches of Average Water Clarity	20	20	24	24
Change in Water Clarity	current	current	20% deeper	20% deeper
Excess Algae Days in Lower bay	80	80	60	60
Change in Excess Algae Days	current	current	25% fewer	25% fewer
Added Cost to Household for 10 Years	50	50	100	25
	Question 17		Question 18	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	63800	60900	63800	58000
Change in Wetlands	10% more	5% more	10% more	current
PCBs - Years Until Safe	70	70	70	20
Percent Increase in Facilities at Existing Parks	0	10	10	0
Acres in New Parks	0	4300	0	0
Change in Acres in Parks	current	5% more	current	current
Inches of Average Water Clarity	34	20	20	20
Change in Water Clarity	70% deeper	current	current	current
Excess Algae Days in Lower bay	40	80	80	80
Change in Excess Algae Days	50% fewer	current	current	current
Added Cost to Household for 10 Years	50	25	50	50

Table A-6
Version 6 Choice Sets

	Question 13		Question 14	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	58000	69600	58000	63800
Change in Wetlands	current	20 % more	current	10% more
PCBs - Years Until Safe	20	100+	100+	100+
Percent Increase in Facilities at Existing Parks	0	0	0	0
Acres in New Parks	0	0	0	0
Change in Acres in Parks	current	current	current	current
Inches of Average Water Clarity	20	20	20	20
Change in Water Clarity	current	current	current	current
Excess Algae Days in Lower bay	80	80	80	80
Change in Excess Algae Days	current	current	current	current
Added Cost to Household for 10 Years	50	50	0	25
	Question 15		Question 16	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	69600	69600	69600	60900
Change in Wetlands	20 % more	20 % more	20 % more	5% more
PCBs - Years Until Safe	20	40	40	70
Percent Increase in Facilities at Existing Parks	10	0	10	10
Acres in New Parks	0	4300	0	8600
Change in Acres in Parks	current	5% more	current	10% more
Inches of Average Water Clarity	20	34	24	24
Change in Water Clarity	current	70% deeper	20% deeper	20% deeper
Excess Algae Days in Lower bay	80	40	60	60
Change in Excess Algae Days	current	50% fewer	25% fewer	25% fewer
Added Cost to Household for 10 Years	100	100	50	100
	Question 17		Question 18	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	60900	63800	69600	58000
Change in Wetlands	5% more	10% more	20 % more	current
PCBs - Years Until Safe	70	100+	100+	20
Percent Increase in Facilities at Existing Parks	10	0	10	0
Acres in New Parks	4300	0	8600	0
Change in Acres in Parks	5% more	current	10% more	current
Inches of Average Water Clarity	24	34	34	20
Change in Water Clarity	20% deeper	70% deeper	70% deeper	current
Excess Algae Days in Lower bay	60	40	40	80
Change in Excess Algae Days	25% fewer	50% fewer	50% fewer	current
Added Cost to Household for 10 Years	200	50	200	200

Table A-7 Version 7 Choice Sets				
	Question 13		Question 14	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	58000	69600	58000	58000
Change in Wetlands	current	20 % more	current	current
PCBs - Years Until Safe	100+	100+	100+	100+
Percent Increase in Facilities at Existing Parks	0	0	0	10
Acres in New Parks	0	0	0	0
Change in Acres in Parks	current	current	current	current
Inches of Average Water Clarity	34	20	20	20
Change in Water Clarity	70% deeper	current	current	current
Excess Algae Days in Lower bay	40	80	80	80
Change in Excess Algae Days	50% fewer	current	current	current
Added Cost to Household for 10 Years	50	50	0	50
	Question 15		Question 16	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	60900	69600	58000	58000
Change in Wetlands	5% more	20 % more	current	current
PCBs - Years Until Safe	40	20	70	40
Percent Increase in Facilities at Existing Parks	10	0	10	0
Acres in New Parks	4300	8600	4300	0
Change in Acres in Parks	5% more	10% more	5% more	current
Inches of Average Water Clarity	20	20	20	20
Change in Water Clarity	current	current	current	current
Excess Algae Days in Lower bay	80	80	80	80
Change in Excess Algae Days	current	current	current	current
Added Cost to Household for 10 Years	50	100	25	25
	Question 17		Question 18	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	63800	63800	69600	63800
Change in Wetlands	10% more	10% more	20 % more	10% more
PCBs - Years Until Safe	40	20	100+	20
Percent Increase in Facilities at Existing Parks	0	10	10	10
Acres in New Parks	0	4300	8600	0
Change in Acres in Parks	current	5% more	10% more	current
Inches of Average Water Clarity	24	24	20	24
Change in Water Clarity	20% deeper	20% deeper	current	20% deeper
Excess Algae Days in Lower bay	60	60	80	60
Change in Excess Algae Days	25% fewer	25% fewer	current	25% fewer
Added Cost to Household for 10 Years	25	50	50	100

Table A-8
Version 8 Choice Sets

	Question 13		Question 14	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	58000	69600	58000	58000
Change in Wetlands	current	20 % more	current	current
PCBs - Years Until Safe	40	100+	100+	100+
Percent Increase in Facilities at Existing Parks	0	0	0	0
Acres in New Parks	0	0	0	4300
Change in Acres in Parks	current	current	current	5% more
Inches of Average Water Clarity	20	20	20	20
Change in Water Clarity	current	current	current	current
Excess Algae Days in Lower bay	80	80	80	80
Change in Excess Algae Days	current	current	current	current
Added Cost to Household for 10 Years	50	50	0	100
	Question 15		Question 16	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	60900	58000	69600	60900
Change in Wetlands	5% more	current	20 % more	5% more
PCBs - Years Until Safe	40	20	100+	70
Percent Increase in Facilities at Existing Parks	10	0	0	0
Acres in New Parks	0	0	4300	0
Change in Acres in Parks	current	current	5% more	current
Inches of Average Water Clarity	20	20	20	24
Change in Water Clarity	current	current	current	20% deeper
Excess Algae Days in Lower bay	80	80	80	60
Change in Excess Algae Days	current	current	current	25% fewer
Added Cost to Household for 10 Years	50	50	100	200
	Question 17		Question 18	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	60900	69600	63800	58000
Change in Wetlands	5% more	20 % more	10% more	current
PCBs - Years Until Safe	40	40	20	100+
Percent Increase in Facilities at Existing Parks	0	10	10	10
Acres in New Parks	8600	4300	8600	8600
Change in Acres in Parks	10% more	5% more	10% more	10% more
Inches of Average Water Clarity	20	34	34	20
Change in Water Clarity	current	70% deeper	70% deeper	current
Excess Algae Days in Lower bay	80	40	40	80
Change in Excess Algae Days	current	50% fewer	50% fewer	current
Added Cost to Household for 10 Years	25	200	100	50

Table A-9 Version 9 Choice Sets				
	Question 13		Question 14	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	58000	58000	58000	58000
Change in Wetlands	current	current	current	current
PCBs - Years Until Safe	100+	70	100+	100+
Percent Increase in Facilities at Existing Parks	0	0	0	0
Acres in New Parks	0	0	0	8600
Change in Acres in Parks	current	current	current	10% more
Inches of Average Water Clarity	24	20	20	20
Change in Water Clarity	20% deeper	current	current	current
Excess Algae Days in Lower bay	60	80	80	80
Change in Excess Algae Days	25% fewer	current	current	current
Added Cost to Household for 10 Years	25	25	0	50
	Question 15		Question 16	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	58000	58000	58000	58000
Change in Wetlands	current	current	current	current
PCBs - Years Until Safe	20	70	40	20
Percent Increase in Facilities at Existing Parks	0	0	10	0
Acres in New Parks	0	8600	0	0
Change in Acres in Parks	current	10% more	current	current
Inches of Average Water Clarity	20	20	24	20
Change in Water Clarity	current	current	20% deeper	current
Excess Algae Days in Lower bay	80	80	60	80
Change in Excess Algae Days	current	current	25% fewer	current
Added Cost to Household for 10 Years	50	100	50	50
	Question 17		Question 18	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	58000	63800	60900	63800
Change in Wetlands	current	10% more	5% more	10% more
PCBs - Years Until Safe	70	current	40	70
Percent Increase in Facilities at Existing Parks	0	0	0	0
Acres in New Parks	0	0	8600	8600
Change in Acres in Parks	current	current	10% more	10% more
Inches of Average Water Clarity	20	20	34	20
Change in Water Clarity	current	current	70% deeper	current
Excess Algae Days in Lower bay	80	80	40	80
Change in Excess Algae Days	current	current	50% fewer	current
Added Cost to Household for 10 Years	25	25	100	25

Table A-10
Version 10 Choice Sets

	Question 13		Question 14	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	58000	58000	58000	58000
Change in Wetlands	current	current	current	current
PCBs - Years Until Safe	40	100+	100+	100+
Percent Increase in Facilities at Existing Parks	0	0	0	0
Acres in New Parks	0	0	0	0
Change in Acres in Parks	current	current	current	current
Inches of Average Water Clarity	20	34	20	24
Change in Water Clarity	current	70% deeper	current	20% deeper
Excess Algae Days in Lower bay	80	40	80	60
Change in Excess Algae Days	current	50% fewer	current	25% fewer
Added Cost to Household for 10 Years	50	50	0	25
	Question 15		Question 16	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	58000	63800	63800	58000
Change in Wetlands	current	10% more	10% more	current
PCBs - Years Until Safe	40	100+	40	40
Percent Increase in Facilities at Existing Parks	0	10	0	0
Acres in New Parks	0	8600	4300	8600
Change in Acres in Parks	current	10% more	5% more	10% more
Inches of Average Water Clarity	24	34	24	24
Change in Water Clarity	20% deeper	70% deeper	20% deeper	20% deeper
Excess Algae Days in Lower bay	60	40	60	60
Change in Excess Algae Days	25% fewer	50% fewer	25% fewer	25% fewer
Added Cost to Household for 10 Years	100	100	50	100
	Question 17		Question 18	
	Alternative A	Alternative B	Alternative A	Alternative B
Wetlands - Acres	58000	58000	69600	60900
Change in Wetlands	current	current	20 % more	5% more
PCBs - Years Until Safe	20	70	70	20
Percent Increase in Facilities at Existing Parks	0	10	0	0
Acres in New Parks	0	0	8600	0
Change in Acres in Parks	current	current	10% more	current
Inches of Average Water Clarity	20	20	34	20
Change in Water Clarity	current	current	70% deeper	current
Excess Algae Days in Lower bay	80	80	40	80
Change in Excess Algae Days	current	current	50% fewer	current
Added Cost to Household for 10 Years	50	50	25	100

Follow-up postcard

Hello,

A few days ago you should have received a questionnaire asking for your opinions about natural resources in Northeast Wisconsin. If you have already completed and returned the questionnaire, accept our sincere thanks. You will soon receive your $15 “Thank You” check. If you have not completed and returned the questionnaire, we ask that you do so today.

It is very important that we hear from you. Your response will help shape decisions being made on natural resource priorities. We cannot survey all households in Northeast Wisconsin, so your responses will represent other households like yours that were not selected for the study. If you need another copy of the questionnaire, please call us at 1-800-935-4277 and we will mail another one. As a thank you for returning the questionnaire with all questions completed, we will send you a $15 “Thank You” check and a summary of the study results. Please return the survey by September 30.

Thank you for your help with this important study.

Pam Rathbun, Manager
Survey Research Center

Follow-up phone survey script

Hello, my name is ________________ and I am calling from the Hagler Bailly Survey Research Center in Madison, Wisconsin. I am trying to reach **[respondent name]**.

[IF RESPONDENT IS NOT AVAILABLE:]
Is there another adult head of household that I could speak to?

[If concerned about purpose of the call] This is not a marketing or sales call. We are collecting citizen input for government, industry, and citizen groups to consider when developing action plans for natural resources in Northeast Wisconsin. I want to assure you that your answers will be kept confidential and your name will not be revealed to anyone.

[If asking about the study sponsor] In order not to bias the responses to the survey, the sponsor is confidential until the results are released to government, industry and the general public later this fall. You will be mailed a summary of the results at that time.

[Response to: "*The response date passed*".] Because receiving responses from every household in our sample is important, we have extended the response date to October 16 (NOTE: this will change if calling goes into next week). If we mail the survey again tomorrow, can you complete it and return it in a week?

[Response to: "*Why are you paying $15?*"]
The survey is very important and we find we can get more citizen input for less money this way. More people return the survey faster, so we don't have to contact as many households, and contact you as often, to get an accurate sample of the public's input.

[If correct respondent is on the phone]

QA Recently, we mailed you a questionnaire asking your opinions about the future of natural resources in Northeast Wisconsin and offered to pay $15 for an adult head of your household to complete the survey. The survey had a map of northeast Wisconsin on the cover and some color graphics inside. Do you remember receiving that questionnaire?

1 YES
2 NO *[SKIP TO QA2]*

QA1 As of today, we have not received your completed questionnaire. Your household is part of a small group of people we are asking for opinions, so your response is very important. We are extending the deadline for completing the survey, and receiving $15 as a thank you for your time and effort. If we send you another survey, could you find the time to complete the survey and return it to us within a week of receiving it?

1 YES – SEND NEW SURVEY *[SKIP TO VERIFY]*
2 YES – DO NOT NEED ANOTHER SURVEY *[THANK AND TERMINATE]*
3 SURVEY HAS ALREADY BEEN RETURNED *[THANK AND TERMINATE]*
4 NO *[SKIP TO QB]*

QA2 We are collecting citizen input for government, industry, and citizen groups to consider when developing actions plans for natural resources in Northeast Wisconsin. Your household is part of a small group of people we are asking for opinions, so your response is very important. If we send you another survey, could you return the survey to us within a week after you receive it? We will send you $15 as a thank you for your time and effort.

1 YES – SEND NEW SURVEY *[SKIP TO VERIFY]*
2 YES – DO NOT NEED ANOTHER SURVEY *[THANK AND TERMINATE]*
3 SURVEY HAS ALREADY BEEN RETURNED *[THANK AND TERMINATE]*
4 NO *[SKIP TO QA2A]*

QA2A Since we only sampled a small number of households, it is very important that we hear from your household. Your opinions will represent those of other households similar to you. Is there another adult head of household that would be interested in completing the survey for $15?

1 YES, GETTING THEM TO THE PHONE *[REPEAT QA2]*
2 YES, BUT NOT AVAILABLE AT THIS TIME *[SET CALLBACK]*
3 NO *[SKIP TO QB]*

QB It is very important for our preliminary analysis that we understand how those who haven't returned the survey compare to those who did. This way we will not misinterpret the results. Could I take about 5 minutes to ask you a few questions? I'd like to remind you that all of your answers are confidential and your name will not be revealed to anyone.

1 YES *[SKIP TO Q1]*
2 NO *[ASK FOR A MORE CONVENIENT TIME, OTHERWISE, THANK AND TERMINATE]*

VERIFY (If new survey needs to be sent) I would like to verify some information that I have.

I have your name as…

NAME____
STREET ADDRESS___________________________________
CITY_______________________STATE ______ ZIP________
PHONE____

Q1 In the last 12 months, have you fished in Green Bay or in rivers or streams near where they enter Green Bay?

1 YES *[SKIP TO Q1A]*
2 NO *[SKIP TO Q1B]*

8 DON'T KNOW *[SKIP TO Q1B]*
9 REFUSED *[SKIP TO Q1B]*

Q1A In the last 12 months, how often did you fish in the Bay of Green Bay or rivers or streams that enter into the Bay of Green Bay? Would it be…

1 LESS THAN 5 DAYS,
2 5 TO 10 DAYS, OR
3 MORE THAN 10 DAYS?

8 DON'T KNOW
9 REFUSED

Q1B In the last 12 months, have OTHER household members fished Green Bay or rivers or streams near where they enter Green Bay?

1 YES
2 NO

8 DON'T KNOW
9 REFUSED

Q2 How often do you participate in each of the following 3 activities in the waters or on the shorelines of the Bay of Green Bay and the rivers or streams near to where they feed into Green Bay. For each activity, tell me if you participate in the activity just around the Bay of Green Bay once a year or less often, about 1 to 5 times a year, or more than 5 times a year.

Q2a Wildlife viewing or enjoying the scenery
Q2b Camping or picnicking
Q2c Biking, hiking, walking, or jogging

1 ONCE A YEAR OR LESS
2 1 TO 5 TIMES A YEAR
3 MORE THAN 5 TIMES A YEAR

8 DON'T KNOW
9 REFUSED

Q3 Next, I am going to read you a list of 4 actions that may be taken to enhance natural resources in Northeast Wisconsin. After I read the list, we will go back through them one by one and I will want you to rate the importance to you of the action on a 1 to 5 scale, where 1 equals not at all important, 3 is somewhat important, and 5 is very important.

1. increase wetland and other habitat around the Bay of Green Bay to support increased populations of birds, fish and other wildlife.

2. remove PCBs in the Lower Fox River and the Bay of Green Bay so that consumption advisories on fish and waterfowl can be removed.

3. remove PCBs in the Lower Fox River and the Bay of Green Bay to reduce risks to birds, fish and other wildlife.

4. add new facilities at existing state and county parks throughout a 10 county Northeast Wisconsin area (new facilities may include boat launches, picnic areas, hiking and biking trails, and the like.)

Q3a OK, let’s take them one at a time. On a 1 to 5 scale, where 1 is not at all important, 3 is somewhat important, and 5 is very important, how important is it to you to…

Increase wetland and other habitats around the Bay of Green Bay to support increased populations of birds, fishing and other wildlife?

1 NOT AT ALL IMPORTANT
2
3 SOMEWHAT IMPORTANT
4
5 VERY IMPORTANT

8 DON’T KNOW
9 REFUSED

Q3b How important is it to you to remove PCBs in the Lower Fox River and the Bay of Green Bay so that consumption advisories on fish and waterfowl can be removed?

1 NOT AT ALL IMPORTANT
2
3 SOMEWHAT IMPORTANT
4
5 VERY IMPORTANT

8 DON’T KNOW
9 REFUSED

Q3c How important is it to you to remove PCBs in the Lower Fox River and the Bay of Green Bay to reduce risks to birds, fish and other wildlife?

1 NOT AT ALL IMPORTANT
2
3 SOMEWHAT IMPORTANT
4
5 VERY IMPORTANT

8 DON’T KNOW
9 REFUSED

Q3d How important is it to add new facilities at existing state and county parks throughout a 10 county Northeast Wisconsin area? (new facilities may include boat launches, picnic areas, hiking and biking trails, and the like.)

1 NOT AT ALL IMPORTANT
2
3 SOMEWHAT IMPORTANT
4
5 VERY IMPORTANT

8 DON'T KNOW
9 REFUSED

(For recreation, if asked: the 10 county area is around the Bay of Green Bay from Winnebago, Calumet and Manitowoc counties on the south to Marinette and Door counties on the north. Your county is in this area).

I have just 3 more quick questions about you and your household to help us group your responses with others.

Q5 What is your age?

____ YEARS OLD
999 REFUSED

Q6 How many people are there in your household, including yourself?

____ PEOPLE
99 REFUSED

Q7 What was your total household income before taxes in 1998? I'll read off the categories, so just stop me when I reach the category that includes your household's total 1998 income.

1 LESS THAN $20,000
2 $20,000 TO $40,000
3 $40,000 TO $60,000
4 $60,000 TO $80,000
5 $80,000 TO $150,000
6 MORE THAN $150,000

8 DON'T KNOW
9 REFUSED

That's all the questions I have for you. Do you have any comments that you would like to add?

Thank you for your time. We really appreciate your participation in this brief survey.
Thanks again, and have a good evening.

[TERMINATE INTERVIEW]

GENDER
Respondent gender:

1 MALE
2 FEMALE

8 DON'T KNOW

LANG Language or other barrier:

1 YES, POSSIBLE LANGUAGE BARRIER
2 YES, DEFINITE LANGUAGE BARRIER
3 NO LANGUAGE, BUT OTHER TYPE OF BARRIER *[SPECIFY]*
4 NO BARRIERS

Follow-up letters for those reached by phone

«CASEID»

Dear «FIRSTNAM» «LASTNAM»:

Enclosed is another copy of the questionnaire we discussed on the phone this week. Thank you for your willingness to complete and return this questionnaire.

Since we were only able to survey a small number of households in Northeast Wisconsin, your response is very important. Informed decisions about natural resource issues can only be made if decision-makers know how citizens like you think about natural resource issues in your area. We want to remind you that the questionnaire does not require any special knowledge--we just ask that you consider each question and respond with your own opinion.

You will be sent a summary of the results of this study later this year. **In addition, if you postmark the questionnaire by October 18 and complete all the questions, we will send you a $15 "Thank You" check.**

All of your answers are confidential; your name will never be revealed to anyone. A code number has been put on the questionnaire so we can send you the $15 check for completing and returning it. If you have any questions, please call me toll-free at 1-800-935-4277.

Thank you for your help, and please remember to complete all questions.

Sincerely,

Pam Rathbun
Hagler Bailly Survey Manager

Follow-up letters for those not reached by phone

«ID»

Dear «FIRST_NAME» «LAST_NAME»,

A couple weeks ago, we sent you a questionnaire asking for your household's opinions on natural resource issues in Northeast Wisconsin. We are pleased that many households have returned their questionnaire, but we still would like to hear from you. If you recently mailed our questionnaire back to us, please accept our thanks and disregard this letter.

Since we were only able to survey a small number of households in Northeast Wisconsin, your response is very important. Regardless of whether you are a full-time resident of Northeast Wisconsin or a seasonal resident, **your opinion counts**. Informed decisions about natural resource issues can only be made if decision-makers know how citizens like you think about natural resource issues in your area. We want to remind you that the questionnaire does not require any special knowledge--we just ask that you consider each question and respond with your own opinion.

In the event that your questionnaire has been misplaced, a replacement questionnaire and a postage paid, self-addressed envelope are enclosed for your convenience. This questionnaire should be answered by either the male or female head of your household.

You will be sent a summary of the results of this study later this year. Because receiving responses from every household in our sample is important, we have extended the response date to October 25--**if you postmark the questionnaire by Monday, October 25 and complete all the questions, we will send you a $15 "Thank You" check.**

If there is anything we can do to help you complete this questionnaire, please feel free to call me toll-free at 1-800-935-4277.

Your cooperation in this study is greatly appreciated!

Sincerely,

Pam Rathbun

Hagler Bailly Survey Manager

Thank you letter

Dear Northeast Wisconsin Resident:

Thank you for responding to the survey about “Your Opinions about the Future of Natural Resources in Northeast Wisconsin”. Enclosed is a $15 check to thank you for your assistance with this important study. Around the end of this year, you will also be receiving a summary of the study results.

Please call me at 608-232-2800 if you have any other questions.

Pam Rathbun, Manager
Survey Research Center

Appendix B — Modeling Consumer Preferences for Green Bay Resource Characteristics Using Stated Preference Data

B.1 Introduction

The purpose of this model is to estimate the parameters in a conditional indirect utility function for natural resource program characteristics using stated preference (SP) data, which consist of the answers to choice questions. Each sampled individual indicated his or her choice between a pair of Green Bay alternatives (Green Bay under different conditions). For each sampled individual, this comparison is repeated *J* times, where the characteristics of the Green Bay alternatives in the pairs are varied over the *J* pairs.

Section B.2 develops the choice probabilities for the two Green Bay alternatives using the SP data that indicate which Green Bay alternative is chosen. Section B.3 presents the likelihood function for the model.

B.2 Choice Probabilities for SP Green Bay Pairs

Let utility for the Green Bay alternatives be given by:

$$U_{ij}^{k_{ij}} = \beta_i' x_{ij}^{k_{ij}} + \varepsilon_{ij}^{k_{ij}}, i = 1,..., m; j = 1,..., J; k_{ij} \in [1,2], \qquad \text{(B-1)}$$

where $U_{ij}^{k_{ij}}$ is the utility of the *k*-th alternative of pair *j* to individual *i*. That is, *i* indexes the *m* respondents, *j* indexes the *J* pairs, and k_{ij} indicates which of the two alternatives within each pair is chosen. The $L \times 1$ vector $x_{ij}^{k_{ij}}$ contains the characteristics of the alternatives, and hence the elements of the unknown $L \times 1$ vector β_i can be interpreted as marginal utilities.[1] The first element of $x_{ij}^{k_{ij}}$ is the difference between income for individual *i* and the cost of alternative k_{ij}, and the model is restricted to one with a constant marginal utility of money, which is the first element of β_i. This specification implies no income effects; that is, the probability of choosing any alternative is independent of income. The term $\beta_i' x_{ij}^{k_{ij}}$ is the nonstochastic part of utility, while $\varepsilon_{ij}^{k_{ij}}$ represents a stochastic component. It is assumed the $\varepsilon_{ij}^{k_{ij}}$ are independent (across *i*) and identically distributed mean zero normal random variables, uncorrelated with $x_{ij}^{k_{ij}}$, with constant unknown variance σ_ε^2. For SP data, it is assumed that the individual does not know his stochastic component before actually deciding on the particular alternative. That is, $\varepsilon_{ij}^{k_{ij}}$ is assumed to be the sum of factors unknown to *both* the individual and the investigator, although its distribution

1. The parameter vector β is subscripted by *i* to indicate the marginal utilities may vary over individuals as a function of individual characteristics.

is assumed to be known.[2,3] That an individual does not know his preferences completely results from the fact that preferences have a component that varies randomly over time. When the individual answers stated-choice questions he does not know exactly what his preferences would be if he were presented with these alternatives as an actual choice at some point in the future. We assume the survey questions are answered probabilistically and reflect what he is likely to do if he were repeatedly presented with the actual choice.

Let $K_{ij} \in [1,2]$ be the Bernoulli random variable that is the choice for individual i on occasion j. The individual is assumed to choose alternative k_{ij} with the probability[4]:

$$P(K_{ij} = k_{ij}) = P_{ij}^{k_{ij}} = P(U_{ij}^{k_{ij}} > U_{ij}^{3-k_{ij}})\,, \tag{B-2}$$

where k_{ij} is the observed value of K_{ij}. That is, we may think of the individual's choice as a drawing from a Bernoulli distribution with the probability given by Equation B-2.

From Equations B-1 and B-2 and assumptions regarding the stochastic component, the probability of choosing alternative k_{ij} is:

---

2. For revealed preference data, the usual discrete-choice model specification is that the disturbances are known to the individual, and the behavioral assumption is utility maximization. The assumption is also sometimes made for SP data, although the rationale is less clear. However, even under the assumption that each unique pair of disturbances for each choice occasion is known to the individual a priori (and that the individual would evaluate utility for the two scenarios under the assumption of utility maximization), the identical likelihood function would be produced.

3. Manski (1999) assumes that stated choices made when it may be impractical for scenarios to contain all information relevant to making some actual choice in the future (which is represented by the stochastic component in equation B-1) do represent respondents' "intentions." According to Manski (p. 62), under this assumption the individual "applies his or her subjective distribution of [the stochastic term] to form a subjective choice probability," and subsequently chooses between alternatives. This theory is adopted in our specification. He provides a formal, theoretical proof that under standard economic and econometric assumptions, the researcher can obtain consistent estimates of choice probabilities (that is, as the sample gets large, the estimated sample probability approaches the true population probability; see p. 59). Choice questions can be used not only to predict choice behavior for the scenarios presented, but also can be used to extrapolate to other feasible scenarios using familiar statistical methods, including the binary probit model (Section 3 in Manski).

4. In this notation, if the individual chooses alternative $K_{ij} = 1\,[\text{or } 2]$, then the alternative that was not chosen is $3 - K_{ij} = 2\,[\text{or } 1]$.

$$\begin{aligned} P_{ij}^{k_{ij}} &= \mathrm{P}(\beta_i' x_{ij}^{k_{ij}} + \varepsilon_{ij}^{k_{ij}} > \beta_i' x_{ij}^{3-k_{ij}} + \varepsilon_{ij}^{3-k_{ij}} \\ &= \mathrm{P}[\varepsilon_{ij}^{3\text{-}k_{ij}} - \varepsilon_{ij}^{k_{ij}} < -\beta_i' (x_{ij}^{3-k_{ij}} - x_{ij}^{k_{ij}})] \\ &= \Phi[-\beta_i' (x_{ij}^{3-k_{ij}} - x_{ij}^{k_{ij}}) / \sqrt{2}\sigma_\varepsilon], \end{aligned} \tag{B-3}$$

where $\sqrt{2}\sigma_\varepsilon$ is the standard deviation of $\varepsilon_{ij}^{3-k_{ij}} - \varepsilon_{ij}^{k_{ij}}$ and $\Phi(\cdot)$ is the univariate standard normal cumulative distribution function. This probability will enter into the likelihood function in Section B.3. The parameter vector β_i is identified only up to the scale factor $\sqrt{2}\sigma_\varepsilon$, and σ_ε is not identified, since only the sign and not the scale of the dependent variable (the utility difference) is observed.[5] Nevertheless, we have chosen to list the parameters of the likelihood function $(\beta, \sigma_\varepsilon)$ separately. Notice also the *J* observations for each respondent have simply been stacked to produce a data set with *Jm* observations.

B.3 The Likelihood Function

The maximum likelihood parameter estimates are consistent. They are also asymptotically efficient under the additional assumption that the $\varepsilon_{ij}^{k_{ij}}$ are uncorrelated across *j*. The likelihood function is a function of the probabilities of the preferred alternatives from the Green Bay pairs (Section B.2). The likelihood function is:

$$L(k_{ij}, i = 1,\ldots,m;\ j = 1,\ldots,J \mid x_{ij}^1, x_{ij}^2; \beta_i, \sigma_\varepsilon) = \prod_{i=1}^{m} \prod_{j=1}^{J} \mathrm{P}(K_{ij} = k_{ij})\,. \tag{B-4}$$

5. However, the scale factor can be allowed to vary across individuals or choice occasions as long as one scale is fixed for identification. Individuals or choice questions with smaller scales will receive less weight in the likelihood function in Section B-3, and will therefore have less influence on the estimation of parameters.

Appendix C — Survey with Means and Frequencies

WHAT ARE YOUR OPINIONS ABOUT THE FUTURE OF NATURAL RESOURCES IN NORTHEAST WISCONSIN?

Important Definition

In this survey "the Bay of Green Bay" means the waters of the Bay of Green Bay and all tributaries up to the first dam or obstruction.

Introduction

Decision makers are examining options for natural resources in northeast Wisconsin. Your responses to this survey will help in making decisions about which options are best.

1 **How often do <u>you</u> personally participate in each of the following activities in Wisconsin on the waters and shorelines of the <u>Bay of Green Bay</u>?** *Circle the letter of your answer for each activity.*

	N	Less than once a year or never	1 to 5 times a year	6 to 10 times a year	More than 10 times a year	Missing
Fishing	446	238	119	36	53	24
Boating (non-fishing)	431	250	132	29	20	39
Waterskiing or jetskiing . .	423	372	36	9	6	47
Canoeing or kayaking	423	363	42	13	5	47
Swimming	433	249	113	36	35	37
Hunting	432	312	59	22	39	39
Wildlife viewing	442	117	150	73	102	28
Enjoying outdoor scenery .	444	53	121	91	179	26
Camping or picnicking . . .	431	178	161	51	41	39
Biking	420	264	87	31	38	38
Hiking, walking, or jogging	438	145	116	66	111	32

This survey addresses four natural resource topics. The information provided reflects the most recent scientific reports about these topics.

- **Wetlands**
- **PCBs**
- **Outdoor recreation**
- **Runoff**

Wetlands

Within 5 miles of the Bay of Green Bay there are about 58,000 acres of wetlands in Wisconsin (see map on the facing page), and another 86,000 acres in Michigan. These nearby wetlands are very important to the fish and wildlife of the Bay of Green Bay.

- **Farming, cutting forests, and developing residential and urban areas have reduced wetlands in this area by more than half in the past 100 years.**
- **Current regulations are designed to prevent further loss of wetlands in this area.**
- **Programs have been proposed to restore wetlands in this area. Any wetlands restoration would take about 10 years.**

2 **Wetlands around the Bay of Green Bay provide spawning and nursery habitats for a majority of the fish species in the Bay, including yellow perch, bluegill, largemouth bass, northern pike, and over 35 other species. These wetlands also provide necessary habitat and food for many bird species in the Bay area, including terns, many species of ducks and geese, shorebirds, bald eagles, several species of hawks, coots, and others. Other wildlife such as deer, muskrat, and mink also use wetlands for habitat.**

Increases in wetlands would support nearly proportional increases in the populations of those bird and fish species that depend on wetlands. For example, increasing wetland acres by 10% would increase the numbers of those birds and fish that rely on wetlands by about 10%.

How important to you, if at all, is it to increase wetland acreage near to the Bay of Green Bay to support birds, fish, and other wildlife? *Circle the number of your answer.*

Not at all important		Somewhat important		Very important	Don't know	N Missing	N	Mean	Std. Dev.
25	26	101	110	198	8	2	460	3.93	1.67

3 **Which of the following options do you prefer for Wisconsin wetlands near to the Bay of Green Bay?** *Circle the number of your answer***.**

Category	Freq.
1 Do less and spend less to maintain wetlands, resulting in a loss of wetlands.	12
2 Do and spend about the same to maintain the current wetland acreage (about 58,000 acres).	192
3 Do more and spend more to restore wetlands. Options to restore wetlands range from restoring 2,900 acres (5% more than now) to restoring 11,600 acres (20% more than now).	257
Missing	9
Total	470

Wisconsin Wetlands Within 5 Miles of the Bay of Green Bay

PCBs

PCBs are substances that were used by industry until the mid-1970s, when they were banned.

- **PCBs released into the Lower Fox River have accumulated in the sediments at the bottom of the Lower Fox River and Green Bay.**
- **PCBs get into fish, birds, and other wildlife through the food chain.**

4 **Because of PCBs, consumption advisories have been issued for all sport-caught fish in Green Bay (including all tributaries up to the first dam) and for some waterfowl in the area. The fish consumption advisories tell how often a meal of fish may be safely eaten (see table on the facing page). Eating more fish than is recommended may increase a woman's risk of bearing children with learning disabilities and slow development, and for everyone may increase the risk of cancer.**

Programs have been proposed to remove PCBs in this area. How important to you, if at all, is it to remove PCBs so that it will be safe to eat fish and waterfowl? *Circle the number of your answer.*

Not at all important		Somewhat important		Very important	Don't know	N Missing	N	Mean	Std. Dev.
17	16	66	88	271	8	4	458	4.27	1.07

5 **PCBs cause harm to wildlife in and near the Bay of Green Bay.**

Birds **Forster's terns and common terns in the area reproduce at rates that are about half of the rate elsewhere in Wisconsin. Both are listed as Wisconsin endangered species.**

Bald eagles in the area also reproduce at about half the normal rate for Wisconsin. PCBs contribute to this problem. Bald eagles are no longer listed as endangered.

A small percentage of cormorants experience deformities such as crossed bills.

Fish **About 25% of walleye have abnormalities that can become cancerous liver tumors.**

Other Wildlife **Some sensitive fish-eating wildlife, like mink, may be harmed.**

Even though PCBs harm wildlife, it is unclear whether the total numbers of terns, eagles, cormorants, walleye, mink and other species in the area are less than if there were no PCBs. This is because wildlife migrates into and out of the area, because there is limited habitat in the area for some species, and because other factors influence wildlife populations.

How important to you, if at all, is it to remove PCBs in the Bay of Green Bay area to reduce harm to birds, fish, and other wildlife? *Circle the number of your answer.*

Not at all important		Somewhat important		Very important	Don't know	N Missing	N	Mean	Std. Dev.
13	17	69	93	270	6	2	462	4.28	1.03

6 **PCB removal would take about 10 years. Any PCB removal would use the best available technology to minimize stirring up PCBs, and the PCBs that are removed would be disposed of in a manner that would prevent future risks to humans and wildlife.**

Not all PCBs can be removed. The PCBs that are not removed may continue to harm some fish and wildlife. For example, with extensive PCB removal, fish consumption advisories for yellow perch and some impacts to wildlife would be eliminated shortly after PCB removal, but it would be 20 years total (10 years for removal plus 10 more years for nature to recover) before PCBs are at safe levels. By safe levels we mean there are no consumption advisories for, and no harm to, nearly all fish and wildlife.

Which of the following options do you prefer for PCBs in the Green Bay area of Wisconsin? *Circle the number of your answer.*

Category	Freq.
1 No further PCB investigations or removal. With no further removal it will be 100 years or more until PCBs are at safe levels.	77
2 Do more and spend more to remove PCBs. Depending on how many PCBs are removed, the time until PCBs are at safe levels would range from 20 years up to 70 years.	382
Missing	11
Total	470

Wisconsin Department of Natural Resources
Fish Consumption Advisories for PCBs

Wisconsin waters of Green Bay, including all tributaries up to the first dam
(PCB advisories in the Lower Fox River are the same or more restrictive)

Species	Eat no more than **One meal/week or 52 meals/year**	Eat no more than **One meal/month or 12 meals/year**	Eat no more than **One meal every two months or six meals/year**	**Do not eat**
Northern Pike	Less than 22"	Larger than 22"		
Walleye		Less than 17"	17-26"	Larger than 26"
Yellow Perch	All sizes			
Carp, White Bass, Sturgeon				All sizes
Smallmouth Bass, White Sucker, Rainbow Trout		All sizes		
Channel Catfish, White Perch, Whitefish			All sizes	
Chinook Salmon		Less than 30"	Larger than 30"	
Brown Trout		Less than 17"	17-28"	Larger than 28"

Outdoor Recreation

In 10 Wisconsin counties around the Bay of Green Bay, there are over 120 state parks, natural areas, and county parks covering more than 86,000 acres (see map on the facing page).

- **These parks include a variety of facilities such as picnic grounds, beaches, scenic sites, piers, boat ramps, biking and hiking trails, and interpretive centers.**
- **To meet the current and future needs of area residents, programs have been proposed to add facilities at existing parks and to open new parks.**

7 **Adding facilities at existing parks can improve recreational opportunities in these parks. For example, 10% more facilities would mean that most parks would see improvements. Some parks would add hiking or biking trails, some parks would add picnic areas, some parks would add a boat ramp, some parks would add adjacent land, and so forth.**

How important to you, if at all, is adding facilities at existing parks throughout the area to enhance recreational opportunities? *Circle the number of your answer.*

Not at all important		Somewhat important		Very important	Don't know	N Missing	N	Mean	Std. Dev.
22	43	168	103	131	3	0	467	3.60	1.13

8 **New parks can be opened throughout the area to increase recreational opportunities. How important to you, if at all, is opening new parks to enhance outdoor recreational opportunities?** *Circle the number of your answer.*

Not at all important		Somewhat important		Very important	Don't know	N Missing	N	Mean	Std. Dev.
41	76	156	90	103	4	0	466	3.30	1.23

9 **Any new facilities at existing parks, and any new parks, would be located throughout the area to best meet the needs of residents and would take up to 10 years to accomplish. Which of the following options do you prefer for state and county parks in northeast Wisconsin?** *Circle the number of your answer.*

Category	Freq.
1 Do less and spend less to maintain existing outdoor recreation parks.	9
2 Do and spend about the same to maintain existing park conditions and facilities.	239
3 Do more and spend more to add facilities at existing parks and/or to open new parks.	220
Missing	2
Total	470

State and County Recreation Areas

Runoff

Runoff from farms, highways, construction sites, and residential and urban neighborhoods carries plant nutrients and sediments into the Bay of Green Bay and its tributaries, causing algae growth, muddy water, and changes in aquatic habitat (see figure on the facing page).

- **Runoff pollution can be reduced by decreasing erosion; controlling farm, urban, and residential wastes; fencing livestock away from streams; and other measures.**
- **Zebra mussels (small shellfish) have invaded Green Bay. They filter the water, making it clearer. However, scientists say we <u>cannot</u> count on zebra mussels to improve water clarity in the future.**
- **Runoff is <u>not</u> a significant source of the PCBs in the Lower Fox River and Green Bay and does not affect the quality of your drinking water.**

10 **When too many plant nutrients are present, excess algae coats the surface of the water with decaying plants and causes a foul odor. The frequency of excess algae varies by location in the Bay of Green Bay from seldom in the central and northern Bay to up to 80 days a summer in the southern Bay. Most excess algae occurs from mid-June to mid-September.**

How important to you, if at all, is it to control runoff to reduce the number of days with excess algae in Green Bay? *Circle the number of your answer.*

Not at all important		Somewhat important		Very important	Don't know	N Missing	N	Mean	Std. Dev.
13	35	134	129	146	13	0	457	3.79	1.07

11 **Because of sediments and algae, you can only see down into the water about 20 inches on average in southern Green Bay, with clearer water to the north. This not only makes the water look less appealing but also reduces the light that reaches underwater plants and thus reduces aquatic habitat. Populations of desirable fish and birds are smaller and carp populations are larger than they would be otherwise, but scientists cannot yet put numbers on the vegetation and wildlife effects.**

How important to you, if at all, is it to control runoff to improve water clarity? *Circle the number of your answer.*

Not at all important		Somewhat important		Very important	Don't know	N Missing	N	Mean	Std. Dev.
7	29	116	134	175	9	0	461	3.96	1.01

12 **Any actions to reduce runoff would take up to 10 years to reach their goals. Which of the following options do you prefer for controlling runoff around the Bay of Green Bay?**
Circle the number of your answer.

Category	Freq.
1 1 Do less and spend less, resulting in reduced water clarity, increased days of excess algae, and less aquatic habitat in Green Bay and its tributaries.	7
2 Do and spend about the same. In the southern parts of Green Bay, average summer water clarity would remain about 20 inches, excess algae would occur up to 80 days a summer, and aquatic habitat would remain the same.	157
3 Do more and spend more to control runoff. Options range up to a 50% reduction in runoff. In the southern parts of Green Bay, this would result in about 34 inches of water clarity, excess algae up to 40 days per year, and increased aquatic habitat.	299
Missing	7
Total	470

Water Pollution from Runoff

What Alternatives Do You Prefer?

In each of the next questions there are two alternatives, labeled A and B (see Question 13).

- **Each alternative describes a possible combination of options for natural resources in and around the Bay of Green Bay and the additional costs to your household beyond what you are now paying.**
- **Depending on the options, some costs will be paid by industry, farmers, and conservation organizations. But taxpayers may have to pay something as well. Assume your household pays its share of any added costs through a combination of federal, state, and local taxes each year for the next 10 years.**
- **Since we do not yet know how much each alternative will actually cost you or others, we are asking about a range of costs.**
- **For each question, even if you do not view either Alternative A or B as ideal, still tell us which of the two alternatives you would prefer.**
- **To help you get started, for Question 13 we have provided information on the right-hand side indicating the differences, if any, between Alternatives A and B.**

REMEMBER

1. **The goal of wetlands restoration is to provide additional habitat for fish and wildlife.**
2. **For PCBs, the "years until safe" is the number of years until there are no consumption advisories for, and no harm to, nearly all fish and wildlife. Many advisories and effects will end sooner, but a few advisories and effects may last longer.**
3. **New recreation facilities at existing parks could include rest rooms, trails, boat ramps, and picnicking and camping facilities. Any new facilities at existing parks and any new parks would be located to best meet the needs of area residents.**
4. **Pollution from runoff creates excess algae, reduces water clarity, and causes the loss of aquatic habitat, all of which occur most often in the southern Bay.**

13 **If you had to choose, would you prefer Alternative A or Alternative B?** *Check one box at the bottom.*

	Alternative A ▼	Alternative B ▼
Wetlands Acres in Wisc. around Green Bay. (Currently 58,000)		
PCBs Years until safe for nearly all fish and wildlife . . . . (Currently 100 years or more)		
Outdoor Recreation Facilities at existing parks		
Acres in new parks. . . . . (Currently 86,000 acres in state and county parks)		
Runoff Average water clarity in southern Bay (Currently 20 inches)		
Excess algae (Currently up to 80 summer days in the southern Bay)		
Added cost to your household Each year for 10 years.		

Check (✓) the box for the alternative you prefer ➔

☐ **I Prefer Alternative A**

☐ **I Prefer Alternative B**

Q13	**Version**										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Alternative A	21	27	18	16	20	36	38	30	21	28	255
Alternative B	17	21	23	32	30	8	14	14	28	20	207
Neither A nor B	0	0	0	0	2	0	0	0	0	0	2
Don't Know	0	0	0	0	0	1	0	0	0	0	1
Missing	0	0	1	0	1	0	1	1	0	1	5
Total	38	48	42	48	53	45	53	45	49	49	470

14 If you had to choose, would you prefer Alternative A or Alternative B? *Check one box at the bottom.*

Q14	**Version**										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Alternative A	15	27	17	27	34	25	33	35	28	21	262
Alternative B	23	21	25	20	17	20	19	10	21	28	204
Neither A nor B	0	0	0	0	1	0	0	0	0	0	1
Missing	0	0	0	1	1	0	1	0	0	0	3
Total	38	48	42	48	53	45	53	45	49	49	470

15 If you had to choose, would you prefer Alternative A or Alternative B? *Check one box at the bottom.*

Q15	**Version**										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Alternative A	20	45	25	43	20	26	34	22	41	25	301
Alternative B	18	3	17	4	30	18	18	23	8	23	162
Neither A nor B	0	0	0	0	2	0	0	0	0	0	2
Don't Know	0	0	0	0	0	1	0	0	0	0	1
Missing	0	0	0	1	1	0	1	0	0	1	4
Total	38	48	42	48	53	45	53	45	49	49	470

16 If you had to choose, would you prefer Alternative A or Alternative B? *Check one box at the bottom.*

Q16	**Version**										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Alternative A	18	4	13	26	13	40	14	30	29	38	225
Alternative B	20	44	29	22	37	4	39	15	20	11	241
Neither A nor B	0	0	0	0	2	0	0	0	0	0	2
Don't Know	0	0	0	0	0	1	0	0	0	0	1
Missing	0	0	0	0	1	0	0	0	0	0	1
Total	38	48	42	48	53	45	53	45	49	49	470

17 If you had to choose, would you prefer Alternative A or Alternative B? *Check one box at the bottom.*

Q17	**Version**										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Alternative A	27	33	36	10	23	16	26	32	37	44	284
Alternative B	11	15	6	38	27	28	27	13	12	4	181
Neither A nor B	0	0	0	0	2	0	0	0	0	0	2
Don't Know	0	0	0	0	0	1	0	0	0	0	1
Missing	0	0	0	0	1	0	0	0	0	1	2
Total	38	48	42	48	53	45	53	45	49	49	470

18 If you had to choose, would you prefer Alternative A or Alternative B? *Check one box at the bottom.*

Q18	Version										
	1	2	3	4	5	6	7	8	9	10	Total
Alternative A	19	41	12	30	16	22	18	33	30	30	251
Alternative B	18	6	30	18	33	22	35	12	19	18	211
Neither A nor B	0	0	0	0	2	0	0	0	0	0	2
Don't Know	0	0	0	0	0	1	0	0	0	0	1
Missing	1	1	0	0	2	0	0	0	0	1	5
Total	38	48	42	48	53	45	53	45	49	49	470

19 **When you were making your choices between alternatives A and B in Questions 13 through 18, how important were each of the following?** *Circle the number of your answer for each item.*

	Not at all important		Average importance		Very important	N Missing	N	Mean	Std. Dev.
Acres of wetland	36	58	189	91	94	2	468	3.32	1.15
Years until safe levels of PCBs	17	37	123	110	181	2	468	3.86	1.13
Facilities at existing parks	43	78	173	113	57	6	464	3.14	1.12
Acres of new parks	68	107	154	87	50	4	466	2.88	1.19
Inches of water clarity	22	53	164	138	88	5	465	3.47	1.07
Days of excess algae each summer.	32	66	170	113	86	3	467	3.33	1.13
Annual cost to your household	15	49	135	99	168	4	466	3.76	1.14

20 **Overall, how confident do you feel about your choices between the alternatives in Questions 13 through 18?** *Circle the number of your answer.*

Not at all confident		Somewhat confident		Very confident	N Missing	Don't know	N	Mean	Std. Dev.
6	23	188	178	73	2	0	468	3.62	0.85

21 **Questions 13 through 18 were asked to provide citizen input for decision makers to consider along with other information from scientists and planners. With this in mind, how much should public officials consider <u>your responses</u> to Questions 13 through 18?** *Circle the number of your answer.*

Should not consider my responses at all		Should somewhat consider my responses		Should completely consider my responses	Don't know	N Missing	N	Mean	Std. Dev.
3	16	128	185	136	0	2	468	3.93	0.87

22 **Prior to receiving this survey, how aware were you of each of the four natural resource topics we addressed?** *Circle the number of your answer for each topic.*

	I was not aware of this topic		I was somewhat aware of this topic		I was very aware of this topic	Don't know	N Missing	N	Mean	Std. Dev.
Wetlands	41	46	172	116	94	0	1	469	3.38	1.17
PCBs	20	12	102	137	191	0	8	462	4.01	1.06
Outdoor recreation .	30	59	165	119	91	0	6	464	3.39	1.13
Runoff	37	51	141	129	106	0	6	464	3.47	1.19

About You and Your Household

This information is used to help group your responses with responses of other households. Your individual responses and your name will not be released.

23 **In the last 12 months, have you fished in Green Bay or its tributaries up to the first dam (see map on the cover)?** *Circle the number of your answer.*

1 No	326.		
(If no) in the last 12 months, have *other* household members fished in Green Bay or its tributaries up to the first dam? *Circle the number of your answer.*		1 No	281
		2 Yes	22
		3 Don't know/Uncertain	16
		Missing	7
		Total	326
2 Yes	143		
(If yes) in the last 12 months, on about how many days have you fished in Green Bay or its tributaries up to the first dam? _______ Days		N	143
		Mean	10.50
		Std. Dev	13.67
		Median	7
Missing	1		
Total	470		

Frequencies for Question 23 Part 2 " about how many days have you fished in Green Bay or its tributaries up to the first dam?"

Days	Frequency	Cumulative Frequency	Cumulative Percent
1	10	10	6.99
2	18	28	19.58
3	18	46	32.17
4	10	56	39.16
5	13	69	48.25
6	11	80	55.94
7	6	86	60.14
8	5	91	63.64
10	14	105	73.43
12	5	110	76.92
15	6	116	81.12
16	1	117	81.82
20	12	129	90.21
23	1	130	90.91
24	1	131	91.61
25	1	132	92.31
30	4	136	95.10
40	2	138	96.50
50	2	140	97.90
60	1	141	98.60
70	1	142	99.30
100	1	143	100.00

24 **Do you own or rent your residence?** *Circle the number of your answer.*

Own	395
Rent	73
Missing	2
Total	470

25 **Do you have a vacation home or cabin in northeast Wisconsin?** *Circle the number of your answer.*

1 Yes	85		
(If yes) about how many miles is it from your vacation home or cabin to the Bay of Green Bay? _______ Miles to Green Bay		N Mean Std. Dev. Median	84 63.91 35.43 65
2 No	377		
Missing	8		
Total	470		

Frequencies for Question 25 - Part 2 "(If yes) about how many miles is it from your vacation home or cabin to the Bay of Green Bay? "

Miles	Frequency	Cumulative Frequency	Cumulative Percent
1	5	5	5.88
6	1	6	7.06
8	1	7	8.24
10	3	10	11.76
15	2	12	14.12
29	1	13	15.29
30	2	15	17.65
35	1	16	18.82
36	1	17	20.00
40	7	24	28.24
45	4	28	32.94
50	6	34	40.00
60	6	40	47.06
64	1	41	48.24
65	5	46	54.12
69	1	47	55.29
70	5	52	61.18
75	4	56	65.88
80	7	63	74.12
90	2	65	76.47
100	12	77	90.59
110	2	79	92.94
125	2	81	95.29
130	1	82	96.47
135	1	83	97.65
140	1	84	98.82
150	1	85	100.00

26 **Your gender:**

Female	135
Male	335
Missing	0
Total	470

27 **Your age:** ______ Years old

Mean	50.92
Std. Dev.	15.85
N	470
Missing	0

Frequencies or responses to Age Question

Age (Years)	Frequency	Cumulative Frequency	Cumulative Percent
21	2	2	0.43
22	6	8	1.70
23	4	12	2.55
24	2	14	2.98
25	3	17	3.62
27	4	21	4.47
28	6	27	5.74
29	6	33	7.02
30	2	35	7.45
31	6	41	8.72
32	2	43	9.15
33	11	54	11.49
34	14	68	14.47
35	8	76	16.17
36	16	92	19.57
37	11	103	21.91
38	18	121	25.74
39	6	127	27.02
40	17	144	30.64
41	9	153	32.55
42	11	164	34.89
43	9	173	36.81
44	18	191	40.64
45	12	203	43.19
46	8	211	44.89
47	8	219	46.60
48	9	228	48.51
49	11	239	50.85
50	12	251	53.40
51	9	260	55.32

Age (Years)	Frequency	Cumulative Frequency	Cumulative Percent
52	11	271	57.66
53	10	281	59.79
54	8	289	61.49
55	11	300	63.83
56	8	308	65.53
57	8	316	67.23
58	7	323	68.72
59	9	332	70.64
60	9	341	72.55
61	8	349	74.26
62	11	360	76.60
63	9	369	78.51
64	5	374	79.57
65	6	380	80.85
66	6	386	82.13
67	3	389	82.77
68	7	396	84.26
69	7	403	85.74
70	7	410	87.23
71	4	414	88.09
72	5	419	89.15
73	3	422	89.79
74	4	426	90.64
75	3	429	91.28
76	1	430	91.49
77	7	437	92.98
78	4	441	93.83
79	2	443	94.26
80	5	448	95.32
81	3	451	95.96
82	5	456	97.02
83	3	459	97.66
84	1	460	97.87
85	1	461	98.09
86	3	464	98.72
87	2	466	99.15
89	1	467	99.36
91	1	468	99.57
96	1	469	99.79
99	1	470	100.00

28 How many people are there in your household, including yourself?

N	468
Mean	2.68
Std. Dev.	1.34
Missing	2

29 How many children do you have, whether living with you or not?

N	467
Mean	2.28
Std. Dev.	1.78
Missing	3

30 How many grandchildren do you have, whether living with you or not?

N	464
Mean	1.99
Std. Dev.	3.82
Missing	6

31 How many listed telephone numbers does your household have?

N	465
Mean	1.13
Std. Dev.	0.44
Missing	5

Frequencies for Question 28 - Number of People in Household

Number	Frequency	Cumulative Frequency	Cumulative Percent
0	2	2	0.43
1	79	81	17.31
2	186	267	57.05
3	67	334	71.37
4	85	419	89.53
5	34	453	96.79
6	13	466	99.57
7	2	468	100.00

Frequencies for Question 29 - Number of Children

Number	Frequency	Cumulative Frequency	Cumulative Percent
0	79	79	16.92
1	71	150	32.12
2	140	290	62.10
3	87	377	80.73
4	49	426	91.22
5	19	445	95.29
6	10	455	97.43
7	5	460	98.50
8	3	463	99.14
9	2	465	99.57
10	1	466	99.79
13	1	467	100.00

Frequencies for Question 30 - Number of Grandchildren

Number	Frequency	Cumulative Frequency	Cumulative Percent
0	286	286	61.64
1	36	322	69.40
2	28	350	75.43
3	20	370	79.74
4	15	385	82.97
5	18	403	86.85
6	11	414	89.22
7	9	423	91.16
8	7	430	92.67
9	6	436	93.97
10	5	441	95.04
11	5	446	96.12
12	4	450	96.98
13	1	451	97.20
14	4	455	98.06
15	3	458	98.71
16	2	460	99.14
17	2	462	99.57
18	1	463	99.78
33	1	464	100.00

Frequencies for Question 31 - Number of Listed Telephones in Household

Number	Frequency	Cumulative Frequency	Cumulative Percent
0	4	4	0.86
1	407	411	88.39
2	44	455	97.85
3	8	463	99.57
4	2	465	100.00

32 **What is the highest level of schooling you have completed?** *Circle the number of your answer*.

	Frequency
Did not complete high school	24
High school diploma or equivalent	179
Some college, two year college degree (AS) or technical school	149
Four year college graduate (BA, BS)	58
Some graduate work but did not receive a graduate degree	20
Graduate degree (MA, MS, MBA, PhD, JD, MD, etc.)	36
Missing	4
Total	470

33 **What is you present employment status?** *Circle the number of your answer.*

	Frequency
Employed full time	460
Employed part time	1
Retired	1
Homemaker	2
Student	4
Unemployed	0
Missing	2
Total	470

34 **Which of the following categories best describes your racial or ethnic background?** *Circle the number of your answer.*

	Frequency
White or Caucasian	460
Black or African American	1
Hispanic or Mexican American	1
Asian or Pacific Islander	2
Native American Indian	4
Other: __________	0
Missing	2
Total	470

35 **What was your household income (before taxes) in 1998?** *Circle the number of your answer.*

	Frequency
less than $10,000	20
$10,000 to $19,999	53
$20,000 to $29,999	58
$30,000 to $39,999	70
$40,000 to $49,999	65
$50,000 to $59,999	48
$60,000 to $79,999	74
$80,000 to $99,999	28
$100,000 to $149,999	17
$150,000 or more	15
Missing	22
Total	470

36 **Is there anything we have overlooked? Please use this space for any additional comments you would like to make.**

	Frequency
No comment	344
Made a comment	126
Total	470

County of respondent

County	Frequency
Brown	214
Calumet	13
Door	20
Kewaunee	17
Manitowoc	25
Marinette	33
Oconto	32
Outagamie	52
Shawano	13
Winnebago	51
Total	470

MAIL_RET - Dates of survey return

Date Code	Frequency	Cumulative Frequency	Cumulative Percent
1-Nov-99	2	2	0.43
1-Oct-99	7	9	1.91
3-Nov-99	2	11	2.34
3-Oct-99	1	12	2.55
4-Oct-99	4	16	3.4
5-Oct-99	2	18	3.83
7-Oct-99	1	19	4.04
8-Oct-99	7	26	5.53
13-Oct-99	13	39	8.3
14-Oct-99	20	59	12.55
14-Sep-99	65	124	26.38
15-Sep-99	30	154	32.77
16-Sep-99	53	207	44.04
17-Oct-99	16	223	47.45
17-Sep-99	30	253	53.83
18-Oct-99	16	269	57.23
19-Oct-99	11	280	59.57
20-Oct-99	9	289	61.49
20-Sep-99	73	362	77.02
21-Oct-99	2	364	77.45
21-Sep-99	24	388	82.55
22-Oct-99	1	389	82.77
22-Sep-99	23	412	87.66
23-Sep-99	6	418	88.94
24-Sep-99	16	434	92.34
25-Oct-99	2	436	92.77
26-Oct-99	1	437	92.98
27-Oct-99	1	438	93.19
27-Sep-99	18	456	97.02
28-Oct-99	2	458	97.45
28-Sep-99	2	460	97.87
29-Oct-99	1	461	98.09
29-Sep-99	5	466	99.15
30-Sep-99	4	470	100

Your Participation Is Greatly Appreciated!

Please return the survey in the enclosed envelope to:

Hagler Bailly Services
University Research Park
455 Science Drive
Madison, Wisconsin 53711

Appendix D — Existing Literature

Several studies have been conducted in the Great Lakes basin, and for Green Bay in particular, addressing the importance and value of environmental resources to the general public. While none of this literature is exactly applicable to the objective of selecting and scaling restoration options and/or valuing all of the specific injuries in this case, the literature shows considerable consistency in that residents are aware of, concerned about, and place a high priority and value on cleaning up contaminated water resources.

Breffle et al. (1999). In a related study to this one, Breffle et al. (1999) estimate damages to current Green Bay recreational anglers from the presence of fish consumption advisories by combining stated preference (SP) choice-pair data on different Green Bay alternatives with SP and revealed preference frequency data on current use and use under various conditions. Using variation on a probit model, it is estimated that anglers would be willing to pay $9.75 more per Green Bay fishing day if FCAs were removed, and $4.17 per existing fishing day to all sites for the option of choosing a Green Bay without FCAs. The study also estimates values for improved catch rates, and how anglers would trade off catch rates for FCAs. Aggregate recreational fishing damages for all **Wisconsin and Michigan** waters of Green Bay from 1980 until FCAs are removed range from $106 million with intensive remediation (FCAs totally removed by 2020) to $148 million with no remediation (all FCAs in place for over 100 years).[1] These damages do not include damages to non-anglers who would fish in the absence of injuries, or to other individuals who do or do not participate in other types of recreation.

Stoll (2000a and 2000b). Stoll (2000a,b) reports results from a 1997 repeat mail survey of the general population conducted to estimate benefits of contaminated sediment remediation in the Fox-Wolf River basin, which contains the Fox River and the entire Green Bay watershed and Area of Concern (21 square miles of lower Green Bay). As reported in an earlier presentation of survey results, the survey was administered to a stratified random sample of 1,500 individuals, 55% in contiguous counties and the rest in other Wisconsin counties (Stoll, 1997). The proportion of respondents reporting that they are “somewhat” or “very” worried about human health concerns from fish consumption is 60%.

Using a double-bounded referendum contingent valuation method (CVM), Stoll estimates total active and passive use benefits from the improvement of water quality within the Area of Concern in congruence with programs envisioned in the 1988 Lower Green Bay Remedial Action Plan (RAP). The basic goals of the Green Bay RAP, based on its Key Action Items, include (Baba et al., 1991; Stoll, 2000b):

1. Breffle et al. (1999) summarize other relevant fishing studies, which generally provide comparable findings that FCAs are significantly adverse to recreational fishing.

- impose greater pollution controls on industry
- provide more public education about water quality issues
- do more to protect wetlands and marshes
- conduct more basic research on water quality
- make sure that harbor dredging does not make the water quality worse
- encourage farmers to use better soil conservation practices
- require much more treatment of municipal wastes
- remove toxins from bottom sediments
- restore swimming and an edible fishery
- provide suitable habitat for enhancing and sustaining a diversity of wildlife
- establish a self-sustaining, balance, and diversified, edible fish community
- improve the water quality and trophic state of the area to relieve ecological stresses
- achieve and maintain water quality that protects the ecosystem from toxic substances
- ensure sustainability of a restored and healthy environment through pollution prevention.

The results show that 70% of households would be willing to pay $10 every year for the removal of contaminated sediments, and 21% would pay at least $1,500 each year (Stoll, 1997). The adjusted mean value of remediation benefits for 100% actualization of RAP projects is $222 per household per year every year (in 1997 dollars), using a logistic function with a truncation at $300 (Stoll, 2000b). Most values fall generally in the range of $100 to $300. This survey addresses environmental problems much broader than the PCB contamination addressed in this study (e.g., the study also addresses dissolved oxygen and temperature), and the study area is much bigger than the Green Bay NRDA assessment area. It is not possible to scale Stoll's values to values that would be just for PCB restoration with the current information, although a significant portion of the value would be expected to be attributable to PCBs, based on the expressed concerns about FCAs in his work (and in the preference for PCB removal in this TVE study).

Another approach to making remediation decisions by considering costs relative to benefits was also presented by Stoll (2000a). Based upon an estimate of $700 million for remediation activities, if remediation costs were borne entirely by Fox River Basin counties, the estimated per household cost would be $167 per year for 30 years. This amount is commensurate with (or less than, considering the finite time frame for incurring costs) remediation benefits estimates typically ranging from $100 to $300 annually indefinitely into the future, with a mean of $222, as reported in Stoll (2000b).

Johnsen et al. (1992). An earlier study also examined public perceptions and attitudes toward environmental rehabilitation of the lower Green Bay watershed and the same Green Bay RAP. Johnsen et al. (1992) is the published article based on the initial report, Baba et al. (1991). The two documents contain different information. Johnsen et al. (1992) report wide public support for items in the RAP. In 1990, over 700 members of Brown County households (which contains the lower Fox River and its mouth), plus a small sample of recreationists to augment the original sample, were interviewed by telephone and asked 71 questions about recreational use, perceptions about water quality and water quality requirements for recreation, and willingness to pay to implement the RAP. Two-thirds of the sample had used the Area of Concern for recreational purposes in the previous year. On a 1-to-10 scale (from worst possible water quality to best), the mean perception of water quality in the lower bay near the mouth of the Fox River was 3.95, and the perceptions of water quality were far below what was considered appropriate for recreation (e.g., 8.05 was the rating associated with "game fish could live in it"). Each of the RAP goals was supported by at least 72% of respondents, and considered important by at least 75% of respondents.

The study also reports a lower-bound mean willingness to pay for implementation of the RAP of $34.08 per household per year every year (in 1990 dollars), although respondents felt that industries polluting the water, as well as recreationists, should help pay to improve water quality (Johnsen et al., 1992). WTP did not differ significantly between recreational users and nonusers. WTP estimates for lower resource quality than the RAP projects would yield (e.g., swimmable water with edible fish) were somewhat lower, ranging from $20.32 to $21.80 (Baba et al., 1991). The primary motivations to pay for resource improvements were for recreational opportunities and a cleaner environment.

Several study design features may be causing WTP values to be considerably lower in this study than the values reported by Stoll (1997 and 2000b). First, this study used a telephone survey format and presented very limited information on the injuries and benefits from remediation; Stoll's mail survey presented more comprehensive and detailed information, making it easier to assess the benefits of the RAP program. Second, this study was conducted seven years earlier than the Stoll study; only 21.8% of respondents had heard of the RAP prior to the survey. Finally, the range of presented values in the iterative referendum format may have been improperly truncated in this study (see Rowe et al., 1996): the highest value was $200, whereas values in the Stoll survey went up to $3,000. Stoll (2000b) reports the mean value for the RAP is higher than the highest value presented in this study ($222). Note that neither of these studies estimate how individuals would be willing to tradeoff different resource improvements.

St. Norbert College Survey Center (1999). An October 1999 news article (Campbell, 1999), based on a 1999 Fox River public opinion survey (St. Norbert College Survey Center, 1999), sums up the current attitudes about health concerns in the Fox River of nearby Brown County residents. The majority of individuals are displeased with the water quality in the Fox River; 38% rate the water quality as "poor," and 34% rate it as "not too good." Almost two-thirds report that they are "somewhat" or "very" concerned with the health effects of the Fox River, and that the paper mills should pay for the cleanup of the Fox River rather than the government. This survey was conducted only with individuals living in Brown County. Other studies confirm that individuals living farther away are also concerned about water quality in the Fox River basin and Green Bay (Breffle et al., 1999; Stoll, 2000b).

Other Studies. Other studies focus on Great Lakes areas outside of the NRDA assessment area. Katz and Schuler (1995) survey public knowledge and opinions about Great Lakes issues in general. Generally, respondents report that water quality is only fair overall. They also report wanting more to be done to reduce pollution harmful to people (93%) and to reduce pollution harmful to fish and wildlife (91%). There is significant concern even by respondents who live at distances over 100 miles from the site, and by individuals living outside of the Great Lakes basin.

Finally, a study was done to learn about environmental awareness and attitudes about Lake Erie and the Ashtabula River by surveying random samples of Ashtabula County voters in Ohio (Lichtkoppler and Blaine, 1999). Part of the contamination in Lake Erie is due to PCBs from the Ashtabula River. The survey and WTP question in particular note that three other rivers (Cuyahoga, Black, and Maumee) are sources of contamination to Lake Erie. While findings from this study are not directly applicable to the Green Bay assessment, the two sites are roughly comparable, and similar attitudes might be expected of Green Bay area residents as reported in the Lichtkoppler and Blaine (1999) study.

In general, respondents attach high levels of importance to improving water quality, and they are moderately aware of pollution problems. Out of 15 environmental issues related to Lake Erie and the Ashtabula River, the three most important were improving water quality in the lake, reducing contaminants in the river, and improving water quality in the river and harbor area. On a 1-to-6 scale (from not important to very important), each of these on average rated higher than 5.5. A higher awareness of contamination issues was significantly correlated with higher importance ratings as well, and higher WTP.

An iterative referendum CVM question for the dredging and disposal of contaminated sediment in the Ashtabula River and Harbor was asked to assess monetary value. In the WTP question, it is stated that the dredging will address the following five issues caused by contamination in the lower Ashtabula River and Harbor areas:

- restrictions on consuming fish from the Ashtabula River and Harbor
- degraded fish and wildlife populations and habitat
- restrictions on dredging that jeopardize commercial and recreational boating
- fish with tumors and other deformities
- diminished quality of bottom habitat in the river.

The lower bound mean estimate of WTP is $32.50 per household per year for 30 years (in 1996 dollars),[2] and value was significantly correlated with resource awareness and recreational use (and other individual characteristics), suggesting that those individual characteristics may be important determinants of preferences in the current study. Note the WTP question describes the benefits of dredging associated with the river only; it does not discuss any water quality improvements to Lake Erie. Also, the range of values presented in the referenda may again be truncated: the highest listed value is $200, although the respondent could report “more than $200” and write in a value.

2. For comparison with results of other studies, the present value of 30 years of payments of $32.50/year, at a 3% discount rate, is approximately $650.

Appendix B — Co-Trustee Coordination Activities

I. Formal public comment periods on Co-trustee assessment plans and addenda (http://www.fws.gov/r3pao/nrda).

1. August 1996. Thirty-day public comment period for review of the Co-trustees' Assessment Plan (61 Fed. Reg. 43,558).

2. October 1997. Thirty-day public comment period for review of the Co-trustees' Assessment Plan Addendum #1 (62 Fed. Reg. 67,888).

3. September 1998. Thirty-day public comment period for review of the Co-trustees' Assessment Plan #2 (63 Fed. Reg. 50,254).

4. May 2000. Thirty-day public comment period for review of the Co-trustees' Assessment Plan #3 (65 Fed. Reg. 33823).

5. October 2000. Forty five-day public comment period for review of this final Restoration and Compensation Determination Plan.

II. Formal public meetings on final published Co-trustee NRDA determinations (http://www.fws.gov/r3pao/nrda).

1. December 10, 1998. Public presentation of November 24, 1998 "Fish Consumption Advisories in the Lower Fox River/Green Bay Assessment Area."

2. May 10, 1999. Public presentation of May 7, 1999 "Injuries to Avian Resources, Lower Fox River/Green Bay Natural Resource Damage Assessment."

3. August 30, 1999. Public presentation of August 30, 1999 "PCB Pathway Determination for the Lower Fox River/Green Bay Natural Resource Damage Assessment."

4. November 8, 1999. Public presentation of November 1, 1999 "Recreational Fishing Damages from Fish Consumption Advisories in the Waters of Green Bay," November 8, 1999 "Injuries to Fishery Resources, Lower Fox River/Green Bay Natural Resource Damage Assessment," and November 8, 1999 "Injuries to Surface Water Resources, Lower Fox River/Green Bay Natural Resource Damage Assessment."

5. October 2000. Public presentation of this final Restoration and Compensation Determination Plan.

III. Other public presentations made by the Co-trustees.

1. December 2, 1992. EPA workshop on dredged material, Chicago, IL. Presentation on the NRDA program and potential applicability at sites like Fox River/Green Bay.

2. March 12, 1993. The Wildlife Society, State Chapter annual meeting, Madison, WI. Presentation on the NRDA program and potential applicability at sites like Fox River/Green Bay.

3. March 24, 1993. The Society for Environmental Toxicology and Chemistry, Midwest Chapter annual meeting, Twin Cities, MN. Presentation on the NRDA program and potential applicability at sites like Fox River/Green Bay.

4. September 29, 1993. Oneida Conservation Department seminar on NRDA for Tribes. Presentation on the NRDA program and potential applicability at sites like Fox River/Green Bay.

5. March 15, 1994. EPA Great Lakes seminar, Chicago, IL. Presentation on the NRDA program and potential applicability at sites like Fox River/Green Bay.

6. March 24, 1994. Fox River Coalition monthly meeting. Presentation on the launching of the Green Bay NRDA.

7. July 21, 1994. Menominee Tribal Legislature meeting. Presentation on the launching of the Green Bay NRDA.

8. August 23, 1994. White House ecosystem management fact-finding public meeting, Chicago, IL. Presentation on the applicability of the NRDA program and the Green Bay NRDA to ecosystem management.

9. November 28, 1994. Meeting with National Wildlife Federation, Ann Arbor, MI. Discussion of the Fox River/Green Bay NRDA.

10. February 21, 1995. Meeting with Fox-Wolf 2000 and the Lake Michigan Federation to answer questions about the Fox River/Green Bay NRDA.

11. March 2, 1995. Green Bay Harbor Commission monthly meeting, Green Bay, WI. Presentation on the launching of the Green Bay NRDA.

12. April 20, 1995. Meeting between the Office of the Secretary and representatives of the Oneida, the Lake Michigan Federation, and the Clean Water Action Council of Northeast Wisconsin to discuss the Green Bay NRDA.

13. September 12, 1995. Public meeting sponsored by the Clean Water Action Council and the Sierra Club on the Green Bay NRDA, Green Bay, WI. Presentation of the NRDA process and site-specific data and analyses.

14. September 13, 1995. Public meeting sponsored by the Clean Water Action Council and the Sierra Club on the Green Bay NRDA, Appleton, WI. Presentation of the NRDA process and site-specific data and analyses.

15. May 20, 1997. Congressman Jay Johnson public meeting on the Green Bay NRDA. Presentation of existing data and analyses being used in the Green Bay NRDA.

16. May 21, 1997. Co-trustee public meeting on existing data and analyses being used in the Green Bay NRDA.

17. April 14, 1998. Green Bay Chamber of Commerce “Leadership Green Bay” environmental day, Green Bay, WI. Presentation on the key elements of the Green Bay NRDA.

18. May 1, 1998. Wisconsin Academy of Arts and Letters annual symposium, De Pere, WI. Presentation on history of investigations in Green Bay leading to the Green Bay NRDA.

19. July 9, 1998. U.S. Coast Guard Spill Response Committee, Port Washington, WI. Presentation on the Green Bay NRDA.

20. July 27, 1998. Public meeting sponsored by the EPA featuring Theo Colburn, Appleton, WI. Presentation on ecological injuries and risks.

21. September 1, 1998. Co-trustee public meeting on risks, injuries, and damages affecting Door County, Fish Creek, WI.

22. September 24, 1998. Appleton League of Women Voters public meeting on Fox River cleanup and restoration, Menasha, WI. Presentation on the Green Bay NRDA.

23. October 20, 1998. Appleton Rotary monthly meeting. Presentation on the Green Bay NRDA and why CERCLA liability makes sense for the private sector.

24. October 27, 1998. Oconto Falls High School Science Class, Oconto Falls, WI. Presentation on how science is used to decide how to fix the river and bay.

25. September 23, 1999. American Chemical Society, Green Bay Chapter monthly meeting, Green Bay, WI. Presentation on the Intergovernmental Partnership, the Green Bay NRDA, and the PCB release and pathway evidence.

26. September 24, 1999. International Joint Commission, Science Advisory Board public meeting, Milwaukee, WI. Presentation on how NRDA can achieve RAP, LaMP, and IJC goals, with the Green Bay NRDA as an example.

27. September 28, 1999. National Academy of Science, River Dredging Committee public meeting, Green Bay, WI. Presentation on the Intergovernmental Partnership, the Green Bay NRDA, and the PCB release and pathway evidence.

28. November 18, 1999. Green Bay Harbor Commission monthly meeting, Green Bay, WI. Review of recent Green Bay NRDA findings.

29. January 19, 2000. Intergovernmental Partnership meeting with local officials, Green Bay, WI. NRDA presentation at Superfund workshop.

30. February 3, 2000. Participation in PCB fate and transport modeling peer review by the American Geological Institute (sponsored by the Fox River Group of paper mills), Green Bay, WI.

31. February 23, 2000. Presentation of the restoration planning process to The Nature Conservancy of Door County, Sturgeon Bay, WI.

32. February 24, 2000. Presentation of the restoration planning process to the Clean Water Action Council Board, Green Bay, WI.

33. March 13, 2000. Presentation of the restoration planning process to the Brown County Conservation Alliance, Green Bay, WI.

34. March 14, 2000. Presentation of the restoration planning process to the Green Bay Remedial Action Plan, Science and Technical Advisory Committee, Green Bay, WI.

35. April 7, 2000. Presentation of restoration planning details to the Green Bay Remedial Action Plan, Science and Technical Advisory Committee, Green Bay, WI.

36. April 11-14, 2000. Participation in Door County habitat prioritization discussions with Door County constituents, Baileys Harbor, WI. Hosted by The Nature Conservancy.

37. May 4, 2000. Presentation of typical NRDA arguments made by responsible parties, and the pitfalls of claim splitting, at the Hudson River, NY and Fox River, WI PCB contaminated sediment workshop, Madison, WI. Sponsored by the WI and NY Attorneys General.

38. May 10, 2000. Participation in Northeast Wisconsin land protection prioritization discussions with Northeast Wisconsin constituents, Menasha, WI. Hosted by the Northeast Wisconsin Land Trust.

39. May 16, 2000. Participation in risk assessment peer review by the Association for Ecological Health of Soils (sponsored by the Fox River Group of paper mills), Neenah, WI.

40. June 2, 2000. Presentation of initial wetland restoration analyses and approaches to the Green Bay Remedial Action Plan, Science and Technical Advisory Committee, Green Bay, WI.

41. July 7, 2000. Presentation of initial nonpoint source restoration analyses and approaches to the Green Bay Remedial Action Plan, Science and Technical Advisory Committee, Green Bay, WI.

42. August 4, 2000. Presentation of draft restoration results and identification of issues to the Green Bay Remedial Action Plan, Science and Technical Advisory Committee, Green Bay, WI.

43. August 31, 2000. Discussion with Northeast Wisconsin Land Trust Board members of potential restoration programs in Northeast Wisconsin which could result from natural resource damages settlements.

44. September 14, 2000. Presentation of draft wetlands and nonpoint source reports to the Green Bay Remedial Action Plan, Science and Technical Advisory Committee, Green Bay, WI.

Appendix C — List of Potential Restoration Projects

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Conduct shoreline beautification projects along lower Fox River: increase green space and retrofit bulkhead lines into green natural shoreline.		Lower Fox River														X		
Establish a fund to provide an annual conservation project source for a core group of seven County Land Conservation Departments (LCDs) within the Lower Fox River/Green Bay drainage area. A longevity of 20 years and focus on habitat restoration and protection.	Brown, Door, Kewaunee, Marinette, Oconto, Outagamie, Shawano (WI)	Lower Fox River/Green Bay watershed																
Establish vegetated areas immediately adjacent to intermittent or perennial streams that function as a filter to decay, absorb, or purify contaminated runoff before it enters watershed streams.	Brown, Outagamie (WI)	Lower Fox River/Green Bay watershed	X															
Identify critical streambank sites and establish vegetative shoreline erosion control using emergent aquatic vegetation along with protection of sites to improve the health of the entire stream corridor system.	Brown, Outagamie (WI)	Lower Fox River/Green Bay watershed	X							X								
Protect headwater wetlands and riparian buffer zones (through purchase or easement throughout the Fox-Wolf Basin to preserve remaining shoreland/floodplain habitats, reduce non point source pollution and reduce flood damage.		Green Bay	X							X								
Purchase easements or property along the Ashwaubenon Creek floodplain to create a parkway, preserve habitat, reduce nonpoint source pollution, and provide a recreational trail.	Brown (WI)	Ashwaubenon Creek floodplain	X							X						X		
Enact buffer and riparian area initiative.	Oconto County (WI)		X															
Develop a prairie habitat in Fonferek Glen park to control nonpoint source pollutant loadings from adjoining agricultural lands. Would control contaminant levels in the East and ultimately Fox Rivers.	Brown (WI)	Fonferek Glen Park														X		
Implement nonpoint source pollution controls (targeting phosphorous loading and suspended sediments) for the East River and Duck Creek watersheds. Five components for a complete program presented with Buffer Strips listed as the highest priority component.	Brown (WI)	East River and Duck Creek watersheds	X															
Implement nonpoint source pollution controls (targeting phosphorous loading and suspended sediments) for the East River and Duck Creek watersheds. Components include Buffer Strips and wetland retention basins among others.		East River and Duck Creek watersheds	X					X										
Protect and enhance the Trout Creek subwatershed.	Oneida Nation Reservation	Trout Creek - Duck Creek Waterway	X							X								

Project Description	Project Category: Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Conduct shoreline beautification projects along lower Fox River: increase green space and retrofit bulkhead lines into green natural shoreline.									P	P	NFP table 10/21/97			1997
Establish a fund to provide an annual conservation project source for a core group of seven County Land Conservation Departments (LCDs) within the Lower Fox River/Green Bay drainage area. A longevity of 20 years and focus on habitat restoration and protection.								X	P	P	Boronow Project Reviews	Lower Fox River/Green Bay Soil and Water Conservation, Protection and Habitat Restoration Fund	John Young w/George Boronow WDNR (920) 492-5854	1997
Establish vegetated areas immediately adjacent to intermittent or perennial streams that function as a filter to decay, absorb, or purify contaminated runoff before it enters watershed streams.									P	P	Boronow Project Reviews	Establish Vegetative Filter Strips along Streams and Upland Areas for Improved Wildlife Habitat Components	Pat Pelky - Oneida Tribe (920) 497-5812	1997
Identify critical streambank sites and establish vegetative shoreline erosion control using emergent aquatic vegetation along with protection of sites to improve the health of the entire stream corridor system.									P	P	Boronow Project Reviews	Implement Vegetative Shoreline Erosion Control Using Emergent Aquatic Vegetation for Habitat Enhancement	Pat Pelky - Oneida Tribe (920) 497-5812	1997
Protect headwater wetlands and riparian buffer zones (through purchase or easement throughout the Fox-Wolf Basin to preserve remaining shoreland/floodplain habitats, reduce non point source pollution and reduce flood damage.									P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1995	Vicky Harris WDNR 920-492-5905	1995
Purchase easements or property along the Ashwaubenon Creek floodplain to create a parkway, preserve habitat, reduce nonpoint source pollution, and provide a recreational trail.									P	P	Boronow Project Reviews	Lawrence, Ashwaubenon Creek Parkway Acquisition	Dick Sachs GBMSD (920) 432-4893	1997
Enact buffer and riparian area initiative.									P	P	Oconto County Office of Land Conservation Restoration Project Proposal 4/15/98	Oconto County Office of Land Conservation: Restoration Project Proposal 4/15/98	Tom Milheiser (920) 834-5688	1998
Develop a prairie habitat in Fonferek Glen park to control nonpoint source pollutant loadings from adjoining agricultural lands. Would control contaminant levels in the East and ultimately Fox Rivers.					X				P	P	Brown County Park Dept. Restroration Project Proposal 3/13/98	Brown County Park Dept. Restoration Project Proposal 3/13/98	Douglas Hartman (920) 434 2824	1998
Implement nonpoint source pollution controls (targeting phosphorous loading and suspended sediments) for the East River and Duck Creek watersheds. Five components for a complete program presented with Buffer Strips listed as the highest priority component.									P	P	Brown County Land Conservation Dept. Restroration Project Proposal 5/14/98	Brown County Land Conservation Dept. Restroration Project Proposal 5/14/98	William C. Hafs (414) 391-4620	1998
Implement nonpoint source pollution controls (targeting phosphorous loading and suspended sediments) for the East River and Duck Creek watersheds. Components include Buffer Strips and wetland retention basins among others.									P	P	P. Sager Restoration Project Proposal 4/16/98	P. Sager Restoration Project Proposal 4/16/98	Paul Sager: e-mail sager@gbms01.uwgb.edu	1998
Protect and enhance the Trout Creek subwatershed.									P	P	Oneida Tribe Restoration Project Proposals 5/19/98	Oneida Tribe Restoration Project Proposals 5/19/98	Tom Nelson (920) 496-7883	1998

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Protect existing sites by reducing erosion potential and restore these areas through shape and seeding, fencing, rock riprap, and bio-bank stabilization.	Brown, Outagamie (WI)	Lower Fox River/Green Bay watershed	X				X											
Upgrade beach area to minimize future erosion at Pulcifer Park	Shawano (WI)	Pulcifer Park					X									X		
Enclose remnant wetlands and shoals on Lake Poygan with rock breakwalls to protect existing habitat, and enhance water quality and fish and wildlife habitat by reestablishing aquatic vegetation.	Winnebago (WI)	Lake Poygan					X	X										
Establish a cost-shared shoreline protection program for riparian owners to protect eroding shorelines.		Wolf and Upper Fox River Basins					X											
Stabilize eroding river bank in Lutz Park.	Outagamie (WI)	Lutz Park, Appleton					X									X		
Complete lagoon shoreline erosion control with rip rap material.	Brown (WI)	Green Bay Wildlife Sanctuary					X											
Stabilize shoreline and install boat tie-up docks at Abe Rochlin Park.	Winnebago (WI)	Abe Rochlin Park, Oshkosh					X										X	
Stabilize streambank at Pamperin Park.	Brown (WI)	Pamperin Park					X									X		
Stabilize shoreline at Bauman Park and Rainbow Park, and stabilize shoreline and develop paths at William Steiger/FVTC Property. (Could be considered as individual projects.)	Winnebago (WI)	Bauman Park, Rainbow Park, William Steiger/FVTC Property					X									X		
Improve shoreline on the east side of the Fox River along Front Street between the East Side Boat Ramp and the Claude Allouez Bridge.	Brown (WI)	Fox River					X											
Install bank protection near the picnic areas at Deerfield Docks and Wietor Warf. (Could be considered as individual projects.)	Brown (WI)	Deerfield Docks and Wieter Warf, Village of Howard					X									X		
Stabilize eroding river bank in Lutz Park.	Outagamie, Winnebago (WI)	Lutz Park, Appleton					X									X		
Rip-rap and stabilize shoreline at Brown County Fairgrounds.	Brown (WI)	Brown County Fairgrounds					X									X		
Stabilize streambank at Pamperin Park.	Brown (WI)	Pamperin Park					X									X		
Extend Lakeside Park East's seawall to increase mooring capacity, further stabilize the shoreline, and accommodate enhanced shore fishing opportunities.	Fond du Lac (WI)	Lakeside Park West, City of Fond du Lac					X										X	

Project Description	Project Category: Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Protect existing sites by reducing erosion potential and restore these areas through shape and seeding, fencing, rock riprap, and bio-bank stabilization.									P	P	Boronow Project Reviews	Protect and Restore Riparian Areas	Pat Pelky - Oneida Tribe (920) 497-5812	1997
Upgrade beach area to minimize future erosion at Pulcifer Park									P	P	10/20/97 Boronow list	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Enclose remnant wetlands and shoals on Lake Poygan with rock breakwalls to protect existing habitat, and enhance water quality and fish and wildlife habitat by reestablishing aquatic vegetation.									P	P	Boronow Project Reviews	Lake Poygan Breakwalls	Terry Lychwick WDNR (920) 448-5140	1997
Establish a cost-shared shoreline protection program for riparian owners to protect eroding shorelines.									P	P	Boronow Project Reviews	Winnebago System Shoreline Protection Program	Terry Lychwick WDNR (920) 448-5140	1997
Stabilize eroding river bank in Lutz Park.									P	P	Boronow Project Reviews	Appleton, Lutz Park River Bank Stabilization	Dick Sachs GBMSD (920) 432-4893	1997
Complete lagoon shoreline erosion control with rip rap material.									P	P	Boronow Project Reviews	Green Bay, Wildlife Sanctuary Lagoon Stabilization	Dick Sachs GBMSD (920) 432-4893	1997
Stabilize shoreline and install boat tie-up docks at Abe Rochlin Park.									P	P	Boronow Project Reviews	Oshkosh, Abe Rochline Park Shoreline Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Stabilize streambank at Pamperin Park.									P	P	Boronow Project Reviews	Pamperin County Park, Streambank Stabilization	Dick Sachs GBMSD (920) 432-4893	1997
Stabilize shoreline at Bauman Park and Rainbow Park, and stabilize shoreline and develop paths at William Steiger/FVTC Property. (Could be considered as individual projects.)									P	P	Boronow Project Reviews	Oshkosh, Parks Shoreline Stabilization	Dick Sachs GBMSD (920) 432-4893	1997
Improve shoreline on the east side of the Fox River along Front Street between the East Side Boat Ramp and the Claude Allouez Bridge.									P	P	Boronow Project Reviews	De Pere, Fox River Shoreline Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Install bank protection near the picnic areas at Deerfield Docks and Wietor Warf. (Could be considered as individual projects.)									P	P	Boronow Project Reviews	Howard, Deerfield Docks and Wietor Warf Bank Protection	Dick Sachs GBMSD (920) 432-4893	1997
Stabilize eroding river bank in Lutz Park.									P	P	10/20/97 Boronow list	Appleton Parks and Recreation Master Plan 1995-1999.	Steven Perry BBL 315-446-9120	1994
Rip-rap and stabilize shoreline at Brown County Fairgrounds.									P	P	10/20/97 Boronow list	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Stabilize streambank at Pamperin Park.									P	P	10/20/97 Boronow list	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Extend Lakeside Park East's seawall to increase mooring capacity, further stabilize the shoreline, and accommodate enhanced shore fishing opportunities.									P	P	10/20/97 Boronow list	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Stabilize shoreline at Abe Rochlin Park.	Winnebago (WI)	Abe Rochlin Park, Oshkosh					X									X		
Stabilize shoreline at Bauman Park.	Winnebago (WI)	Bauman Park, Oshkosh					X									X		
Stabilize shoreline at Rainbow Park.	Winnebago (WI)	Rainbow Park, Oshkosh					X									X		
Stabliize shoreline at William Steiger/FVTC Property.	Winnebago (WI)	Oshkosh					X									X		
Protect and enhance shoreline, develop waterfront trails, and upgrade and increase boat mooring facilities at Smith Park.	Brown, Outagamie, Winnebago (WI)	Smith Park, Menasha					X									X	X	
Riprap the banks of the Fox River and Ashwaubenon Creek at Ashwaubomay Park.	Outagamie (WI)	Ashwaubomay Park, Village of Ashwaubenon					X									X		
Install bank protection near picnic area at Deerfield Docks.	Brown (WI)	Deerfield Docks, Village of Howard					X									X		
Stabilize banks of Glatz Creek.	Winnebago (WI)	Glatz Park, Oshkosh					X											
Maintain shoreline at Carl Steiger Park.	Winnebago (WI)	Carl Steiger Park, Oshkosh					X									X		
Stabilize streambank.	Brown (WI)	Reforestation Camp					X											
Upgrade existing rock shoreline.	Calumet, Winnebago (WI)	Municipal Beach, Menasha																
Install bank protection near picnic areas at Wietor Wharf.	Brown (WI)	Wietor Wharf, Village of Howard					X									X		
Provide financial support to county Land Conservation Departments to implement existing and future water quality protection programs.		Wolf and Upper Fox River Basins	X	X	X													
Restore wetlands to control nonpoint sources of pollution. Includes plugging or breaking up of existing tile drainage system, plugging of open channel drainage system, and other methods.	Brown, Outagamie (WI)	Lower Fox River/Green Bay watershed	X					X										
Provide cost-sharing funding to implement BMPs for structural and non-structural practices in urban sites that address stormwater conveyance, sediment from construction site erosion, and streambank erosion.	Brown, Outagamie (WI)	Lower Fox River/Green Bay watershed				X												

	Project Category													
Project Description	**Point source controls**	**PCB cleanup**	**Study**	**Public education**	**Upland habitat/species programs**	**Other recreation**	**Misc.**	**Unknown**	**Addresses injured resources or services lost as a result of injuries**	**Type: Idea or Project**	**Idea or Project Source Document**	**Reference Document or Project Title**	**Reference Document Contact**	**Reference Document Year**
Stabilize shoreline at Abe Rochlin Park.									P	P	10/20/97 Boronow list	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Stabilize shoreline at Bauman Park.									P	P	10/20/97 Boronow list	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Stabilize shoreline at Rainbow Park.									P	P	10/20/97 Boronow list	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Stabliize shoreline at William Steiger/FVTC Property.									P	P	10/20/97 Boronow list	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Protect and enhance shoreline, develop waterfront trails, and upgrade and increase boat mooring facilities at Smith Park.									P	P	10/20/97 Boronow list	The Fox River Corridor Study	Steven Perry BBL 315-446-9120	1989
Riprap the banks of the Fox River and Ashwaubenon Creek at Ashwaubomay Park.									P	P	10/20/97 Boronow list	Village of Ashwaubenon Comprehensive Park and Recreation Plan	Steven Perry BBL 315-446-9120	1989
Install bank protection near picnic area at Deerfield Docks.									P	P	10/20/97 Boronow list	Village of Howard Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1994
Stabilize banks of Glatz Creek.									P	P	10/20/97 Boronow list	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Maintain shoreline at Carl Steiger Park.									P	P	10/20/97 Boronow list	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Stabilize streambank.									P	P	10/20/97 Boronow list	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Upgrade existing rock shoreline.								X	P	P	10/20/97 Boronow list	City of Menasha Open Space and Recreation Facilities Plan	Steven Perry BBL 315-446-9120	1996
Install bank protection near picnic areas at Wietor Wharf.									P	P	10/20/97 Boronow list	Village of Howard Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1994
Provide financial support to county Land Conservation Departments to implement existing and future water quality protection programs.									P	P	Boronow Project Reviews	Winnebago System Water Quality Protection Program	Terry Lychwick WDNR (920) 448-5140	1997
Restore wetlands to control nonpoint sources of pollution. Includes plugging or breaking up of existing tile drainage system, plugging of open channel drainage system, and other methods.									P	P	Boronow Project Reviews	Restoration and Protection of Wetland	Pat Pelky - Oneida Tribe (920) 497-5812	1997
Provide cost-sharing funding to implement BMPs for structural and non-structural practices in urban sites that address stormwater conveyance, sediment from construction site erosion, and streambank erosion.	X								P	P	Boronow Project Reviews	Implement Urban Best Management Practices (BMPs) through Cost-Sharing Funding	Pat Pelky - Oneida Tribe (920) 497-5812	1997

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Provide cost-sharing funding to implement BMPs on rural specific sites or areas within the watershed for those practices that range from alteration in farm management to engineered structures and are tailored to specific rural landowner situations.	Brown, Outagamie (WI)	Lower Fox River/Green Bay watershed		X	X													
Develop watershed maintenance program to address/control nonpoint source pollution.	Oconto County (WI)		X	X	X	X												
Purchase easements to acquire and protect headwater wetlands and bottomland forests in the Ashwaubenon Creek floodplain. The parkway would be developed with nature trails for passive recreational use.	Brown (WI)	Ashwaubenon Creek floodplain								X						X		
Protect critically important fish spawning and rearing habitat via land acquisition.	Brown, Door, Marinette, Oconto (WI)	Lower Fox River/Green Bay watershed								X								
Purchase wetlands contiguous with upriver lakes as opportunities arise.	Waushara, Winnebago (WI)	Lower Fox River/Green Bay watershed								X								
Fund a feasibility study and acquisition of land within the Wolf River Basin as available from sellers to the WDNR.	Outagamie, Shawano, Waupaca, Winnebago (WI)	Wolf River Basin								X								
Acquire shoreland property to restore floodplain wetlands.		Green Bay watershed								X								
Purchase and preserve Little Tail Point and Green Island.		Little Tail Point and Green Island							X	X								
Update the State's West Shore acquisition priorities plan and purchase all available properties.		Green Bay								X								
Expansion of the Fox River National Wildlife Refuge.	Marquette (WI)	Fox River National Wildlife Refuge, Buffalo								X						X		
Acquire land to preserve unique habitats and provide a buffer for the L.H. Barkhausen Waterfowl preserve (includes 5 specific parcels to be acquired).	Brown (WI)	Barkhausen Waterfowl Preserve								X						X		
Purchase Badger Paper Mill (approximately 964.14 acres) south of the City of Peshtigo. This would provide virtually continuous public use of the river frontage.	Marinette (WI)	Badger Paper Mill														X		
Aquire land and purchase options of the Wequiock Creek corridor downstream from Wequiock Falls County Park to Green Bay to preserve scenic and significant geological resource.	Brown (WI)	Wequiock Creek								X						X		

	Project Category													
Project Description	Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Provide cost-sharing funding to implement BMPs on rural specific sites or areas within the watershed for those practices that range from alteration in farm management to engineered structures and are tailored to specific rural landowner situations.									P	P	Boronow Project Reviews	Implement Agricultural Best Management Practices (BMPs) through Cost-Sharing Funding	Pat Pelky - Oneida Tribe (920) 497-5812	1997
Develop watershed maintenance program to address/control nonpoint source pollution.									P	P	Oconto County Office of Land Conservation Restoration Project Proposal 4/15/98	Oconto County Office of Land Conservation: Restoration Project Proposal 4/15/98	Tom Milheiser (920) 834-5688	1998
Purchase easements to acquire and protect headwater wetlands and bottomland forests in the Ashwaubenon Creek floodplain. The parkway would be developed with nature trails for passive recreational use.									P	P	Boronow Project Reviews	Create Ashwaubenon Creek Parkway	Vicky Harris (920) 448-5134	1997
Protect critically important fish spawning and rearing habitat via land acquisition.									P	P	Boronow Project Reviews	Coastal Zone Wetland: Spawning and Rearing Habitat Protection via Land Acquisition - Green Bay Watersheds	Terry Lychwick WDNR (920) 448-5140	1997
Purchase wetlands contiguous with upriver lakes as opportunities arise.									P	P	Boronow Project Reviews	Upriver Lakes Wetland Acquisition Program	Terry Lychwick WDNR (920) 448-5140	1997
Fund a feasibility study and acquisition of land within the Wolf River Basin as available from sellers to the WDNR.			X						P	P	Boronow Project Reviews	Acquisition of Projects along the Wolf River Basin	Dick Nikolai WDNR wildlife mgr. (920) 832-1804	1997
Acquire shoreland property to restore floodplain wetlands.									P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1994	Vicky Harris WDNR 920-492-5904	1994
Purchase and preserve Little Tail Point and Green Island.									P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1995	Vicky Harris WDNR 920-492-5905	1995
Update the State's West Shore acquisition priorities plan and purchase all available properties.									P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1995	Vicky Harris WDNR 920-492-5905	1995
Expansion of the Fox River National Wildlife Refuge.									P	P	10/20/97 Boronow list	Marquette County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1991
Acquire land to preserve unique habitats and provide a buffer for the L.H. Barkhausen Waterfowl preserve (includes 5 specific parcels to be acquired).									P	P	Brown County Park Dept. Restroration Project Proposal 3/13/98	Brown County Park Dept. Restoration Project Proposal 3/13/98	Douglas Hartman (920) 434 2824	1998
Purchase Badger Paper Mill (approximately 964.14 acres) south of the City of Peshtigo. This would provide virtually continuous public use of the river frontage.									P	P	Boronow Project Reviews	Land Acquisition, Badger Paper Mill Lands	Terry Gardon WDNR Land Agent (920) 492-5814	1997
Aquire land and purchase options of the Wequiock Creek corridor downstream from Wequiock Falls County Park to Green Bay to preserve scenic and significant geological resource.									P	P	Boronow Project Reviews	Wequiock Falls County Park, Land Acquisition	Dick Sachs GBMSD (920) 432-4893	1997

Project Description	County or Reservation	Location	Project Category: Riparian buffer zone restoration	Agricultural practices improvements	Animal waste handling improvements	Urban non-point source controls	Shoreline stabilization	Wetland restoration	Island habitat restoration	Wetland preservation	Fish artificial habitat creation	Bird artificial habitat creation	Rare/endangered spp. programs	Shoreline softening	Exotic species control	Improve parks or trails	Rec. fishing access improvements	Native American land preservation
Preserve wetlands of the Bayport area and the Tank Farm Marsh (Atkinson's Marsh).	Brown (WI)	Atkinson's Marsh								X								
Enhance wetlands established for mitigation along the I-43 highway corridor east and west of the Tower Bridge Drive.		Green Bay						X										
Create a marsh at the L.H. Barkhausen Waterfowl Preserve for northern pike spawning.	Brown (WI)	Barkhausen Waterfowl Preserve						X										
Purchase wetlands for subsequent restoration in conjunction with WDNR or local conservation organizations. Have interested land owners adjacent to Fox River in Omro.		Fox River						X										
Preserve priority properties including headwater wetlands and riparian buffer zones through conservation easements or fee simple purchase. Interest in partnering with WDNR for purchase of a 486 acre parcel with 2 miles of frontage on the Wolf River in Outagamie County.	Outagamie (WI)	Fox and Wolf Rivers								X								
Close gaps on Long Tail Point using clean dredged material from Suamico Harbor. Project will reduce ecological and property damage from wind/storm events and restore wetland and aquatic habitat.		Green Bay						X										
Modify bulkhead lines in AOC communities to protect remaining wetlands from filling.		Green Bay						X										
Modify bulkhead lines to protect remaining wetlands from filling .		Green Bay						X										
Soften shorelines "hardened" by linear, rip-rapped surfaces by creating headlands, bays, beaches, spawning beds, wetlands and offshore reefs that reduce wave energy and enhance littoral habitats.	Brown (WI)	Lower Green Bay												X				
Create vegetated aquatic habitat and other softened shorelines near marinas, boat launches and other shorelines hardened by rip rap.		Green Bay												X				
Soften shorelines near McDonald Marin, Renard Isle, Bayport and other public shorelines hardened by rip rap to reduce wave energy and erosion, create littoral aquatic habitat and enhance fish spawning.		Green Bay												X		X		
Construct two flowages ranging up to a total of 228 acres on Brillion Wildlife Area. Site would be an enhancement of several drainage ways leading into Spring Creek.	Calumet (WI)	Brillon Wildlife Area						X								X		
Construct a flowage of approximately 50 acres on Brillion WA located near Hilbert with a dam height not to exceed six feet.	Calumet (WI)	Brillon Wildlife Area						X										

Project Description	Project Category: Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Preserve wetlands of the Bayport area and the Tank Farm Marsh (Atkinson's Marsh).									P	P	Boronow Project Reviews	Green Bay, Bayport Area and Tank Farm Marsh Wetland Preservation	Dick Sachs GBMSD (920) 432-4893	1997
Enhance wetlands established for mitigation along the I-43 highway corridor east and west of the Tower Bridge Drive.									P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1994	Vicky Harris WDNR 920-492-5904	1994
Create a marsh at the L.H. Barkhausen Waterfowl Preserve for northern pike spawning.									P	P	Brown County Park Dept. Restroration Project Proposal 3/13/98	Brown County Park Dept. Restoration Project Proposal 3/13/98	Richard Rost (715) 582-5007	1998
Purchase wetlands for subsequent restoration in conjunction with WDNR or local conservation organizations. Have interested land owners adjacent to Fox River in Omro.									P	P	Northeast Wisconsin Land Trust Restoration Project Proposals 6/2/98	Northeast Wisconsin Land Trust Project Proposal 6/2/98	Leslie Taylor (414) 738-7025	1998
Preserve priority properties including headwater wetlands and riparian buffer zones through conservation easements or fee simple purchase. Interest in partnering with WDNR for purchase of a 486 acre parcel with 2 miles of frontage on the Wolf River in Outagamie County.									P	P	Northeast Wisconsin Land Trust Restoration Project Proposals 6/2/98	Northeast Wisconsin Land Trust Project Proposal 6/2/98	Leslie Taylor (414) 738-7025	1998
Close gaps on Long Tail Point using clean dredged material from Suamico Harbor. Project will reduce ecological and property damage from wind/storm events and restore wetland and aquatic habitat.									P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1995	Vicky Harris WDNR 920-492-5905	1995
Modify bulkhead lines in AOC communities to protect remaining wetlands from filling.									P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1995	Vicky Harris WDNR 920-492-5905	1995
Modify bulkhead lines to protect remaining wetlands from filling .									P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1994	Vicky Harris WDNR 920-492-5904	1994
Soften shorelines "hardened" by linear, rip-rapped surfaces by creating headlands, bays, beaches, spawning beds, wetlands and offshore reefs that reduce wave energy and enhance littoral habitats.									P	P	Boronow Project Reviews	"Soften" Shorelines and Enhance Coastal Habitats in Southern Green Bay	Vicky Harris (920) 448-5134	1997
Create vegetated aquatic habitat and other softened shorelines near marinas, boat launches and other shorelines hardened by rip rap.									P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1994	Vicky Harris WDNR 920-492-5904	1994
Soften shorelines near McDonald Marin, Renard Isle, Bayport and other public shorelines hardened by rip rap to reduce wave energy and erosion, create littoral aquatic habitat and enhance fish spawning.									P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1995	Vicky Harris WDNR 920-492-5905	1995
Construct two flowages ranging up to a total of 228 acres on Brillion Wildlife Area. Site would be an enhancement of several drainage ways leading into Spring Creek.									P	P	Boronow Project Reviews	Conservation Road Flowages (two sites)	Dick Nikolai WDNR wildlife mgr. (920) 832-1804	1997
Construct a flowage of approximately 50 acres on Brillion WA located near Hilbert with a dam height not to exceed six feet.									P	P	Boronow Project Reviews	Southwest Flowage Acquisition/Impoundment	Dick Nikolai WDNR wildlife mgr. (920) 832-1804	1997

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Restore the Cat Island chain and construct artificial islands in lower Green Bay.		Green Bay							X									
Reconstruct a chain of barrier islands and a diversity of associated island, wetland and aquatic habitats using dredged materials from the outer Green Bay navigation channel.	Brown (WI)	Cat Island							X									
Restore the Cat Island archipelago (highest overall recommendation) to create critical habitat for endangered colonial nesting birds and a variety of fish spawning substrates, and enhance recovery of sub aquatic vegetation		Green Bay							X									
Construct cobble islands/reefs to enhance habitat diversity. Suggested locations include Frying Pan Shoal, Point au Sable and Grassy Island - widen the area of rubble and cobble along southeastern Green Bay shoreline to increase spawning sites.		Green Bay									X							
Provide a contingency fund which would be used to incorporate habitat structures and spawning habitat. Create habitats in private development projects and structures along the shoreline which could not be mandated by state law or regulations.		Fox River/Lower Green Bay						X			X	X						
Create northern pike spawning and other incidental wildlife habitat along the drainage ditches of the west shore.		Green Bay						X										
Incorporate preserves and/or fishery habitat into existing or planned shoreline structures, especially during the development of the Green Bay/Fox River Waterfront Development plan.		Lower Fox River/Green Bay								X								
Place "catfish condos" in the Fox and East Rivers.		Green Bay									X							
Create northern pike spawning and other incidental wildlife habitat along the drainage ditches of the west shore.		Green Bay						X										
Construct artificial reefs for lake trout spawning.		Clay Banks area of Lake Michigan									X		X					
Restore the headwater wetlands and riparian/buffer corridor areas of the Fish Creek subwatershed to improve water quality and quantity entering Duck Creek.	Oneida Nation Reservation	Fish Creek - Duck Creek Waterway	X					X										
Restore northern pike wetland spawning and rearing habitat within the Green Bay Coastal Zone.	Brown, Door, Marinette, Oconto (WI)	Green Bay						X										
Enhance and restore spawning habitat along the shorelines of the Fox River and lower Green Bay over a twenty year period and attempt to construct six spawning reefs.		Fox River/Lower Green Bay						X			X							

Project Description	Project Category: Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Restore the Cat Island chain and construct artificial islands in lower Green Bay.									P	P	P. Sager Restoration Project Proposal 4/16/98	P. Sager Restoration Project Proposal 4/16/98	Paul Sager: e-mail sager@gbms01.uwgb.edu	1998
Reconstruct a chain of barrier islands and a diversity of associated island, wetland and aquatic habitats using dredged materials from the outer Green Bay navigation channel.									P	P	Boronow Project Reviews	Restore the Cat Island Shoals and Wetlands	Vicky Harris (920) 448-5134	1997
Restore the Cat Island archipelago (highest overall recommendation) to create critical habitat for endangered colonial nesting birds and a variety of fish spawning substrates, and enhance recovery of sub aquatic vegetation									P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1994	Vicky Harris WDNR 920-492-5904	1994
Construct cobble islands/reefs to enhance habitat diversity. Suggested locations include Frying Pan Shoal, Point au Sable and Grassy Island - widen the area of rubble and cobble along southeastern Green Bay shoreline to increase spawning sites.									P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1995	Vicky Harris WDNR 920-492-5905	1995
Provide a contingency fund which would be used to incorporate habitat structures and spawning habitat. Create habitats in private development projects and structures along the shoreline which could not be mandated by state law or regulations.									P	P	Boronow Project Reviews	Incorporate Fisheries Habitat into Existing or Planned Shoreline Structures	Terry Lychwick WDNR (920) 448-5140	1997
Create northern pike spawning and other incidental wildlife habitat along the drainage ditches of the west shore.									P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1994	Vicky Harris WDNR 920-492-5904	1994
Incorporate preserves and/or fishery habitat into existing or planned shoreline structures, especially during the development of the Green Bay/Fox River Waterfront Development plan.									P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1994	Vicky Harris WDNR 920-492-5904	1994
Place "catfish condos" in the Fox and East Rivers.									P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1995	Vicky Harris WDNR 920-492-5905	1995
Create northern pike spawning and other incidental wildlife habitat along the drainage ditches of the west shore.									P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1995	Vicky Harris WDNR 920-492-5905	1995
Construct artificial reefs for lake trout spawning.									P	P	WDNR Artificial reefs for lake trout 2/9/96	WDNR Artificial reefs for lake trout 2/9/96	Mark Holey USFWS (920) 465-7435	1998
Restore the headwater wetlands and riparian/buffer corridor areas of the Fish Creek subwatershed to improve water quality and quantity entering Duck Creek.									P	P	Oneida Tribe Restoration Project Proposals 5/19/98	Oneida Tribe Restoration Project Proposals 5/19/98	Tom Nelson (920) 496-7883	1998
Restore northern pike wetland spawning and rearing habitat within the Green Bay Coastal Zone.									P	P	Boronow Project Reviews	Restoration of Northern Pike Wetland Spawning and Rearing Habitat - Green Bay Coastal Watersheds	Terry Lychwick WDNR (920) 448-5140	1997
Enhance and restore spawning habitat along the shorelines of the Fox River and lower Green Bay over a twenty year period and attempt to construct six spawning reefs.									P	P	Boronow Project Reviews	Enhance Walleye Spawning Habitat	Terry Lychwick WDNR (920) 448-5140	1997

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Restore the Burma Swamp habitat which is in the headwaters of Duck Creek.	Oneida Nation Reservation	Burma Swamp, Duck Creek Waterway						X										
Restore and protect the estuarine/marsh habitat at the mouth of Duck Creek and the riparian habitat along its length.	Oneida Nation Reservation	Duck Creek Waterway	X					X										
Restore riparian areas and headwater wetlands of the Oneida Creek.	Oneida Nation Reservation	Oneida Creek - Duck Creek Waterway	X					X										
Protect and enhance the Lancaster Brook subwatershed.	Oneida Nation Reservation	Lancaster Brook	X					X		X								
Restore the ponds within the marsh area, re-establish native wetland vegetation, and construct hiking trails and observation areas.	Winnebago (WI)	Wilderness Park, Neenah						X								X		
Rehabilitate nearshore wetlands west of Green Bay.		Green Bay						X										
Restore habitat values and environmental quality of the 28 acre wetland within the northwest corner of the Bayport dredged material disposal area.		Green Bay						X										
Rehabilitate drained nearshore wetlands west of Green Bay.		Green Bay						X										
Remove Little Rapids dam to restore fish movement and public access between two river reaches, promote rapids flow improve habitat and water quality and reduce risk of damage from dam failure.		Green Bay																
Establish breeding sanctuaries and management program for endangered tern populations (6.16).		Lower Fox River/Green Bay											X					
Continue the attempt to re-establish Great Lakes Spotted Muskellunge by capturing and spawning brood stock in Long Lake. Raise 6,600 fish annually for 15 years and stock Green Bay and the Menominee River Remedial Action Plan areas.		Lower Green Bay											X					
Initiate effort to re-introduce muskellunge to lower Green Bay as water quality improves (8.4).		Lower Fox River/Green Bay											X					
Provide bald eagle stocking/breeding support.		Lower Fox River/Green Bay watershed											X					
Develop a sustainable fishery at the Oneida Quarry Park site (USGS has determined site could support a sustainable fishery).	Oneida Nation Reservation	Quarry Park															X	
Develop a stocked or put-and-take fishery at Decaster Lake on the Oneida Reservation (US FWS studies conclude site most likely cannot support a sustainable fishery).	Oneida Nation Reservation	Decaster Lake															X	

	Project Category													
Project Description	**Point source controls**	**PCB cleanup**	**Study**	**Public education**	**Upland habitat/species programs**	**Other recreation**	**Misc.**	**Unknown**	**Addresses injured resources or services lost as a result of injuries**	**Type: Idea or Project**	**Idea or Project Source Document**	**Reference Document or Project Title**	**Reference Document Contact**	**Reference Document Year**
Restore the Burma Swamp habitat which is in the headwaters of Duck Creek.									P	P	Oneida Tribe Restoration Project Proposals 5/19/98	Oneida Tribe Restoration Project Proposals 5/19/98	Tom Nelson (920) 496-7883	1998
Restore and protect the estuarine/marsh habitat at the mouth of Duck Creek and the riparian habitat along its length.									P	P	Oneida Tribe Restoration Project Proposals 5/19/98	Oneida Tribe Restoration Project Proposals 5/19/98	Tom Nelson (920) 496-7883	1998
Restore riparian areas and headwater wetlands of the Oneida Creek.									P	P	Oneida Tribe Restoration Project Proposals 5/19/98	Oneida Tribe Restoration Project Proposals 5/19/98	Tom Nelson (920) 496-7883	1998
Protect and enhance the Lancaster Brook subwatershed.									P	P	Oneida Tribe Restoration Project Proposals 5/19/98	Oneida Tribe Restoration Project Proposals 5/19/98	Tom Nelson (920) 496-7883	1998
Restore the ponds within the marsh area, re-establish native wetland vegetation, and construct hiking trails and observation areas.									P	P	Boronow Project Reviews	Neenah, Wilderness Park Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Rehabilitate nearshore wetlands west of Green Bay.									P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1994	Vicky Harris WDNR 920-492-5904	1994
Restore habitat values and environmental quality of the 28 acre wetland within the northwest corner of the Bayport dredged material disposal area.									P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1995	Vicky Harris WDNR 920-492-5905	1995
Rehabilitate drained nearshore wetlands west of Green Bay.									P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1995	Vicky Harris WDNR 920-492-5905	1995
Remove Little Rapids dam to restore fish movement and public access between two river reaches, promote rapids flow improve habitat and water quality and reduce risk of damage from dam failure.							X		P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1995	Vicky Harris WDNR 920-492-5905	1995
Establish breeding sanctuaries and management program for endangered tern populations (6.16).									P	P	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Continue the attempt to re-establish Great Lakes Spotted Muskellunge by capturing and spawning brood stock in Long Lake. Raise 6,600 fish annually for 15 years and stock Green Bay and the Menominee River Remedial Action Plan areas.									P	P	Boronow Project Reviews	Re-establish Great Lakes Strain Spotted Muskellunge	Terry Lychwick WDNR (920) 448-5140	1997
Initiate effort to re-introduce muskellunge to lower Green Bay as water quality improves (8.4).									P	P	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Provide bald eagle stocking/breeding support.									P	I	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Develop a sustainable fishery at the Oneida Quarry Park site (USGS has determined site could support a sustainable fishery).									P	P	Oneida Tribe Restoration Project Proposals 5/19/98	Oneida Tribe Restoration Project Proposals 5/19/98	Tom Nelson (920) 496-7883	1998
Develop a stocked or put-and-take fishery at Decaster Lake on the Oneida Reservation (US FWS studies conclude site most likely cannot support a sustainable fishery).									P	P	Oneida Tribe Restoration Project Proposals 5/19/98	Oneida Tribe Restoration Project Proposals 5/19/98	Tom Nelson (920) 496-7883	1998

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Restore one or more harvestable lake sturgeon populations in waters of the Menominee Reservation (Wolf River).	Menominee Reservation	Wolf River											X					
Restock fishing pond at Mielke Park.	Shawano (WI)	Mielke Park															X	
Develop a management plan for Lone Tree Island to minimize human disturbance (Coast Guard activities) and protect existing vegetation.		Green Bay							X									
Purchase lands within existing project area to help preserve and protect rare or imperiled species and habitats. Includes habitat for birds and spawning grounds for fish species found in Green Bay. (Note: maps with proposal specifically locate the project areas.)	Door (WI)	Mink River Project Area								X			X					
Purchase lands within existing project area to help preserve and protect rare or imperiled species and habitats. Includes habitat for birds and spawning grounds for fish species found in Green Bay. (Note: maps with proposal specifically locate the project areas.)	Door (WI)	North Bay/Three Springs Project Area								X			X					
Purchase lands within existing project area to help preserve and protect rare or imperiled species and habitats. Includes habitat for birds and spawning grounds for fish species found in Green Bay. (Note: maps with proposal specifically locate the project areas.)	Door (WI)	Kangaroo Lake/Meridian Park Project Area								X			X					
Purchase lands within existing project area to help preserve and protect rare or imperiled species and habitats. Includes habitat for birds and spawning grounds for fish species found in Green Bay. (Note: maps with proposal specifically locate the project areas.)	Door (WI)	Shivering Sands Project Area								X			X					
Subsidize removal of carp by commercial fishermen to protect fish and wildlife habitat and water quality.	Waushara, Winnebago (WI)	Winnebago system													X			
Purchase about 15-20 acres of land along the Fox River adjacent to the existing Lost Dauphin Park and develop public access, parking, nature trails, scenic overlook, picnic areas, and landscaping for the entire park.	Brown (WI)	Lost Dauphin Park														X		
Improve lock sites following state acquisition of the locks and designation as a State Parkway; elements include park construction, wildlife habitat preservation, and fishing pier construction.	Outagamie (WI)	Appleton Locks														X	X	
Create riverfront park and lagoon, construct walkways and seating areas on Vulcan Island, preserve wildlife habitat, and restore Vulcan Hydroelectric Plant.	Outagamie (WI)	Vulcan Site, Appleton														X		
Construct a new park that extends east of Monroe to Whitney Park, fishing piers at Fox River View Place, and small fishing platforms along the East River in the East River Van Beaver Park.	Brown (WI)	Fox River														X	X	
Create a street end park on the Fox River's west shore, purchase land south of the former Kerscher Building, and construct a fishing pier when the Hazelwood/railroad bridge is abandoned. (Could be considered as individual projects.)	Brown (WI)	Fox River														X	X	

Project Description	Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
	Project Category													
Restore one or more harvestable lake sturgeon populations in waters of the Menominee Reservation (Wolf River).									P	P	Menominee Reservation Lake Sturgeon Mgmt Plan	Menominee Reservation Lake Sturgeon Management Plan	Doug Cox (715) 799-4937	1995
Restock fishing pond at Mielke Park.									P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Develop a management plan for Lone Tree Island to minimize human disturbance (Coast Guard activities) and protect existing vegetation.									P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1995	Vicky Harris WDNR 920-492-5905	1995
Purchase lands within existing project area to help preserve and protect rare or imperiled species and habitats. Includes habitat for birds and spawning grounds for fish species found in Green Bay. (Note: maps with proposal specifically locate the project areas.)									P	P	TNC - Door Peninsula Office Restoration Project Proposals 8/6/98	TNC - Door Peninsula Office Restoration Project Proposals 8/6/98	Mike Grimm (920) 743-8695	1998
Purchase lands within existing project area to help preserve and protect rare or imperiled species and habitats. Includes habitat for birds and spawning grounds for fish species found in Green Bay. (Note: maps with proposal specifically locate the project areas.)									P	P	TNC - Door Peninsula Office Restoration Project Proposals 8/6/98	TNC - Door Peninsula Office Restoration Project Proposals 8/6/98	Mike Grimm (920) 743-8695	1998
Purchase lands within existing project area to help preserve and protect rare or imperiled species and habitats. Includes habitat for birds and spawning grounds for fish species found in Green Bay. (Note: maps with proposal specifically locate the project areas.)									P	P	TNC - Door Peninsula Office Restoration Project Proposals 8/6/98	TNC - Door Peninsula Office Restoration Project Proposals 8/6/98	Mike Grimm (920) 743-8695	1998
Purchase lands within existing project area to help preserve and protect rare or imperiled species and habitats. Includes habitat for birds and spawning grounds for fish species found in Green Bay. (Note: maps with proposal specifically locate the project areas.)									P	P	TNC - Door Peninsula Office Restoration Project Proposals 8/6/98	TNC - Door Peninsula Office Restoration Project Proposals 8/6/98	Mike Grimm (920) 743-8695	1998
Subsidize removal of carp by commercial fishermen to protect fish and wildlife habitat and water quality.									P	P	Boronow Project Reviews	Winnebago System Carp Removal Subsidy	Terry Lychwick WDNR (920) 448-5140	1997
Purchase about 15-20 acres of land along the Fox River adjacent to the existing Lost Dauphin Park and develop public access, parking, nature trails, scenic overlook, picnic areas, and landscaping for the entire park.									P	P	Boronow Project Reviews	Lost Dauphin Park Acquisition and Development	Vicky Harris (920) 448-5134	1997
Improve lock sites following state acquisition of the locks and designation as a State Parkway; elements include park construction, wildlife habitat preservation, and fishing pier construction.									P	P	Boronow Project Reviews	Appleton, Locks #1, #3, and #4 Site Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Create riverfront park and lagoon, construct walkways and seating areas on Vulcan Island, preserve wildlife habitat, and restore Vulcan Hydroelectric Plant.									P	P	Boronow Project Reviews	Appleton, Vulcan Site Restoration and Riverfront Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Construct a new park that extends east of Monroe to Whitney Park, fishing piers at Fox River View Place, and small fishing platforms along the East River in the East River Van Beaver Park.									P	P	Boronow Project Reviews	Green Bay, East River Park Construction	Dick Sachs GBMSD (920) 432-4893	1997
Create a street end park on the Fox River's west shore, purchase land south of the former Kerscher Building, and construct a fishing pier when the Hazelwood/railroad bridge is abandoned. (Could be considered as individual projects.)									P	P	Boronow Project Reviews	Green Bay, Fox River Shoreline Improvements	Dick Sachs GBMSD (920) 432-4893	1997

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Purchase land adjacent to Little Rapids dam providing additional access and riparian habitat preservation; develop public access, parking, nature trail, landscaping and scenic overlook at the park. (Could be considered as individual projects.)	Brown (WI)	Little Rapids dam								X						X		
Purchase 20 acre parcel along entrance road for additional parking and day use at Bay Shore Park.	Brown (WI)	Bay Shore Park														X		
Protect Lakeside Park East's lakeshore setting and the openness of views of the lake from Promen and Frazier Drives.	Fond du Lac (WI)	Lakeside Park East, City of Fond du Lac																
Develop a state or county park with camping facilities and facilities for canoers and other boaters at the Lost Dauphin site.	Brown, Outagamie (WI)	Lost Dauphin Park														X	X	
Develop additional green space along the river at Sunset Point Park.	Brown, Outagamie (WI)	Sunset Point Park, Village of Kimberly														X		
Extend Heritage Hill down to the river and create park space with boat mooring and additional facilities.	Brown, Outagamie (WI)	Heritage Hill														X	X	
Construct a park space and overlook along a short section of County Highway Z featuring a bluff overlooking the river	Brown, Outagamie (WI)	Village of Combined Locks														X		
Improve and expand beach area at Voelz Memorial Park.	Shawano (WI)	Voelz Memorial Park, Shawano County														X		
Acquire shoreline frontage on White Lake for the development of a new county park.	Shawano (WI)	White Lake														X		
Create public access to Big Lake.	Shawano (WI)	Big Lake														X		
Create public access to Long Lake.	Shawano (WI)	Long Lake														X		
Create riverfront park and lagoon for picnicking and viewing the dam by filling in the mouth of the canal/ Vulcan Hydro Plant/Atlas Mill.	Brown, Outagamie, Winnebago (WI)	Appleton														X		
Construct neighborhood park at an area located adjacent the south side of Duck Creek south of Riverview Drive and north of Memorial Drive.	Brown (WI)	Village of Howard														X		
Purchase the eight parcels along the shoreline from Bay Beach Park west to Sauk Avenue to form the Bay Beach Parkway.	Brown (WI)	Bay Beach Park														X		
Increase walk-in access along the streams in the Embarrass River Fishery.	Shawano (WI)	Embarrass River														X		

Project Description	Project Category: Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Purchase land adjacent to Little Rapids dam providing additional access and riparian habitat preservation; develop public access, parking, nature trail, landscaping and scenic overlook at the park. (Could be considered as individual projects.)									P	P	Boronow Project Reviews	Lawrence, Lost Dauphin Park Acquisition and Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Purchase 20 acre parcel along entrance road for additional parking and day use at Bay Shore Park.									P	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Protect Lakeside Park East's lakeshore setting and the openness of views of the lake from Promen and Frazier Drives.								X	P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Develop a state or county park with camping facilities and facilities for canoers and other boaters at the Lost Dauphin site.						X			P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Develop additional green space along the river at Sunset Point Park.									P	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997
Extend Heritage Hill down to the river and create park space with boat mooring and additional facilities.									P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Construct a park space and overlook along a short section of County Highway Z featuring a bluff overlooking the river									P	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997
Improve and expand beach area at Voelz Memorial Park.									P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Acquire shoreline frontage on White Lake for the development of a new county park.									P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Create public access to Big Lake.									P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Create public access to Long Lake.									P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Create riverfront park and lagoon for picnicking and viewing the dam by filling in the mouth of the canal/ Vulcan Hydro Plant/Atlas Mill.									P	P	Boronow list 10/20/97	The Fox River Corridor Study	Steven Perry BBL 315-446-9120	1989
Construct neighborhood park at an area located adjacent the south side of Duck Creek south of Riverview Drive and north of Memorial Drive.									P	P	Boronow list 10/20/97	Village of Howard Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1994
Purchase the eight parcels along the shoreline from Bay Beach Park west to Sauk Avenue to form the Bay Beach Parkway.									P	P	Boronow Project Reviews	Green Bay, Bay Beach Land Acquisition	Dick Sachs GBMSD (920) 432-4893	1997
Increase walk-in access along the streams in the Embarrass River Fishery.									P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Purchase property abutting the East River when available for trail development and extend trail (East River Parkway).	Brown (WI)	East River														X		
Construct multi-purpose trail along Fox River from Pierce Street to Water Street, including landscaping and erosion control along river.	Outagamie (WI)	Fox River					X									X		
Construct a riverwalk connecting the Lincoln Mills development to the south side of river, and extend the walkway connecting Paper Valley Hotel to Jones Park and Lincoln Mills.	Outagamie (WI)	Appleton														X		
Construct a historic interpretive trail extending from Oneida Street on the west end of North Island to the Vulcan Power Plant replica on the east; elements include construction of a recreational trail, shoreline protection, and landscaping.	Outagamie (WI)	Vulcan Site, Appleton					X									X		
Grade, landscape, and construct trails, fishing piers, parking lot, picnic area, shelter, and observation deck on river level in Telulah Park.	Outagamie (WI)	Telulah Park, Appleton														X	X	
Construct a trail along the East River linking Ledgeview to Green Bay.	Brown (WI)	East River														X		
Develop the proposed ravine trail providing a pedestrian trail network utilizing the ravine floor.	Outagamie (WI)	Village of Combined Locks														X		
Construct paved hiking and biking trails along the lakeshore at Lakeside Park East.	Fond du Lac (WI)	Lakeside Park East, City of Fond du Lac														X		
Develop trails in the prairie area and the construct a boardwalk/observation platform out into the marsh at Lakeside Park West.	Fond du Lac (WI)	Lakeside Park West, City of Fond du Lac														X		
Complete Baird Creek Parkway, creating a link to UWGB; construct pedestrian/bike path from Ann Sullivan School/Park Walkway; and create Newberry Conservancy walking/hiking trails.	Brown (WI)	Baird Creek Parkway														X		
Construct a trail along the East River behind East High School connecting Baird Street to the Joannes walks, and in the future tie into the proposed and existing trail to the south along the East River.	Brown (WI)	East River														X		
Construct Fox River Walk System in the downtown area connecting both sides of the Fox River, develop dock facilities/marina, and construct pedestrian at-grade crossing at the Neville Museum. (Could be considered as individual projects.)	Brown (WI)	Fox River														X	X	
Increase size of Ken Euers parkway, extend parkway to Bylsby Street, connect parkway to Fox Valley Railroad right-of way trail, and create a small street-end overlook with parking at Bylsby Street. (Could be considered as individual projects.)	Brown (WI)	Ken Euers Nature Area														X		
Create waterfront pedestrian/bike trail from Bay Beach Park/Parkway to the city's Metropolitan Boat Launch.	Brown (WI)	Green Bay														X		

Project Description	Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
	Project Category													
Purchase property abutting the East River when available for trail development and extend trail (East River Parkway).									P	P	Boronow Project Reviews	Allouez, East River Parkway Extension	Dick Sachs GBMSD (920) 432-4893	1997
Construct multi-purpose trail along Fox River from Pierce Street to Water Street, including landscaping and erosion control along river.									P	P	Boronow Project Reviews	Appleton, Construction of Multi-Purpose Trail	Dick Sachs GBMSD (920) 432-4893	1997
Construct a riverwalk connecting the Lincoln Mills development to the south side of river, and extend the walkway connecting Paper Valley Hotel to Jones Park and Lincoln Mills.									P	P	Boronow Project Reviews	Appleton, Lincoln Mills Riverwalk Construction	Dick Sachs GBMSD (920) 432-4893	1997
Construct a historic interpretive trail extending from Oneida Street on the west end of North Island to the Vulcan Power Plant replica on the east; elements include construction of a recreational trail, shoreline protection, and landscaping.									P	P	Boronow Project Reviews	Appleton, North Island Trail Construction	Dick Sachs GBMSD (920) 432-4893	1997
Grade, landscape, and construct trails, fishing piers, parking lot, picnic area, shelter, and observation deck on river level in Telulah Park.									P	P	Boronow Project Reviews	Appleton, Telulah Park Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Construct a trail along the East River linking Ledgeview to Green Bay.									P	P	Boronow Project Reviews	Bellevue, East River Parkway Construction	Dick Sachs GBMSD (920) 432-4893	1997
Develop the proposed ravine trail providing a pedestrian trail network utilizing the ravine floor.									P	P	Boronow Project Reviews	Combined Locks, Ravine Trail Development	Dick Sachs GBMSD (920) 432-4893	1997
Construct paved hiking and biking trails along the lakeshore at Lakeside Park East.									P	P	Boronow Project Reviews	Fond du Lac, Lakeside Park East Trail Construction	Dick Sachs GBMSD (920) 432-4893	1997
Develop trails in the prairie area and the construct a boardwalk/observation platform out into the marsh at Lakeside Park West.									P	P	Boronow Project Reviews	Fond du Lac, Lakeside Park West Construction	Dick Sachs GBMSD (920) 432-4893	1997
Complete Baird Creek Parkway, creating a link to UWGB; construct pedestrian/bike path from Ann Sullivan School/Park Walkway; and create Newberry Conservancy walking/hiking trails.									P	P	Boronow Project Reviews	Green Bay, Baird Creek Parkway Completion	Dick Sachs GBMSD (920) 432-4893	1997
Construct a trail along the East River behind East High School connecting Baird Street to the Joannes walks, and in the future tie into the proposed and existing trail to the south along the East River.									P	P	Boronow Project Reviews	Green Bay, East River Trail Completion	Dick Sachs GBMSD (920) 432-4893	1997
Construct Fox River Walk System in the downtown area connecting both sides of the Fox River, develop dock facilities/marina, and construct pedestrian at-grade crossing at the Neville Museum. (Could be considered as individual projects.)									P	P	Boronow Project Reviews	Green Bay, Fox River Walk and Dock Construction	Dick Sachs GBMSD (920) 432-4893	1997
Increase size of Ken Euers parkway, extend parkway to Bylsby Street, connect parkway to Fox Valley Railroad right-of way trail, and create a small street-end overlook with parking at Bylsby Street. (Could be considered as individual projects.)									P	P	Boronow Project Reviews	Green Bay, Ken Euers Nature Area Parkway Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Create waterfront pedestrian/bike trail from Bay Beach Park/Parkway to the city's Metropolitan Boat Launch.									P	P	Boronow Project Reviews	Green Bay, Waterfront Trail Construction	Dick Sachs GBMSD (920) 432-4893	1997

			Project Category															
Project Description	County or Reservation	Location	Riparian buffer zone restoration	Agricultural practices improvements	Animal waste handling improvements	Urban non-point source controls	Shoreline stabilization	Wetland restoration	Island habitat restoration	Wetland preservation	Fish artificial habitat creation	Bird artificial habitat creation	Rare/endangered spp. programs	Shoreline softening	Exotic species control	Improve parks or trails	Rec. fishing access improvements	Native American land preservation
Complete Fox Locks Trail past the five locks in the system to the end of the canal, complete Thilmany Park fishing pier construction, and link two trail segments near Kankapot Creek.	Outagamie (WI)	Fox River														X	X	
Construct a series of hard surfaced trails for bicyclists and pedestrians through the park, and create expanded green space along the river east of the boat landing.	Outagamie (WI)	Sunset Point Park, Village of Kimberly														X		
Construct waterfront trails to connect the Village of Little Chutes' three major waterfront parks, Heesakker's, Doyle, and Island parks.	Outagamie (WI)	Heesakker's, Doyle, and Island parks														X		
Develop a 70 acre parcel adjacent to Bay Shore Street and Green Bay to provide for the Nature Walk Conservation Lands Trails, and construct a trail to the government pier on Green Bay. (Could be considered as individual projects.)	Marinette (WI)	Green Bay														X		
Purchase property south of railroad tracks as a trail link to Jefferson Park at Heckrodt Wetland Reserve.	Winnebago (WI)	Heckrodt Wetland Reserve														X		
Construct a pedestrian pathway along the lake/river shore, dredge off-shore to improve navigation, upgrade and increase boat mooring facilities. (Could be considered as individual projects.)	Winnebago (WI)	Jefferson Park														X	X	
Extend riverwalk to the Menasha lock and link the Menasha lock site to the Wiouwash Trail using the railroad trestle over Little Lake Butte des Morts.	Winnebago (WI)	Menasha Riverwalk														X		
Construct walking/biking trail along Neenah Slough.	Winnebago (WI)	Neenah Slough														X		
Construct sidewalks/bike paths and boat docks, replace lagoon bridge at Menominee Park, and dredge Millers Bay to enhance boating and remove navigation hazards. (Could be considered as individual projects.)	Winnebago (WI)	Menimonee Park and Millers Bay														X	X	
Complete the riverwalk between Jackson Street and Riverside Park, develop a river trail system through the Marion Road area, and develop trail linking Downtown Oshkosh and Lake Winnebago. (Could be considered as individual projects.)	Winnebago (WI)	Oshkosh														X		
Construct multi-purpose trail along Fox River from Pierce Street to Water Street.	Outagamie, Winnebago (WI)	Appleton														X		
Construct walkways and seating areas on Vulcan Island.	Outagamie, Winnebago (WI)	Vulcan Site, Appleton														X		
Develop trails in the prairie area and construct a boardwalk/observation platform out into the marsh at Lakeside Park West.	Fond du Lac (WI)	Lakeside Park West, City of Fond du Lac														X		
Create paved hiking and biking trails along the lakeshore at Lakeside Park East.	Fond du Lac (WI)	Lakeside Park East, City of Fond du Lac														X		

	Project Category													
Project Description	Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Complete Fox Locks Trail past the five locks in the system to the end of the canal, complete Thilmany Park fishing pier construction, and link two trail segments near Kankapot Creek.									P	P	Boronow Project Reviews	Kaukauna, Fox Locks Trail Completion	Dick Sachs GBMSD (920) 432-4893	1997
Construct a series of hard surfaced trails for bicyclists and pedestrians through the park, and create expanded green space along the river east of the boat landing.									P	P	Boronow Project Reviews	Kimberly, Sunset Point Park Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Construct waterfront trails to connect the Village of Little Chutes' three major waterfront parks, Heesakker's, Doyle, and Island parks.									P	P	Boronow Project Reviews	Little Chute, Trail Construction	Dick Sachs GBMSD (920) 432-4893	1997
Develop a 70 acre parcel adjacent to Bay Shore Street and Green Bay to provide for the Nature Walk Conservation Lands Trails, and construct a trail to the government pier on Green Bay. (Could be considered as individual projects.)									P	P	Boronow Project Reviews	Marinette, Bayshore Trails Construction	Dick Sachs GBMSD (920) 432-4893	1997
Purchase property south of railroad tracks as a trail link to Jefferson Park at Heckrodt Wetland Reserve.									P	P	Boronow Project Reviews	Menasha, Heckrodt Wetland Reserve Land Acquisition	Dick Sachs GBMSD (920) 432-4893	1997
Construct a pedestrian pathway along the lake/river shore, dredge off-shore to improve navigation, upgrade and increase boat mooring facilities. (Could be considered as individual projects.)									P	P	Boronow Project Reviews	Menasha, Jefferson Park Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Extend riverwalk to the Menasha lock and link the Menasha lock site to the Wiouwash Trail using the railroad trestle over Little Lake Butte des Morts.									P	P	Boronow Project Reviews	Menasha, Riverwalk Extension	Dick Sachs GBMSD (920) 432-4893	1997
Construct walking/biking trail along Neenah Slough.									P	P	Boronow Project Reviews	Neenah, Slough Park Trail Construction	Dick Sachs GBMSD (920) 432-4893	1997
Construct sidewalks/bike paths and boat docks, replace lagoon bridge at Menominee Park, and dredge Millers Bay to enhance boating and remove navigation hazards. (Could be considered as individual projects.)									P	P	Boronow Project Reviews	Oshkosh, Menominee Park Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Complete the riverwalk between Jackson Street and Riverside Park, develop a river trail system through the Marion Road area, and develop trail linking Downtown Oshkosh and Lake Winnebago. (Could be considered as individual projects.)									P	P	Boronow Project Reviews	Oshkosh, Trail Construction	Dick Sachs GBMSD (920) 432-4893	1997
Construct multi-purpose trail along Fox River from Pierce Street to Water Street.									P	P	Boronow list 10/20/97	Appleton Parks and Recreation Master Plan 1995-1999.	Steven Perry BBL 315-446-9120	1994
Construct walkways and seating areas on Vulcan Island.									P	P	Boronow list 10/20/97	Appleton Parks and Recreation Master Plan 1995-1999.	Steven Perry BBL 315-446-9120	1994
Develop trails in the prairie area and construct a boardwalk/observation platform out into the marsh at Lakeside Park West.									P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Create paved hiking and biking trails along the lakeshore at Lakeside Park East.									P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Connect Neville Public Museum and Veteran's Plaza on the west side of river to Proposed Fox River Trail on the east side.	Brown, Outagamie (WI)	Fox River														X		
Create linkage of Menasha lock site to the Wiouwash Trail using the railroad trestle over Little Lake Butte des Morts.	Brown, Outagamie (WI)	Menasha Lock														X		
Construct a riverwalk that would make use of an existing railroad trestle and connect the Lincoln Mills development to the south side of the river.	Brown, Outagamie (WI)	Fox River														X		
Construct waterfront trails to connect the Village of Little Chute's three major waterfront parks: Heesaker, Doyle and Island parks.	Brown, Outagamie (WI)	Village of Little Chute														X		
Complete the riverwalk between Jackson Street and Riverside Park.	Winnebago (WI)	Oshkosh														X		
Construct sidewalks/bike paths at Menominee Park.	Winnebago (WI)	Menominee Park, Oshkosh														X		
Develop a route/trail linking downtown Oshkosh and Winnebago. This trail will utilize existing routes through Menominee Park along the Lake Winnebago shoreline.	Winnebago (WI)	Oshkosh														X		
Develop a river trail system through the Marion Road area.	Winnebago (WI)	Oshkosh														X		
Develop paths at William Steiger/FVTC Property.	Winnebago (WI)	Oshkosh														X		
Purchase property abutting the East River in Allouez, when available, for trail development, and update East River Parkway.	Brown (WI)	East River Parkway, Village of Allouez														X		
Island Park: construct waterfront trail with fishing pier, boat dock and two observation decks.		Island Park														X	X	
Ken Euers Nature Area (w or w/o island): construct/upgrade access, parking, dike, trail, and signage, street end park at Bylsby Ave.		Ken Euers Nature Area														X		
Provide four new miles of trails and construct a small lake at the Fort Howard Paper Foundation Wildlife Area.	Brown (WI)	Fort Howard Paper Foundation Wildlife Area														X		
Develop Riverfront Trail westerly to Brooke Street and extend the trail along the river to Johnson Street.	Fond du Lac (WI)	City of Fond du Lac														X		
Extend Riverfront Trail southward to Hass Estate Park.	Fond du Lac (WI)	Hass Estate Park, City of Fond du Lac														X		
Extend Riverfront Trail toward the trail's north end, which presently terminates at Doty Street.	Fond du Lac (WI)	Riverfront Trail, City of Fond du Lac														X		

Project Description	Project Category: Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Connect Neville Public Museum and Veteran's Plaza on the west side of river to Proposed Fox River Trail on the east side.									P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Create linkage of Menasha lock site to the Wiouwash Trail using the railroad trestle over Little Lake Butte des Morts.									P	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997
Construct a riverwalk that would make use of an existing railroad trestle and connect the Lincoln Mills development to the south side of the river.									P	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997
Construct waterfront trails to connect the Village of Little Chute's three major waterfront parks: Heesaker, Doyle and Island parks.									P	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997
Complete the riverwalk between Jackson Street and Riverside Park.									P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Construct sidewalks/bike paths at Menominee Park.									P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Develop a route/trail linking downtown Oshkosh and Winnebago. This trail will utilize existing routes through Menominee Park along the Lake Winnebago shoreline.									P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Develop a river trail system through the Marion Road area.									P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Develop paths at William Steiger/FVTC Property.									P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Purchase property abutting the East River in Allouez, when available, for trail development, and update East River Parkway.									P	P	Boronow list 10/20/97	Village of Allouez Five Year Action Plan 1994-1999	Steven Perry BBL 315-446-9120	1993
Island Park: construct waterfront trail with fishing pier, boat dock and two observation decks.									P	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Ken Euers Nature Area (w or w/o island): construct/upgrade access, parking, dike, trail, and signage, street end park at Bylsby Ave.									P	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Provide four new miles of trails and construct a small lake at the Fort Howard Paper Foundation Wildlife Area.									P	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Develop Riverfront Trail westerly to Brooke Street and extend the trail along the river to Johnson Street.									P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Extend Riverfront Trail southward to Hass Estate Park.									P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Extend Riverfront Trail toward the trail's north end, which presently terminates at Doty Street.									P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994

Project Description	County or Reservation	Location	Riparian buffer zone restoration	Agricultural practices improvements	Animal waste handling improvements	Urban non-point source controls	Shoreline stabilization	Wetland restoration	Island habitat restoration	Wetland preservation	Fish artificial habitat creation	Bird artificial habitat creation	Rare/endangered spp. programs	Shoreline softening	Exotic species control	Improve parks or trails	Rec. fishing access improvements	Native American land preservation
			Project Category															
Extend riverwalk concept along the canal westward from Washington Street to the Menasha Lock.	Calumet, Winnebago (WI)	Menasha Marina														X		
Develop a pedestrian walkway extending along the East River from the City of Green Bay through Bellevue, connecting to the Village of Allouez at Green Isle Park.	Brown (WI)	Bellevue														X		
Connect De Pere lock site to Voyageur Park.	Brown, Outagamie (WI)	De Pere lock														X		
Create trail link from Cedars lock to the Treaty of the Cedars site and monument.	Brown, Outagamie (WI)	Village of Little Chute														X		
Create Fox River Heritage State Parkway stretching from Green Bay to Portage.	Brown, Outagamie (WI)	Fox River														X		
Develop a trail from Princeton lock to downtown Princeton.	Brown, Outagamie (WI)	Princeton														X		
Develop a trail network beginning at the Wisconsin Avenue Plaza east of the Lawe Street bridge and extending all the way down to and past lock #5 to the point of the peninsula.	Brown, Outagamie (WI)	Fox River														X		
Develop trail network and linear parkway linking Portage lock and other historic sites at Fort Winnebago lock.	Brown, Outagamie (WI)	Fox River														X		
Develop and promote a designated canoe route and heritage bike tour along the river from the Little Kaukauna to the Rapid Croche lock sites.	Brown, Outagamie (WI)	Little Kaukauna and Rapid Croche lock sites														X		
Extend Fox River Trail from Walnut Street to Admiral Flatley Park.	Brown, Outagamie (WI)	Fox River														X		
Extend walkway that currently extends from the museum to Walnut Street over the bridge to the proposed Fox River Trail on the east side.	Brown, Outagamie (WI)	Fox River														X		
Link Princeton lock site to the White River Wildlife area, developing campsites and restroom facilities along the trail.	Brown, Outagamie (WI)	White River Wildlife area, Princeton														X		
Connect lock sites 2,3, and 4 through development of a waterfront trail that would connect to the Newberry Street trail presently being developed (refer to City of Appleton Plan).	Brown, Outagamie (WI)	Appleton														X		
Develop interpretive nature trails at Heesakker's Park.	Brown, Outagamie (WI)	Heesakker's Park, Village of Little Chute														X		
Extend Newberry Street Recreation Trail connecting lock #2 to lock #1.	Brown, Outagamie (WI)	Appleton														X		

	Project Category													
Project Description	**Point source controls**	**PCB cleanup**	**Study**	**Public education**	**Upland habitat/species programs**	**Other recreation**	**Misc.**	**Unknown**	**Addresses injured resources or services lost as a result of injuries**	**Type: Idea or Project**	**Idea or Project Source Document**	**Reference Document or Project Title**	**Reference Document Contact**	**Reference Document Year**
Extend riverwalk concept along the canal westward from Washington Street to the Menasha Lock.									P	P	Boronow list 10/20/97	City of Menasha Open Space and Recreation Facilities Plan	Steven Perry BBL 315-446-9120	1996
Develop a pedestrian walkway extending along the East River from the City of Green Bay through Bellevue, connecting to the Village of Allouez at Green Isle Park.									P	P	Boronow list 10/20/97	East River Parkway Plan - Town of Bellevue	Steven Perry BBL 315-446-9120	1991
Connect De Pere lock site to Voyageur Park.									P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Create trail link from Cedars lock to the Treaty of the Cedars site and monument.									P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Create Fox River Heritage State Parkway stretching from Green Bay to Portage.									P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Develop a trail from Princeton lock to downtown Princeton.									P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Develop a trail network beginning at the Wisconsin Avenue Plaza east of the Lawe Street bridge and extending all the way down to and past lock #5 to the point of the peninsula.									P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Develop trail network and linear parkway linking Portage lock and other historic sites at Fort Winnebago lock.									P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Develop and promote a designated canoe route and heritage bike tour along the river from the Little Kaukauna to the Rapid Croche lock sites.						X			P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Extend Fox River Trail from Walnut Street to Admiral Flatley Park.									P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Extend walkway that currently extends from the museum to Walnut Street over the bridge to the proposed Fox River Trail on the east side.									P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Link Princeton lock site to the White River Wildlife area, developing campsites and restroom facilities along the trail.									P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Connect lock sites 2,3, and 4 through development of a waterfront trail that would connect to the Newberry Street trail presently being developed (refer to City of Appleton Plan).									P	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997
Develop interpretive nature trails at Heesakker's Park.									P	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997
Extend Newberry Street Recreation Trail connecting lock #2 to lock #1.									P	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Extend the riverwalk to the Menasha lock for the canal area west of the Tayco Street Bridge.	Brown, Outagamie (WI)	Menasha														X		
Create linkage of combined locks site by canal trail to Little Chute lock #2 and the guard lock. Could ultimately link the combined locks site and Heesaker's Park to the "island park" at the guard lock as well as Doyle Park.	Brown, Outagamie (WI)	Village of Little Chute														X		
Construct trail access to the shore of White Lake.	Marquette (WI)	White Lake														X		
Construct boardwalks to environmentally fragile areas at John Muir County Park.	Marquette (WI)	John Muir County Park														X		
Develop strategically placed trails and markers at Muir Park Natural Area.	Marquette (WI)	Muir Park Natural Area														X		
Develop walking trails and limited picnic facilities at Birch Lake Access.	Marquette (WI)	Birch Lake Access														X		
Construct handicapped-accessible hiking trails at Waukechon Riverside Park.	Shawano (WI)	Waukechon Riverside Park														X		
Upgrade hiking trails at Hayman Falls Park.	Shawano (WI)	Hayman Falls Park														X		
Upgrade hiking trails at Voelz Memorial Park (Wilson Lake).	Shawano (WI)	Voelz Memorial Park, Shawano County														X		
Construct Newberry Street Recreation Trail running from lock #2 along the south side of the river east past locks #3 and #4 to Telulah Park.	Brown, Outagamie, Winnebago (WI)	Appleton														X		
Re-construct service roads and trails at Green Isle Park.	Brown (WI)	Green Isle Park, Village of Allouez														X		
Extend Menasha riverwalk to Menasha Lock, construct observation deck/rest area/fishing pier.		Menasha														X	X	
Construct an 8'-10' linear asphalt pedestrian pathway running along the lake river shore.	Calumet, Winnebago (WI)	Jefferson Park														X		
Install a trail along the Fox River.	Brown (WI)	Fox River, Village of Allouez														X		
Rebuild bridge and walkway to island.	Brown (WI)	Boat Launch, Village of Howard														X		
Purchase property south of railroad tracks as a link to Jefferson Park.	Calumet, Winnebago (WI)	Heckrodt Wetland Reserve														X		

	Project Category													
Project Description	**Point source controls**	**PCB cleanup**	**Study**	**Public education**	**Upland habitat/species programs**	**Other recreation**	**Misc.**	**Unknown**	**Addresses injured resources or services lost as a result of injuries**	**Type: Idea or Project**	**Idea or Project Source Document**	**Reference Document or Project Title**	**Reference Document Contact**	**Reference Document Year**
Extend the riverwalk to the Menasha lock for the canal area west of the Tayco Street Bridge.									P	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997
Create linkage of combined locks site by canal trail to Little Chute lock #2 and the guard lock. Could ultimately link the combined locks site and Heesaker's Park to the "island park" at the guard lock as well as Doyle Park.									P	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997
Construct trail access to the shore of White Lake.									P	P	Boronow list 10/20/97	Marquette County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1991
Construct boardwalks to environmentally fragile areas at John Muir County Park.									P	P	Boronow list 10/20/97	Marquette County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1991
Develop strategically placed trails and markers at Muir Park Natural Area.									P	P	Boronow list 10/20/97	Marquette County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1991
Develop walking trails and limited picnic facilities at Birch Lake Access.									P	P	Boronow list 10/20/97	Marquette County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1991
Construct handicapped-accessible hiking trails at Waukechon Riverside Park.									P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Upgrade hiking trails at Hayman Falls Park.									P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Upgrade hiking trails at Voelz Memorial Park (Wilson Lake).									P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Construct Newberry Street Recreation Trail running from lock #2 along the south side of the river east past locks #3 and #4 to Telulah Park.									P	P	Boronow list 10/20/97	The Fox River Corridor Study	Steven Perry BBL 315-446-9120	1989
Re-construct service roads and trails at Green Isle Park.									P	P	Boronow list 10/20/97	Village of Allouez Five Year Action Plan 1994-1999	Steven Perry BBL 315-446-9120	1993
Extend Menasha riverwalk to Menasha Lock, construct observation deck/rest area/fishing pier.									P	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Construct an 8'-10' linear asphalt pedestrian pathway running along the lake river shore.									P	P	Boronow list 10/20/97	City of Menasha Open Space and Recreation Facilities Plan	Steven Perry BBL 315-446-9120	1996
Install a trail along the Fox River.									P	I	Boronow list 10/20/97	Village of Allouez Five Year Action Plan 1994-1999	Steven Perry BBL 315-446-9120	1993
Rebuild bridge and walkway to island.									P	P	Boronow list 10/20/97	Village of Howard Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1994
Purchase property south of railroad tracks as a link to Jefferson Park.									P	P	Boronow list 10/20/97	City of Menasha Open Space and Recreation Facilities Plan	Steven Perry BBL 315-446-9120	1996

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Construct an historic interpretive trail (the North Island Trail) extending from Oneida Street on the west end of North Island to the Vulcan Power Plant replica on the east.	Brown, Outagamie (WI)	Appleton														X		
Connect Voyageur Park in De Pere to Heritage Hill to downtown Green Bay as far as Walnut Street.	Brown, Outagamie (WI)	Voyageur Park														X		
Construct trolley route from the north bank of the river, near the Heritage Park and the Atlas Mill, across a vacant railroad trestle to the island as far as Oneida Street.	Brown, Outagamie, Winnebago (WI)	Appleton														X		
Rip-rap and stabilize shoreline at Brown County Fairgrounds, replace or upgrade existing boat ramps, and construct transient boat docking or tie-ups near boat landing.	Brown (WI)	Brown County Fairgrounds					X									X	X	
Extend Lakeside Park East's seawall, stabilize the shoreline, and develop a new boat launch area along the east side of the Fond du Lac River near its mouth.	Fond du Lac (WI)	Lakeside Park East, City of Fond du Lac					X									X	X	
Install shoreline protection and enhancement, construct shoreline walkway, and upgrade and increase temporary boat mooring facilities at Smith Park. (Could be considered as individual projects.)	Winnebago (WI)	Smith Park, Menasha					X									X	X	
Stabilize shoreline and replace concrete dock with treated wood dock.	Winnebago (WI)	Riverside Park, Neenah					X										X	
Protect and enhance shoreline, create waterfront trails, and upgrade and increase boat mooring facilities at Jefferson Park.	Brown, Outagamie (WI)	Jefferson Park					X									X	X	
Purchase 230 acres of property east of Barkhausen, four parcels along Lineville Road, and 18 acres southeast of park along Green Bay for boat launch facility and shore fishing opportunities. (Could be considered as individual projects.)	Brown (WI)	Barkhausen Waterfowl Preserve															X	
Renovate the Fox River public access boat launch site.	Brown (WI)	Fox River															X	
Build a fishing pier over the "pink" structure at mouth of river.	Brown (WI)	Lower Fox River/Green Bay															X	
Improve the launch at East Lawn Park.	Brown (WI)	East Lawn Park, Village of Allouez															X	
Construct fishing pier and boat launch at Edison Cul-de-Sac and adjacent properties.	Outagamie (WI)	Edison Cul-de-Sac, Appleton															X	
Improve and enlarge the boat ramps, install finger piers and a marina on the Fox River, extend park land to bulkhead line and riprap the banks of the Fox River and Ashwaubenon Creek.	Brown (WI)	Ashwaubomay Park, Village of Ashwaubenon					X									X	X	
Expand boat launching and associated parking facilities.	Brown (WI)	Bay Shore Park															X	

Project Description	Project Category: Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Construct an historic interpretive trail (the North Island Trail) extending from Oneida Street on the west end of North Island to the Vulcan Power Plant replica on the east.									P	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997
Connect Voyageur Park in De Pere to Heritage Hill to downtown Green Bay as far as Walnut Street.									P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Construct trolley route from the north bank of the river, near the Heritage Park and the Atlas Mill, across a vacant railroad trestle to the island as far as Oneida Street.									P	P	Boronow list 10/20/97	The Fox River Corridor Study	Steven Perry BBL 315-446-9120	1989
Rip-rap and stabilize shoreline at Brown County Fairgrounds, replace or upgrade existing boat ramps, and construct transient boat docking or tie-ups near boat landing.									P	P	Boronow Project Reviews	Brown County Fairgrounds, Shoreline Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Extend Lakeside Park East's seawall, stabilize the shoreline, and develop a new boat launch area along the east side of the Fond du Lac River near its mouth.									P	P	Boronow Project Reviews	Fond du Lac, Lakeside Park East Shoreline Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Install shoreline protection and enhancement, construct shoreline walkway, and upgrade and increase temporary boat mooring facilities at Smith Park. (Could be considered as individual projects.)									P	P	Boronow Project Reviews	Menasha, Smith Park Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Stabilize shoreline and replace concrete dock with treated wood dock.									P	P	Boronow Project Reviews	Neenah, Riverside Park Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Protect and enhance shoreline, create waterfront trails, and upgrade and increase boat mooring facilities at Jefferson Park.									P	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997
Purchase 230 acres of property east of Barkhausen, four parcels along Lineville Road, and 18 acres southeast of park along Green Bay for boat launch facility and shore fishing opportunities. (Could be considered as individual projects.)									P	P	Boronow Project Reviews	Barkhausen Waterfowl Preserve, Land Acquisition and Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Renovate the Fox River public access boat launch site.									P	P	Boronow Project Reviews	Brown County Wrightstown Fox River Public Access Renovation	Jeff Pagels - George Boronow (920) 492-5821	1997
Build a fishing pier over the "pink" structure at mouth of river.									P	P	Boronow Project Reviews	Green Bay Fox River Fishing Pier at Metro Launch	Jeff Pagels - George Boronow (920) 492-5821	1997
Improve the launch at East Lawn Park.									P	P	Boronow Project Reviews	Allouez, East Lawn Park Boat Lunch Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Construct fishing pier and boat launch at Edison Cul-de-Sac and adjacent properties.									P	P	Boronow Project Reviews	Appleton, Edison Cul-de-Sac Boat Launch and Fishing Pier Construction	Dick Sachs GBMSD (920) 432-4893	1997
Improve and enlarge the boat ramps, install finger piers and a marina on the Fox River, extend park land to bulkhead line and riprap the banks of the Fox River and Ashwaubenon Creek.									P	P	Boronow Project Reviews	Ashwaubenon, Ashwaubomay Park Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Expand boat launching and associated parking facilities.									P	P	Boronow Project Reviews	Bay Shore County Park, Improvements	Dick Sachs GBMSD (920) 432-4893	1997

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Construct fishing platforms or piers along the shoreline, and develop a trail connection to High Cliff State Park.	Calumet (WI)	High Cliff State Park														X	X	
Construct boat ramps and additional boat/trailer parking, repair bulkhead wall, dredge channel, install combination boat/camper sanitary dump station, and purchase Camp Shaganappi.	Fond du Lac (WI)	Calumet County Park														X	X	
Acquire land for public access to Fox River shoreline, and construct a community fishing pier at the site.	Outagamie (WI)	Fox River														X	X	
Construct a convention marina northeast of the Convention Center along the East River providing boat docking facilities.	Brown (WI)	East River															X	
Construct a canoe/kayak launch site, fishing pier, small paved parking lot, picnic tables/benches, and a street end park as an overlook at Van Laanen Road.	Brown (WI)	Joliet Park														X	X	
Add fishing pier to existing structure, construct an observation structure, and install permanent picnic tables/benches for use by boaters and visitors.	Brown (WI)	Green Bay Metropolitan Boat Launch														X	X	
Rebuild existing boat docks and increase the number of rental slips.	Winnebago (WI)	Shattuck Park, Neenah															X	
Install additional boat launching ramps.	Winnebago (WI)	Fugleberg Park, Oshkosh															X	
Develop Stockbridge harbor as a major launch site and protected harbor on the east shore of Lake Winnebago.	Calumet (WI)	Stockbridge harbor															X	
Grade, landscape, and construct trails, fishing piers, parking lot, picnic area, shelter, boathouse, and observation deck on River level in Telulah Park.	Outagamie, Winnebago (WI)	Telulah Park, Appleton														X	X	
Expand boat launching and associated parking facilities at Bay Shore.	Brown (WI)	Bay Shore Park															X	
Purchase 18 acres of property southeast of park along Green Bay for boat launch facility and for shore fishing opportunities.	Brown (WI)	Barkhausen Waterfowl Preserve															X	
Develop new boat launch area along the east side of the Fond du Lac River near its mouth.	Fond du Lac (WI)	Lakeside Park East, City of Fond du Lac															X	
Renovate, eliminate, or reconstruct current boat slip area in the east end of Jefferson Park	Calumet, Winnebago (WI)	Jefferson Park															X	
Construct boat tie-up docks at Menominee Park.	Winnebago (WI)	Menominee Park, Oshkosh															X	

Project Description	Project Category: Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Construct fishing platforms or piers along the shoreline, and develop a trail connection to High Cliff State Park.									P	P	Boronow Project Reviews	Calumet County Park, Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Construct boat ramps and additional boat/trailer parking, repair bulkhead wall, dredge channel, install combination boat/camper sanitary dump station, and purchase Camp Shaganappi.									P	P	Boronow Project Reviews	Columbia County Park, Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Acquire land for public access to Fox River shoreline, and construct a community fishing pier at the site.									P	P	Boronow Project Reviews	Combined Locks, Riverfront Acquisition for Public Access	Dick Sachs GBMSD (920) 432-4893	1997
Construct a convention marina northeast of the Convention Center along the East River providing boat docking facilities.									P	P	Boronow Project Reviews	Green Bay, East River Convention Marina Construction	Dick Sachs GBMSD (920) 432-4893	1997
Construct a canoe/kayak launch site, fishing pier, small paved parking lot, picnic tables/benches, and a street end park as an overlook at Van Laanen Road.									P	P	Boronow Project Reviews	Green Bay, Joliet Park Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Add fishing pier to existing structure, construct an observation structure, and install permanent picnic tables/benches for use by boaters and visitors.									P	P	Boronow Project Reviews	Green Bay, Metropolitan Boat Launch Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Rebuild existing boat docks and increase the number of rental slips.									P	P	Boronow Project Reviews	Neenah, Shattuck Park Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Install additional boat launching ramps.									P	P	Boronow Project Reviews	Oshkosh, Fugleberg Park Boat Launch Construction	Dick Sachs GBMSD (920) 432-4893	1997
Develop Stockbridge harbor as a major launch site and protected harbor on the east shore of Lake Winnebago.									P	P	Boronow Project Reviews	Stockbridge, Harbor Development	Dick Sachs GBMSD (920) 432-4893	1997
Grade, landscape, and construct trails, fishing piers, parking lot, picnic area, shelter, boathouse, and observation deck on River level in Telulah Park.									P	P	Boronow list 10/20/97	Appleton Parks and Recreation Master Plan 1995-1999.	Steven Perry BBL 315-446-9120	1994
Expand boat launching and associated parking facilities at Bay Shore.									P	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Purchase 18 acres of property southeast of park along Green Bay for boat launch facility and for shore fishing opportunities.									P	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Develop new boat launch area along the east side of the Fond du Lac River near its mouth.									P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Renovate, eliminate, or reconstruct current boat slip area in the east end of Jefferson Park									P	P	Boronow list 10/20/97	City of Menasha Open Space and Recreation Facilities Plan	Steven Perry BBL 315-446-9120	1996
Construct boat tie-up docks at Menominee Park.									P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Dredge Millers Bay to enhance boating and remove navigational hazards.	Winnebago (WI)	Menominee Park, Oshkosh															X	
Install additional boat launching ramps.	Winnebago (WI)	Fugleberg Park, Oshkosh															X	
Install boat tie-up docks at Abe Rochlin Park.	Winnebago (WI)	Abe Rochlin Park, Oshkosh															X	
Construct a public boat access ramp and fishing/viewing pier to the north of the four Appleton locks.	Brown, Outagamie, Winnebago (WI)	Appleton															X	
Develop public boat access ramp, boat mooring and/or future marina site at Telulah Park.	Brown, Outagamie, Winnebago (WI)	Telulah Park, Appleton															X	
Update boat landing at East Lawn Park.	Brown (WI)	East Lawn Park, Village of Allouez															X	
Improve and enlarge the boat ramps at Ashwaubomay Park.	Outagamie (WI)	Ashwaubomay Park, Village of Ashwaubenon															X	
Install finger piers and a marina on the Fox River at Ashwaubomay Park.	Outagamie (WI)	Ashwaubomay Park, Village of Ashwaubenon															X	
Boat Ramp East: construct parking, docks, fishing pier, signage.		?															X	
Brown County Fairgrounds: construct/upgrade parking, boat launch, and boat dock.	Brown (WI)	Brown County Fairgrounds															X	
Telulah Park: construct boat launch, boat dock, observation deck, fishing pier, picnic shelter, trails.		Telulah Park, Appleton														X	X	
Acquire land adjacent to the wastewater treatment plant for a boat launch site on Little Lake Butte des Morts.	Calumet, Winnebago (WI)	Shepard Park, Menasha															X	
Develop boat mooring and minimal launch facilities at the Berlin lock.	Brown, Outagamie (WI)	Berlin															X	
Develop boat mooring at the Portage lock.	Brown, Outagamie (WI)	Portage															X	
Develop boat mooring facilities and facilities for canoe launching and portaging at the Eureka lock.	Brown, Outagamie (WI)	Eureka															X	
Develop boat mooring for access to Montello lock from Buffalo Lake.	Brown, Outagamie (WI)	Montello															X	
Develop boat moorings at Kaukauna lock #5 to allow boaters access to site from down river.	Brown, Outagamie (WI)	Appleton															X	

Project Description	Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
	Project Category													
Dredge Millers Bay to enhance boating and remove navigational hazards.									P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Install additional boat launching ramps.									P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Install boat tie-up docks at Abe Rochlin Park.									P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Construct a public boat access ramp and fishing/viewing pier to the north of the four Appleton locks.									P	P	Boronow list 10/20/97	The Fox River Corridor Study	Steven Perry BBL 315-446-9120	1989
Develop public boat access ramp, boat mooring and/or future marina site at Telulah Park.									P	P	Boronow list 10/20/97	The Fox River Corridor Study	Steven Perry BBL 315-446-9120	1989
Update boat landing at East Lawn Park.									P	P	Boronow list 10/20/97	Village of Allouez Five Year Action Plan 1994-1999	Steven Perry BBL 315-446-9120	1993
Improve and enlarge the boat ramps at Ashwaubomay Park.									P	P	Boronow list 10/20/97	Village of Ashwaubenon Comprehensive Park and Recreation Plan	Steven Perry BBL 315-446-9120	1989
Install finger piers and a marina on the Fox River at Ashwaubomay Park.									P	P	Boronow list 10/20/97	Village of Ashwaubenon Comprehensive Park and Recreation Plan	Steven Perry BBL 315-446-9120	1989
Boat Ramp East: construct parking, docks, fishing pier, signage.									P	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Brown County Fairgrounds: construct/upgrade parking, boat launch, and boat dock.									P	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Telulah Park: construct boat launch, boat dock, observation deck, fishing pier, picnic shelter, trails.									P	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Acquire land adjacent to the wastewater treatment plant for a boat launch site on Little Lake Butte des Morts.									P	P	Boronow list 10/20/97	City of Menasha Open Space and Recreation Facilities Plan	Steven Perry BBL 315-446-9120	1996
Develop boat mooring and minimal launch facilities at the Berlin lock.									P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Develop boat mooring at the Portage lock.									P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Develop boat mooring facilities and facilities for canoe launching and portaging at the Eureka lock.						X			P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Develop boat mooring for access to Montello lock from Buffalo Lake.									P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Develop boat moorings at Kaukauna lock #5 to allow boaters access to site from down river.									P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997

			Project Category															
Project Description	County or Reservation	Location	Riparian buffer zone restoration	Agricultural practices improvements	Animal waste handling improvements	Urban non-point source controls	Shoreline stabilization	Wetland restoration	Island habitat restoration	Wetland preservation	Fish artificial habitat creation	Bird artificial habitat creation	Rare/endangered spp. programs	Shoreline softening	Exotic species control	Improve parks or trails	Rec. fishing access improvements	Native American land preservation
Develop boat moorings at Rapid Croche if Little Kaukauna lock is operational.	Brown, Outagamie (WI)	Rapid Croche lock															X	
Develop canoe launching and portaging, and boat mooring and launching at the Governor Bend lock.	Brown, Outagamie (WI)	Governor Bend															X	
Develop river access including canoe portaging and launching and boat mooring at White River lock.	Brown, Outagamie (WI)	White River															X	
Develop site access through boat mooring and canoe portage facilities at the Princeton lock.	Brown, Outagamie (WI)	Princeton															X	
Develop boat mooring access as well as canoe portages and additional boat launching facilities at the Grand River lock.	Brown, Outagamie (WI)	Grand River															X	
Develop boat moorings and river access at Admiral Flatley Park.	Brown, Outagamie (WI)	Admiral Flatley Park															X	
Provide boat mooring as terminus to operating stretch of river from Green Bay to Little Kaukauna lock site if Little Kaukauna lock site in not operational.	Brown, Outagamie (WI)	Fox River															X	
Provide boat mooring facilities at the De Pere lock.	Brown, Outagamie (WI)	De Pere lock															X	
Develop additional boat slips and marina facilities at The Appleton Yacht Club and boat launching ramps at Lutz Park.	Brown, Outagamie (WI)	Lutz Park, Appleton															X	
Construct fishing pier and boat landing at Edison Cul-de-Sac and adjacent properties.	Brown, Outagamie (WI)	Edison Cul-de-Sac, Appleton															X	
Clean-up the White and Mecan rivers and Neenah Creek for canoeing access.	Marquette (WI)	White River, Mecan River, and Neenah Creek																
Improve parking and launching areas at Birch Lake Access.	Marquette (WI)	Birch Lake Access															X	
Construct public boat ramps to Mud Lake, Silver Lake, East Spring Lake, Emrik Lake, Knights Lake, Myers Lake, Peters Lake and Pine Lake.	Marquette (WI)	Mud, Silver, East Spring, Emrik, Knights, Myers, Peters, and Pine Lakes															X	
Construct boat slips at Sunset Island Park.	Shawano (WI)	Sunset Island Park															X	
Create handicapped-accessible fishing pier at Mielke Park.	Shawano (WI)	Mielke Park															X	

	Project Category													
Project Description	**Point source controls**	**PCB cleanup**	**Study**	**Public education**	**Upland habitat/species programs**	**Other recreation**	**Misc.**	**Unknown**	**Addresses injured resources or services lost as a result of injuries**	**Type: Idea or Project**	**Idea or Project Source Document**	**Reference Document or Project Title**	**Reference Document Contact**	**Reference Document Year**
Develop boat moorings at Rapid Croche if Little Kaukauna lock is operational.									P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Develop canoe launching and portaging, and boat mooring and launching at the Governor Bend lock.						X			P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Develop river access including canoe portaging and launching and boat mooring at White River lock.						X			P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Develop site access through boat mooring and canoe portage facilities at the Princeton lock.						X			P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Develop boat mooring access as well as canoe portages and additional boat launching facilities at the Grand River lock.						X			P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Develop boat moorings and river access at Admiral Flatley Park.									P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Provide boat mooring as terminus to operating stretch of river from Green Bay to Little Kaukauna lock site if Little Kaukauna lock site in not operational.									P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Provide boat mooring facilities at the De Pere lock.									P	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Develop additional boat slips and marina facilities at The Appleton Yacht Club and boat launching ramps at Lutz Park.									P	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997
Construct fishing pier and boat landing at Edison Cul-de-Sac and adjacent properties.									P	P	Boronow list 10/20/97	Fox River Upper Flats Development Opportunities A Strategic Plan	Steven Perry BBL 315-446-9120	1992
Clean-up the White and Mecan rivers and Neenah Creek for canoeing access.								X	P	P	Boronow list 10/20/97	Marquette County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1991
Improve parking and launching areas at Birch Lake Access.									P	P	Boronow list 10/20/97	Marquette County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1991
Construct public boat ramps to Mud Lake, Silver Lake, East Spring Lake, Emrik Lake, Knights Lake, Myers Lake, Peters Lake and Pine Lake.									P	P	Boronow list 10/20/97	Marquette County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1991
Construct boat slips at Sunset Island Park.									P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Create handicapped-accessible fishing pier at Mielke Park.									P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Improve boat launch and access road at Hayman Falls Park.	Shawano (WI)	Hayman Falls Park															X	
Improve canoe access facilities along the Red River.	Shawano (WI)	Red River																
Upgrade the landing near the southwest corner of Grass Lake.	Shawano (WI)	Grass Lake															X	
Fox Point Boat Launch: construct fishing pier and signage.		Fox Point Boat Launch															X	
Peninsula State Park: construct launches and parking, fishing piers, observation deck, signage.		Peninsula State Park														X	X	
Suamico Boat Landing: construct parking, fishing pier, observation deck, signage.		Suamico Boat Landing														X	X	
Voyageur Park: construct/upgrade fishing pier, boat dock, picnic area, and signage.		Voyageur Park															X	
Construct transient boat docking or tie-ups near boat landing.	Brown (WI)	Brown County Fairgrounds															X	
Replace or upgrade existing boat ramps.	Brown (WI)	Brown County Fairgrounds															X	
Install docks and boat tie-ups.	Brown (WI)	Boat Launch, Village of Howard															X	
Rebuild bridge and walkway to island, install boat docks, and reconstruct south retaining wall of boat launch.	Brown (WI)	Howard														X	X	
Joliet Park: construct parking, small boat launch, fishing pier/observation deck, picnic area.		Joliet Park														X	X	
Construct a full-scale nature center.	Winnebago (WI)	Heckrodt Wetland Reserve														X		
Construct an observation tower at Lakeside Park	Fond du Lac (WI)	Lakeside Park West, City of Fond du Lac														X		
Construct a full-scale nature center.	Calumet, Winnebago (WI)	Heckrodt Wetland Reserve														X		
Construct observation deck in marsh at Barkhausen Waterfowl Preserve.	Brown (WI)	Barkhausen Waterfowl Preserve														X		
Construct interpretive center at John Muir County Park (163).	Marquette (WI)	John Muir County Park														X		

	Project Category													
Project Description	Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Improve boat launch and access road at Hayman Falls Park.									P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Improve canoe access facilities along the Red River.						X			P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Upgrade the landing near the southwest corner of Grass Lake.									P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Fox Point Boat Launch: construct fishing pier and signage.									P	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Peninsula State Park: construct launches and parking, fishing piers, observation deck, signage.									P	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Suamico Boat Landing: construct parking, fishing pier, observation deck, signage.									P	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Voyageur Park: construct/upgrade fishing pier, boat dock, picnic area, and signage.									P	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Construct transient boat docking or tie-ups near boat landing.									P	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Replace or upgrade existing boat ramps.									P	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Install docks and boat tie-ups.									P	P	Boronow list 10/20/97	Village of Howard Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1994
Rebuild bridge and walkway to island, install boat docks, and reconstruct south retaining wall of boat launch.									P	P	Boronow Project Reviews	Howard, Boat Launch Improvements	Dick Sachs GBMSD (920) 432-4893	1997
Joliet Park: construct parking, small boat launch, fishing pier/observation deck, picnic area.									P	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Construct a full-scale nature center.				X					P	P	Boronow Project Reviews	Menasha, Heckrodt Wetland Reserve Nature Center Construction	Dick Sachs GBMSD (920) 432-4893	1997
Construct an observation tower at Lakeside Park									P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Construct a full-scale nature center.				X					P	P	Boronow list 10/20/97	City of Menasha Open Space and Recreation Facilities Plan	Steven Perry BBL 315-446-9120	1996
Construct observation deck in marsh at Barkhausen Waterfowl Preserve.									P	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Construct interpretive center at John Muir County Park (163).				X					P	P	Boronow list 10/20/97	Marquette County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1991

Project Description	County or Reservation	Location	Riparian buffer zone restoration	Agricultural practices improvements	Animal waste handling improvements	Urban non-point source controls	Shoreline stabilization	Wetland restoration	Island habitat restoration	Wetland preservation	Fish artificial habitat creation	Bird artificial habitat creation	Rare/endangered spp. programs	Shoreline softening	Exotic species control	Improve parks or trails	Rec. fishing access improvements	Native American land preservation
			Project Category															
Construct observation tower at John Muir County Park.	Marquette (WI)	John Muir County Park														X		
1,000 Islands Environmental Center: construct canoe launch, water-front trail, and observation decks, and install interpretive signage.		1000 Islands Environmental Center														X		
Point Au Sable (including acquisition): construct access, parking, trail, 3 observation decks, fishing pier, and signage.		Point Au Sable														X	X	
Develop Visitor Center/Trailhead as part of the Fox River National Heritage Corridor Program near the Highway 110/Highway 41 interchange.	Winnebago (WI)	Oshkosh														X		
Bay Beach Parkway: construct bay observation deck, signage.		Bay Beach Parkway														X		
Institute a public awareness/education program focused on eliminating disturbance to colonies during the breeding season. Place signs at boat launches and breeding sites.		Green Bay											X					
Develop and implement an information and education program to accompany a land acquisition project aimed at habitat restoration and/or non point source pollution control.	Outagamie (WI)							X										
Acquire the property associated with nine gathering sites historically used by Oneida tribal members for fishing and ceremonies along the Duck Creek watershed.	Oneida Nation Reservation	Duck Creek Waterway																X
Purchase 230 acres of property east of Barkausen park to develop bicyclist and tent camping.	Brown (WI)	Barkhausen Waterfowl Preserve														X		
Replace lagoon bridge at Menominee Park.	Winnebago (WI)	Menominee Park, Oshkosh														X		
Obtain the lease from the City of Green Bay to Insure county ownership of the Triangle Sports Hill.	Brown (WI)	Baird Creek Parkway																
Purchase 37 acre parcel west of ball diamond for passive recreation.	Brown (WI)	Bay Shore Park														X		
Purchase at least one new county park and preferably two in the southwestern and central portions of Brown County.	Brown (WI)															X		
Develop picnic area in southeast corner of Lakeside Park.	Fond du Lac (WI)	Lakeside Park, City of Fond du Lac														X		
Develop a linear park connecting Rochlin Park/Bauman Park on the north to William Steiger Park on the south.	Winnebago (WI)	Oshkosh														X		
Create a new county park at the Shawano County Farm.	Shawano (WI)	Shawano County Farm														X		

	Project Category													
Project Description	**Point source controls**	**PCB cleanup**	**Study**	**Public education**	**Upland habitat/species programs**	**Other recreation**	**Misc.**	**Unknown**	**Addresses injured resources or services lost as a result of injuries**	**Type: Idea or Project**	**Idea or Project Source Document**	**Reference Document or Project Title**	**Reference Document Contact**	**Reference Document Year**
Construct observation tower at John Muir County Park.									P	P	Boronow list 10/20/97	Marquette County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1991
1,000 Islands Environmental Center: construct canoe launch, water-front trail, and observation decks, and install interpretive signage.						X			P	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Point Au Sable (including acquisition): construct access, parking, trail, 3 observation decks, fishing pier, and signage.									P	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Develop Visitor Center/Trailhead as part of the Fox River National Heritage Corridor Program near the Highway 110/Highway 41 interchange.									P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Bay Beach Parkway: construct bay observation deck, signage.									P	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Institute a public awareness/education program focused on eliminating disturbance to colonies during the breeding season. Place signs at boat launches and breeding sites.				X					P	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1995	Vicky Harris WDNR 920-492-5905	1995
Develop and implement an information and education program to accompany a land acquisition project aimed at habitat restoration and/or non point source pollution control.				X					P	I	Outagamie County Land Conservation Dept Restoration Project Proposal 4/22/98	Outagamie County Land Conservation Dept.: Restoration Project Proposal 4/22/98	Roy Burton (414) 832-5073	1998
Acquire the property associated with nine gathering sites historically used by Oneida tribal members for fishing and ceremonies along the Duck Creek watershed.									P	P	Oneida Tribe Restoration Project Proposals 3/22/00	Oneida Tribe Restoration Project Proposals 3/22/00	Tom Nelson (920) 496-7883	2000
Purchase 230 acres of property east of Barkausen park to develop bicyclist and tent camping.						X			P	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Replace lagoon bridge at Menominee Park.									P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Obtain the lease from the City of Green Bay to Insure county ownership of the Triangle Sports Hill.						X			P	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Purchase 37 acre parcel west of ball diamond for passive recreation.									P	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Purchase at least one new county park and preferably two in the southwestern and central portions of Brown County.									P	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Develop picnic area in southeast corner of Lakeside Park.									P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Develop a linear park connecting Rochlin Park/Bauman Park on the north to William Steiger Park on the south.									P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Create a new county park at the Shawano County Farm.									P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Develop a major county-operated campground at Shawano Lake County Park.	Shawano (WI)	Shawano Lake County Park														X		
Develop a small campground area in the pine grove along the east shoreline of the lake at Voelz Memorial Park.	Shawano (WI)	Voelz Memorial Park, Shawano County														X		
Integrate Red River Park into the county park system.	Shawano (WI)	Red River Park														X		
Acquire appropriate property and develop new recreation site(s) in the area that was recently annexed from the Town of Hobart.	Outagamie (WI)	Village of Ashwaubenon														X		
Install exercise trail in Appleton Memorial Park.	Outagamie, Winnebago (WI)	Appleton Memorial Park, Appleton														X		
Construct county-level bicycle path along the proposed minor arterial road on the boundary between the Towns of Fond du Lac and Empire.	Fond du Lac (WI)	Towns of Fond du Lac and Empire																
Construct county-level bicycle path through flood protection open space directly south of the city and west of US 41 along the Fond du Lac River. Include a sidewalk along Main Street in the city.	Fond du Lac (WI)	City of Fond du Lac														X		
Construct county-level bicycle path east-west along the abandoned Chicago & Northwestern Railroad line and including Scott Street and Winnebago Drive.	Fond du Lac (WI)	Chicago & Northwestern Railroad line, City of Fond du Lac														X		
Construct county-level bicycle paths along the abandoned Chicago & Northwestern Railroad tracks to the southwest.	Fond du Lac (WI)	Chicago & Northwestern Railroad line, City of Fond du Lac														X		
Construct fitness trail at Adelaide Park.	Fond du Lac (WI)	Adelaide Park, City of Fond du Lac														X		
Develop bicycle/pedestrian trail, particularly from the proposed extension of Riverfront Trail north to Lakeside Park and the proposed county trail on the abandoned rail line heading west from the city towards Rosendale and Ripon.	Fond du Lac (WI)	Lakeside Park, City of Fond du Lac														X		
Construct a walkway connecting the park to Butte des Morts School's Legacy Park.	Calumet, Winnebago (WI)	Pleasants Park, Menasha														X		
Acquire a parcel or two of property by the gas station near the corner on Pulaski Street for safety/visibility reasons and future trail amenities.	Brown (WI)	Village of Pulaski														X		
Construct walkway between the parking area and restrooms at Birch Lake Access.	Marquette (WI)	Birch Lake Access														X		
Link the UW-Oshkosh and FVTC campuses to the City and regional trail systems.	Winnebago (WI)	Oshkosh														X		

Project Description	Project Category: Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Develop a major county-operated campground at Shawano Lake County Park.						X			P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Develop a small campground area in the pine grove along the east shoreline of the lake at Voelz Memorial Park.						X			P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Integrate Red River Park into the county park system.									P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Acquire appropriate property and develop new recreation site(s) in the area that was recently annexed from the Town of Hobart.									P	P	Boronow list 10/20/97	Village of Ashwaubenon Comprehensive Park and Recreation Plan	Steven Perry BBL 315-446-9120	1989
Install exercise trail in Appleton Memorial Park.									P	P	Boronow list 10/20/97	Appleton Parks and Recreation Master Plan 1995-1999.	Steven Perry BBL 315-446-9120	1994
Construct county-level bicycle path along the proposed minor arterial road on the boundary between the Towns of Fond du Lac and Empire.						X			P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Construct county-level bicycle path through flood protection open space directly south of the city and west of US 41 along the Fond du Lac River. Include a sidewalk along Main Street in the city.									P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Construct county-level bicycle path east-west along the abandoned Chicago & Northwestern Railroad line and including Scott Street and Winnebago Drive.									P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Construct county-level bicycle paths along the abandoned Chicago & Northwestern Railroad tracks to the southwest.									P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Construct fitness trail at Adelaide Park.									P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Develop bicycle/pedestrian trail, particularly from the proposed extension of Riverfront Trail north to Lakeside Park and the proposed county trail on the abandoned rail line heading west from the city towards Rosendale and Ripon.									P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Construct a walkway connecting the park to Butte des Morts School's Legacy Park.									P	P	Boronow list 10/20/97	City of Menasha Open Space and Recreation Facilities Plan	Steven Perry BBL 315-446-9120	1996
Acquire a parcel or two of property by the gas station near the corner on Pulaski Street for safety/visibility reasons and future trail amenities.									P	P	Boronow list 10/20/97	Kelly to Howard State Recreation Trail Master Plan	Steven Perry BBL 315-446-9120	1995
Construct walkway between the parking area and restrooms at Birch Lake Access.									P	P	Boronow list 10/20/97	Marquette County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1991
Link the UW-Oshkosh and FVTC campuses to the City and regional trail systems.									P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Acquire and develop the east-west rail line through Shawano as a connecting multi-purpose recreational trail.	Shawano (WI)															X		
Construct lighting for night cross-country skiing at Shawano Lake County Park.	Shawano (WI)	Shawano Lake County Park																
Develop a network of "ridge top" hiking trails on private lands in the highly scenic south central and southwestern portions of the county.	Shawano (WI)															X		
Construct an exercise/nature trail at Argonne Park.	Outagamie (WI)	Argonne Park, Village of Ashwaubenon														X		
Groom trails for cross country ski use at Meadowbrook Park.	Brown (WI)	Meadowbrook Park, Village of Howard																
Build a short trail system connecting nearby subdivisions to park.	Calumet, Winnebago (WI)	Unnamed neighborhood park, Menasha														X		
Construct a separated bike/pedestrian pathway a minimum of 8' wide on the south side of the road.	Calumet, Winnebago (WI)	Adjacent STH 114, Menasha														X		
Develop the north end of village by the old pickle ponds as a State park adjoining the trail.	Brown (WI)	Village of Pulaski														X		
Develop village owned property off of Sherwood Drive into a passive park with a nature preserve and hiking-biking and cross-country ski trails.	Outagamie (WI)	Sherwood Drive, Village of Ashwaubenon														X		
Heckrodt Wetland Reserve: install additional interpretive signage.		Heckrodt Wetland Reserve														X		
Construct a larger nature center building at the Navarino Nature Center.	Shawano (WI)	Navarino Nature Center														X		
Acquire land for new community park in southeast Appleton.	Outagamie, Winnebago (WI)	Appleton														X		
Acquire land for new neighborhood park in north-central Appleton.	Outagamie, Winnebago (WI)	Appleton														X		
Acquire land for new neighborhood park in northeast Appleton.	Outagamie, Winnebago (WI)	Appleton														X		
Construct new district park on WP&L Site.	Fond du Lac (WI)	WP&L Site, City of Fond du Lac														X		
Develop a new neighborhood park near West Neighborhood.	Fond du Lac (WI)	City of Fond du Lac														X		

	Project Category													
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Acquire and develop the east-west rail line through Shawano as a connecting multi-purpose recreational trail.									P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Construct lighting for night cross-country skiing at Shawano Lake County Park.						X			P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Develop a network of "ridge top" hiking trails on private lands in the highly scenic south central and southwestern portions of the county.									P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Construct an exercise/nature trail at Argonne Park.									P	P	Boronow list 10/20/97	Village of Ashwaubenon Comprehensive Park and Recreation Plan	Steven Perry BBL 315-446-9120	1989
Groom trails for cross country ski use at Meadowbrook Park.						X			P	P	Boronow list 10/20/97	Village of Howard Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1994
Build a short trail system connecting nearby subdivisions to park.									P	P	Boronow list 10/20/97	City of Menasha Open Space and Recreation Facilities Plan	Steven Perry BBL 315-446-9120	1996
Construct a separated bike/pedestrian pathway a minimum of 8' wide on the south side of the road.									P	P	Boronow list 10/20/97	City of Menasha Open Space and Recreation Facilities Plan	Steven Perry BBL 315-446-9120	1996
Develop the north end of village by the old pickle ponds as a State park adjoining the trail.									P	P	Boronow list 10/20/97	Kelly to Howard State Recreation Trail Master Plan	Steven Perry BBL 315-446-9120	1995
Develop village owned property off of Sherwood Drive into a passive park with a nature preserve and hiking-biking and cross-country ski trails.									P	P	Boronow list 10/20/97	Village of Ashwaubenon Comprehensive Park and Recreation Plan	Steven Perry BBL 315-446-9120	1989
Heckrodt Wetland Reserve: install additional interpretive signage.									P	P	NFP table 10/21/97			1997
Construct a larger nature center building at the Navarino Nature Center.									MI/P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Acquire land for new community park in southeast Appleton.									MI/P	P	Boronow list 10/20/97	Appleton Parks and Recreation Master Plan 1995-1999.	Steven Perry BBL 315-446-9120	1994
Acquire land for new neighborhood park in north-central Appleton.									MI/P	P	Boronow list 10/20/97	Appleton Parks and Recreation Master Plan 1995-1999.	Steven Perry BBL 315-446-9120	1994
Acquire land for new neighborhood park in northeast Appleton.									MI/P	P	Boronow list 10/20/97	Appleton Parks and Recreation Master Plan 1995-1999.	Steven Perry BBL 315-446-9120	1994
Construct new district park on WP&L Site.									MI/P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Develop a new neighborhood park near West Neighborhood.									MI/P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Develop a joint school/park on the Maplewood site.	Calumet, Winnebago (WI)	Maplewood Junior High School Site, Menasha														X		
Acquire a parcel west of Rockwell and east of Pinecrest as a future park.	Brown (WI)	Village of Howard														X		
Acquire a site for a community park on the north side of Oshkosh, west of Jackson Street and north of Murdock Avenue.	Winnebago (WI)	Oshkosh														X		
Acquire East Hall from UW-O in order to construct a complete neighborhood park.	Winnebago (WI)	East Hall, Oshkosh														X		
Acquire land for and develop two neighborhood parks on the west side of Oshkosh.	Winnebago (WI)	Oshkosh														X		
Develop a neighborhood park in the far south side of the city near Fond du Lac Road south of Waukau Avenue.	Winnebago (WI)	Oshkosh														X		
Develop a new community park west of Highway 41, between STH 21 and 20th Avenue, to serve the expanding westside neighborhoods.	Winnebago (WI)	Oshkosh														X		
Develop a new neighborhood park in the far northwest quadrant of the city.	Winnebago (WI)	Oshkosh														X		
Develop a new neighborhood park facility in the Brooklyn-Oregon Street Area.	Winnebago (WI)	Oshkosh														X		
Develop a new neighborhood park facility in the neighborhood to the north of the UW-Oshkosh campus.	Winnebago (WI)	Oshkosh														X		
Develop a new neighborhood park facility near Harrison and Bowen Streets, north of Murdock, to overcome total deficiency in the existing park system.	Winnebago (WI)	Oshkosh														X		
Develop a park on the WPSC substation site east of Riverside Park.	Winnebago (WI)	WPSC substation site, Oshkosh														X		
Purchase property adjacent to Hole #17.	Winnebago (WI)	Municipal Golf Course, Oshkosh														X		
Revise sledding hill to promote safety and multi-use at Red Arrow Park.	Winnebago (WI)	Red Arrow Park, Oshkosh														X		
Acquire a five to ten acre neighborhood park site for the residential neighborhood located north of CTH "JJ" and west of Ontario Road.	Brown (WI)	Bellevue														X		
Acquire property for 10-20 acre neighborhood park east of Lime Kiln Road on or near the Clarence Vanden Heuvel farm south of Verlin Road.	Brown (WI)	Bellevue														X		

Project Description	Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
	Project Category													
Develop a joint school/park on the Maplewood site.									MI/P	P	Boronow list 10/20/97	City of Menasha Open Space and Recreation Facilities Plan	Steven Perry BBL 315-446-9120	1996
Acquire a parcel west of Rockwell and east of Pinecrest as a future park.									MI/P	P	Boronow list 10/20/97	Kelly to Howard State Recreation Trail Master Plan	Steven Perry BBL 315-446-9120	1995
Acquire a site for a community park on the north side of Oshkosh, west of Jackson Street and north of Murdock Avenue.									MI/P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Acquire East Hall from UW-O in order to construct a complete neighborhood park.									MI/P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Acquire land for and develop two neighborhood parks on the west side of Oshkosh.									MI/P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Develop a neighborhood park in the far south side of the city near Fond du Lac Road south of Waukau Avenue.									MI/P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Develop a new community park west of Highway 41, between STH 21 and 20th Avenue, to serve the expanding westside neighborhoods.									MI/P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Develop a new neighborhood park in the far northwest quadrant of the city.									MI/P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Develop a new neighborhood park facility in the Brooklyn-Oregon Street Area.									MI/P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Develop a new neighborhood park facility in the neighborhood to the north of the UW-Oshkosh campus.									MI/P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Develop a new neighborhood park facility near Harrison and Bowen Streets, north of Murdock, to overcome total deficiency in the existing park system.									MI/P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Develop a park on the WPSC substation site east of Riverside Park.									MI/P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Purchase property adjacent to Hole #17.									MI/P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Revise sledding hill to promote safety and multi-use at Red Arrow Park.									MI/P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Acquire a five to ten acre neighborhood park site for the residential neighborhood located north of CTH "JJ" and west of Ontario Road.									MI/P	P	Boronow list 10/20/97	Town of Bellevue Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1991
Acquire property for 10-20 acre neighborhood park east of Lime Kiln Road on or near the Clarence Vanden Heuvel farm south of Verlin Road.									MI/P	P	Boronow list 10/20/97	Town of Bellevue Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1991

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Acquire property for a 20-25 acre community park adjacent Cottage Road (consistent with the Town of Bellevue Comprehensive Plan).	Brown (WI)	Bellevue														X		
Construct a neighborhood park in the vicinity of Verlin Road.	Brown (WI)	Bellevue														X		
Reserve or acquire a 25 to 40 acre site east of Ontario Road for a community park site.	Brown (WI)	Ontario Road, Bellevue														X		
Construct a community park, preferably along Trout Creek Road.	Brown (WI)	Hobart														X		
Plan and develop an additional park site in the southwest quadrant of the village.	Outagamie (WI)	Village of Ashwaubenon														X		
Construct community park at the eastern portion of an area bounded by Glendale Avenue, Shawano Avenue, Milltown Road and Marley Street.	Brown (WI)	Village of Howard														X		
Construct community park at the south-central portion of the area bounded by Evergreen Avenue, Pinecreast Road and Shawano Avenue.	Brown (WI)	Village of Howard														X		
Construct neighborhood park at the central portion of an area bounded by Woodale Avenue, I Hillcrest Heights, Sunray Lane and Rockwell Road.	Brown (WI)	Village of Howard														X		
Construct neighborhood park at the extreme southwestern portion of the area bounded by Pinecrest Road, Lineville Road, Hillcrest Heights and the Chicago and northwestern Railroad Line.	Brown (WI)	Village of Howard														X		
Construct neighborhood park at the southeastern portion of an area bounded by Melody Drive, Lenwood Avenue and Military Avenue.	Brown (WI)	Village of Howard														X		
Construct bicycle lanes along entrance roads.	Brown (WI)	Pamperin Park														X		
Construct walkways between parking aisles at Pamperin Park.	Brown (WI)	Pamperin Park														X		
Construct a sidewalk along the north side of Harbor View Drive from Park Avenue to Winnebago Drive.	Fond du Lac (WI)	Lakeside Park West, City of Fond du Lac														X		
Develop a bicycle/pedestrian crossing over Highway 41. Optimum location is between 20th Avenue and Ninth Avenue	Winnebago (WI)	Oshkosh														X		
Remove the bridge over the railroad on Hillcrest Heights.	Brown (WI)	Village of Howard																
Remove the overhead structure at Velp Avenue.	Brown (WI)	Village of Howard																

	Project Category													
Project Description	Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Acquire property for a 20-25 acre community park adjacent Cottage Road (consistent with the Town of Bellevue Comprehensive Plan).									MI/P	P	Boronow list 10/20/97	Town of Bellevue Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1991
Construct a neighborhood park in the vicinity of Verlin Road.									MI/P	P	Boronow list 10/20/97	Town of Bellevue Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1991
Reserve or acquire a 25 to 40 acre site east of Ontario Road for a community park site.									MI/P	P	Boronow list 10/20/97	Town of Bellevue Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1991
Construct a community park, preferably along Trout Creek Road.									MI/P	P	Boronow list 10/20/97	Town of Hobart Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1991
Plan and develop an additional park site in the southwest quadrant of the village.									MI/P	P	Boronow list 10/20/97	Village of Ashwaubenon Comprehensive Park and Recreation Plan	Steven Perry BBL 315-446-9120	1989
Construct community park at the eastern portion of an area bounded by Glendale Avenue, Shawano Avenue, Milltown Road and Marley Street.									MI/P	P	Boronow list 10/20/97	Village of Howard Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1994
Construct community park at the south-central portion of the area bounded by Evergreen Avenue, Pinecreast Road and Shawano Avenue.									MI/P	P	Boronow list 10/20/97	Village of Howard Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1994
Construct neighborhood park at the central portion of an area bounded by Woodale Avenue, I Hillcrest Heights, Sunray Lane and Rockwell Road.									MI/P	P	Boronow list 10/20/97	Village of Howard Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1994
Construct neighborhood park at the extreme southwestern portion of the area bounded by Pinecrest Road, Lineville Road, Hillcrest Heights and the Chicago and northwestern Railroad Line.									MI/P	P	Boronow list 10/20/97	Village of Howard Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1994
Construct neighborhood park at the southeastern portion of an area bounded by Melody Drive, Lenwood Avenue and Military Avenue.									MI/P	P	Boronow list 10/20/97	Village of Howard Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1994
Construct bicycle lanes along entrance roads.									MI/P	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Construct walkways between parking aisles at Pamperin Park.									MI/P	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Construct a sidewalk along the north side of Harbor View Drive from Park Avenue to Winnebago Drive.									MI/P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Develop a bicycle/pedestrian crossing over Highway 41. Optimum location is between 20th Avenue and Ninth Avenue									MI/P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Remove the bridge over the railroad on Hillcrest Heights.								X	MI/P	P	Boronow list 10/20/97	Kelly to Howard State Recreation Trail Master Plan	Steven Perry BBL 315-446-9120	1995
Remove the overhead structure at Velp Avenue.								X	MI/P	P	Boronow list 10/20/97	Kelly to Howard State Recreation Trail Master Plan	Steven Perry BBL 315-446-9120	1995

Project Description	County or Reservation	Location	Project Category															
			Riparian buffer zone restoration	Agricultural practices improvements	Animal waste handling improvements	Urban non-point source controls	Shoreline stabilization	Wetland restoration	Island habitat restoration	Wetland preservation	Fish artificial habitat creation	Bird artificial habitat creation	Rare/endangered spp. programs	Shoreline softening	Exotic species control	Improve parks or trails	Rec. fishing access improvements	Native American land preservation
Landscape and plant trees at Danbury Park.	Fond du Lac (WI)	Danbury Park, City of Fond du Lac														X		
Landscape the northwest corner of Plamore Park.	Fond du Lac (WI)	Plamore Park, City of Fond du Lac														X		
Replant oaks throughout Taylor Park.	Fond du Lac (WI)	Taylor Park, City of Fond du Lac														X		
Replace trees at Taylor Park.	Fond du Lac (WI)	Taylor Park, City of Fond du Lac														X		
Preserve the mature oak trees at East Hall.	Winnebago (WI)	East Hall, Oshkosh														X		
Replace mature oaks decimated by oak wilt with coniferous and deciduous species at Shawano Lake County Park.	Shawano (WI)	Shawano Lake County Park														X		
Purchase the remaining 12.5 acres at the Fairgrounds site presently owned by the City of De Pere.	Brown (WI)	Brown County Fairgrounds														X		
Require the use of shoreland buffer and green strips (1.7).		Lower Fox River/Green Bay	X															
Purchase natural buffer strips.		Lower Fox River/Green Bay watershed	X															
Implement comprehensive watershed management projects to reduce phosphorus and other pollutant loads from nonpoint sources (1.4).		Lower Fox River/Green Bay	X	X	X	X												
Seek innovative and alternative ways to achieve nonpoint source management objectives. (1.5)		Lower Fox River/Green Bay	X	X	X	X												
Require and use construction erosion and storm-water runoff controls (1.6).		Lower Fox River/Green Bay				X												
Evaluate and, as necessary, control urban stormwater discharges and runoff (11.2).		Lower Fox River/Green Bay				X												
Use Best Management Practices for agriculture.		Lower Fox River/Green Bay watershed		X	X													

Project Description	Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Landscape and plant trees at Danbury Park.									MI/P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Landscape the northwest corner of Plamore Park.									MI/P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Replant oaks throughout Taylor Park.									MI/P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Replace trees at Taylor Park.									MI/P	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Preserve the mature oak trees at East Hall.									MI/P	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Replace mature oaks decimated by oak wilt with coniferous and deciduous species at Shawano Lake County Park.									MI/P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Purchase the remaining 12.5 acres at the Fairgrounds site presently owned by the City of De Pere.									MI/P	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Require the use of shoreland buffer and green strips (1.7).									MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Purchase natural buffer strips.									MI/P	I	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Implement comprehensive watershed management projects to reduce phosphorus and other pollutant loads from nonpoint sources (1.4).									MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Seek innovative and alternative ways to achieve nonpoint source management objectives. (1.5)									MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Require and use construction erosion and storm-water runoff controls (1.6).	X								MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Evaluate and, as necessary, control urban stormwater discharges and runoff (11.2).									MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Use Best Management Practices for agriculture.									MI/P	I	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Initiate industrial lot and urban runoff control demonstration projects (11.4).		Lower Fox River/Green Bay				X												
Adopt animal waste management ordinances and use Best Management Practices (1.8).		Lower Fox River/Green Bay		X	X													
Use the Department of Natural Resources fee acquisition authority for land within the project boundary of the Green Bay West Shores Wildlife Area to buy property from willing sellers. Note: list of key acquisition parcels included.	Brown, Marinette, Oconto (WI)	Green Bay								X								
Include additional land in conservation reserve (2.1).		Lower Fox River/Green Bay								X								
Continue West Shoreline acquisition (6.1).		Lower Fox River/Green Bay								X								
Establish goals for wetland and other habitat protection and use existing authorities to achieve them (6.2).		Lower Fox River/Green Bay																
Encourage private wetland preservation (6.5).		Lower Fox River/Green Bay								X								
Revert 160 acres of agricultural land.		?						X										
Acquire the hillside and shoreline to the west and north of the Birch Lake Access.	Marquette (WI)	Birch Lake Access																
Gordon Bubolz Nature Preserve: up to 493.48 acres.		Gordon Bubolz Nature Preserve														X		
Improve Interstate-43 wetland mitigation areas (6.12).		Lower Fox River/Green Bay						X										
Create diked wetlands (Peter's Marsh and Malchow Marsh).		Peter's Marsh and Malchow Marsh						X										
Dike wetlands if needed (6.11).		Lower Fox River/Green Bay																

	Project Category													
Project Description	**Point source controls**	**PCB cleanup**	**Study**	**Public education**	**Upland habitat/species programs**	**Other recreation**	**Misc.**	**Unknown**	**Addresses injured resources or services lost as a result of injuries**	**Type: Idea or Project**	**Idea or Project Source Document**	**Reference Document or Project Title**	**Reference Document Contact**	**Reference Document Year**
Initiate industrial lot and urban runoff control demonstration projects (11.4).				X					MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Adopt animal waste management ordinances and use Best Management Practices (1.8).									MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Use the Department of Natural Resources fee acquisition authority for land within the project boundary of the Green Bay West Shores Wildlife Area to buy property from willing sellers. Note: list of key acquisition parcels included.									MI/P	P	Boronow Project Reviews	Green Bay West Shore Wildlife Area - Acquisition	Terry Gardon WDNR Land Agent (920) 492-5814	1997
Include additional land in conservation reserve (2.1).									MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Continue West Shoreline acquisition (6.1).									MI/P	P	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Establish goals for wetland and other habitat protection and use existing authorities to achieve them (6.2).								X	MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Encourage private wetland preservation (6.5).									MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Revert 160 acres of agricultural land.									MI/P	I	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Acquire the hillside and shoreline to the west and north of the Birch Lake Access.								X	MI/P	P	Boronow list 10/20/97	Marquette County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1991
Gordon Bubolz Nature Preserve: up to 493.48 acres.									MI/P	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Improve Interstate-43 wetland mitigation areas (6.12).									MI/P	P	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Create diked wetlands (Peter's Marsh and Malchow Marsh).									MI/P	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Dike wetlands if needed (6.11).								X	MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Change bulkhead lines as necessary to protect habitat (6.6).		Lower Fox River/Green Bay								X								
Consider stabilizing Cat Island (6.10).		Lower Fox River/Green Bay							X									
Re-establish submerged aquatic vegetation .		Green Bay																
Restore former vegetative condition at breeding colonies of waterbirds.		Green Bay																
Create artificial island/colonial waterbird nesting area.		Green Bay										X						
Consider development of artificial reefs (6.13).		Lower Fox River/Green Bay									X							
Provide upland bird nesting habitat (6.14).		Lower Fox River/Green Bay																
Develop and use habitat enhancement (6.9).		Lower Fox River/Green Bay																
Create fish spawning/feeding areas for walleye, northern pike.		Green Bay								X	X							
Fish stocking/hatchery support.		Green Bay															X	
Seasonally limit public entry to critical habitat (6.8).		Lower Fox River/Green Bay																
Conduct pilot project to evaluate and manage carp populations (7.2).		Lower Fox River/Green Bay													X			
Complete purple loosestrife control plan and manage accordingly in the Area of Concern (6.15).		Lower Fox River/Green Bay													X			

Project Description	Project Category: Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Change bulkhead lines as necessary to protect habitat (6.6).									MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Consider stabilizing Cat Island (6.10).									MI/P	P	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Re-establish submerged aquatic vegetation .								X	MI/P	I	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1994	Vicky Harris WDNR 920-492-5904	1994
Restore former vegetative condition at breeding colonies of waterbirds.								X	MI/P	I	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1994	Vicky Harris WDNR 920-492-5904	1994
Create artificial island/colonial waterbird nesting area.									MI/P	I	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Consider development of artificial reefs (6.13).									MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Provide upland bird nesting habitat (6.14).					X				MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Develop and use habitat enhancement (6.9).								X	MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Create fish spawning/feeding areas for walleye, northern pike.									MI/P	I	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Fish stocking/hatchery support.									MI/P	I	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Seasonally limit public entry to critical habitat (6.8).								X	MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Conduct pilot project to evaluate and manage carp populations (7.2).									MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Complete purple loosestrife control plan and manage accordingly in the Area of Concern (6.15).									MI/P	P	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988

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Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Manage alewife as necessary (7.3).		Lower Fox River/Green Bay													X			
Accelerate efforts to revitalize the waterfronts and enhance the shoreline (14.6).		Lower Fox River/Green Bay																
Evaluate potential for developing a swimming beach in the area of concern (14.3).		Lower Fox River/Green Bay																
Protect and develop recreational and environmental corridors (14.5).		Lower Fox River/Green Bay																
Connect Peabody Park Trail with trails to Lawrence University and east to Ballard Road.	Outagamie (WI)	Appleton														X		
Gordon Bubolz Nature Preserve: construct additional trails and observation decks.		Gordon Bubolz Nature Preserve														X		
Heckrodt Wetland Reserve: construct additional trails/boardwalk.		Heckrodt Wetland Reserve														X		
Evaluate and upgrade boat launch facilities as necessary (14.1).		Lower Fox River/Green Bay															X	
Develop shoreline fishing facilities (14.4).		Lower Fox River/Green Bay															X	
Encourage development of marina facilities if environmentally and fiscally sound (14.2).		Lower Fox River/Green Bay															X	
Improve launches on the Cloverleaf Chain.	Shawano (WI)	Cloverleaf Chain															X	
Gordon Bubolz Nature Preserve: construct major observation deck at nature center.		Gordon Bubolz Nature Preserve														X		
Gordon Bubolz Nature Preserve: expand nature center, construct observation decks, and replace signage.		Gordon Bubolz Nature Preserve														X		
Gordon Bubolz Nature Preserve: install additional interpretive signage.		Gordon Bubolz Nature Preserve														X		
Edison Heritage Park: construct access/parking and boardwalk with 3 observation decks, and install interpretive signage.		Edison Heritage Park														X		

Project Description	Project Category: Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Manage alewife as necessary (7.3).									MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Accelerate efforts to revitalize the waterfronts and enhance the shoreline (14.6).								X	MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Evaluate potential for developing a swimming beach in the area of concern (14.3).						X			MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Protect and develop recreational and environmental corridors (14.5).								X	MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Connect Peabody Park Trail with trails to Lawrence University and east to Ballard Road.									MI/P	P	Boronow Project Reviews	Appleton, Trail Connection	Dick Sachs GBMSD (920) 432-4893	1997
Gordon Bubolz Nature Preserve: construct additional trails and observation decks.									MI/P	P	NFP table 10/21/97			1997
Heckrodt Wetland Reserve: construct additional trails/boardwalk.									MI/P	P	NFP table 10/21/97			1997
Evaluate and upgrade boat launch facilities as necessary (14.1).									MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Develop shoreline fishing facilities (14.4).									MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Encourage development of marina facilities if environmentally and fiscally sound (14.2).									MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Improve launches on the Cloverleaf Chain.									MI/P	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Gordon Bubolz Nature Preserve: construct major observation deck at nature center.									MI/P	P	NFP table 10/21/97			1997
Gordon Bubolz Nature Preserve: expand nature center, construct observation decks, and replace signage.									MI/P	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Gordon Bubolz Nature Preserve: install additional interpretive signage.									MI/P	P	NFP table 10/21/97			1997
Edison Heritage Park: construct access/parking and boardwalk with 3 observation decks, and install interpretive signage.									MI/P	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Evaluate and control ammonia toxicity (3.8).		Lower Fox River/Green Bay		X	X	X												
Monitor and control discharges of acute and chronic toxicity (3.9).		Lower Fox River/Green Bay		X	X	X												
Encourage inclusion of both economic and environmental viewpoints on policy advisory boards (13.5).		Lower Fox River/Green Bay																
Clean-up contaminated sediments based on results of the feasibility study (4.4).		Lower Fox River/Green Bay																
Coordinate navigational dredging projects and remedial measures (4.8).		Lower Fox River/Green Bay																
Consider pilot projects to control suspended sediments (9.1).		Lower Fox River/Green Bay	X	X														
Consider spoil bed stabilization (9.2).		Lower Fox River/Green Bay					X											
Determine causes of and manage turbidity (9.3).		Lower Fox River/Green Bay																
Disinfect municipal wastewater treatment plant discharges as needed to protect swimming and other recreational uses of the bay and river (10.2).		Lower Fox River/Green Bay																
Evaluate and control runoff of toxic substances from all watershed sources (11.1).		Lower Fox River/Green Bay	X	X	X	X												
Prevent chemical and coal stockpile runoff (11.3).		Lower Fox River/Green Bay		X	X	X												

Project Description	Project Category: Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Evaluate and control ammonia toxicity (3.8).	X								MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Monitor and control discharges of acute and chronic toxicity (3.9).	X								MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Encourage inclusion of both economic and environmental viewpoints on policy advisory boards (13.5).								X	MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Clean-up contaminated sediments based on results of the feasibility study (4.4).		X							MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Coordinate navigational dredging projects and remedial measures (4.8).		X							MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Consider pilot projects to control suspended sediments (9.1).									MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Consider spoil bed stabilization (9.2).								X	MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Determine causes of and manage turbidity (9.3).								X	MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Disinfect municipal wastewater treatment plant discharges as needed to protect swimming and other recreational uses of the bay and river (10.2).								X	MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Evaluate and control runoff of toxic substances from all watershed sources (11.1).	X								MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Prevent chemical and coal stockpile runoff (11.3).	X								MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Minimize impacts of ultimate disposal of toxic contaminants (4.10).		Lower Fox River/Green Bay																
Avoid re-introduction of toxic pollutants to the River system (4.5).		Lower Fox River/Green Bay																
Protect against outbreaks of avian disease (6.17).		Lower Fox River/Green Bay																
Continue adoption and strict enforcement of local wetland zoning (6.3).		Lower Fox River/Green Bay								X								
Consider additional wetland zoning (6.4).		Lower Fox River/Green Bay								X								
Continue to use shoreland modification permits to protect habitat and water quality (6.7).		Lower Fox River/Green Bay								X								
Recognize swimming as a desired use of the Bay and River when reviewing and revising applicable water quality standards (10.1).		Lower Fox River/Green Bay																
Precision agriculture GIS project.	Brown (WI)																	
Complete development of a program to prevent sea lamprey migration (7.1).		Lower Fox River/Green Bay													X			
Acquire or develop use agreement for the portion of the Escanaba & Lake Superior railroad corridor from its intersection of the trail on the west side of Velp Avenue south to Riverview Drive in Downtown Howard.	Brown (WI)	Village of Howard														X		
Acquire or secure properties along the East River and Bower Creek (recommended as part of East River Parkway Plan).	Brown (WI)	Bellevue														X		
Extend park land to bulkhead line.	Outagamie (WI)	Ashwaubomay Park, Village of Ashwaubenon														X		

Project Description	Project Category: Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Minimize impacts of ultimate disposal of toxic contaminants (4.10).								X	MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Avoid re-introduction of toxic pollutants to the River system (4.5).								X	MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Protect against outbreaks of avian disease (6.17).								X	MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Continue adoption and strict enforcement of local wetland zoning (6.3).									MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Consider additional wetland zoning (6.4).									MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Continue to use shoreland modification permits to protect habitat and water quality (6.7).									MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Recognize swimming as a desired use of the Bay and River when reviewing and revising applicable water quality standards (10.1).						X			MI/P	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Precision agriculture GIS project.								X	MI	P	Boronow Project Reviews	Brown County, Precision Agriculture GIS Project	Dick Sachs GBMSD (920) 432-4893	1997
Complete development of a program to prevent sea lamprey migration (7.1).									MI	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Acquire or develop use agreement for the portion of the Escanaba & Lake Superior railroad corridor from its intersection of the trail on the west side of Velp Avenue south to Riverview Drive in Downtown Howard.									MI	P	Boronow list 10/20/97	Kelly to Howard State Recreation Trail Master Plan	Steven Perry BBL 315-446-9120	1995
Acquire or secure properties along the East River and Bower Creek (recommended as part of East River Parkway Plan).									MI	P	Boronow list 10/20/97	Town of Bellevue Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1991
Extend park land to bulkhead line.									MI	P	Boronow list 10/20/97	Village of Ashwaubenon Comprehensive Park and Recreation Plan	Steven Perry BBL 315-446-9120	1989

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Construct a man-made lake.	Brown (WI)	Neshota Park														X		
Develop the Andy Krakow Memorial Park at the Montello lock site.	Brown, Outagamie (WI)	Montello														X		
Improve and expand Riverside Park.	Winnebago (WI)	Riverside Park, Oshkosh														X		
Acquire land at the northwest corner of Roe Park.	Winnebago (WI)	Roe Park, Oshkosh														X		
Develop a special purpose park at the rock quarry located west of South Park.	Winnebago (WI)	Oshkosh														X		
Stabilize water lagoons and reconstruct dam at South Park.	Winnebago (WI)	South Park, Oshkosh																
Expand Heritage Park.	Shawano (WI)	Heritage Park														X		
Install handicapped-accessible facilities at Shawano Lake County Park.	Shawano (WI)	Shawano Lake County Park														X		
Acquire one to three acres south of creek adjacent Josten Park.	Brown (WI)	Josten Park, Bellevue														X		
Acquire parcels #340 and 342-1, located between Bellevue Street and the East River for the development of a community park facility (recommended as part of East River Parkway Plan).	Brown (WI)	Bellevue														X		
Develop a community park, preferably along the proposed East River parkway.	Brown (WI)	East River Parkway, Bellevue														X		
Expand Brussels Town Park.	Brown (WI)	Brussels Town Park														X		
Initiate program to evaluate and manage northern pike populations (8.3).		Lower Fox River/Green Bay																
Improve air quality and associated aesthetics (14.8).		Lower Fox River/Green Bay																
Continue and expand walleye management program (8.1).		Lower Fox River/Green Bay															X	

	Project Category													
Project Description	**Point source controls**	**PCB cleanup**	**Study**	**Public education**	**Upland habitat/species programs**	**Other recreation**	**Misc.**	**Unknown**	**Addresses injured resources or services lost as a result of injuries**	**Type: Idea or Project**	**Idea or Project Source Document**	**Reference Document or Project Title**	**Reference Document Contact**	**Reference Document Year**
Construct a man-made lake.									MI	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Develop the Andy Krakow Memorial Park at the Montello lock site.									MI	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Improve and expand Riverside Park.									MI	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Acquire land at the northwest corner of Roe Park.									MI	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Develop a special purpose park at the rock quarry located west of South Park.									MI	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Stabilize water lagoons and reconstruct dam at South Park.								X	MI	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Expand Heritage Park.									MI	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Install handicapped-accessible facilities at Shawano Lake County Park.									MI	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Acquire one to three acres south of creek adjacent Josten Park.									MI	P	Boronow list 10/20/97	Town of Bellevue Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1991
Acquire parcels #340 and 342-1, located between Bellevue Street and the East River for the development of a community park facility (recommended as part of East River Parkway Plan).									MI	P	Boronow list 10/20/97	Town of Bellevue Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1991
Develop a community park, preferably along the proposed East River parkway.									MI	P	Boronow list 10/20/97	Town of Bellevue Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1991
Expand Brussels Town Park.									MI	P	Boronow list 10/20/97	Town of Brussels Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1995
Initiate program to evaluate and manage northern pike populations (8.3).			X						MI	P	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Improve air quality and associated aesthetics (14.8).								X	MI	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Continue and expand walleye management program (8.1).									MI	P	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Continue perch management program and complete research projects (8.2).		Lower Fox River/Green Bay															X	
Complete mass balance study of toxic substances (16.1).		Lower Fox River/Green Bay																
Determine mass and availability of PCB and other contaminants in the River system (4.1).		Lower Fox River/Green Bay																
Make detention basin modifications at Adelaide Park du Lac.	Fond du Lac (WI)	Adelaide Park, City of Fond du Lac																
Reconstruct south retaining wall of boat launch.	Brown (WI)	Boat Launch, Village of Howard															X	
Construct trails within and along Baird Creek Parkway (Triangle Sports Hill).	Brown (WI)	Baird Creek Parkway														X		
Connect Peabody Park Trail with trails to Lawrence University.	Brown, Outagamie (WI)	Appleton														X		
Construct hard surface trails through Sunset Point Park.	Brown, Outagamie (WI)	Sunset Point Park, Village of Kimberly														X		
Extend walkway that connects the rear exit of the Paper Valley Convention Hotel to Jones Park to the Lincoln Mill Project.	Brown, Outagamie, Winnebago (WI)	Fox River														X		
Construct multi-purpose trail through Appleton Memorial Park.	Outagamie, Winnebago (WI)	Appleton Memorial Park, Appleton														X		
Construct multi-purpose trail through planting strip in Ballard Road right-of-way between Northland Avenue and Glendale Avenue.	Outagamie, Winnebago (WI)	Appleton														X		
Construct multi-use trails at Neshota Park.	Brown (WI)	Neshota Park														X		
Construct trail system at Lily Lake Park.	Brown (WI)	Lily Lake Park														X		
Construct trails with bridge along STH "29" and in the area by the quarry.	Brown (WI)	Pamperin Park														X		
Develop trails at Way-Morr Park.	Brown (WI)	Way-Morr Park														X		

	Project Category													
Project Description	**Point source controls**	**PCB cleanup**	**Study**	**Public education**	**Upland habitat/species programs**	**Other recreation**	**Misc.**	**Unknown**	**Addresses injured resources or services lost as a result of injuries**	**Type: Idea or Project**	**Idea or Project Source Document**	**Reference Document or Project Title**	**Reference Document Contact**	**Reference Document Year**
Continue perch management program and complete research projects (8.2).			X						MI	P	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Complete mass balance study of toxic substances (16.1).			X						MI	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Determine mass and availability of PCB and other contaminants in the River system (4.1).			X						MI	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Make detention basin modifications at Adelaide Park du Lac.								X	MI	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Reconstruct south retaining wall of boat launch.									MI	P	Boronow list 10/20/97	Village of Howard Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1994
Construct trails within and along Baird Creek Parkway (Triangle Sports Hill).									MI	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Connect Peabody Park Trail with trails to Lawrence University.									MI	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997
Construct hard surface trails through Sunset Point Park.									MI	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997
Extend walkway that connects the rear exit of the Paper Valley Convention Hotel to Jones Park to the Lincoln Mill Project.									MI	P	Boronow list 10/20/97	The Fox River Corridor Study	Steven Perry BBL 315-446-9120	1989
Construct multi-purpose trail through Appleton Memorial Park.									MI	P	Boronow list 10/20/97	Appleton Parks and Recreation Master Plan 1995-1999.	Steven Perry BBL 315-446-9120	1994
Construct multi-purpose trail through planting strip in Ballard Road right-of-way between Northland Avenue and Glendale Avenue.									MI	P	Boronow list 10/20/97	Appleton Parks and Recreation Master Plan 1995-1999.	Steven Perry BBL 315-446-9120	1994
Construct multi-use trails at Neshota Park.									MI	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Construct trail system at Lily Lake Park.									MI	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Construct trails with bridge along STH "29" and in the area by the quarry.									MI	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Develop trails at Way-Morr Park.									MI	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990

			Project Category															
Project Description	County or Reservation	Location	Riparian buffer zone restoration	Agricultural practices improvements	Animal waste handling improvements	Urban non-point source controls	Shoreline stabilization	Wetland restoration	Island habitat restoration	Wetland preservation	Fish artificial habitat creation	Bird artificial habitat creation	Rare/endangered spp. programs	Shoreline softening	Exotic species control	Improve parks or trails	Rec. fishing access improvements	Native American land preservation
Extension of Lallier Park trail across National Avenue into Brookside Park.	Fond du Lac (WI)	Lakeside Park West, City of Fond du lac														X		
Create a marked bike route from Menasha to High Cliff State Park cooperatively with the Town of Harrison.	Calumet, Winnebago (WI)	Menasha														X		
Develop linkage from Portage lock to Fort Winnebago site.	Brown, Outagamie (WI)	Portage																
Construct linkages of Vulcan site to the Hearthstone and of the Locktender site to the Country Club.	Brown, Outagamie (WI)	Appleton																
Acquire a parcel at the southwest corner of the intersection of the trail and Velp Avenue for access/parking lot and trailhead to the trail. A ramp could be constructed to bring trail users to the elevated grade.	Brown (WI)	Village of Howard														X		
Construct 10-mile segment of the Ice Age Trail between Portage and John Muir County Park.	Marquette (WI)	John Muir County Park														X		
Extend Ice Age Trail north from John Muir County Park.	Marquette (WI)	John Muir County Park														X		
Extend Ice Age Trail to Montello, Harrisville, Westfield, and north into Waushara County.	Marquette (WI)	John Muir County Park														X		
Designate the former electrical company right-of-way that parallels the existing Wisconsin Central Railroad track as a scenic pathway.	Winnebago (WI)	Oshkosh														X		
Link the City trail system with the WIOUWASH regional recreation trail and other regional trails.	Winnebago (WI)	Oshkosh														X		
Upgrade sidewalk/bikeway.	Winnebago (WI)	South Park, Oshkosh														X		
Upgrade sidewalk/walk paths.	Winnebago (WI)	Algoma Park, Oshkosh														X		
Acquire, develop and promote the Shawano County portion of the proposed WIOUWASH Recreational Trail, which generally follows the abandoned railroad right-of-way between Marion and Antigo.	Shawano (WI)															X		
Connect Shawano County trail with Ice Age Trail.	Shawano (WI)															X		
Develop Duck Creek Parkway/Corridor.	Brown (WI)	Hobart														X		

Project Description	Project Category: Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Extension of Lallier Park trail across National Avenue into Brookside Park.									MI	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Create a marked bike route from Menasha to High Cliff State Park cooperatively with the Town of Harrison.									MI	P	Boronow list 10/20/97	City of Menasha Open Space and Recreation Facilities Plan	Steven Perry BBL 315-446-9120	1996
Develop linkage from Portage lock to Fort Winnebago site.								X	MI	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Construct linkages of Vulcan site to the Hearthstone and of the Locktender site to the Country Club.								X	MI	P	Boronow list 10/20/97	Fox River Upper Flats Development Opportunities A Strategic Plan	Steven Perry BBL 315-446-9120	1992
Acquire a parcel at the southwest corner of the intersection of the trail and Velp Avenue for access/parking lot and trailhead to the trail. A ramp could be constructed to bring trail users to the elevated grade.									MI	P	Boronow list 10/20/97	Kelly to Howard State Recreation Trail Master Plan	Steven Perry BBL 315-446-9120	1995
Construct 10-mile segment of the Ice Age Trail between Portage and John Muir County Park.									MI	P	Boronow list 10/20/97	Marquette County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1991
Extend Ice Age Trail north from John Muir County Park.									MI	P	Boronow list 10/20/97	Marquette County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1991
Extend Ice Age Trail to Montello, Harrisville, Westfield, and north into Waushara County.									MI	P	Boronow list 10/20/97	Marquette County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1991
Designate the former electrical company right-of-way that parallels the existing Wisconsin Central Railroad track as a scenic pathway.									MI	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Link the City trail system with the WIOUWASH regional recreation trail and other regional trails.									MI	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Upgrade sidewalk/bikeway.									MI	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Upgrade sidewalk/walk paths.									MI	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Acquire, develop and promote the Shawano County portion of the proposed WIOUWASH Recreational Trail, which generally follows the abandoned railroad right-of-way between Marion and Antigo.									MI	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Connect Shawano County trail with Ice Age Trail.									MI	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Develop Duck Creek Parkway/Corridor.									MI	P	Boronow list 10/20/97	Town of Hobart Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1991

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Develop a connecting path at Barney Williams Park.	Brown (WI)	Barney Williams Park, Village of Howard														X		
Develop paths at Lehner Park.	Brown (WI)	Lehner Park, Village of Howard														X		
Develop pathway at Pinewood Park.	Brown (WI)	Pinewood Park, Village of Howard														X		
Develop trail system at Spring Green Park.	Brown (WI)	Spring Green, Village of Howard														X		
Extend trails into new property at Meadowbrook Park.	Brown (WI)	Meadowbrook Park, Village of Howard														X		
Construct hiking and nature trails at west side of camp.	Brown (WI)	Reforestation Camp														X		
Develop the Fox River Trail on the abandonment railroad corridor and linkage to the WIOUWASH Trail.	Winnebago (WI)	Fox River Trail, Oshkosh														X		
Consider forming a bay and river interest group or coalition (13.6).		Lower Fox River/Green Bay																
Develop signage and trailhead for WIOUWASH Trail.	Winnebago (WI)	Carl Steiger Park, Oshkosh														X		
Establish a coordinating council and institutional structure to facilitate plan implementation (12.1).		Lower Fox River/Green Bay																
Remove structures in Fox River at William Steiger/FVTC Property.	Winnebago (WI)	Oshkosh																
Clean-up Neenah Creek downstream from Oxford.	Marquette (WI)	Neenah Creek																
Include opportunities for public participation and input on major decisions that affect the Bay and River (13.1).		Lower Fox River/Green Bay																
Preserve Duck Creek Parkway Corridor.	Brown (WI)	Village of Howard																

Project Description	Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
	Project Category													
Develop a connecting path at Barney Williams Park.									MI	P	Boronow list 10/20/97	Village of Howard Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1994
Develop paths at Lehner Park.									MI	P	Boronow list 10/20/97	Village of Howard Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1994
Develop pathway at Pinewood Park.									MI	P	Boronow list 10/20/97	Village of Howard Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1994
Develop trail system at Spring Green Park.									MI	P	Boronow list 10/20/97	Village of Howard Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1994
Extend trails into new property at Meadowbrook Park.									MI	P	Boronow list 10/20/97	Village of Howard Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1994
Construct hiking and nature trails at west side of camp.									MI	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Develop the Fox River Trail on the abandonment railroad corridor and linkage to the WIOUWASH Trail.									MI	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Consider forming a bay and river interest group or coalition (13.6).								X	MI	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Develop signage and trailhead for WIOUWASH Trail.									MI	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Establish a coordinating council and institutional structure to facilitate plan implementation (12.1).								X	MI	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Remove structures in Fox River at William Steiger/FVTC Property.								X	MI	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Clean-up Neenah Creek downstream from Oxford.								X	MI	P	Boronow list 10/20/97	Marquette County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1991
Include opportunities for public participation and input on major decisions that affect the Bay and River (13.1).								X	MI	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Preserve Duck Creek Parkway Corridor.								X	MI	P	Boronow list 10/20/97	Village of Howard Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1994

			Project Category															
Project Description	County or Reservation	Location	Riparian buffer zone restoration	Agricultural practices improvements	Animal waste handling improvements	Urban non-point source controls	Shoreline stabilization	Wetland restoration	Island habitat restoration	Wetland preservation	Fish artificial habitat creation	Bird artificial habitat creation	Rare/endangered spp. programs	Shoreline softening	Exotic species control	Improve parks or trails	Rec. fishing access improvements	Native American land preservation
Purchase four parcels along Lineville Road.	Brown (WI)	Barkhausen Waterfowl Preserve																
Construct ponds near east end of property.	Brown (WI)	Barkhausen Waterfowl Preserve																
Dig ponds west of Shelter No. 2.	Brown (WI)	Reforestation Camp																
Purchase 80 acre parcel along Pine Lane at Reforestation Camp.	Brown (WI)	Reforestation Camp																
Renovate quarry area and include fencing around quarry.	Brown (WI)	Pamperin Park																
Dredge selected channels in Supple Marsh.	Fond du Lac (WI)	Lakeside Park West, City of Fond du Lac																
Construct gravity dam at guard lock.	Brown, Outagamie (WI)	Village of Little Chute																
Dredge water lagoons.	Winnebago (WI)	Municipal Golf Course, Oshkosh																
Acquire land across the Red River from the Town of Richmond's park site east of the Alexan Brothers Novitiate.	Shawano (WI)	Red River														X		
Acquire the 40-acre parcel located directly south of Voelz Memorial Park.	Shawano (WI)	Voelz Memorial Park, Shawano County														X		
Acquire the two wooded parcels west of the existing School Site.	Brown (WI)	Hillcrest Elementary School, Hobart																
Adventure Island: 44 acres.		Adventure Island																
Flow-Clipping.		?																
Pilot Program.		?																
Chambers Island: 2,800 acres.		Chambers Island																
Detroit Island: 640 acres, with 20 acres of wetland.		Detroit Island																
Green Island: 86 acres.		Green Island																
Heckrodt Preserve: 6.7 acres.		Heckrodt Wetland Reserve							X									

	Project Category													
Project Description	Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Purchase four parcels along Lineville Road.								X	MI	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Construct ponds near east end of property.								X	MI	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Dig ponds west of Shelter No. 2.								X	MI	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Purchase 80 acre parcel along Pine Lane at Reforestation Camp.								X	MI	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Renovate quarry area and include fencing around quarry.								X	MI	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Dredge selected channels in Supple Marsh.								X	MI	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Construct gravity dam at guard lock.								X	MI	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Dredge water lagoons.								X	MI	F	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Acquire land across the Red River from the Town of Richmond's park site east of the Alexan Brothers Novitiate.									MI	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Acquire the 40-acre parcel located directly south of Voelz Memorial Park.									MI	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Acquire the two wooded parcels west of the existing School Site.								X	MI	P	Boronow list 10/20/97	Town of Hobart Comprehensive Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1991
Adventure Island: 44 acres.								X	MI	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Flow-Clipping.								X	MI	I	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Pilot Program.								X	MI	?	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Chambers Island: 2,800 acres.								X	MI	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Detroit Island: 640 acres, with 20 acres of wetland.								X	MI	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Green Island: 86 acres.								X	MI	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Heckrodt Preserve: 6.7 acres.									MI	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Jack Island: 6 acres.		Jack Island																
Little Strawberry Island: 10 acres.		Little Strawberry Island																
Little Summer Island: 415 acres.		Little Summer Island																
Little Tail Point: 335 acres.		Little Tail Point								X								
Malchow Marsh: 332 acres, 160 wetland acres.		Malchow Marsh								X								
Mouth of Creek near Deposit C: 10 acres.		Fox River								X								
Mouth of Little Suamico River: up to 900 acres.		Little Suamico River								X								
Mouth of Tibbet Creek: up to 150 acres.		Tibbet Creek								X								
North Shore of Peats Lake: 345 acres, 50 wetland acres.		Peats Lake								X								
Shore west of Deposits E and F: 200 acres.		Fox River																
Snake Island: 2 acres.		Snake Island																
Southern end of deposit POG: 10 acres.		Fox River																
Southwest shore of Deadhorse Bay: 191 acres, 160 wetland acres.		Deadhorse Bay								X								
St. Martin Island: 1,280 acres.		St. Martin Island																
Summer Island: 810 acres.		Summer Island																
Upstream of Deposit EE: 15 acres.		Fox River																
Wetland #79: 2 acres, 8 wetland acres.		Wetland #79								X								
Maintain and upgrade vegetative soil cover over past landfill areas to reduce gas production and contamination of ground water.	Winnebago (WI)	Quarry Park, Oshkosh																
Upgrade Cedars lock to operational status.	Brown, Outagamie (WI)	Village of Little Chute																
Fully restore the upstream lock in Appleton - Appleton #1 (refer to Fox River Upper Flats Development Opportunities- A Strategic Plan, in addition to Fox River Corridor Study for potential uses).	Brown, Outagamie (WI)	Fox River																
Restore Appleton lock #3.	Brown, Outagamie (WI)	Appleton																

Project Description	Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
	Project Category													
Jack Island: 6 acres.								X	MI	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Little Strawberry Island: 10 acres.								X	MI	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Little Summer Island: 415 acres.								X	MI	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Little Tail Point: 335 acres.									MI	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Malchow Marsh: 332 acres, 160 wetland acres.									MI	P	NFP table & PRP slides		Steven Perry BBL 315-446-9120	1997
Mouth of Creek near Deposit C: 10 acres.									MI	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Mouth of Little Suamico River: up to 900 acres.									MI	P	NFP table 10/21/97			1997
Mouth of Tibbet Creek: up to 150 acres.									MI	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
North Shore of Peats Lake: 345 acres, 50 wetland acres.									MI	P	NFP table & PRP slides		Steven Perry BBL 315-446-9120	1997
Shore west of Deposits E and F: 200 acres.								X	MI	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Snake Island: 2 acres.								X	MI	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Southern end of deposit POG: 10 acres.								X	MI	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Southwest shore of Deadhorse Bay: 191 acres, 160 wetland acres.									MI	P	NFP table & PRP slides		Steven Perry BBL 315-446-9120	1997
St. Martin Island: 1,280 acres.								X	MI	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Summer Island: 810 acres.								X	MI	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Upstream of Deposit EE: 15 acres.								X	MI	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Wetland #79: 2 acres, 8 wetland acres.									MI	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Maintain and upgrade vegetative soil cover over past landfill areas to reduce gas production and contamination of ground water.									F	P	10/20/97 Boronow list	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Upgrade Cedars lock to operational status.									F	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Fully restore the upstream lock in Appleton - Appleton #1 (refer to Fox River Upper Flats Development Opportunities- A Strategic Plan, in addition to Fox River Corridor Study for potential uses).									F	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997
Restore Appleton lock #3.									F	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997

			Project Category																
Project Description	County or Reservation	Location	Riparian buffer zone restoration	Agricultural practices improvements	Animal waste handling improvements	Urban non-point source controls	Shoreline stabilization	Wetland restoration	Island habitat restoration	Wetland preservation	Fish artificial habitat creation	Bird artificial habitat creation	Rare/endangered spp. programs	Shoreline softening	Exotic species control	Improve parks or trails	Rec. fishing access improvements	Native American land preservation
Restore Appleton lock #4.	Brown, Outagamie (WI)	Appleton																
Restore combined locks structure in Little Chute and convert brick locktender's house for visitor support services.	Brown, Outagamie (WI)	Village of Little Chute																
Restore Kaukauna lock #1 and locktender's house.	Brown, Outagamie (WI)	Fox River																
Restore Kaukauna lock #4.	Brown, Outagamie (WI)	Fox River																
Restore Little Chute locks to provide a river connection between Kaukauna and Appleton.	Brown, Outagamie (WI)	Village of Little Chute																
Upgrade the dam area and the north approach to the dam at Pulcifer Park.	Shawano (WI)	Pulcifer Park																
Fox River Lock System: close all 17 locks.		Fox River																
Fox River Lock System : rehabilitate all 17 locks.		Fox River																
Evaluate potential for groundwater contamination from other land uses to impact the Bay and River and control as necessary (11.7).		Lower Fox River/Green Bay																
Adopt water quality standards for PCB and other bioaccumulating substances (3.3).		Lower Fox River/Green Bay																
Complete adoption of new administrative rules for disposal of dredged materials (4.6).		Lower Fox River/Green Bay																
Adequately evaluate and contain, as necessary, existing dredged material disposal sites so that contaminants do not re-enter the ecosystem (4.7).		Lower Fox River/Green Bay																
Establish federal, state and local programs to effectively clean-up in-place contaminated sediments (4.3).		Lower Fox River/Green Bay																
Further evaluate phosphorus point source loads and treatment plant capabilities, making reductions in phosphorus loads as soon as possible (1.1).		Lower Fox River/Green Bay																

	Project Category													
Project Description	**Point source controls**	**PCB cleanup**	**Study**	**Public education**	**Upland habitat/species programs**	**Other recreation**	**Misc.**	**Unknown**	**Addresses injured resources or services lost as a result of injuries**	**Type: Idea or Project**	**Idea or Project Source Document**	**Reference Document or Project Title**	**Reference Document Contact**	**Reference Document Year**
Restore Appleton lock #4.									F	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997
Restore combined locks structure in Little Chute and convert brick locktender's house for visitor support services.									F	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997
Restore Kaukauna lock #1 and locktender's house.									F	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997
Restore Kaukauna lock #4.									F	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997
Restore Little Chute locks to provide a river connection between Kaukauna and Appleton.									F	P	Boronow list 10/20/97	Fox River Locks Abandonment Issues	Fred Scharnke ECRPC 920-751-4770	1997
Upgrade the dam area and the north approach to the dam at Pulcifer Park.									F	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Fox River Lock System: close all 17 locks.									F	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Fox River Lock System : rehabilitate all 17 locks.									F	P	PRP slides 10/21/97		Steven Perry BBL 315-446-9120	1997
Evaluate potential for groundwater contamination from other land uses to impact the Bay and River and control as necessary (11.7).	X		X						F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Adopt water quality standards for PCB and other bioaccumulating substances (3.3).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Complete adoption of new administrative rules for disposal of dredged materials (4.6).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Adequately evaluate and contain, as necessary, existing dredged material disposal sites so that contaminants do not re-enter the ecosystem (4.7).	X								F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Establish federal, state and local programs to effectively clean-up in-place contaminated sediments (4.3).	X								F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Further evaluate phosphorus point source loads and treatment plant capabilities, making reductions in phosphorus loads as soon as possible (1.1).	X								F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Establish phosphorus water quality standards (1.2).		Lower Fox River/Green Bay																
Establish waste load allocation for phosphorus if necessary to achieve desired reductions (1.3).		Lower Fox River/Green Bay																
Consider in-river phosphorus removal (1.9).		Lower Fox River/Green Bay																
Correct failing septic systems (10.3).		Lower Fox River/Green Bay																
Control industrial discharges as needed to protect swimming and other recreational uses of the bay and river (10.4).		Lower Fox River/Green Bay																
Evaluate and minimize impacts of spills on the River and Bay (11.10).		Lower Fox River/Green Bay																
Require emission controls that consider secondary impacts on water quality and human health (11.13).		Lower Fox River/Green Bay																
Evaluate and control contributions of toxic substances from landfill and land disposal sites (11.6).		Lower Fox River/Green Bay																
Complete rule adoption for water quality standard and associated effluent setting procedures for toxic substances (3.1).		Lower Fox River/Green Bay																
Adopt anti-degradation and mixing zone rules to protect lower Green Bay (3.2).		Lower Fox River/Green Bay																
Establish water quality standard and effluent limit setting procedures that recognize additive effects (3.7).		Lower Fox River/Green Bay																

Project Description	Project Category: Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Establish phosphorus water quality standards (1.2).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Establish waste load allocation for phosphorus if necessary to achieve desired reductions (1.3).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Consider in-river phosphorus removal (1.9).									F	P	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Correct failing septic systems (10.3).	X								F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Control industrial discharges as needed to protect swimming and other recreational uses of the bay and river (10.4).	X								F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Evaluate and minimize impacts of spills on the River and Bay (11.10).	X								F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Require emission controls that consider secondary impacts on water quality and human health (11.13).	X								F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Evaluate and control contributions of toxic substances from landfill and land disposal sites (11.6).	X								F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Complete rule adoption for water quality standard and associated effluent setting procedures for toxic substances (3.1).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Adopt anti-degradation and mixing zone rules to protect lower Green Bay (3.2).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Establish water quality standard and effluent limit setting procedures that recognize additive effects (3.7).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Remove the winter dissolved oxygen water quality standard variance from the Bay (5.1)		Lower Fox River/Green Bay																
Continue to periodically review and revise the waste load allocations on the Lower Fox River (5.2).		Lower Fox River/Green Bay																
Restore Vulcan Hydroelectric Plant and Site (refer to document for potential uses).	Brown, Outagamie (WI)	Vulcan Site, Appleton																
Develop a 25 year dredge disposal plan and evaluate harbor and port alternatives (4.9).		Lower Fox River/Green Bay																
Conduct hydrodynamic, bathymetric and substrate studies of the lower bay and nearshore area to assess the feasibility and potential impacts of priority habitat restoration projects.		Green Bay																
Create a wetland education area where wetland functions, values, and rehabilitation measures would be demonstrated to increase public awareness and support for rehabilitation problems.		Green Bay																
Purchase 10 acres across from existing shelter building for non-competitive sports play.	Brown (WI)	Neshota Park																
Improve drainage at Municipal Golf Course.	Winnebago (WI)	Municipal Golf Course, Oshkosh																
Restore locktender house at the Berlin lock.	Brown, Outagamie (WI)	Berlin																
Purchase the Noble House Property for passive recreation and preserve the Noble House itself.	Brown (WI)	Noble House Property, Town of Gibraltar																
Restore or relocate the existing dilapidated pier at Chambers Island Light House Park.	Brown (WI)	Chambers Island Light House Park, Town of Gibraltar																
Restore lighthouse at Chambers Island Light House Park.	Brown (WI)	Chambers Island Light House Park, Town of Gibraltar																
Develop lock tenders house at De Pere lock for visitor center.	Brown, Outagamie (WI)	De Pere lock																
Renovate old band shell in Taylor Park.	Fond du Lac (WI)	Taylor Park, City of Fond du Lac																
Retain chamber structure at the Portage lock and develop site as historic park.	Brown, Outagamie (WI)	Portage																

Project Description	Project Category: Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Remove the winter dissolved oxygen water quality standard variance from the Bay (5.1)									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Continue to periodically review and revise the waste load allocations on the Lower Fox River (5.2).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Restore Vulcan Hydroelectric Plant and Site (refer to document for potential uses).									F	P	Boronow list 10/20/97	Fox River Upper Flats Development Opportunities A Strategic Plan	Steven Perry BBL 315-446-9120	1992
Develop a 25 year dredge disposal plan and evaluate harbor and port alternatives (4.9).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Conduct hydrodynamic, bathymetric and substrate studies of the lower bay and nearshore area to assess the feasibility and potential impacts of priority habitat restoration projects.									F	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1994	Vicky Harris WDNR 920-492-5904	1994
Create a wetland education area where wetland functions, values, and rehabilitation measures would be demonstrated to increase public awareness and support for rehabilitation problems.									F	P	1994 HRW Summary	Green Bay Restoration Worshop Summary April 13-14, 1995	Vicky Harris WDNR 920-492-5905	1995
Purchase 10 acres across from existing shelter building for non-competitive sports play.									F	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Improve drainage at Municipal Golf Course.									F	P	Boronow list 10/20/97	Oshkosh Comprehensive Park and Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Restore locktender house at the Berlin lock.									F	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Purchase the Noble House Property for passive recreation and preserve the Noble House itself.									F	P	Boronow list 10/20/97	Town of Gibraltar Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1995
Restore or relocate the existing dilapidated pier at Chambers Island Light House Park.									F	P	Boronow list 10/20/97	Town of Gibraltar Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1995
Restore lighthouse at Chambers Island Light House Park.									F	P	Boronow list 10/20/97	Town of Gibraltar Outdoor Recreation Plan	Steven Perry BBL 315-446-9120	1995
Develop lock tenders house at De Pere lock for visitor center.									F	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997
Renovate old band shell in Taylor Park.									F	P	Boronow list 10/20/97	City of Fond du Lac Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1994
Retain chamber structure at the Portage lock and develop site as historic park.									F	P	Boronow list 10/20/97	Fox River Heritage Parkway Concept Plan	Fred Scharnke ECRPC 920-751-4770	1997

Project Description	County or Reservation	Location	Project Category: Riparian buffer zone restoration	Agricultural practices improvements	Animal waste handling improvements	Urban non-point source controls	Shoreline stabilization	Wetland restoration	Island habitat restoration	Wetland preservation	Fish artificial habitat creation	Bird artificial habitat creation	Rare/endangered spp. programs	Shoreline softening	Exotic species control	Improve parks or trails	Rec. fishing access improvements	Native American land preservation
Inventory nongame species along the West Shore and develop management program if needed (6.19).		Lower Fox River/Green Bay																
Through cooperative effort, develop management plan and program for Renard Isle (Kidney Island) (14.7).		Lower Fox River/Green Bay																
Develop a remedial surveillance program for toxic substances and routinely report on findings (15.1).		Lower Fox River/Green Bay																
Periodically map macrophytes (rooted aquatic plants) in the Bay (15.10).		Lower Fox River/Green Bay																
Increase fish and wildlife tissue monitoring to evaluate trends and develop consumption advisories (15.2).		Lower Fox River/Green Bay																
Monitor trophic status (15.4).		Lower Fox River/Green Bay																
Increase bacteria monitoring in the Bay and River (15.5).		Lower Fox River/Green Bay																
Monitor waterfowl population trends (15.6).		Lower Fox River/Green Bay																
Monitor endangered tern species population trends and reproductive success in the Area of Concern (15.7).		Lower Fox River/Green Bay																
Continue monitoring fish population trends and harvests (15.8).		Lower Fox River/Green Bay																
Continue to monitor benthic (bottom dwelling) organisms (15.9).		Lower Fox River/Green Bay																

Project Description	Project Category: Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Inventory nongame species along the West Shore and develop management program if needed (6.19).									F	P	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Through cooperative effort, develop management plan and program for Renard Isle (Kidney Island) (14.7).									F	P	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Develop a remedial surveillance program for toxic substances and routinely report on findings (15.1).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Periodically map macrophytes (rooted aquatic plants) in the Bay (15.10).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Increase fish and wildlife tissue monitoring to evaluate trends and develop consumption advisories (15.2).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Monitor trophic status (15.4).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Increase bacteria monitoring in the Bay and River (15.5).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Monitor waterfowl population trends (15.6).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Monitor endangered tern species population trends and reproductive success in the Area of Concern (15.7).									F	P	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Continue monitoring fish population trends and harvests (15.8).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Continue to monitor benthic (bottom dwelling) organisms (15.9).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988

			Project Category															
Project Description	**County or Reservation**	**Location**	**Riparian buffer zone restoration**	**Agricultural practices improvements**	**Animal waste handling improvements**	**Urban non-point source controls**	**Shoreline stabilization**	**Wetland restoration**	**Island habitat restoration**	**Wetland preservation**	**Fish artificial habitat creation**	**Bird artificial habitat creation**	**Rare/endangered spp. programs**	**Shoreline softening**	**Exotic species control**	**Improve parks or trails**	**Rec. fishing access improvements**	**Native American land preservation**
Determine causes of walleye and bird reproductive impairments (16.2).		Lower Fox River/Green Bay																
Conduct exposure and expanded epidemiological study (16.3).		Lower Fox River/Green Bay																
Study benthic (bottom dwelling) organisms to determine why population numbers are low (16.4).		Lower Fox River/Green Bay																
Periodically evaluate trophic dynamics (16.5).		Lower Fox River/Green Bay																
Complete comprehensive studies of fish in the Area of Concern (16.6).		Lower Fox River/Green Bay																
Conduct study to evaluate potential for "Top Down" management in the Area of Concern (16.7).		Lower Fox River/Green Bay																
Improve capability to analyze water resource alternatives and seek solutions that will benefit both the environment and economy (16.8).		Lower Fox River/Green Bay																
Identify areas where chronic toxicity in mixing zones may jeopardize fish and aquatic life uses, and identify steps to remedy, if necessary (3.10).		Lower Fox River/Green Bay																
Evaluate mink and muskrat populations in the Area of Concern and manage as necessary (6.18).		Lower Fox River/Green Bay																
Evaluate potential for white perch to impact the Green Bay fishery (7.4).		Lower Fox River/Green Bay																
Fox-Wolf Basin 2000: develop basin specific data and info database.		Fox-Wolf Basin																
Fox-Wolf Basin 2000: sponsor additional research of projects.		Fox-Wolf Basin																
Determine atmospheric deposition's contribution to toxic substances found in the Bay and River and establish load reduction goals (11.11).		Lower Fox River/Green Bay																

Project Description	Project Category: Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Determine causes of walleye and bird reproductive impairments (16.2).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Conduct exposure and expanded epidemiological study (16.3).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Study benthic (bottom dwelling) organisms to determine why population numbers are low (16.4).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Periodically evaluate trophic dynamics (16.5).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Complete comprehensive studies of fish in the Area of Concern (16.6).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Conduct study to evaluate potential for "Top Down" management in the Area of Concern (16.7).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Improve capability to analyze water resource alternatives and seek solutions that will benefit both the environment and economy (16.8).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Identify areas where chronic toxicity in mixing zones may jeopardize fish and aquatic life uses, and identify steps to remedy, if necessary (3.10).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Evaluate mink and muskrat populations in the Area of Concern and manage as necessary (6.18).									F	P	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Evaluate potential for white perch to impact the Green Bay fishery (7.4).									F	P	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Fox-Wolf Basin 2000: develop basin specific data and info database.									F	P	NFP table 10/21/97			1997
Fox-Wolf Basin 2000: sponsor additional research of projects.									F	P	NFP table 10/21/97			1997
Determine atmospheric deposition's contribution to toxic substances found in the Bay and River and establish load reduction goals (11.11).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988

			Project Category															
Project Description	County or Reservation	Location	Riparian buffer zone restoration	Agricultural practices improvements	Animal waste handling improvements	Urban non-point source controls	Shoreline stabilization	Wetland restoration	Island habitat restoration	Wetland preservation	Fish artificial habitat creation	Bird artificial habitat creation	Rare/endangered spp. programs	Shoreline softening	Exotic species control	Improve parks or trails	Rec. fishing access improvements	Native American land preservation
Identify emission sources that may be contributing to atmospheric depositions of toxic substances to the River, Bay and Great Lakes (11.12).		Lower Fox River/Green Bay																
Participate in development of regional, national, and international strategies to reduce toxic contaminants in the atmosphere (11.14).		Lower Fox River/Green Bay																
Assess possible impacts of pesticide and herbicide use and control as necessary (11.5).		Lower Fox River/Green Bay																
Investigate sites of past coal gas manufacturing (11.8).		Lower Fox River/Green Bay																
Monitor fuel storage tanks for leaks and spills, and initiate measures to prevent and correct as necessary (11.9).		Lower Fox River/Green Bay																
Periodically monitor loads of PCB, phosphorus, sediment, and other substances of concern from the River to the Bay (15.3).		Lower Fox River/Green Bay																
Develop and evaluate new technology to cleanup, contain or otherwise reduce the effects of in-place contaminated sediments (16.9).		Lower Fox River/Green Bay																
Establish and use standard tests for toxicity monitoring (3.11).		Lower Fox River/Green Bay																
Increase WDNR capabilities for monitoring toxicants (3.12).		Lower Fox River/Green Bay																
Include additional types of toxicity monitoring in laboratory certification and registration programs (3.13).		Lower Fox River/Green Bay																
Identify all PCB sources (3.4).		Lower Fox River/Green Bay																

Project Description	Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
	Project Category													
Identify emission sources that may be contributing to atmospheric depositions of toxic substances to the River, Bay and Great Lakes (11.12).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Participate in development of regional, national, and international strategies to reduce toxic contaminants in the atmosphere (11.14).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Assess possible impacts of pesticide and herbicide use and control as necessary (11.5).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Investigate sites of past coal gas manufacturing (11.8).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Monitor fuel storage tanks for leaks and spills, and initiate measures to prevent and correct as necessary (11.9).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Periodically monitor loads of PCB, phosphorus, sediment, and other substances of concern from the River to the Bay (15.3).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Develop and evaluate new technology to cleanup, contain or otherwise reduce the effects of in-place contaminated sediments (16.9).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Establish and use standard tests for toxicity monitoring (3.11).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Increase WDNR capabilities for monitoring toxicants (3.12).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Include additional types of toxicity monitoring in laboratory certification and registration programs (3.13).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Identify all PCB sources (3.4).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988

Project Description	County or Reservation	Location	Project Category: Riparian buffer zone restoration	Agricultural practices improvements	Animal waste handling improvements	Urban non-point source controls	Shoreline stabilization	Wetland restoration	Island habitat restoration	Wetland preservation	Fish artificial habitat creation	Bird artificial habitat creation	Rare/endangered spp. programs	Shoreline softening	Exotic species control	Improve parks or trails	Rec. fishing access improvements	Native American land preservation
Use fish tissue monitoring to track and flag the need for point source control of furans and dioxins (3.5).		Lower Fox River/Green Bay																
Monitor and control discharges of PCB and other bioaccumulating substances (3.6).		Lower Fox River/Green Bay																
Conduct a remedial investigation/feasibility study of in-place pollution control options for the River (4.2).		Lower Fox River/Green Bay																
Update or replace existing stations along the marked interpretive walking trail at Mielke Park.	Shawano (WI)	Mielke Park																
Construct sugar shack north of barn for outdoor education programs.	Brown (WI)	Barkhausen Waterfowl Preserve																
Construct or renovate an existing structure into a small learning center or classroom.	Calumet, Winnebago (WI)	Heckrodt Wetland Reserve																
Develop public information programs (13.2).		Lower Fox River/Green Bay																
Develop education programs (13.3).		Lower Fox River/Green Bay																
Make water quality information easily accessible and understandable (13.4).		Lower Fox River/Green Bay																
Survey public attitudes on River and Bay Issues (15.11).		Lower Fox River/Green Bay																
Periodically measure people's use of the Bay and River (15.12).		Lower Fox River/Green Bay																
Collect and update socioeconomic and demographic information that will help in assessment of management options for the Bay and River (15.13).		Lower Fox River/Green Bay																
Fox-Wolf Basin 2000: develop internet site for education and information.		Fox-Wolf Basin																

Project Description	Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Use fish tissue monitoring to track and flag the need for point source control of furans and dioxins (3.5).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Monitor and control discharges of PCB and other bioaccumulating substances (3.6).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Conduct a remedial investigation/feasibility study of in-place pollution control options for the River (4.2).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Update or replace existing stations along the marked interpretive walking trail at Mielke Park.									F	P	Boronow list 10/20/97	Shawano County Outdoor Recreation Plan	Fred Scharnke ECRPC 920-751-4770	1993
Construct sugar shack north of barn for outdoor education programs.									F	P	Boronow list 10/20/97	Brown County Open Space and Outdoor Recreation 1990 Update	Steven Perry BBL 315-446-9120	1990
Construct or renovate an existing structure into a small learning center or classroom.									F	P	Boronow list 10/20/97	City of Menasha Open Space and Recreation Facilities Plan	Steven Perry BBL 315-446-9120	1996
Develop public information programs (13.2).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Develop education programs (13.3).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Make water quality information easily accessible and understandable (13.4).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Survey public attitudes on River and Bay Issues (15.11).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Periodically measure people's use of the Bay and River (15.12).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Collect and update socioeconomic and demographic information that will help in assessment of management options for the Bay and River (15.13).									F	I	1988 RAP	Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern	Vicky Harris WDNR 920-492-5904	1988
Fox-Wolf Basin 2000: develop internet site for education and information.									F	P	NFP table 10/21/97			1997

			Project Category															
Project Description	County or Reservation	Location	Riparian buffer zone restoration	Agricultural practices improvements	Animal waste handling improvements	Urban non-point source controls	Shoreline stabilization	Wetland restoration	Island habitat restoration	Wetland preservation	Fish artificial habitat creation	Bird artificial habitat creation	Rare/endangered spp. programs	Shoreline softening	Exotic species control	Improve parks or trails	Rec. fishing access improvements	Native American land preservation
Heckrodt Wetland Reserve: construct "Living Laboratory."		Heckrodt Wetland Reserve																

	Project Category													
Project Description	Point source controls	PCB cleanup	Study	Public education	Upland habitat/species programs	Other recreation	Misc.	Unknown	Addresses injured resources or services lost as a result of injuries	Type: Idea or Project	Idea or Project Source Document	Reference Document or Project Title	Reference Document Contact	Reference Document Year
Heckrodt Wetland Reserve: construct "Living Laboratory."									F	P	NFP table 10/21/97			1997

Appendix D — Ranking of Potential Restoration Projects

This appendix provides additional details on how the Co-trustees ranked each of the 15 potential restoration project categories against the Co-trustees' NRDA criteria. The information in this appendix supports Section 3.2.3 of the RCDP. Tables D.1 and D.2 show how each project category was scored against each ranking criterion of higher priority and of medium or lower priority, respectively. Included in the tables are brief comments that summarize the basis for each score.

For the first criterion of Table D.1 (restores river/bay habitat), project categories vary widely in their project score. The project categories that are based on river/bay habitat restoration all score high. Wetland preservation and rare/endangered species programs score medium in this criterion because they are based primarily on habitat preservation versus restoration, and exotic species control scores medium because although it is restorative in nature, the methods used typically are not habitat-based. Improving agricultural practices and stabilizing streambanks also both scored medium, as they are not primarily habitat based but do provide habitat benefits. The remaining project categories all score low in this criterion because they do not restore natural habitat in the area.

All project categories scored either high or medium in the second criterion of providing benefits that can be scaled and measured except for shoreline softening, which scored low. Shoreline softening can provide habitat benefits by dampening wave action, increasing water access, restoring natural sediment transport, and providing shallow water and shoreline habitat, but these benefits are most likely difficult to predict quantitatively. The other projects differ in the degree to which the benefits provided are predictable, but all are quantifiable to some degree.

Project categories that address nonpoint source pollution control all scored high in the criterion of providing a broad scope of benefits over a wide area, since nonpoint source pollution control can benefit the entire Green Bay. Similarly, wetland restoration, wetland preservation, shoreline softening, and exotic species control can provide a range of ecological benefits over the entire area. Fish and bird artificial habitat creation provides benefits generally limited to the targeted fish or bird species, and the spatial extent over which such actions could be implemented is limited. Projects that address improvements in recreational facilities scored low on this criterion because they provide human recreational use benefits only.

All projects were assigned a score of high in their probability of success except exotic species control and creation of artificial fish or bird habitat. Programs to control exotic species have a history of mixed success, especially for attempts to control exotic species at the landscape scale (Mack et al., 2000). The creation of artificial nesting habitat has been proposed for specific bird

Table D.1. Scoring of restoration project categories against higher priority criteria.

		Restores river/bay habitat or services		Benefits can be predicted and measured		Provides broad scope of benefits	
Project category	**Project subcategory[a]**	**Project score**	**Comments**	**Project score**	**Comments**	**Project score**	**Comments**
Nonpoint source pollution control	**Install vegetated buffer strips**	High	Restores riparian habitat as well as bay aquatic habitat	High	Acres restored and pollution control can be predicted and measured	High	Aquatic and riparian resource benefits, area-wide
	Improve agricultural practices	Medium	Some practices can provide habitat enhancements	High	Pollution control can be predicted and measured	High	Aquatic resource benefits, bay-wide
	Stabilize eroding streambanks	Medium	Helps restore habitat, but often uses engineering-based methods	Medium	Pollution control benefits more difficult to predict	High	Aquatic resource benefits, bay-wide
	Improve animal waste handling practices	Low	Not focused on habitat restoration	Medium	Pollution control benefits more difficult to predict	High	Aquatic resource benefits, bay-wide
	Control urban nonpoint source pollution	Low	Not focused on habitat restoration	Medium	Pollution control benefits more difficult to predict	High	Aquatic resource benefits, bay-wide
Habitat/ species programs	**Restore wetlands**	High	Restores critical river/bay habitat	High	Acres restored can be predicted, measured	High	Benefits to many species, area-wide
	Restore island habitat	High	Restores critical bay habitat	Medium	Ecological benefits may be difficult to predict and scale	Medium	Selected locations only
	Preserve wetlands	Medium	Restoration preferred over preservation	High	Acres restored can be predicted, measured	High	Benefits to many species, area-wide
	Create artificial fish habitat	Low	Does not restore natural habitat	High	Increase in fish production can be predicted, measured	Low	Focused on specific species in limited areas
	Create artificial bird habitat	Low	Does not restore natural habitat	High	Increase in bird production can be predicted, measured	Low	Focused on specific species in limited areas
	Rare/endangered spp. programs	Medium	Often focused on habitat preservation, not restoration	Medium	Benefits difficult to predict	Low	Focused on specific species in limited areas

Table D.1. Scoring of restoration project categories against higher priority criteria (cont.).

		Restores river/bay habitat or services		Benefits can be predicted and measured		Provides broad scope of benefits	
Project category	**Project subcategory**[a]	**Project score**	**Comments**	**Project score**	**Comments**	**Project score**	**Comments**
Habitat/ species programs	Soften shoreline	High	Restores natural shoreline	Low	Benefits difficult to predict	High	Broad benefits, region-wide
	Control exotic species	Medium	Restoration action in nature, but often not habitat based	Medium	Benefits difficult to predict	High	Broad benefits, region-wide
Recreational facilities	Waterfront parks or trails	Low	Not habitat based, not restoration	High	Number of parks, acres, etc. can be "predicted" and measured	Low	Human use benefits only
	Improve recreational fishing access	Low	Not habitat based, not restoration	High	Number facilities can be "predicted" and measured	Low	Human use benefits only

a. The project subcategories that were selected by the Co-trustees are shown in bold.

Table D.2. Scoring of restoration project categories against medium and lower priority criteria.

		Probability of success (medium priority)		Maximizes time for benefit accrual (lower priority)	
Project category	**Project subcategory**	**Project score**	**Comments**	**Project score**	**Comments**
Nonpoint source pollution control	**Install vegetated buffer strips**	High	Proven effective, recommended by NPS programs	High	Provides long-term benefits that begin immediately after implementation
	Improve agricultural practices	High	Proven effective, recommended by NPS programs	High	Provides long-term benefits that begin immediately after implementation
	Stabilize eroding streambanks	High	Proven effective, recommended by NPS programs	High	Provides long-term benefits that begin immediately after implementation
	Improve animal waste handling practices	High	Proven effective, recommended by NPS programs	High	Provides long-term benefits that begin immediately after implementation
	Control urban nonpoint source pollution	High	Proven effective, recommended by NPS programs	High	Provides long-term benefits that begin immediately after implementation
Habitat/species programs	**Restore wetlands**	High	Restoration more effective than “creation”	High	Provides long-term benefits that begin immediately after implementation
	Restore island habitat	High	Expected to be successful	High	Provides long-term benefits that begin immediately after implementation
	Preserve wetlands	High	Acquisition, management proven tools for preservation	Medium	Benefits begin when wetland would have been loss from development, etc.
	Create artificial fish habitat	Medium	Proven tool, but effectiveness varies	High	Provides long-term benefits that begin immediately after implementation

Table D.2. Scoring of restoration project categories against medium and lower priority criteria (cont.).

		Probability of success (medium priority)		Maximizes time for benefit accrual (lower priority)	
Project category	**Project subcategory**	**Project score**	**Comments**	**Project score**	**Comments**
Habitat/species programs	Create artificial bird habitat	Medium	Often successful, but untested in Green Bay	High	Provides long-term benefits that begin immediately after implementation
	Rare/endangered spp. programs	Medium	Success varies	High	Provides long-term benefits that begin immediately after implementation
	Soften shoreline	Medium	Requires appropriate habitat restoration to reduce erosion	High	Provides long-term benefits that begin immediately after implementation
	Control exotic species	Medium	Success varies	High	Provides long-term benefits that begin immediately after implementation
Recreational facilities	Waterfront parks or trails	High	Type, location is important in amount of human use	High	Provides long-term benefits that begin immediately after implementation
	Improve recreational fishing access	High	Type, location is important in amount of human use	High	Provides long-term benefits that begin immediately after implementation

a. The project subcategories that were selected by the Co-trustees are shown in bold.

species such as Forster's terns, common terns, and bald eagles to increase the number of these birds breeding in the Green Bay area. Artificial rafts covered with either vegetation (for Forster's terns) or gravel (for common terns) have been successful in attracting breeding terns in other areas (Matteson and Erdman, 1992). Artificial nesting habitat for bald eagles or osprey typically consists of platforms placed within tall trees or atop tall poles to mimic their natural nesting habitat.

Although such restoration actions address bird species determined to be injured by PCBs in the Co-trustees' injury assessment, their likelihood for successfully increasing the number of breeding birds in Green Bay is uncertain. Although tern mats have been successful elsewhere, they may or may not prove to be successful in the particular conditions of Green Bay (Matteson and Erdman, 1992). Eagle roosting and nesting sites are plentiful along the bay shores, much of which remains forested. Furthermore, although not an explicit criterion, the Co-trustees are also concerned about the fact that even if artificial nesting habitat is successful in increasing the numbers of terns and/or eagles in the area, these species are injured by exposure to PCBs. Thus increasing the numbers of these species that breed in the area may only serve to increase the PCB injuries.

Finally, all projects were assigned a score of high for the criterion of maximizing the time over which benefits accrue, except for wetland preservation, which was assigned a score of medium. Since wetland preservation addresses resources that already exist, the benefits do not begin until the time at which the wetlands would have been lost as a result of development, siltation, surrounding land use changes, etc. Therefore, the benefits do not begin accruing until some time in the future. The rest of the project categories were assigned a score of high for this criterion since they all provide long-term benefits (assuming operations and maintenance activities are continued) that begin immediately or soon after the restoration actions take place.

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Appendix E — Wetland Habitat Restoration Opportunities in the Green Bay Area

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WETLAND HABITAT ACQUISITION AND RESTORATION OPPORTUNITIES IN THE GREEN BAY AREA

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OCTOBER, 2000

INTRODUCTION

This report is a component of the Restoration and Compensation Determination Plan (RCDP) being prepared by the U.S. Fish and Wildlife Service (USFWS) for the Green Bay area of Wisconsin and Michigan. It has been determined that certain fish species in the lower Fox River and Green Bay are injured as a result of exposure to polychlorinated biphenyls (PCBs) in surface water. The most significant injury to the fishery resource in the lower Fox River and Green Bay area is the continued fish consumption advisories issued by both Wisconsin and Michigan that are in effect for several species (Stratus Consulting, Inc., November 8, 1999). Additionally, certain bird species have suffered or likely suffered reproduction problems, physical deformations, and/or behavioral abnormalities as a result of exposure to PCBs. Surface waters of the lower Fox River and Green Bay continue to exceed injury thresholds. U.S. Food and Drug Administration (USFDA) tolerances also are exceeded for a number of fish species.

Acquisition, preservation and enhancement of existing wetlands, restoration of wetlands, and creation of new wetlands are among the projects that have been identified and are being considered to restore lost habitat values in the lower Fox River-Green Bay area. In preliminary rankings of projects, those designed to create, preserve, or enhance wetlands have received high relative rankings among project participants. This report assesses the value and potential for wetland preservation/restoration to improve overall fish and wildlife habitat in the Green Bay area. Other projects designed to preserve, create, or enhance impacted fish and wildlife habitat also will be discussed as appropriate.

As set forth in the *Lower Fox River/Green Bay NRDA Initial Restoration and Compensation Determination Plan* "restoration" includes rehabilitation, replacement or acquisition of resources or services (with services being defined as the physical and biological functions performed by the resource, including human uses of the functions). Restoration can be accomplished by restoring or rehabilitating resources or by replacing or acquiring the undamaged equivalent of the impaired natural resources.

To assist with the preparation of this document, interviews were conducted with federal and state agencies in both Wisconsin and Michigan that are involved in the management and protection of natural resources. Also, staff of the Nature Conservancy of both Wisconsin and Michigan was consulted for perspectives related to this project. In addition, a limited field reconnaissance was conducted to view the extant conditions of wetland resources in selected locations of lower Green Bay.

WETLAND FUNCTIONAL VALUES

Wetlands offer a variety of habitat types depending upon their hydrologic and vegetative characteristics. All wetlands rely on hydrology as their primary driving force, but wetlands are also defined by their hydrophytic vegetation and their hydric soils characteristics.

Wetlands have been demonstrated to have a great deal of biological richness and are a key feature of the natural environment. Wetlands in their natural state provide a variety of essential habitat for a diverse range of flora and fauna, including several threatened and endangered species. Wetlands provide food, cover, loafing and nesting habitat for birds (including colonial waterbirds and waterfowl), reptiles, amphibians and insects. Wetlands also serve as breeding habitat for many species of fish, including large game species such as northern pike and smaller, forage species on which larger species are dependent. Wetlands also harbor a diverse assortment of herbaceous and woody plant species that are specially adapted to wetland environments.

Beyond habitat values, wetlands also provide other important functions, including flood and stormwater storage, sediment reduction, and pollutant and nutrient removal. In coastal areas along the shores of Green Bay, wetlands provide barriers and buffers to the erosive forces of wave action. Wetlands also serve as sources of groundwater recharge and/or discharge. Human-oriented benefits include active and passive recreation, public education and environmental awareness, and aesthetics.

PREDOMINANT WETLANDS

Wetlands tend to be clustered along the western shore of the Bay area, and are primarily comprised of emergent marsh and wet prairie, forested, and shrub/scrub types.

The USFWS conducted a large scale study of the wetlands along Green Bay in 1993, resulting in the Special Wetland Inventory Study (SWIS), (USEPA, 1993). This study documented the current status of community types and other special features of the wetlands within portions of the Wisconsin counties. The study produced an updated GIS database for public use. Other references for wetland types occurring along and near Green

Bay include Dodge and Kavetsky (1995), Howlett (1974) and Harris et. al. (1977). Bosley (1976) gives a thorough overview of the community types of Green Bay's west shore area in Wisconsin.

a. **Emergent Marsh and Wet Prairie** This habitat type is prevalent along the west shore of Green Bay and is significant for a number of reasons, including the fact that emergent marsh especially offers spawning and nursery habitat for a variety of fish species. These include northern pike, yellow perch, bass, sunfish, bullhead, white sucker, carp, alewife, rainbow smelt, and various forage species (*Habitat Characterization for the Lower Fox River and Green Bay Assessment Area*, *September 1998 Draft*). Many of these species are or have been the subject of fish consumption advisories. Marshes also provide feeding, nesting, or resting habitat for a variety of birds including colonial waterbirds and waterfowl. Marshes and wet prairie offer habitat to common mammal species such as muskrat and raccoon, and to a range of herpetofauna and insects.

   Many of the coastal wetlands in the Green Bay area are emergent marshes affected by fluctuating Lake Michigan water levels (Harris et. al., 1977). Wetlands on the shallow and gently sloping shoreline of the west shore area especially sensitive to rising and falling water levels. Some coastal wetlands do not support substantial vegetation during low water years such as are currently occurring and may exist as exposed, largely unvegetated mudflats. However, prolonged low water levels may develop extensive marshes. Conversely, during high water years, wetland vegetation extended outward into Green Bay is often inundated and lost.

b. **Shrub/Scrub Wetlands** These wetlands are concentrated along the western shore of the bay (*Habitat Characterization for the Lower Fox River and Green Bay Assessment Area*, 1998). They offer habitat to a variety of mammal, songbirds, and waterfowl species, and offer nesting habitat for various other bird species including listed species.

c. **Forested Wetlands** These wetlands occur throughout the area primarily along rivers and streams. They provide nesting habitat for a variety of raptor species, as well as adapted waterfowl species. Deer, raccoon, mink, and weasel are among the more common mammalian species utilizing this type of habitat. Forested wetlands along rivers and streams provide valuable corridors for wildlife, and often exist in large, unfragmented blocks that are essential for propagation of various species.

WETLANDS PROTECTION

In keeping with the prevailing spirit of the times, as the United States was being developed agriculturally and industrially, federal and state agencies provided incentives to drain, fill, or otherwise impact wetlands. However, since widespread environmental awareness and protection were ushered in during the 1970's, there is a regulatory framework in place that emphasizes avoiding or minimizing wetland impacts. This has served to slow the rate of wetland filling, while at the same time contributing to an increase in wetland creation and restoration, often as compensation for permitted impacts to existing wetlands.

Wetlands in the Green Bay area have been subject to the same types of pressures as wetlands nationwide that have sustained long-term net losses. Historical impacts have largely been due to dredging and spoil disposal for large-scale navigation projects, as well as smaller projects for public and private boat slips and docks. Still other wetlands have been filled for commercial, residential, and industrial users (Bosley, 1976; USFWS, 1977). Historically, before federal and state regulation, the nature of dredge and fill activities varied with water levels. During low water periods, dredging impacts were more common while in high water periods, filling for "land reclamation" projects was more common. (*The Green Bay Watershed: Past/Present/Future,* 1979).

The regulatory system now in place requiring authorization from the Army Corps of Engineers (Sections 10 and 404) and water quality certification and water quality standards compliance from the Wisconsin Department of Natural Resources (NR229 and NR103) serves as deterrent to wetland impacts. Additional protection is offered by shoreland-wetland zoning minimum standards (NR115) and coastal management requirements. In the pre-regulatory era, navigation, land filling, and agricultural-related wetland impacts occurred at a rapid pace, with impacts limited only by the economic costs of undertaking them. Present day regulations require potential impacts to be authorized and permitted, a process which usually involves a delineation of the wetland area on an applicant's property, a vegetative survey, soils and hydrology evaluation and attention to impact minimization and avoidance. Other peripheral concerns such as site archaeological questions and issues regarding threatened or endangered species habitat protection also come into play. Mitigation is usually required for impacts exceeding certain acreage thresholds. The combined effect of the regulatory process and the costs of addressing and meeting regulatory requirements have served to deter all but the most economically-pressing projects involving wetland impacts. The thoroughness of the process has been supplemented by a more aggressive approach to surveillance and enforcement so that attempts to circumvent the permit process do not succeed.

Protection of wetlands and management of wildlife and habitat were "moderate priority key actions" recommended by *The Green Bay Remedial Action Plan* (RAP) in 1991. The Plan stated that about 90 percent of the original marshes in the RAP Area of Concern had been lost as a result of filling, dredging, development and high water. Among the RAP's Recommendations were:

- Continued acquisition of wetlands on the West Shore of Green Bay.
- Establishment of goals for wetland and habitat protection.
- Continued adoption and enforcement of local wetland zoning.
- Establishment of breeding sanctuaries and management programs for endangered tern populations.

DEVELOPMENT PRESSURES AND WETLAND PERMITTING

Attempts were made to assess the level or intensity at which wetland areas are being actively developed (i.e., filled or otherwise impacted). Discussions with the Army Corps of Engineers (ACOE) were instructive to determine the amount of wetland filling. The ACOE officers interviewed indicated that they are presented with very few permit applications for large fills (i.e., larger than 1/3 acre). They stated that there is extensive consultation with applicants and potential applicants to minimize the amount of wetland fills, limiting difficulties during permitting. The larger the proposed fill or impact, the more difficult the environmental permitting becomes. Applicants are required as part of Section 404(b)(1) guidelines to justify proposed actions as being water dependent, and also are required to consider alternatives to their proposed actions which would avoid and minimize the amount of wetland impact required. In the case of the Nationwide Permit (NWP) authorizations typically sought for less extensive impacts, alternative concept plans or designs for the subject parcel must be considered to determine whether impacts can be avoided or minimized by locating development features in non-wetland portions of the development sites. In the case of Individual Permits, alternative sites must be considered and evaluated in addition to alternative on-site designs that would avoid or minimize the extent of wetland impact. The need to provide wetland mitigation as compensation for permitted impacts also serves as a deterrent to impacts. Impacts greater than 0.25 acre typically require wetland mitigation, with a standard management and monitoring period of 5 years.

The St. Paul District of the U.S. Army Corps of Engineers was requested to provide a summary of permit requests for the Wisconsin counties contained in the study area. The data for permit requests include all NWP26, General, and Individual Permit requests. Table 1 tallies permit requests, by county from 1991 to 1999. Over the nine-year period (1991-1999), the Army Corps issued Nationwide, General and Individual permits authorizing the impact of 168 acres of wetlands in the five Wisconsin counties in the assessment area under its jurisdiction. This represents average impacts of only about 19 acres per year in the assessment area.

X. Table 1: Corps of Engineers Permit Actions Which Authorized

WATER OR WETLAND FILLING IN WISCONSIN PORTION OF ASSESSMENT AREA[1]

Year	County	No. Permits (Individual)	No. Permits (Nationwide and General)	Requested Impact (Ac)	Approved Impact (Ac)	Mitigation (Ac)
1991	Brown	0	1	0.030	0.030	0.030
1992	Brown	0	5	2.480	2.480	2.500
1992	Oconto	0	4	0.830	0.230	0.500
1993	Brown	0	6	1.780	2.740	0.060
1993	Door	0	3	0.120	0.000	0.020
1993	Marinette	0	2	0.700	0.700	0.000
1993	Oconto	0	3	1.010	1.010	0.000
1994	Brown	0	7	2.220	2.220	7.500
1994	Kewaunee	1	0	0.470	0.240	0.300
1994	Marinette	2	6	2.890	2.890	16.400
1994	Oconto	0	8	4.650	2.430	6.400
1995	Brown	2	12	8.870	4.940	8.490
1995	Door	0	8	1.970	1.820	0.040
1995	Kewaunee	0	3	4.050	4.050	0.000
1995	Marinette	0	5	3.060	2.000	0.200
1995	Oconto	0	8	2.400	1.280	0.990
1996	Brown	1	6	3.560	3.430	1.200
1996	Door	0	10	4.000	4.000	0.100

1996	Kewaunee	0	3	1.140	1.140	0.000
1996	Marinette	1	15	13.100	2.130	9.350
1996	Oconto	0	12	3.180	3.080	0.020
1997	Brown	0	16	3.820	3.820	21.130
1997	Door	0	16	2.330	2.330	0.000
1997	Kewaunee	1	10	4.810	4.810	0.000
1997	Marinette	0	9	1.810	1.810	0.000
1997	Oconto	0	18	70.140	22.120	28.900
1998	Brown	1	18	3.280	1.680	3.410
1998	Door	0	32	9.290	9.290	0.000
1998	Kewaunee	0	12	5.170	5.170	0.900
1998	Marinette	0	18	6.380	5.800	2.030
1998	Oconto	0	14	7.220	7.110	5.420
1999	Brown	0	16	2.930	2.930	1.410
1999	Door	0	37	6.070	6.070	3.640
1999	Kewaunee	0	20	8.44	8.44	1.68
1999	Marinette	1	6	9.140	9.140	9.900
1999	Oconto	1	13	35.320	35.130	25.860
Totals		**11**	**382**	**238.66**	**168.49**	**158.38**

[1] Data provides by St. Paul District, Army Corps of Engineers

Most of the applications that are processed in the assessment area by the ACOE are for small projects. These include culvert crossings, minor fills for driveway/roadway crossings and dredging for private and municipal docks. However, the trend for applications and impacts has been on the increase during the 1990's. Although these authorizations do not amount to large wetland impacts in and of themselves, their largest impact may be in the form of indirect impact to adjacent wetlands through land use changes and edge disturbances. These impacts can be direct, as with mowing of wetland near private lots, or more indirect and systemic, as with hydrologic changes resulting from culverted crossings and driveways.

Such indirect impacts are most evident along Green Bay's west shore, where many residential homes have been built over the decades. By and large, these houses have been built on non-wetlands areas, although they may be surrounded by or adjacent to wetland or coastal areas. In aggregate, however, the development of these areas has created a patchwork of private lots, roadways and remnant natural land. These areas were not necessarily included in the West Shores Master Plan (WDNR, 1979) since it was believed at the time that these types of properties were not vulnerable to development. However, as the west shore has become very attractive to development, this assumption was proven false.

A similar perspective was given by the Michigan Department of Environmental Quality, which stated that applications for large wetland fills are uncommon. Similar to Wisconsin, most of the applications are for private and municipal dredging projects (especially during low water years), private driveways and culvert crossings, and pond creation. Michigan state regulations help curtail much of the development along wetland areas, although development corridors along major highways and populated areas do put pressure on natural areas through urbanization and direct and indirect disturbances.

In summary, wetlands apparently are not being lost through direct filling to any significant degree, amounting to less than 20 acres of direct impact a year area-wide. However, urbanization pressures and hydrologic changes may account for greater areas of wetland being impacted through indirect means. It is worth pointing out that the Army Corps regulates the *discharge of dredged or fill material* into wetlands, not all wetland impacts, per se. For example, wetland impacts can and regularly do occur as a result of excavation, which is an allowable activity not requiring a permit. The Corps of Engineers also has been historically overextended in terms of its regulatory functions, and has therefore had to rely on Nationwide permits rather than Individual permits. This has allowed individually insignificant but cumulatively significant projects involving wetland impacts to move ahead. There are also uncertainties associated with current judicial issues, the outcome of which will determine the Army Corps future role in wetlands regulation.

Although the long-term protection of remaining wetlands may require additional zoning restrictions or local ordinances requiring wetland buffers (Scherberle and Pagel, 1999), these types of environmental regulations are beyond the scope and intent of this report. It does illustrate the need for prioritization for acquisition of those wetland and non-wetland (upland) areas that are ecologically significant to the habitat of Green Bay. These areas include, but are not limited to, undeveloped coastal areas and areas zoned for future commercial/industrial and residential development in near-coastal areas. Access to water or a view of water is often the driving force for this development. The infilling of undeveloped lots in existing developments or neighborhoods contributes to this problem.

PRESERVATION AND RESTORATION

One issue to be considered involves the relative advantages, disadvantages, and opportunities for acquiring and preserving existing wetlands versus restoring former wetlands to their original condition. Existing wetlands by definition have the hydrology, plant communities, and soils characteristics needed to function on a self-sustaining and essentially perpetual basis. On the other hand, restoration of wetlands in areas that were converted to other land types or uses may provide more direct and immediate ecological benefits since the incremental benefits of wetland preservation do not begin until such time as the wetlands would have been lost. The U.S. Fish and Wildlife Service will balance these factors in its restoration planning process. The discussion presented here is intended to provide technical background on this issue.

Preservation should be accomplished via the existing governmental regulatory protection program and through acquisition by governmental resource management agencies and environmental groups such as The Nature Conservancy and Ducks Unlimited. Preservation efforts should be supplemented by wetland restoration projects, particularly those projects which will add key habitat to the existing resource base and which are adjacent to existing large blocks of habitat. Candidates for restoration are those sites, especially marginal agricultural lands, which formerly supported wetland characteristics and which can be easily acquired and economically restored through relatively simple hydrologic modifications. Lower priority should be assigned to wetland creation projects designed to produce wetland from areas that were not historic wetlands. These types of projects typically have higher construction and long-term management costs associated with their successful implementation and have demonstrated lower success rates.

Preservation objectives usually relate to preventing disruptive impacts to the source of wetland hydrology, control of weedy plant species, and control of land use in the immediate wetland tributary watershed. Preservation goals have been simplified by the federal and state programs that are in place to afford wetlands protection, including the Section 404 permit requirements of the Army Corps of Engineers, the natural resources protection requirements of the States of Michigan and Wisconsin, and "swampbuster" provisions of federal agricultural programs designed to ensure that those programs do not contribute to future wetland losses. Concurrently, land acquisitions focusing on habitat preservation and recreation have added to the stock of wetland landscape preserved in the assessment area. There also seems to be clear public sentiment to preserve remaining coastal wetlands and to stop incremental losses which ultimately degrade entire ecosystems.

The base of preserved wetlands in public and quasi-public ownership helps fulfill needed ecological functions including fish and wildlife habitat, water quality, and floodwater storage. Preservation efforts should place emphasis on acquiring key habitats, unique botanical resource areas, and wetlands adjacent to other existing public or public interest holdings so that larger blocks are preserved. Expanded acquisition of existing wetlands (particularly coastal wetlands) coupled with continued Army Corps and state enforcement will allow remaining high functional value wetland habitats in the assessment area to be preserved.

There are a number of practical reasons supporting the continued acquisition of wetlands in the lower Fox River-Green Bay area. Perhaps the foremost from a resource management perspective is the fact that acquisition allows the opportunity for the full range of management tools to be employed. Under public ownership, monitoring and management protocols can be funded and implemented to maximize wetland resource values. For example, intensive herbicidal treatment, prescribed burning, and supplemental seeding can be used to maintain or achieve botanical richness at sites that might otherwise be threatened by weedy species invasion. Another example would be construction and operation of water control structures to optimally manipulate water levels throughout the course of growing or nesting seasons. On lands not held in public or quasi-public ownership, there is little or no incentive on behalf of landowners to implement such management and monitoring practices. The resource integrity of sites may be fundamentally protected by regulations, but other factors may gradually work to diminish overall functional values.

Acquisition also provides a measure of protection over and above that given by the regulatory program that is in place. The existing regulatory system essentially provides disincentives for fill-related impacts, but does not necessarily protect against other activities that may impinge upon resource values. This includes impacts associated with excavation, which is permissible as a result of the *Tulloch* decision. Other activities such as tree cutting can radically alter a site's habitat structure but no permit is required. Wetland draining also may occur as a result of activities for which permits are not required. For example, farmers are permitted to maintain the integrity of existing agricultural drainage systems, allowing farmers to repair damaged drain tile lines and re-drain areas that may have reverted back to wetland conditions. Other non-permit related activities include the installation of storm sewer systems in new residential and commercial developments, which may have the effect of depriving local wetlands of their source of hydrology. If there is no actual wetland filling associated with the stormwater system, permits for wetland impacts are not required. Conversely, the discharge of non-detained and untreated stormwater to natural wetlands can cause existing hydrology and plant communities to be disturbed. Such discharges do not require permits if the discharge outlet structures are not located within jurisdictional wetland boundaries.

A final reason for expanded wetland acquisition relates to the somewhat tenuous nature of the wetland regulatory system in place, particularly at the federal level. Federal regulation of wetland impacts has only been in place for about 25 years, and because of its effect on land use, it has been a controversial issue. There have been repeated efforts both in Congress and in the courts to scale back or eliminate the Army Corps' regulatory involvement with respect to wetlands., especially isolated wetlands. The U.S. Supreme Court is scheduled to hear a case in the fall, 2000 term that is expected to define the Corps' jurisdiction over wetlands as related to migratory waterfowl and interstate commerce. The results of this case likely will either validate the Corps' role or else severely limit the Corps' future wetland regulatory involvement.

Wetland restoration and creation can be used to supplement preservation and acquisition efforts. Restored wetlands have greater potential for achieving long-term, self-sustaining status, and therefore are preferred (in general) over the wetland creation approach (Illinois Natural History Survey, 1997). Restoration projects have generally been found to be less disruptive because restoration seeks to re-establish features that were historically present. Created wetlands are more difficult to establish and maintain over time because they typically require greater manipulation of the landscape to create and sustain wetland conditions. Creation projects usually involve earth excavation or water impoundment. In our experience with wetland mitigation projects, created wetlands can sometimes be stirring successes given proper design, construction, planting, and monitoring and management. Alternatively, there are abundant cases where created wetlands have resulted in failed mitigation, usually because of inappropriate long-term hydrology or because of inadequate monitoring and management to deal with invasive species colonization.

PRIMARY ACQUISITION OBJECTIVES

The following types of land acquisition projects are recommended for priority consideration. The landforms recommended for acquisition offer high probability of success in terms of habitat preservation and restoration, and are directed toward returning Green Bay resources to baseline conditions. Various methodologies for categorizing and assessing values of wetland habitats have been formulated. One or a combination of methodologies may be useful in prioritizing areas for acquisition to meet regional objectives. These methodologies include Adamus and Stockwell (1983), Adamus, et al (1987), Brinson (1993) and Novitski (1994). The Nature Conservancy of Michigan provided significant input on the priorities for the Upper Peninsula of Michigan.

a. **Coastal Areas** Acquisition of undeveloped Green Bay coastal areas should be a high priority, regardless of habitat type. Coastal wetlands should be a primary concern, but other habitat types such as riparian areas at the mouths of tributary rivers and streams, islands, points, and large tracts of wooded uplands are similarly valuable in terms of species protection and propagation.

   In both wetland and non-wetland areas, acquisition emphasis should be placed on preserving large habitat blocks and preventing or minimizing habitat fragmentation. This is particularly important for avian species which often require large tracts of undisturbed forested habitat. Forested wetlands and emergent marshes, rookeries, known fish spawning areas, and known avian foraging habitats should be acquisition objectives. Noteworthy opportunities exist along the Michigan shore, including upper Bay de Noc, the Whitefish River and the Stonington and Garden Peninsulas.

b. **Wetlands** A range of potential wetland creation, restoration, and enhancement projects are available that would result in environmental benefits. Because of the variety of functional values offered, wetlands throughout the assessment area should be prioritized for acquisition or preservation by other means, such as conservation easements. Special emphasis should be placed upon acquisition or preservation of the following wetland habitat types:

- Large, remnant wetlands along the bayshore, offering high botanic richness, special attractiveness for migrating birds, or fish spawning habitat.

- Riparian wetlands along rivers and streams directly tributary to the bay. Often these wetlands exist within the context of forested floodplain areas. An excellent example of high quality riparian woodland occurs along the Peshtigo River, downstream of the City of Peshtigo. The Ford River and Lower Menominee River in Michigan also examples of possible acquisition areas. They provide unique corridors for short and long-term movement of wildlife, breeding bird habitat and also fish spawning. These wetlands also offer water quality and flood storage benefits allowing multiple use benefits to be realized.

- "Natural Area" quality wetlands of all types which approximate pre-settlement habitat conditions. These wetlands contain unusually high numbers and high diversity of native plant species, and typically have not been invaded by weedy or opportunistic plant species. These are classic natural wetlands offering a glimpse into the past as to pre-development ecological richness. Aside from their intrinsic habitat value, such wetlands offer public education and environmental awareness opportunities. The Ford River and Garden Peninsula contain near pristine natural communities.

- Wetlands known to provide habitat for threatened and endangered species also should be prioritized for acquisition and preservation. In this category, wetlands providing breeding habitat for colonial wading birds and marsh-dependent species should be acquired.

- Remaining areas identified in the Green Bay West Shore Master Plan (1979) also should continue to be targeted for acquisition.

c. **Marginal Agricultural Areas** Marginally productive farmlands should be acquired and converted to various habitat types. While limited in habitat value under current conditions, many tilled and pastured areas have great propensity to revert back to natural-like conditions. This is particularly true of croplands which have been created through drainage of historic wetlands. Reverting these areas back to wetlands also may contribute to stabilizing the hydrology of the river and stream systems, which are becoming "flashy."

In considering agricultural areas for acquisition, priority should be given to the following:

- Farmlands adjacent to or bisected by riparian corridors. The floodplain wetlands associated with rivers and streams offer myriad habitat benefits and may present low land cost opportunities. They further environmental corridor objectives advocated by resource agencies.

- Agricultural lands that were historical wetlands offer great potential for restoration success. In many cases, extensive wetland can be created easily and at low cost by simple measures such as drain tile disruption and drainage ditch blockage. In these situations, wetland hydrology can usually be quickly and permanently restored. Restoration efforts are often rewarded by spontaneous site revegetation from seeds from dormant seedbanks, which lowers planting and management costs.

- Other marginal farmlands that should be investigated for acquisition are those which have the potential to extend existing habitat. These include lands adjacent to large existing forested or wetland areas already in public ownership. Farmed areas that are adjacent to high quality wetland complexes and stream corridors should be prioritized for ecological restoration because of the potential for these areas to provide buffer benefits. In evaluating restoration opportunities, the possibility of incorporating recreational benefits (either active or passive) should be fully exploited to maximize public use and benefits. Recreation and other access should be curtailed, however, at sites that are environmentally-sensitive or which harbor listed species.

HABITAT RESTORATION AND MANAGEMENT OBJECTIVES

In addition to acquisition objectives, attention should be directed at managing and improving the ecological condition of existing resources. Periodic management of natural wetlands is critical to ensure that the community types and the condition of the resources are meeting regional goals. Lack of management may cause whole community shifts in vegetation types (e.g., herbaceous to woody) when natural forces are insufficient in preventing (or reversing) these trends. Wetlands directly influenced by lake levels may not require active vegetation management, other than noxious weed control. Those wetlands that are unaffected by lake levels will likely require some form of human intervention to maximize vegetative and vertebrate diversity. The following are among the activities that should be implemented as funding allows.

a. **Promote Management of Existing Habitats** Management measures should be utilized to enhance the quality of existing wetland resources. Very often, dramatic environmental improvement benefits can be realized with minimal management protocols. In nearly every case, "management" translates to invasive species control, particularly cattail (*Typha* spp.), reed canary grass (*Phalaris arundinacea*), purple loosestrife (*Lythrum salicaria*) and in some cases woody vegetation. Measures that should be implemented in key habitat areas include:

- Use of periodic controlled burns to control weedy species in both wetland and upland areas,
- Woody plant management to include removal of dense understories and selective cutting of trees to permit light penetration.
- Selective herbiciding and mowing (in drier areas) to control undesirable or overly-abundant weedy herbaceous and woody species.
- Water level manipulation to create conditions favorable for listed bird breeding and nesting habitat. This is particularly critical for such species as yellow-headed blackbird, common moorhen, and Forster's terns. The breeding success of these species is dependent upon wetland vegetative conditions, and these conditions can be enhanced or denigrated by water levels. Very often, simple, adjustable weir structures can be used in key habitat areas so that optimal water levels and vegetative conditions can be achieved and maintained throughout the nesting seasons.
- Biological controls have begun to be utilized as part of wetland management protocols. Perhaps foremost among these is the use of *Galerucella* beetles for purple loosestrife containment. The use of *Galerucella* should be investigated particularly in high quality wetlands where native species abundance and diversity is threatened by purple loosestrife colonization.

b. **Hydrologic Alterations** Various land managers have mentioned concerns about hydrologic alterations in coastal and near coastal wetlands, particularly along the west shore. These modifications typically take the form of roadways and driveways and associated culverts and ditches. Often such disturbances are created when new seasonal or year-round residences are constructed along the bayshore and wetlands must be traversed to gain access. The individual impact of these alterations is surficially small since the actual area of filling is relatively minor for each dwelling. However, the cumulative effect can be substantial, particularly if the hydrology of lineal nearshore wetlands is altered by fills and inappropriately sized culverts (or no culverts at all).

It would be desirable to conduct investigations into the effects of such disturbances and to investigate alternatives that minimize wetland intrusions. Such studies would include looking into the potential for removing problem road and drive segments, removing improperly-sized culverts, and correctly sizing replacement culverts. In areas where these situations have created altered wetland hydrology, the possibility of cost-share arrangements to implement corrective measures should be explored.

On a larger scale, investigations should be made to determine the efficacy of re-connecting coastal wetlands currently cut off from bay hydrology by artificial means, such as levees and revetments. Under natural conditions these lacustrine wetland areas were connected directly with Green Bay which offered a dependable source of hydrology in normal years. With the addition of artificial shore protection structures, some wetlands have been deprived of their natural water source. Furthermore, these structures limit accessibility to the coastal wetlands by wetland-dependent spawning fish species such as northern pike. It may be possible to re-establish hydrologic connections between wetlands and the bay while still preserving shore protection functions.

Previously filled wetlands could be restored through the removal of fill materials. The most striking example of this type of restoration is the area known as Atkinson's Marsh in extreme lower Green Bay. It has been reported that as much as 400 acres of coastal wetland were filled to provide dredge spoilage areas and promote commercial development in the Bayport Industrial Park. This diked disposal area contains countless cubic yards of dredge spoils, fly ash, and a municipal landfill (Bosley, 1976). The area is also used for snow removal and disposal purposes. Given funding, limited areas of fill could be removed down to original substrates and wetland habitats restored. Areas near Duck Creek and Peats Lake could be restored as extensions of existing wetland habitats.

Other potential projects that should be considered include creating and restoring riparian wetlands along stream and river corridors, which often can be accomplished with minimal grading followed by seeding and planting with native species. Incorporation of undisturbed native vegetative buffers along stream corridors is advantageous from both water quality and habitat perspectives. Finally, areas of extensive streambank erosion should be prioritized for remedial streambank stabilization projects. This is particularly important from a water quality standpoint in watersheds tributary to the bay that have high sediment delivery rates. An example of projects of this nature is the *Priority Watershed Plans* for East River and Duck Creek. Implementation of applicable portions of these plans would result in land acquisition, habitat restoration and enhancement and streambank stabilization. This is the type of plan that would result in projects yielding both water quality and habitat improvement benefits.

c. **Water Quality Improvement** Restoration of Green Bay wetlands would be expected to have positive impacts on water quality. Restoration of natural wetland hydrologic regime will result in increased water residence times, allowing greater opportunity for solids and other pollutants to settle out or be biologically assimilated. Transported nutrients also would be reduced through settling and nutrient uptake by wetland vegetation.

All wetlands (whether natural, created or restored) have demonstrated benefits for improving water quality by absorbing and filtering pollutants and sediments. Research at the Des Plaines River Demonstration Project in Lake County, Illinois has demonstrated wetland phosphorous removal efficiencies of 65 to 80 percent and nitrate nitrogen removal efficiencies ranging from 66 to 92 percent (USEPA, 1993). Opportunities may arise to route stormwater into restored wetlands (with some pre-discharge treatment being provided by settling basins). Such opportunities need to be evaluated on a case-by-case basis. Still other opportunities might include re-routing channelized stream sections through new, constructed, meandered reaches having riparian wetlands adjacent to them. Here too, water quality would benefit from the settling and filtration capabilities of a wetland environment. Riparian wetlands adjacent to streams also will allow transported sediments to settle out during periodic conditions of overbank flooding.

The water quality of Green Bay has been and will continue to be a major impediment to the restoration and survivorship of coastal and submerged wetland areas in lower Green Bay (Harris, et al 1977; Howlett, 1974; WDNR, 1991). With the implementation of large scale source controls and restoration of lost wetland habitats, however, opportunities for the establishment of aquatic vegetation may become available. With the gradual improvement of water quality in the lower Bay, projects aimed at reestablishing aquatic macrophytes (through natural recruitment or native planting) would be feasible. Under current water quality conditions, projects of this type would be of limited utility.

RESTORATION APPROACHES

Due to the size and complexity of the assessment area, the sequence and process of wetland restoration will be a challenge. As the restoration of individual sites is considered, topics such as site access for equipment, adjacent land blocks, seasonal moisture levels, and non-target species impacts all need to be considered. To maximize overall benefits of restoration, it may be beneficial to choose restoration sites that are adjacent to each other, for concurrent restoration within a certain time frame. This allows for economies of scale in the financial and administrative management aspects of the restoration process. Clustering management areas (or choosing large single restoration areas) may have greater impact on the goal of restoration of native communities than scattered small restoration units. Wetland restoration can be coordinated with upland habitat restoration projects to maximize localized ecological benefits.

Due to the seasonal nature of water levels and soil moisture within wetland areas, access can be limited or impossible at certain times of the year. Constraints of this type can impose a significant impediment to the restoration process. Alternative approaches to the timing of restoration activity can provide effective control of the target species of management concern. For example, if the soils in a wetland area are too wet to access with a tractor and spray equipment in the spring when chemicals such as glyphosate are most effective, waiting until midsummer to begin the restoration activities may be required. Waiting may allow for the use of traditional agricultural equipment which provides a less expensive per acre cost for the work being conducted.

The sequencing of the restoration will be equally important to a successful implementation. On those sites where hydrologic modification is possible (e.g., ditch filling or drain tile breakage) it will likely be advantageous to conduct invasive plant control prior to the irreversible modification of moisture conditions. Although hydrologic restoration can easily provide significant benefits to relatively large areas and contribute greatly to the overall progress of the restoration, it can hamper the implementation of certain other important segments of the restoration program by limiting access by crews and equipment.

Wetland restoration work is dependent upon a range of factors and is necessarily site specific. Factors influencing restoration include the extent of hydrologic modifications that may be needed to secure dependable wetland hydrology, the need for invasive species management, and the extent of need for seeding and planting.

Potential approaches include impounding water at an appropriate depth behind a berm or weir or excavating depressional wetland from non-wetland areas. With these types of projects, maintenance of a steady dependable water level is the key to establishing desirable vegetation communities. Excessive water levels will cause vegetation to die-off, leaving open water rather than true wetland conditions. Conversely, inadequate water will deprive hydrophytic vegetation of the moisture needed to survive and flourish.

According to research conducted by the Wisconsin Wetlands Association, the most ecologically sound and cost-effective approach to restoration involves restoring degraded, formerly drained wetlands by undoing the man-made modifications that were done to them (Wisconsin Wetlands Association, 2000). This also has been the experience of Hey and Associates in its efforts at wetland restoration over the past decade.

Projects involving drain tile disruption and ditch plugging seem to offer the best chance at maintaining self-sustaining hydrologic wetland conditions. Many marginal farmlands were created by ditching and tiling former wetlands. If the ditches are plugged with earthen materials, flows are disrupted and water backs up on-site. The same result is obtainable when subsurface agricultural drain tiles are disrupted. Soils re-hydrate and drained areas quickly revert to original wetland hydrologic conditions. Often long-dormant seedbanks are activated by a return to wetland hydrology, and there is spontaneous revegetation of formerly cropped lands with native wetland species. Volunteer vegetation emergence can be supplemented with installation of seed and plants appropriate to the recovered hydrology. In some cases this may be shallow marsh, while in others it may be wet meadow or forested wetland.

This approach is simple, direct and cost-effective. Ditches can usually be plugged with soil obtained on-site. Clay is preferable, but virtually all material can be made to work if sufficient quantity is used. Critical to tile disruption and ditch plugging projects are pre-project surveys to locate buried tiles and make provisions for continued drainage of off-site areas. It is of paramount importance that adjacent lands continue to be drained without interruption. Local drain tile contractors or excavators can be contracted to conduct tile surveys and to install replacement PVC pipes and other structures that may be needed to ensure uninterrupted drainage from upstream lands. Local Natural Resources Conservation Service (NRCS) offices contain a wealth of information on agricultural drainage conditions, and also have soil survey data that will yield important information on historic hydric soils areas which may be candidates for restoration. In the case of ditch plugging, WDNR permits are required if the affected ditches constitute jurisdictional floodplain. Corps of Engineers authorization is also needed for ditch plugging projects.

Breaking/Modifying Drainage Tile Normally a backhoe is used to excavate to the tile, crush a section, install plugs at the upstream and downstream ends of the remaining tile, and to backfill. Depending on soil composition and permeability, the length and frequency of plugging will vary. Plug lengths commonly vary between 20 and 30 feet (Wenzel, 1992), and long tile lines may be plugged at 200-foot intervals; again depending on conditions (Tom Huddleston, pers. comm.)

Another option for the modification of tile networks consists of fitting tile lines with adjustable water level control structures. These structures are easy to install and cause limited soil disturbance. The elevation of the outlet can be manipulated to surcharge the tile with water or let the water freely drain if drier conditions are preferred for management purposes. These structures afford flexibility with water level control, although the restoration of hydrology may be more unpredictable than physical dismantlement of the on-site tile network.

Filling Drainage Ditches Depending on the size of the drainage basin, either spilling or non-spilling plugs can be installed in ditches to hold back the water and raise the water table. Small drainage areas can use non-spilling plugs, well-anchored along the base and sides to prevent washout. Excavation of organic soil from the ditch base and sides, and installation of a clay plug is one construction method. Alternatively, sheet piling can be installed. Larger drainage areas may require culverts, weirs, or other structures to release excess water.

Complete filling of the ditch will be most effective at restoring natural hydrology and removing the scar of a linear ditch on the landscape. This requires more earthen materials to fill the channel, which may be available as old spoil along the banks of the ditches. Such material will need to be relatively impermeable to be suitable, but it is not necessary to use hydric soils or to pretreat fill material to achieve hydric quality. Hydric soils are more valuable where they are and should not be moved, and appropriate fill material will acquire hydric soil characteristics over time when exposed to prolonged wetland hydrologic conditions.

At least two caveats are in order when ditch-plugging is being considered in wetland restoration. The first relates to the need to conduct adequate hydraulic analyses to ensure that localized flooding problems are not created or exacerbated on upstream, non-project properties. The second relates to concerns expressed by Wisconsin DNR fisheries management staff (WDNR Communication, September 29, 2000) that the importance of west shore ditches as spawning habitat for northern pike and other fish species not be impinged. The Wisconsin DNR emphasized the need for caution in ditch-plugging projects to ensure that plugs do not interfere with long-established migratory routes and existing spawning habitat.

ESTIMATED COSTS

If wetland restoration activities are undertaken, the following estimates of unit costs are offered to give perspective on the funding levels that may be required in the project area.

Drain Tile Surveys and Abandonment Drain surveys are a necessary preliminary phase of restoration involving tile breakage. Surveys include manpower and equipment needed to locate and map main drain tiles and laterals and to inventory and evaluate other site features. Typical costs for tile investigation work are from \$40 to \$70 per acre. As restoration proceeds, the costs for tile abandonment are approximately \$2.00 per foot (cost is for 4-man crew, using a combination of equipment including trencher, backhoe, and swamp dozer) (pers. comm. Tom Huddleston, Huddleston-McBride Drainage Co.). If overflow/bypass structures are utilized, installed costs range from \$1200 - \$1800 (assuming 4 to 5 foot depths).

Ditch Plugging Costs for this activity involve labor and equipment to fill-in existing drainage ditches. Costs for this work are on the order of \$1200 to \$1600 per day, assuming one backhoe, one operator and one laborer. This assumes that ditch spoil is suitable and available on-site for fill placement, and that outside material will not have to be trucked in. Overflow or bypass structures would be additional costs if required.

Wetland Seeding and Planting Costs for wetland seeding and planting depend upon the species selected and the installation rate. As a general rule, current prices for 2" plugs are on the order of \$1.00 per plant. Installation and herbivore protection may be expected to add on additional \$1.00 to \$1.25, for a total installed cost of approximately \$2.00 to \$2.25 per installed plant for common wetland species such as sedges, most bulrushes, burreed, sweet flag, marsh milkweed, and prairie cord grass. Approximately 2000 plants per acre would be a reasonable initial planting rate in a newly established wetland.

Seed prices are extremely variable depending upon species selected. $750 to $1250 per acre is a reasonable anticipated range of cost for compiling a reasonable diverse wetland seeding mix. Cover crop and seed installation will add to overall project costs. Installation costs will vary depending on methods of installation (broadcast or drilling), access with equipment, soil preparation needs and moisture levels. A range of $1500-$2000 per acre of wetland seed installed should be anticipated.

Herbicide Applications The need for herbicidal control of invasive plant species such as cattail, reed canary grass, purple loosestrife, and common reed should be expected in wetland restorations, and often is needed to manage and maintain preserved wetlands if botanic richness is desired. Costs for herbicide application (usually of a glyphosate-based product) depend upon the method of application and the amount of invasive plant material requiring control and the way it is distributed in the landscape. Cost for using "Terragator" type ATV sprayers range from about $125 to $175 per acre (including equipment, labor, and herbicide). Deployment of applicators with backpack sprayer equipment will cost about $40 to $60 per hour for labor and equipment. On very large scale wetland projects experiencing problems with monotypic stands of cattail or reed canary grass, helicopter spraying can be contracted for at a cost of $200 to $250 per acre. All herbicide applicators need to be state licensed, and in Wisconsin, permitting is required by WDNR.

Mowing Mowing can be used to manage wetland vegetative conditions provided conditions are stable enough to permit movement of mowing equipment. Typical costs for mowing (labor and equipment) are from $60 to $100 per acre.

Prescribed Burning Burning is useful as a restoration management tool, although its value may be greater in upland rather than wetland situations. Costs vary according to the size of the area burned, the size of the burn crew and type of equipment deployed, and the extent to which special measures need to be employed to protect structures, traffic, or other "non-burnable" features. Typical costs with full crew and equipment range widely from about $100 to $450 per acre.

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Appendix F — Description of GIS and Mapping Analysis

This appendix describes the methods and results of geographic information system (GIS) and mapping analyses that were conducted to support the RCDP. The analyses discussed here are in addition to the analyses conducted as part of estimating current nonpoint source loads into Green Bay that are described in Appendix G, and to analyses described elsewhere in the RCDP.

The sources of the data used in the GIS analyses are shown in Table F.1. The following GIS and/or mapping analyses were conducted based on these data and are described in this appendix:

- the distribution of land classified as agricultural with hydric soils, for use in estimating the distribution of lands with the potential for restoration to wetlands

- the distribution of population density changes, for use in evaluating where development pressure may be the highest and where wetland preservation efforts should be focused

- the distribution of coastal wetlands around Green Bay, for use in evaluating where coastal wetland preservation efforts should be focused.

- the type and amount of land cover falling within 15 and 105 m stream buffers within the Green Bay watershed

- unit area loads of total suspended solids and phosphorus for corn and soybean land cover classifications.

Table F.1. GIS data sources.

Theme	Data layer	Scale	Source	Spatial coverage
General land use/land cover	Land use/land cover	1:250,000	USGS, 2000a	Wisconsin and Michigan
Detailed land use/land cover	WISCLAND land cover	30-m cell size (approx. 1:24k) (5 acre minimum mapping unit)	WDNR, 1993	Wisconsin
Wisconsin wetlands inventory	Wetlands	1:20,000	WDNR, 1999a	Wisconsin
General soils	STATSGO soils	1:250,000	NRCS, 2000a	Wisconsin and Michigan
Detailed soils	SSURGO soils	1:24,000	NRCS, 2000b	Brown, Door, Kewaunee counties, Wisconsin
General hydrography	100k hydrography	1:100,000	USGS, 2000b	Wisconsin and Michigan
Detailed hydrography	Preliminary 24k Hydrography (swpnw224)	1:24,000	WDNR, 1999b	Wisconsin
Federal and tribal lands	Federal and tribal lands	1:1M-1:2M (640 acre minimum mapping unit)	USGS, 2000d	Wisconsin and Michigan
Watersheds	Watersheds	1:24,000	P. Baumgart, Fox-Wolf Basin 2000, pers. comm., 8/2000	Watersheds of Green Bay
Upper Bower Creek watershed	Reference watershed	1:24,000	P. Baumgart, Fox-Wolf Basin 2000, pers. comm., 8/2000	Upper Bower Creek Watershed, Wisconsin
County boundaries	Detailed county boundaries	1:100,000	ESRI, 1999	Wisconsin and Michigan
State boundaries	Detailed state boundaries	1:100,000	ESRI, 1999	Wisconsin and Michigan
Cities and towns	Cities and towns	1:100,000	ESRI, 1999	Wisconsin and Michigan
Census tracts	Census tracts	1:100,000	ESRI, 1999	Wisconsin and Michigan
Township/range lines	Public lands data (PLSS)	1:100,000	USGS, 2000c	Wisconsin and Michigan
Unit-area load — total phosphorus	UAL TotP	30-meter cell size (approx. 1:24k)	P. Baumgart, Fox-Wolf Basin 2000, pers. comm., 10/2000	Wisconsin
Unit-area load TSS	UAL TSS	30-meter cell size (approx. 1:24k)	P. Baumgart, Fox-Wolf Basin 2000, pers. comm., 10/2000	Wisconsin
Floodplains	FEMA floodplains	1:24,000	FEMA, 1998	Delta County, Michigan, Marinette and Brown Counties, Wisconsin

Agricultural lands on hydric soils

This analysis was conducted for both Wisconsin and Michigan for all counties that border Green Bay, but with different data layers for each state. For Wisconsin, land use/land cover data from WISCLAND were used. Lands classified as agricultural (for the selected counties this included codes for row crops, corn, other row crops, forage crops, herbaceous/field crops, and agriculture selected from the highest level of precision available) were considered. For Michigan, general land use/land cover data from the USGS were used to identify areas as agricultural, using the classifications of agricultural land, cropland and pasture, and other agricultural land. These areas were overlaid with STATSGO or SSURGO soils data, depending on the county (see Table F.1). The soil type classification in STATSGO or SSURGO was used to identify soils that are hydric by selecting soils classified as such in the "COMP" relational database file. In cases where there were multiple components for a specific soil polygon, the polygon was considered hydric if any component of that polygon contained a soil classified as hydric. Only STATSGO data are available for the Michigan counties surrounding Green Bay. Results were separated by county using the layer of county boundaries. The results of the analysis by county are shown in Table F.2. A map showing the results of the analysis is shown in Figure F.1.

Table F.2. Acres of agricultural land on hydric soils for counties that border Green Bay.

County	State	Acres of agricultural lands on hydric soils
Delta	Michigan	30,946[a]
Menominee	Michigan	47,422[a]
Brown	Wisconsin	15,941
Door	Wisconsin	6,888
Kewaunee	Wisconsin	20,270
Marinette	Wisconsin	1,436
Oconto	Wisconsin	2,472

a. The acres for these two counties were estimated by dividing the GIS analysis results by a factor of two to account for the different spatial scale of the GIS information.

Population density changes

The difference between 1999 Census projections and 1990 Census data was used to estimate the change in number of people within each census tract around Green Bay. This change was normalized to census tract area to obtain the density changes within each census tract from 1990 to 1999. The results are shown in Figure F.2.

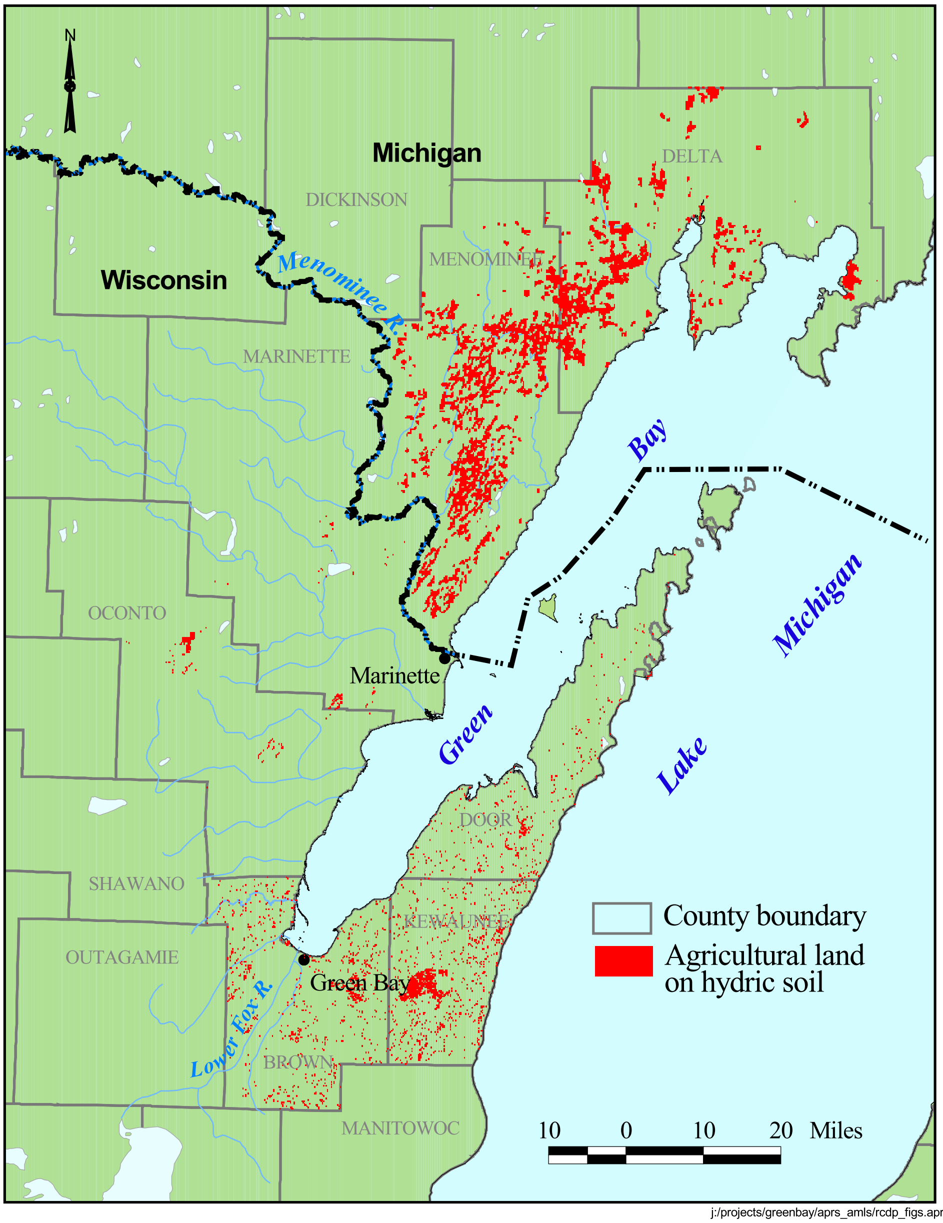
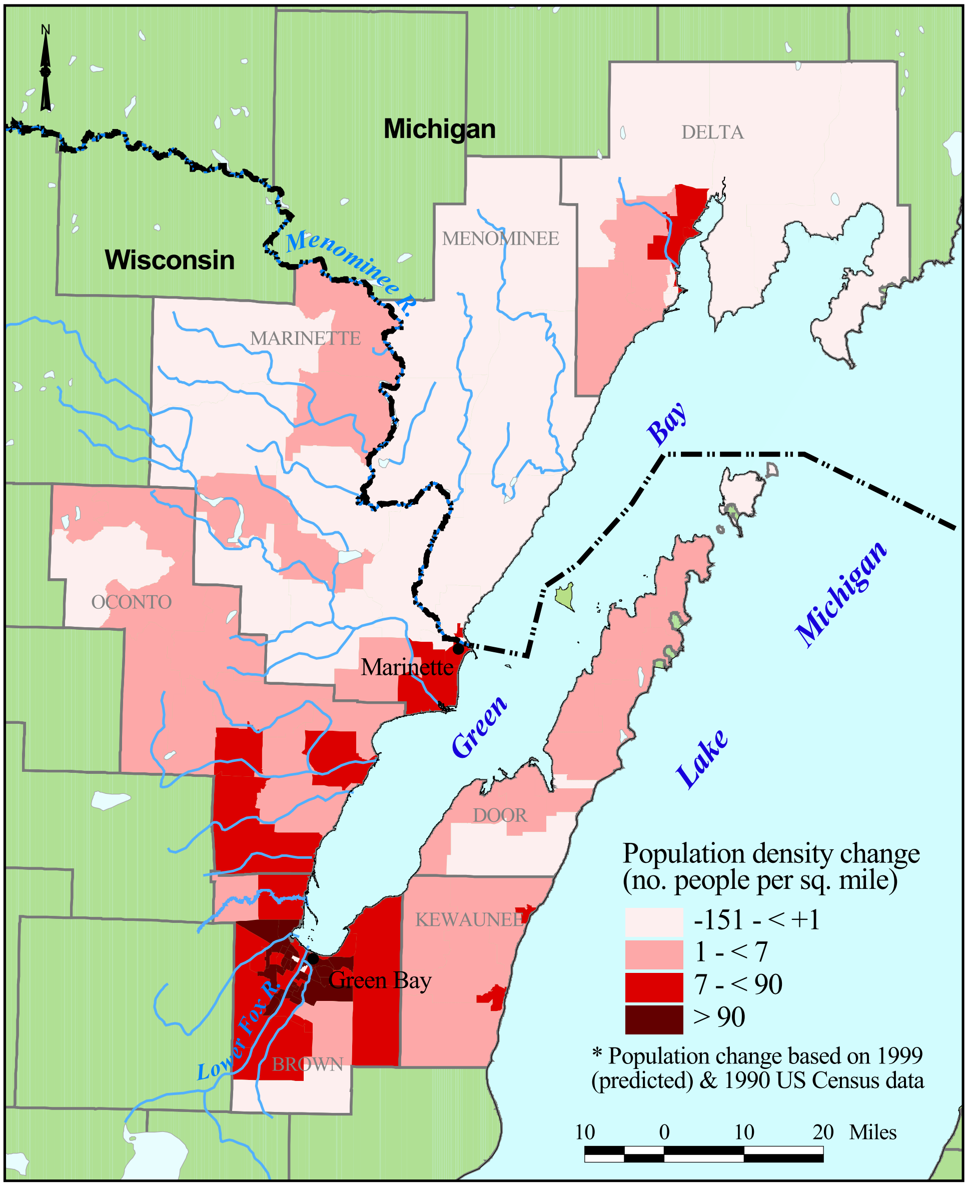


Figure F.1. Distribution of agricultural lands on hydric soils in counties that border Green Bay.



j:/projects/greenbay/aprs_amls/rcdp_figs.apr

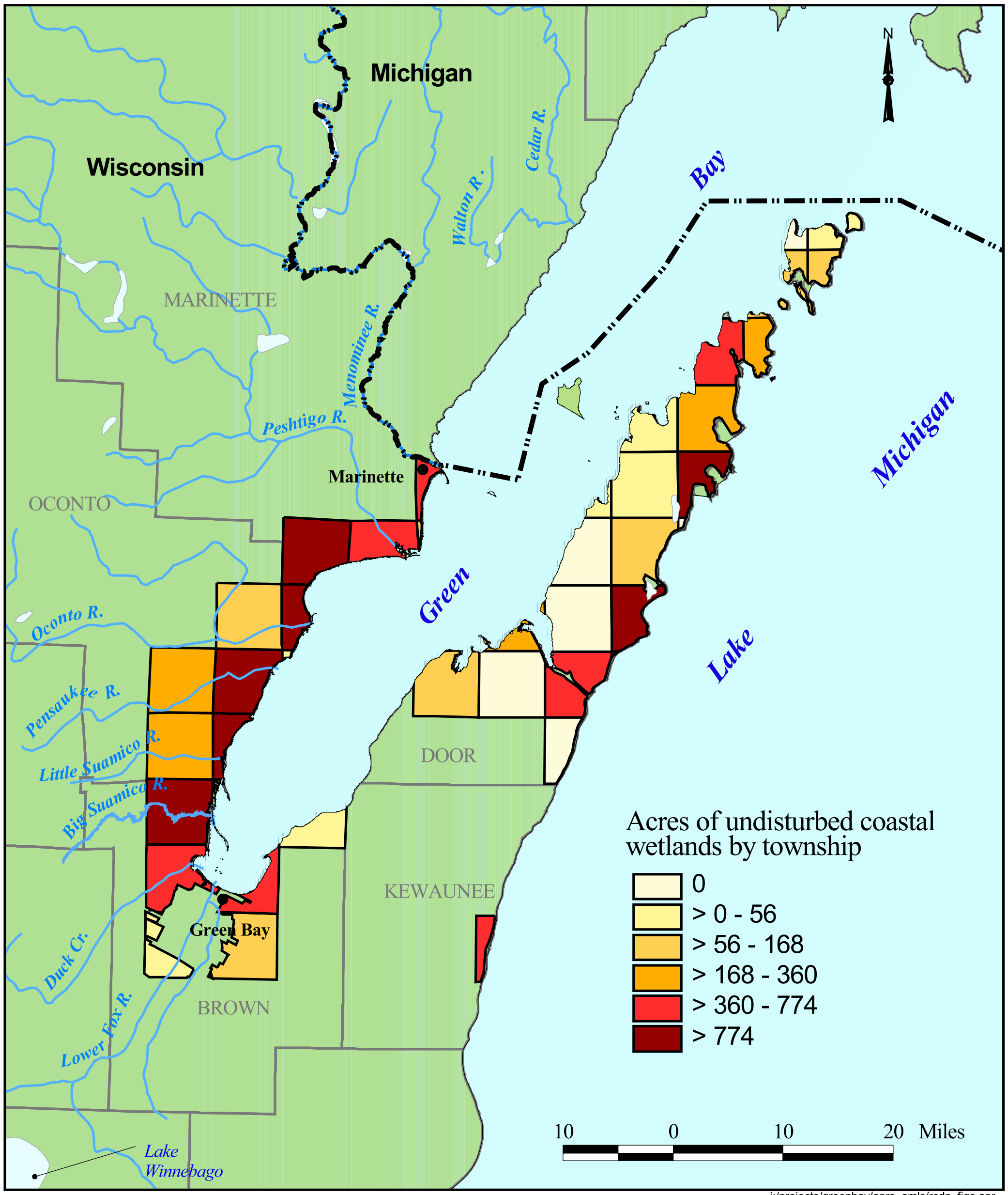
Figure F.2. Population density change in areas around Green Bay, 1990-1999.

Coastal wetland distribution

The U.S. Fish and Wildlife Service conducted an inventory of coastal wetlands in selected areas of Green Bay in the early 1990s (U.S. FWS, 1993). Information on the distribution of coastal wetlands around Green Bay was obtained from Jeremy Husnik of Hey & Associates, Inc. (SWIS dataset originated from the Bay Lake RPC). This information included the size of areas identified as coastal wetlands, the township(s) in which the coastal wetlands are located, and the disturbance state of each coastal wetland. This information was developed into a GIS overlay to display the distribution of coastal wetlands in the areas around Green Bay where the coastal wetland survey was conducted. The results of the analysis are shown in Figure F.3.

Land cover within stream buffers

This analysis was conducted to determine the type and amount of land cover in Wisconsin falling within stream buffers of 15 and 105 m of all streams within the Green Bay watershed. Two buffer layers were generated by buffering the detailed stream 1:24,0000 GIS layer from the WDNR using buffer widths of 15 m and 105 m. The buffer layers were intersected with the WISCLAND land use/land cover data (converted to polygons) and a subwatershed dataset provided by Paul Baumgart of Fox-Wolf Basin 2000. Acres of land cover types falling within each buffer width and subwatershed combination were then summarized into the following classifications of WISCLAND: "**Herbaceous and field crops**" ("level2" codes of "herbaceous/field crops"); "**Urban**" ("level1" codes of "urban/developed"); "**Open water**" ("level1" codes of "open water"); "**Forested and shrubland**" ("level1" codes of "forest" or "shrubland"), "**Grassland**" ("level1" codes of "grassland"), "**Wetland**" ("level1" code of "wetland"), "**Barren**" (level1 code of "barren"), "**Other agriculture**" ("level2" codes of "woody agriculture," "cranberry bog," or "agriculture"), and "**Other lands**" (all codes not falling in any of the other categories). The results of this analysis are shown in Table F.3 and are used in the estimation of vegetated buffer strip installation described in Appendix I of the RCDP.



j:/projects/greenbay/aprs_amls/rcdp_figs.apr

Figure F.3. Distribution of coastal wetlands in selected areas of Wisconsin.

Table F.3. Watershed acres, 15 m and 105 m waterway buffer acres, and cropland within 15 m of waterways.

Watershed name	Watershed ID	Total watershed acres	Total watershed acres within 15 m of streams	Percent of watershed acres within 15 m that are herbaceous or field crops	Total watershed acres within 105 m of streams
Suamico and Little Suamico Rivers	GB01-130	109,903.0	4,715.9	55%	30,522.7
Pensaukee River	GB02-130	104,783.7	4,550.3	48%	28,109.3
Lower Oconto River	GB03-140	125,716.3	5,309.7	29%	30,447.4
Little River	GB04-140	134,565.0	4,397.1	40%	28,144.1
Lower North Branch Oconto River	GB05-140	249,127.6	7,795.0	6.3%	45,311.2
South Branch Oconto River	GB06-140	140,340.6	3,868.2	6.9%	23,393.0
Lower Peshtigo River	GB07-150	124,709.8	4,742.5	22%	26,620.1
Little Peshtigo River	GB08-150	101,357.3	3,090.6	24%	20,021.6
Middle Inlet and Lake Noquebay	GB09-150	99,523.8	2,263.6	2.5%	14,132.4
Middle Peshtigo and Thunder Rivers	GB10-150	123,838.5	4,394.4	0.8%	25,533.3
Upper Peshtigo River	GB11-150	216,553.3	5,965.2	0.4%	33,330.4
Otter Creek and Rat River	GB12-150	90,572.2	2,686.3	0.2%	15,679.8
Wausaukee and Lower Menominee Rivers	GB13-160	119,642.7	3,354.1	4.4%	20,005.9
Pike River	GB14-160	182,181.8	5,172.7	0.1%	31,042.3
Pemebonwon and Middle Menominee Rivers	GB15-160	186,027.5	5,347.9	1.2%	31,953.2
Pine River	GB16-160	219,267.1	6,750.2	0.4%	38,584.6
Popple River	GB17-160	148,010.0	3,918.3	0.2%	22,783.4
Brule River	GB18-160	124,646.6	3,288.8	0.8%	19,910.1
East River	LF01-113	131,985.1	6,269.8	67%	38,658.7
Apple and Ashwaubenon Creeks	LF02-113	72,519.8	3,146.5	75%	20,449.6
Plum and Kankapot Creeks	LF03-113	53,772.7	2,574.5	70%	16,004.9
Fox River/Appleton	LF04-113	25,198.1	1,092.8	39%	6,680.3
Duck Creek	LF05-113	97,009.3	3,926.5	59%	25,112.5

Table F.3. Watershed acres, 15 m and 105 m waterway buffer acres, and cropland within 15 m of waterways (cont.).

Watershed name	Watershed ID	Total watershed acres	Total watershed acres within 15 m of streams	Percent of watershed acres within 15 m that are herbaceous or field crops	Total watershed acres within 105 m of streams
Little Lake Butte des Morts	LF06-113	28,009.7	1,026.9	37%	6,098.7
Red River and Sturgeon Bay	TK07-100	88,986.5	2,030.3	48%	13,842.4
Lake Winnebago/North and West	UF01-111	14,549.1	464.4	40%	2,658.1
Lake Winnebago/East	UF02-111	63,609.1	2,508.3	63%	16,257.5
Fond du Lac River	UF03-111	156,643.8	7,034.9	45%	43,158.8
Lake Butte Des Morts	UF04-111	50,980.3	2,002.2	48%	12,071.7
Fox River	UF05-111	76,662.2	4,079.9	36%	22,164.8
Fox River/Berlin	UF06-111	133,663.9	5,506.0	20%	31,424.2
Big Green Lake	UF07-111	68,704.2	2,281.9	30%	14,051.8
White River	UF08-111	95,949.6	2,779.5	7.8%	15,734.6
Mecan River	UF09-111	94,997.8	2,911.8	9.0%	17,062.3
Buffalo and Puckaway Lakes	UF10-111	144,190.8	5,547.9	14%	32,637.9
Lower Grand River	UF11-111	70,056.9	2,664.7	24%	15,965.2
Upper Grand River	UF12-111	39,667.9	1,164.0	42%	7,421.4
Montello River	UF13-111	86,159.7	2,775.6	15%	16,674.3
Neenah Creek	UF14-111	111,057.7	3,828.7	21%	22,316.1
Swan Lake	UF15-111	51,628.2	1,652.0	21%	10,115.6
Arrowhead River and Daggets Creek	WR01-112	91,476.8	3,560.9	50%	21,051.5
Pine and Willow Rivers	WR02-112	193,431.4	5,816.8	25%	33,871.2
Walla Walla and Alder Creeks	WR03-112	71,771.2	2,751.5	18.8%	15,294.8
Lower Wolf River	WR04-112	76,790.7	3,844.6	18.2%	20,264.8

Table F.3. Watershed acres, 15 m and 105 m waterway buffer acres, and cropland within 15 m of waterways (cont.).

Watershed name	Watershed ID	Total watershed acres	Total watershed acres within 15 m of streams	Percent of watershed acres within 15 m that are herbaceous or field crops	Total watershed acres within 105 m of streams
Waupaca River	WR05-112	186,228.0	4,626.2	14%	25,826.7
Lower Little Wolf River	WR06-112	98,350.0	3,068.3	23%	18,367.7
Upper Little Wolf River	WR07-112	116,593.4	2,624.4	8.6%	16,955.5
South Branch Little Wolf River	WR08-112	102,644.8	3,106.4	9.7%	18,035.0
North Branch & Mainstem Embarrass River	WR09-112	200,133.2	8,031.4	30%	44,523.8
Pigeon River	WR10-112	74,473.3	2,158.0	24%	13,146.4
Middle & South Branches Embarrass River	WR11-112	160,095.6	4,322.4	9.5%	26,213.6
Wolf River/New London and Bear Creek	WR12-112	91,196.8	3,930.3	44%	22,573.9
Shioc River	WR13-112	121,443.5	4,983.0	55%	30,810.6
Middle Wolf River	WR14-112	85,627.9	3,865.0	24%	20,066.4
Shawano Lake	WR15-112	45,544.6	1,433.0	26%	8,935.8
Red River	WR16-112	132,606.6	3,318.3	7.8%	19,848.4
West Branch Wolf River	WR17-112	170,354.9	4,640.5	2.8%	25,860.2
Wolf River/Langlade and Evergreen Rivers	WR18-112	115,064.1	2,584.5	1.4%	13,958.4
Lily River	WR19-112	134,107.9	4,137.6	0.6%	23,475.0
Upper Wolf River and Post Lake	WR20-112	130,175.8	3,973.6	0.8%	22,854.8

Percent unit area loads by crop type

As part of the evaluation of the reductions in loadings that would result from implementation of conservation tillage, initial unit area loads (UALs) by crop type are required for each watershed (see Appendix H of the RCDP). The percent of initial UALs originating from each crop type were calculated by overlaying WISCLAND land use/land cover data with subwatershed data for the Green Bay watershed and TSS and phosphorus GIS data provided by Paul Baumgart of Fox-Wolf Basin 2000. The UAL data were the raw UALs and not the loads routed to Green Bay, but the analytical process of routing the loads to Green Bay does not change the relative UALs within a watershed. UALs were determined for WISCLAND cells falling into one of two categories: “Corn” (classified from WISCLAND codes of “agriculture,” “herbaceous/field crops,” “row crops,” “corn,” or “barren”) or “Soybean/Other row crop” (classified from WISCLAND codes of “Other row crops” or “Cranberry bog”). Percents of UALs originating from corn and soybean/other row crop were calculated from the unrouted UALs from each land type category and the total unrouted UALs for the watershed. The results of this analysis are shown in Table F.4.

Table F.4. Percent of unit area loads from different landcover types.

Watershed name	Watershed ID	% of phosphorus load from soybean fields	% of phosphorus load from corn fields	% of phosphorus load from other land type
Suamico and Little Suamico Rivers	GB01-130	19%	72%	10%
Pensaukee River	GB02-130	22%	69%	9%
Lower Oconto River	GB03-140	21%	70%	8%
Little River	GB04-140	21%	65%	14%
Lower North Branch Oconto River	GB05-140	14%	68%	19%
South Branch Oconto River	GB06-140	20%	71%	9%
Lower Peshtigo River	GB07-150	18%	72%	9%
Little Peshtigo River	GB08-150	21%	69%	10%
Middle Inlet and Lake Noquebay	GB09-150	0%	96%	4%
Middle Peshtigo and Thunder Rivers	GB10-150	3%	93%	4%
Upper Peshtigo River	GB11-150	0%	64%	36%
Otter Creek and Rat River	GB12-150	0%	46%	54%
Wausaukee and Lower Menominee Rivers	GB13-160	0%	93%	7%
Pike River	GB14-160	0%	78%	22%
Pemebonwon and Middle Menominee Rivers	GB15-160	0%	92%	8%
Pine River	GB16-160	6%	83%	11%
Popple River	GB17-160	0%	57%	43%
Brule River	GB18-160	5%	77%	18%
East River	LF01-113	3%	78%	18%
Apple and Ashwaubenon Creeks	LF02-113	21%	58%	21%
Plum and Kankapot Creeks	LF03-113	3%	66%	31%
Fox River/Appleton	LF04-113	16%	38%	45%
Duck Creek	LF05-113	21%	64%	14%
Little Lake Butte des Morts	LF06-113	17%	53%	30%
Red River and Sturgeon Bay	TK07-100	0%	87%	13%
Lake Winnebago/North and West	UF01-111	7%	69%	24%
Lake Winnebago/East	UF02-111	24%	65%	11%
Fond du Lac River	UF03-111	32%	57%	11%
Lake Butte Des Morts	UF04-111	18%	51%	31%
Fox River	UF05-111	21%	70%	9%
Fox River/Berlin	UF06-111	21%	70%	10%
Big Green Lake	UF07-111	30%	57%	13%
White River	UF08-111	32%	62%	6%
Mecan River	UF09-111	35%	57%	8%

Table F.4. Percent of unit area loads from different landcover types (cont.).

Watershed name	Watershed ID	% of phosphorus load from soybean fields	% of phosphorus load from corn fields	% of phosphorus load from other land type
Buffalo and Puckaway Lakes	UF10-111	27%	60%	13%
Lower Grand River	UF11-111	32%	61%	7%
Upper Grand River	UF12-111	33%	55%	12%
Montello River	UF13-111	30%	55%	15%
Neenah Creek	UF14-111	32%	57%	11%
Swan Lake	UF15-111	30%	62%	7%
Arrowhead River and Daggets Creek	WR01-112	27%	60%	13%
Pine and Willow Rivers	WR02-112	24%	63%	13%
Walla Walla and Alder Creeks	WR03-112	20%	67%	13%
Lower Wolf River	WR04-112	20%	67%	13%
Waupaca River	WR05-112	18%	67%	15%
Lower Little Wolf River	WR06-112	21%	65%	14%
Upper Little Wolf River	WR07-112	23%	71%	6%
South Branch Little Wolf River	WR08-112	20%	70%	10%
North Branch & Mainstem Embarrass River	WR09-112	21%	70%	9%
Pigeon River	WR10-112	22%	66%	12%
Middle & South Branches Embarrass River	WR11-112	22%	70%	8%
Wolf River/New London and Bear Creek	WR12-112	28%	60%	12%
Shioc River	WR13-112	26%	64%	10%
Middle Wolf River	WR14-112	19%	70%	10%
Shawano Lake	WR15-112	27%	65%	9%
Red River	WR16-112	13%	79%	7%
West Branch Wolf River	WR17-112	7%	83%	10%
Wolf River/Langlade and Evergreen Rivers	WR18-112	0%	98%	2%
Lily River	WR19-112	2%	87%	10%
Upper Wolf River and Post Lake	WR20-112	8%	70%	22%

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Appendix G — Simulated TSS and Phosphorus Loads to Green Bay, Wisconsin

Simulated TSS and Phosphorus Loads to Green Bay, Wisconsin

October, 2000

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Objective

The primary objective of the modeling project was to estimate TSS (total suspended solids) and total phosphorus export to Green Bay so that the relative loads within the basin could be compared. To accomplish this objective, the Soil and Water Assessment Tool (SWAT) and a GIS model were applied to the Green Bay drainage basin. SWAT was developed by USDA-ARS to improve the technology used in the SWRRBWQ model (Arnold et al. 1996). SWAT is a distributed parameter, daily time step model that was developed to assess non-point source pollution from watersheds and large river basins. SWAT simulates hydrologic and related processes to predict the impact of management on water, sediment, nutrient and pesticide export from rural basins. A more detailed description of this model can be found at the following Internet address: http://www.brc.tamus.edu/swat/.

This report describes: (1) overall GIS-SWAT approach used to derive TSS and phosphorus loads to Green Bay; (2) GIS layers, methods and other inputs; (3) SWAT methods; (4) delivery ratio and export coefficients; (5) simulated loads to Green Bay; and (6) other loads, sensitivity analysis and caveats; and (7) summary and conclusions.

CHAPTER 1. GIS-SWAT MODELING OVERVIEW

Basin description

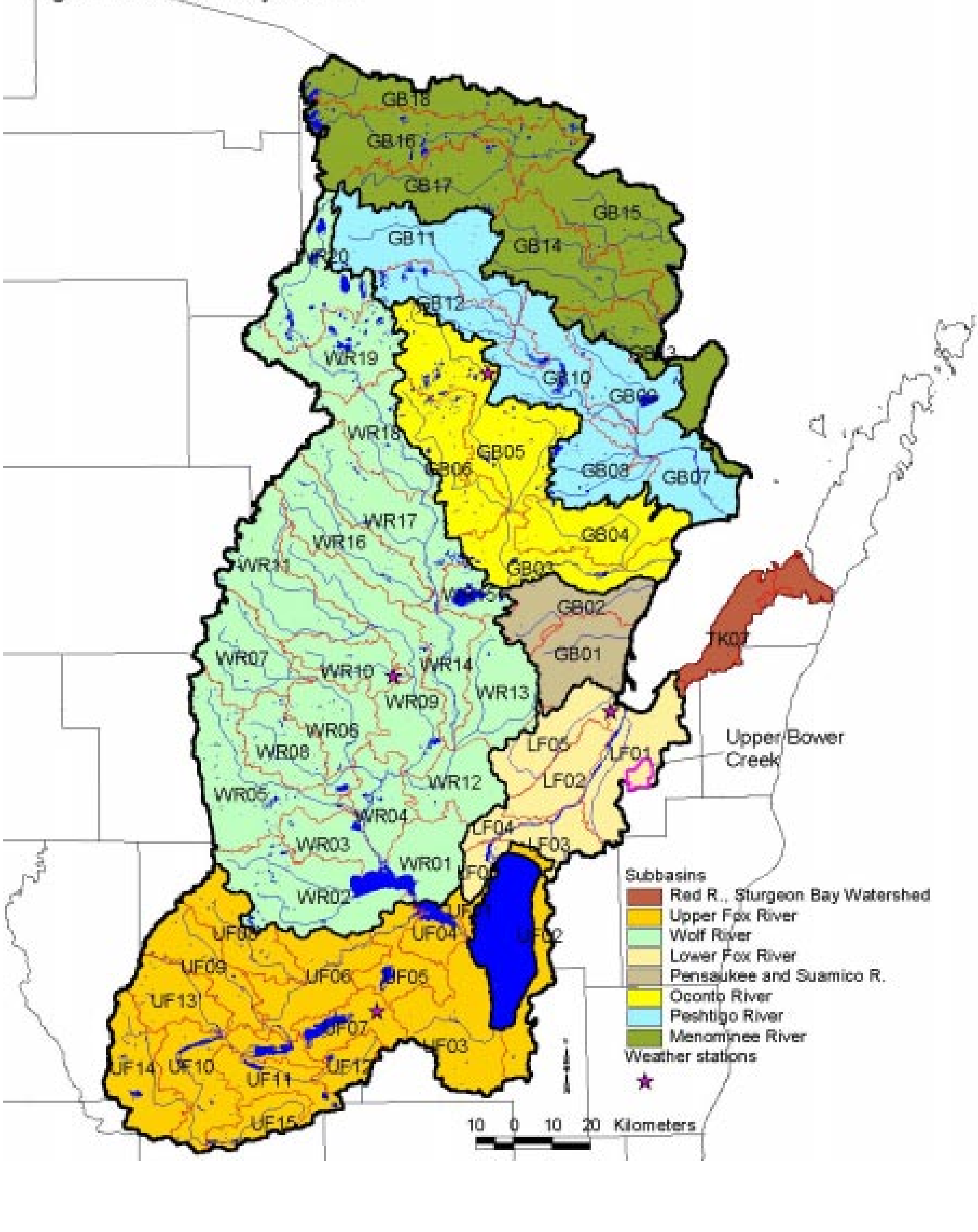
As illustrated in Figure 1, the Green Bay Basin is sub-divided by the Wisconsin Department of Natural Resources (WDNR) into seven major hydrologic units (subbasins): (1) LF - Lower Fox River; (2) UF - Upper Fox River; (3) WR - Wolf River; (4) Pensaukee River-Suamico River; (5) Oconto River; (6) Peshtigo River; and (7) Menominee River. These subbasins are further delineated by the WDNR into a total of 60 watersheds as shown in Figure 1. Only the Wisconsin portion of the Menominee River subbasin is shown in Figure 1. The remaining portion of this subbasin was not modeled; however, both sides of the subbasin have similar characteristics. Watersheds that drain into upper Green Bay, north of the Menominee River subbasin, were not modeled in this project because these watersheds are not major non-point source contributors of TSS and phosphorus to Green Bay (Robertson and Saad 1996). The Red River Sturgeon Bay Watershed was also modeled in this project.

In this report, the Green Bay Basin shall be referred to as the "Basin".

Model Overview

The overall approach used to develop TSS and phosphorus loads in the Basin was to generate unit-area loads (UALs) with the SWAT model, which were applied to a GIS model that used land cover, soils and climate GIS layers to represent the 128 combinations of UALs that were determined for the Basin. Figure 2 summarizes the overall approach. The GIS model was used to assign to each 30 square meter grid cell in the Basin the appropriate unit-area load on the basis of which combination of 8 land cover types, 4 soil types, and 4 climates were present in that cell (8 * 4 * 4 = 128 combinations). Land cover within the Basin was determined from the Level 3 classification of the Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and

Figure 1. Green Bay Basin.



Data 1992 land cover image (WISCLAND), which was based on LANDSAT Thematic Mapper images. Reclassification of the Level 3 classification produced eight land covers which were simulated by both SWAT and the GIS model: corn, forage/alfalfa, other row crops/soybeans, urban, grassland, forest, wetland and water.

Long-term unit-area loads were simulated with the SWAT model by applying the model to a

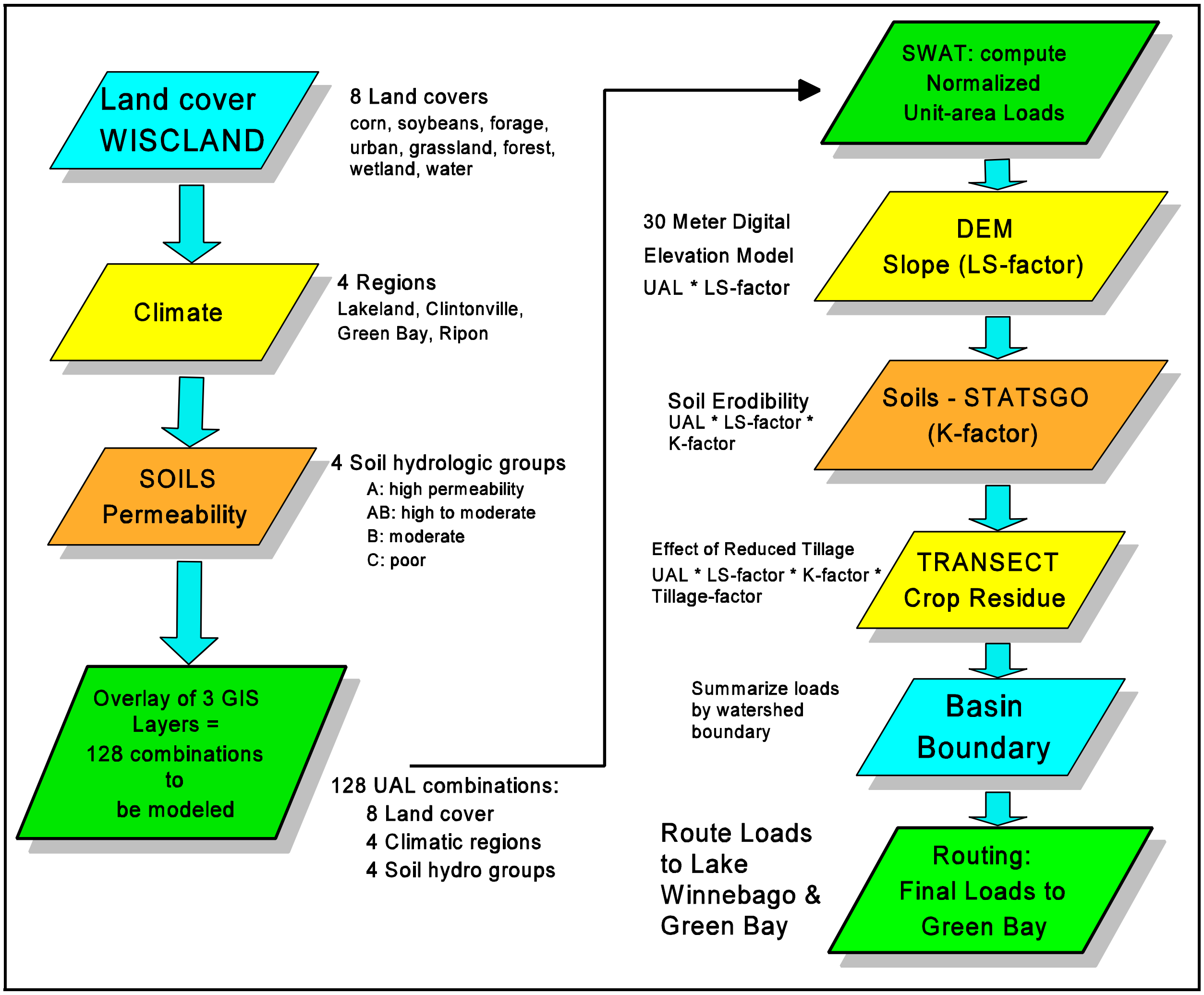


Figure 2. Overview of SWAT-GIS modeling scheme.

calibration watershed for the 1978-92 climatic period using a variety of inputs to generate results that were representative of 128 different combinations of land cover, soils and climate. Apart from these three major characteristics, overland slope and soil erodibility were accounted for by normalizing SWAT-simulated unit-area loads by dividing them by the Universal Soil Loss Equation (USLE) slope/slope-length factor (LS-factor) and the USLE soil erodibility factor (K-factor) of the Upper Bower Creek calibration watershed (35.6 sq. km) to provide base-level normalized unit area loads ($UAL_{n\text{-}base}$). A modified form of the USLE is used by SWAT, and it is described in Chapter 3.

$UAL_{n\text{-}base}$ = (land cover + soil permeability + climate), combined with SWAT norm. UAL's (Eq. 1)

These loads were then multiplied by LS-factor and K-factor GIS layers within the GIS model to produce non-normalized base-level unit-area loads (UAL_{base}).

$$UAL_{base} = UAL_{n\text{-}base} * \text{LS-factor} * \text{K-factor} \quad \text{(Eq. 2)}$$

To further refine current load estimates, another GIS layer was created to reflect the average crop residue levels estimated to be present within each watershed in 1999 (TRANSECT survey data). Since the base-level unit-area loads assumed conventional (high tillage) conditions, the unit-area loads in the GIS model were reduced according to the percentage of each of the four crop residue categories reported in each watershed (Table 1). The fractional reductions shown in Table 1 were simulated with the SWAT model by applying the different tillage practices to the calibration watershed.

Table 1. Simulated reductions based on estimated crop residue present from Transect Surveys.

Crop Residue %	Tillage	Simulated Reduction					
		Corn			Soybeans/other row crops		
		TSS	Org P	Sol P	TSS	Org P	Sol P
0-15%	conventional	0.000	0.000	0.000	0.000	0.000	0.000
16-30%	low mulch-till	0.242	0.234	0.000	0.137	0.140	-0.056
>30%	mulch-till	0.483	0.469	-0.020	0.274	0.280	-0.111
N/A	no-till/ridge till	0.747	0.658	-0.223	0.599	0.520	-0.302

Each UAL_{base} within the GIS model was then reduced according to the proportion of reduced tillage reported to be present in each watershed by the Transect Survey data. Reductions listed in Table 1 for the corn crop would have been higher had corn silage not been included in the rotation. From the 1999 Transect survey data, an estimate of the crop residue present during the 1978-92 period was made, and used to simulate 1978-92 loads so they could be compared to loads computed by USGS and others.

The final loads represent unit-area loads that reflect the land cover, soils, climatic region, topography and tillage practices presumed to be present in each grid cell for two periods: 1978-92; and current 1999 conditions. To obtain the estimated loads of TSS and organic phosphorus that are delivered to the watershed outlet, Green Bay and Lake Winnebago, the unit-area loads were multiplied by a delivery ratio (DR) which roughly accounts for deposition in stream channels, impoundments and small lakes:

$$DR = DA^{-0.15}/DA_{UBC}^{-0.15} \quad \text{(Eq. 3)}$$

where DA is the drainage area of the watershed in square kilometers, or the cumulative drainage area from the watershed to Green Bay or Lake Winnebago (i.e., the load must travel from the watershed outlet to Green Bay or Lake Winnebago). To account for the delivery ratio inherent to the loads generated in the calibration watershed, the un-weighted delivery ratio ($DA^{-0.15}$) was divided by the delivery ratio ($DA_{UBC}^{-0.15}$) of the Upper Bower Creek calibration watershed (35.6 sq. km).

These loads were then summed for each watershed to give an estimate of their respective contribution to Green Bay. In general, the DR decreases inversely as approximately the 0.2 power of the drainage area; that is, the delivery ratio decreases as drainage area increases (USDA-SCS 1983).

The delivery ratio exponent (-0.15) was set so that simulated loads for the Menominee and Fox Rivers corresponded closely to the loads estimated by USGS with a constituent transport model which relied on continuous flow data and available concentration data. Where loads from point sources were determined to be significant, they were added to the non-point load estimates solely to compare the simulated loads to measured loads, or load estimates from other sources. Thus, Figures 4 and 5 show only the non-point loads, to facilitate relative comparisons of non-point sources. The delivery ratio is not intended to provide precise estimates at specific locations between watershed outlets and Green Bay; rather, it is assumed to integrate the effects of stream deposition/aggradation, and the effect of various lakes, reservoirs, dams and other impoundments that are located throughout the system.

Phosphorus trapping in the Winnebago pool system was set to correspond to deposition rates determined by Pierre-Gustin (1995). These same trapping efficiencies were also used to determined amount of TSS that was trapped in the Winnebago pool system, so that the simulated 1978-92 average annual TSS load at Wrightstown corresponded closely with the loads estimated for the same period and location with the constituent transport model of Robertson (1996), which relies on daily flows and available concentrations. The composition of the suspended solids entering the Winnebago pool system is unlikely to be the same as that exiting the system, so a mass balance approach was not utilized in determining trapping efficiency of TSS.

Importantly, the local effects of impoundments (lakes, dams etc.), wetlands, and natural or man-made riparian filter strips were not directly considered in this model. Instead, some of these effects were partially accounted for through gross lumping or through the delivery ratio. The complex nature of the effects of these factors combined with the scale and time constraints of this project did not permit a thorough investigation of the these factors.

Loads were derived for the 1978-92 period so they could be compared to measured values; whereas, the simulated 1999 loads are to be used to compare the relative contributions to Green Bay from watersheds in the Basin.

CHAPTER 2. GIS METHODS/ANALYSIS AND INPUTS

Application of Geographical Information System: PC ARC/INFO (vector-based GIS), ARCVIEW, and ARCVIEW Spatial Analyst (grid-based GIS) were used to construct, process and analyze GIS coverages. All of these software programs were developed by Environmental Systems Research Institute, Inc. (ESRI). All raster-based layers were processed with the same 30 square meter cell resolution of the WISCLAND land cover layer.

Land Cover Analysis with WISCLAND Classified Land Cover Image: Land cover within the Basin was determined from the Level 3 classification of the 1992 WISCLAND land cover image, which was obtained from the WDNR and is based on LANDSAT Thematic Mapper images. The 1992 land cover for the Basin, based on a six level classification of the WISCLAND land cover image, is illustrated in Figure 3. Most of the southern and southeastern watersheds are predominantly agricultural, while forest is the dominant land cover is in the north and northwestern watersheds.

The WISCLAND classified land cover image was reclassified to generate 8 major land covers/uses which were modeled with SWAT: agriculture (corn, forage, other row crops), urban, grassland, forest, wetland and surface water. For this project, it was assumed that "other row crops" was either soybeans or another fragile crop, so this land cover was simulated as soybeans in the SWAT model.

Watershed Delineation: The 1:24,000 statewide watershed boundary GIS layer (wsdnt024), provided by the Wisconsin Department of Natural Resources (WDNR) determined the Basin boundary, subbasin boundaries and watershed boundaries.

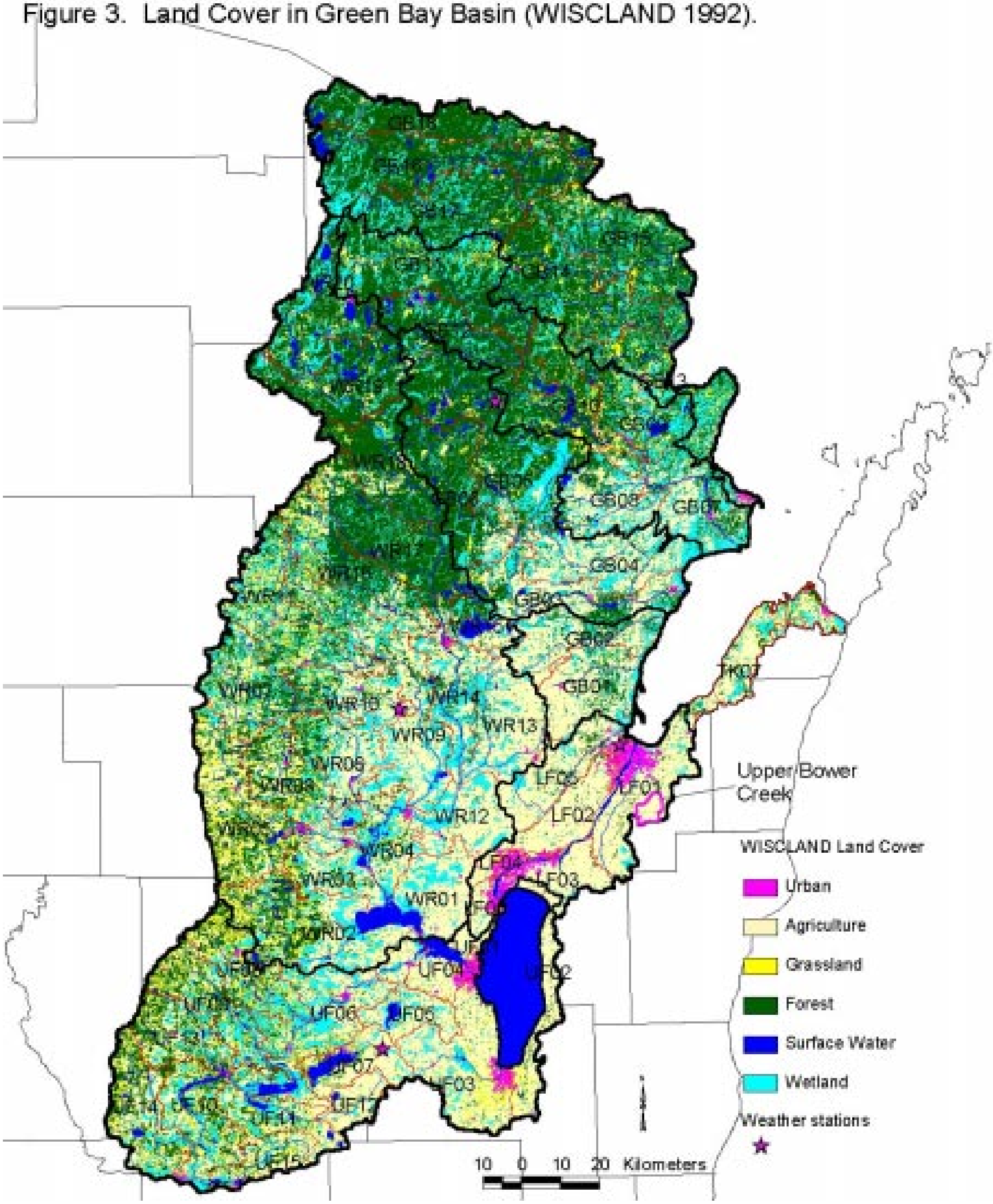
Hydrology: A statewide 1:24,000 hydrologic layer from the WDNR was used to define the highest resolution stream network. This coverage was provisional, so no annotation or hydrological attributes. In addition, major tributaries was best illustrated with the 1:2,000,000 stream hydrology layer from the WDNR.

Soils - Hydrological Group GIS Layer: Only four representative soils were utilized for this project to limit the number of model runs required to represent all possible combinations of soil, climate and land cover/use. In addition, the SWAT model is most sensitive to hydrologic Group, so this was the primary basis for choosing representative soil characteristics.

The soil permeability/texture GIS layer supplied by the WDNR (schpy250) was used to provide the soil hydrologic Group, which is a critical input parameter because it directly affects the NRCS curve number. The following hydrologic Groups were assigned to each of the four soil permeability categories: (1) hydrologic Group A - high permeability; (2) hydrologic Group A to B - high/medium permeability; (3) hydrologic Group B - medium permeability; and (4) hydrologic Group C - low permeability.

Default NRCS curve numbers from SWAT documentation were then utilized for each combination of soil hydrologic Group and landuse during the creation of SWAT management files. Curve numbers were decreased from the default values by 6 units for A soils (67 to 61), 3.5 units for AB soils (72.5 to 69) and 2 units for B soils (78 to 77). This change was made

Figure 3. Land Cover in Green Bay Basin (WISCLAND 1992).



because loads were too high for agricultural crops with A soils, compared C soils, all else being equal. Available water capacity was also increased for A soils to better reflect the types of A soils where crops are grown, rather than an A soil whose dominant soil series might have 95% sand in the top layer, and would therefore have limited agricultural potential. The latter change seemed necessary because preliminary SWAT model results showed that total water yield increases substantially as the available water capacity decreases; whereas, it would seem more likely that only percolation and recharge increases as the AWC increases, not surface runoff. In addition, the seasonal curve numbers used in the management files may not vary as much for an A soil as they do for C soils; rather than have a different management file for each soil, it was more reasonable to simply reduce the curve number.

Soils - Erodibility GIS Layer: The STATSGO GIS soil layer supplied the WDNR (sgdpw92d), was combined with the STATSGO soil database, which was downloaded from the USDA-ARS, Temple Texas Internet site, to supply the USLE K-factor to the GIS model on an area-weighted basis. The K-factor determines the relative erodibility of various soils. An area-weighted soil hydrologic Group value was also generated from the STATSGO coverage and associated database, but the soil permeability layer was favored for determining hydrologic Group because by definition, it was delineated on the basis of soil permeability.

Slope/slope length (LS-factor) GIS Layer: The LS-factor was derived using the same method as in SWAT, except the maximum value of the slope length exponent was set to 0.5 instead of 0.6, and the minimum was set to 0.2 instead of 0.0. This modification conforms more closely with the values used in the EPIC model, as well as the values recommended by Wischmeier and Smith (1978) in USDA Agricultural Handbook #537. In addition, the modification made it possible to create the LS factor GIS layer with one equation/operation, rather than several operations.

The 30 meter resolution of the DEM did not permit the direct calculation of slope length. Instead, Equation 4 was used to calculate slope length on the basis of an empirical relationship between slope and slope-length.

$$\text{slope length (in feet)} = 350 \text{ ft} / (\% \text{ slope} + 1)^{0.5} \qquad \text{(Eq. 4)}$$

This equation was set to conform closely with default values utilized by the Outagamie County LCD. Equation 4 was converted to meters in the GIS model. The Beta version of the BASIN's-SWAT ARCVIEW interface increases the slope length according to several slope intervals, so the approach used here seemed reasonable.

Precipitation and Temperature Data: The locations of the weather stations used in this study to provide measured daily precipitation and temperature data to the SWAT model are shown in Figure 1. These stations are located in Green Bay, Ripon, Clintonville and Lakewood, Wisconsin. The number of stations utilized in this project was limited to only 4 to reduce the number of model runs required to represent all possible combinations. The Green Bay site was the only NOAA National Weather Service (NWS) Station utilized in this study. The remaining stations were official NWS cooperative observers. Daily precipitation and temperature from 1976-96 was input to the SWAT model to simulate TSS and phosphorus loads within this period. All of the daily weather data were supplied in ASCII format by the Geological and Natural

History Survey State Climatology Office in Madison, Wisconsin. Only the Lakewood weather station was used to represent the fairly large northern area because about 10% of the daily precipitation recordings were missing from the Goodman and Crivitz weather stations; instead, data from these sites were used to supplement data that was missing at the Lakewood station.

Days with trace amounts of precipitation were set to zero. Data from the closest available site were substituted whenever daily values were missing.

Watershed Climatological Assignment: The weather database furnished with the SWAT model was used to supply the SWAT weather generator with statistical weather information for the Green Bay NWS site. This information generates miscellaneous climatological data, such as rainfall intensity. General climatological data from the following weather stations was used to supply statistical weather inputs to the model that was associated with the daily weather data stations: Green Bay (Green Bay), Portage (Ripon), Laona (Lakewood), and Stevens Point (Clintonville) were used to assign SWAT with general climatological data inputs. In this project, the model was not sensitive to these inputs because measured precipitation and temperature was used instead of simulated data.

Transect Survey - crop residue levels: The 1999 Conservation Technology Information Center (CTIC) Conservation Tillage Reports from counties within the Basin were analyzed to determine the primary tillage practice inputs to SWAT. These "Transect Survey" reports were based on statistical sampling procedures of farm fields to estimate residue levels present on farm fields shortly after spring planting, as well as other information. Most of the information was gathered by county Land Conservation Departments. The data was analyzed with the Transect 2.13 software program produced by Purdue Research Foundation, Purdue University. Crop residue levels and tillage practices were summarized on a watershed basis by the program. Importantly, some of the watersheds may have contained too few points to be statistically reliable; however, most of the data seemed to be similar for adjacent watersheds. Where too few points were available, residue values were assigned on the basis of the average value from nearby watersheds.

Four residue categories were assigned based on the percent residue present and the level of no-till or ridge-till practiced: conventional tillage (CT: 0-15%); limited mulch tillage (MT15: 15-30%); mulch tillage (MT30: >30%); and no-till or ridge-till (NT). Where no-till or ridge-till were present, the amount of acres which qualified as mulch-till were reduced accordingly to prevent double-accounting. The data was summarized for two crop categories: corn, and a combination of soybeans, small grains and other crops. This data was then used to assign the appropriate tillage practices for the corn and soybean crop rotations. The level of residue present in alfalfa or forage fields was not directly related to the Transect survey data because there was limited data on this crop. Most of the time, no residue level was indicated even when the previous crop was alfalfa. For this project, moldboard plow tillage was utilized after the last alfalfa crop in the rotation was harvested.

Transect survey data gathered by the Brown County LCD in 1999 were not utilized in this project because the reported data did not seem reasonable. For example, when compared to Transect Survey data collected by NRCS in 1996, the reported percentage of present-crop corn fields with 30% or greater residue (mulch-till) apparently increased from 2% in 1996 (NRCS figures) to

60% in 1999 (Brown County LCD figures) for the East River watershed in Brown County (LF01). In a similar fashion, the percentage of fields with 30% or greater residue was reported to increase from 3% in 1996 to 65% in 1999 for the entire county, which is very unlikely. In contrast, the percentage of present-crop corn fields with 30% or greater residue was 4% in the East River, according to the NRCS 2000 survey data. Essentially, the same number of fields were checked in all of these surveys. Therefore, survey data gathered by NRCS in 2000 for Brown County was utilized in this project. The 2000 data for Brown County was made available near the end of this project, and had not been compiled by the Wisconsin NRCS office with data from other counties. In addition, reported 1999 residue levels from other counties did not seem unusually high or low, so no attempt was made to see if NRCS had gathered data for additional counties in 2000.

It is important to understand that the TRANSECT surveys are somewhat subjective because they are not based on direct in-field physical measurements of residue cover in each field. Although Brown County data from 1999 is very different than what was gathered by NRCS in 2000, the likely explanation is that reported residue levels are off by one category (e.g., > 30% residue is more likely to be in the 15% to 30% category). It is equally important to note that overstating the amount of residue present in cropped fields can understate the actual contributions of TSS and total phosphorus to Green Bay.

Urban Areas: The median TSS yield from 15 urban streams in southeastern Wisconsin tills was reported by Corsi et al. (1997) to be 0.455 t/ha. The urban routine in SWAT98.2 did not function correctly, so the simulated TSS values were raised by a factor of 1.5 to give a yield closer to this median value, and a concentration of about 150 mg/L, which was found to be representative of values found in a previous literature review (Baumgart 1998). The simulated total phosphorus yield of 1.2 kg/ha is equivalent to 0.436 mg/L, given 275 mm of total water yield. This is the highest possible yield that was modeled for the Green Bay climatic region, so the average value is actually lower. This values falls between the median and maximum total phosphorus yields from urban areas in southeastern Wisconsin tills of 0.557 kg/ha and 2.12 kg/ha, respectively (Corsi et al. 1997).

CHAPTER 3. SWAT METHODS AND MODEL INPUTS

This section describes the methods used to generate the unit-area loads that were input to the GIS model. A modified version of SWAT98.2 model was applied in this project. The modifications were made prior to this project by Fox-Wolf Basin 2000 to make the model more flexible and suitable to conditions in Northeast Wisconsin. Most of the major code modifications are documented by Baumgart (1998).

SWAT was run on a daily time step, so daily precipitation and temperature data from four locations were input to the model to represent four climatic regions. The total simulation period was from 1976 to 1996; however, only the 15 year period between 1978 and 1992 was selected to generate the long-term average loads so that watershed yields and loads in the Basin could be compared. In addition, this period was utilized because it coincided most closely with periods for which loads were estimated by USGS: 1980-90 period (Robertson and Saad 1996) and 1975-90 period (Robertson 1996).

Land covers indicated by the reclassified WISCLAND Level 3 classification were directly modeled in SWAT's crop/management database as corn, forage, soybeans (other row crops), urban, grassland, forest, wetland and water. The agricultural land cover classes refer to the crop, not the management practice or typical crop rotation. That is, there is no direct way to differentiate between a corn field that is part of a dairy rotation or a cash-grain crop rotation. Therefore, only single-crop rotations were assumed, but two thirds of the corn rotation and all of the alfalfa rotation were assumed to be under dairy management with associated manure applications (Table 2).

As shown in Table 2, a four year rotation was assumed for alfalfa, three years for corn and one year for soybeans. For each of the agricultural rotations, all possible phases were modeled in each simulation and the results were averaged to provide the UAL for each crop. Otherwise, large variations could occur depending on whether the most, or least erosive phase of the rotation happened to occur during a wet or dry year. All other land covers were modeled as single-year rotations.

Table 2. Land cover and simulated crop rotations.

	WISCLAND Land Classification		
Year/phase	corn/row crop	forage crop	other row crop (soybeans)
1	corn-grain, dairy	alfalfa, plant	soybean
2	corn-grain, cash crop	alfalfa	N/A
3	corn-silage, dairy	alfalfa	N/A
4	N/A	alfalfa, CT Till	N/A

To derive unit-area loads (UAL's), the model was applied to the Upper Bower Creek watershed (35.6 sq. km; USGS # 04085119), which is located in the East River watershed, LF01 (Figure 1).

This site has been intensively monitored through a joint effort by both the USGS and WDNR. Extensive calibration and validation efforts were not undertaken because a previous version of the model had been successfully calibrated to data from Upper Bower Creek, and validated at nearby sites by Baumgart (1998). Instead, long-term average annual simulated flows (210 mm) and TSS loads (0.45 t/ha) derived by Baumgart (1998) were used to calibrate the model to the Bower Creek site. The simulated long-term TSS yield was close to the measured annual average TSS yield of 0.39 t/ha for the 1991-94 period (excluding 1993). The long-term average annual total phosphorus yield was set to 1.45 kg/ha for this same site. This figure falls between the observed 1991-94 average load of 1.79 kg/ha (with 1993), and the 1991-94 average load of 1.25 kg/ha (without 1993), and was based on assuming that the long-term simulated phosphorus yield is directly related to the long-term simulated TSS yield of 0.45 t/ha (1.25 kg/ha observed total phosphorus * 0.45 t/ha simulated TSS/0.39 t/ha observed TSS = 1.45 kg/ha total phosphorus. Data from 1993 was excluded during calibration because the model was unable to accurately simulate the loads under this unusually wet year. This problem was due in part, to the late planting and delayed growth of crops which occurred during this excessively wet year, which depressed evapotranspiration and greatly increased runoff. In addition, some of the reported loads in 1993 included some major events for which no samples were collected, but were instead estimated, and the loads seemed rather high for the time of year (mid June to July).

Detailed methods and procedures concerning inputs to SWAT and calibration can be found in Baumgart (1998, 2000). However, some specifics are included here. During calibration, the potential evapotranspiration coefficient (PET) was set to 0.77 for Lakewood and Green Bay climatic areas, and to 0.82 for Ripon and Clintonville climatic regions. This adjustment had the effect of raising initial stream water yields simulated by the model, to long-term expected yields normally found in streams. To calibrate the model to expected TSS yields, parameters in the modified universal soil loss equation (MUSLE) were adjusted to obtain a reasonable fit between observed and simulated TSS loads. MUSLE is shown in Equation 5.

$$\text{MUSLE:}\ \ Y = a\,(Q)^b\,(q_p)^c\,(DA)^d\ \ [(K)\,(C)\,(PE)\,(LS)] \qquad \text{(Eq. 5)}$$

where:

- Y = sediment yield in metric tons/ha (MT/ha)
- Q = surface runoff volume in mm
- q_p = peak flow rate in mm/hr
- DA = drainage area in hectares
- K = soil erosion factor
- C = crop management factor
- LS = slope-length and slope-steepness factor
- PE = erosion control practice factor
- a,b,c,d = constants, set at $a = 0.0298$, $b = 1.7$, & $c = 0.0$, $d = 0.0$

The amount of manure applied in the model management files was more than doubled for the alfalfa crop, from the 56 MT/ha (25 t/acre) normally simulated in the 4 year alfalfa rotation, to 120 MT/ha (53.6 t/acre). This increase was required because the crop would otherwise be deficient in phosphorus, and the soil appeared to be depleted of soluble phosphorus in long model runs.

As shown in Table 3, annual simulated TSS and phosphorus loads from 1991 to 1996 in Upper

Bower Creek were reasonably close to observed values with the exception of 1993.

Table 3. Observed and simulated TSS and phosphorus yields at Upper Bower Creek.

year[1]	TSS (t/ha)		Total Phosphorus (kg/ha)	
	observed	simulated	observed	simulated
1991	0.18	0.26	1.21	0.84
1992	0.37	0.44	1.38	1.38
1993	2.84	0.89	3.40	2.79
1994	0.62	0.68	1.17	2.04
1995	no data	0.25	no data	0.81
1996[1]	0.39	0.44	0.98	1.46

After calibration of the model was complete, the remaining UAL's were developed for other areas by altering the daily precipitation, daily temperature, general climatic data, soils, NRCS curve numbers, and land cover inputs. UAL's from the SWAT model were normalized to the average LS-factor of the calibration watershed so that the GIS model could account for local slopes and slope-lengths (LS-factor) throughout the Basin.

To reflect an expected reduction in the phosphorus enrichment ratio with reduced clay content, the maximum phosphorus enrichment ratio was set to 6.55 for C soils, 5.5 for B soils, 5.0 for AB soils, and 4.5 for A soils. Still, the SWAT-simulated ratio of soluble phosphorus to total phosphorus was fairly low for agricultural crops (approximately 7.5%). This result was primarily due to the need to calibrate the model to observed values; that is, simulated total phosphorus levels were too low until certain parameters were adjusted to raise the phosphorus level, which in turn increased the relative proportion of organic phosphorus to soluble phosphorus. In addition, if the relative proportion of simulated soluble phosphorus levels were set to be more representative of expected in-stream values, then SWAT-simulated reductions of total phosphorus due to conservation tillage became too low.

Phosphorus associated with soil particles and large molecular weight organic matter generally accounts for 60-95% of phosphorus transported from cultivated lands during flow events (60-90%: Pietilainen and Rekolainen 1991; 75-95%: Sharpley et al. 1994). Local sampling efforts show a range of 10% to 90% between individual water samples, with a trend toward greater particulate phosphorus during larger events (unpublished results, Fox-Wolf Basin 2000, 1999-2000). Bannerman (1984) reported soluble phosphorus to total phosphorus ratios of 0.37 in 1980, 0.17 in 1981 and 0.06 in 1982 for the Fox River at Rapide Croche dam; however, some of the non-soluble phosphorus is of biological origin. To better reflect expected in stream conditions, simulated soluble phosphorus was therefore increased by reapportioning 20% of the simulated organic phosphorus fraction to the soluble phase. Unit-area loads for all land covers were altered in this fashion. The resulting soluble phosphorus fraction was generally 30% from agricultural sources.

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[1] Observed annual loads are from October 1 to September 31 (USGS water years); simulated loads are for calendar years. The observed 1996 yields are from April 1996 to Sept. 31, 1996.

Finally, the unit-area loads were multiplied by export coefficient(s) to provide the estimated load at the watershed outlet, to Green Bay, and where applicable, Lake Winnebago. This procedure is described in the following section.

CHAPTER 4. DELIVERY RATIO AND EXPORT COEFFICIENTS

This chapter describes the methods used to estimate the amount of TSS and total phosphorus delivered to Lake Winnebago and Green Bay. To estimate the amount of TSS and non-soluble phosphorus that are delivered to the watershed outlet, Lake Winnebago pool system, or to Green Bay, the annualized unit-area TSS and non-soluble phosphorus loads were multiplied by the sediment delivery ratio shown in Equation 3. These loads were then summed to give an estimate of each watershed's contribution at the watershed outlet, to the Lake Winnebago pool system, and to Green Bay. Soluble phosphorus was assumed to be conservative as it was routed throughout the Basin. In general, the delivery ratio decreases inversely as approximately the 0.2 power of the drainage area; that is, the delivery ratio decreases as drainage area increases (USDA-SCS 1983). The drainage area (DA) can be the watershed area, or the cumulative drainage area from the watershed to Green Bay or Lake Winnebago (i.e., the load must travel from the watershed outlet to Green Bay or Lake Winnebago).[2] To account for the delivery ratio inherent to the loads generated for the outlet of the calibration watershed, the un-weighted delivery ratio ($DA^{-0.15}$) was divided by the delivery ratio ($DA_{UBC}^{-0.15}$) of the Upper Bower Creek calibration watershed (35.6 sq. km).

The exponent in the delivery ratio equation (-0.15) was set so that simulated loads for the Menominee and Fox Rivers corresponded closely to the loads estimated by the USGS with a constituent transport model which relied on continuous flow data and available concentration data (Robertson and Saad 1996; Robertson 1996). To compare simulated loads to measured loads, or load estimates from other sources, point source loads were added to the simulated non-point load estimates where loads from point sources were determined to be significant. The delivery ratio is not intended to provide precise estimates at specific locations between watershed outlets and Green Bay; rather, it is assumed to integrate the effects of stream deposition/aggradation, and the effect of various lakes, reservoirs, dams and other impoundments located throughout the drainage network.

Phosphorus trapping in the Winnebago pool system was set to correspond to deposition rates of 90,000 kg/yr for the upper pool lakes and 170,000 kg/yr for Lake Winnebago, which were determined by Pierre-Gustin (1995). Therefore, these amounts were subtracted from the simulated loads entering these lake systems. Point source loads of 22,674 kg/yr and 17,721 kg/yr contributed to the Upper Fox and Wolf Watersheds, respectively (WNDR 1993a), of which an estimated 25,000 kg/yr was assumed to make it to the Lake Winnebago outlet. The resulting average 1978-92 simulated load at the Winnebago outlet of 365,000 kg/yr corresponds well with a measured load estimate for 1990 of 360 MT (WDNR 1993a).

Based on a relationship between trapping efficiency and the reservoir capacity/average annual inflow ratio that was developed by Brune (1953) and extended by Dendy (1974), an estimated

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[2] For the Menominee River, the computed cumulative drainage area was multiplied by a factor of two. Although the ratio of the total drainage area in Wisconsin and Michigan (10,180 sq. km), to the drainage area in Wisconsin (3,966 sq. km) is 2.57, I used 2.0 as the assumed ratio because the most upstream areas in Michigan are at the top of the watershed, and should not be included in the cumulative area at that routing point. The total load could be determined by multiplying the Wisconsin load by the watershed area ratio of 2.57 ratio.

5% of the Fox River TSS was assumed trapped between the Lake Winnebago outlet and the Little Rapids dam (10.6 km upstream from the DePere dam), while an additional 15% was assumed to be deposited between the Little Rapids dam and Fox River mouth. For phosphorus, 2.5% (1 minus sq. root of 95%) and 7.8% (1 minus the sq. root of 85%) of the non-soluble fraction was assumed to be trapped between these two river reaches, respectively. Based on these net deposition rates, the simulated 1978-92 total phosphorus load at Wrightstown after point sources and additional drainage area are added is 467,000 kg/yr; which includes an additional 60,000 kg/yr from point sources between the Lake Winnebago outlet and Rapide Croche dam near Wrightstown. This simulated load compares to 474,900 kg/year estimated by Robertson and Saad (1996) for a 1980-90 period using regression analysis of observed data.

The simulated 1978-92 phosphorus load at the Fox River outlet to Green Bay is 598,000 kg/yr, which includes another 60,000 kg/yr from point sources (LF05, Duck Creek is not included). If Duck Creek is included, the total load is 628,000 kg/yr. The former value falls within the 395,000 kg/yr to 719,000 kg/yr range of loads summarized by Klump et al. (1997) and close to the 500,000 kg/yr to 605,000 kg/yr range estimated by Robertson and Saad (1996) for a 1980-90 period using regression analysis.

The same trapping efficiencies that were utilized for phosphorus were also applied to determine the amount of TSS that was trapped in the Winnebago pool system. The composition of the suspended solids entering the Winnebago pool system is unlikely to be the same as that exiting the system, so a mass balance approach was not utilized in determining trapping efficiency of TSS. To compensate for any differences between the simulated 1978-92 average annual TSS load at Rapide Croche dam, near Wrightstown and the loads estimated for the same period and location with the constituent transport model of Robertson (1996) and Robertson and Saad (1996), a biotic solids component was added to the load at the Winnebago outlet so that the loads were reasonably close.

Pierre-Gustin (1995) used an estimated load at the Lake Winnebago outlet of 68,000 MT of TSS per year (1986-90) to construct the following sediment budget for the lake system: upper pool lakes could trap as much as 220,000 MT of TSS, with 200,000 MT input to Lake Winnebago at Oshkosh, about 80,000 to 120,000 coming from direct watershed discharges to the Lake (UF01, UF02, and UF03), 250,000 MT net burial of sediment, and about 68,000 MT exported to the Lower Fox River at the Lake Winnebago outlet. However, Robertson's (1996) regression equation was applied by Fox-Wolf Basin 2000 to estimate a TSS load of 97,000 MT at downstream Rapide Croche during 1986-90 period, and 130,000 MT of TSS for the 1978-92 simulation period. If the load at Rapide Croche is assumed to be directly proportional to the load at the Winnebago outlet, a TSS load of 91,000 MT at the outlet, instead of 68,000 MT, may be more appropriate for the 1978-92 period (68,000 MT TSS * 130,100/97,000).

The simulated 1978-92 TSS load at the Lake Winnebago outlet was 57,300 MT/yr, so a biotic TSS component of 33,700 MT was added to make up the difference (91,000 MT = 57,300 MT + 33,700 MT). Steuer et al. (1995; Fig. 5-60) estimated a point source load of 1,900 MT TSS and a river growth contribution of 14,600 MT TSS to the Lower Fox River between Lake Winnebago and the DePere dam in 1989. Therefore, if 70% of the river growth and all of the point source contributions are added to the simulated load at Rapide Croche dam, the resulting total simulated TSS load for the 1978-92 period is 117,500 MT/yr. This load is lower than the previous estimated load of 130,000 MT/yr which was derived with the constituent transport model developed by Robertson (1996), but it is still reasonable given the potential errors in this analysis.

Robertson and Saad (1996) estimated the average 1980-90 Fox River TSS load at Wrightstown to be 143,700 MT per year. Bannerman's (1984) annual load estimates of TSS at Wrightstown were 100,200 MT in 1980, 71,700 MT in 1981, and 99,700 MT in 1982, for an overall average of 90,500 MT; however, the estimated load in 1982 was not reliable because it was less than the 95% confidence interval. Smith et al. (1982) estimated an average annual load of 88,000 for the 1974-81 period. Therefore, even when measured data are involved, load estimates for this system vary substantially depending on the time period and the methodology used to calculate load estimates.

The simulated 1978-92 TSS load at the Fox River outlet to Green Bay is 136,000 MT/yr, compared to 151,000 MT/yr estimated by Robertson and Saad (1996) for a 1980-90 period using regression analysis. If Duck Creek is included, the total simulated load is 144,000 MT/yr. Both of these load estimates include point source contributions.

Importantly, the local effects of impoundments (lakes, dams etc.), wetlands, and natural and man-made riparian filter strips were not directly accounted for in this model. Instead, some of these effects were partially accounted for through gross lumping in SWAT simulations, or through the delivery ratio. The complex nature of the effects of these factors combined with the scale and time constraints of this project did not permit a precise accounting of all these factors.

CHAPTER 5. SIMULATED LOADS to GREEN BAY

Simulated loads generated with a fifteen year climatic period between 1978 and 1992 were selected to represent average long-term loads, so that relative watershed yields and loads in the Basin could be compared. These loads were generated with assumptions about farm tillage operations that reflect the estimated crop residue levels in 1999. Data presented in previous sections was based on estimated 1987-92 crop residue levels so that comparisons between observed and simulated loads could be made.

The simulated annual TSS contributions (yields: mass/ha) to Green Bay from each watershed are shown in Figure 4. Simulated annual total phosphorus yields to Green Bay from each watershed are shown in Figure 5. These figures clearly show that the majority of the TSS and phosphorus loads to Green Bay are from those areas closest to Green Bay, including all of the watersheds in the Lower Fox subbasin and those watersheds adjacent to Lake Winnebago (LF01, LF02, LF03, LF04, LF05, LF06; UF01, UF02). Total phosphorus and TSS yields and loads routed to the watershed outlet and to Green Bay are summarized in Table 4. Red River and Sturgeon Bay, Lake Butte des Mortes, and Fond du Lac watersheds all have total phosphorus yields to Green Bay that are higher than 0.5 kg/ha. Although TSS and phosphorus yields from the Red River and Sturgeon Bay Watershed are relatively high, areas within this watershed are heavily influenced by karst geology, which was not accounted for in the model; therefore, simulated yields and loads are probably lower than indicated for this watershed.

Table 4. Simulated annual TSS and total phosphorus yields and loads to the watershed outlet and to Green Bay.

		Watershed Outlet		Routed to Green Bay		Watershed Outlet		Routed to Green Bay	
Wshed ID	Watershed Name	TSS (MT/ha)	Tot. P (kg/ha)	TSS (MT/ha)	Tot. P (kg/ha)	TSS (MT)	Tot. P (kg)	TSS (MT)	Tot. P (kg)
GB01	Suamico and Little Suamico Rivers	0.075	0.313	0.075	0.313	3,295	13,736	3,295	13,736
GB02	Pensaukee River	0.081	0.329	0.081	0.329	3,351	13,535	3,351	13,535
GB03	Lower Oconto River	0.075	0.264	0.075	0.264	3,806	13,448	3,806	13,448
GB04	Little River	0.111	0.459	0.111	0.459	6,064	25,016	6,064	25,016
GB05	Lower North Branch Oconto River	0.024	0.085	0.021	0.082	2,387	8,615	2,144	8,274
GB06	South Branch Oconto River	0.046	0.146	0.039	0.135	2,626	8,299	2,243	7,651
GB07	Lower Peshtigo River	0.066	0.290	0.066	0.290	3,323	14,659	3,323	14,659
GB08	Little Peshtigo River	0.140	0.476	0.140	0.476	5,750	19,532	5,751	19,534
GB09	Middle Inlet and Lake Noquebay	0.059	0.232	0.050	0.212	2,361	9,251	1,974	8,460
GB10	Middle Peshtigo and Thunder Rivers	0.023	0.093	0.019	0.087	1,142	4,670	942	4,349
GB11	Upper Peshtigo River	0.019	0.070	0.016	0.066	1,653	6,162	1,397	5,814
GB12	Otter Creek and Rat River	0.024	0.070	0.019	0.063	892	2,569	683	2,307
GB13	Wausaukee and L. Menominee R.	0.034	0.153	0.034	0.153	1,638	7,402	1,638	7,402
GB14	Pike River	0.015	0.066	0.013	0.064	1,092	4,893	963	4,715
GB15	Pemebonwon and Middle Menominee Rivers	0.029	0.102	0.023	0.093	2,162	7,680	1,741	7,039
GB16	Pine River	0.024	0.078	0.018	0.071	2,016	6,583	1,553	5,950
GB17	Popple River	0.017	0.062	0.012	0.057	1,011	3,733	746	3,396
GB18	Brule River	0.032	0.085	0.021	0.071	1,620	4,263	1,082	3,564
LF01	East River	0.286	0.926	0.286	0.926	15,264	49,483	15,264	49,483

Table 4. Simulated annual TSS and total phosphorus yields and loads to the watershed outlet and to Green Bay.

		Watershed Outlet		Routed to Green Bay		Watershed Outlet		Routed to Green Bay	
Wshed ID	Watershed Name	TSS (MT/ha)	Tot. P (kg/ha)	TSS (MT/ha)	Tot. P (kg/ha)	TSS (MT)	Tot. P (kg)	TSS (MT)	Tot. P (kg)
LF02	Apple and Ashwaubenon Creeks	0.278	0.871	0.237	0.826	8,168	25,566	6,943	24,252
LF03	Plum and Kankapot Creeks	0.498	1.468	0.402	1.357	10,808	31,826	8,728	29,424
LF04	Fox River/Appleton	0.355	0.977	0.287	0.912	3,625	9,962	2,927	9,302
LF05	Duck Creek	0.198	0.629	0.198	0.629	7,776	24,660	7,776	24,660
LF06	Little Lake Butte des Morts	0.267	0.845	0.215	0.793	2,969	9,413	2,397	8,832
TK07	Red River and Sturgeon Bay	0.296	0.867	0.296	0.867	7,071	20,685	7,071	20,685
UF01	Lake Winnebago/North and West	0.660	1.982	0.212	1.165	2,482	7,454	798	4,381
UF02	Lake Winnebago/East	0.831	2.143	0.267	1.013	21,402	55,172	6,885	26,076
UF03	Fond du Lac River	0.307	0.948	0.099	0.556	19,437	60,086	6,252	35,247
UF04	Lake Butte Des Mortes	0.351	1.089	0.076	0.558	7,235	22,455	1,570	11,519
UF05	Fox River	0.312	0.938	0.068	0.450	9,571	28,755	2,077	13,799
UF06	Fox River/Berlin	0.162	0.498	0.033	0.250	8,716	26,891	1,769	13,515
UF07	Big Green Lake	0.346	0.887	0.058	0.358	9,571	24,525	1,610	9,908
UF08	White River	0.041	0.129	0.008	0.082	1,595	4,994	291	3,179
UF09	Mecan River	0.048	0.150	0.008	0.092	1,837	5,771	314	3,539
UF10	Buffalo and Puckaway Lakes	0.079	0.207	0.013	0.110	4,611	12,097	773	6,411
UF11	Lower Grand River	0.179	0.444	0.029	0.191	5,071	12,585	811	5,420
UF12	Upper Grand River	0.462	1.220	0.066	0.456	7,353	19,399	1,045	7,247
UF13	Montello River	0.101	0.290	0.016	0.146	3,505	10,113	565	5,090
UF14	Neenah Creek	0.118	0.366	0.019	0.182	5,284	16,416	835	8,150
UF15	Swan Lake	0.257	0.611	0.036	0.235	5,371	12,755	751	4,897
WR01	Arrowhead River and Daggets Creek	0.217	0.711	0.047	0.364	8,024	26,322	1,742	13,457
WR02	Pine and Willow Rivers	0.101	0.351	0.022	0.198	7,792	27,007	1,691	15,235
WR03	Walla Walla and Alder Creeks	0.113	0.389	0.022	0.204	2,998	10,344	586	5,423
WR04	Lower Wolf River	0.183	0.605	0.036	0.292	5,685	18,792	1,125	9,072
WR05	Waupaca River	0.068	0.219	0.013	0.127	4,992	16,133	994	9,355
WR06	Lower Little Wolf River	0.201	0.615	0.035	0.262	7,925	24,269	1,381	10,350
WR07	Upper Little Wolf River	0.038	0.115	0.006	0.070	1,815	5,444	288	3,302
WR08	South Branch Little Wolf River	0.066	0.199	0.012	0.108	2,758	8,264	483	4,463
WR09	North Branch & Mainstem Embarrass River	0.096	0.348	0.017	0.194	7,774	28,213	1,367	15,738
WR10	Pigeon River	0.154	0.483	0.023	0.214	4,641	14,536	682	6,443
WR11	Middle & S. Branches Embarrass R.	0.051	0.156	0.008	0.088	3,271	10,130	514	5,705
WR12	Wolf River/New London and Bear Cr.	0.273	0.832	0.045	0.364	10,083	30,695	1,643	13,430
WR13	Shioc River	0.105	0.396	0.016	0.225	5,036	19,091	788	10,839
WR14	Middle Wolf River	0.095	0.316	0.014	0.159	3,301	10,940	494	5,495
WR15	Shawano Lake	0.119	0.346	0.015	0.145	2,190	6,369	284	2,681
WR16	Red River	0.061	0.182	0.009	0.094	3,298	9,755	495	5,052
WR17	West Branch Wolf River	0.037	0.110	0.006	0.059	2,583	7,552	396	4,092
WR18	Wolf River/Langlade & Evergreen R.	0.044	0.121	0.006	0.068	2,060	5,619	295	3,168
WR19	Lily River	0.027	0.081	0.004	0.050	1,465	4,390	213	2,737
WR20	Upper Wolf River and Post Lake	0.033	0.096	0.005	0.057	1,741	5,073	249	3,010

Figure 4. Simulated TSS yields to Green Bay (MT/ha).

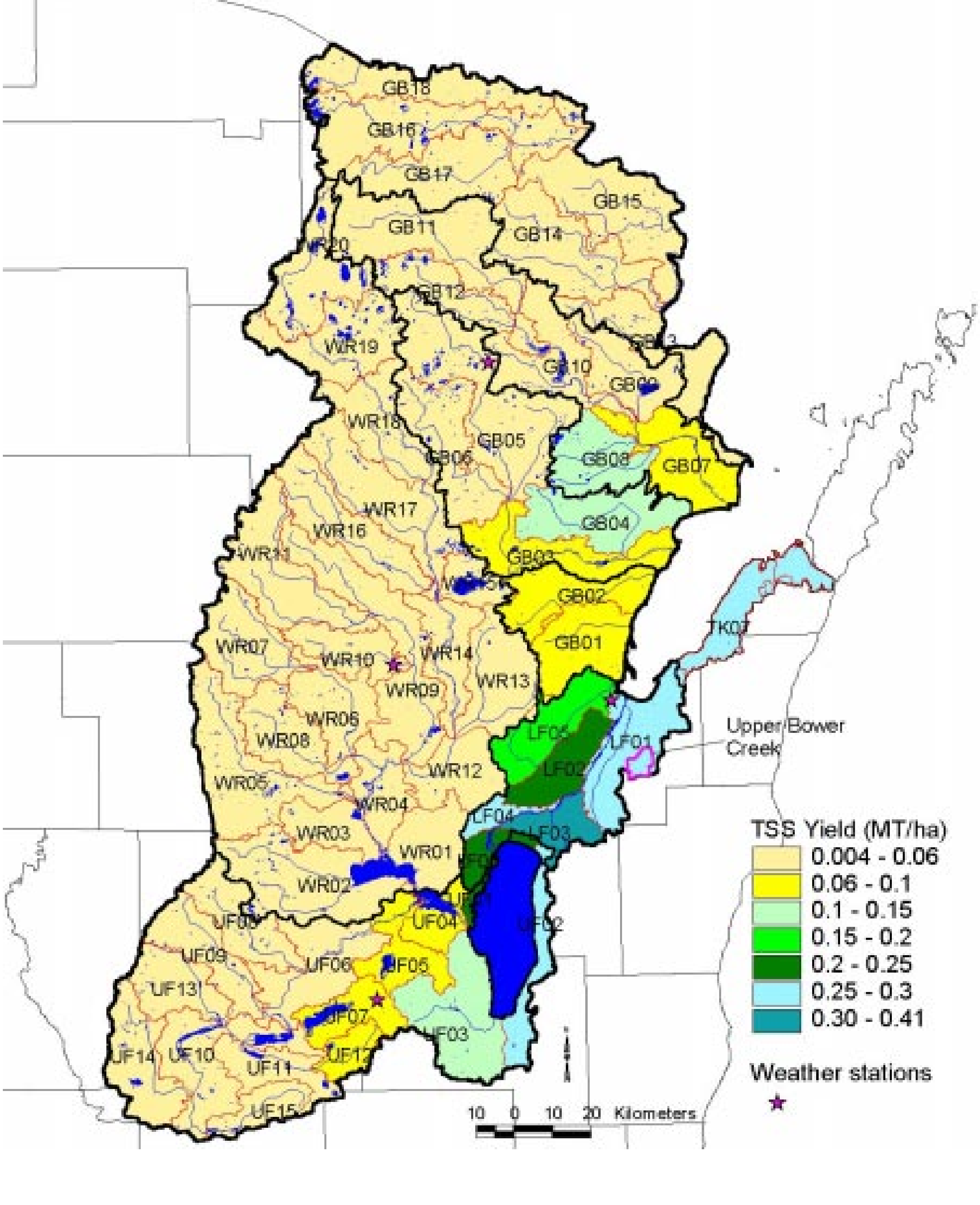
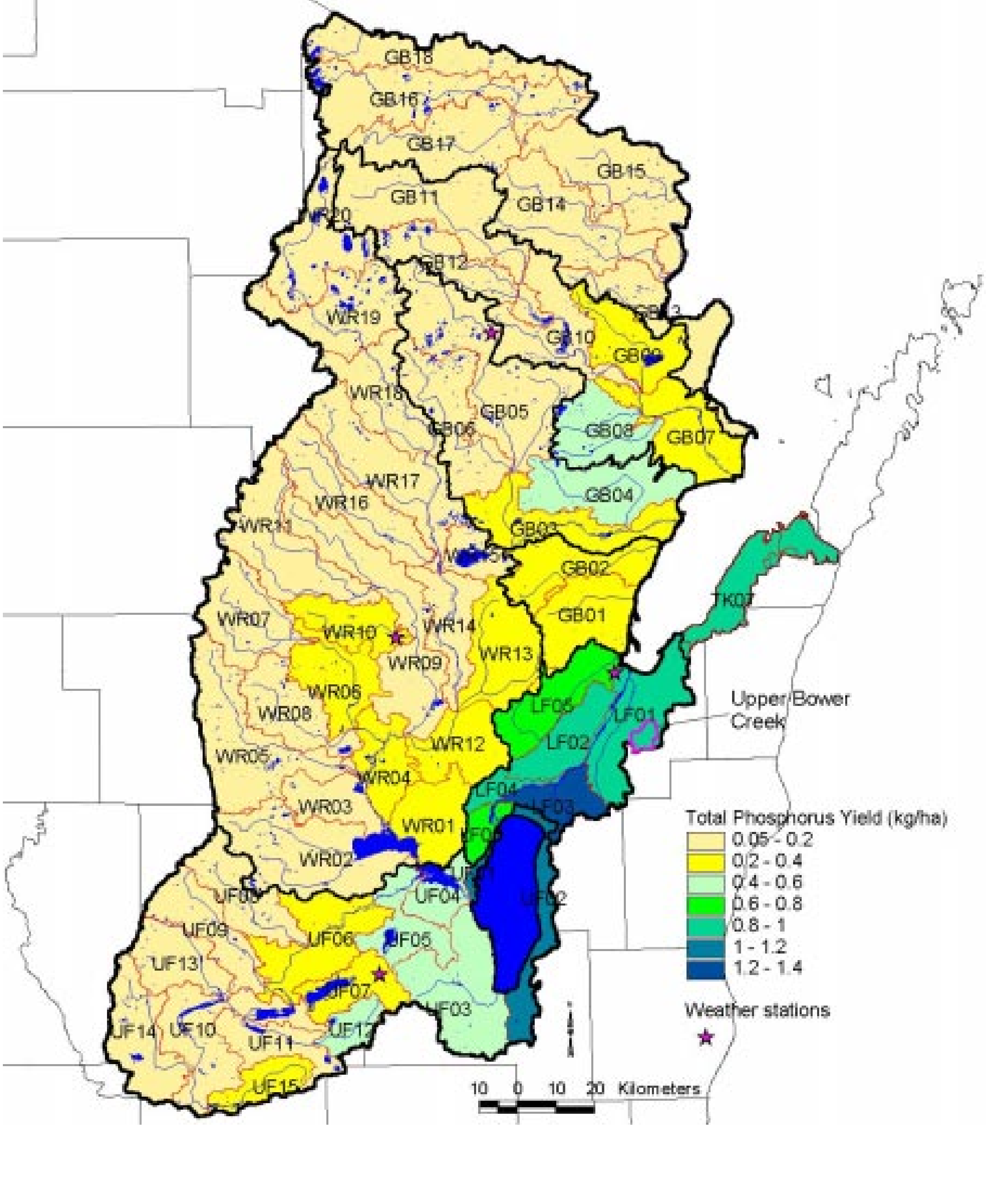


Figure 5. Simulated total phosphorus yields to Green Bay (kg/ha).



CHAPTER 6. OTHER LOADS, SENSITIVITY ANALYSIS and CAVEATS

Barnyard runoff, gully erosion, streambank/shoreline erosion, and existing riparian buffers were not explicitly accounted for in the model framework, but will be discussed in this section. Also, a detailed sensitivity analysis is not warranted for this project; however, some information is provided in this section so that potential errors in the data presented in this report, as well as data interpretation, can be better understood. A more thorough analysis of the sensitivity of the SWAT model, as applied to the Duck Creek Watershed, was conducted by Baumgart (1998).

Existing riparian buffers: The modeling assumptions did not directly account for the riparian buffers that may exist in the Basin. As a result, the simulated load from a watershed which has a high percentage of cropland whose runoff drains through an existing riparian buffer may be overstated, while the simulated load from a watershed with a lower percentage of buffers may be understated. To attempt to determine what effect this might have on the simulated loads, a GIS analysis of WISCLAND land cover types that are intersected by the 1:24k hydrology network within the Green Bay Basin was conducted by Stratus Consulting. This analysis can be roughly interpreted to indicate whether riparian areas are already buffered by existing forest or wetland; however, it cannot show whether the upland source is a high contributor (cropland), or low contributor (forest or wetland). The results of this analysis are summarized in Table 5, which shows the percentage of forest and wetland land cover that is adjacent to surface waters for each watershed in the Green Bay Basin, as well as the Upper Bower Creek reference/calibration subwatershed. The resolution of the WISCLAND land cover image (30 m cells) is not sufficient to provide precise percentages of existing riparian forest or wetland buffers; rather, this analysis is primarily intended to provide relative values for comparison between watersheds in the Basin. The low resolution of the land cover image implies that the percentage of streams that are actually buffered is higher than estimated here.

Excluding the Duck Creek watershed, the percent forest and wetland land cover that intersect the 1:24k hydrology network ranged from 5.5% to 18% within the Lower Fox River Subbasin. These figures are similar to that found in the Upper Bower Creek reference/calibration subwatershed (13%). For the four Upper Fox River watersheds with the highest phosphorus yields to Green Bay, the percent forest and wetland that intersect the 1:24k hydrology network ranged from 16% to 36%, which is not that dissimilar from the Upper Bower Creek reference/calibration subwatershed (13%), given the rough nature of the buffer analysis. In general, watersheds with higher proportions of estimated riparian buffers have lower yields to Green Bay. Although existing riparian buffers were not directly accounted for in the modeling assumptions, the simulated total phosphorus yield to Green Bay was strongly correlated (r^2 = 0.75) to the percent forest and wetland land cover that intersected the 1:24 hydrology network.

A much more intensive effort would be required to accurately estimate the amount of existing riparian buffer strips within the entire Basin, but the scale of the project area and the requisite land cover resolution precluded such an effort. Consequently, no further adjustments of delivery ratios or unit-area loads were made to account for differences between watersheds with regards to the amount of estimated riparian buffer strips.

The strong relationship between phosphorus yield to Green Bay, and the GIS buffer analysis, is probably due to the strong positive relationship between simulated yields and the percent land cover that is cropland or urban; and conversely, the strong inverse relationship between simulated yields and the percent land cover that is forest or wetland. The GIS analysis did not distinguish between forested or wetland riparian areas that either had a high contributing upland source draining though it (e.g., cropland), or an upland source that was a low contributor (e.g., wetland or forest). Therefore, it is likely that in many cases, the indicated riparian wetland and forested buffers are often just an extension of the dominant land cover that is adjacent to the riparian wetland or forested buffer. Consequently, the higher the proportion of wetland and forest in a watershed, the greater the proportion of existing riparian buffers. But watersheds with high proportions of wetlands and forests are not large contributors of TSS or phosphorus to Green Bay. So the importance of the estimated riparian buffered areas is diminished because the GIS analysis did not distinguish between source areas to the riparian buffer, and the greatest contributions to Green Bay come from those watersheds with lower proportions of both upland and riparian forest or wetland land cover. Therefore, excluding the effects of existing riparian buffer strips is not believed to substantially alter the results and conclusions presented in this report.

Table 5. Percentage of riparian areas that are adjacent to forest or wetland.

Watershed ID	Watershed	Wetland & forest (%)
GB01	Suamico and Little Suamico Rivers	38.5
GB02	Pensaukee River	46.7
GB03	Lower Oconto River	58.2
GB04	Little River	56.6
GB05	Lower North Branch Oconto River	81.2
GB06	South Branch Oconto River	78.7
GB07	Lower Peshtigo River	65.3
GB08	Little Peshtigo River	69.7
GB09	Middle Inlet and Lake Noquebay	81.0
GB10	Middle Peshtigo and Thunder Rivers	74.9
GB11	Upper Peshtigo River	89.5
GB12	Otter Creek and Rat River	86.1
GB13	Wausaukee and Lower Menominee Rivers	71.9
GB14	Pike River	88.5
GB15	Pemebonwon and Middle Menominee Rivers	81.6
GB16	Pine River	81.8
GB17	Popple River	92.2
GB18	Brule River	87.6
LF01	East River	18.0
LF02	Apple and Ashwaubenon Creeks	14.2
LF03	Plum and Kankapot Creeks	14.5
LF04	Fox River/Appleton	5.5
LF05	Duck Creek	34.0
LF06	Little Lake Butte des Morts	9.8
Reference	**Upper Bower Creek**	**12.9**
TK07	Red River and Sturgeon Bay	43.8
UF01	Lake Winnebago/North and West	19.4
UF02	Lake Winnebago/East	23.4

Table 5. Percentage of riparian areas that are adjacent to forest or wetland.

Watershed ID	Watershed	Wetland & forest (%)
UF03	Fond du Lac River	36.2
UF04	Lake Butte Des Mortes	16.5
UF05	Fox River	48.7
UF06	Fox River/Berlin	62.7
UF07	Big Green Lake	44.8
UF08	White River	70.1
UF09	Mecan River	75.5
UF10	Buffalo and Puckaway Lakes	61.0
UF11	Lower Grand River	63.3
UF12	Upper Grand River	43.7
UF13	Montello River	67.0
UF14	Neenah Creek	61.0
UF15	Swan Lake	58.0
WR01	Arrowhead River and Daggets Creek	40.2
WR02	Pine and Willow Rivers	58.7
WR03	Walla Walla and Alder Creeks	65.8
WR04	Lower Wolf River	65.2
WR05	Waupaca River	62.6
WR06	Lower Little Wolf River	67.1
WR07	Upper Little Wolf River	77.8
WR08	South Branch Little Wolf River	69.6
WR09	North Branch & Mainstem Embarrass River	64.6
WR10	Pigeon River	64.4
WR11	Middle & South Branches Embarrass River	77.8
WR12	Wolf River/New London and Bear Creek	49.5
WR13	Shioc River	42.3
WR14	Middle Wolf River	64.0
WR15	Shawano Lake	50.9
WR16	Red River	83.0
WR17	West Branch Wolf River	77.7
WR18	Wolf River/Langlade and Evergreen Rivers	77.7
WR19	Lily River	81.1
WR20	Upper Wolf River and Post Lake	83.6

Barnyard runoff: Barnyard contributions were not directly considered in the modeling assumptions. Instead, the effects of barnyards and upland practices were lumped together. As a result, phosphorus loads from upland sources should be somewhat lower than indicated in this analysis. Had barnyard runoff contributions been included as a separate phosphorus load, the effect of installing BMPs intended for upland or streambank controls, such as conservation tillage, grass waterways, vegetated buffer strip and streambank stabilization would be lessened. According to the Duck, Apple and Ashwaubenon Creeks Priority Watershed Project Plan (WNDR 1997), about 4% (9,000 lbs or 4,100 kg) of the phosphorus load delivered to streams is from barnyard runoff. However, when the same phosphorus load delivered to the stream (4,100 kg) is compared to the SWAT/GIS-simulated phosphorus load generated for the Duck, Apple and

Ashaubenon Creek watersheds (50,000 kg), the percent phosphorus from barnyard runoff is 8%. The barnyard runoff phosphorus load attributed to barnyard runoff in the Lake Winnebago East Priority Watershed Project was estimated to be 1,040 kg, or 2,300 lb (WDNR 1994), which is about 2% of the total phosphorus load simulated in this project. The barnyard runoff load of 1,870 kg (4,120 lbs) estimated for the East River Priority Watershed Project cannot be directly compared to the simulated loads generated by the SWAT model because the barnyard numbers were based on a single 10-year, 24-hour storm (WDNR 1993a), but this value is small compared to the total simulated phosphorus load of 49,500 kg in the East River. According to the Arrowhead River, Daggets Creek and Rat River Priority Watershed Project Plan (WDNR 1993b), barnyard runoff accounts for 10% (3,680 lbs/38,717 lbs) of the total phosphorus load in the watershed.

If the barnyard phosphorus load estimates are accurate, and if other watersheds have similar proportional contributions from barnyards, the effect of not including phosphorus loads from barnyards in the model framework should be small given the expected errors in the simulated results. However, expected load reductions may have to be decreased for BMP's that do not affect barnyard runoff.

Streambank and shoreline contributions: The sediment load from streambanks and shorelines, estimated miles of eroding streambank, and the percentage of total sediment load that were estimated by LCD's in their respective priority watershed projects and water resource plans is summarized in Table 6.

Lake Winnebago East has the highest percentage of streambank and shoreline erosion compared to total sediment load (20%), followed by Winnebago County (18%), the Tomorrow/Waupaca Watershed (24%) and Waupaca County (12%). Of those watersheds that contribute the greatest proportion of the simulated TSS load to Green Bay, estimates from LCD's show that streambank and shoreline erosion contribute about 20% from the eastern and western watersheds surrounding Lake Winnebago, and 7.7% from the East River Watershed.

Table 6. Estimated sediment and phosphorus loads from streambank and shoreline erosion.

Watershed	WDNR ID	sediment (English tons)/ phosphorus (lbs)	miles of eroding stream-bank	Routed to Green Bay		Watershed fraction of total TSS and phosphorus		
				TSS (MT)	total phos. (kg)	to stream or watershed outlet (LCD estimate)	to Green Bay (FWB2k)	
							TSS	phos.
East River (WDNR 1993b)	LF01	3,250 current est.	15	1,370	580	7.7%	9.0%	1.2%
Duck Creek Apple/Ashwaubenon (WNDR 1997c)	LF05 LF02	2,330 4,710	14	1,030 2,180	430 960	8.5% 5.6%	13.3% 31.4%	1.8% 4.0%
Arrowhead/Rat/Daggets (Winn. Cty LCD 1997, WDNR 1993c)	WR01	> 880 Winn. Cty. only		> 85	> 84	7.8%	4.9%	0.6%
Tomorrow/Waupaca (WDNR 1995)	WR05	1,660	6	130	180	23.9%	13.4%	1.9%
Lower Little Wolf (WDNR 1997b)	WR06	1,920	10	150	150	6.7%	10.7%	1.4%
Neenah Creek (WDNR 1994b)	WR14	760		50	70	4.6%	6.3%	0.9%
Red River/Sturgeon Bay (WDNR 1996)	TK07	540	5	350	130	3.6%	4.9%	0.6%
Lake Winnebago East (WDNR 1994a)	UF02	3,430		700	390	20.0%	10.2%	1.5%
Fond du Lac (WDNR 2000)	UF03	9,170	24	1,400	1,000	5.6%	22.1%	3.0%
Lake Buttes des Morts (Winnebago Cty LCD 1997)	UF04	630		70	64	7.5%	4.2%	0.6%
Fox River/Rush Lake (Winnnebago Cty LCD 1997)	UF05	> 4,400 Winn. Cty. only		> 440	> 400	18%	21.1%	2.9%
Winnebago County (Winnebago Cty. LCD 1997)		11,500 tons/ 8,600 lbs of P		1,200	1,200	18% / 9% of Winn. Cty. rural load	NA	NA
Waupaca County (Waupaca Cty. LCD 1998)		8,500 tons/ 6,400 lbs of P		680	900	12% / 5.8% of Waupaca Cty. rural load	NA	NA
Pensaukee (WDNR 1997a)	GB02	380	4	170	74	1.3%	5.0%	0.5%

However, total sediment loads that were estimated for each of the Priority Watersheds do not correspond closely to the SWAT/GIS simulated loads, so relative loads based upon the aforementioned percentages are not necessarily appropriate. For example, the simulated TSS load for the East River Watershed was 15,300 MT, compared to the combined rural TSS load of 38,300 MT reported by WDNR (1993b) for all sources. An even greater discrepancy occurs in the Duck, Apple and Ashwaubenon Watersheds where the simulated TSS load is 16,000 MT, compared to the combined rural TSS load of 101,000 MT reported by WDNR (1997c). The latter estimated total load may be sediment delivered to the stream, rather than sediment delivered to the watershed outlet. In addition, it can probably be assumed that reported streambank and shoreline erosion estimates are to the stream or lake, rather than to the watershed outlet, so actual sediment contributions to a watershed outlet from these sources ought to be lower when this material is transported downstream.

Therefore, to estimate the sediment export to Green Bay due to streambank erosion, the streambank loads estimated by LCD's were routed to Green Bay with the same delivery ratio equation and trapping efficiencies used here to route sediment and phosphorus to the watershed outlet and to Green Bay. An additional delivery ratio was added because unit-area loads were based on delivery to the outlet of the reference subwatershed, Upper Bower Creek, which has an area of 35.6 sq. km. Potential phosphorus loads were estimated by assuming that there is 0.75 lbs of phosphorus per ton of eroded streambank (Winnebago Cty LCD 2000, Waupaca Cty. LCD 1999). The resulting streambank and shoreline load estimates routed to Green Bay, and the percent of each watershed's load routed to Green Bay, are summarized in Table 6.

The estimated percent of TSS due to streambank/shoreline erosion that reached Green Bay from each watershed ranged from 1.3% in the Pensaukee Watershed, to 31% from the Apple and Ashwaubenon Creek Watershed. Most of the watersheds were within the 4% to 14% range. The estimated percent of phosphorus associated with streambank/shoreline erosion that reached Green Bay from each watershed ranged from 0.5% in several watersheds, to 4.0% from the Apple and Ashwaubenon Creek Watershed.

As with barnyard runoff, expected load reductions may have to be decreased for BMP's that do not fully affect streambank or shoreline erosion.

Gully erosion: Gully erosion can contribute a significant proportion of the total TSS load from a watershed. However, both conservation tillage and vegetated buffer strips should reduce gully formation and resultant loads, especially when both practices are combined.

Climatic differences: For agricultural crops, the assumed unit-area loads that were assigned to watersheds in the Ripon climatic region were approximately 1.5 times greater than those watersheds within the Green Bay climatic regions. Therefore, simulated loads and the percent contribution to Green Bay from Upper Fox watersheds near Lake Winnebago would have been lower if Green Bay weather had been utilized instead of Ripon weather. While it is possible that Ripon may have experienced an unusually high number or intensity of precipitation events during the simulation period, the unit-area loads for the Lakeland climatic region were the same as the loads in the Ripon region. However, generating additional sets of unit-area loads by including other weather stations should improve confidence in the relative differences between watersheds (i.e., relative simulated loads, but not actual differences in loads).

Soil permeability: If all other parameters are kept constant, changing the soil from hydrologic Group B to Group C, would increase the simulated TSS and phosphorus unit-area loads by a factor of 1.55 and 1.6, respectively. Similarly, changing the soil from Group AB to Group B, would increase the simulated TSS and phosphorus unit-area loads by a factor of 1.35 and 1.85, respectively. Increasing the resolution of the soils databases by using individual digital county soil surveys would improve results. However, at this time, such an endeavor would be impractical because of the scale of the Green Bay basin; plus, many of the soil surveys within the Basin have not been put in digital format yet. In addition, many models with an integrated GIS simply choose the dominant soil within the primary modeling unit (e.g., watershed or subwatershed), which defeats the purpose of utilizing a high resolution soil layer for input to a model.

CHAPTER 7. SUMMARY AND CONCLUSIONS

- The SWAT/GIS model was applied to simulate long-term average annual TSS and total phosphorus loads to Green Bay from watersheds in the Basin.

- Simulated TSS and phosphorus loads to Lake Winnebago, Rapide Croche dam near Wrightstown, and Green Bay were reasonably close to observed loads.

- The majority of the TSS and phosphorus loads to Green Bay are from those areas closest to Green Bay, including all of the watersheds in the Lower Fox subbasin and those watersheds adjacent to Lake Winnebago (LF01, LF02, LF03, LF04, LF05, LF06; UF01, UF02). Somewhat lower phosphorus yields to Green Bay were simulated for the UF03, UF04, UF05, UF06, UF12, GB4 and GB8 watersheds.

- Although simulated TSS and phosphorus yields from the Red River and Sturgeon Bay Watershed were relatively high, areas within this watershed are heavily influenced by karst geology, which was not accounted for in the model. Therefore, simulated yields and loads are probably lower than indicated for this watershed.

- Existing riparian buffers were not explicitly accounted for in the model framework. Relative loads among the watersheds may therefore vary somewhat, depending on the extent of buffers in each watershed, but the major results and conclusions presented in this report are not expected to be substantially affected.

- Barnyard runoff, streambank/shoreline erosion, and gully erosion were not explicitly modeled, but loads to Green Bay were estimated where data was available for streambank/shoreline erosion. Estimated contributions from these sources can be significant, and should be accounted for when estimating reductions from BMP's that have little or no effect on the pollutant source.

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Appendix H — Estimation of Loadings Reductions from Conservation Tillage and Vegetated Buffer Strips

This appendix describes how estimates were made of the loading reductions of phosphorus that result from improved tillage practices and installation of vegetated buffer strips. The basic approach is as follows:

- Estimate current loading of phosphorus into Green Bay from each watershed.
- Estimate per unit reductions in loading for improved conservation tillage and vegetated buffer strips.
- Estimate reductions from each watershed under different levels of implementation by applying the per unit reductions to the number of units changed (acres farmed using an improved tillage technique or converted to a vegetated buffer strip); sum the reductions across all watersheds to obtain an estimate of the overall reduction in loading to Green Bay.
- Translate reductions in phosphorus loadings to Green Bay to increases in water clarity or decreases in algae.

Although the methods described here can also be used to estimate TSS reduction, only phosphorus loading reductions were calculated here since nonpoint source pollution reduction benefits are expressed in the RCDP as increases in water clarity and decreases in algae, which are calculated from phosphorus loading.

H.1 Estimating Current Loading

The approach, methods, and results of the application of a SWAT-based model to estimate the current loading of phosphorus from each watershed into Green Bay are presented in Appendix G.

H.2 Estimating per Unit Reductions in Loading

Tillage practices

Appendix G presents the relative per acre phosphorus loading from croplands under different tillage practices. The values are shown in Table H.1. These relative loading values are used to calculate the reduction in loadings upon conversion of cropland from one tillage category to another.

Table H.1. Estimated reductions in unit area phosphorus loads from different tillage practices.

		Estimated percent reduction in organic phosphorus relative to conventional till	
Crop residue %	**Tillage**	**Corn**	**Soybeans/other row crops**
0-15%	conventional	0	0
16-30%	low mulch-till	23.4	14.0
>30%	mulch-till	46.9	28.0
N/A	no-till/ridge till	65.8	52.0

Source: Appendix G.

Buffer strips

Appendix I describes in detail the derivation of loading reduction factors that represent the effectiveness of buffer strips at reducing loads of phosphorus from croplands into adjacent waterways. A value of 0.35 for phosphorus (compared to a value of 0.40 for TSS) was selected to represent the fractional decrease in loading provided by buffer strips. This value is based on the application of numerous field and laboratory studies reported in the literature to the specific conditions of the Green Bay watershed. Appendix I also describes how buffer strips are generally effective at reducing only runoff loading that is generated from within a limited distance of the buffer strip. Buffer strips are most effective at removing particles and nutrients from runoff that enters the strip as sheet flow, but are typically ineffective at reducing loading in flow that reaches the strip as channelized flow. Appendix I estimates that buffer strips are effective at reducing only the loading that is generated from within approximately 90 m of the buffer strip edge, and are ineffective at reducing loads that originate from farther away.

H.3 Estimating Reductions by Watershed and Summing across Watersheds

Conservation tillage

The reduction in phosphorus loadings that results from applying conservation tillage practices is estimated separately for corn fields and for soybeans and other row crops (hereafter referred to simply as soybeans), since the runoff reduction factors vary for these two types of fields. Data on the percent of cropland within each of the four tillage categories, for each watershed and crop type, are available from the TRANSECT survey conducted in 1999 and described in Appendix G. Table H.2 shows the results of the survey and the number of acres within each watershed that are classified as corn or soybeans based on WISCLAND land use/land cover data (see Appendix F).

It was assumed that a conservation tillage program would result in the conversion of cropland from conventional or low-mulch till to mulch till and no till/ridge till (WDNR et al., 1997). However, conservation tillage programs typically do not achieve complete farmer participation. Therefore, we calculated loadings reductions under the assumption that at maximum implementation of a conservation tillage program, 25% of cropland within each watershed would remain in conventional till.[1] This scenario is consistent with the 75% farmer participation level that is commonly assumed in priority watershed plans (e.g., WDNR et al., 1993, 1997). For watersheds where the percent of land in conventional till is already less than 25%, no acres were converted to conservation tillage. We also ran simulations assuming 15% of cropland would remain in conventional till to evaluate the possibility of higher farmer participation. Of the acres that are converted from the conventional tillage and low mulch-till categories, 90% are assumed to be converted to the mulch till category and 10% are assumed to be converted to no-till/ridge till, since no-till/ridge till is relatively uncommonly used (R. Burton, Outagamie Land Conservation Department, personal communication, 2000).

1. The loadings reductions are calculated assuming that 0% remains in the low-till mulch category. In this way, only farms currently under conventional tillage are assumed to not participate in a conservation program.

Table H.2. Distribution of tillage categories for corn and soybeans.

		Corn					Soybeans				
Watershed ID	**Watershed name**	**Corn acres in watershed**	**% of corn in conventional tillage**	**% of corn in low-mulch till**	**% of corn in mulch till**	**% of corn in no till/ridge till**	**Soybean acres in watershed**	**% of soybeans in conventional tillage**	**% of soybeans in low-mulch till**	**% of soybeans in mulch till**	**% of soybeans in no till/ridge till**
GB01-130	Suamico and Little Suamico Rivers	30,838	70%	18%	12%	1%	11,502	79%	16%	4%	0%
GB02-130	Pensaukee River	28,006	90%	6%	4%	0%	8,191	87%	13%	0%	0%
GB03-140	Lower Oconto River	22,061	93%	6%	1%	0%	5,313	100%	0%	0%	0%
GB04-140	Little River	30,693	80%	11%	4%	4%	6,729	98%	2%	0%	0%
GB05-140	Lower North Branch Oconto River	5,376	79%	15%	0%	6%	1,902	100%	0%	0%	0%
GB06-140	South Branch Oconto River	5,629	75%	25%	0%	0%	817	100%	0%	0%	0%
GB07-150	Lower Peshtigo River	20,025	89%	11%	0%	0%	3,611	93%	7%	0%	0%
GB08-150	Little Peshtigo River	19,794	79%	17%	3%	1%	3,757	76%	12%	0%	12%
GB09-150	Middle Inlet and Lake Noquebay	10,280	89%	11%	0%	0%	0	100%	0%	0%	0%
GB10-150	Middle Peshtigo and Thunder Rivers	4,003	100%	0%	0%	0%	37	67%	11%	0%	22%

Table H.2. Distribution of tillage categories for corn and soybeans (cont.).

		Corn					Soybeans				
Watershed ID	Watershed name	Corn acres in watershed	% of corn in conventional tillage	% of corn in low-mulch till	% of corn in mulch till	% of corn in no till/ridge till	Soybean acres in watershed	% of soybeans in conventional tillage	% of soybeans in low-mulch till	% of soybeans in mulch till	% of soybeans in no till/ridge till
GB11-150	Upper Peshtigo River	665	100%	0%	0%	0%	0	100%	0%	0%	0%
GB12-150	Otter Creek and Rat River	151	100%	0%	0%	0%	0	100%	0%	0%	0%
GB13-160	Wausaukee and Lower Menominee Rivers	8,489	100%	0%	0%	0%	85	100%	0%	0%	0%
GB14-160	Pike River	1,452	100%	0%	0%	0%	0	100%	0%	0%	0%
GB15-160	Pemebonwon and Middle Menominee Rivers	7,994	100%	0%	0%	0%	0	100%	0%	0%	0%
GB16-160	Pine River	2,574	100%	0%	0%	0%	43	100%	0%	0%	0%
GB17-160	Popple River	89	100%	0%	0%	0%	0	100%	0%	0%	0%
GB18-160	Brule River	1,367	100%	0%	0%	0%	36	100%	0%	0%	0%
LF01-113	East River	55,695	76%	20%	2%	2%	586	80%	13%	7%	0%
LF02-113	Apple and Ashwaubenon Creeks	22,613	32%	31%	37%	0%	14,169	46%	31%	23%	0%
LF03-113	Plum and Kankapot Creeks	26,307	79%	21%	0%	0%	40	75%	25%	0%	0%

Table H.2. Distribution of tillage categories for corn and soybeans (cont.).

		Corn					Soybeans				
Watershed ID	Watershed name	Corn acres in watershed	% of corn in conventional tillage	% of corn in low-mulch till	% of corn in mulch till	% of corn in no till/ridge till	Soybean acres in watershed	% of soybeans in conventional tillage	% of soybeans in low-mulch till	% of soybeans in mulch till	% of soybeans in no till/ridge till
LF04-113	Fox River/Appleton	2,838	61%	21%	18%	0%	2,996	75%	9%	17%	0%
LF05-113	Duck Creek	28,107	70%	15%	13%	1%	16,048	57%	29%	7%	7%
LF06-113	Little Lake Butte des Morts	5,644	62%	21%	11%	6%	3,381	53%	24%	15%	9%
TK07-100	Red River and Sturgeon Bay	29,830	86%	10%	4%	0%	0	67%	1%	6%	26%
UF01-111	Lake Winnebago/ North and West	4,495	62%	21%	11%	6%	858	53%	24%	15%	9%
UF02-111	Lake Winnebago/ East	23,930	80%	10%	5%	5%	7,257	75%	13%	0%	13%
UF03-111	Fond du Lac River	47,714	57%	25%	16%	2%	29,071	49%	18%	27%	6%
UF04-111	Lake Butte Des Morts	15,458	61%	19%	14%	6%	6,966	42%	39%	15%	4%
UF05-111	Fox River	27,272	61%	18%	22%	0%	8,088	28%	21%	32%	20%
UF06-111	Fox River/Berlin	31,088	49%	31%	8%	12%	7,507	43%	25%	16%	15%
UF07-111	Big Green Lake	15,230	53%	31%	10%	6%	14,288	65%	21%	8%	6%
UF08-111	White River	7,851	42%	20%	26%	13%	8,670	58%	15%	23%	4%

Table H.2. Distribution of tillage categories for corn and soybeans (cont.).

		Corn					Soybeans				
Watershed ID	Watershed name	Corn acres in watershed	% of corn in conventional tillage	% of corn in low-mulch till	% of corn in mulch till	% of corn in no till/ridge till	Soybean acres in watershed	% of soybeans in conventional tillage	% of soybeans in low-mulch till	% of soybeans in mulch till	% of soybeans in no till/ridge till
UF09-111	Mecan River	8,313	78%	15%	7%	0%	8,919	48%	23%	27%	2%
UF10-111	Buffalo and Puckaway Lakes	16,682	56%	25%	12%	7%	11,256	54%	30%	3%	13%
UF11-111	Lower Grand River	12,376	48%	34%	10%	9%	9,250	62%	5%	12%	21%
UF12-111	Upper Grand River	12,683	56%	21%	21%	2%	10,873	61%	17%	7%	15%
UF13-111	Montello River	10,757	74%	19%	3%	5%	8,048	93%	0%	7%	0%
UF14-111	Neenah Creek	15,180	64%	18%	12%	6%	10,114	42%	23%	22%	13%
UF15-111	Swan Lake	10,827	51%	42%	7%	0%	6,271	32%	64%	0%	5%
WR01-112	Arrowhead River and Daggets Creek	22,170	40%	26%	33%	1%	14,884	29%	11%	56%	4%
WR02-112	Pine and Willow Rivers	32,486	40%	33%	19%	8%	12,396	39%	15%	44%	3%
WR03-112	Walla Walla and Alder Creeks	15,725	44%	26%	22%	7%	2,365	75%	0%	13%	13%
WR04-112	Lower Wolf River	18,182	58%	29%	11%	2%	3,693	41%	39%	21%	0%
WR05-112	Waupaca River	30,680	62%	21%	15%	2%	10,590	65%	14%	16%	5%

Table H.2. Distribution of tillage categories for corn and soybeans (cont.).

		Corn					Soybeans				
Watershed ID	**Watershed name**	**Corn acres in watershed**	**% of corn in conventional tillage**	**% of corn in low-mulch till**	**% of corn in mulch till**	**% of corn in no till/ridge till**	**Soybean acres in watershed**	**% of soybeans in conventional tillage**	**% of soybeans in low-mulch till**	**% of soybeans in mulch till**	**% of soybeans in no till/ridge till**
WR06-112	Lower Little Wolf River	22,595	55%	13%	24%	9%	3,557	56%	13%	19%	13%
WR07-112	Upper Little Wolf River	11,763	75%	15%	8%	2%	3,508	83%	9%	8%	0%
WR08-112	South Branch Little Wolf River	15,432	56%	24%	16%	5%	2,729	77%	18%	6%	0%
WR09-112	North Branch & Mainstem Embarrass River	48,460	66%	23%	10%	2%	13,428	68%	12%	12%	8%
WR10-112	Pigeon River	16,669	35%	22%	31%	13%	2,683	28%	24%	40%	8%
WR11-112	Middle & South Branches Embarrass River	16,954	85%	9%	6%	0%	2,153	100%	0%	0%	0%
WR12-112	Wolf River/New London and Bear Creek	22,312	39%	40%	17%	3%	15,839	56%	36%	8%	0%
WR13-112	Shioc River	34,168	61%	19%	13%	7%	17,970	74%	13%	13%	0%
WR14-112	Middle Wolf River	16,445	88%	8%	4%	0%	5,290	85%	15%	0%	0%

Table H.2. Distribution of tillage categories for corn and soybeans (cont.).

		Corn					Soybeans				
Watershed ID	**Watershed name**	**Corn acres in watershed**	**% of corn in conventional tillage**	**% of corn in low-mulch till**	**% of corn in mulch till**	**% of corn in no till/ridge till**	**Soybean acres in watershed**	**% of soybeans in conventional tillage**	**% of soybeans in low-mulch till**	**% of soybeans in mulch till**	**% of soybeans in no till/ridge till**
WR15-112	Shawano Lake	6,657	88%	6%	6%	0%	1,943	100%	0%	0%	0%
WR16-112	Red River	17,220	87%	7%	7%	0%	1,483	78%	22%	0%	0%
WR17-112	West Branch Wolf River	9,255	95%	0%	5%	0%	456	100%	0%	0%	0%
WR18-112	Wolf River/Langlade and Evergreen Rivers	7,389	100%	0%	0%	0%	0	87%	0%	13%	0%
WR19-112	Lily River	1,646	100%	0%	0%	0%	66	100%	0%	0%	0%
WR20-112	Upper Wolf River and Post Lake	2,149	100%	0%	0%	0%	569	100%	0%	0%	0%

Watershed phosphorus loading to Green Bay after implementation of a conservation tillage program is estimated by multiplying the final number of acres of corn or soybean in each of the four tillage categories by the specific phosphorus loading per acre for each category:

$$L_t = \sum A_{ij} \times l_{ij} \ ,$$

where:

L_t is the total phosphorus loading from a watershed after conservation tillage practices are employed (kg per year)

$A_{i,j}$ is the number of watershed acres within tillage category *i* and crop type *j* (corn or soybeans) after implementation

$l_{i,j}$ is the average phosphorus loading per acre for croplands in tillage category *i* and crop type *j* (kg per year per acre)

The average phosphorus loading per acre for croplands within each tillage category and crop type ($l_{i,j}$) is calculated separately for each watershed. The average loading for croplands under conventional tillage ($l_{1,j}$) is calculated as:

$$l_{1j} = \frac{L_{cj}}{\sum A_{ij} \times r_{ij}} \ ,$$

where:

$L_{c,j}$ is the initial watershed phosphorus loading from all cropland of type *j* (corn or soybean) (kg per year)

$r_{i,j}$ is the relative loading factor for cropland within tillage category *i* for crop type *j* (from Table H.1).

The per acre loadings for the other three tillage categories ($l_{1,j}$, $l_{2,j}$, and $l_{3,j}$) are then calculated from l_1 using the relative loading factors shown in Table H.1:

$$l_{ij} = l_{1j} \times r_{ij} \ .$$

The initial watershed phosphorus loading from all corn or soybean cropland within a watershed was estimated from the unit area loads derived in Appendix G. The unit area loads from each 30 m by 30 m cell of type corn or soybean were summed within each watershed to obtain the initial watershed loadings from all land within each watershed that is corn or soybean. The results of this analysis are shown in Appendix F.

The resultant phosphorus loadings from each watershed after improvements in tillage practices (L_t) are summed to provide the total loadings from cropland to Green Bay. This number is added to the total loading to Green Bay from lands that are not cropland (calculated simply as the difference between the total initial loads and the initial loads from cropland) to obtain an estimate of the final total loadings of phosphorus to Green Bay after program implementation. To evaluate the effectiveness of different levels of program implementation or farmer participation, it was assumed that efforts to establish conservation tillage would begin in those watersheds where the greatest loading reduction per acre converted would be achieved. Watersheds were ranked in order of the reduction in phosphorus loadings to Green Bay per acre converted to conservation tillage, and these rankings were used to provide cost-effective estimates of the benefits of partial program implementation. Watersheds were ranked separately according to effectiveness of corn fields and of soybean fields, and watersheds were converted to conservation tillage such that the relative proportion of loadings reduction from corn and soybean fields remained constant.

The results are shown in Table H.3. Under an assumption of a maximum of 85% of conventional till acres being converted to conservation tillage, 997,000 acres of cropland can be converted across all of the watersheds, producing a 29% reduction in phosphorus loadings to Green Bay. Assuming a maximum of 75% of conventional till acres converted to conservation tillage results in a maximum of 910,000 acres converted with a 26% reduction in phosphorus loads to Green Bay.

Table H.3. Estimated reductions in phosphorus loads to Green Bay under different implementation levels of conservation tillage.

Acres converted to conservation tillage[a]	Estimated percent reduction in phosphorus loadings to Green Bay
997,000[b,c]	29.0
910,000[c,d]	26.0
499,000[d]	20.0
303,000[d]	15.0
169,000[d]	10.0

a. Conservation tillage is defined as mulch till or no till/ridge till; total includes corn and soybean crops.

b. Assumes maximum of 85% of lands in conventional till are converted to conservation tillage.

c. Conservation tillage scenario is applied to all Green Bay watersheds.

d. Assumes maximum of 75% of lands in conventional till are converted to conservation tillage.

Buffer strips

Appendix I of the RCDP presents a detailed analysis of the effectiveness of buffer strips at reducing phosphorus loads. Buffer strips are assumed to reduce watershed phosphorus loads into Green Bay in two ways: (1) they capture 35% of the phosphorus load that is generated within the range of buffer strip effectiveness (assumed to be 90 m); (2) they have a lower rate of phosphorus generation from runoff than does the cropland they replace. Buffer strip width is assumed to be 15 m.

The amount that phosphorus loading is reduced within a watershed because of phosphorus capture is calculated as:

$$R_e = \left[L_0 \times \left(\frac{A_e}{A_T} \right) \right] \times \left[\frac{A_{c15}}{A_{T15}} \right] \times 0.35 \ ,$$

where:

R_e is the reduction in watershed phosphorus loading (kg/year)

L_0 is the total watershed phosphorus loading before buffer strip installation (kg/year)

A_e is the number of acres within the watershed that are between 15 m and 105 m from the edge of waterways

A_T is the total number of acres within the watershed

A_{c15} is the number of acres within 15 m of the edge of waterways that are converted from agriculture to vegetated buffer strip

A_{T15} is the total number of acres within 15 m of the edge of waterways.

The variables within first bracket represent the initial phosphorus loading from areas within the buffer strip effectiveness zone of 15 m to 105 m from the edge of waterways. The variables within the second bracket represent the fraction of land within 15 m of waterways that is converted from agriculture to vegetated buffer strip. Only a portion of the land within each watershed falls within the assumed buffer strip effectiveness zone, and only a portion of the land within 15 m of waterways is currently agricultural and thus could be converted to a vegetated buffer strip.

The fractions of the different types of land that are within 15 m and 105 m of waterways were determined through GIS analysis. Land use/land cover data from WISCLAND and waterways defined in a 1:24,000 hydrographic layer were used (see Appendix F for additional details). The

WISCLAND classifications used to identify agricultural lands with the potential for conversion to vegetated buffer strips were all lands classified as “herbaceous/field crops” and other agriculture classified as “agriculture,” “woody agriculture,” or “cranberry bog” at level 2. The results of the GIS analysis are shown in Table H.4, which shows the fraction of lands within each watershed within 15 m and 105 m of a waterway, and the fraction of the lands within 15 m of a waterway with the potential for conversion to a vegetated buffer strip.

To estimate the reduction in phosphorus loading that results from conversion of agricultural land to vegetated buffer strip, we assume that the phosphorus loading generated from vegetated buffer strips is 10% of the loading generated from the agricultural land it replaces. The reduction of phosphorus loading that results (R_c) is calculated for each watershed as:

$$R_c = 0.9 \times L_0 \times \frac{A_{c15}}{A_T} \ .$$

The reduction from buffer strip replacement of agricultural land (R_c) is added to the reduction from buffer strip effectiveness (R_e) to obtain the total reduction in phosphorus loading for each watershed. These watershed loading reductions are then added to obtain the basin-wide reduction.

The results of the analysis for different levels of buffer strip implementation are shown in Table H.5. Watersheds were ranked in terms of the kilogram of phosphorus loading reduction to Green Bay achieved per acre of vegetated buffer strips installed. Implementation is assumed to take place first in the watersheds where the highest loading reduction per acre converted is achieved, thereby providing a cost-effective means for partial implementation.

The loading reductions achieved through buffer strip installation can be added to those achieved through implementation of conservation tillage practices. Thus the percent reduction in loadings from current levels achieved through a certain level of conservation tillage can be added to the percent reduction in loadings achieved through buffer strip installation.

Table H.4. Watershed acres, 15 m and 105 m waterway buffer acres, and cropland within 15 m of waterways.

Watershed name	Watershed-ID	Total watershed acres	Total watershed acres within 15 m of streams	Percent of watershed acres within 15 m that are herbaceous or field crops	Total watershed acres within 105 m of streams
Suamico and Little Suamico Rivers	GB01-130	109,903	4,716	55.3%	30,523
Pensaukee River	GB02-130	104,784	4,550	48.7%	28,109
Lower Oconto River	GB03-140	125,716	5,310	28.9%	30,447
Little River	GB04-140	134,565	4,397	40.4%	28,144
Lower North Branch Oconto River	GB05-140	249,128	7,795	6.3%	45,311
South Branch Oconto River	GB06-140	140,341	3,868	6.9%	23,393
Lower Peshtigo River	GB07-150	124,710	4,743	22.4%	26,620
Little Peshtigo River	GB08-150	101,357	3,091	23.6%	20,022
Middle Inlet and Lake Noquebay	GB09-150	99,524	2,264	2.5%	14,132
Middle Peshtigo and Thunder Rivers	GB10-150	123,838	4,394	0.8%	25,533
Upper Peshtigo River	GB11-150	216,553	5,965	0.4%	33,330
Otter Creek and Rat River	GB12-150	90,572	2,686	0.2%	15,680
Wausaukee and Lower Menominee Rivers	GB13-160	119,643	3,354	4.4%	20,006
Pike River	GB14-160	182,182	5,173	0.1%	31,042
Pemebonwon and Middle Menominee Rivers	GB15-160	186,027	5,348	1.2%	31,953
Pine River	GB16-160	219,267	6,750	0.4%	38,585
Popple River	GB17-160	148,010	3,918	0.2%	22,783
Brule River	GB18-160	124,647	3,289	0.9%	19,910
East River	LF01-113	131,985	6,270	66.7%	38,659
Apple and Ashwaubenon Creeks	LF02-113	72,520	3,147	74.6%	20,450
Plum and Kankapot Creeks	LF03-113	53,773	2,575	69.5%	16,005
Fox River/Appleton	LF04-113	25,198	1,093	38.4%	6,680
Duck Creek	LF05-113	97,009	3,927	58.6%	25,113
Little Lake Butte des Morts	LF06-113	28,010	1,027	37.3%	6,099

Table H.4. Watershed acres, 15 m and 105 m waterway buffer acres, and cropland within 15 m of waterways (cont.).

Watershed name	Watershed-ID	Total watershed acres	Total watershed acres within 15 m of streams	Percent of watershed acres within 15 m that are herbaceous or field crops	Total watershed acres within 105 m of streams
Red River and Sturgeon Bay	TK07-100	88,987	2,030	48.4%	13,842
Lake Winnebago/North and West	UF01-111	14,549	464	40.5%	2,658
Lake Winnebago/East	UF02-111	63,609	2,508	62.8%	16,257
Fond du Lac River	UF03-111	156,644	7,035	45.1%	43,159
Lake Butte Des Mortes	UF04-111	50,980	2,002	48.2%	12,072
Fox River	UF05-111	76,662	4,080	36.4%	22,165
Fox River/Berlin	UF06-111	133,664	5,506	20.3%	31,424
Big Green Lake	UF07-111	68,704	2,282	30.0%	14,052
White River	UF08-111	95,950	2,779	7.8%	15,735
Mecan River	UF09-111	94,998	2,912	9.5%	17,062
Buffalo and Puckaway Lakes	UF10-111	144,191	5,548	16.4%	32,638
Lower Grand River	UF11-111	70,057	2,665	24.5%	15,965
Upper Grand River	UF12-111	39,668	1,164	42.4%	7,421
Montello River	UF13-111	86,160	2,776	15.3%	16,674
Neenah Creek	UF14-111	111,058	3,829	21.8%	22,316
Swan Lake	UF15-111	51,628	1,652	21.7%	10,116
Arrowhead River and Daggets Creek	WR01-112	91,477	3,561	49.6%	21,051
Pine and Willow Rivers	WR02-112	193,431	5,817	24.9%	33,871
Walla Walla and Alder Creeks	WR03-112	71,771	2,751	18.8%	15,295
Lower Wolf River	WR04-112	76,791	3,845	18.2%	20,265
Waupaca River	WR05-112	186,228	4,626	13.8%	25,827
Lower Little Wolf River	WR06-112	98,350	3,068	23.2%	18,368
Upper Little Wolf River	WR07-112	116,593	2,624	8.6%	16,955
South Branch Little Wolf River	WR08-112	102,645	3,106	9.7%	18,035

Table H.4. Watershed acres, 15 m and 105 m waterway buffer acres, and cropland within 15 m of waterways (cont.).

Watershed name	Watershed-ID	Total watershed acres	Total watershed acres within 15 m of streams	Percent of watershed acres within 15 m that are herbaceous or field crops	Total watershed acres within 105 m of streams
North Branch & Mainstem Embarrass River	WR09-112	200,133	8,031	29.6%	44,524
Pigeon River	WR10-112	74,473	2,158	24.3%	13,146
Middle & South Branches Embarrass River	WR11-112	160,096	4,322	9.5%	26,214
Wolf River/New London and Bear Creek	WR12-112	91,197	3,930	44.1%	22,574
Shioc River	WR13-112	121,444	4,983	55.1%	30,811
Middle Wolf River	WR14-112	85,628	3,865	24.3%	20,066
Shawano Lake	WR15-112	45,545	1,433	26.0%	8,936
Red River	WR16-112	132,607	3,318	7.8%	19,848
West Branch Wolf River	WR17-112	170,355	4,640	2.8%	25,860
Wolf River/Langlade and Evergreen Rivers	WR18-112	115,064	2,584	1.4%	13,958
Lily River	WR19-112	134,108	4,138	0.6%	23,475
Upper Wolf River and Post Lake	WR20-112	130,176	3,974	0.9%	22,855

Table H.5. Percent reductions in phosphorus loadings to Green Bay under different levels of buffer strip implementation.

Acres converted to vegetated buffer strips[a]	Percentage of eligible Green Bay watershed acres converted	Percent reduction in phosphorus loads to Green Bay
52,745	100	4.1
32,900	62	3.5
23,900	45	3.0
17,300	33	2.5
12,300	23	2.0
8,500	16	1.5
5,250	10	1.0

a. Assuming that conversion is conducted in the most cost-effective watersheds first.

H.4 Translating Loading Reductions to Increases in Water Clarity

The Green Bay Metropolitan Sewerage District has an extensive database of water quality measurements in Green Bay that include the parameters of phosphorus concentration and water clarity (expressed as Secchi disk depth, or the maximum depth at which a Secchi disk can be seen) (D. Sachs, Green Bay Metropolitan Sewage District, personal communication, 1999). We used these data to derive a quantitative relationship between water clarity (as measured by Secchi disk depth) and phosphorus concentration. In general, Green Bay water quality data show that water clarity decreases as phosphorus concentration increases, reflecting both the increased algae production with increased phosphorus loadings to the bay and the close correlation between phosphorus and TSS loadings to the bay. The relationship is described by the following statistically significant ($p < 0.001$) regression:

$$\ln(\text{Secchi depth, in inches}) = 4.17 - 7.70 \times (\text{phosphorus concentration, in mg/L})\ .$$

This equation will be used to relate reductions in phosphorus concentrations to increases in water clarity. This approach is similar to that used as part of the Green Bay Remedial Action Plan (Harris and Christie, 1987) but is based on more recent (1991-1997) water quality data.

The analysis of buffer strip installation and streambank stabilization presented above expresses expected benefits in terms of TSS and phosphorus loadings reductions to Green Bay. By assuming a linear relationship between changes in phosphorus loadings to Green Bay and changes in phosphorus water concentrations, as was done for the Green Bay Mass Balance Study (Bierman et al., 1992; DePinto et al., 1994; Hydroqual, 1999; LTI Environmental Engineering, 1999; Fitzpatrick and Meyers, 2000), we can relate estimated loadings reductions to estimated concentration reductions. Table H.6 shows examples of the water clarity predicted from estimated reductions in phosphorus loadings to Green Bay under different levels of restoration. The starting water clarity depth is 20 inches, which is the approximate mean of the values for inner Green Bay from the Green Bay Metropolitan Sewerage District database and was the starting value assumed in the Co-trustees' TVE study.

Table H.6. Resulting Green Bay water clarity from reductions in phosphorus loadings.

Percent reduction in phosphorus runoff loadings into Green Bay	Resulting water clarity[a] (inches)
4.0	21.0
8.0	22.0
12.0	23.0
16.0	24.2
20.0	25.3
24.0	26.5
28.0	27.8
32.0	29.1

a. Initially 20 inches.

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Appendix I — Evaluation of the Effectiveness of Riparian Buffer Strips and Stream Bank Stabilization BMPs to Control Non-point Source Pollution to Green Bay

Evaluation of the Effectiveness of Riparian Buffer Strips and Stream Bank Stabilization BMPs to Control Non-point Source Pollution to Green Bay

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Contents

I. Introduction

Vegetative buffer strips (VBS), also known as vegetative filter strips or riparian buffers/filter strips, and streambank stabilization measures represent two options for reducing sediment and nutrient loads to waterways.

VBSs are defined as "a strip or area of herbaceous vegetation situated between cropland, grazing land, or disturbed land (including forest land) and environmentally sensitive areas" (Natural Resource Conservation Service, 1999). The primary goal of VBSs is to help reduce sediment and nutrient loadings to waterways. Additional potential benefits of VBSs include their ability to moderate water temperature, maintain and improve wildlife distribution and diversity (Paine, et al, 1996), and to reduce human impact in urban environments.

VBSs help to reduce sediment and nutrient loadings to waterways in a number of ways including:

- Slowing runoff and allowing sediment and organic matter to settle
- Increasing sediment and nutrient infiltration
- Providing attachment sites for sediment and nutrients by increasing the number of plant stems in the flowpath
- Stabilizing stream banks by increasing root structures
- Reducing the development of gullies by slowing flow adjacent to the stream or ditch

A measure of a VBS's impact and effectiveness in reducing sediment and nutrient delivery to waterways is its trapping efficiency. Trapping efficiency measures the percentage of a given constituent load (e.g., sediment, phosphorous) that reaches the VBSs that the VBS prevents from reaching the adjoining waterway. For example, if a VBS receives a sediment load of 100 kg from adjacent agricultural land and retains 70 kg its trapping efficiency would be 70%.

Streambank stabilization measures can encompass a number of activities such as placing riprap along streambanks, introducing vegetation, reshaping, or placing livestock barriers. All streambank stabilization measures have the primary goal of reducing or virtually eliminating the erosion of the streambank into the adjoining waterway. The effectiveness of streambank stabilization measures will be expressed as a percentage reduction in the loadings from the area that is being actively eroding.

The goal of this paper is to develop a range of potential trapping efficiency estimates for VBSs and percentage loadings reductions for streambank stabilization measures that could be implemented in waterways of the Green Bay watershed. The trapping efficiency estimates will be developed from results observed in studies along with local experience developed from conversations with county land conservation departments (LCD) in the Green Bay drainage. Similarly, estimates of the potential loadings reductions from streambank stabilization measures will be developed based on the results of conversations with local county land conservation departments.

This paper proceeds as follows. Section 2 presents the development of the trapping efficiency estimates from VBSs. This section first presents a literature review of studies that provide VBS trapping efficiency results and a set of general conclusions and observations on the apparent sensitivity of results to watershed characteristics. This is followed by a more focused evaluation of the observed study results by first defining the critical loadings regions for sediment and phosphorous in the Green Bay watershed, determined in a previous analysis (Baumgart, 2000), in terms of those characteristics identified as having a potentially significant impact on trapping efficiency estimates. The results from those studies that provide the closest match in terms of watershed characteristics with those observed in Green Bay will then be closely examined. This section will also introduce available evidence regarding the trapping efficiencies of VBSs based on the experience with their implementation in the counties included in the Green Bay watershed. Finally caveats with regard to the interpretation of the available information will be offered. Section 3 presents the development of the percentage loadings reductions associated with streambank stabilization measures. This section will initially provide a brief summary of the types of actions that have been taken as streambank stabilization measures and then provide the estimated percentage loadings reductions based on the conversations with the county land conservation departments. Section 4 will provide a summary set of conclusions with regard to VBS sediment and phosphorous trapping efficiency estimates and percent loadings reductions for streambank stabilization measures that are most suitable for use in estimating the likely impacts of implementing these sediment and nutrient loadings control measures in the Green Bay watershed.

II. Vegetated Buffer Strips

A. General Findings from Literature Review

A review of studies which evaluated the ability of buffer strips to trap sediment and phosphorus was conducted to determine the applicability and effectiveness of vegetated buffer strips to conditions within the Green Bay Basin. The results of this review are summarized in Tables 1 and 2.[1] The original publications were reviewed whenever possible. Where available, the type of study, buffer type and dimensions, soils, trapping efficiency, and other related information are included in Tables 1 and 2 to see how the results may be applied in the Basin. For this report, trapping efficiency (TE) is defined as the amount of the constituent retained by the buffer strip, divided by the amount entering the buffer, multiplied by 100%. Buffer width is the distance, perpendicular to stream flow, between the start of the buffer near the stream bank and the up slope end of the buffer. In this report, buffer width only refers to one side of the stream; for example, a 20 meter buffer strip would actually entail a total buffer width of 40 meters if it was installed on both sides of a stream.

Farmers and resource managers often wish to know how much sediment and phosphorus export to streams can be reduced if buffer strips are installed in their area. Unfortunately, the answer is not straightforward as illustrated by the wide range of sediment and phosphorus trapping efficiencies (15% to > 90%) found in the studies summarized in Tables 1 and 2. However, some general observations can be drawn from the reviewed studies and the data summarized in Tables 1 and 2: (1) trapping efficiency was correlated with infiltration, especially for clay-sized particles and soluble nutrients (Lee et al. 1999 and 2000); (2) trapping efficiencies were lower for smaller particles (Neibling and Alberts 1979, Line 1991, Meyer et al. 1994, Dabney et al. 1994, Lee et al. 2000); (3) for VBS widths less than 17 meters, the average trapping efficiency for total suspened solids (TSS) was 75%; (4) for VBS widths less than 17 meters, the average trapping efficiency for total phosphorus was 61%; and (5) comparisons of paired VBS sets from Table 1 showed that median sediment reductions were about 1.2 times greater with buffered strips that were twice as wide (absolute difference of 11%), although greater differences were found for clay-sized particles.

Site-specific conditions and the nature of the studies may explain much of the variation in trapping efficiency. Certain characteristics such as the nature of the soil in a study area ought to be of use in estimating how effective buffer strips might be in a particular area of interest. The ability of a VBS to slow runoff and promote particle settling, the particle size distribution of the eroded soil which reaches the VBS from up slope areas, and the permeability of the soil in both

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[1] The raw data from many of these studies are reported in more than one publication or presentation.

the VBS and up slope source areas are three important factors that affect the ability of a VBS to reduce TSS and phosphorus export to streams. Other factors aside, VBS's in areas that have fine-textured soils with low permeability tend to have the lowest reduction potential for TSS and phosphorus because: (1) sediment delivered to a VBS from up slope areas, that is not suspended in a concentrated flow channel, has a greater proportion of smaller particles which are more difficult to settle; (2) runoff volumes are greater which raises water velocity and reduces the amount of time available for particles to settle; and (3) infiltration rates are lower near the stream where the soil is saturated for most of the duration of the runoff event.

B. Interpretation of literature review results, as applied to the Green Bay Basin

Characteristics of the Green Bay Basin: In the literature review, soil permeability was identified as a major factor affecting VBS trapping efficiency. Within the Green Bay Basin, fine-textured, low permeability soils are mostly found in watersheds within the Lower Fox River Subbasin, and the lowermost watersheds of the Upper Fox River and Wolf River Subbasins (Figure 1). Most of these fine-textured, clayey surficial depositss are of glaciolacustrine origin (Robertson and Saad 1995). Coarse-textured soils with the greatest permeability are primarily found along the Green Bay shoreline, and the northwestern, western, and southwestern portions of the Basin.

Baumgart (2000) applied the Soil and Water Assessment Tool model (SWAT) to simulate TSS and phosphorus export to Green Bay. The greatest yields of phosphorus and TSS were from watersheds within the Lower Fox River Subbasin as well as those surrounding Lake Winnebago. Low soil permability, agricultural or urban landuse, and proximity to Green Bay were factors that favored high contributions of TSS and phosphorus to Green Bay. The lowest TSS and phosphorus yields were from watersheds with coarse-textured soils which were furthest from Green Bay. Consequently, special emphasis will be placed on determining the potential effectiveness of buffer strips installed in areas with low soil permeability, and associated low infiltration rates.

Basis for selection of appropriate studies and recommended trapping efficiency: There are a number of reasons for not directly applying the average reduction found from the studies listed in Tables 1 and 2 for TSS (75%) and total phosphorus (61%) to estimate reductions to streams from the major contributors of TSS and phosphorus to Green Bay, including:

(1) most of the areas with the greatest contributions of TSS and phosphorus to Green Bay tend to be fine-textured clayey soil with low permeability;

(2) Meyer et al. (1994) and Dabney et al. (1994) found that VBS trapping efficiency was reduced in a silt loam soil (17-43%) with higher clay content and lower permeability compared to sandy loam (59-73%);

(3) Lee et al. (2000) found the greatest correlations between mass reduction and infiltration in buffers with clay particles ($r^2 = 0.97$) and total phosphorus ($r^2 = 0.90$), and least with sand sized particles ($r^2 = 0.65$), which suggests that infiltration may be the primary mechanism in trapping clay-sized particles and nutrients. Similar results were reported by Lee et al. (1999) in a separate study. Thus, buffers installed in soils with low infiltration rates should have disproportionally lower efficiencies in removing clay-sized particles and phosphorus than buffers installed in soils with highly permeable soils;

(4) trapping efficiencies were lower for smaller particles (Neibling and Alberts 1979, Line 1991, Meyer et al. 1994, Dabney et al. 1994, Lee et al. 2000);

(5) Hughes (1993) reported that 66% of suspended sediment in the East River was composed of clay-sized particles, 83% of the particles were less than 8 um, and 98% were clay or silt-sized particles;

(6) Wilson (1967) reported that the maximum percentage of clay-sized particles were trapped at about 350 ft. along two VBS plots fed by water extracted from the Gila River, thereby indicating that a very wide buffer might be needed to sufficiently reduce export of clay-sized particles;

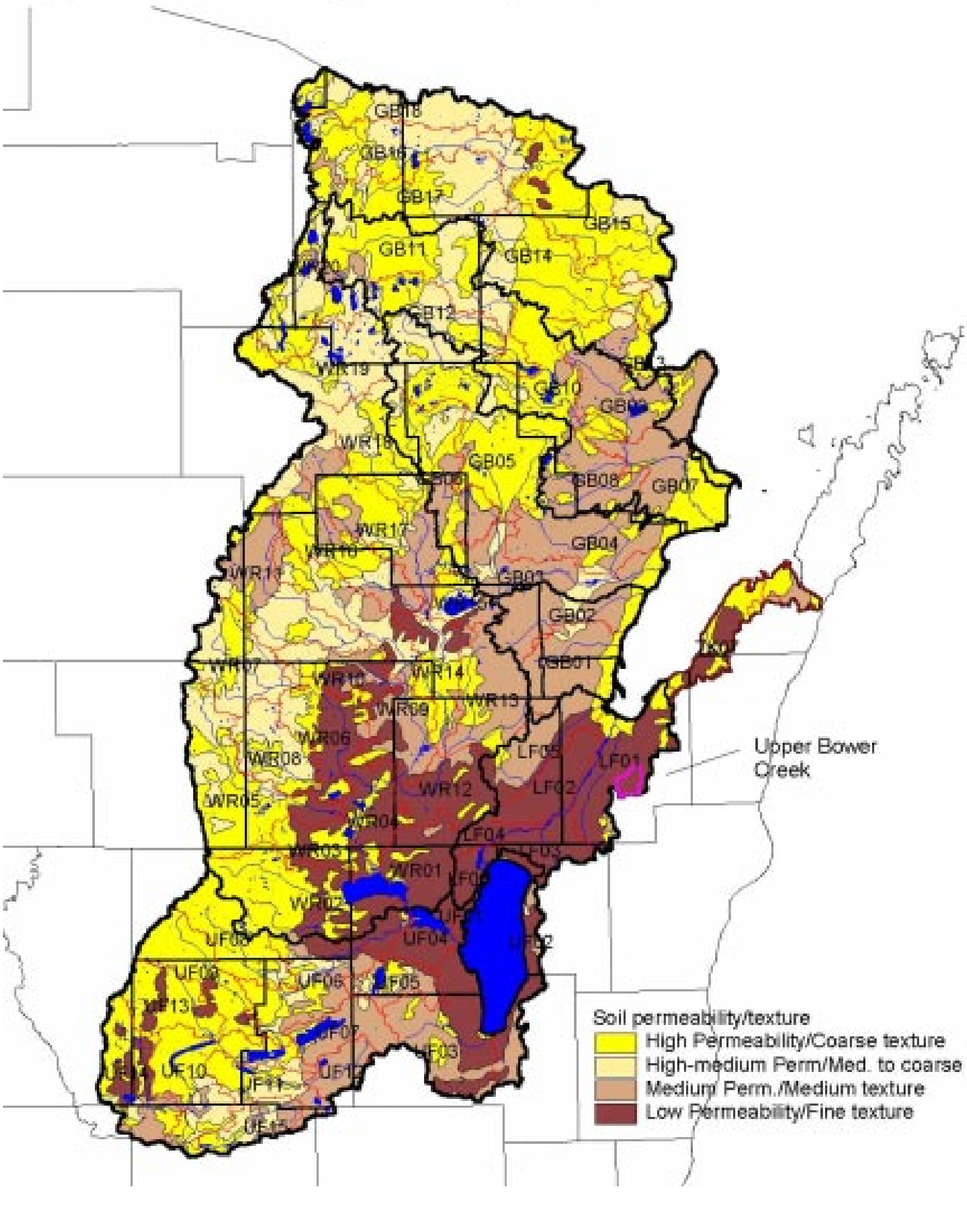
(7) in simulations with an infiltration model, Munoz-Carpena et al. (1993) found that when buffer strip flow length (i.e., width) was increased, runoff increased in clay soils, but decreased in sandy loam soils;

(8) most studies utilized bare fallow soil as the source area to the VBS, but Raffaelle et al. (1996) found that sediment reduction efficiencies with conventional till (63%) and no-till (57%) source plots were lower than with the bare fallow source plots (84%);

(9) Young et al. (1980) and Schmitt et al.(2000) reported that VBS's vegetated with standard field crops (corn or sorghum) had trapping efficiencies that were similar or better than some standard grassed VBS's, which suggests that some "buffering" capacity is already in place;

(10) the length of the sediment source area in the experimental plots (typically 22 m or less) of the studies listed in Tables 1 and 2 was much smaller than is generally found in field conditions (Dillaha 1989a);

Figure 1. Soil Permeability in Green Bay Basin.



(11) in real world conditions, selective transport of smaller particles sizes occurs as sediment is transported down slope, but experimental plots were too small to fully display this enrichment via input to the experimental buffer plots;

(12) sediment transport capacity beyond the source plot appeared to be quite low in some studies because very high TSS yields and concentrations of up to 60 MT/ha (Line 1991) and 130,000 mg/L (Robinson et al. 1996), respectively, were applied or generated from the source plot/material;

(13) effect of frozen and partially frozen soils was not investigated;

(14) effect of freeze/thaw action on early spring soil structure was not investigated in most if not all of the studies;

(15) grasses in the VBS may be flattened by snow during winter, thereby reducing the ability of the VBS to slow runoff;

(16) clay and small silt-sized particles are preferentially transported to Green Bay, where the smallest particles are easily suspended and create turbidity problems; and

(17) the studies did not directly evaluate in-stream load reductions; that is, no watershed-scale studies were found which evaluated the direct impact of buffer installation in agricultural areas on in-stream water quality.

Not unexpectedly, reduction efficiencies varied widely between different soil series, particle sizes and infiltration rates. Therefore, it is reasonable to expect that applicability to our area may be based in part on the similarity of soil types, particle sizes and expected infiltration rates. The effects of frozen soil during runoff events, freeze/thaw action on soil structure, and snow pack will not be evaluated in this report, but these factors may have a detrimental impact on VBS trapping efficiency. Only four of the reviewed studies reported the actual <u>measured</u> particle size distribution of material entering and exiting the buffer strips[2]. The results from these studies are examined more closely in the following section to provide a better means of estimating VBS trapping efficiencies than applying the average of the reductions listed in Tables 1 and 2.

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[2] Many of the studies do not actually measure the constituent concentration prior to entering the VBS. Instead, the constituent load from a plot without a VBS (control) is often compared to the plot with a VBS (treatment) to determine the relative difference.

Table 1. Summary of buffer control efficiencies found in literature review: Sediment.

Reference	Buffer Type - Upland Source	Buffer Width	Trapping Efficiency	Soil Characteristics	Other Comments
Brockway (1977)[b] irrigation studies Boise & Magic Valleys, Idaho	Buffer: blue grass Runoff source: Irrigation water over corn field ------------------ Buffer: wheat parallel to stream Source: 0.6 ha wheat plots	61 m ------------ 8 ft 16 ft	83% 1st run only -------- 60% 79%	loessal silt loam Magic Valley area has calcareous loamy subsoils, usually consists of hardpan at 60-90 cm depth	After 1st run, buffer strip was inundated with sediment and ineffective. 68-71% of irrigation water was retained.
Broderson (1973)	buffers	61 m (200 ft)	effective on steep slopes		
Cooper et al. (1987a)	cultivated agriculture source riparian forest VBS	100 m	> 50%	sandy loam	Cesium-137 tracer study.
Daniels and Gilliam (1996) North Carolina Piedmont	fescue grass buffer passive runoff and collection with buried bottles Actual rainfall (Note: data from combination of grass and riparian buffer not included here.)	3.0 m 6.0 m ----------- 3.0 m 6.0 m	52% 59% ---------- silt/clay only 41% silt/clay only 75%	Cecil sandy loam to clay loam 48-64% of the total sediment collected at field edge was silt and clay 12% clay top 11"; 27% clay below 11" [d] permeability of 102 mm/hr in top layer, 33 mm/hr in subsoil [d]	Upland bottles overflowed while those at bottom of buffer strip often had little or no water. Indicates high infiltration rates (little runoff) during study or runoff was concentrated away from buffer along its edge. Another possible problem was indicated by higher reductions for silt/clay fractions (75%) compared to total reduction (59%) at 6 meter point of buffer (although large clay aggregates may account for this). No explanation of how reductions were calculated using the bottle collection technique
Edwards et al. (1983)	fescue grass paved feedlot source	30 m	50%		Reduction based on input from settling basin, which preceded the VBS. 2nd 30 m VBS removed 45% of solids from 1st VBS

Reference	Buffer Type - Upland Source	Buffer Width	Trapping Efficiency	Soil Characteristics	Other Comments
Dillha et al. (1987; 1989)[b] Blacksburg, Virginia * simulated feedlot plot used for conc. flow reductions extensive study	trimmed 10 cm orchardgrass VBS sets of 3 - 5.5 x 18.3 m. fallow no-till corn plots * one plot served as "control" Simulated rain	4.6 m 9.1 m ------------ sim. conc. flow 4.6 m 9.1 m	70% 84% -------- simulated conc. flow 31% 58%	Groseclose silt loam (clayey, mixed) 17% clay in top 10" and 47% below 10" [d] described as "deep well drained soil with slowly permeable subsoil.. 18% sand, 59% silt, 23% clay" - Mostaghimi et al. (1994) permeability of 102 mm/hr saturated conductivity [d]	Calculated average water runoff reduction of 73% for 9.1 m plots (ave. of 2 sets of plots; other set showed more runoff from buffer strips compared to "control" plot. Indicates soils are more permeable than those in our area, variability between plots, and/or other problems. Authors noted slope length of 18.3 m in plot vs. 100 m. in typical field - overstates effectiveness under real-world conditions.
Ghaffarzadeh et al. (1992))[a or b]	grass	9.1 m and wider	85%		0 to 18.3 m were evaluated, but only data reported by Castelle (1995) is shown.
Horner & Mar (1982)	grassy swale	61 m (200 ft)	80%		
Lee et al. (2000)[b] Story County, Iowa Study conducted in October, 1997.	4.1 m by 22.1 m bare cropland source (7% slope) VBS had 5% slope simulated rainfall switchgrass ------------------------------ switchgrass/woody buffer	7.1 m switch grass ------------ 7.1+9.2 m switch grass + woody buffer	sand 82-89% silt 72-76% clay 15-49% sediment: 70% --------- sand >98% silt >93% clay 52-89% sediment: 93%	source plot: Clarion loam buffer strip: Coland silty clay loam particle size analysis conducted without chemical dispersion.	Infiltration rates very high: (no buffer 78.5% & 58.5%) 2 hour, 50 mm "rainfall" 85% (7.1 m buffer) 1 hour,69 mm "rainfall" 69% (7.1 m buffer) -- 2 hour, 50 mm "rainfall" 96% (16.3 m buffer) 1 hour,69 mm "rainfall" 79% (16.3 m buffer)
Lee et al. (1999) Story Cty, Iowa Study conducted in summer 1996.	No source plot, mixture from tank used as source to VBS. simulated rainfall switch grass; cool season mix (brome, timothy, fescue)	3 m 6 m	65.5% 76.5%		Average infiltration was 37% (6 m) and 23% (3 m); however, both simulated runoff and simulated rainfall were added to plots.

Reference	Buffer Type - Upland Source	Buffer Width	Trapping Efficiency	Soil Characteristics	Other Comments
Line (1991)[a] Panola County, Mississippi May-Aug. 1989	0.9 m wide by 9.1 m tilled source plot, plus fed by additional inflow ryegrass-fescue mixture in VBS Simulated rainfall ** NOTE: all particle size efficiencies are based on the average efficiency of the four runoff rates listed by Line (Table 3, 1991)	1.5 m 3.0 & 6.1 m ------------ 1.5 m 3.0 m 6.1 m 3.0 6.1 m	40-80% 72-95% ------------- (< 4 um) 22%** 44% 40% (16-31 um) 86% 96%	Grenada silt loam 5% slope buffer 5.3-8.2% up slope area 14% clay top 5", 27% clay below 5" 33 mm/hr saturated conductivity [d]	Particle size analysis appears to have been conducted without chemical dispersion. Inconsistencies occurred with some estimated particle size-specific reductions (e.g., negative reductions). Very high load of sediment from source plot (I calculated about 20 to 60 MT/ha for just the amount trapped, assuming 9.1 m by 0.9 m source plot, from Table 2 in Line, 1991).
Lynch et al. (1985)	buffer logging	30 m (98 ft)	75-80% ave.		
Magette et al. (1987)[b] Queenstown, MD.	22 m fallow source areas feeding fescue strips Simulated rainfall	4.6 m 9.2 m	65-72% ave. 67.8% 82-86% ave. 83.4%	Woodstown sandy loam permeability of 88 mm/hr in topsoil, 33 mm/hr in subsoil [d]	
McGregor & Dabney (1993); McGregor & Dabney, data (1994)[b] Holly Springs, Mississippi	Stiff grass hedges- *Miscanthus sinensis*, below cotton plots of 13.3 ft wide by 72.6 ft long with 5% slope Actual rainfall	single row first year of hedges ----------- July 1991-June 1994	conventional tillage: 44% no-till: 43% -------- 73% (conv.) 57% (no-till)	5% slopes of mostly Providence silt loam 8% clay in top 10", 25% clay below 10" permeability of 33 mm/hr [d]	Greater reductions were observed after 1st year of establishment. Runoff losses similar with and without hedges. High load rates of 25 t/a with conventional till w/o buffer, and 14 t/a with buffer. No-till without a hedge much more effective than conventional tillage with a hedge: soil loss with no-till without hedge (1/4 t/a) was 1/10 that of conventional till with hedge (14.5 t/a).

Reference	Buffer Type - Upland Source	Buffer Width	Trapping Efficiency	Soil Characteristics	Other Comments
Meyer et al. (1994) and Dabney et al. (1994)[c]	Stiff grass hedges: including switchgrass, vetiver, fescue and miscanthus **laboratory flume study** (i.e., no infiltration considered) Very high concentrations fed into flume (3.5-7% soil solution). 5% slope	0.2 m switch-grass 0.2 m switch-grass ----------- generalized results based on vetifer and switch-grass and different hedge widths	17-43% 25% ave. 59-73% 67% ave. ------------ 20% 20-58% 46-88% 90-100% (varies due to different flow rates)	*by Soil Series* 80% < 32 um (Grenada silt loam) (i.e., finer than 32 um) 63% > 125 um (Smithdale sandy loam subsoil) -------------------------- *by particle size* (Dubbs sandy loam) < 32 um 32-63 um 63-125 um > 125 um	Substantial difference in trapping efficiency between Grenada silt loam (25%) and Smithdale sandy loam (67%) due to particle size differences. Infiltration was not accounted for, or a larger difference would be expected. Undispersed sediments, particle size analysis conducted without chemical dispersion. All Switchgrasses performed well Fescue placed before switchgrass worked well, but fescue alone was not effective at high flow rates Ponding, not filtering was stated as primary mechanism. Well mixed soil solution added (cement mixer for 1 hour), but less than half was water.
Mickelson & Baker (1993)[a] Iowa	vegetative buffer brome, bluegrass and fescue plots Buffers fed by simulated runoff with simulated rainfall over plot	4.6 m 9.1 m	72% 76%		A tank with a mixture of water and sediment was fed into plot to simulate runoff (about 10,000 mg/L). Rainfall of 2.7 inches was less than infiltration amt. of 3.1 in. Indicates high permeability of soil and/or buffer strip. However, total infiltration (rainfall + inflow - outflow)/(rainfall + inflow) was 43.5%; inflow was 4.5 inches.

Reference	Buffer Type - Upland Source	Buffer Width	Trapping Efficiency	Soil Characteristics	Other Comments
Neibling & Alberts (1979)[b] **NOTE: trapping efficiency based on difference between "sediment discharge rates"	Bluegrass sod fed by 1.83 by 6.1 m bare soil plot. 7% slope Simulated rain of 63 mm/hr applied for two 30 min. periods.	0.6 m - 4.9 m 0.6 m 1.2 m 2.4 m 4.9 m	TSS** > 90% TSS-clay 37% 78% 82% 83%	Miami silt loam 16% clay [d] 33 mm/hr sat. cond. [d]	. No infiltration data reported. Data from "dry", "wet" and "very wet" runs were combined, and not reported separately. Determination of "sediment discharge rate" (g/m/s) not explained, nor why averaging of rates was appropriate for VBS efficiency..
Parsons et al. (1990, 1994) grass buffer[b] riparian[a] North Carolina Piedmont	grass buffer: fescue ----------------- riparian buffer: mixed hardwood pine Actual rainfall	grass 4.2 m 8.4 m ------------ riparian 4.2 m 8.4 m	grass 74% 84% ------------- riparian 78% 82%	Piedmont site: State sandy loam to sandy clay loam, and Cecil sandy loam in Wake County plots ----------------------------------- Coastal Plain site: Norfolk and Goldsboro sandy loam to loamy sand all soils except State: 102 mm/hr sat. conductivity and 10-12% clay [d] State soil: 84 mm/hr, 10% clay [d]	Results presented here are average of 1990-91 data since more recent data not published yet. Sandy soils, although some clay present in B horizon at Piedmont site. Overall results not presented in report, instead, data presented by an event basis in form of table or graph. Only outflow measured for grass buffers, but riparian buffers had both inflow and outflow monitored.
Peterjohn & Correll (1984) ** "reductions" based on surface water concen-tration change, not mass reduction	forest buffer strip Actual precipitation	19 m ~50 m	90%** 94%**		4 liter bottle collectors. Average TSS concentrations were very high (6,480 mg/L upland; 419 mg/L exiting VBS), indicating potential problems with the technique of using bottles to collect surface runoff (i.e., soil movement measured, but not neccessarily export to stream)..
Raffaelle et al. 1996[b] Holly Springs, Mississippi 1993-95 study	fallow, conventional, and no-till 3.7 m by 10 m source plots, 10% slope, bermuda grass/volunteer VBS Simulated rainfall	0.6 m	fallow 84% conventional 63% no-till 57%	Lexington silt loam	converted CRP land as source, with small strip of CRP left as VBS No-till without grass hedge had 1/4 the sediment load of conventional till with grass hedge.

Reference	Buffer Type - Upland Source	Buffer Width	Trapping Efficiency	Soil Characteristics	Other Comments
Robinson et al. 1996[b] N.E. Iowa	18.3 m fallow source plot, tilled every 3 weeks from April to August brome grass VBS Actual rainfall	3.0 m 9.1 m	> 70% > 85%	Fayette, fine silty 77% silt, 18% clay, 2% OM	High infiltration within VBS: Runoff water/rainwater ratio dropped from 0.45 in upland area to 0.06 with 9.1 m VBS during very high intensity rainfall events. Very high sediment loads (up to 27 MT/ha & 130,000 mg/L during two rainfall events).
Schellinger & Clausen (1992)[a]	fescue, ryegrass, bluegrass input: dairy feedlot, 2% slope VBS	22.9 m (75 ft)	33% ** not significant	Massena silt loam Kingsbury silty clay loam	** No significant reduction detected (P < 0.05). Reduction is combined surface and subsurface reduction.
Schmitt et al. (1999)[b] Nebraska study in July 1996 **** Relative to contour sorghum plot, in std. 76 cm (30") rows**	mixing tank source; 2 yr. old switchgrass & fescue ------------------------------ 2 yr. old grass/shrubs/trees ------------------------------ 25 yr old grass ------------------------------ contour sorghum strip	7.5 m 15 m 7.5 m 15 m --------- 7.5 m 15 m --------- 7.5 m 15 m --------- 7.5 m	84% 96% 25%** 36%** ---- 46%** 11%** ----- 77%** 82%** --------- 79%	Sharpsburg silty clay loam; surface soil varied from silty clay loam to sandy loam infiltration fairly high on 15 meter buffers: 51% to 82%; sorghum 81% & 25 yr. grass 82%	Small 3m by 7.5 m or 15 m plots; 8 plots replicated 5 times (total of 40 plots) four 19 mm irrigations prior to simulated 25 mm rainfall on buffer, plus fed by simulated runoff with representative contaminants from mixing tank TSS reduction with 7.5 m grass VBS was 79% vs 84% with contour planting.
USDA-ARS (1994)[b] note: 14 in. wide hedge 21% lower erosion than 7 in. wide hedge	soybean plots stiff grass hedges: gama grass ------------------------------- switchgrass ------------------------------- *Miscanthus sinensis*	NA	67% ------------ 62% ------------ 59%		

Reference	Buffer Type - Upland Source	Buffer Width	Trapping Efficiency	Soil Characteristics	Other Comments
Young et al. (1980)	4 m by 13.7 m feedlot source to VBS; Corn Buffer ------------------------------- Oats Buffer ------------------------------- Orchardgrass ------------------------------- Sorghum-sudangrass simulated rainfall	27.4 m 21.3 m ------- 21.3 m ------- 27.4 m ------- 27.4 m	93% 81% ------------ 75% ------------ 66% ------------ 82%		Runoff reduced 98% in corn (1st year), 66% in corn (2nd year), 81% in orchardgrass (1st year), 61% in sorghum-sudan mixture (1st year), and 41% in oats (2nd year), indicating highly permeable soils. Corn VBS (93%) outperformed orchardgrass (66%) and sorghum/sudangrass (82%) buffer strips.
African Studies cited in McGregor & Dabney (1993)	stiff grass hedges on plots of 10% slope	1.5-5 ft	approx. 67%		Water loss reduced by about 50% indicating highly permeable soils.

Table 2. Summary of buffer control efficiencies found in literature review: Phosphorus.

Reference	Buffer Type - Upland Source	Buffer Width	Trapping Efficiencies	Soil Characteristics	Other Comments
Bingham et al. (1983)	fescue grass strip, source poultry manure	13 m	25%	eroded Cecil clay loam 6-8% slope	
Cooper & Gilliam (1987b)	cultivated agriculture source riparian forest VBS	> 100 m	50%	sandy loam	Cesium-137 tracer study
Daniels and Gilliam (1996) North Carolina	fescue buffer buried bottles collect runoff	3.0 m 6.0 m	48% 66%	Cecil sandy loam to clay loam	see Table 1
Dillaha et al. (1987; 1989)[b]	orchardgrass simulated rain	4.6 m 9.1 m	61% 79%	see Table 1	see Table 1
Edwards et al. (1983)	fescue grass paved feedlot source	30 m	49%		2nd 30 m VBS removed 46% of solids from 1st VBS
Lee et al. (2000)[b] Story County, Iowa study conducted in October, 1997	4.1 m by 22.1 m bare cropland source(8% slope) simulated rainfall VBS slope 5% switchgrass ------------------------- switchgrass/woody buffer	7.1 m switch grass ------------ 7.1+9.2 m switch grass + woody buffer	"rainfall" Total P 50 mm: 68% 69 mm: 46% Ortho P 50 mm: 44% 69 mm: 28% ----------------- Total P 50 mm: 93% 69 mm: 81% Ortho P 50 mm: 85% 69 mm: 35%	source plot Clarion loam buffer strip Coland silty clay loam	Infiltration rates/losses high: 2 hour, 50 mm "rainfall" 85% (7.1 m buffer) 1 hour, 69 mm "rainfall" 69% (7.1 m buffer) -------------------------------- 2 hour, 50 mm "rainfall" 96% (16.3 m buffer) 1 hour,69 mm "rainfall" 79% (16.3 m buffer)

Reference	Buffer Type - Upland Source	Buffer Width	Trapping Efficiencies	Soil Characteristics	Other Comments
Lee et al. (1999) Story Cty, Iowa study conducted in summer 1996	mixer tank as source, rainfall simulator; switch grass;, cool season mix (brome, timothy, fescue)	3 m 6 m	37.5% 52.3%		infiltration was 37% (6 m) and 23% (3 m)
Madison et al. (1992)	grass	4.6 m 9.1 m > 9.1 m	90% 96-99% no improvement		
Magette et al. (1987)[b] Queenstown, MD. std 3 plot design	22 m fallow source areas feeding fescue strips simulated rain	4.6 m 9.2 m	23-41% ave. 30.2% 42-53% ave. 46.9%	see Table 1	see Table 1
Murdock and Capobianco (1979)	canary grass	NA	80% of available P		
Peterjohn & Correll (1984) ** "reductions" based on surface water concentration change, not mass reduction	forest buffer strip Actual precipitation	19 m ~50 m	70%** 81%**		4 liter bottle collectors. Average TSS concentrations were very high (6,480 mg/L upland; 419 mg/L exiting VBS), indicating potential problems with the technique of using bottles to collect surface runoff (i.e., soil movement measured, but not neccessarily export to stream)..
Schellinger & Clausen (1992)[a]	fescue, ryegrass, bluegrass input: dairy feedlot 2 % slope VBS	22.9 m (75 ft)	12% ** not significant	Massena silt loam Kingsbury silty clay loam	** No significant reduction detected ($P < 0.05$). Reduction is combined surface and subsurface reduction.

Reference	Buffer Type - Upland Source	Buffer Width	Trapping Efficiencies	Soil Characteristics	Other Comments
Schmitt et al. (1999)[b] Nebraska study in July 1996 **** Efficiencies relative to contour sorghum plot, in std. 76 cm (39") rows**	Mixing tank source. 2 yr. old switchgrass & fescue ------------------------- 2 yr. old grass/shrubs/trees ------------------------- 25 yr old grass ------------------------- Contour sorghum strip	7.5 m 15 m 7.5 m 15 m --------- 7.5 m 15 m --------- 7.5 m 15 m --------- 7.5 m 15 m	71% 90% -1%** -13%** --------- 17%** -53%** --------- 56%** 60%** --------- 71% 91%	Sharpsburg silty clay loam; surface from silty clay loam to sandy load infiltration fairly high on 15 meter buffers: 51% to 82%; sorghum 81% & 25 yr. grass 82%	Small 3m by 7.5 m or 15 m plots; 8 plots replicated 5 times (total of 40 plots) four 19 mm irrigations prior to simulated 25 mm rainfall on buffer, plus fed by simulated runoff with contaminants from mixing tank Contour strip as effective as 2 yr old grass strips.
Uusi-Kamppa et al. (2000) Finland	grass shrubs and trees	10 m 10 m	38% 27%	clay to clay loam	7 years of data
Vanderholm and Dickey (1978)	NA feedlots	91.5 m at 0.5% slope to 262.2 m at 4% slope	80% (nutrients and solids)		
Young et al. (1980)	4 m by 13.7 m feedlot source to VBS; Corn Buffer --------------------------- Oats Buffer --------------------------- Orchardgrass --------------------------- Sorghum-sudangrass simulated rainfall	27.4 m 21.3 m ------- 21.3 m ------- 27.4 m ------- 27.4 m	98% 74% ------------ 50% ------------ 76% ------------ 48%		Runoff reduced 98% in corn (1st year), 66% in corn (2nd year), 81% in orchardgrass (1st year), 61% in sorghum-sudan mixture (1st year), and 41% in oats (2nd year), indicating highly permeable soils. Corn VBS (98%) outperformed orchardgrass (76%) and sorghum/sudangrass (48%) buffer strips in first year.

a. Experimental design similar to that shown in Figure 2.

b. Experimental design similar to that shown in Figure 3, where runoff and sediment (and other constituents) entering the buffer strips were not measured. Instead, the amount of the constituent exiting the buffer strips was compared to the amount leaving a plot ("control") without a buffer strip to provide an estimated "reduction". This method is not entirely reliable unless there are a number of replicate plots because the variability between adjacent plots can be quite high (Line, 1991). For example, sediment load from one of the bare field plots was 2.9 times greater than the other bare field plot during the highest 1991 load event, yet for the purposes of calculating load reductions, Parsons et al. (1994) assumed that these loads represented the amount of sediment entering the grass buffer strips. Some of the cited studies did not appear to use a sufficient number of replicate plots to conduct a sound statistical analysis of the data. However, Lee et al. (2000) and Schmitt et al. (2000) both included a thorough statistical analysis of their data.

c. Laboratory flume study. Infiltration effects not accounted for.

d. Permeability and clay percentages were not provided in the study documentation, but were derived from the Soils 5 database that is provided with USDA-ARS's SWRRBWQ and SWAT models.

C. Effect of particle size distribution and infiltration on VBS trapping efficiency

This section reviews the results of four studies of buffer strips which provided particle size analysis to determine their applicability to the characteristics of the primary contributors of TSS and phosphorus to Green Bay.

Of the four reviewed studies which reported particle size analysis, only the Lee et al. (2000) paper was published as a refereed journal article, and therefore subjected to formal peer review. Of these four studies, only Lee and others reported whether there were statistically significant differences between the treatment and control ($P < 0.05$). These are not unimportant points. For example, Neibling and Alberts (1979) did not report infiltration rates, nor did they explain how they derived the "sediment discharge rates" (reported in units of g/m/s instead of mass) which were averaged for simulation runs of different runoff durations, and then used to determine the relative difference between the control (no buffer) and the treatment (with buffer).[3] Formal peer review would've likely answered these questions so their results could be better interpreted.

Flume studies conducted by Meyer et al. (1994) and Dabney et al. (1994) to evaluate the effectiveness of stiff grass hedges demonstrated that sediment size distribution usually governed trapping efficiency. Narrow grass hedges were found to have an average reduction efficiency of 25% with Grenada silt loam soils compared to 67% for Smithdale sandy loam soils, the latter having a much higher proportion of larger particles. This study also found that 20% of sediment smaller than 32 um (less than or equal to medium silt particles) was trapped by grass hedges. Simple settling theory alone was not able to account for the observed trapping of fine sediment, so flocculation and coagulation[4] were suggested as possible explanations for the greater than expected settling of fine sediments. Ponding capabilities of the grasses were observed to be the most important characteristic which affected sediment trapping. They concluded that the grass hedges did not act as a filter to stop sediment, for essentially all of the sediment that reached the

[3] Neibling and Alberts (1979) do not explain how they derived the "sediment discharge rates", which were reported in units of g/m/s. These units were directly used to determine the relative difference between the control (no buffer) and the treatment (with buffer). Three different events were simulated: 60 minute simulated rainfall ("dry"), followed 24 hours later by a 30 minute event ("wet"), followed 30 minutes later by a 30 minute event ("very wet"). Runoff duration should not be expected to be the same for all of these runs, so it is difficult to understand how and why the results from these runs were averaged to produce a single point for comparison purposes in such unusual units (g/m/s), instead of more conventional total mass units. Their study would've been easier to interpret had they presented their results from the different runs separately, and in mass units. Infiltration rates were also not reported. If this paper had been subjected to a formal peer review process, it is likely that these types of questions would've been asked. Therefore, it is difficult to apply results from this study to the Green Bay Basin without knowing whether the infiltration rates were similar to what we might expect, or equally important, knowing exactly what the presented results really measured (i.e., g/m/s averaged for different rainfall simulations).

[4] Flocculation is the process of agglomeration of small suspended particles by joining and bridging them into a larger heavier floc which can settle more rapidly. Coagulation reduces the net electrical repulsive forces at particle surfaces so that agglomeration of particles can take place more readily.

grass hedge passed through it. Instead, the sediment was trapped primarily above the hedge due to ponding and settling. Meyer et al. (1994) concluded that "For those soils that produce fine sediment dominantly in the silt and clay range, stiff-grass hedges should not be expected to trap more than 20-30% of the eroded material".

Given these results, most of the other cited sediment trapping efficiencies summarized in Table 1 would appear to be too high to be applicable to locations with soils that have high proportions of silt and clay-sized particles. Table 3 illustrates that the estimated relative buffer width required to meet a specific trapping efficiency is inversely proportional to the square of the particle size when Stokes Law is applied (Wong and McCuen (1993). In other words, the smaller the particle size, the greater the width of buffer required for trapping. Thus, very wide buffers should be necessary to trap fine clay particles.

Table 3. Example of relative relationship between particle size and required buffer width based on settling velocity and Stokes Law.

Particle class	Particle size (um)	Estimated buffer width (feet)
coarse silt	50	10
med-coarse silt	32	24
med silt	20	62
fine silt	10	250
fine silt to clay	4	1563
coarse clay	2	6250

However, these theoretical estimates do not seem to correspond well with field plot data presented by Line (1993), where about 44% of particles of 4 um or less were captured within a 3.0 m buffer strip, while 96% of the particles between 16 and 31 um were trapped within a 6.1 m buffer strip. In addition, Neibling and Alberts (1979) evaluated buffer strips fed by 1.83 m wide by 6.1 m soil plots, with simulated rainfall, and they found that 37%, 78%, 82% and 83% of clay-sized particles were trapped by 0.6m, 1.2 m, 2.4 m, and 4.9 m bluegrass sod buffer strips, respectively. Results from these two studies seem to contradict those found by Meyer et al. (1994), where even the 20% reduction obtained for particles less than 32 um was deemed unusually high compared to the theoretical value. Thus, they suggested that flocculation or coagulation could be possible mechanisms for the greater than expected settling of very fine sediments.[5] Buffer strips of substantial width combined with vegetation with many tillers would also be expected to adsorb some of the finer material onto plant stems and leaves.

[5] This flume study did not account for reduction due to infiltration, but Dabney et al. (1994) stressed that this would be minor except in highly permeable locations.

In a VBS study conducted in Iowa, Lee et al. (2000) reported VBS sediment reduction efficiencies of 82-89% for sand, 72-76% for silt, and 15-49% for clay-sized particles with a 7.1 m switchgrass VBS paired with a 4.1 m wide by 22.1 m long bare cropland source area. The lower end of the range in efficiencies reflects a higher intensity simulated rainfall of 69 mm over a 1 hour period; whereas, the higher efficiencies coincide with a simulated rainfall of 50 mm over a 2 hour period. Infiltration rates were quite high with the 2 hour simulated rainfall event: 78.5% without the VBS and 85% with the 7.1 m VBS; and somewhat lower with the 1 hour event: 58.5% without the VBS and 69% with the 7.1 m VBS. Sediment reduction efficiencies of 98-99% for sand, 94-96% for silt, and 52-89% for clay-sized particles were found for a VBS consisting of 7.1 m of switchgrass, followed by 9.2 m of woody vegetation. With the combined switchgrass/woody vegetation VBS, infiltration rates were 96% for the 1 hour event, and 79% for the 2 hour event.

These conflicting estimates of trapping efficiencies for fine soil particles by buffer strips are somewhat perplexing. One possible explanation for the wide range in estimates may be attributed to soil structure, or state of aggregation. However, none of the four studies specifically reported using chemical dispersion during determination of particle size distributions, which would have broken the aggregates down into primary particles. Instead, wet sieving combined with the pipette method seems to have been used for particle size analysis. Still, it is possible that some of the differences between the studies was due to differential breakdown of aggregates during sample collection, preparation or particles size analysis.

Sediment yields from the source plot areas utilized by Lee et al. (2000) averaged 0.484 MT/ha during the high intensity event, and 0.034 MT/ha during the lower intensity event. These yields are much closer to the average annual TSS yield that was simulated for the Upper Bower Creek (0.45 MT/ha) compared to the other studies which provided detailed particle size analysis (Neibling and Alberts, 1979, did not report sediment yields). Sediment yields of 20 to 60 MT/ha were calculated from the data presented by Line (1991) for their up-slope source plots; thereby, indicating that the soil that served as the source material to the VBS had undergone severe erosion. Such high erosion rates and resulting high sediment concentrations are subject to greater deposition due to reduced transport capacity at high concentrations; consequently, much of this sediment would settle and form deposits before ever reaching a stream, unless it enters a concentrated flow channel. The different sediment loading rates used in the experiments may explain some of the difference between the studies regarding trapping efficiencies of small particles.

Meyer et al. (1994) and Dabney et al. (1994) also applied high concentrations of sediment as source material to the grass hedge strips (3.7% and 7%), but their study utilized a laboratory flume with an artificial "up-slope" area which was not subject to infiltration effects. With regard to trapping efficiencies of small particles, the laboratory flume study of Meyer et al. (1994) and Dabney et al. (1994) seem to correspond most closely with results from Lee et al. (2000) despite the different types of VBS, and different experimental designs: no infiltration in the former study, and relatively high infiltration rates in the latter study.

In a different type of VBS study, Wilson (1967) routed river water into two large riparian VBS's and measured sediment deposition within them. Wilson (1967) stated that the maximum percentage of clay-sized particles were trapped at about 350 ft. along the test plots. Unfortunately, the percent of clay in the inflow was not reported in Wilson's paper, so the percent reduction of clay-sized particles cannot be determined directly. However, it is fairly reasonable to assume that the inflow source (Gila river water) had a relatively high proportion of clay particles, particularly since there was still a significant fraction of clay remaining in the outflow at the San Jose, Arizona station. Therefore, based upon the numbers provided by Wilson (1967), it is estimated that 9% and 15.6% of the material deposited within the first 25 ft. of the two tested buffers was composed of clay particles. It is also estimated that the percentage of clay sized material deposited within the entire 400 and 500 ft. buffer length was 18% and 26% of the total deposited material, respectively.[6] Thus, if equal proportions of the 3 measured particle size classes were in the incoming stream flow, then approximately 9-16% of the clay particles were captured within the first 25 feet of the buffer strip. This estimated percent reduction would be lower if the clay fraction was greater than 33%, and it would be higher if the clay fraction was less than 33%. Donovan (1995, 1996) stated that clay-sized particles would not be effectively removed by a VBS.

Therefore, based on the weight of evidence, the particle size-specific trapping efficiencies reported by Lee et al. (2000) were primarily relied on as a basis for estimating the ability of a VBS to reduce TSS and phosphorus export to streams and to Green Bay.

D. Estimating VBS efficacy based on particle size distribution: applying study results to Green Bay Basin

With a 7.1 m switchgrass VBS, Lee et al. (2000) reported an average sediment reduction of 70% for both the high and low intensity simulated rainfall events, which is close to the 75% average of all of the studies reviewed in this review with buffers strips less than 17 meters. Therefore, VBS trapping efficiencies that are based in part on this data set, should be fairly representative of the average VBS efficiency found in the literature review.

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[6] These estimates are based upon a power regression between the percentage of clay particles, the distance at which the depth of the deposit was measured, and substitution of a distance of one meter to find the percent of clay at a distance of zero meters.

Lee et al. (2000) found the greatest correlation between mass reduction and infiltration in buffers with clay particles (r^2 = 0.97), compared to silt (r^2 = 0.72) and sand sized particles (r^2 = 0.65); which suggests that infiltration may be the primary mechanism in trapping clay-sized particles. They concluded that the removal of clay particles and dissolved nutrients was mainly dependent on infiltration. On this basis, it would seem inappropriate to utilize trapping efficiencies that were markedly affected by infiltration rates much higher than we could expect from areas which contribute the largest loads to Green Bay. Of the data presented by Lee et al. (2000), the results reported for the higher intensity event with the 7.1 m VBS seemed most suited for application to N.E. Wisconsin because the infiltration rates more closely resemble what might be expected during significant load events from areas with the greatest export to Green Bay (hydrological group C soils, which have low permeability). Infiltration rates for the low intensity event were quite high: 79% without a VBS; 85% with the 7.1 m VBS, and 96% with the 16.3 VBS (Lee et al. 2000). These are not the conditions under which significant load events are likely to occur from those areas within the Basin which are the primary contributors. Infiltration rates during the high intensity event were somewhat lower: 59% without a VBS; 69% with the 7.1 m VBS, and 79% with the 16.3 VBS.

In Upper Bower Creek, infiltration rates during the most important TSS events appear to be lower than those reported by Lee et al. (2000) and most of the other studies listed in Table 1 and 2 (except flume studies which had no infiltration). For example, of the 56 measured events in Upper Bower Creek which were selected for later analysis by USGS (1991-96), 15 events contributed 90% of the total measured TSS event loads. During these 15 events, 408 mm of stream flow was observed compared to about 575 mm of rainfall. Roughly speaking, 70% of the rainfall during these runoff events could be viewed as contributing to stream flow. In addition, baseflow analysis of Upper Bower Creek discharge data shows that only 9% to 14% of stream flow is from groundwater recharge, the remainder is due to direct surface runoff. Importantly, soil in and near the VBS should be saturated for most of the duration of moderate and large runoff events because the VBS is at a low point where surface water and groundwater are directed. Consequently, infiltration within and adjacent to a VBS is expected to be low during the most important events; therefore, infiltration may have a negligible role in reducing TSS and phosphorus export to streams with a VBS.

Table 4 shows the particles size distribution of suspended sediments reported by Hughes (1993) for the East River (LF01). In four large volume composite water samples collected from the East River (368 km^2) , Hughes (1993) found the average particle proportions were 98% (< 0.062 mm; silt and clay); 96% (< 0.031); 90% (< 0.016 mm); 83% (< 0.008 mm); 66% (< 0.004 mm; clay-sized based on USGS definition); and 50% (< 0.002 mm, or clay).

Table 4. VBS trapping efficiency based on particle size distribution in East River and VBS efficiencies reported by Lee et al. (2000).

Particle size distribution in East River (Hughes 1993)		**Regrouped East River particle distribution**	**VBS Reduction (%)** (Lee et al. 2000) Rainfall intensity & Infiltration rates		**VBS Reduction (%)** Enriched larger sizes & trapping efficiency (T.E.) altered	
			Low intensity High infil. (T.E.)	High int./ Lower infil. (T.E.)	reapportioned particles size distribution	T.E.
98 % < 62 um	62 um < 2%	62 um < 2%	89%	82%	62 um < 4%	94%
96% < 31 um	31 um < 2% < 62 um	8 um < 15% < 62 um	76%	71%	8 um < 28% < 62um	74%
90% < 16 um	16 um < 6% < 31 um	2 um < 33% < 8 um	76%	71%	2 um < 28% < 8 um	30%
83% < 8 um	8 um < 7% < 16 um	50% < 2 um	49%	15%	40% < 2 um	15%
66% < 4 um	4 um < 17% < 8 um		-----	-----		
50% < 2 um	2 um < 16% < 4 um		-----	-----		
	50% < 2 um		-----	-----		
VBS reduction of all sediment sizes reported by Lee et al. (2000)			70%	70%	------	------
VBS estimated reductions with East River particle sizes			63%	43%	------	39%

In addition, sand sized particles (> 0.062 mm) constituted 2.2% of the sediment measured in 40 samples collected from Upper Bower Creek (35 km^2) in 1993 (USGS water year). Therefore, VBS reduction efficiencies from studies which reported particle size distributions were weighted according to these expected particle size distributions.

This distribution was combined with the VBS efficiencies of Lee et al. (2000) to calculate a weighted average trapping efficiency of 63% for the low intensity, high infiltration event, and a trapping efficiency of 43% for the high intensity, lower infiltration event (Table 4). The latter efficiency is more applicable here because the infiltration rates (see Table 1), while still much higher than expected adjacent to a stream during a storm event, are at least lower than the rates Lee et al. (2000) reported for the larger VBS or lower intensity simulated events.

Note that the East River particle size distribution shown in Table 4 indicates that there is a sharp decline in the proportion of particles greater than 8 um, which suggests that upland and channel transport processes strongly select against particles greater than this size (neglecting bed load). A similar result was found by Waterfall and Walling (1997) in the Burn River, England where the slope of the particle size distribution curves of both suspended river sediments and upland eroded/mobilized sediment were very steep (from smaller to larger particles), but started to level off at about 20 um (see figure in Appendix A). These researchers also found that the particles size distribution of eroded sediment more closely resembled that of suspended solids in the river, than the parent soil. They stated that the data suggests that coarser particles are not being eroded from the soil, and that deposition of the coarser component of eroded soil is occurring between erosion and entry into the channel.

This data suggests that applying a single VBS trapping efficiency to all particles between 2 um and 62 um may not be appropriate. In addition, USGS defines clay particles as those between 0.2 um and 4 um. Therefore, the VBS efficiencies of Lee et al. (2000) could be applied using the following alternatives: (1) all particles less than 4 um treated as clay and particles greater than 4 um but less than 62 um treated as silt; (2) all particles less than 8 um treated as clay and particles greater than 8 um but less than 62 um treated as silt; or (3) particles less than 2 um treated as clay, particles greater than 8 um but less than 32 um treated as silt, and particles between these two categories treated separately. The first alternative gives an overall trapping efficiency of 34% for the East River; whereas, the second alternative gives a trapping efficiency of 25%. The third alternative gives an overall trapping efficiency of 28%, 30%, and 31% if it is assumed that the trapping efficiency of particles between 2 um and 8 um is 25%, 30%, and 35%, respectively. The assumed trapping efficiency for sand has little impact because the proportion is low; for example, the overall trapping efficiency varied by only 2% when the sand TE ranged from 0% to 100%. The overall trapping efficiency increased by only 5% when the silt TE was raised from 71% to 100%.

Some of the aggregates that enter the stream from upland sources may break down into finer particles or aggregates before being collected from a downstream location; consequently, it will be assumed that the particles that enter the stream ought to have a greater proportion of coarser material than the suspended solids measured in the stream. On this basis, the particle size distribution indicated for the East River was altered to reflect what might be transported directly to the stream at the field edge, and therefore potentially affected by a VBS.[7] Thus, 10% was reapportioned from the fraction that is less than 2 um and 5% from the fraction between 2 um

[7]Additional selective transport processes that favor the transport of smaller particle sizes in the stream were not considered because we are primarily interested in the particles that are transported to Green Bay, so coarser primary particles that settle out are not critical.

and 8 um; from this amount, 13% was added to the larger silt fraction and 2% to the sand fraction. In addition, the trapping efficiencies of the larger particle sizes were raised slightly to better reflect other studies. This fourth alternative gives an overall trapping efficiency of 37%, 39%, and 40% if it is assumed that the trapping efficiency of particles between 2 and 8 um is 25%, 30%, and 35%, respectively. The fourth alternative with the modified trapping efficiencies and particle size distributions is shown in the last column of Table 4. Based on a literature review, Donovan (1996), of the WDNR, stated that a typical VBS should remove nearly all of the sand particles, but it would not effectively remove clay particles. The particle size-specific trapping efficiencies utilized in the fourth alternative do not appear to conflict with these findings.

For sediment reaching the VBS, the lower boundary of the particle size distribution was based on the expected particle size distribution of TSS in the East River and similar streams. As previously mentioned, the resulting lowest value for the weighted average trapping efficiency was 28% (four particle size classes were assigned and the trapping efficiency of particles between 2 and 8 um ranged from 25% to 35%). On the other hand, the estimated uppermost boundary of the particle size distribution for sediment entering a VBS should be similar to the parent topsoil; that is, no enrichment of smaller particles from selective particle transport occurs to sediment that reaches the VBS, which is not likely. If we then assume that the parent soil is a silt loam consisting of 20% sand, 35% large silt (8-62 um), 25% small silt (2-8 um), and 20% clay-sized particles in the top horizon, the highest weighted average trapping efficiency is 56%. Given the assumptions used in this analysis, the trapping efficiency value of 39% that was determined with the fourth alternative is near the middle of this range of potential values.

Recommended trapping efficiencies: The overall VBS TSS trapping efficiency determined for the fourth alternative is therefore selected as the preferred estimate for areas with hydrologic group C soils, such as those that contribute the greatest proportion of TSS and total phosphorus to Green Bay. This value is rounded to 40% for TSS. To reflect the expected lower reduction for total phosphorus that was found in VBS studies that evaluated both phosphorus and TSS trapping efficiencies, the VBS trapping efficiency for phosphorus could be proportionally reduced to 32%. However, phosphorus is expected to preferentially sorb to small particles, which has been accounted for in the assumed particle size distribution. Consequently, the selected trapping efficiency for phosphorus is raised slightly to 35%. Because soluble phosphorus is not expected to be reduced much when infiltration is low, the actual reduction of total phosphorus could be lower if the proportion of soluble phosphorus in runoff is high. Areas dominated by hydrologic group B soils should expect a greater reduction due to increased infiltration (perhaps 40% for phosphorus and 45% for TSS). When site-specific reduction estimates are determined, an additional reduction should be credited to the VBS for land taken out of production within the areal extent of the VBS, so the combined effect of a VBS in reducing TSS and phosphorus loads will be somewhat greater than the values recommended here.

Local estimates of trapping efficiency: The Duck, Apple and Ashwaubenon Creeks Priority Watershed Project (WDNR 1997) utilized a 50% trapping efficiency for TSS and total phosphorus to credit VBS's installed within these watersheds. According to the Project's Plan, reductions could only be credited to areas where sheet flow occurs. Manitowoc County estimated a weighted average VBS sediment trapping efficiency of 58% for the Branch River, which was based on the particle size composition of a Kewaunee Loam soil (assumed 47% clay, 28% silt, 25% sand) and assumed trapping efficiencies of 40% for clay, 60% for silt, and 90% for sand-sized particles (Brown County LCD 1995).[8] A portion of the Branch River Watershed is located in Brown County, but the watershed is just outside of the project area (adjacent and southeast of the East River Watershed, LF01). Donovan (1996), of the WDNR, estimated a sediment removal rate of 46% for the Branch River Watershed, which was midway between the range of 42% to 50% which he had estimated earlier for the same watershed (Donovan 1995). Based on a literature review, Donovan (1995, 1996) also concluded that clay-sized particles would not be effectively removed by a VBS. The Brown County LCD (1999) has estimated a 70-80% sediment trapping efficiency based on the removal rates reported for buffer strips less than 19 m in a literature review conducted by Desbonnet et al. (1994), as well as many other supporting documents (Brown County LCD 1995).

The 50% trapping efficiency utilized by the Duck, Apple and Ashwaubenon Creek Priority Watershed Project (WDNR 1997), and the 42% to 50% removal rate estimated by Donovan (1995, 1996) for the Branch River Watershed are both fairly close to the trapping efficiency recommended in this report for TSS in areas with Group C soils, especially after the reduction due to land taken out of production by the VBS is factored into the recommended value. The 70-80% reduction estimated by the Brown County LCD (1999) is considered too high for reasons already stated in this report (i.e., small scale of experimental plots, low infiltration rates, and the nature of the particles expected to be delivered to the stream). In addition, an average VBS trapping efficiency of 25% was determined by Meyer et al. (1994) and Dabney et al. (1994) for Grenada silt loam soil compared to 67% for sandy loam. The former soil is more representative of important contributing areas to Green Bay, so the trapping efficiencies recommended in this report do not appear to be conservative.

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[8] A "loam" or "silt loam" soil by definition must contain about 27% or less clay. It appears that the particle size composition of the "Loam" soil was the composition of the subsoil, and not the surface layer. However, a silt loam soil consisting of 20% clay, 80% silt and 20% sand has a weighted average trapping efficiency 62% which is nearly the same as the "Loam" soil. Importantly, this method of calculating weighted average trapping efficiencies wrongly assumes that sediment entering the stream is the same as the parent material.

There is also evidence that strongly suggests that the practice of using bare fallow source areas as the source material in experimental VBS studies exaggerates the reductions we might expect when agricultural crops are planted next to a VBS. For example, most studies utilized bare fallow soil as the source area to the VBS, but Raffaelle et al. (1996) found that sediment trapping efficiencies with conventional till (63%) and no-till (57%) source plots were lower than with the bare fallow source plots (84%). Young et al. (1980) also reported lower reductions for a 27.4 m corn VBS (TSS 93%; total P 98%), compared to an orchardgrass VBS (TSS 66%; total P 76%), or a sorghum-sudangrass VBS (TSS 82%, total P 48%).[9] Schmitt et al. (2000) found that the TSS trapping efficiency from a 7.5 m contour sorghum strip (79%) was nearly the same as with a 7.5 m grass VBS (84%). Therefore, it appears that reported trapping efficiencies for buffer strips fed by bare source plots, which includes the study by Lee et al. (2000), would have been lower if the source area had been cropped during the growing season. Consequently, in areas with hydrologic group C soils, the recommended VBS trapping efficiency of 35% for phosphorus, and 40% for TSS, are believed to be more realistic than the higher values that were estimated by the local Land Conservation Departments.

Recommended minimum buffer widths: Reducing the export of small particles to streams is of greatest concern; therefore, minimum buffer widths of 18 meters (60 ft) are recommended for areas with hydrologic group C soils (low permeability) where runoff is higher and infiltration near the VBS may be negligible during the most important runoff events. A minimum buffer width of 12 meters (40 ft) is recommended for type B and more permable soils. Type A soils are not expected to contribute substantial amounts of TSS or total phosphorus to Green Bay. These recommendations are based solely on water quality, as well as a trade-off between cost effectiveness and expected VBS reductions with a larger VBS. Habitat considerations may require a larger VBS.

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[9] For at least the headland rows, row crops such as corn are planted parallel to the stream, which is essentially along the contour. This practice produces small ridges and valleys that serve to slow down runoff and capture sediment, and this effect can be enhanced by a row cultivator. However, the trapping ability is not likely to be as great as ridge-till or rough chisel plowing along the contour.

E. Application of VBS trapping efficiencies to watershed scale: drainage area effectively treated by buffer strip - VBS impact zone/catchment area

Just as it would not be prudent to assume that pollutant reductions obtained from small-scale wastewater treatment studies are valid when applied to un-tested full scale operations, it is equally inappropriate to directly transfer VBS reductions based on small-scale experimental plots to what we might expect in a watershed. Figures 2 and 3 illustrate typical study designs used by researchers listed in Tables 1 and 2. The superscript next to each reference in these Tables identifies the type of study design. Importantly, the up-slope boundary of the source plots limits the amount of runoff and sediment load that reaches the VBS in study designs that are similar to that shown in Figure 3. Obviously, the scale of these experimental source plots is not representative of actual field and watershed conditions. Study designs that utilize small plots can provide much needed information, but they do not permit studying the effect of extensive rills, concentrated flows, potential breakthroughs, and other macro-scale phenomenon on buffer efficiency. Sediment transport over the short distances utilized in these plots will also be different than what we might expect under real-world conditions where enrichment of finer particles occurs as sediment is transported down slope. In-stream studies such as a paired watershed study design would provide answers that are more directly transferrable to the watershed scale.

As previously stated, for VBS widths less than 17 m, the average trapping efficiency of the studies listed in Table 1 was 75% for TSS, and the average trapping efficiency of the studies listed in Table 2 was 61% for total phosphorus. However, applying these trapping efficiencies or the previously recommended efficiencies directly to the watershed scale is inappropriate in most cases. For example, Dillaha et al. (1986a) found an average reduction in sediment of 91% for a 9.1 m buffer strip; however, they expressed a number of reservations about extrapolating experimental study results directly to the field lest we expect too much from buffer strips:

- Dillaha et al. (1986a) reported that deviations from shallow sheet flow resulted in a 40% to 95% reduced efficiency of sediment, nitrogen and phosphorus removals.

- Dillaha et. al (1986b,1989b) conducted a study of existing buffer strips in Virginia and found that VBS in hilly areas were ineffective because the drainage became concentrated and inundated the VBS, resulting in very little observed sediment deposition. However, these VBS's were still judged to be beneficial because they provided effective cover in the area adjacent to the stream which is ordinarily susceptible to channel and gully erosion.

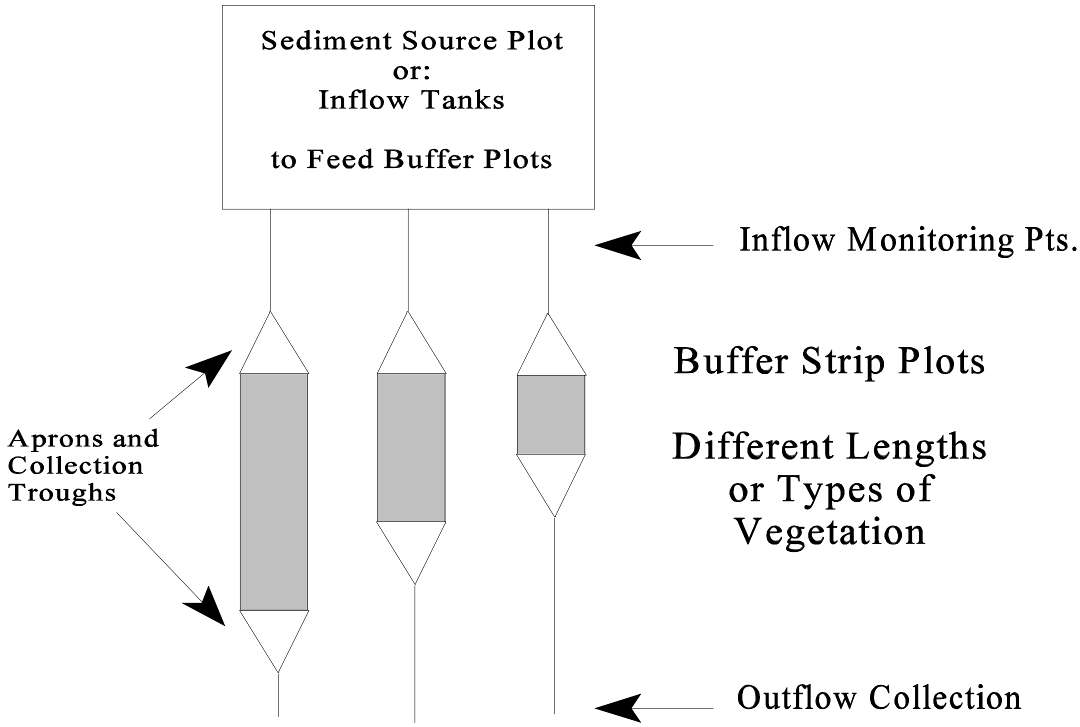


Figure 2. Typical experimental plot, study design type 1.

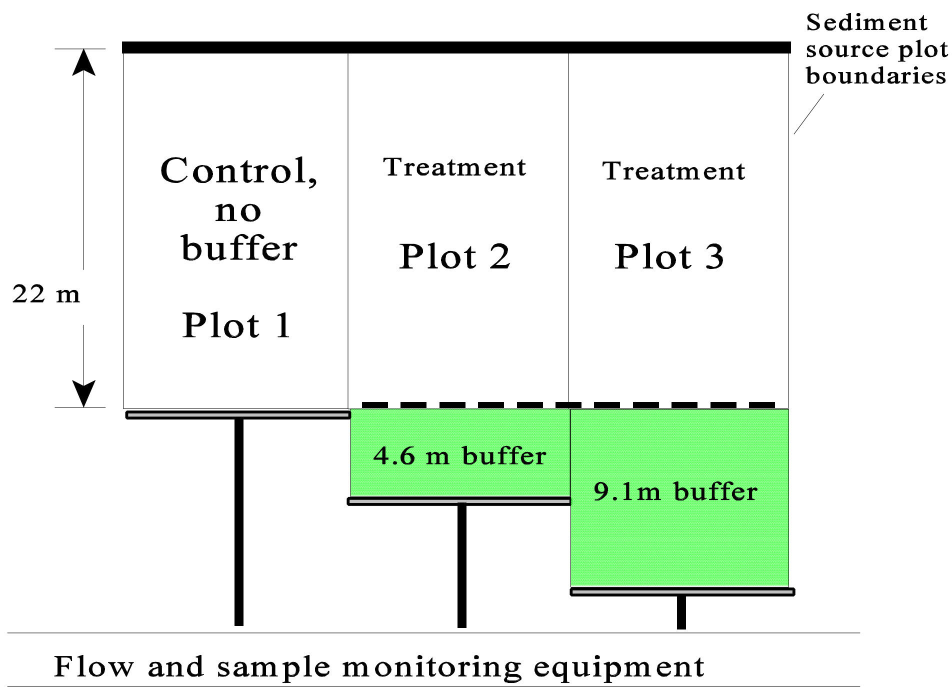


Figure 3. Typical experimental plot, study design type 2.

- Dillaha et al. (1987) stated that "Observation of existing cropland buffer strips were not likely to be as effective as experimental field plots because of problems with flow concentrations."

- Dillaha et al. (1989a) re-emphasized that field plots do not duplicate field conditions. The most significant difference is that cropland will have larger up slope areas (comparted to 22 m or less in typical field plots) contributing to runoff, thereby concentrating the runoff into narrow channels that will cross the buffer strips in narrow areas, and reducing the effectiveness of the buffer strips under real conditions.

- In a report for the Chesapeake Bay Program, Dillaha et al. (1987) described an approach which can be used to provide rough estimates of VBS performance in an actual field using topographic field data. Regression equations derived from small experimental VBS plots were used to estimate VBS performance under field conditions. They used a hypothetical field to illustrate that a reduction in TSS of 78% might be expected if the effects of drainage ways are neglected and all the flow from the field is assumed to flow across the VBS as shallow sheet flow. However, when their recommended method of accounting for concentrated flows was used, they obtained a reduction of only 17%.

- Dillaha et al. (1986b,1989b) evaluated existing buffer strips in the field. They noted that runoff tended to flow parallel to the buffer until it crossed a low point as concentrated flow when the buffer had accumulated sediment to the point that it was higher than the adjacent field. Unfilled moldboard plow furrows at the boundary between the buffer and up-slope area also served as concentrated flow paths that diverted runoff from the buffer until it crossed at a low point where it often formed gullies through the buffer strip, thereby nullifying the buffer's effectiveness.

- Dillaha et al. (1987) concluded that the majority of existing cropland VBS's which were visited "were judged to be ineffective for sediment and nutrient removal. The majority of flow entering the buffers was judged to be concentrated because runoff tended to accumulate in natural drainage ways long before reaching the VFS."

Therefore, scale is an important characteristic to consider when applying VBS trapping efficiencies to determine reductions in TSS and phosphorus export to Green Bay. Of those studies that evaluated the ability of VBS's to reduce pollutant loads from upland areas, none were found which were based on actual in-stream water quality measurements. However, two paired watershed studies are underway which look at the effect of restoring the riparian area by keeping cattle out of the stream for a set distance (Galeone 1999, Vermont DEC 2000). Studies of this nature should be conducted to evaluate the effectiveness of VBS to reduce upland pollutants (i.e., not just focus on stream bank problems primarily caused by cattle). Until such work is completed, various methods are necessary to extrapolate results from small experimental plots to the watershed scale[10], such as that recommended by Dillaha (1987) in a report for the Chesapeake Bay Program. Therefore, different methods were utilized in this project to extrapolate the results from studies involving small experimental plots and apply them to the subwatershed scale.

To estimate the effectiveness of a VBS in removing material from upland sources, the characteristics and amount of the material entering the buffer strip must first be determined. The characteristics of the sediment with regard to particle sizes has already been estimated earlier in this report. The drainage area which flows directly into a given stream segment from adjacent upland sources (i.e., not from upstream) is critical to understanding the amount of material which enters the VBS, and therefore the potential reduction from the VBS. For example, a riparian buffer strip along the Fox River will affect sediment from upland areas that are directly adjacent to the river, but it won't remove sediment coming from major tributaries like the East River. Similarly, a buffer strip along an intermittent or perennial stream cannot adequately trap sediment that reaches the stream in channelized or concentrated flow from upland areas (Dillaha et al. 1989a and 1989b). Not all of the surface water runoff from a 40 acre farm field flows directly to a stream: some may go to a road ditch, some may flow toward a natural drainage way in the field before it exits the parcel and eventually reaches a stream, some may go to a wetland and be lost as a surface runoff source, and some of the runoff may flow directly to a stream as dispersed, non-channelized flow. If VBS's are installed solely on streams, then pollutant loads that enter streams from road ditches and natural drainage ways in the field cannot be credited as being reduced.

Four alternative methods for determining the typical drainage area of a VBS were evaluated. This drainage area is the amount of upland area that drains through a specified length of riparian buffer strip (i.e., hectare of upland area per kilometer of stream), and it can also be thought of as the "effective" drainage area of a VBS, or the drainage area that is effectively influenced by the VBS. Each method was applied to the Upper Bower Creek subwatershed because the stream density is not unusual, and this subwatershed is fairly representative of both the Lower Fox

[10] Some upland BMP's such as conservation tillage are different because the effectiveness can generally be applied at different scales, so a simple percent reduction obtained from a small plot may be applied to a watershed scale with some form of safety factor and certain precautions. By protecting the soil surface, conservation tillage reduces the formation of concentrated flow channels (shallow rills to deep gullies), which otherwise promote greater sediment transport over large distances. However, other BMPs such as grass waterways, VBS, streambank stabilization are far more spatially sensitive; that is, their location largely dictates how effective the BMP is in reducing the total pollutant load that enters a stream.

Subbasin and the northern portion of the Upper Fox Subbasin, both of which are large contributors of TSS and phosphorus to Green Bay.

<u>Alt. 1: Main stream network (i.e., 1:24k stream network):</u> In this alternative, it is assumed that the stream network from the 1:24k hydrological stream network effectively filters constituent loads from the entire subwatershed (Figure 4). Only the stream length indicated in the 1:24k hydrological layer is therefore considered in this method (57,484 m). The total subwatershed area is 3,426 ha. The area used here is less than the 3,560 ha utilized elsewhere in this project because the watershed delineator utilized in Alternatives 3 and 4 decreased the subwatershed boundary slightly.

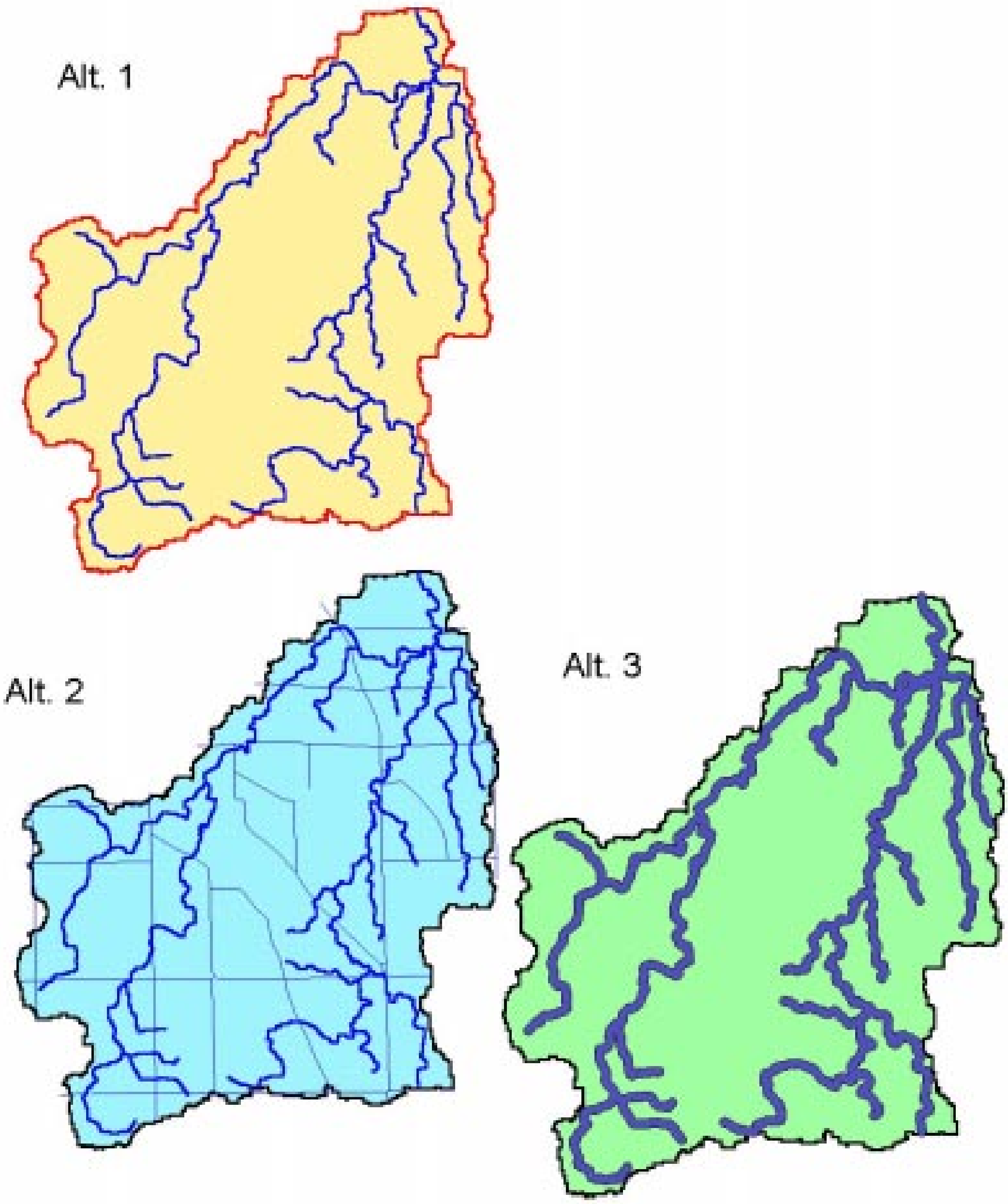
Therefore, the average stream length to drainage area ratio for the VBS is 16.8 m/ha with this method (57,484 m/3,426 ha). That is, with the assumptions used in this method, 17 meters of stream length are required to effectively buffer one hectare of upland area within this subwatershed. In English units, the stream length to catchment area ratio is 22 ft/acre. Put another way, the catchment area to stream length ratio is 59.6 ha per kilometer of stream (3,426 ha/57,484 m * 1,000 m/km), which is about 298 meters on each side of the stream if the drainage area is an ideal rectangle split evenly between both sides of the stream (59.6 ha/km * 1 km/1000 m * 10,000 m^2/ha, divided by 2). This distance (298 m in this example), will be referred to as the effective average VBS slope length, which is specific to each method, and it shall be used as a criteria to assess the merits of each alternative method.

It is not reasonable to expect that a VBS could effectively treat runoff 300 meters or more from the stream because it would channelize, so this method does not yield acceptable results. The effect of existing riparian VBS's are ignored at this point in the analysis, but will be discussed later.

<u>Alt. 2: Combined main stream network (i.e., 1:24k stream network) and road ditches:</u> In addition to the streams indicated by the 1:24k hydrological layer, road ditches also play a major role in removing runoff. In fact, the road network in the Upper Bower Creek subwatershed is equal in length to the stream length delineated in the 1:24k hydrological layer, so the combined network is theoretically twice as large as the 1:24k stream network.

The same analysis that was conducted in Alternative 1, was performed with a stream network that consisted of the road ditches merged with the 1:24k stream network (Figure 4). The combined length of the road ditches and stream lengths indicated in the 1:24k hydrological layer is 111,100 m. Therefore, the average stream length to catchment area ratio is 32.4 m/ha. Thus, under the assumptions used in this method, 32 meters of stream length per hectare of upland area are required to effectively buffer the entire load from the subwatershed. This analysis assumes

Figure 4. Alternatie methods for determining VBS - influenced zone.



that all of the road ditches drain runoff to the stream, which is probably not entirely true. In addition, streams are more likely to intercept runoff from upland areas than road ditches because streams tend to be at the lowest point; whereas, road ditches are artificially placed in the landscape. If road ditches are one half to three quarters as effective drainage ways as streams, then 24.6 to 28.5 meters of stream length per hectare of upland area are required to effectively buffer the entire load from the subwatershed under the assumptions utilized in this method.

Therefore, average stream length to catchment area ratio is 26 m/ha with this method; or conversely, 38.5 ha per kilometer of stream. The average effective VBS slope length with this method is therefore 192 meters, so this method does not yield reasonable results because concentrated flows are expected to form at much shorter distances.

Alt. 3: Impact Zone adjacent to VBS: In this method, a zone on each size of the VBS is assumed to be effectively treated by the VBS. The dimensions of the zone are determined by the maximum distance beyond which concentrated flow is assumed to likely occur. For this example, a slope length of 61 meters (200 ft) will be assumed to define the dimensions of the zone around the VBS, and this area is shown in Figure 4. This method is similar to that used to assess the cost-effectiveness of VBS's by the Rock River Partnership, in southern Wisconsin (draft Economic BMP Spreadsheet), although the load calculations are different. The underlying rationale is that on average, constitiuent loads beyond the specified distance from the stream, in this case 61 m. (200 ft), must enter the stream via a concentrated flow channel or drainage way, so the buffer strip should only be expected to filter runoff from areas that are within this distance. In truth, concentrated flow may occur in shorter distances, which reduces VBS effectiveness; conversely, VBS effectiveness is increased when some of the constituent load from distances greater than 61 meters away reaches the VBS in a manner that can be trapped by the VBS.

The assumptions used in this method are: (1) 61 meters (200 ft) on each side of the VBS is assumed to be effectively treated by the VBS, and (2) 57,484 meters of stream length exist in the subwatershed, as indicated by 1:24k hydrological GIS layer. By applying a GIS buffer command with these assumptions, the area within the subwatershed that is effectively treated by the VBS is 633 ha with this method.

Therefore, the average stream length to catchment area ratio is 91 m/ha with this method (57,484 m/633 ha), or conversely, 11 ha per kilometer of stream. That is, with the assumptions used in this method, 91 meters of stream length are required to effectively buffer one hectare of upland area within this subwatershed. The average effective VBS slope length with this method was assumed to be 61 m (200 ft), but back-calculating yields a slope length of 55 m (180 ft).

An assumed 76 m (250 ft) slope length would have yielded an average stream length to catchment area ratio of 73.4 m/ha (57,484 m of stream length divided by 783 ha, which is the GIS-based area within 76 m of the stream).

Alt. 4: Extended watershed delineation: In this method, a detailed watershed delineation of the Upper Bower Creek subwatershed was conducted to better estimate the amount of TSS and total phosphorus that real-world VBS's might intercept. By extending the drainage network beyond that delineated in the 1:24k hydrological GIS layer, I was able to roughly estimate the direct drainage area emptying to each stream segment, which is a potential candidate for a VBS. This method of applying experimentally-based reductions from small plots to a watershed/field scale is similar to that recommended by Dillaha (1987) in a report for the Chesapeake Bay Program, although Dillaha coupled the delineation with a regression model, which was based on reductions from experimental plots.[11]

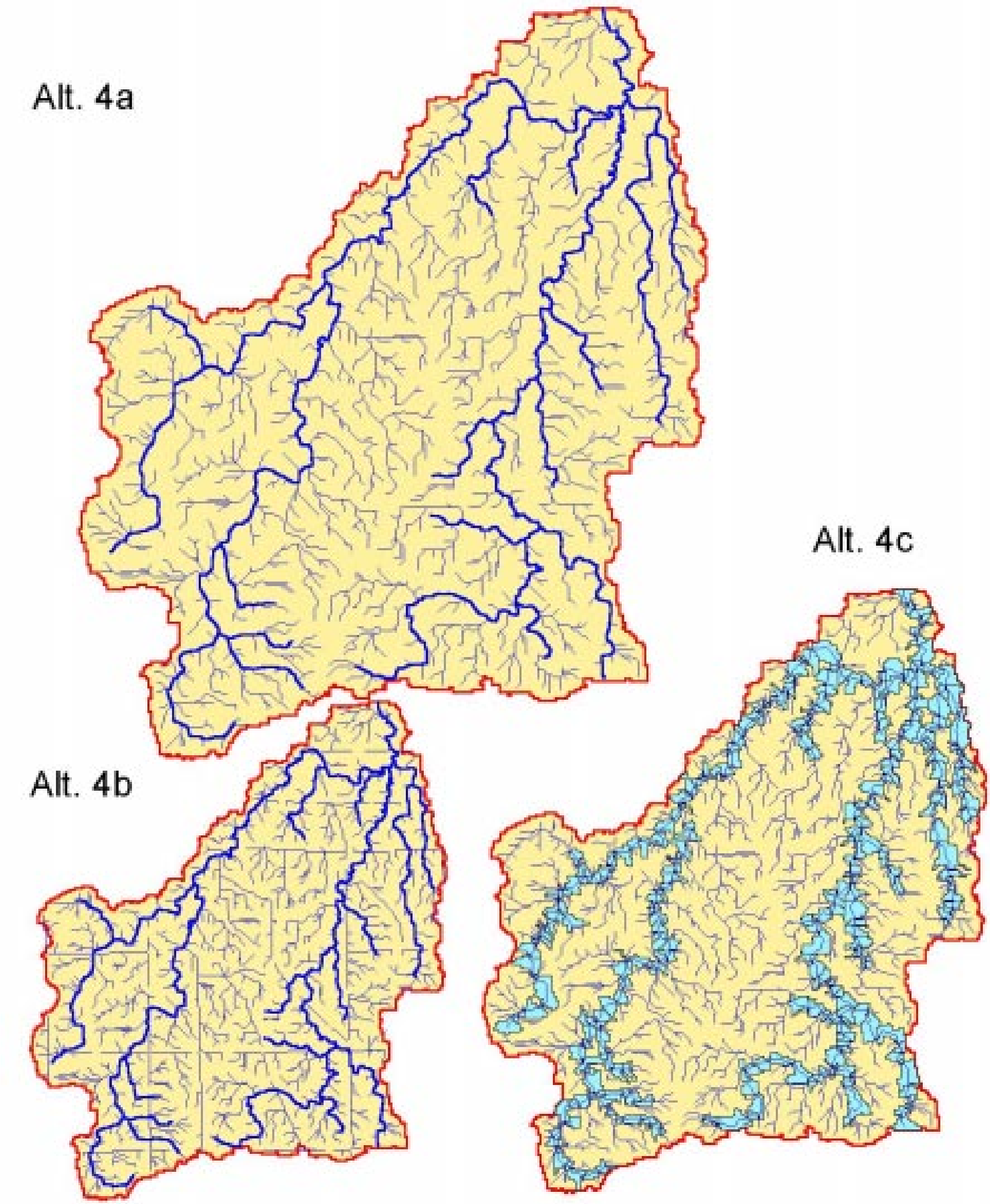
The same digital elevation model (DEM) that was used to derive the overland slope values in the SWAT simulations (Baumgart 2000) was used to perform the extended watershed delineation. A DEM, is a raster-based GIS layer with an average elevation for each grid cell. Importantly, the vertical resolution of the DEM (derived from 10 foot contours), and possibly the horizontal resolution (30 meter grid cells), are not ideally suited for this task. However, no other source of DEM's were readily available from the Lower Fox River subbasin which were from agricultural areas and had better resolution.

Based on the GIS-extended watershed delineation shown in Figure 5, the average drainage area of the polygons in the delineated subwatershed was 2.16 ha (total subwatershed area divided by the number of polygons), or 5.3 acres. The same average drainage area (2.2 ha) was found for the polygons directly adjacent to the main tributary, which would be the areas affected by a VBS installed on only the main tributary in the UBC subwatershed. The total length of the combined stream and extended drainage network was 236,965 meters. Therefore, the average stream length to catchment area ratio is 69 m/ha with this method; or conversely, 14.5 ha per kilometer of stream. The average effective VBS slope length with this method is therefore 72 meters (237 ft). This method (Alt. 4a) yields results that are similar to Alternative 3.

This same analysis was conducted with a stream network that consisted of the road ditches merged with the extended drainage network (Figure 5, Alternative 4b). The effect of merging these two types of surface water drainage was to reduce the average drainage area to 1.94 ha, but the total length of the stream network associated with the extended delineation process was

[11] In the example used by Dillaha et al. (1987), the reduction associated with the VBS was assumed to be negligible when flow rates exceeded 1.8 L/s-m for sediment and 1.3 L/s-m for total phosphorus (i.e., channelized flow).

Figure 5. Alternatie methods for determining VBS - influenced zone.



basically the same as without the road network. As a result, essentially the same stream length to drainage area ratio was determined with the combined stream and road ditch network (70.3 m/ha); or conversely, 14.2 ha per kilometer of stream.

If only the 1:24k hydrology network is considered, the drainage area that primarily drains directly into this stream network without becoming channelized can be estimated by selecting those polygons that are adjacent to the stream, but do not have major drainage channels that are distinctly separate from the 1:24k network. The result of this approach (Alt. 4c) is the effective drainage area of a potential VBS, which is shown in Figure 5. The total effective drainage area is 740 ha, or approximately 22% of the subwatershed area. Therefore, the average stream length to catchment area ratio is 67 m/ha with this method; or conversely, the effective drainage area is 13 ha per kilometer of stream. The average effective VBS slope length with this method is therefore 65 meters (213 ft). This method yields results that are similar to alternative 3. The total area affected by a VBS would be larger if road ditches had been included and the 1:24k stream network had been extended to channels that required a VBS; however, the stream length to catchment area, effective drainage area and effective slope length would probably be similar to those found in Alternatives 3, 4a and 4b.

Area effectively influenced by VBS -- conclusions: Similar results were found with Methods #3 and #4: (1) average stream length to drainage area ratios ranged from 67 m/ha to 90 m/ha, (2) average effective drainage area to stream length ratios ranged from 11 ha/km to 14.5 ha/km, and (3) the average effective slope lengths ranged from 61 to 90 meters. These two methods are believed to provide the most reasonable estimates of parameters that can be used to estimate the effective drainage area for a given length of buffer strip in Upper Bower Creek and similar areas. However, the change in landuse within the area covered by the VBS offers additional benefits, and it should be accounted for when determining the potential of a VBS to reduce TSS and phosphorus export from a watershed.

Other considerations -- VBS versus conservation tillage: McGregor and Dabney (1993, 1994) found that in cotton plots 13.3 ft wide by 72.6 ft long, sediment yields from conventional-till small plots averaged 25 t/ha, compared to 14 t/ha with grass hedges. However, soil loss from no-till plots without grass hedges was much lower (1.4 t/ha), and even lower with grass hedges (0.8 t/ha). In a similar study, Rafaelle et al. (1996) found that average soil losses from no-till corn plots with a grass hedge (0.3 t/ha), and without a grass hedge (0.7 t/ha), were much lower than conventional till corn plots with a grass hedge (2.74 t/ha). Results from these studies do not support replacing BMPs like conservation tillage with a VBS, or relying solely on a VBS to reduce TSS and phosphorus export from upland cultivated sources.

F. Further Research Recommendations for Buffer Strips

Applying results from studies of small buffer strip plots in other areas of the country with different soils and climate to what we might expect to occur on a watershed scale in N.E. Wisconsin must be done with great caution. Application of buffer strips or other conservation techniques as tools that can be used to cost-effectively reduce pollution at the watershed level requires that their effectiveness in reducing sediment and phosphorus export to streams be clearly demonstrated at the appropriate scale. After reviewing a number of different vegetative buffer study designs, we believe that a study that involves in-stream monitoring in a watershed context is needed to better assess the impact of buffer strips on water quality. Small field plots cannot adequately assess what is actually prevented from reaching the stream when buffer strips are installed.

U.S. EPA has approved of three in-stream monitoring designs that can be used to evaluate the effectiveness of BMP's and other management techniques under the Section 319 National Monitoring Program: (1) upstream-downstream study design; (2) single downstream station study design that uses a before versus after BMP implementation comparison; and (3) a paired watershed approach (Osmond et al. 1995). If two or more watersheds can be found that match well, the paired watershed design is arguably the most robust method because climatic and temporal variations are factored out, and upstream background concentrations are not a concern with this study design (Osmond et al. 1995).[12]

Encouraging results have been reported for at least two paired watershed studies currently underway which come close to studying the effectiveness of VBS's on stream quality, but these studies primarily focused on evaluating the effect of streambank fencing and other strategies to keep cattle out of streams dominated by pasture use. That is, the primary mechanism studied is not filtering of upland sediments and nutrients; rather, it is the stabilization of stream banks and removal of manure from the stream and near-stream areas by excluding dairy animals from the stream. With calibration of the paired watersheds completed, Galeone (1999) reported that the

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[12] The concept behind the paired watershed approach involves evaluating the change or lack of change in the relationship between two or more nearby watersheds after the management in one watershed has been altered. During the first part, or calibration period of the study, no major management changes are made in either watershed, and a statistical relationship is established between the watersheds. As the intensity of rain storms increase or decrease, it is expected that both watersheds will show a similar response. If this is not the case, then the watersheds should not be used in this type of study design. The calibration period may take two to three years depending on weather and how closely the selected watersheds match up. After it has been determined that enough runoff events have occurred to establish a sufficient background data set, the management of one of the watersheds will be altered to determine if the relationship between the untreated watershed (control) and the treated watershed (treatment) changes as a result of BMP implementation. With the paired watershed design, the effect of BMP's are more readily isolated because climatic and other temporal variations are factored out to a large degree. A more thorough discussion of the paired watershed study design is described by U.S. EPA (1993).

pretreatment relation between treatment and control basins in his study would need to change by only 9% for storm events to be able to detect a significant change in total phosphorus as a result of treatment. A change of 24% would be required to detect a significant change in total phosphorus during low flow. In this study, 70% of the land adjacent to the streambanks were used as pasture; clearly, the results will not be transferrable to areas with water quality problems that are mostly attributed to upland agricultural practices. The magnitude of TSS yields (> 2 MT/ha) indicates that substantial streambank erosion is occurring, given that pastured land should not normally contribute such high loads.

In the Lake Champlain Basin Watersheds Section 319 NMP Project, a paired watershed study was conducted to evaluate the effectiveness of livestock exclusion, streambank protection, and riparian restoration practices in reducing runoff of sediment, nutrients and bacteria to streams (Vermont DEC 2000). Two treatment watersheds and one control watershed are being used to study the effects of treatment. This study has been ongoing since May, 1994, and has been in the treatment phase since Nov, 1997. Statistically significant reductions were reported in the second treatment year (year 6) for total phosphorus and TSS export. Reductions in the second treatment year of 32% for TSS export, and 46% for total phosphorus export were estimated by comparing the observed mean values to values predicted by the calibration regression models.

While the final results of these studies will not be directly transferred to other sites, they will at least provide boundaries for evaluating the effectiveness of the streambank controls that were implemented. In particular, the second study seems to clearly indicate that stabilizing the streambank and limiting cattle access has substantially reduced export of TSS and total phosphorus to the stream.

Until these type of real-world studies are completed for vegetated buffer strips, we cannot reliably predict the effectiveness of installing riparian buffer strips at a watershed scale. However, the recommendations outlined in this report provide a reasonable method to estimate expected reductions on a watershed scale.

G. Conclusions and recommendations for estimating the effectiveness of VBS's to reduce TSS and phosphorus export to Green Bay

- The average reduction found from the studies listed in Tables 1 and 2 for TSS (75%) and total phosphorus (61%) are inappropriate to estimate reductions to streams from the major contributors of TSS and phosphorus to Green Bay.

- Recommend a phosphorus trapping efficiency of 35% for areas with hydrologic group C soils.

- Recommend a TSS trapping efficiency of 40% for areas with hydrologic group C soils.

- An additional reduction should be credited to a VBS for land taken out of production within the areal extent of the VBS.

- Recommend methodology used in Alternatives 3 or 4 be used to determine area effectively influenced by buffer strip.

- Recommend the following range in parameters: (1) an average stream length to drainage area ratios from 67 m/ha to 90 m/ha, (2) an average effective drainage area to stream length ratio from 11 ha/km to 14.5 ha/km, and (3) an average effective slope lengths from 61 to 90 meters.

- Recommend minimum buffer widths of 18 meters (60 ft) for areas with hydrologic group C soils and a minimum buffer width of 12 meters (40 ft) for type B and more permable soils. These recommendations are based solely on water quality, as well as a trade-off between cost effectiveness and expected VBS reductions with a larger VBS. Habitat considerations may require a larger VBS.

- Existing riparian buffer strips were not directly accounted for in the SWAT/GIS simulations (Baumgart 2000); therefore, the yield from land that is not affected by an existing VBS should be somewhat higher than the simulated values. On the other hand, phosphorus yields estimated by Baumgart (2000) did not directly account for contributions from barnyards; rather, the simulated phosphorus yields were the total from all sources (all sources were lumped together). Since a VBS intended to remove phosphorus from upland sources cannot impact phosphorus from barnyard runoff, the watershed phosphorus loads should be reduced to account for barnyard contributions before estimating the reduction potential. The same reasoning applies to conservation tillage BMP's.

III. Streambank stabilization - potential to reduce TSS and phosphorus export to Green Bay (not finished yet)

Streambank stabilization measures include placing riprap or other materials along streambanks, introducing vegetation, reshaping the banks, or placing livestock barriers and cattle crossings. All streambank stabilization measures have the primary goal of reducing or virtually eliminating the erosion of the streambank into the adjoining waterway. The purpose of this section is to provide a basis for determining load reductions resulting from streambank stabilization efforts.

For many eroding sites, virtually all of the load should be eliminated through installation and maintenance of appropriate BMPs. Although it is best to assume that less than 100% of the sediment load from an eroding streambank can be remediated, substantial erosion still occurring after a streambank has been stabilized (e.g., > 20%) may be indicative of incomplete remedial measures or an unacceptable risk of failure in the long-term. Therefore, a 90% reduction is recommended for purposes of estimating generalized reductions related to streambank stabilization measures that are implemented on a watershed basis, unless site-specific or BMP-specific information is offered.

Total phosphorus and TSS delivered to streams from streambank and shoreline erosion were estimated by LCD's for a number of watersheds in the Basin. These loads were routed downstream to estimate the total annual export of these constituents to Green Bay due to streambank and shoreline erosion (Baumgart 2000; Table 6). Where data was available, the estimated percent of TSS due to streambank/shoreline erosion that reached Green Bay from each watershed ranged from 1.3% in the Pensaukee Watershed, to 31% from the Apple and Ashwaubenon Creek Watershed. Most of the watersheds were within the 4% to 14% range. The estimated percent of phosphorus associated with streambank/shoreline erosion that reached Green Bay from each watershed ranged from 0.6% in several watersheds, to 4.0% from the Apple and Ashwaubenon Creek Watershed. Therefore, where streambank erosion data is unavailable, a reasonable assumption might be to estimate that approximately 9% of the total TSS and 2% of the total phosphorus that reaches Green Bay from a watershed might be attributed to streambank erosion.

The total estimated annual load to Green Bay due to streambank erosion from LF01, LF02, LF05, UF02 and TK07 was 5,700 MT of TSS, and 2,500 kg of phosphorus. If we assume that 9% of the total TSS load and 2% of the total phosphorus load to Green Bay from UF01, LF03, LF04 and LF06 watersheds is from streambank erosion, then the total average annual streambank contribution to Green Bay from these watersheds is 1,350 MTof TSS and 1,000 kg of phosphorus. The combined total average annual streambank erosion contribution to Green Bay from both sets of watersheds is estimated to be 7,000 MT of TSS and 3,500 kg of phosphorus, which compares to a total annual load of 151,000 MT of TSS and 500,0000 to 605,000 kg of phosphorus exported to Green Bay from the Fox River, as estimated by Robertson and Saad (1996).

The following streambank and shoreline sediment reduction objectives were proposed as part of a Priority Watershed Project or County Land and Water Resource Plan:

(1) 10% -- Duck, Apple, Ashwaubenon Creeks Priority Watershed (LF05, LF02; WDNR 1997);
(2) 50% -- East River Priority Watershed Project (LF01; WDNR 1993a);
(3) 75% -- Arrowhead River, Rat River and Daggets Creek Priority Watershed (WDNR 1993b);
(4) 50% -- Waupaca County LCD (1999);
(5) 50% -- Winnebago County LCD (1998);

If these reduction estimates are applied to their respective watersheds (LF01, LF02, LF05), and a 50% reduction is assumed for the remaining watersheds (LF03, LF04, LF06, UF01, UF02, TK07), then the total reduced annual export to Green Bay would be 2,100 MT of TSS and 1,100 kg of phosphorus.

Streambank erosion is a natural phenomenom that may be worsened by anthropogenic factors. For example, heavily wooded areas may contain streambanks with high erosion rates, but high bank recession rates may be caused by upstream agricultural or urban practices that accelerate the rate of erosion by altering the flow regime. Trying to fix the problem at the streambank may be difficult and cause other problems. Many such locations will be difficult to stabilize because they are heavily wooded, not easily accessable, and conventional methods to stabilize the banks may cause an unacceptable level of disturbance. Placing riprap along a small stream that is heavily wooded may be unfeasible or unacceptable. Reshaping and revegetating the streambank may be impractical without heavy equipment, and revegetating the streambank may be difficult or incomplete unless the trees are removed to let sunlight in. These types of factors influenced the relatively low 10% reduction objective for controlling streambank erosion in the Duck, Apple and Ashwaubenon Creek Priority Watershed Project (Burton 2000). Similar impediments to implementing streambank stabilization measures may exist in other watersheds (Neuberger 2000).

Even if landowners can be fully compensated for stabilizing streambanks, they may not be wish to do anything within non-cropped areas they own which are not perceived as causing obvious problems; whereas, they might want eroding streambanks adjacent to their cropped fields stabilized. Another consideration is that a small amount of streambank erosion may occur along the entire stream length, and although this minor streambank erosion is too low to be treated, it may contribute a small, but not insignificant portion of the total export of TSS or phosphorus to Green Bay (i.e., background). For example purposes only, the contribution from streambank erosion was estimated to be about 5% of the total TSS load in the Upper Bower Creek subwatershed if the average bank recession rate is assumed to be 10 times higher (0.029 cm/yr) than the estimated vertical erosion rate of upland areas.[13] Therefore, we cannot expect that all streambank erosion can, or should be controlled. Furthermore, reduction objectives greater than 50% may be overly optimistic, and are not recommended.

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[13]Assume: (1) TSS yield is 0.45 MT/ha for Upper Bower Creek reference subwatershed (35.6 sq. km); (2) bulk density of soil/sediment is 1.55 MT/m^3; (3) eroding streambank length is equal to 1.5 times stream length indicated by 1:24k hydrologic network, due to additional streams/ditches and a fraction of the road ditches; and (4) eroding bank slope is 1 meter on each side of the stream. Therefore, the vertical erosion rate from upland areas is about 0.029 mm/yr, as measured at the subwatershed outlet. Streambank erosion is equal to 77 MT/yr (1 m * 2 *57,000 m * 1.5 * 0.029 cm/yr * 1.55 MT/m^3), or about 5% of total subwatershed load of 1,600 MT/yr.

IV. Conclusions and Recommendations

Based on the literature review presented in this paper, the potential impact of installing buffer strips on a watershed basis cannot be precisely estimated. Reported trapping efficiencies of buffer strips vary widely. Results from the four reviewed studies that presented detailed particle size analysis were not in complete agreement. However, trapping efficiencies decreased with smaller particle sizes and lower infiltration rates, so these parameters were used as a basis to extrapolate results from experimental plot studies to our area. Studies that have examined the effectiveness of buffer strips under actual field conditions have concluded that results from controlled plot experiments overstate their effectiveness, sometimes greatly so. Consequently, the area influenced by a VBS was reduced to account for these problems.

The following recommendations:

- The use of vegetated buffer strips should be considered a viable component of a phosphorus and suspended solids reduction strategy employing a range of best management practices to improve surface waters impacted by agricultural runoff in the Green Bay Basin.

- In a letter to the Brown County LCD supporting their efforts to install buffer strips, Gilliam (1997) stated that "Vegetated buffers can be utilized to improve the quality of water draining from most any watershed. They should not be used to replace other best management practices but are a great final treatment just before drainage water enters a small stream." As previously stated, experimental plots under conventional tillage which utilized a VBS had sediment yields that were 4 to 10 times greater than plots under conservation tillage without a VBS. Therefore, information presented in this report does not suppport relying solely on a VBS to reduce TSS and phosphorus export from upland cultivated sources.

- The average reduction found from the studies listed in Tables 1 and 2 for TSS (75%) and total phosphorus (61%) are inappropriate to estimate reductions to streams from the major contributors of TSS and phosphorus to Green Bay.

- VBS trapping efficiencies of 40% for TSS, and 32% for total phosphorus are recommended for areas with hydrologic group C soils, such as those that contribute the greatest proportion of TSS and total phosphorus to Green Bay.

- An additional reduction should be credited to a VBS for land taken out of production within the areal extent of the VBS.

- Recommend methodology used in Alternatives 3 or 4 be used to determine area effectively influenced by buffer strip.

- Recommend the following range in parameters to determine area effectively influenced by buffer strip:
  (1) average stream length to drainage area ratios from 67 m/ha to 90 m/ha,
  (2) average effective drainage area to stream length ratio from 11 ha/km to 14.5 ha/km,
  (3) average effective slope lengths from 61 to 90 meters.

- Smaller particles are of greatest concern; therefore, minimum buffer widths of 18 meters (60 ft) are recommended for areas with hydrologic group C soils, and a minimum buffer width of 12 meters (40 ft) is recommended for type B and more permable soils. These recommendations are based solely on water quality, as well as a trade-off between cost effectiveness and expected VBS reductions with a larger VBS. Habitat considerations may require a larger VBS.

- Buffer strip width (flow length) should be allowed to vary so that the VBS is placed along the contour, as much as is practical. Otherwise, runoff will tend to concentrate along the edge of the VBS and flow parallel to the edge in a concentrated fashion rather than flow through the VBS in a dispersed manner.

- Where possible, concentrated flows to the VBS should be minimized by installing shrubs and/or stiff grasses at the up slope edge of the VBS, installing grassed waterways, utilizing upland conservation practices, and through proper design and installation of the VBS.

- A watershed-scale study should be conducted to better assess the impact of installing vegetated buffer strips to reduce phosphorus and suspended solids loadings to watershed outlets within the Basin. Analysis of particle size distribution should be conducted for both upland soils and suspended solids so that results can be more easily extrapolated to other locations.

- On a watershed basis, reduction objectives from streambank stabilization efforts have ranged from 10% to 75% in Priority Watershed Projects within the Basin; however, even a 50% reduction may be difficult to achieve without greatly disturbing wooded areas..

- If local reduction objectives for streambank stabilization are applied to TK07, UF01, UF02, and all of the watersheds in the Lower Fox Subbasin, the potential annual load reductions to Green Bay are estimated to be 2,100 MT of TSS and 1,100 kg of phosphorus.

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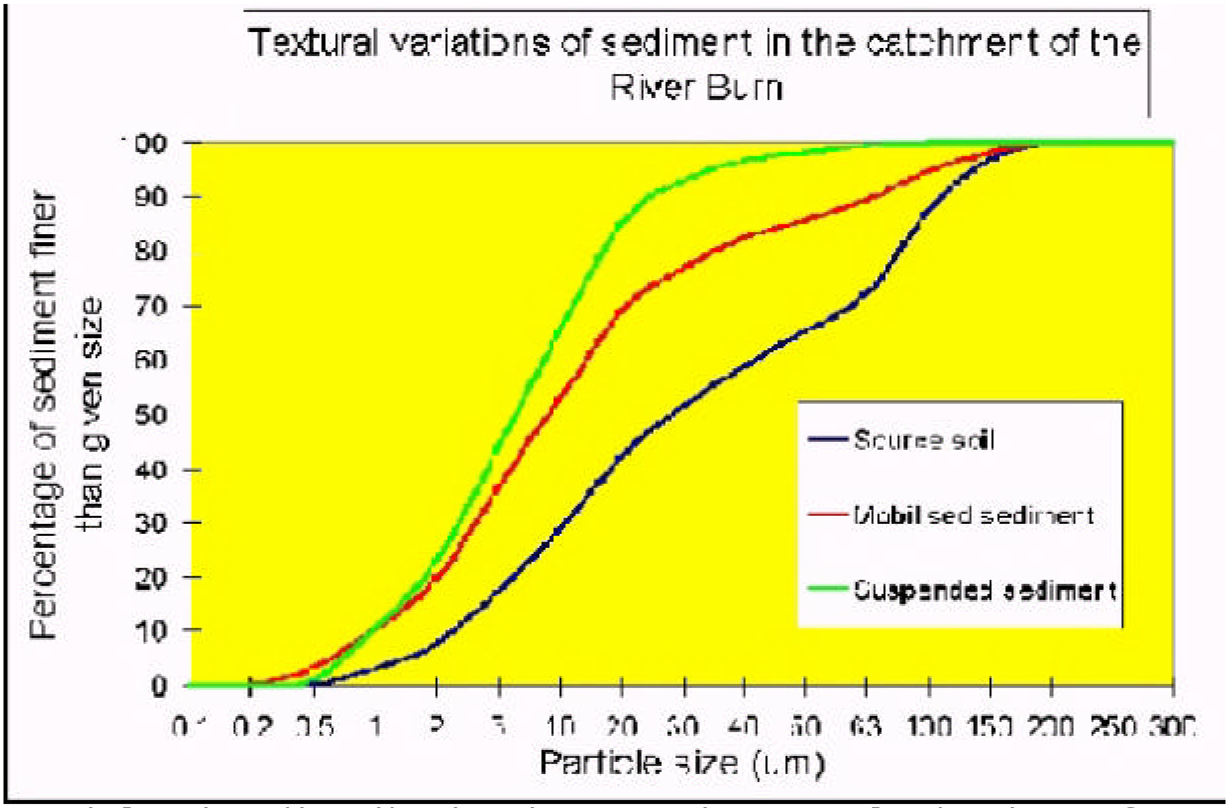
Appendix A.



Particle size distribution in Burn River, England. Figure from Waterfall and Walling, 1997.

Appendix J — General Land Cost Estimate

A MARKET STUDY

OF THE

GENERAL PRICES LEVELS OF WETLANDS AND WATER FRONTAGE LANDS IN MARINETTE, OCONTO, OUTAGAMIE, DOOR, AND BROWN COUNTIES, ALL IN WISCONSIN, FOR THE NATURAL RESOURCE DAMAGE ASSESSMENT FOR THE LOWER FOX RIVER/GREEN BAY ENVIRONMENT

PREPARED FOR

MR. DOUGLAS BELTMAN
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PREPARED BY

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DATE OF THE MARKET STUDY: MAY 12, 2000

RITTER APPRAISALS, INC.

Lawrence E. Ritter, SRA Steven L. Ritter, MAI

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May 12, 2000

Mr. Douglas Beltman
Stratus Consulting, Inc.
1881 9th Street, Suite 201
Boulder, Colorado 80302

Dear Mr. Beltman:

As you requested, I have completed a market study of Marinette County, Oconto County, Outagamie County, Door County, and Brown County, all in Wisconsin. The purpose of the market study is to report the general price levels of wetland and water frontage land, as further described herein, of the above mentioned counties. The use of the market study is to assist Stratus Consulting, Inc. and U.S. Fish and Wildlife Service in the Natural Resource Damage Assessment for the Lower Fox River/Green Bay Environment.

The accompanying market study report, which contains 187 pages including the Addenda, considers actual sales transactions of similar lands in each of the five counties as well as interviews with real estate agents, appraisers, buyers, sellers, government officials, and other informed persons about the local market.

The market study considers the general price level of wetland properties in the 40+ acre size range for each of the counties followed by an analysis of the impact of water frontage on price for all counties.

Please note that this market study is made subject to the Assumptions and Limiting Conditions and the Certification stated in this report. **The reader is warned that this is a market study of the "general price levels" and should not be used in assigning a "value" to a specific property. Individual properties are unique and may require special consideration in estimating a "value."**

Based upon my investigation and analysis of the data gathered for this market study, the general price level conclusions are summarized below, as of **May 12, 2000.**

Wetland Market Study Summary - *Marinette County*

Overall Price Range.......................	$500 per acre to $1,200 per acre
Most Common Price Range (few limitations)..	$800 per acre to $1,000 per acre
Severely Limited Property Price Range......	$600 per acre to $ 800 per acre

Wetland Market Study Summary - *Oconto County*

Overall Price Range.....................	$ 750 per acre to $1,250 per acre
Most Common Price Range (North Region)...	$ 750 per acre to $1,000 per acre
Most Common Price Range (South Region)...	$1,000 per acre to $1,250 per acre

Wetland Market Study Summary - *Outagamie County*

Overall Price Range.....................	$ 750 per acre to $1,250 per acre
Most Common Price Range.................	$1,000 per acre to $1,250 per acre

Wetland Market Study Summary - *Door County*

Overall Price Range.....................	$ 600 per acre to $ 1,500 per acre
Typical Price Range (No Bldg Site Pot.).	$ 600 per acre to $ 800 per acre
*Typical Price Range (Some Bldg Pot.)...	$1,000 per acre to $ 1,250 per acre
** Typical Price Range (Some Bldg Pot.).	$1,250 per acre to $1,500+ per acre

* South Region
** North Region

Wetland Market Study Summary - *Brown County*

Typical Price Range for Pure Wetland.....	$1,000 per acre to $1,500 per acre
Most Likely Price Range for Pure Wetland.	$1,200 per acre to $1,500 per acre

Wetland Market Study Summary - *Coastal and Water Front Tracts*

See Market Analysis Section for Coastal and Water Front Tracts

Formed hydric soils appear to have similar general price levels as wetland properties with similar factors affecting prices.

The above conclusions are explained in detail in this report along with a discussion of the primary factors that influence the price ranges. **The user of this report is strongly advised to thoroughly understand the explanations and conclusions prior to the use of any of the conclusions**.

I trust you will find the report complete, but please contact me if you have any questions. Thank you for the opportunity to be of service to you.

Respectfully submitted,

Steven L. Ritter

Steven L. Ritter

SLR:tds

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PART I

INTRODUCTION

OBJECTIVE AND FUNCTION OF THE MARKET STUDY

The **objective of this market study** is to report the general price levels of wetland properties and water frontage properties, as further defined in this report, for Marinette County, Oconto County, Outagamie County, Door County, and Brown County, all in Wisconsin, as of the date of the market study.

The **function of this market study** is to assist Mr. Douglas Beltman, Stratus Consulting, Inc., and the U.S. Fish and Wildlife Service in the Natural Resource Damage Assessment for the Lower Fox River/Green Bay Environment.

DATE OF THE MARKET STUDY

Field work for the market study occurred on May 7, 2000 through May 13, 2000. The effective date of the market study is May 12, 2000, which is also the date of this report.

PROPERTY RIGHTS CONSIDERED

The type of ownership and the property rights considered in this market study for the specific property types are **fee simple estate** (subject to normal utility and road easements). Fee simple estate is defined as:

> Absolute ownership unencumbered by any other interest or estate; subject only to the limitations of eminent domain, escheat, police power, and taxation.[1]

IDENTIFICATION OF THE PROPERTY TYPE

This market study is of a specific property type (wetlands and water frontage lands) in Marinette County, Oconto County, Outagamie County, Door County, and Brown County, Wisconsin having a minimum size of 40 acres. The market study does not identify a specific property. The study is intended to report the general price levels for wetlands and water frontage lands as defined below.

Definition of Wetland. This market study considers the general price levels of wetland tracts having a minimum area of 40 acres. The criteria used to determine if a property is a wetland was established based on interviews with the Army Corp of Engineers, the Wisconsin Department of Natural Resources, Mr. Vincent J. Mosca of Hey and Associates, Inc. (a specialist in water resources, wetlands, and ecology), as well as *The Valuation of Wetlands* by Mr. David Michael Keating, MAI published by the Appraisal Institute.

The United States government established specific guidelines and definitions for wetlands in the 1986 Emergency Wetlands Resource Act. The Act defines wetland as

> land that has a predominance of *hydric soils* and that is *inundated* or *saturated by surface or ground water* (hydrology) at a frequency and duration sufficient to support, and that under normal condition does support, a prevalence of *hydrophytic vegetation* typically adapted for life in saturated soil conditions.

The key terms of the wetland definition are hydric soils, hydrology, and hydrophytic vegetation, which are further described below.

1. **Hydric Soils** are defined as those that are saturated , flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part. Anaerobic conditions result from the lack of oxygen. Generally, such soils have a low rate of percolation and consist of materiel such as clay or muck.

2. **Hydrology** is the study of the movement of water on the surface and subsurface of land. Wetlands are characterized by a specific hydrology as they are periodically saturated and inundated with water, which in turn deprives the soil of oxygen and creates anaerobic conditions.

3. **Hydrophytic Vegetation** can grow despite anaerobic soil conditions and periodic water inundation. These species may grow in the soil or may float on the water. Common examples of hydrophytic vegetation include cypress trees, cattails, and water lilies.

The author of this study is not qualified to definitively determine if a property qualifies as a wetland. Only a specialist such as a soil scientist, hydrologist, environmental engineer, or biologist is uniquely qualified to make a determination as to whether a particular property is a wetland.

Sale data from at least 200 transactions were considered for this market study. It is not feasible, due to time and economic considerations, to retain a specialist to make a wetland determination for each of the sale data. Therefore, it was necessary to identify sale data as either having a high probability of being a wetland or having a low probability of being a wetland.

For this market study, the primary factor considered in determining if a property is a wetland is the predominance of hydric soils. Properties that predominately consist of hydric soils have a high probability of being wetland as defined on the previous page. The United States Department of Agriculture Soil Conservation Service (ASCS) publishes a soil survey for each of the counties considered in this market study. The survey maps the various soil types in the county and provides a detailed description of the soils and soil characteristics. Characteristics common of hydric soils include a level topography, poorly drained, located in depressions and drainageways, subject to ponding, high water table, not suited to dwellings, etc.

In summary, properties that contain hydric soils have a high probability of being wetland and, therefore, are considered wetlands for this market study. It is possible that further study by a qualified professional may reveal that a particular tract identified as being a wetland in this study may not actually be a wetland. However, considering the preponderance of the data contained in this study and the high probability properties with hydric soils are wetlands, the soil determination is believed to be reasonably accurate.

Definition of Water Frontage Land. This market study considers the general price levels of water frontage tracts having a minimum area of 40 acres. There are two basic types of water frontage land in the five counties included in this study. The first is "coastal property" or land with frontage along the bay of Green Bay or Lake Michigan. The second is river frontage land or inland lake frontage land referred to in the report as "water front" land. There is a limited amount of sale data available for these types of properties, therefore, the general price levels for water frontage properties have been considered together for all five counties. The water frontage land study considers both wetland and upland property types.

SCOPE OF THE WORK

A market study is the identification and study of the market for a particular economic good or service. This market study, specifically, is to report the general price levels of two distinct property types within a given area. General price levels are defined as prices commonly paid in a given area. The specific property types are wetlands and water frontage lands. The given area is defined as Marinette County, Oconto County, Outagamie County, Door County, and Brown County, all in Wisconsin.

This market study consists of researching the market to obtain information about transactions, listings, and other offerings of properties similar to the property type being considered. The methodology assumes that the market will determine the price of similar property types in the same manner that it determined the price of the comparable properties through the relationship between the principles of supply and demand, balance, substitution, and externalities.

Market research was directed primarily toward sales of unimproved tracts of land or sales with limited improvements that predominately consist of hydric soils and, therefore, have a high probability of being wetlands as previously defined. In addition, data was gathered on all types of water front properties available in the area. At least 200 sale transactions were analyzed of which 73 sales were considered good market indicators and included in the study. The sale data in the Addenda section of this report shows the location, property type, legal description, grantor, grantee, date of closing, property rights conveyed, financing terms, conditions of sale, data source, sale price, site size, sales price per acre, and other pertinent information.

The sale data is analyzed for each market area requested and the general price levels are reported. Furthermore, the primary influences on price for each market area are considered.

* * *

This market study is based on information gathered by the author from public records, other identified sources, inspection of the sale data and the neighborhood, and selection of sales within each market area. The original source of the sale is shown in the sale data along with the source of confirmation, if available. The original source is presented first. The sources and data are considered reliable. When conflicting information is provided, the source deemed most reliable is used. Data believed to be unreliable is not included in the report nor used as a basis for conclusions.

Sources for sale data are the transfer returns from the Wisconsin Department of Revenue, real estate agents, real estate appraisers, and area landowners in each market area. Verification of sale information was obtained from transfer return records and from interviews with a party to the transaction--either the seller or the buyer, or other informed persons as much as possible.

ASSUMPTIONS AND LIMITING CONDITIONS

This market study report is of general price levels for the described market areas contained herein. The price levels are not reported for a specific property but rather a specific property type. Therefore, the market study has been made with the following general assumptions for the specific property type:

1. No responsibility is assumed for matters pertaining to legal or title considerations. Title to the property type is assumed to be good and marketable.

2. The property type is assumed to be free and clear of any or all liens or encumbrances.

3. Responsible ownership and competent property management are assumed.

4. The information furnished by others is believed to be reliable, but no warranty is given for its accuracy.

5. All engineering studies are assumed to be correct. The plot plans and illustrative material in this report are included only to help the reader visualize the property and/or property type.

6. It is assumed that there are no hidden or unapparent conditions of the property type, subsoil, or structures that render it more or less valuable. No responsibility is assumed for such conditions or for obtaining the engineering studies that may be required to discover them.

7. It is assumed that the property type is in full compliance with all applicable federal, state, and local environmental regulations and laws unless the lack of compliance is stated, described, and considered in the market study report.

8. It is assumed that the property type conforms to all applicable zoning and use regulations and restrictions unless a nonconformity has been identified, described, and considered in the market study report.

9. It is assumed that all required licenses, certificates of occupancy, consents, and other legislative or administrative authority from any local, state, or national government or private entity or organization have been or can be obtained or renewed for any use on which the price level contained in this report is based.

10. It is assumed that the use of the land and improvements is confined within the boundaries of property type lines of the property type described and that there is no encroachment or trespass.

11. The property type is assumed to contain no environmental hazards. The presence of potentially hazardous materials may affect the price level of the property type. The price levels reported in this market study are predicated on the assumption that there is no such material on or in the property type that would cause a loss in price. No responsibility is assumed for such conditions or for any expertise or engineering knowledge required to discover them. The client is urged to retain an expert in this field, if desired.

This market study report has been made with the following general limiting conditions:

1. Any allocation of the total price estimated in this report between the land and the improvements applies only under the stated program of utilization. The separate prices allocated to the land and buildings must not be used in conjunction with any other market study and are invalid if so used.

2. Possession of this report, or a copy thereof, does not carry with it the right of publication.

3. The author, by reason of this market study, is not required to give further consultation or testimony or to be in attendance in court with reference to the property type in question unless arrangements have been previously made.

4. Neither all nor any part of the contents of this report (especially any conclusions, the identity of the author, or the firm with which the author is connected) shall be disseminated to the public through advertising, public relations, news, sales, or other media without the prior written consent and approval of the author.

PART II

THE MARKET STUDY

REGIONAL OVERVIEW

This market study focuses on five counties in northeastern Wisconsin along the bay of Green Bay. The counties include Marinette County, Oconto County, Outagamie County, Door County, and Brown County.

The total population for the region included in this study is summarized below.

County	1990 Census	1998 Estimate
Marinette County........	40,548	42,523
Oconto County...........	30,226	33,089
Outagamie County........	140,510	155,953
Door County.............	25,690	26,537
Brown County............	194,594	218,149
Total Population........	**431,568**	**476,251**

Important industries for the region are manufacturing (primarily in the wood using industry, paper products, etc.), recreation, and agriculture. The recreation industry continues to grow in the area due to recreational opportunities associated with the bay of Green Bay, Lake Michigan, and the vast acres of forested land and wetland with a mixture of public and private ownership. A more detailed description of each county is provided in each market analysis section of this report.

PART IIa

WETLANDS

MARINETTE COUNTY

LOCATION MAP SHOWING MARINETTE COUNTY

[not available]

NEIGHBORHOOD DATA

The map on the facing page shows the location of Marinette County. A neighborhood is a group of complementary land uses.[2] Marinette County is bordered on the north by the State of Michigan and Florence County, Wisconsin, on the east by Michigan and the bay of Green Bay, on the south by the bay of Green Bay and Oconto County, and on the west by Oconto County and Forest County.

Marinette County is in the northeastern part of Wisconsin. It is entirely within the drainage basin of the Peshtigo and Menominee River and has a total area of 916,051 acres. Of this total, about 893,011 acres is land and 23,040 acres is water areas of more than 40 acres.

Within the county there are three main physiographic regions. The western and northern sections are in the Northern Highlands, the central section is part of the Wisconsin Central Plain, and the southeast part of the county is in the Eastern Ridges and Lowlands region. The elevation ranges mainly from about 1,400 feet in the northwestern part of the county to about 580 feet at the shoreline of Green Bay in the southeast corner. The surface water flows primarily to the southeast and eventually to Green Bay. The Peshtigo River is a major drainageway, which flows southeast and enters Green Bay. Other major drainages are the Pemebenwon, Pike, and Wausaukee River systems, which are part of the Menominee River watershed. The Menominee River forms the north and eastern boundary of the county and also flows into Green Bay.

Winters in Marinette County are very cold, and the short summers are fairly warm. Precipitation is fairly well distributed throughout the year. Snow covers the ground much of the time from late fall through early spring. In winter, the average temperature is 15° F and the average daily minimum temperature is 3° F. In summer, the average temperature is 64° F and the average daily maximum temperature is 76° F. The total annual precipitation is about 31 inches, and the average seasonal snowfall is about 52 inches.

The Marinette County population was 40,548 in 1990 according to the 1990 Census. The 1998 estimated population was 42,523 according to the State of Wisconsin Department of Administration. This suggests a stable population. Significant municipalities within the county are shown below along with the 1990 Census population and the 1998 population estimate.

Municipality	1990 Census	1998 Estimate
Marinette, City	11,843	11,995
Peshtigo	3,564	3,847
Peshtigo, City	3,154	3,317
Stephenson	2,288	2,462
Niagara, City	1,999	2,072
Porterfield	1,805	1,927
Grover	1,670	1,709
Pound	1,386	1,440
Dunbar	838	1,115
Wausaukee	937	1,094

Marinette is the largest city in the county and is the county seat.

Following is the industry group for Marinette County, their number of employees, and their percent of total employees according to the 1990 census.

Industry Group – Marinette County	Employees	Percent of Total
Agriculture, forestry, and fisheries................	923	5%
Mining..	50	0%
Construction..	863	5%
Manufacturing.......................................	5,623	33%
Transportation......................................	622	4%
Communications & other public utilities.............	232	1%
Wholesale trade.....................................	421	2%
Retail trade..	3,217	19%
Finance, insurance, & real estate...................	633	4%
Business & repair services..........................	395	2%
Personal services...................................	488	3%
Entertainment & recreation services.................	116	1%
Health services.....................................	1,252	7%
Educational services................................	1,242	7%
Other professional services.........................	613	4%
Public administration...............................	531	3%
Total Employees....................................	**17,221**	

The economy in Marinette County is adequately diverse, but the two main industries in the county are manufacturing and retail trade. These two industries comprise 52.0 percent of the total employment.

Wood using industries (paper and wood products manufacturing) and lumbering are major enterprises in Marinette County. Outdoor recreation is also an important industry. Marinette County is considered a recreational county, since at least 20 percent of the housing units are vacant and held for seasonal, recreational, or occasional use. Dairy farming previously had a major influence on the local economy, but its influence has been declining in recent years.

The top 10 private sector employers for Marinette County are shown below.

Major Employers - Marinette County	Product Type	Employees
Karl Schmidt Unisia, Inc.....	Carburetors, Pistons, Rings, Valves..	500-999
Waupaca Foundry, Inc.........	Gray Iron Foundry....................	500-999
Marinette Marine Corp........	Water Craft Manufacturer.............	500-999
Ansul, Inc...................	Manufacturing........................	500-999
Consolidated Papers, Inc.....	Paper Products Manufacturing.........	500-999
Bay Area Medical Center, Inc.	Health Services......................	500-999
Goodman Forest Indust., Inc..	Hardwood Veneer and Plywood..........	250-499
Kimberly-Clark Tissue Co.....	Paper Products Manufacturing.........	250-499
Badger Paper Mills, Inc......	Paper Products Manufacturing.........	250-499
Patz Sales, Inc..............	Farm Machinery.......................	250-499

In April 2000, the unemployment rate for Marinette County was 4.5 percent compared 5.2 percent in April 1999. The April 2000 unemployment rate for the State of Wisconsin was 3.5 percent. Therefore, while the Marinette County unemployment rate has improved over the last year, it remains higher than the state average unemployment rate. The Marinette County labor force totals approximately 21,000 workers.

Nearly 1,000 more workers enter the county for work than leave it for work in neighboring counties. However, approximately one sixth of the Marinette County labor force works outside the county. The majority of commuting occurs with the State of Michigan, primarily between the cities of Marinette, Wisconsin and Menominee, Michigan. Some workers commute daily to Green Bay for employment.

The 1997 per capita personal income was $18,963 for Marinette County and $24,048 for the State of Wisconsin. This suggests a slightly depressed economy, however, the standard of living for the county is likely significantly lower than that of the state as suggested by typical housing costs. Median gross rent for the county is $298 per month and the median housing value is $41,600 compared to median gross rent for the state of $399 per month and a median housing value of $62,100. Therefore, the income for the county is considered adequate. Income in Marinette County has remained stable, with no major fluctuations that greatly affect the economy.

Financing is readily available in the area typically via conventional loans on all types of real property--agriculture, commercial, and residential. There are several banks in the area that actively make loans.

Government services, police and fire protection, education, and health services are adequately provided within the county. Transportation is adequately provided within the county via a series of federal, state, and county road systems. Major highways include Highway 41, 141, 8, and 64. Marinette contains a port to handle freight and recreation traffic. Recreational opportunities are adequate via numerous national, state, and county publicly owned lands and the bay of Green Bay and numerous inland lakes.

In summary, Marinette County has a stable and reasonably diversified economic base. Population, income, and employment are all stable. Most shopping, education, health care, recreation, and employment facilities are adequately provided for within the county, and additional amenities are available in Michigan and the city of Green Bay. There are no known changes that could substantially impact the economy. Therefore, a continued stable economy is most likely.

Following is a summary of neighborhood trends and neighborhood characteristics for Marinette County.

Neighborhood Trends – Marinette County	Up	Stable	Down
Development............................		x	
Value..................................	x	x	
Vacancy................................		x	
Population.............................		x	
Employment.............................		x	
Demand.................................	x	x	
Effective Purchase Power................		x	

Neighborhood Characteristics – Marinette County	Ex	Gd	Av	Fr	Pr
Maintenance/Condition...........		x	x	x	
Property Compatibility..........			x		
Appeal/Appearance...............			x		
Protection/Adverse Influence....			x		
Development Potential...........			x		
Transportation Access...........			x		
Police/Fire Protection..........			x		
Soil Quality/Productivity.......			x		

LOCATION MAP SHOWING THE MARINETTE COUNTY SALES

[not available]

MARINETTE COUNTY MARKET ANALYSIS

The objective of this market analysis is to demonstrate the general price levels for vacant wetland properties in Marinette County with a minimum size of 40 acres. This study focused on properties with a highest and best use of recreation with little to no development influence. The study also reports on the primary factors that influence prices.

In vacant land analysis, the most reliable method of measuring the market is by comparable sale data or actual sale transactions of similar land types in the market area. This data provides direct market indications of what sellers are willing to accept and what buyers are willing to pay for a particular property type.

For this analysis, data was gathered on over 60 sale transactions (occurring between 1997 and 2000) and listings in Marinette County. From this group of data, 19 sales and listings were selected for consideration in reporting the general price levels. A sale data sheet for each of the 19 sales and listings are provided in the Addenda section of this report. The sale data sheet shows the location, property type, legal description, grantor, grantee, date of closing, property rights conveyed, financing terms, conditions of sale, data source, sale price, site size, sales price per acre, and other pertinent information for each sale. A sale location map is presented on the facing page.

Criteria for selecting market data was good arm’s-length transactions, primarily low land or wetland (having primarily hydric soils), minimum site size of 40 acres, unimproved tracts, and purchased for recreation. Specifically excluded from this study that meet the criteria above are water front properties as they are discussed in "Part III" of this report. A total of 17 sales and 2 listings are considered in this analysis.

As additional support for the sale data, consideration is given to market summaries compiled by the Wisconsin Department of Revenue for vacant land and interviews with real estate agents and appraisers in Marinette County.

The market analysis will begin with a discussion of the Wisconsin Department of Revenue reports followed by the results of interviews of real estate agents and appraisers in the Marinette County area as this will give a general overview of the current market conditions.

With each sale of a parcel of real estate, the buyer is required to file a "Wisconsin Real Estate Transfer Return" documenting the parcel size, sale price, present use, and intended use of the property. The transfer returns are filed with the Wisconsin Department of Revenue, Equalization Board (DOR). State appraisers inspect the site of each sale and verify the transfer return. The following information is averages from the transfer return data. As of the date of this report, the most current information available is 1998 due to the lag time required to inspect, verify, and process the data.

The DOR information indicates that overall agricultural land prices have increased each year since 1993. The following chart shows the average sale price for agricultural land for the State of Wisconsin from 1993 to 1998. The averages include vacant land and improved agricultural land.

Wisconsin Average Agriculture Land Prices

(All farms-Vacant & Improved)

Year	# Sales	Acres	$/Acre	Change
1993	7,462	430,575	$ 969	
1994	6,094	383,002	1,033	+ 6.6%
1995	4,507	283,711	1,127	+ 9.1%
1996	4,637	290,860	1,284	+ 13.9%
1997	4,045	263,456	1,413	+ 10.1%
1998	4,088	264,606	1,515	+ 7.2%

The above information indicates the Wisconsin agriculture market has maintained considerable strength during the years show above.

The DOR further breaks down land sales to agricultural land without buildings, forested lands, and swamp or marsh land by county. Separate sale data is reported for "Land continuing in use" and "Land being diverted to other uses."

Following is a summary of land sale data for agricultural land sales without buildings; comparing Marinette County to other area counties and to the State of Wisconsin.

1998 Agricultural Land Sales Summary--*Without Buildings*

Source: Wisconsin Department of Revenue-Board of Equalization

	Ag Land Continuing Use			Ag Land Diverting Use			Total Ag Land		
County	# Trans	Acres Sold	$ Per Acre	# Trans	Acres Sold	$ Per Acre	# Trans	Acres Sold	$ Per Acre
Marinette	22	828	$ 785	5	163	$1,042	27	991	$ 827
Oconto	38	1,645	891	18	524	1,926	56	2,169	1,141
Outagamie	17	1,227	1,323	5	265	3,234	22	1,492	1,682
Door	20	671	1,058	3	65	1,549	23	736	1,102
Brown	10	648	1,839	16	633	6,833	26	1,281	4,307
State Avg.	1,472	--	1,173	767	--	1,785	2,239	--	1,332

The above data indicates the average price for agricultural land with a continuing use in Marinette County was $785 per acre and the average price for agricultural land with a diverting use (likely some type of development land) was $1,042 per acre. The average price for agricultural land overall in the county was $827 per acre. The average agriculture unit sold was 36.7 acres (991 acres ÷ 27 sales). It is interesting to note the above information indicates that the far majority of sales in the county sold for agricultural purposes. Only 19 percent of the above sales transferred for a diverting use. In addition, average land prices for Marinette County are below the average land prices for the state. Marinette County contains the lowest average land sale price of the five counties displayed above.

Following is a summary of land sale data for forested sales; comparing Marinette County to other area counties and to the State of Wisconsin. Forested land sales include both upland and wetland sales.

1998 Land Sales Summary--*Forested Lands*

Source: Wisconsin Department of Revenue-Board of Equalization

	Land Continuing Use			**Land Diverting Use**			**Total Land**		
County	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**
Marinette	90	4,092	$ 925	19	1,114	$1,054	109	5,206	$ 953
Oconto	56	1,772	934	27	796	1,319	83	2,568	1,053
Outagamie	27	675	1,126	6	73	2.724	33	748	1,282
Door	32	906	1,222	12	228	2,014	44	1,134	1,381
Brown	13	205	1,028	10	195	4,170	23	400	2,559
State Avg	2,959	--	789	1,325	--	1,015	4,284	--	854

The above data indicates the average price for forested land with a continuing use in Marinette County was $925 per acre and the average price for forested land with a diverting use (likely some type of development land) was $1,054 per acre. The average price for forested land overall in the county was $953 per acre. The average forested unit sold was 47.8 acres (5,206 acres ÷ 109 sales). It is interesting to note the above information indicates that the far majority of sales in the county sold for continuing use. Only 17 percent of the above sales transferred for a diverting use. Forested land sale prices for the county exceed state averages, however, Marinette County contains the lowest average sale price of the five counties shown above.

Following is a summary of land sale data for swamp and waste land sales; comparing Marinette County to other area counties and to the State of Wisconsin.

1998 Land Sales Summary--*Swamp/Waste Land*

Source: Wisconsin Department of Revenue-Board of Equalization

	Land Continuing Use			**Land Diverting Use**			**Total Land**		
County	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**
Marinette	48	447	$ 535	11	119	$ 519	59	566	$ 532
Oconto	49	538	410	24	308	479	73	846	435
Outagamie	30	661	697	11	364	2,193	41	1,025	1,228
Door	24	332	838	7	56	308	31	388	761
Brown	13	132	732	9	95	6,093	22	227	2,976
State Avg	2,259	--	408	882	--	788	3,141	--	503

The above data indicates the average price for swamp/waste land with a continuing use in Marinette County was $535 per acre and the average price for swamp/waste land with a diverting use (likely some type of development land) was $519 per acre. The average price for swamp/waste land overall in the county was $532 per acre. It is interesting to note diverting use land sold at nearly the same price as continuing use land. Swamp/waste land sale prices for the county are similar to state averages. Marinette County is at the low end of the average sale price of the five counties shown above.

The above information from the DOR demonstrates that the Marinette County market is active. The data offers average prices for the three land types above and demonstrates their price relationship. The average price for all agricultural land without buildings in 1998 was $827 per acre. The average price for forested land in 1998 was $953 per acre. The average price for swamp/waste land in 1998 was $532 per acre. Furthermore, the trend analysis indicates the market for Wisconsin has been improving in recent years and shows a considerable amount of strength.

In the process of gathering and confirming sale data for Marinette County, the author interviewed several real estate agents, appraisers, and/or market participants. Following is a summary of some of their comments about the county market. The persons interviewed are believed to be knowledgeable about the local market. The interviews focused on the market for vacant land in the 40+ acre size range and specifically on wetlands and water front properties.

All persons interviewed characterized the overall market as being strong with good demand. Most described the market as being a seller’s market with prices continuing to increase as experienced in previous years. The primary factor influencing the market is non-local recreational buyers seeking hunting land or a "get away second home." Some influence has been realized by persons seeking primary rural residences and commuting to Iron Mountain, Michigan or Green Bay, Wisconsin for major employment. However, the rural residential buyers were believed to have only minor influence. Historically, buyers in Marinette County were local (loggers, farmers, residents, and/or investors). The local buyers remain active market participants, however, a significant amount of competition for land has been added to the market by the non-local buyer seeking a recreational site or a second home get away. The added competition has had a positive effect on sale prices and is expected to continue to have a positive effect in the foreseeable future.

The non-local recreational buyers are primarily from south of Marinette County in and around the city of Green Bay. However, some buyers were reported to come from as far away as Milwaukee, Wisconsin and Chicago, Illinois, as these areas are within a reasonable driving distance to Marinette County. This is confirmed by the 17 sale transactions (Sale 1 through Sale 17) included in the Addenda of this report. Eight of the 17 sales transferred to local buyers (buyer with their principle residence in Marinette County). Nine of the sales transferred to non-local buyers. The majority of the non-local buyers were from areas surrounding the city of Green Bay. Two of the sales transferred to buyers from the Chicago, Illinois area.

All those interviewed indicated the market for wetland properties was also strong with the primary buyer purchasing for recreation, more specifically hunting. A small area capable of supporting a hunting cabin or dwelling is an added benefit, although nearly all wetland type properties are capable of this. Most related it would be a detriment to a property if it were impossible to construct some type of cabin or dwelling on a given tract.

The most commonly offered price range for wetland tracts was between $500 per acre to $1,000 per acre. The primary influences on price is size, access, degree of wetness, and potential for a hunting cabin. Size was believed to impact price as there are a limited amount of buyers with the ability to purchase tracts in the 100+ acre size range for recreational use only. Tracts with any kind of water frontage sell at a substantial premium above $1,000 per acre. Properties with limited or no legal or physical access and that are very low and wet typically sell at the low end of the above range. Properties with public road access or adequate access with some area capable of supporting a cabin or dwelling sell closer to the high end of the range. Properties with a site size in the 40 acre to 80 acre range are commonly sold.

The final step in this market analysis is to consider some actual sale transactions and listings and the implications of the data. Following is a summary of the 17 sales in Marinette County considered for the market analysis. The sales are arranged by date of sale beginning with the most recent.

Summary of Marinette County Sale Data

Sale	$/Acre	Date	# Acres	% Wet	Bld Site	Access
1	$ 715	12/99	119	100	poor	public rd
2	1,063	11/99	40	100	none	easement
3	1,000	11/99	939	25	yes	public rd
4	638	10/99	80	100	poor	land lock
5	1,100	10/99	40	100	poor	public rd
6	500	8/99	120	50	yes	easement
7	1,071	4/99	56	85	yes	easement
8	1,000	4/99	50	100	poor	public rd
9	583	3/99	120	100	none	public rd
10	400	2/99	120	95	fr/pr	easement
11	825	1/99	40	95	fair	easement
12	975	1/99	40	70	fair	easement
13	350	1/99	80	92	fair	easement
14	993	1/99	59	90	yes	public rd
15	650	12/98	60	70	fair	private rd
16	667	3/98	42	100	poor	public rd
17	325	12/97	38	100	poor	public rd

All of the above sales were purchased for recreation and most of the sales contain primarily wetland. The sales indicate an overall price range of $325 per acre to $1,100 per acre. The mean indicated sale price is $756 per acre and the median indicated price is $715 per acre, therefore, the high prices and low prices are fairly equally disbursed around the midpoint. However, some additional analysis provides more precise price level ranges.

As additional support, current listings have been considered. A data sheet for each listing is included in the Addenda section of this report (Sale 18 and Sale 19). The listings are summarized below.

Summary of Marinette County Listings

Sale	$/Acre	Date	# Acres	% Wet	Bld Site	Access
18	$ 874	list	80	50	none	easement
19	1,463	list	270	80	yes	public rd

Five characteristics are believed to have the most influence on price levels and include date of sale, site size, amount of wetland verses upland, potential for a building site, and access. Each of these characteristics is discussed on the following pages.

Date of Sale. According to the DOR information and the interviews with local persons familiar with the market, the county market has been increasing in recent years. In general, the sale data confirms this observation.

The sale data summary on the previous page is arranged by date of sale beginning with the most recent. At first glance, there appears to be little to no relationship between sale price and date of sale. However, additional analysis of the data indicates evidence of increasing sale prices.

The most recent sale (Sale 1; 12/99) sold for $715 per acre. The oldest sale (Sale 17; 12/97) sold for $325 per acre. This indicates substantial market improvement during this time period. Furthermore, prior to April 1999 none of the sales exceeded the sale price of $1,000 per acre. Between April 1999 and December 1999, five of eight sales contain a sale price of $1,000 per acre or more.

The improving market conditions are more evident if the sales are grouped by size. The chart below groups the sales in order by date of sale for tracts in the 0 to 79 acre size range and 80+ acre size range.

0 to 79 Acre Tracts				**80+ Acre Tracts**			
Sale	**$/Acre**	**Date**	**# Acres**	**Sale**	**$/Acre**	**Date**	**# Acres**
2	$1,063	11/99	40	1	$ 715	12/99	119
5	1,100	10/99	40	3	1,000	11/99	939
7	1,071	4/99	56	4	638	10/99	80
8	1,000	4/99	50	6	500	8/99	120
11	825	1/99	40	9	583	3/99	120
12	975	1/99	40	10	400	2/99	120
14	993	1/99	59	13	350	1/99	80
15	650	12/98	60				
16	667	3/98	42				
17	325	12/97	38				

By grouping the sales by size, a clear pattern of an improving market is provided. For the sales in the 80+ acre group, Sale 3 appears to be a high sale. However, this sale contains 75 percent upland woods and is likely superior to the other sales in this group. Sale 3 is included only because it is a very large tract sale.

Considering properties that are offered for sale provides a current perception of market prices. Sale 18 is a listing of an 80 acre mixed upland and bottomland tract that is subject to a conservation easement. The easement prohibits all uses but recreation, which includes dwellings and/or hunting cabins. The property is listed for sale at $874 per acre. The selling agent reported two offers on the property at or near the list price and the seller is considering the offers. This listing is near the high end of the 80+ acre sale group above, which suggests continued market improvement.

Sale 19 is a listing of 270 acres for $1,463 per acre. The listing agent indicated that this sale is probably listed a little high but the sellers had rejected an offer of $1,000 per acre. The listing agent believed a likely price would be in the $1,250 per acre range. This listing is similar to Sale 7 in land type, which sold for $1,071 per acre. Therefore, this listing suggests continued market improvement. The listing contains marketable timber, but the exact amount of timber is unknown. The real estate agent believed it had some added value to the property due to enhanced recreational appeal. Sale 7 does not contain similar timber, however, this sale is smaller than the listing. The marketable timber and size differences are considered offsetting.

Therefore, the sale data suggests the market has been improving in recent years and will continue to improve in the foreseeable future.

Site Size. The site size of a property affects price. Generally, as the size of a property increases, the price per acre decreases. This is because there are fewer buyers with the ability to purchase the larger tracts. In the Marinette County market, a 40 acre tract is considered a large tract, however, an 80+ acre tract is considered a very large tract. The chart below groups the sales in order by date of sale for tracts in the 0 to 79 acre size range and 80+ acre size range.

0 to 79 Acre Tracts				**80+ Acre Tracts**			
Sale	**$/Acre**	**Date**	**# Acres**	**Sale**	**$/Acre**	**Date**	**# Acres**
2	$1,063	11/99	40	1	$ 715	12/99	119
5	1,100	10/99	40	3	1,000	11/99	939
7	1,071	4/99	56	4	638	10/99	80
8	1,000	4/99	50	6	500	8/99	120
11	825	1/99	40	9	583	3/99	120
12	975	1/99	40	10	400	2/99	120
14	993	1/99	59	13	350	1/99	80
15	650	12/98	60				
16	667	3/98	42				
17	325	12/97	38				

The sale price of 0 to 79 acre tracts ranges from $325 per acre to $1,100 per acre. However, a much closer range in prices is provided for the sales in this size range that occurred in 1999 of $825 per acre to $1,100 per acre. The mean indicated sale price for the 1999 sales is $1,004 per acre.

The sale price of the 80+ acre tracts ranges from $350 per acre to $1,000 per acre. All these sales occurred in 1999 and have a mean sale price of $598 per acre.

Therefore, the sale data suggests size does impact price. As the size of the site increases, the price per unit decreases.

Percentage Wetland. The degree of wetness and the percentage of wetland verses upland impacts price. Generally, the wetter the property, the lower the price. In other words, the higher the percentage of wetland, the lower the price. In the chart below, the 17 sales have been grouped according to wetness or by percentage of wetland. The first group is of sales with less than 90 percent of the site being wetland. The second group is of sales with 90 percent or more of the land being wetland.

0 to 89 Percent Wetland				90+ Percent Wetland			
Sale	**$/Acre**	**Date**	**% Wet**	**Sale**	**$/Acre**	**Date**	**% Wet**
3	$1,000	11/99	25	1	$ 715	12/99	100
6	500	8/99	50	2	1,063	11/99	100
7	1,071	4/99	85	4	638	10/99	100
12	975	1/99	70	5	1,100	10/99	100
15	650	12/98	70	8	1,000	4/99	100
				9	583	3/99	100
				10	400	2/99	95
				11	825	1/99	95
				13	350	1/99	92
				14	993	1/99	90
				16	667	3/98	100
				17	325	12/97	100

The sale price range of the sales containing 0 to 89 percent wetland ranges from $500 per acre to $1,071 per acre with a mean sale price of $839 per acre.

The sale price range of the sales containing 90 percent or more wetland ranges from $325 per acre to $1,100 per acre with a mean sale price of $722 per acre.

In conclusion, the percentage of wetness is believed to impact price as suggested by the mean sale prices above.

Potential for Building Site. Each of the 17 sales are rated as to their suitability for a building site. Typically, the main limiting factor for building site potential is wetness. Tracts that have potential for a building site require some upland or higher ground.

It is physically possible to construct improvements on nearly every tract in the county if cost is of no concern. However, costs can limit the feasibility of building on a particular tract. Those tracts that require no significant alterations for use as a building site should be reflected positively in price.

Many of the sales contain 100 percent hydric soils, however, some of the soils are typically on slightly higher land and can be built on with fewer limitations to overcome. Most wetland properties in Marinette County contain similar situations.

As most Marinette County properties contain some degree of building potential, an exact adjustment for this characteristic is difficult to measure. The limitations associated with building on a lower tract are believed to be reflected in the price comparison of percentage of wetland. The wetter a property is the more likely additional building limitations exist. Therefore, any adjustment to sale price for building potential is reflected in the percentage of wetland considerations.

Access. Access generally impacts price. Interviews with persons familiar with the market indicate access was one of the primary influences on price. Good physical and legal access has a positive effect on price. Poor physical or legal access has a negative effect on price.

In the State of Wisconsin, access cannot be denied to a tract of land. However, obtaining an easement to a "landlocked" parcel can require legal action, which has associated costs in time and legal fees. Therefore, poor physical or legal access can have a negative effect on price.

Generally, public road access is slightly superior to easement access or private road access. An easement or private road requires road maintenance expenses by the landowner. This is an added cost of ownership and typically is reflected in price.

In the chart below, the sales are grouped by access.

Easement Access			**Public Road Access**		
Sale	**$/Acre**	**Date**	**Sale**	**$/Acre**	**Date**
2	$1,063	11/99	1	$ 715	12/99
6	500	8/99	3	1,000	11/99
7	1,071	4/99	5	1,100	10/99
10	400	2/99	8	1,000	4/99
11	825	1/99	9	583	3/99
12	975	1/99	14	993	1/99
13	350	1/99	16	667	3/98
15	650	12/98	17	325	12/97

The sale price range for the tracts with easement access is $350 per acre to $1,071 per acre and the mean sale price was $729 per acre.

The sale price range for the tracts with public road access is $325 per acre to $1,100 per acre and the mean sale price was $798 per acre. This indicates a slight premium is typically paid for superior access. The indicated premium is enhanced if only the 1999 sales with public road access are considered. The 1999 sales have a mean sale price of $899 per acre.

Sale 4 is the only sale that is considered to be landlocked. The sale price of Sale 4 was $638 per acre, which is below the mean price for easement access and the mean price of public road access. This indicates a parcel with very limited or no access has a negative effect on price compared to easement and public road access.

NOTE. Many of the sales contain a mixture of cropland and woods. All the sales are generally low land. The farmed hydric soils appear to have similar general price levels as wetland with similar factors influencing price.

CONCLUSIONS

The market for wetland properties in the 40+ acre size range has been strong in recent years and is expected to remain strong in the foreseeable future.

The overall price range for 40+ acres wetland tracts in Marinette County is estimated at $500 per acre to $1,200 per acre. The primary factors that impact price are size, percentage wetland/building potential, and access.

There is an inverse relationship between size and sale price. As the size of the site increases, the price per unit decreases. 40 acres to 80 acres appears to be the optimum site size within this study and command the higher prices. The price level of tracts larger than 80 acres decreases as the size of the site increases.

The lower and wetter a property, the lower the price. Tracts containing a high percentage of wetland and limited building potential sell at the lower end of the above range.

The optimum access for a property is public road frontage. Public road frontage properties typically sell at the high end of the range as they contain good physical and legal access. The second best access is an easement within a reasonable distance to public road and adequate physical access. The least desirable access is a landlocked parcel with poor or no legal access or poor physical access.

Most properties will contain a mixture of the above characteristics, containing mostly positive attributes but with one negative attribute. Therefore**, most properties will have a price range of $800 per acre to $1,000 per acre**. An example of an optimum property is a 40 acre tract with public road frontage and a small area of higher land capable of supporting a dwelling or hunting cabin. This property would be expected to contain a price at the high end of the range between $1,000 per acre and $1,100 per acre.

Properties that are severely limited will contain several characteristics that negatively affect price. **Severely limited properties would be expected to have a price range of $600 per acre to $800 per acre**. An example of a property in this price range is a 120 acre tract that is landlocked and containing 95 percent wetlands. This property would be expected to contain a price at the low end of the range or between $500 per acre to $600 per acre.

Farmed hydric soils appear to have similar general price levels as wetland with similar factors influencing price.

The following is a summary of the conclusions of this market analysis for wetland properties having a minimum size of 40 acres in Marinette County. (Not included in the below price ranges are properties with development potential or water frontage.)

Wetland Market Study Summary - *Marinette County*

Overall Price Range........................	$500 per acre to $1,200 per acre
Most Common Price Range (few limitations)..	$800 per acre to $1,000 per acre
Severely Limited Property Price Range......	$600 per acre to $ 800 per acre

PART IIb

WETLANDS

OCONTO COUNTY

LOCATION MAP SHOWING OCONTO COUNTY

[not available]

NEIGHBORHOOD DATA

The map on the facing page shows the location of Oconto County. A neighborhood is a group of complementary land uses.[3] Oconto County is bordered on the north by Marinette County and Forest County, on the east by Marinette County and the bay of Green Bay, on the south by Brown County, and on the west by Shawano County, Menominee County, and Langlade County.

Oconto County is in the northeastern part of Wisconsin and has a total area of 650,976 acres. Of this total, about 9,600 acres is water. Most of the county is drained by Oconto River, which flows southeast and east into Green Bay. Small areas in the northeastern parts of the county are within the basin of the Peshtigo River and part of the southern county is in the Pensaukee and Little Suamico watersheds.

Within the county there are three main physiographic regions. The northern region (Armstrong, Doty, Lakewood, Riverview, and Townsend Townhips) was once a mountainous area, but the area was smoothed by a long period of erosion and glaciation. The central region is a hilly and undulating end moraine. The southeastern region is a broad, undulating ground moraine, which slopes to the east. It is overlain by glacial lake deposits along Green Bay. The entire ground moraine encloses numerous depressions and basins and is interspersed with lake plains and outwash plains. The highest elevations for the county are in the northern region at about 1,400 feet. The lowest elevations are in the southeast corner near the bay of Green Bay at about 580 feet. About 55 percent of the county is woodland.

Winters in Oconto County are very cold, and the short summers are fairly warm. Precipitation is fairly well distributed throughout the year. Snow covers the ground much of the time from late fall through early spring. In winter, the average temperature is 19° F and the average daily minimum temperature is 9° F. In summer, the average temperature is 67° F and the average daily maximum temperature is 79° F. The total annual precipitation is about 30 inches, and the average seasonal snowfall is about 45 inches.

The Oconto County population was 30,226 in 1990 according to the 1990 Census. The 1998 estimated population was 33,089 according to the State of Wisconsin Department of Administration. This suggests a stable, but growing population. The majority of the population growth is in the southern areas of the county within easy commuting distance to the city of Green Bay for major employment. Many residents of Brown County are relocating to the outlying areas and commuting into Green Bay daily for employment. Significant municipalities within the county are shown below along with the 1990 Census population and the 1998 population estimate.

Municipality	1990 Census	1998 Estimate
Little Suamico..........	2,637	3,315
Abrams..................	1,347	1,627
Chase...................	1,375	1,611
Gillett, City...........	1,243	1,369
Little River............	1,003	1,086
Oconto, City............	4,474	4,764
Oconto Falls, Town......	1,014	1,079
Oconto Falls, City......	2,584	2,726
Stiles..................	1,303	1,369
Brazeau.................	1,169	1,201

Oconto is the largest city in the county and is the county seat. The majority of the cities indicating substantial growth between 1990 and 1998 are located in the southern areas of the county.

Following is the industry group for Oconto County, their number of employees, and their percent of total employees according to the 1990 census.

Industry Group – Oconto County	Employees	Percent of Total
Agriculture, forestry, and fisheries................	1,405	11%
Mining..	21	0%
Construction..	785	6%
Manufacturing.......................................	4,122	32%
Transportation......................................	636	5%
Communications & other public utilities.............	184	1%
Wholesale trade.....................................	415	3%
Retail trade..	1,945	15%
Finance, insurance, & real estate...................	434	3%
Business & repair services..........................	308	2%
Personal services...................................	219	2%
Entertainment & recreation services.................	111	1%
Health services.....................................	863	7%
Educational services................................	830	6%
Other professional services.........................	509	4%
Public administration...............................	326	2%
Total Employees...................................	**13,113**	

The economy in Oconto County is adequately diverse, but the three main industries in the county are agriculture/forestry, manufacturing, and retail trade. These three industries comprise 58.0 percent of the total employment.

Wood using industries and lumbering are major enterprises in Oconto County. Agriculture and outdoor recreation are also important industries.

The top 10 private sector employers for Oconto County are shown below.

Major Employers - Oconto County	Product Type	Employees
KCS International, Inc.......	Boat Manufacturing...................	500-999
Saputo Cheese USA, Inc.......	Cheese Processing....................	250-499
Even Flo Company, Inc........	Furniture............................	100-249
Community Memorial Hospital..	Health Care..........................	100-249
Cera-Mite Corporation........	Electronic Capacitors................	100-249
Sharpe Care Ltd..............	Skilled Nursing Care Facility........	100-249
TRM, Inc.....................	Hardwood Veneer and Plywood..........	100-249
Unlimited Services of WI, Inc	Current-Carrying Wiring Devices......	100-249
Nercon Engine & Mfg, Inc.....	Conveyors and Conveying Equipment....	100-249
Beverly Health & Rehabilitat.	Skilled Nursing Care Facility........	100-249

In April 2000, the unemployment rate for Oconto County was 4.8 percent, which was the same as April 1999. The April 2000 unemployment rate for the State of Wisconsin was 3.5 percent. Therefore, while the Oconto County unemployment rate has stable over the last year, it remains higher than the state average unemployment rate. The Oconto County labor force totals approximately 15,500 workers.

Nearly 3,000 more workers leave the county for work in neighboring counties than enter for work. Approximately one third of the Oconto County labor force works outside the county. The majority of commuting occurs to Green Bay. Over 70 percent of the outbound workers commute to Green Bay.

The 1997 per capita personal income was $16,602 for Oconto County and $24,048 for the State of Wisconsin. This suggests a slightly depressed economy, however, the standard of living for the county is likely significantly lower than that of the state as suggested by typical housing costs. Median gross rent for the county is $294 per month and the median housing value is $43,200 compared to median gross rent for the state of $399 per month and a median housing value of $62,100. Therefore, the income for the county is considered adequate. Income in Oconto County has remained stable, with no major fluctuations that greatly affect the economy.

Financing is readily available in the area typically via conventional loans on all types of real property--agriculture, commercial, and residential. There are several banks in the area that actively make loans.

Government services, police and fire protection, education, and health services are adequately provided within the county. Transportation is adequately provided within the county via a series of federal, state, and county road systems. Major highways include Highway 41, 141, 32, 22, and 64. Recreational opportunities are adequate via numerous national, state, and county publicly owned lands and the bay of Green Bay and numerous inland lakes, rivers, and streams. Nicolet National Forest is located within the county.

In summary, Oconto County has a stable and reasonably diversified economic base. Population, income, and employment are all stable. Most shopping, education, health care, recreation, and employment facilities are adequately provided for within the county, and additional amenities are available in the city of Green Bay. There are no known changes that could substantially impact the economy. Therefore, a continued stable economy is most likely.

Following is a summary of neighborhood trends and neighborhood characteristics for Oconto County.

Neighborhood Trends – Oconto County	Up	Stable	Down
Development.............................	x*	x	
Value...................................	x	x	
Vacancy.................................		x	
Population..............................		x	
Employment..............................		x	
Demand..................................	x	x	
Effective Purchase Power................		x	

Neighborhood Characteristics – Oconto County	Ex	Gd	Av	Fr	Pr
Maintenance/Condition...........		x	x	x	
Property Compatibility..........			x		
Appeal/Appearance...............			x		
Protection/Adverse Influence....			x		
Development Potential...........			x		
Transportation Access...........			x		
Police/Fire Protection..........			x		
Soil Quality/Productivity.......			x		

*Increased development activity is mostly in the southern portion of the county.

LOCATION MAP SHOWING THE OCONTO COUNTY SALES

[not available]

OCONTO COUNTY MARKET ANALYSIS

The objective of this market analysis is to demonstrate the general price levels for vacant wetland properties in Oconto County with a minimum size of 40 acres. This study focused on properties with a highest and best use of recreation with little to no development influence. The study also reports on the primary factors that influence prices.

In vacant land analysis, the most reliable method of measuring the market is by comparable sale data or actual sale transactions in the market area of similar land types. This data provides direct market indications of what sellers are willing to accept and what buyers are willing to pay for a particular property type.

For this analysis, data was gathered on over 40 sale transactions (occurring between 1997 and 2000) and listings in Oconto County. From this group of data, 13 sales and listing were selected for consideration in reporting the general price levels. A sale data sheet for each of the 13 sales and listing are provided in the Addenda section of this report. The sale data sheet shows the location, property type, legal description, grantor, grantee, date of closing, property rights conveyed, financing terms, conditions of sale, data source, sale price, site size, sales price per acre, and other pertinent information for each sale. A sale location map is presented on the facing page.

Criteria for selecting market data was good arm’s-length transactions, primarily low land or wetland (having primarily hydric soils), minimum site size of 40 acres, unimproved tracts, and purchased for recreation. Specifically excluded from this study that meet the criteria above are water front properties as they are discussed in "Part III" of this report.

As additional support for the sale data, consideration is given to market summaries compiled by the Wisconsin Department of Revenue for vacant land and interviews with real estate agents and appraisers in Oconto County.

The market analysis will begin with a discussion of the Wisconsin Department of Revenue reports followed by the results of interviews of real estate agents and appraisers in the Oconto County area as this will give a general overview of the current market conditions.

With each sale of a parcel of real estate, the buyer is required to file a "Wisconsin Real Estate Transfer Return" documenting the parcel size, sale price, present use, and intended use of the property. The transfer returns are filed with the Wisconsin Department of Revenue, Equalization Board (DOR). State appraisers inspect the site of each sale and verify the transfer return. The following information is averages from the transfer return data. As of the date of this report, the most current information available is 1998 due to the lag time required to inspect, verify, and process the data.

The DOR information indicates that overall agricultural land prices have increased each year since 1993. The following chart shows the average sale price for agricultural land for the State of Wisconsin from 1993 to 1998. The averages include vacant land and improved agricultural land.

Wisconsin Average Agriculture Land Prices
(All farms-Vacant & Improved)

Year	# Sales	Acres	$/Acre	Change
1993	7,462	430,575	$ 969	
1994	6,094	383,002	1,033	+ 6.6%
1995	4,507	283,711	1,127	+ 9.1%
1996	4,637	290,860	1,284	+ 13.9%
1997	4,045	263,456	1,413	+ 10.1%
1998	4,088	264,606	1,515	+ 7.2%

The above information indicates the Wisconsin agriculture market has maintained considerable strength during the years shown above.

The DOR further breaks down land sales to agricultural land without buildings, forested lands, and swamp or marsh land by county. Separate sale data is reported for "Land continuing in use" and "Land being diverted to other uses."

Following is a summary of land sale data for agricultural land sales without buildings; comparing Oconto County to other area counties and to the State of Wisconsin.

1998 Agricultural Land Sales Summary--*Without Buildings*
Source: Wisconsin Department of Revenue-Board of Equalization

	Ag Land Continuing Use			Ag Land Diverting Use			Total Ag Land		
County	# Trans	Acres Sold	$ Per Acre	# Trans	Acres Sold	$ Per Acre	# Trans	Acres Sold	$ Per Acre
Marinette	22	828	$ 785	5	163	$1,042	27	991	$ 827
Oconto	38	1,645	891	18	524	1,926	56	2,169	1,141
Outagamie	17	1,227	1,323	5	265	3,234	22	1,492	1,682
Door	20	671	1,058	3	65	1,549	23	736	1,102
Brown	10	648	1,839	16	633	6,833	26	1,281	4,307
State Avg.	1,472	--	1,173	767	--	1,785	2,239	--	1,332

The above data indicates the average price for agricultural land with a continuing use in Oconto County was $891 per acre and the average price for agricultural land with a diverting use (likely some type of development land) was $1,926 per acre. The average price for agricultural land overall in the county was $1,141 per acre. The average agriculture unit sold was 38.7 acres (2,169 acres ÷ 56 sales). It is interesting to note the above information indicates that the majority of sales in the county sold for agricultural purposes, however, 32 percent of the above sales transferred for a diverting use. In addition, average land prices for Oconto County are below the average land prices for the state. Oconto County is at the low end of the range of the average land sale price of the five counties displayed above.

Following is a summary of land sale data for forested sales; comparing Oconto County to other area counties and to the State of Wisconsin. Forested land sales include both upland and wetland sales.

1998 Land Sales Summary--*Forested Lands*

Source: Wisconsin Department of Revenue-Board of Equalization

	Land Continuing Use			**Land Diverting Use**			**Total Land**		
County	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**
Marinette	90	4,092	$ 925	19	1,114	$1,054	109	5,206	$ 953
Oconto	56	1,772	934	27	796	1,319	83	2,568	1,053
Outagamie	27	675	1,126	6	73	2,724	33	748	1,282
Door	32	906	1,222	12	228	2,014	44	1,134	1,381
Brown	13	205	1,028	10	195	4,170	23	400	2,559
State Avg	2,959	--	789	1,325	--	1,015	4,284	--	854

The above data indicates the average price for forested land with a continuing use in Oconto County was $934 per acre and the average price for forested land with a diverting use (likely some type of development land) was $1,319 per acre. The average price for forested land overall in the county was $1,053 per acre. The average forested unit sold was 30.9 acres (2,568 acres ÷ 83 sales). It is interesting to note the above information indicates that the majority of sales in the county sold for continuing use, however, 33 percent of the above sales transferred for a diverting use. Forested land sale prices for the county exceed state averages, however, Oconto County is at the low end of the range of the five counties displayed above.

Following is a summary of land sale data for swamp and waste land sales; comparing Oconto County to other area counties and to the State of Wisconsin.

1998 Land Sales Summary--*Swamp/Waste Land*

Source: Wisconsin Department of Revenue-Board of Equalization

	Land Continuing Use			**Land Diverting Use**			**Total Land**		
County	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**
Marinette	48	447	$ 535	11	119	$ 519	59	566	$ 532
Oconto	49	538	410	24	308	479	73	846	435
Outagamie	30	661	697	11	364	2,193	41	1,025	1,228
Door	24	332	838	7	56	308	31	388	761
Brown	13	132	732	9	95	6,093	22	227	2,976
State Avg	2,259	--	408	882	--	788	3,141	--	503

The above data indicates the average price for swamp/waste land with a continuing use in Oconto County was $410 per acre and the average price for swamp/waste land with a diverting use (likely some type of development land) was $479 per acre. The average price for swamp/waste land overall in the county was $435 per acre. It is interesting to note diverting use land sold at nearly the same price as continuing use land. Swamp/waste land sale prices for the county are below state averages. Oconto County has the lowest average sale price of the five counties shown above.

The above information from the DOR demonstrates that the Oconto County market is active. The data offers average prices for the three land types above and demonstrates their price relationship. The average price for all agricultural land without buildings in 1998 was $1,141 per acre. The average price for forested land in 1998 was $1,053 per acre. The average price for swamp/waste land in 1998 was $435 per acre. Furthermore, the trend analysis indicates the market for Wisconsin has been improving in recent years and shows a considerable amount of strength.

In the process of gathering and confirming sale data for Oconto County, the author interviewed several real estate agents, appraisers, and/or market participants. Following is a summary of some of their comments about the county market. The persons interviewed are believed to be knowledgeable about the local market. The interviews focused on the market for vacant land in the 40+ acre size range and specifically on wetlands and water front properties.

All persons interviewed characterized the overall market as being strong with good demand. Most described the market as being a seller’s market with prices continuing to increase as experienced in previous years. Two factors are driving the market, which include rural homesite buyers and recreational buyers.

Southern Oconto County has experienced significant growth in population and demand for real estate. The growth is the result of many residents of the city of Green Bay and Brown County relocating to outlying areas and commuting into Green Bay daily for employment. The strong demand for rural residential property is primarily concentrated in southern Oconto County as it is within easy commuting distance to Green Bay. The northern areas of the county are somewhat removed from Green Bay and require a longer daily commuting distance than market participants are willing to forego. One person interviewed stated "values decline rapidly north of Highway 22" because of the greater commuting time required. In addition, most persons interviewed indicated overall property prices were the highest at the Brown/Oconto County line and decreased as they move north with Highway 22 being the general cut off line where rural residential demand rapidly decreased.

The demand for recreational land is also reported to be strong. There is good demand for recreational land throughout the county. Recreational land demand is not so much concentrated to the southern region of the county. However, most interviewed indicated that the price of recreational land increased the closer it is to Brown County as the majority of the buyers are Brown County residents. The primary recreational use is hunting. Recreational land can be both upland and wetland, although few upland tracts in southern Oconto County sell for recreation only as the recreational buyer has to compete with the rural homesite buyer. Prices for rural homesite buyers typically far exceed that of the recreational buyer.

The overall price range offered for wetland properties was $800 per acre to $1,500 per acre. The lower end of the range ($800 per acre to $1,000 per acre) was typically offered by persons located in the northern portions of Oconto County. The higher end of the range ($1,000 per acre to $1,500 per acre) was typically offered by persons located in the southern portions of the county with the highest prices being nearest to Brown County. Other factors offered that influence price include having some area capable of supporting a dwelling or cabin, access, and size.

The final step in this market analysis is to consider some actual sale transactions and listings and the implications of the data. Following is a summary of the 13 sales in Oconto County considered for the market analysis. The sales are arranged by date of sale beginning with the most recent.

Summary of Oconto County Sale Data

Sale	$/Acre	Date	# Acres	% Wet	Bld Site	Access	Region*
20	$1,150	12/99	40	100	poor	none	north
21	1,048	10/99	42	60	yes	fair	north
22	875	9/99	80	100	poor	public rd	south
23	909	8/99	44	100	poor	public rd	south
24	1,000	5/99	40	100	poor	public rd	south
25	1,250	4/99	80	100	poor	public rd	south
26	375	4/99	400	100	poor	public rd	north
27	1,116	4/99	43	100	poor	public rd	south
28	1,600	3/99	60	100	poor	public rd	south
29	875	2/99	40	100	none	public rd	north
30	750	2/98	40	100	poor	easement	north
31	1,213	12/97	40	100	poor	public rd	south
32	950	10/97	40	100	poor	public rd	south

*North Region = North of Hgy 22 & West of Hgy 32
*South Region = South of Hgy 22 & East of Hgy 32

All of the above sales were purchased for recreation and most of the sales contain primarily wetland. The sales indicate an overall range in sale prices of $375 per acre to $1,600 per acre. Excluding the highest sale price and the lowest sale price provides a much closer range of $750 per acre to $1,250 per acre. The mean indicated sale price is $1,009 per acre and the median indicated price is $1,000 per acre, therefore, the high prices and low prices are fairly equally disbursed around the midpoint.

The lowest sale above is Sale 26, which contained 400 acres of wetland and sold for $375 per acre. The sale occurred between friends and may not have been a completely arm's-length transaction. The seller indicated they had sold other wetland tracts in the 100 acre to 200 acre size range for $750 per acre. Specific information on these transactions was not available. However, based on the circumstances of the sale and in comparison with the other 12 sales, this is believed to be a below market transaction. The sale is included only as it is a large wetland tract.

The highest sale above is Sale 28, which contained 60 acres of wetland and sold for $1,600 per acre. This sale is located within close proximity to Sale 24, Sale 25, Sale 31, and Sale 32. The price range of these four sales was $950 per acre to $1,250 per acre. Therefore, Sale 28 may have been a high sale and not representative of the market. The sale is located next door to a hunting lodge, which may have influenced price.

Therefore, Sale 26 and Sale 28 are given no additional consideration in this market analysis. As previously stated, the remaining sales provide a much closer range in prices of $750 per acre to $1,250 per acre. Therefore, the Oconto County sale summary is presented below, excluding Sale 26 and Sale 28.

Summary of Oconto County Sale Data

Sale	$/Acre	Date	# Acres	% Wet	Bld Site	Access	Region*
20	$1,150	12/99	40	100	poor	none	north
21	1,048	10/99	42	60	yes	fair	north
22	875	9/99	80	100	poor	public rd	south
23	909	8/99	44	100	poor	public rd	south
24	1,000	5/99	40	100	poor	public rd	south
25	1,250	4/99	80	100	poor	public rd	south
27	1,116	4/99	43	100	poor	public rd	south
29	875	2/99	40	100	none	public rd	north
30	750	2/98	40	100	poor	easement	north
31	1,213	12/97	40	100	poor	public rd	south
32	950	10/97	40	100	poor	public rd	south

*North Region = North of Hgy 22 & West of Hgy 32
*South Region = South of Hgy 22 & East of Hgy 32

The 11 sales above are given primary consideration in this market study.

As additional support, current listings have been considered. One wetland listing was confirmed for Oconto County. The listing is a prior sale and the data for this property is in the Addenda section of this report as Sale 29. The listing is summarized below.

Summary of Oconto County Listings

Sale	$/Acre	Date	# Acres	% Wet	Bld Site	Access
29	$ 998	list	40	100	none	public rd

Six characteristics are believed to have the most influence on price levels and include date of sale, site size, amount of wetland verses upland, potential for a building site, access, and location. Each of these characteristics is discussed below.

Date of Sale. According to the DOR information and the interviews with local persons familiar with the market, the county market has been increasing in recent years.

The sale data summary above is arranged by date of sale beginning with the most recent. At first glance, there appears to be little to no relationship between sale price and date of sale. However, additional analysis of the data indicates evidence of increasing sale prices.

The improving market conditions are more evident if the sales are grouped by region. The chart below groups the sales in order by date of sale for the north and south regions.

North Region				South Region			
Sale	**$/Acre**	**Date**	**# Acres**	**Sale**	**$/Acre**	**Date**	**# Acres**
20	$1,150	12/99	40	22	$875	9/99	80
21	1,048	10/99	42	23	909	8/99	44
29	875	2/99	40	24	1,000	5/99	40
30	750	2/98	40	25	1,250	4/99	80
				27	1,116	4/99	43
				31	1,213	12/97	40
				32	950	10/97	40

The north region indicates a clear pattern of an improving market. The most recent sale price was $1,150 per acre and the most dated sale price was $750 per acre. Furthermore, the listing previously provided is of Sale 29. Sale 29 sold in February 1999 for $875 per acre and is currently listed for $998 per acre. This indicates the most current market perceptions of price levels.

The south market contains more mixed sale data and demonstrates no clear pattern for market conditions.

In summary, the north market clearly demonstrates improvement. The south market is inclusive but mostly suggests a stable market. Interviews with area real estate agents indicate an increasing market, although a few rated the market as stable. Based on all the information, the Oconto County market is rated stable to increasing with similar market conditions expected in the foreseeable future.

Site Size. The site size of a property affects price. Generally, as the size of a property increases, the price per acre decreases. This is because there are fewer buyers with the ability to purchase the larger tracts. In the Oconto County market, a 40 acre tract is considered a large tract, however, an 80+ acre tract is considered a very large tract.

The site size of the Oconto County sales ranges from 40 acres to 400 acres. However, the 400 acre sale is not considered a good arm’s-length sale and is given no consideration. The remaining sales have a site size range of 40 acres to 80 acres. Only two of the sales are 80 acre tracts and the remaining sales are generally 40 acre tracts. This data is inadequate to discern the impact of size on price.

In considering the impact of size on price, most consideration has been given to comments of interviews with real estate agents and the data from other surrounding counties. This information indicates that as size increases the price per unit decreases as there are fewer buyers with the ability to purchase the larger tracts.

Percentage Wetland. The degree of wetness and the percentage of wetland verses upland impacts price. Generally, the wetter the property, the lower the price. In other words, the higher the percentage of wetland, the lower the price.

The majority of the Oconto County sales are wetland tracts. In addition, most of the properties contain some small area of higher ground that could likely support a structure. Sale 21 is the only sale in this group with an area of upland. However, access to this tract is fair with a narrow lane through low land, therefore, any added upland value is not reflected in this sale.

Interviews with real estate agents indicated that upland tracts were selling in excess of $2,000 per acre for rural homesites or for development land. Therefore, the Oconto County sales included in this report are believed to reflect a reduced price for wetness.

In conclusion, the percentage of wetness is believed to impact price. The majority of the sales included in this report are wet properties and reflect a reduced price. Any property with some upland (and good access) would likely sell at a premium above the prices indicated within these sales.

Potential for Building Site. Each of the 11 sales are rated as to their suitability for a building site. Typically, the main limiting factor for building site potential is wetness. Tracts that have potential for a building site require some upland or higher ground.

It is physically possible to construct improvements on nearly every tract in the county if cost is of no concern. However, costs can limit the feasibility of building on a particular tract. Those tracts that require no significant alterations for use as a building site should be reflected positively in price.

Many of the sales contain 100 percent hydric soils, however, some of the soils are typically on slightly higher land and can be built on with fewer limitations to overcome. Most wetland properties in Oconto County contain similar situations.

As most Oconto County properties contain some degree of building potential, an exact adjustment for this characteristic is difficult to measure. The limitations associated with building on a lower tract are believed to be reflected in the sales as nearly all contain 100 percent hydric soils.

Access. Access generally impacts price. Interviews with persons familiar with the market indicate access was one of the primary influences on price. Good physical and legal access has a positive effect on price. Poor physical or legal access has a negative effect on price.

In the State of Wisconsin, access cannot be denied to a tract of land. However, obtaining an easement to a "landlocked" parcel can require legal action, which has associated costs in time and legal fees. Therefore, poor physical or legal access can have a negative effect on price.

Generally, public road access is slightly superior to easement access or private road access. An easement or private road requires road maintenance expenses by the landowner. This is an added cost of ownership and typically is reflected in price.

Location. As previously indicated, most persons interviewed stated that the south region (being generally south of Highway 22) is superior to the north region (being generally north of Highway 22). The Oconto County sale data supports this conclusion. Following is a summary of the sale data organized by date of sale and region.

North Region				South Region			
Sale	$/Acre	Date	# Acres	Sale	$/Acre	Date	# Acres
20	$1,150	12/99	40	22	$ 875	9/99	80
21	1,048	10/99	42	23	909	8/99	44
29	875	2/99	40	24	1,000	5/99	40
30	750	2/98	40	25	1,250	4/99	80
				27	1,116	4/99	43
				31	1,213	12/97	40
				32	950	10/97	40

The mean sale price of the north region was $956 per acre. The mean sale price of the south region was $1,045 per acre. Therefore, the data suggests there are location differences within Oconto County. In addition, based on interviews with persons familiar with the market, prices are believed to increase closer to Brown County.

NOTE. Many of the sales contain a mixture of cropland and woods. All the sales are generally low land. The farmed hydric soils appear to have similar general price levels as wetland with similar factors influencing price.

CONCLUSIONS

The market for wetland properties in the 40+ acre size range has been strong in recent years and is expected to remain strong in the foreseeable future.

The overall price range for 40+ acre wetland tracts in Oconto County is estimated at $750 per acre to $1,250 per acre. The primary factors that impact price are size, percentage wetland/building potential, access, and location.

As the size of the site increases, the price per unit will decrease. The higher the percentage of wetland, the lower the price. Public road access is the preferred access. Easement access and no access typically has a negative effect on price. Generally, the closer a tract is to Brown County, the higher the price.

For the **north region**, as previously defined, **most properties will have a price range of $750 per acre to $1,000 per acre**. A 40 acre tract with good access and the ability to support a structure will be at the high end of the price range. A tract that is 80+ acres, contains poor access, **or** contains severe building limitations will be at the lower end of the price range.

For the **south region**, as previously defined, **most properties will have a price range of $1,000 per acre to $1,250 per acre**. A 40 acre tract with good access located within close proximity to Brown County will be at the high end of the price range. A tract that is 80+ acres, contains poor access, **or** contains severe building limitations will be at the lower end of the price range.

Farmed hydric soils appear to have similar general price levels as wetland with similar factors influencing price.

The following is a summary of the conclusions of this market analysis for wetland properties having a minimum size of 40 acres in Oconto County. (Not included in the below price ranges are properties with development potential or water frontage.)

Wetland Market Study Summary - *Oconto County*

Overall Price Range......................	$ 750 per acre to $1,250 per acre
Most Common Price Range (North Region)...	$ 750 per acre to $1,000 per acre
Most Common Price Range (South Region)...	$1,000 per acre to $1,250 per acre

PART IIc

WETLANDS

OUTAGAMIE COUNTY

LOCATION MAP SHOWING OUTAGAMIE COUNTY

[not available]

NEIGHBORHOOD DATA

The map on the facing page shows the location of Outagamie County. A neighborhood is a group of complementary land uses.[4] Outagamie County is bordered on the north by Shawano County, on the east by Brown County, on the south by Calumet County and Winnebago County, and on the west by Waupaca County.

Outagamie County is in the northeastern part of Wisconsin and has a total area of 406,016 acres. Most of the county is drained by the Fox River, although portions are drained by Duck Creek and Wolf River. All of the Outagamie County drainage ends up in the bay of Green Bay.

Within the county there are three main topographic regions. The northwestern quarter is mostly flat land formed by glacial lake deposits and flood plain deposits and is somewhat poorly drained. The area along the Fox River in the southeastern corner is relatively flat but well drained. The remainder of the county is mostly gently sloping. Originally, the majority of the county was forested, however, much of the land was cleared in early logging days. Currently, about 69,000 acres or 17 percent of the county remains in woodland. Approximately 38,000 acres or 9 percent of the county is in wetlands that remain in their natural state.

Outagamie County has a continental climate. Winters are long, cold, and snowy. Summers are warm and occasionally humid. The average daily minimum temperature for January is 9.8° F. January is the coldest month. The average daily maximum temperature in July is 82.6° F. July is the warmest temperature. The average annual rain fall is 28.45 inches, and the average annual snowfall is 43.4 inches.

The Outagamie County population was 140,510 in 1990 according to the 1990 Census. The 1998 estimated population was 155,953 according to the State of Wisconsin Department of Administration. This is an increase of 11 percent (about 1 percent per year) and suggests a stable, but growing population. Growth for the county has outpaced the state (7 percent) and country (7 percent) during the same period 1990-1998. Significant municipalities within the county are shown below along with the 1990 Census population and the 1998 population estimate.

Municipality	1990 Census	1998 Estimate
Appleton................	65,695	69,607
Grand Chute, Town.......	14,490	17,693
Kaukauna................	11,982	12,793
Little Chute............	9,207	10,436
Kimberly................	5,405	5,817
Greenville, Town........	3,806	5,538
Freedom, Town...........	4,114	4,998
Buchanan, Town..........	2,484	4,581
Seymour.................	2,782	3,222
Brazeau.................	2,716	2,990

Appleton is the largest city in the county and is the county seat. Many of the cities indicate substantial growth between 1990 and 1998.

Following is the industry group for Outagamie County, their number of employees, and their percent of total employees according to the 1990 census.

Industry Group – Outagamie County	Employees	Percent of Total
Agriculture, forestry, and fisheries................	2,370	3%
Mining..	69	0%
Construction..	4,106	6%
Manufacturing.......................................	20,755	30%
Transportation......................................	2,297	3%
Communications & other public utilities.............	1,034	1%
Wholesale trade.....................................	2,977	4%
Retail trade..	12,667	18%
Finance, insurance, & real estate...................	4,803	7%
Business & repair services..........................	3,144	4%
Personal services...................................	1,660	2%
Entertainment & recreation services.................	630	1%
Health services.....................................	4,927	7%
Educational services................................	5,009	7%
Other professional services.........................	3,440	5%
Public administration...............................	1,242	2%
Total Employees.................................	**71,130**	

The economy in Outagamie County is adequately diverse, but the two main industries in the county are manufacturing and retail trade. These two industries comprise 48.0 percent of the total employment.

The dominate industry and manufacturer in the county is the paper industry. The industrial development is primarily concentrated along the Fox River. Other important manufacturing industries include plastics, printing and graphic arts, machinery, metals, electronics, and food processing. Agriculture is a significant contributor to the local economy both directly and indirectly. The dairy producers remain the primary component of the agriculture industry of the county, although the number of dairy cattle and dairy farms are declining.

The top 10 private sector employers for Outagamie County are shown below.

Major Employers - Outagamie County	Product Type	Employees
Appleton Papers, Inc.........	Coated Paper.........................	1,000+
Hillshire Farm & Kahn’s......	Meat Processing......................	1,000+
Miller Electric Mfg. Co......	Welding Machines.....................	1,000+
AAL..........................	Insurance............................	1,000+
St. Elizabeth Hospital.......	Health Care..........................	1,000+
Anchor Food Products.........	Frozen Food Products.................	1,000+
Inter Lake, Inc..............	Paper................................	1,000+
United Health................	Health Care..........................	500-999
Oscar J. Boldt...............	Construction.........................	500-999
A.C. Compressor Corporation..	Compressors..........................	250-499

There are a total of 4,181 private sector employers in Outagamie County. The top 10 employers employ 13 percent of all workers working in the county. Six of the ten largest private employers are in the manufacturing industry.

In April 2000, the unemployment rate for Outagamie County was 2.7 percent, which was similar to the April 1999 rate of 2.6 percent. The April 2000 unemployment rate for the State of Wisconsin was 3.5 percent. Therefore, the county unemployment rate has been stable and below that of the state. The Outagamie County labor force totals approximately 100,800 workers.

Almost 45 percent of all employed Outagamie County residents work outside of the county. Winnebago County is the destination for two-thirds of the outbound commuters. The majority of those commuting to Winnebago County work in the paper industry. However, there are 1,400 more workers that enter the county for employment than leave the county for employment.

The 1997 per capita personal income was $25,845 for Outagamie County and $24,048 for the State of Wisconsin. Outagamie County's per capita income ranked sixth highest of Wisconsin's 72 counties during 1997. Therefore, income levels for the county are adequate. Income for the county has remained stable in recent years.

Median gross rent for the county is $385 per month and the median housing value is $63,900 compared to median gross rent for the state of $399 per month and a median housing value of $62,100. Therefore, the cost of living in the county is similar to the state.

Financing is readily available in the area typically via conventional loans on all types of real property--agriculture, commercial, and residential. There are several banks in the area that actively make loans.

Government services, police and fire protection, education, and health services are adequately provided within the county. Transportation is adequately provided within the county via a series of federal, state, and county road systems. Major highways include Highway 10, 41, 45, 47, 54, 55, and 76. Recreational opportunities are adequate via Lake Winnebago, just southeast of the county, and a variety of cultural, artistic, and sporting events.

In summary, Outagamie County has a stable and reasonably diversified economic base. Population, income, and employment are all stable. Most shopping, education, health care, recreation, and employment facilities are adequately provided for within the county, and additional amenities are available in Winnebago County and Brown County, an easy driving distance. There are no known changes that could substantially impact the economy. Therefore, a continued stable economy is most likely.

Following is a summary of neighborhood trends and neighborhood characteristics for Outagamie County.

Neighborhood Trends – Outagamie County	Up	Stable	Down
Development	x	x	
Value	x	x	
Vacancy		x	
Population		x	
Employment		x	
Demand	x	x	
Effective Purchase Power		x	

Neighborhood Characteristics – Outagamie County	Ex	Gd	Av	Fr	Pr
Maintenance/Condition		x	x	x	
Property Compatibility			x		
Appeal/Appearance			x		
Protection/Adverse Influence			x		
Development Potential			x		
Transportation Access			x		
Police/Fire Protection			x		
Soil Quality/Productivity			x		

LOCATION MAP SHOWING THE OUTAGAMIE COUNTY SALES

[not available]

OUTAGAMIE COUNTY MARKET ANALYSIS

The objective of this market analysis is to demonstrate the general price levels for vacant wetland properties in Outagamie County with a minimum size of 40 acres. This study focused on properties with a highest and best use of recreation with little to no development influence. The study also reports on the primary factors that influence prices.

In vacant land analysis, the most reliable method of measuring the market is by comparable sale data or actual sale transactions in the market area of similar land types. This data provides direct market indications of what sellers are willing to accept and what buyers are willing to pay for a particular property type.

For this analysis, data was gathered on over 20 sale transactions (occurring between 1996 and 2000). From this group of data, 14 sales were selected for consideration in reporting the general price levels. A sale data sheet for each of the 14 sales is provided in the Addenda section of this report. The sale data sheet shows the location, property type, legal description, grantor, grantee, date of closing, property rights conveyed, financing terms, conditions of sale, data source, sale price, site size, sales price per acre, and other pertinent information for each sale. A sale location map is presented on the facing page.

Criteria for selecting market data was good arm’s-length transactions, primarily low land or wetland (having primarily hydric soils), minimum site size of 40 acres, unimproved tracts, and purchased for recreation.

As additional support for the sale data, consideration is given to market summaries compiled by the Wisconsin Department of Revenue for vacant land and interviews with real estate agents and appraisers in Outagamie County.

The market analysis will begin with a discussion of the Wisconsin Department of Revenue reports followed by the results of interviews of real estate agents and appraisers in the Outagamie County area as this will give a general overview of the current market conditions.

With each sale of a parcel of real estate, the buyer is required to file a "Wisconsin Real Estate Transfer Return" documenting the parcel size, sale price, present use, and intended use of the property. The transfer returns are filed with the Wisconsin Department of Revenue, Equalization Board (DOR). State appraisers inspect the site of each sale and verify the transfer return. The following information is averages from the transfer return data. As of the date of this report, the most current information available is 1998 due to the lag time required to inspect, verify, and process the data.

The DOR information indicates that overall agricultural land prices have increased each year since 1993. The following chart shows the average sale price for agricultural land for the State of Wisconsin from 1993 to 1998. The averages include vacant land and improved agricultural land.

Wisconsin Average Agriculture Land Prices

(All farms-Vacant & Improved)

Year	# Sales	Acres	$/Acre	Change
1993	7,462	430,575	$ 969	
1994	6,094	383,002	1,033	+ 6.6%
1995	4,507	283,711	1,127	+ 9.1%
1996	4,637	290,860	1,284	+ 13.9%
1997	4,045	263,456	1,413	+ 10.1%
1998	4,088	264,606	1,515	+ 7.2%

The information on the previous page indicates the Wisconsin agriculture market has maintained considerable strength during the years shown.

The DOR further breaks down land sales to agricultural land without buildings, forested lands, and swamp or marsh land by county. Separate sale data is reported for "Land continuing in use" and "Land being diverted to other uses."

Following is a summary of land sale data for agricultural land sales without buildings; comparing Outagamie County to other area counties and to the State of Wisconsin.

1998 Agricultural Land Sales Summary--*Without Buildings*

Source: Wisconsin Department of Revenue-Board of Equalization

	Ag Land Continuing Use			Ag Land Diverting Use			Total Ag Land		
County	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**
Marinette	22	828	$ 785	5	163	$1,042	27	991	$ 827
Oconto	38	1,645	891	18	524	1,926	56	2,169	1,141
Outagamie	17	1,227	1,323	5	265	3,234	22	1,492	1,682
Door	20	671	1,058	3	65	1,549	23	736	1,102
Brown	10	648	1,839	16	633	6,833	26	1,281	4,307
State Avg.	1,472	--	1,173	767	--	1,785	2,239	--	1,332

The above data indicates the average price for agricultural land with a continuing use in Outagamie County was $1,323 per acre and the average price for agricultural land with a diverting use (likely some type of development land) was $3,234 per acre. The average price for agricultural land overall in the county was $1,682 per acre. The average agriculture unit sold was 67.8 acres (1,492 acres ÷ 22 sales). It is interesting to note the above information indicates that the majority of sales in the county sold for agricultural purposes, however, 23 percent of the above sales transferred for a diverting use. In addition, average land prices for Outagamie County are above the average land prices for the state. Outagamie County is at the upper end of the range of the average land sale price of the five counties displayed above.

Following is a summary of land sale data for forested sales; comparing Outagamie County to other area counties and to the State of Wisconsin. Forested land sales include both upland and wetland sales.

1998 Land Sales Summary--*Forested Lands*

Source: Wisconsin Department of Revenue-Board of Equalization

	Land Continuing Use			Land Diverting Use			Total Land		
County	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**
Marinette	90	4,092	$ 925	19	1,114	$1,054	109	5,206	$ 953
Oconto	56	1,772	934	27	796	1,319	83	2,568	1,053
Outagamie	27	675	1,126	6	73	2,724	33	748	1,282
Door	32	906	1,222	12	228	2,014	44	1,134	1,381
Brown	13	205	1,028	10	195	4,170	23	400	2,559
State Avg	2,959	--	789	1,325	--	1,015	4,284	--	854

The above data indicates the average price for forested land with a continuing use in Outagamie County was $1,126 per acre and the average price for forested land with a diverting use (likely some type of development land) was $2,724 per acre. The average price for forested land overall in the county was $1,282 per acre. It is interesting to note the above information indicates that the majority of sales in the county sold for continuing use, however, 18 percent of the above sales transferred for a diverting use. Forested land sale prices for the county exceed state averages, however, Outagamie County is at the middle of the range of the five counties displayed above.

Following is a summary of land sale data for swamp and waste land sales; comparing Outagamie County to other area counties and to the State of Wisconsin.

1998 Land Sales Summary--*Swamp/Waste Land*

Source: Wisconsin Department of Revenue-Board of Equalization

	Land Continuing Use			Land Diverting Use			Total Land		
County	# Trans	Acres Sold	$ Per Acre	# Trans	Acres Sold	$ Per Acre	# Trans	Acres Sold	$ Per Acre
Marinette	48	447	$ 535	11	119	$ 519	59	566	$ 532
Oconto	49	538	410	24	308	479	73	846	435
Outagamie	30	661	697	11	364	2,193	41	1,025	1,228
Door	24	332	838	7	56	308	31	388	761
Brown	13	132	732	9	95	6,093	22	227	2,976
State Avg	2,259	--	408	882	--	788	3,141	--	503

The above data indicates the average price for swamp/waste land with a continuing use in Outagamie County was $697 per acre and the average price for swamp/waste land with a diverting use (likely some type of development land) was $2,193 per acre. The average price for swamp/waste land overall in the county was $1,228 per acre. Swamp/waste land sale prices for the county are above state averages. Outagamie County is at the high end of the range of the five counties shown above.

The above information from the DOR demonstrates that the Outagamie County market is active. The data offers average prices for the three land types above and demonstrates their price relationship. The average price for all agricultural land without buildings in 1998 was $1,682 per acre. The average price for forested land in 1998 was $1,282 per acre. The average price for swamp/waste land 98 was $1,228 per acre. Furthermore, the trend analysis indicates the market for Wisconsin has been improving in recent years and shows a considerable amount of strength.

In the process of gathering and confirming sale data for Outagamie County, the author interviewed several real estate agents, appraisers, and/or market participants. Following is a summary of some of their comments about the county market. The persons interviewed are believed to be knowledgeable about the local market. The interviews focused on the market for vacant land in the 40+ acre size range and specifically on wetlands.

All persons interviewed characterized the overall market as being strong with good demand. Most described the market as being a seller’s market with prices continuing to increase as experienced in previous years.

The largest concentration of population in the county is in the southeast corner of the county. This area includes Appleton, several smaller cities surrounding Appleton, and county areas surrounding Appleton. In this area of the county, rural homesite buyers are driving the market for upland tracts capable of supporting a single family residence. In addition, the larger population provides an increased demand for recreational tracts. Recreational uses are primarily hunting. Recreational land can be both upland and wetland, although few upland tracts in Outagamie County sell for recreation only as the recreational buyer has to compete with the rural homesite buyer. Prices for rural homesites buyers typically far exceed that of the recreational buyer. Tracts typically purchased for recreation are not desirable rural homesites due to wetness. There is good demand for recreational property throughout the county as most areas of the county are within easy driving distance from Appleton.

The overall price range offered for wetland properties was $1,000 per acre to $1,250 per acre. Factors offered that influence price include having some area capable of supporting a dwelling or cabin, access, and size.

The final step in this market analysis is to consider some actual sale transactions and the implications of the data. Following is a summary of the 14 sales in Outagamie County considered for the market analysis. The sales are arranged by date of sale beginning with the most recent.

Summary of Outagamie County Sale Data

Sale	$/Acre	Date	# Acres	% Wet	Bld Site	Access
33	$1,429	10/99	56	90	poor	public rd
34	1,200	10/99	80	100	none	public rd
35	1,000	9/99	40	100	poor	private rd
36	1,188	8/99	40	100	poor	public rd
37	1,667	8/99	90	80	yes	public rd
38	906	8/99	39	95	yes	public rd
39	698	7/99	157	75	yes	public rd
40	875	6/99	40	100	none	easement
41	1,000	6/99	80	100	poor	easement
42	1,000	4/99	40	100	poor	public rd
43	900	3/99	80	95	yes	public rd
44	1,063	2/99	80	100	fair	public rd
45	810	2/99	52	100	none	private rd
46	708	11/96	240	100	none	private rd

All of the above sales were purchased for recreation and most of the sales contain primarily wetland. The sales indicate an overall indicated range in sale prices of $698 per acre to $1,667 per acre. The mean indicated sale price is $1,032 per acre and the median indicated price is $1,000 per acre, therefore, the high prices and low prices are fairly equally disbursed around the midpoint.

Sale 33 is bisected by Embarrass River. The river provides a scenic setting and offers added recreational appeal. This is believed to have had a positive effect on the sale price. As water front properties are considered later in this report, Sale 33 is given no further consideration in determining the general price levels of Outagamie County wetland tracts.

Sale 37 contains a significant amount of upland and appears to be a high sale compared to the remaining sales. This sale is included only for thorough reporting of the market but is given no further consideration.

Sale 39 is the lowest sale of the 14 sales provided. Based on a comparison with the other 14 sales, Sale 39 appears to be below the market and is given no further consideration.

Therefore, Sale 33, Sale 37, and Sale 39 are given no additional consideration in this market analysis. The remaining sales provide a much closer range in prices of $708 per acre to $1,200 per acre. Therefore, the sale data given most reliance in this market analysis is presented below.

Summary of Outagamie County Sale Data

Sale	$/Acre	Date	# Acres	% Wet	Bld Site	Access
34	$1,200	10/99	80	100	none	public rd
35	1,000	9/99	40	100	poor	private rd
36	1,188	8/99	40	100	poor	public rd
38	906	8/99	39	95	yes	public rd
40	875	6/99	40	100	none	easement
41	1,000	6/99	80	100	poor	easement
42	1,000	4/99	40	100	poor	public rd
43	900	3/99	80	95	yes	public rd
44	1,063	2/99	80	100	fair	public rd
45	810	2/99	52	100	none	private rd
46	708	11/96	240	100	none	private rd

The above 11 sales are given primary consideration in this market study.

Five characteristics are believed to have the most influence on price levels and include date of sale, site size, amount of wetland verses upland, potential for a building site, and access. Each of these characteristics is discussed below.

Date of Sale. According to the DOR information and the interviews with local persons familiar with the market, the county market has been increasing in recent years.

The sale data summary above is arranged by date of sale beginning with the most recent. All but one of the sales provided above closed in 1999. Sale 34 through Sale 45 closed between February 1999 and October 1999. This is a fairly short time period to extract an exact adjustment. However, the highest overall per acre sale price is Sale 34, which is the most recent. The lowest 1999 sale is Sale 45, which closed in February 1999. The lowest overall sale is Sale 46, which closed in November 1996.

Generally, the sale data supports the likeliness of an improving market. However, the time period covered within this sales is not great enough to definitely prove the market is improving. The oldest sale (Sale 46) closed in November 1996 and is significantly lower than the remaining sales, but this could be due to other factors such as size.

Based on the DOR information, interviews with persons familiar with the local market, and the indications of the sale data, the Outagamie County market is believed to have been improving. Therefore, the general price level should be near the high end of the overall range offered above.

Site Size. The site size of a property affects price. Generally, as the size of a property increases, the price per acre decreases. This is because there are fewer buyers with the ability to purchase the larger tracts. In the Outagamie County market, a 40 acre tract is considered a large tract, however, an 80+ acre tract is considered a very large tract.

The site size of the Outagamie County sales ranges from 39 acres to 240 acres. The chart below groups the sales in order by date of sale for tracts in the 0 to 79 acre size range and 80+ acre size range.

0 to 79 Acre Tracts				80+ Acre Tracts			
Sale	**$/Acre**	**Date**	**# Acres**	**Sale**	**$/Acre**	**Date**	**# Acres**
35	$1,000	9/99	40	34	$1,200	10/99	80
36	1,188	8/99	40	41	1,000	6/99	80
38	906	8/99	39	43	900	3/99	80
40	875	6/99	40	44	1,063	2/99	80
42	1,000	4/99	40	46	708	11/96	240
45	810	2/99	52				

The mean sale price of the smaller size group is $963 per acre. The mean sale price of the large size group is $974 per acre. This suggests there is no size adjustment. However, the lowest sale in the group is Sale 46, which is by far the largest tract containing 240 acres. This suggests a size adjustment may be warranted.

In considering the impact of size on price most consideration has been given to comments of interviews with real estate agents and the data from other surrounding counties. This information indicates that as size increases the price per unit decreases, as there are fewer buyers with the ability to purchase the larger tracts.

Percentage Wetland. The degree of wetness and the percentage of wetland verses upland impacts price. Generally, the wetter the property, the lower the price. In other words, the higher the percentage of wetland, the lower the price.

The majority of the Outagamie County sales are wetland tracts. In addition, most of the properties contain some small area of higher ground that could likely support a structure. Sale 38 and Sale 43 are the only sales in this group with any area of upland. These sales are near the low end of the range.

Interviews with real estate agents indicated that upland tracts were selling in excess of $2,000 per acre for rural homesites or for development land. Therefore, all of the Outagamie County sales included in this report are believed to reflect a reduced price for wetness.

In conclusion, the percentage of wetness is believed to impact the price. The majority of the sales included in this report are wet properties and reflect a reduced price. Any property with some upland (and good access) would likely sell at a premium above the prices indicated within these sales.

Potential for Building Site. Each of the 11 sales are rated as to their suitability for a building site. Typically, the main limiting factor for building site potential is wetness. Tracts that have potential for a building site require some upland or higher ground.

It is physically possible to construct improvements on nearly every tract in the county if cost is of no concern. However, costs can limit the feasibility of building on a particular tract. Those tracts that require no significant alterations for use as a building site should be reflected positively in price.

Most of the sales contain 100 percent hydric soils, however, some of the soils are typically on slightly higher land and can be built on with fewer limitations to overcome. Most wetland properties in Outagamie County contain similar situations.

As most Outagamie County properties contain some degree of building potential an exact adjustment for this characteristic is difficult to measure. The limitations associated with building on a lower tract are believed to be reflected in the sales included in this analysis.

Access. Access generally impacts price. Interviews with persons familiar with the market indicate access was one of the primary influences on price. Good physical and legal access has a positive effect on price. Poor physical or legal access has a negative effect on price.

In the State of Wisconsin, access cannot be denied to a tract of land. However, obtaining an easement to a "landlocked" parcel can require legal action, which has associated costs in time and legal fees. Therefore, poor physical or legal access can have a negative effect on price.

Generally, public road access is slightly superior to easement access or private road access. An easement or private road requires road maintenance expenses by the landowner. This is an added cost of ownership and typically is reflected in price. This is supported by the Outagamie sale data. Following is a summary of the sale data organized by access: public road access or private road/easement.

Public Road			**Priv.Rd/Esmt**		
Sale	**$/Acre**	**Date**	**Sale**	**$/Acre**	**Date**
34	$1,200	10/99	35	$1,000	9/99
36	1,188	8/99	40	875	6/99
38	906	8/99	41	1,000	6/99
42	1,000	4/99	45	810	2/99
43	900	3/99	46	708	11/96
44	1,063	2/99			

The mean sale price for the sales containing public road access is $1,043 per acre. The mean sale price for the sales containing private road or easement access is $879 per acre.

NOTE. Many of the sales contain a mixture of cropland and woods. All the sales are generally low land. The farmed hydric soils appear to have similar general price levels as wetland with similar factors influencing price.

CONCLUSIONS

The market for wetland properties in the 40+ acre size range has been strong in recent years and is expected to remain strong in the foreseeable future.

The overall price range for 40+ acre wetland tracts in Outagamie County is estimated at $750 per acre to $1,250 per acre. The primary factors that impact price are size, percentage wetland/building potential, and access.

As the size of the site increases, the price per unit will decrease. The higher the percentage of wetland, the lower the price. Public road access is the preferred access. Easement access and no access typically has a negative effect on price.

Most properties will have a price range of $1,000 per acre to $1,250 per acre. A 40 acre tract with good access will be at the high end of the price range. A tract that is 80+ acres, contains poor access, **or** contains severe building limitations will be at the lower end of the price range.

Farmed hydric soils appear to have similar general price levels and wetland with similar factors influencing price.

The following is a summary of the conclusions of this market analysis for wetland properties having a minimum size of 40 acres in Outagamie County. (Not included in the below price ranges are properties with development potential or water frontage.)

Wetland Market Study Summary - *Outagamie County*

Overall Price Range......................	$ 750 per acre to $1,250 per acre
Most Common Price Range..................	$1,000 per acre to $1,250 per acre

PART IId

WETLANDS

DOOR COUNTY

LOCATION MAP SHOWING DOOR COUNTY

[not available]

NEIGHBORHOOD DATA

The map on the facing page shows the location of Door County. A neighborhood is a group of complementary land uses.[5] Door County is in the northeastern part of Wisconsin occupying most of the peninsula that separates Green Bay from Lake Michigan and includes several islands in Green Bay and Lake Michigan as far as eight miles from the mainland. The west, north, and east boundaries are formed by the waters of Green Bay and Lake Michigan. The south boundary is formed by Kewaunee County.

Door County has a total area of 314,560 acres. The county is 15 miles wide near the south boundary and gradually tapers to about 4 miles near the north boundary of the mainland. The distance from the extreme southwest corner of the county to the northern tip of the peninsula is nearly 60 miles. However, there are over 200 miles of shoreline in the county. The elevation at Lake Michigan is 580 feet and is the lowest elevation in the county. The highest elevation is 851 feet.

The topography of Door County is modified by glaciation and influenced by underlying bedrock. The topography ranges from nearly level in large depressions to steep on upland moraines. Most of the soils in the northern two-thirds of the county are rough or shallow over bedrock. Many areas in this part of the county are not farmed but remain in woodland or wetland. The southern one-third of the county is smoother and most of this area is farmed. Swamps and high water table depressions, typical of a glaciated region, are also scattered throughout the county. According to an inventory made in 1961, there were approximately 28,000 acres of wetlands. Most of these wetlands are wooded swamps.

The most prominent topographic feature in the county is the long line of rugged bluffs bordering Green Bay roughly from Sturgeon Bay to the northeast point of the peninsula (known as Niagara escarpments). In some places the bluffs reach the waters edge, but elsewhere they are some distance from the shore. These bluffs rise to an elevation of 200 feet above the bay.

The Ahnapee River watershed is the largest in the county and is located in the southern portion of the county. The river flows south into Kewaunee County. There are many smaller creeks that flow into Green Bay and Lake Michigan from the southern half of the county. Mink River drains much of Liberty Grove Township in the north. Small short streams drain most of the northern part of the county into Lake Michigan.

Door County has a continental climate, although it is modified considerably by Green Bay and Lake Michigan. This modification is reflected in the fewer number of days with extremely high and low temperatures than is common for the latitude. Spring and early summer are delayed by surrounding cool waters. Mild and pleasant summers prevail. The first freeze in fall is delayed by the now relatively warm surrounding water. The average daily minimum temperature for January is 10.4° F. January is the coldest month. The average daily maximum temperature in July is 80.1° F. July is the warmest temperature. The average annual rain fall is 27.2 inches, and the average annual snowfall is 40.3 inches.

The Door County population was 25,690 in 1990 according to the 1990 Census. The 1998 estimated population was 26,537 according to the State of Wisconsin Department of Administration. This is an increase of 3.3 percent and suggests a stable population. Significant municipalities within the county are shown below along with the 1990 Census population and the 1998 population estimate.

Municipality	1990 Census	1998 Estimate
Sturgeon Bay, City......	9,176	9,480
Sevastopol..............	2,552	2,638
Nasewaupee..............	1,798	1,804
Liberty Grove...........	1,506	1,589
Brussels................	1,042	1,070
Egg Harbor..............	1,019	1,062
Gibraltar...............	939	1,007
Forestville.............	999	992
Gardner.................	1,025	983
Sturgeon Bay, Town......	853	904

Sturgeon Bay is the largest city in the county and is the county seat.

Following is the industry group for Door County, their number of employees, and their percent of total employees according to the 1990 census.

Industry Group – Door County	Employees	Percent of Total
Agriculture, forestry, and fisheries................	914	8%
Mining..	8	0%
Construction..	949	8%
Manufacturing.......................................	2,740	23%
Transportation......................................	273	2%
Communications & other public utilities.............	187	1%
Wholesale trade.....................................	263	2%
Retail trade..	2,577	22%
Finance, insurance, & real estate...................	544	5%
Business & repair services..........................	323	3%
Personal services...................................	625	5%
Entertainment & recreation services.................	171	1%
Health services.....................................	685	6%
Educational services................................	770	6%
Other professional services.........................	549	5%
Public administration...............................	301	3%
Total Employees....................................	**11,879**	

The economy in Door County is adequately diverse, but the two main industries in the county are manufacturing and retail trade. These two industries comprise 45.0 percent of the total employment.

Prior to 1980, ship building was the leading industry. However, the ship building industry has declined considerably since the mid 1980's. Tourism and commercial development related to the tourism industry has increased since 1990. Tourism is considered the leading industry. Based on the 1990 census, Door County is designated a recreational county as at least 20 percent of the housing units are vacant and held for seasonal, recreational, or occasional use. The impact of tourism is more realized north of Sturgeon Bay. Egg Harbor, Fish Creek, Ephriam, Sister Bay, and Ellison Bay are small coastal villages north of Sturgeon Bay that are noted summer resort areas that attract thousands of tourists each year. It is estimated that summer residents and tourists total 75,000 or more per week. Tourism influence and demand is expected to continue to increase. Door County attracts tourists from Green Bay, Milwaukee, and Chicago, Illinois. Due to the large impact of tourism to the county economy, many of the jobs in the county are seasonal.

The south half of the county contains more agriculture influence. Dairy farming and orchard crops are important farming segments, although declining in recent years.

The top 10 private sector employers for Door County are shown below.

Major Employers - Door County	Product Type	Employees
Door County Memorial Hospital	Health Care	250-499
Manitowoc Marine Group, Inc.	Manufacturer of Water Craft	250-499
Hatco Corp	Industrial & Commercial Machinery	250-499
Palmer Johnson	Manufacturer of Water Craft	100-249
Baylake Bank	Banking and Financial Services	100-249
Wal-Mart Stores, Inc	Retail Sales	100-249
Beverly Health & Rehab	Skilled Nursing Facility	100-249
Therma-Tron-X, Inc	Industrial Furnaces and Ovens	100-249
Econo Foods	Retail Food Store	100-249
Wiretech Fabricators	Fabricated Wire Products	100-249

In April 2000, the unemployment rate for Door County was 5.5 percent, which was similar to the April 1999 rate of 5.4 percent. The April 2000 unemployment rate for the State of Wisconsin was 3.5 percent. Therefore, the county unemployment rate has been stable and below that of the state. The Door County labor force totals approximately 15,700 workers.

Nearly 93 percent of the workers in Door County are employed within the county. The number of workers that leave the county for employment is similar to the number of workers that enter the county for employment. Green Bay is the main destination for most outbound workers, although this accounts for only 2 percent of the Door County labor force. The primary reason most Door County residents work within the county is because the required commuting distance to other employment areas is too great. Most persons working outside the county choose to relocate closer to employment.

The 1997 per capita personal income was $22,237 for Door County and $24,048 for the State of Wisconsin. Therefore, income levels for the county are adequate. Income for the county has remained stable in recent years.

Median gross rent for the county is $348 per month and the median housing value is $67,000 compared to median gross rent for the state of $399 per month and a median housing value of $62,100. Overall, the cost of living is similar to that of the state. The median housing value is higher for the county due to seasonal home demand.

Financing is readily available in the area typically via conventional loans on all types of real property--agriculture, commercial, and residential. There are several banks in the area that actively make loans.

Government services, police and fire protection, education, and health services are adequately provided within the county. Transportation is adequately provided within the county via a series of federal, state, and county road systems. Major Highways include Highway 42 and 57. Recreational opportunities are good via the surrounding lakes and numerous publicly owned lands throughout the county. Recreational activities include camping, snowmobiling, picnicking, bicycling, hiking, boating, golfing, and shopping.

In summary, Door County has a stable and reasonably diversified economic base. Population, income, and employment are all stable. Most shopping, education, health care, recreation, and employment facilities are adequately provided for within the county, and additional amenities are available in Brown County, an easy driving distance. There are no known changes that could substantially impact the economy. Therefore, a continued stable economy is most likely.

Following is a summary of neighborhood trends and neighborhood characteristics for Door County.

Neighborhood Trends – Door County	**Up**	**Stable**	**Down**
Development	x	x	
Value	x	x	
Vacancy		x	
Population		x	
Employment		x	
Demand	x	x	
Effective Purchase Power		x	

Neighborhood Characteristics – Door County	**Ex**	**Gd**	**Av**	**Fr**	**Pr**
Maintenance/Condition		x	x	x	
Property Compatibility			x		
Appeal/Appearance			x		
Protection/Adverse Influence			x		
Development Potential			x		
Transportation Access			x		
Police/Fire Protection			x		
Soil Quality/Productivity			x		

LOCATION MAP SHOWING THE DOOR COUNTY SALES

DOOR COUNTY MARKET ANALYSIS

The objective of this market analysis is to demonstrate the general price levels for vacant wetland properties in Door County with a minimum size of 40 acres. This study focused on properties with a highest and best use of recreation with little to no development influence. The study also reports on the primary factors that influence prices.

In vacant land analysis, the most reliable method of measuring the market is by comparable sale data or actual sale transactions in the market area of similar land types. This data provides direct market indications of what sellers are willing to accept and what buyers are willing to pay for a particular property type.

For this analysis, data was gathered on over 50 sale transactions (occurring between 1997 and 2000). From this group of data, 12 sales were selected for consideration in reporting the general price levels. A sale data sheet for each of the 12 sales is provided in the Addenda section of this report. The sale data sheet shows the location, property type, legal description, grantor, grantee, date of closing, property rights conveyed, financing terms, conditions of sale, data source, sale price, site size, sales price per acre, and other pertinent information for each sale. A sale location map is presented on the facing page.

Criteria for selecting market data was good arm’s-length transactions, primarily low land or wetland (having primarily hydric soils), minimum site size of 40 acres, unimproved tracts, and purchased for recreation.

As additional support for the sale data, consideration is given to market summaries compiled by the Wisconsin Department of Revenue for vacant land and interviews with real estate agents and appraisers in Door County.

The market analysis will begin with a discussion of the Wisconsin Department of Revenue reports followed by the results of interviews of real estate agents and appraisers in the Door County area as this will give a general overview of the current market conditions.

With each sale of a parcel of real estate, the buyer is required to file a "Wisconsin Real Estate Transfer Return" documenting the parcel size, sale price, present use, and intended use of the property. The transfer returns are filed with the Wisconsin Department of Revenue, Equalization Board (DOR). State appraisers inspect the site of each sale and verify the transfer return. The following information is averages from the transfer return data. As of the date of this report, the most current information available is 1998 due to the lag time required to inspect, verify, and process the data.

The DOR information indicates that overall agricultural land prices have increased each year since 1993. The following chart shows the average sale price for agricultural land for the State of Wisconsin from 1993 to 1998. The averages include vacant land and improved agricultural land.

Wisconsin Average Agriculture Land Prices

(All farms-Vacant & Improved)

Year	# Sales	Acres	$/Acre	Change
1993	7,462	430,575	$ 969	
1994	6,094	383,002	1,033	+ 6.6%
1995	4,507	283,711	1,127	+ 9.1%
1996	4,637	290,860	1,284	+ 13.9%
1997	4,045	263,456	1,413	+ 10.1%
1998	4,088	264,606	1,515	+ 7.2%

The information on the previous page indicates the Wisconsin agriculture market has maintained considerable strength during the years shown.

The DOR further breaks down land sales to agricultural land without buildings, forested lands, and swamp or marsh land by county. Separate sale data is reported for "Land continuing in use" and "Land being diverted to other uses."

Following is a summary of land sale data for agricultural land sales without buildings; comparing Door County to other area counties and to the State of Wisconsin.

1998 Agricultural Land Sales Summary--*Without Buildings*

Source: Wisconsin Department of Revenue-Board of Equalization

	Ag Land Continuing Use			Ag Land Diverting Use			Total Ag Land		
County	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**
Marinette	22	828	$ 785	5	163	$1,042	27	991	$ 827
Oconto	38	1,645	891	18	524	1,926	56	2,169	1,141
Outagamie	17	1,227	1,323	5	265	3,234	22	1,492	1,682
Door	20	671	1,058	3	65	1,549	23	736	1,102
Brown	10	648	1,839	16	633	6,833	26	1,281	4,307
State Avg.	1,472	--	1,173	767	--	1,785	2,239	--	1,332

The above data indicates the average price for agricultural land with a continuing use in Door County was $1,058 per acre and the average price for agricultural land with a diverting use (likely some type of development land) was $1,549 per acre. The average price for agricultural land overall in the county was $1,102 per acre. The average agriculture unit sold was 32.0 acres (736 acres ÷ 23 sales).

Following is a summary of land sale data for forested sales; comparing Door County to other area counties and to the State of Wisconsin. Forested land sales include both upland and wetland sales.

1998 Land Sales Summary--*Forested Lands*

Source: Wisconsin Department of Revenue-Board of Equalization

	Land Continuing Use			Land Diverting Use			Total Land		
County	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**
Marinette	90	4,092	$ 925	19	1,114	$1,054	109	5,206	$ 953
Oconto	56	1,772	934	27	796	1,319	83	2,568	1,053
Outagamie	27	675	1,126	6	73	2,724	33	748	1,282
Door	32	906	1,222	12	228	2,014	44	1,134	1,381
Brown	13	205	1,028	10	195	4,170	23	400	2,559
State Avg	2,959	--	789	1,325	--	1,015	4,284	--	854

The above data indicates the average price for forested land with a continuing use in Door County was $1,222 per acre and the average price for forested land with a diverting use (likely some type of development land) was $2,014 per acre. The average price for forested land overall in the county was $1,381 per acre. It is interesting to note the above information indicates that the majority of sales in the county sold for continuing use, however, 27 percent of the above sales transferred for a diverting use. Forested land sale prices for the county exceed state averages, however, Door County is at the middle to upper end of the range of the five counties displayed above.

Following is a summary of land sale data for swamp and waste land sales; comparing Door County to other area counties and to the State of Wisconsin.

1998 Land Sales Summary--*Swamp/Waste Land*

Source: Wisconsin Department of Revenue-Board of Equalization

	Land Continuing Use			Land Diverting Use			Total Land		
County	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**
Marinette	48	447	$ 535	11	119	$ 519	59	566	$ 532
Oconto	49	538	410	24	308	479	73	846	435
Outagamie	30	661	697	11	364	2,193	41	1,025	1,228
Door	24	332	838	7	56	308	31	388	761
Brown	13	132	732	9	95	6,093	22	227	2,976
State Avg	2,259	--	408	882	--	788	3,141	--	503

The above data indicates the average price for swamp/waste land with a continuing use in Door County was $838 per acre and the average price for swamp/waste land with a diverting use (likely some type of development land) was $308 per acre. The average price for swamp/waste land overall in the county was $761 per acre. Swamp/waste land sale prices for the county are above state averages.

The above information from the DOR demonstrates that the Door County market is active. The data offers average prices for the three land types above and demonstrates their price relationship. The average price for all agricultural land without buildings in 1998 was $1,102 per acre. The average price for forested land in 1998 was $1,381 per acre. The average price for swamp/waste land in 1998 was $761 per acre. Furthermore, the trend analysis indicates the market for Wisconsin has been improving in recent years and shows a considerable amount of strength.

In the process of gathering and confirming sale data for Door County, the author interviewed several real estate agents, appraisers, and/or market participants. Following is a summary of some of their comments about the county market. The persons interviewed are believed to be knowledgeable about the local market. The interviews focused on the market for vacant land in the 40+ acre size range and specifically on wetlands.

All persons interviewed characterized the overall market as being strong with good demand. Most described the market as being a seller’s market with prices continuing to increase as experienced in previous years.

The strongest demand for vacant land in Door County is for upland tracts capable of supporting a dwelling for a second home or vacation home. Upland tracts typically command the higher prices. However, there remains good demand for recreational tracts for hunting. Recreational land can be both upland and wetland, although few upland tracts in Door County sell for recreation only as the recreational buyer has to compete with the homesite buyer. Prices for rural homesites buyers typically far exceed that of the recreational buyer. Tracts typically purchased for recreation are not desirable rural homesites due to wetness. Most of the recreational buyers are from within the county. Of the 12 Door County wetland sales provided in this report (Sale 47 through Sale 58), 10 sales were to local buyers.

Generally, land prices increase the further north in the county a property is located. The majority of the tourist activity is in the north half of the county, therefore, there is greater demand and higher prices. However, this tends to have more impact on upland tracts that can support buildings as 100 percent wetland properties have no other use than recreation or hunting.

The most commonly offered price range for wetland tracts was $750 per acre to $1,000 per acre. Factors offered that influence price include having some area capable of supporting a dwelling or cabin, access, and size.

The final step in this market analysis is to consider some actual sale transactions and the implications of the data. Following is a summary of the 12 sales in Door County considered for the market analysis. The sales are arranged by date of sale beginning with the most recent.

Summary of Door County Sale Data

Sale	$/Acre	Date	# Acres	% Wet	Bld Site	Access
47	$ 665	12/99	40	100	none	public rd
48	1,350	10/99	100	95	yes	public rd
49	1,104	5/99	72	85	yes	public rd
50	963	4/99	40	90	yes	public rd
51	1,000	2/99	40	90	yes	public rd
52	670	11/98	40	100	poor	public rd
53	688	11/98	40	100	none	limited
54	1,389	11/98	72	80	yes	public rd
55	690	5/98	52	100	poor	easement
56	1,125	3/98	40	95	yes	easement
57	475	1/98	40	100	poor	public rd
58	625	1/97	80	95	poor*	limited

*Sale 58 contains 5% upland soils but due to access and location of the soils it is considered poorly suited as a building site.

All of the above sales were purchased for recreation and most of the sales contain primarily wetland. The sales indicate an overall indicated range in sale prices of $475 per acre to $1,389 per acre. The mean indicated sale price is $895 per acre and the median indicated price is $827 per acre, therefore, the high prices and low prices are fairly equally disbursed around the midpoint.

Sale 57 contains a sale price of $475 per acre, which is significantly lower than all the other sales. This sale is believed to be below the market and is given no further consideration. The remaining sales provide a much closer range in prices of $625 per acre to $1,389 per acre. Therefore, the sale data given most reliance in this market analysis is presented below.

Summary of Door County Sale Data

Sale	$/Acre	Date	# Acres	% Wet	Bld Site	Access
47	$ 665	12/99	40	100	none	public rd
48	1,350	10/99	100	95	yes	public rd
49	1,104	5/99	72	85	yes	public rd
50	963	4/99	40	90	yes	public rd
51	1,000	2/99	40	90	yes	public rd
52	670	11/98	40	100	poor	public rd
53	688	11/98	40	100	none	limited
54	1,389	11/98	72	80	yes	public rd
55	690	5/98	52	100	poor	easement
56	1,125	3/98	40	95	yes	easement
58	625	1/97	80	95	poor*	limited

*Sale 58 contains 5% upland soils but due to access and location of the soils it is considered poorly suited as a building site.

The above 11 sales are given primary consideration in this market study.

Six characteristics are believed to have the most influence on price levels and include date of sale, site size, amount of wetland verses upland, potential for a building site, access, and location. Each of these characteristics is discussed below.

Date of Sale. According to the DOR information and the interviews with local persons familiar with the market, the county market has been increasing in recent years.

The sale data summary above is arranged by date of sale beginning with the most recent. Viewing the sale data above, there appears to be little to no correlation between date of sale and price. However, based on the DOR information, interviews with persons familiar with the local market, and the indications surrounding county data, the Door County market is believed to have been improving. Therefore, the general price level should be near the high end of the overall range offered above.

Site Size. The site size of a property affects price. Generally, as the size of a property increases, the price per acre decreases. This is because there are fewer buyers with the ability to purchase the larger tracts. In the Door County market, a 40 acre tract is considered a large tract, however, an 80+ acre tract is considered a very large tract.

Only two of the above sales contain 80 acres or more. This is not adequate data to support a size adjustment.

In considering the impact of size on price, most consideration has been given to comments of interviews with real estate agents and the data from other surrounding counties. This information indicates that as size increases the price per unit decreases, as there are fewer buyers with the ability to purchase the larger tracts.

Percentage Wetland. The degree of wetness and the percentage of wetland verses upland impacts price. Generally, the wetter the property, the lower the price. In other words, the higher the percentage of wetland, the lower the price.

Among the group of sales on the previous page, the impact of wetness on size is best reflected by the rating for building site potential. Therefore, the impact of percentage of wetland is considered in the following section of "Potential for Building Site."

Potential for Building Site. Each of the 11 sales are rated as to their suitability for a building site. Typically, the main limiting factor for building site potential is wetness. Tracts that have potential for a building site require some upland or higher ground.

In the chart below, the sales are organized according to their suitability as a building site. Tracts containing some portion capable of supporting a building are classified as "yes." Those tracts generally not well suited for a building site are classified as "none" or "poor."

Not Suitable Bld St			**Suitable Bld Site**		
Sale	**$/Acre**	**Date**	**Sale**	**$/Acre**	**Date**
47	$ 665	12/99	48	$1,350	10/99
52	670	11/98	49	1,104	5/99
53	688	11/98	50	963	4/99
55	690	5/98	51	1,000	2/99
58	625	1/97	54	1,389	11/98
			56	1,125	3/98

The mean sale price of the sales not suitable for building sites is $668 per acre. The mean sale price of the sales containing mostly wetland but having some small area capable of supporting a building is $1,155 per acre.

This relationship is best demonstrated by a comparison of Sale 53 and Sale 54. These tracts closed on the same day with different sellers but the same buyer. Sale 53 contains no suitable building site and sold for $688 per acre. Sale 54 contains some adequate upland or higher land areas and sold for $1,389 per acre. This is a difference of $701 per acre. However, a portion of the price difference is also believed to be attributable to access differences. Sale 53 contains limited access, while Sale 54 contains public road access.

In summary, the potential for a building site definitely affects price. If a property contains no high ground, then the price will likely be near the lower end of the range. If the property contains some small area of high ground, the price will be at the higher end of the range.

It should be noted, properties containing all or primarily upland usually sell at significantly higher prices, particularly in the northern areas of the county. Upland prices in the northern region could be two times higher or ten or more times higher depending on location, utilities, amenities, etc.

Access. Access generally impacts price. Interviews with persons familiar with the market indicate access was one of the primary influences on price. Good physical and legal access has a positive effect on price. Poor physical or legal access has a negative effect on price.

In the State of Wisconsin, access cannot be denied to a tract of land. However, obtaining an easement to a "landlocked" parcel can require legal action, which has associated costs in time and legal fees. Therefore, poor physical or legal access can have a negative effect on price.

Generally, public road access is slightly superior to easement access or private road access. An easement or private road requires road maintenance expenses by the landowner. This is an added cost of ownership and typically is reflected in price.

The Door County sale data is inclusive about the impact of access on price as the majority of the sales contain public road access. Therefore, most reliance is given to the interviews with real estate agents and data of other surrounding counties. Limited access or no access is believed to have a negative effect on price.

Location. Location is believed to impact price. Generally, the further north in the county a tract is located, the higher the price. The lowest land sale prices are expected south of Sturgeon Bay. The highest land sale prices are expected north of Sturgeon Bay.

Following is a summary of the 11 Door County sales organized by location and building site potential. The south region is south of Sturgeon Bay. The north region is north of Sturgeon Bay.

TRACTS *WITH* BUILDING SITE POTENTIAL

North Region			South Region		
Sale	**$/Acre**	**Date**	**Sale**	**$/Acre**	**Date**
49	$1,104	5/99	48	$1,350	10/99
54	1,389	11/98	50	963	4/99
56	1,125	3/98	51	1,000	2/99
Mean	**$1,206**		**Mean**	**$1,104**	

TRACTS *WITHOUT* BUILDING SITE POTENTIAL

North Region			South Region		
Sale	**$/Acre**	**Date**	**Sale**	**$/Acre**	**Date**
47	$ 665	12/99	52	$ 670	11/98
53	688	11/98	55	690	5/98
58	625	1/97			
Mean	**$ 659**		**Mean**	**$ 680**	

The tracts with building site potential indicate the north region contains slightly higher prices than the south region. The difference between the two areas is believed to be greater than that indicated by these sales.

Sale 48 is located within close proximity to Sturgeon Bay and contains additional influence from being close to town.

The location is believed to have less of an influence on price among tracts having no building potential as shown by the sale data above.

NOTE. Many of the sales contain a mixture of cropland and woods. All the sales are generally low land. The farmed hydric soils appear to have similar general price levels as wetland with similar factors influencing price.

CONCLUSIONS

The market for wetland properties in the 40+ acre size range has been strong in recent years and is expected to remain strong in the foreseeable future.

The overall price range for 40+ acre wetland tracts in Door County is estimated at $600 per acre to $1,250 per acre. The primary factors that impact price are size, percentage wetland/building potential, access, and location.

As the size of the site increases, the price per unit will decrease. The higher the percentage of wetland, the lower the price. Public road access is the preferred access. Easement access and no access typically has a negative effect on price. The price of wetland properties containing a small area capable of supporting a building will increase moving north across the county.

Most wetland properties with no building site potential will have a price range of $600 per acre to $800 per acre in the south region. Most wetland properties with some building potential will have a price range of $1,250 per acre to $1,500+ per acre in the north region. A 40 acre tract with good access will be at the high end of the price range. A tract that is 80+ acres **or** contains poor access will be at the lower end of the price range.

Farmed hydric soils appear to have similar general price levels as wetland with similar factors influencing price.

Most wetland properties with some building site potential will have a price range of $1,000 per acre to $1,250 per acre. A 40 acre tract with good access and a small area capable of supporting a building will be at the high end of the price range. A tract that is 80+ acres **or** contains poor access and a small area capable of supporting a building will be at the lower end of the price range.

The following is a summary of the conclusions of this market analysis for wetland properties having a minimum size of 40 acres in Door County. (Not included in the below price ranges are properties with development potential or water frontage.)

Wetland Market Study Summary - *Door County*

Overall Price Range....................	$ 600 per acre to $ 1,500 per acre
Typical Price Range (No Bldg Site Pot.).	$ 600 per acre to $ 800 per acre
*Typical Price Range (Some Bldg Pot.)...	$1,000 per acre to $ 1,250 per acre
** Typical Price Range (Some Bldg Pot.).	$1,250 per acre to $1,500+ per acre

* South Region
** North Region

PART IIe

WETLANDS

BROWN COUNTY

LOCATION MAP SHOWING BROWN COUNTY

[not available]

NEIGHBORHOOD DATA

The map on the facing page shows the location of Brown County. A neighborhood is a group of complementary land uses.[6] Brown County is in the northeastern part of Wisconsin. Brown County is bordered on the north by Oconto County and the bay of Green Bay, on the east by Kewaunee County, on the south by Manitowoc County and Calumet County, and on the west by Outagamie County and Shawano County.

Brown County is bisected by the Fox River, which flows from Lake Winnebago to Green Bay. The majority drains to the north into Green Bay. However, the southeastern and eastern portion of the county drains southeast eventually into Lake Michigan. Major rivers and watersheds in the county include Suamico River, Duck Creek, Fox River, Neshota River, Branch River, and East River.

The north half and west half of the county are mostly urbanized or at a minimum contain a strong urban influence. The southeast quadrant of the county contains more of a rural setting with less urban influence.

Brown County has a continental climate. Winters are long, cold, and snowy. Summers are warm and occasionally humid.

The Brown County population was 194,594 in 1990 according to the 1990 Census. The 1998 estimated population was 218,149 according to the State of Wisconsin Department of Administration. This is an increase of 12.1 percent and suggests a stable, but growing population. Brown County population growth exceeded that of the state and nation. Significant municipalities within the county are shown below along with the 1990 Census population and the 1998 population estimate.

Municipality	1990 Census	1998 Estimate
Green Bay, City.........	96,466	102,726
De Pere.................	16,594	19,511
Ashwaubenon.............	16,376	17,476
Allouez.................	14,431	14,967
Howard..................	9,874	12,495
Bellevue................	7,541	10,443
Suamico.................	5,214	7,379
Hobart..................	4,284	4,864
Pulaski.................	2,200	2,749
Scott...................	2,044	2,597

Green Bay is the largest city in the county and is the county seat. Many of the cities within the county have experienced significant growth between 1990 and 1997. Suamico contained the largest growth in population of 41.5 percent. This is largely due to residents within Green Bay relocated to the outlying suburbs.

Following is the industry group for Brown County, their number of employees, and their percent of total employees according to the 1990 census.

Industry Group – Brown County	Employees	Percent of Total
Agriculture, forestry, and fisheries................	2,355	2%
Mining...	60	0%
Construction.......................................	4,790	5%
Manufacturing......................................	22,405	23%
Transportation.....................................	4,940	5%
Communications & other public utilities.............	2,678	3%
Wholesale trade....................................	5,065	5%
Retail trade.......................................	20,022	20%
Finance, insurance, & real estate..................	5,954	6%
Business & repair services.........................	3,835	4%
Personal services..................................	2,601	2%
Entertainment & recreation services................	1,115	1%
Health services....................................	7,886	8%
Educational services...............................	7,125	7%
Other professional services........................	5,657	6%
Public administration..............................	2,654	3%
Total Employees..................................	**99,142**	

The economy in Brown County is adequately diverse, but the two main industries in the county are manufacturing and retail trade. These two industries comprise 43.0 percent of the total employment. The two leading manufacturing groups are paper products and food products. Agriculture affects only a small percentage of the population and contains very minor economic impact.

The top 12 private sector employers for Brown County are shown below.

Major Employers - Brown County	Product Type	Employees
Fort James Corporation.......	Paper Products......................	4,023
Humana......................	Group Health Insurance...............	3,390
Schneider National, Inc......	Truck Load Carrier..................	3,346
Oneida Tribe of Indians of WI	Tribal Enterprises & Gov. of Oneida..	2,994
Green Bay Public Schools.....	Public School System................	2,450
Shopko Stores, Inc...........	Discount Merchandiser Retail.........	2,350
American Medical Security....	Health and Life Insurance Plans......	1,933
St. Vincent Hospital.........	Health Care.........................	1,773
Bellin Memorial Hospital.....	Health Care.........................	1,663
Procter & Gamble.............	Paper Products......................	1,550
Packerland Packing Co........	Beef Slaughterer and Processing......	1,524
Brown County................	County Government Services...........	1,498

In April 2000, the unemployment rate for Brown County was 2.5 percent, which was similar to the April 1999 rate of 2.3 percent. The April 2000 unemployment rate for the State of Wisconsin was 3.5 percent. Therefore, the county unemployment rate has been stable and below that of the state. The Brown County labor force totals approximately 132,200 workers.

Nearly 93 percent of the workers in Brown County are employed within the county. Brown County is the employment destination for 12,537 workers. A total of 7,185 workers leave the county for employment. Outagamie County is the most common destination for outbound workers.

The 1997 per capita personal income was $25,559 for Brown County and $24,048 for the State of Wisconsin. Therefore, income levels for the county are adequate and slightly above that of the state. Income for the county has remained stable in recent years.

Median gross rent for the county is $373 per month and the median housing value is $62,200 compared to median gross rent for the state of $399 per month and a median housing value of $62,100. Therefore, the cost of living is similar to that of the state.

Financing is readily available in the area typically via conventional loans on all types of real property--agriculture, commercial, and residential. There are several banks in the area that actively make loans.

Government services, police and fire protection, education, and health services are adequately provided within the county. Transportation is adequately provided within the county via a series of federal, state, and county road systems. Major Highways include Highway 41, 141, 29, 54, and Interstate 43. Recreational opportunities are good via Green Bay and numerous publicly owned lands throughout the county. Recreational activities include camping, snowmobiling, picnicking, bicycling, hiking, boating, golfing, and shopping. Numerous cultural and social activities are available in the city of Green Bay. In addition, the major sporting draw for the county is the Green Bay Packers, which have experienced good success in recent years.

In summary, Brown County has a stable and reasonably diversified economic base. Population, income, and employment are all stable. Most shopping, education, health care, recreation, and employment facilities are adequately provided for within the county, and additional amenities are available within an easy driving distance in surrounding. There are no known changes that could substantially impact the economy. Therefore, a continued stable economy is most likely.

Following is a summary of neighborhood trends and neighborhood characteristics for Brown County.

Neighborhood Trends – Brown County	**Up**	**Stable**	**Down**
Development................................	x	x	
Value......................................	x	x	
Vacancy....................................		x	
Population.................................		x	
Employment.................................		x	
Demand.....................................	x	x	
Effective Purchase Power...................		x	

Neighborhood Characteristics – Brown County	**Ex**	**Gd**	**Av**	**Fr**	**Pr**
Maintenance/Condition...........		x	x	x	
Property Compatibility..........			x		
Appeal/Appearance...............			x		
Protection/Adverse Influence....			x		
Development Potential...........			x		
Transportation Access...........			x		
Police/Fire Protection..........			x		
Soil Quality/Productivity.......			x		

LOCATION MAP SHOWING THE BROWN COUNTY SALES

[not available]

BROWN COUNTY MARKET ANALYSIS

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As additional support for the sale data, consideration is given to market summaries compiled by the Wisconsin Department of Revenue for vacant land and interviews with real estate agents and appraisers in Brown County.

The market analysis will begin with a discussion of the Wisconsin Department of Revenue reports followed by the results of interviews of real estate agents and appraisers in the Brown County area as this will give a general overview of the current market conditions.

With each sale of a parcel of real estate, the buyer is required to file a "Wisconsin Real Estate Transfer Return" documenting the parcel size, sale price, present use, and intended use of the property. The transfer returns are filed with the Wisconsin Department of Revenue, Equalization Board (DOR). State appraisers inspect the site of each sale and verify the transfer return. The following information is averages from the transfer return data. As of the date of this report, the most current information available is 1998 due to the lag time required to inspect, verify, and process the data.

The DOR information indicates that overall agricultural land prices have increased each year since 1993. The following chart shows the average sale price for agricultural land for the State of Wisconsin from 1993 to 1998. The averages include vacant land and improved agricultural land.

Wisconsin Average Agriculture Land Prices

(All farms-Vacant & Improved)

Year	# Sales	Acres	$/Acre	Change
1993	7,462	430,575	$ 969	
1994	6,094	383,002	1,033	+ 6.6%
1995	4,507	283,711	1,127	+ 9.1%
1996	4,637	290,860	1,284	+ 13.9%
1997	4,045	263,456	1,413	+ 10.1%
1998	4,088	264,606	1,515	+ 7.2%

The information on the previous page indicates the Wisconsin agriculture market has maintained considerable strength during the years shown.

The DOR further breaks down land sales to agricultural land without buildings, forested lands, and swamp or marsh land by county. Separate sale data is reported for "Land continuing in use" and "Land being diverted to other uses."

Following is a summary of land sale data for agricultural land sales without buildings; comparing Brown County to other area counties and to the State of Wisconsin.

1998 Agricultural Land Sales Summary--*Without Buildings*

Source: Wisconsin Department of Revenue-Board of Equalization

	Ag Land Continuing Use			Ag Land Diverting Use			Total Ag Land		
County	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**
Marinette	22	828	$ 785	5	163	$1,042	27	991	$ 827
Oconto	38	1,645	891	18	524	1,926	56	2,169	1,141
Outagamie	17	1,227	1,323	5	265	3,234	22	1,492	1,682
Door	20	671	1,058	3	65	1,549	23	736	1,102
Brown	10	648	1,839	16	633	6,833	26	1,281	4,307
State Avg.	1,472	--	1,173	767	--	1,785	2,239	--	1,332

The above data indicates the average price for agricultural land with a continuing use in Brown County was $1,839 per acre and the average price for agricultural land with a diverting use (likely some type of development land) was $6,833 per acre. The average price for agricultural land overall in the county was $4,307 per acre. The average agriculture unit sold was 49.27 acres (1,281 acres ÷ 26 sales). It is interesting to note the majority of agriculture land in the county transferred for a diverting use. In addition, the average price of Brown county agricultural land with a continuing use is significantly higher than the other four counties indicating it may have some added urban influence. The second highest average sale price in this category is from Outagamie County, which is of a similar size (but smaller) as Brown County. Brown County contains the highest overall prices of the five counties displayed above.

Following is a summary of land sale data for forested sales; comparing Brown County to other area counties and to the State of Wisconsin. Forested land sales include both upland and wetland sales.

1998 Land Sales Summary--*Forested Lands*

Source: Wisconsin Department of Revenue-Board of Equalization

	Land Continuing Use			Land Diverting Use			Total Land		
County	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**
Marinette	90	4,092	$ 925	19	1,114	$1,054	109	5,206	$ 953
Oconto	56	1,772	934	27	796	1,319	83	2,568	1,053
Outagamie	27	675	1,126	6	73	2.724	33	748	1,282
Door	32	906	1,222	12	228	2,014	44	1,134	1,381
Brown	13	205	1,028	10	195	4,170	23	400	2,559
State Avg	2,959	--	789	1,325	--	1,015	4,284	--	854

The above data indicates the average price for forested land with a continuing use in Brown County was $1,028 per acre and the average price for forested land with a diverting use (likely some type of development land) was

$4,170 per acre. The average price for forested land overall in the county was $2,559 per acre. 43 percent of the forested land sold for a diverting use. Brown County contains the highest overall forested land prices.

Following is a summary of land sale data for swamp and waste land sales; comparing Brown County to other area counties and to the State of Wisconsin.

1998 Land Sales Summary--*Swamp/Waste Land*

Source: Wisconsin Department of Revenue-Board of Equalization

	Land Continuing Use			Land Diverting Use			Total Land		
County	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**	**# Trans**	**Acres Sold**	**$ Per Acre**
Marinette	48	447	$ 535	11	119	$ 519	59	566	$ 532
Oconto	49	538	410	24	308	479	73	846	435
Outagamie	30	661	697	11	364	2,193	41	1,025	1,228
Door	24	332	838	7	56	308	31	388	761
Brown	13	132	732	9	95	6,093	22	227	2,976
State Avg	2,259	--	408	882	--	788	3,141	--	503

The above data indicates the average price for swamp/waste land with a continuing use in Brown County was $732 per acre and the average price for swamp/waste land with a diverting use (likely some type of development land) was $6,093 per acre. The average price for swamp/waste land overall in the county was $2,976 per acre.

The above information from the DOR demonstrates that the Brown County market is active. The data offers average prices for the three land types above and demonstrates their price relationship. The average price for all agricultural land without buildings in 1998 was $4,307 per acre. The average price for forested land in 1998 was $2,559 per acre. The average price for swamp/waste land in 1998 was $2,976 per acre. Furthermore, the trend analysis indicates the market for Wisconsin has been improving in recent years and shows a considerable amount of strength.

In the process of gathering and confirming sale data for Brown County, the author interviewed several real estate agents, appraisers, and/or market participants. Following is a summary of some of their comments about the county market. The persons interviewed are believed to be knowledgeable about the local market. The interviews focused on the market for vacant land in the 40+ acre size range and specifically on wetlands.

All persons interviewed characterized the overall market as being strong with good demand. Most described the market as being a seller’s market with prices continuing to increase as experienced in previous years.

The strongest demand for vacant land in Brown County is for upland tracts capable of supporting a buildings for development to residential, commercial, or industrial uses. Upland tracts typically command the highest prices. However, there remains good demand for recreational tracts for hunting. Recreational land can be both upland and wetland, although few to no upland tracts in Brown County sell for recreation only as the recreational buyer has to compete with the developers. Prices for development land far exceed that of the recreational buyer. Tracts typically purchased for recreation are not desirable for development or rural homesites due to wetness. Most of the recreational buyers are from within the county. Of the 5 Brown County wetland sales provided in this report (Sale 59 through Sale 63), all were to local buyers.

The most commonly offered price range for wetland tracts was $1,000 per acre to $1,250 per acre. Factors offered that influence price include having some area capable of supporting a dwelling or cabin, access, and size. Properties containing any area capable of supporting a dwelling or building receive a substantial positive impact on price.

The final step in this market analysis is to consider some actual sale transactions and the implications of the data. Following is a summary of the 5 sales in Brown County considered for the market analysis. The sales are arranged by date of sale beginning with the most recent.

Summary of Brown County Sale Data

Sale	$/Acre	Date	# Acres	% Wet	Bld Site	Access
59	$2,022	6/99	89	85	yes	public rd
60	2,417	6/99	60	80	yes	public rd
61	1,639	3/99	54	100	poor	public rd
62	1,200	2/99	20	100	poor	public rd
63	1,075	8/98	40	100	poor	easement

All of the above sales were primarily purchased for recreation and most of the sales contain primarily wetland. The sales indicate an overall indicated range in sale prices of $1,075 per acre to $2,417 per acre. The mean indicated sale price is $1,671 per acre and the median indicated price is $1,639 per acre.

The primary factor that influenced the sale price of the five sales above was degree of wetness and building site potential.

Sale 59 and Sale 60 contain the two highest sale prices. Both tracts contain a small percentage that is capable of supporting a building. These two tracts indicate a price range of $2,022 per acre to $2,417 per acre for this land category. In addition, the sale containing the lower percentage of wetland sold for the highest price.

The impact of percentage of wetland can be demonstrated by considering Sale 59, which sold for $2,022 per acre. Several sales were confirmed of properties within a 5 mile radius containing primarily upland. The neighborhood upland sale prices ranged from about $6,000 per acre to $13,000 per acre. In fact, a property located one mile north sold for $6,380 per acre and a property located one mile east sold for $13,300 per acre.

Sale 61 is currently all classified as wetland by the DNR. However, the buyer believed some of the land could be reclassified as non wetland and allow development. Therefore, while the wetland classification definitely had an negative impact on sale price, the possibility of changing the wetland classification had a positive impact on sale price.

Sale 62 and Sale 63 are purely wetland properties with no building potential. The two sales provide an indicated range in price of $1,075 per acre to $1,200 per acre.

As additional support for Brown County wetland tracts, consideration has been given to the results of bordering Oconto County and Outagamie County due to a lack of Brown County sale data. Southern Oconto County is influenced by

Brown County activity and Outagamie County is similar in size to Brown County. On the following page is a summary of the conclusion for both counties.

Wetland Market Study Summary - *Oconto County*

Overall Price Range......................	$ 750 per acre to $1,250 per acre
Most Common Price Range (North Region)...	$ 750 per acre to $1,000 per acre
Most Common Price Range (South Region)...	$1,000 per acre to $1,250 per acre

Wetland Market Study Summary - *Outagamie County*

Overall Price Range......................	$ 750 per acre to $1,250 per acre
Most Common Price Range..................	$1,000 per acre to $1,250 per acre

Southern Oconto County is most similar to Brown County and indicates a typical price range of $1,000 per acre to $1,250 per acre. Outagamie County indicates a typical price range of $1,000 per acre to $1,250 per acre.

CONCLUSIONS

The market for wetland properties in the 40+ acre size range has been strong in recent years and is expected to remain strong in the foreseeable future.

The overall price range for 40+ acre purely wetland tracts in Brown County is estimated at $1,000 per acre to $1,500 per acre. The primary factors that impact price are size, percentage wetland/building potential, and access. Location appears to have little or no influence on wetland prices as most properties in Brown County are within an easy driving distance to a large core population as compared to outlying areas such as northern Oconto County and Marinette County.

However, simply being located in Brown County is considered a slight advantage and Brown County wetlands would likely be nearer the high end of the range. Therefore, **the most likely price of wetland in Brown County is $1,200 per acre to $1,500 per acre**.

It is not possible to estimate a general price level for properties with any building potential or higher land because these prices are highly sensitive to multiple factors and have a vary wide price range of $2,000 per acre to $15,000+ per acre.

Therefore, it should be clearly understood that the general price levels estimated for Brown County are for purely wetland properties with no potential for building development.

Farmed hydric soils appear to have similar general price levels as wetland with similar factors influencing price.

The following is a summary of the conclusions of this market analysis for wetland properties having a minimum size of 40 acres in Brown County. (Not included in the below price ranges are properties with development potential or water frontage.)

Wetland Market Study Summary - *Brown County*

Typical Price Range for Pure Wetland.....	$1,000 per acre to $1,500 per acre
Most Likely Price Range for Pure Wetland.	$1,200 per acre to $1,500 per acre

PART III

COASTAL
&
WATER FRONT

LANDS

ALL COUNTIES

LOCATION MAP SHOWING THE DOOR COUNTY SALES

[not available]

LOCATION MAP SHOWING THE OCONTO COUNTY SALES

[not available]

LOCATION MAP SHOWING THE MARINETTE COUNTY SALES

[not available]

LOCATION MAP SHOWING THE BROWN COUNTY SALES

[not available]

COASTAL AND WATER FRONT MARKET ANALYSIS

The objective of this market analysis is to demonstrate the general price levels for vacant coastal land and water front land with a minimum size of 40 acres in Marinette County, Oconto County, Outagamie County, Door County, and Brown County. Coastal land is defined as land containing frontage along the bay of Green Bay or Lake Michigan and being both upland and bottomland. Water front land is defined as land containing frontage on inland lakes or rivers.

Due to the limited amount of data in this very specific property type, all five counties are considered together in this analysis. In addition, more reliance has been placed on interviews with persons familiar with the local market being primarily real estate agents.

The general prices of coastal land and water front land are highly sensitive to a number of factors. Some of the factors that affect price are size, location, wetness, potential for building site, amount of water frontage, utilities, access, proximity to town, etc. Prices for these properties can be very site specific. **The reader is warned that the below estimated price levels are very general and should not be relied on in estimating the value of a specific property. In the market analysis of coastal lands and water front tracts, sale data is very limited, therefore, the reliability of the conclusions is very limited.** The general price levels below are for land in unincorporated areas or land not included in any municipality as prices within a municipality could be significantly different.

In vacant land analysis, the most reliable method of measuring the market is by comparable sale data or actual sale transactions in the market area of similar land types. This data provides direct market indications of what sellers are willing to accept and what buyers are willing to pay for a particular property type.

For this analysis, data research occurred on transactions occurring between 1997 and presently pending. A total of 11 sales and listings were selected for consideration in reporting these general price levels. A sale data sheet for each of the 11 sales and listings is provided in the Addenda section of this report. The sale data sheet shows the location, property type, legal description, grantor, grantee, date of closing, property rights conveyed, financing terms, conditions of sale, data source, sale price, site size, sales price per acre, and other pertinent information for each sale. Sale location maps are presented on the previous pages.

Criteria for selecting market data was good arm's-length transactions, with a minimum site size of 40 acres, unimproved tracts, and containing coastal frontage or inland water frontage.

The market analysis will begin with a discussion of the interviews of real estate agents and appraisers in the five county area as this will give a general overview of the current market conditions.

In the process of gathering and confirming sale data for the five counties, the author interviewed several real estate agents, appraisers, and/or market participants. Following is a summary of some of their comments about the county market. The persons interviewed are believed to be knowledgeable about the local market. The interviews focused on the market for vacant land in the 40+ acre size range and specifically on wetlands.

All persons interviewed characterized the overall market as being strong with good demand. Most described the market as being a seller's market with prices continuing to increase. Demand for coastal land and water front land was described as being extremely strong and probably the hottest vacant land market. These properties offer the most scenic settings for primary residences and second homes. Properties containing any type of water frontage sell quickly when priced reasonably within the market. In addition, any type of water frontage property sells at a premium.

There are a limited number of coastal and water front properties in the area in the 40+ acre size range as most have been subdivided and sold as smaller tracts. Of the properties that remain in this larger size category, fewer yet have transferred in recent years or are offered for sale.

The most common buyers of these properties are developers or buyers for public interest. There appears to be some willingness and desire in the market of sellers to protect the remaining large coastal and water front tracts. Many of the sellers prefer to sell to public interests that will protect the land from development and preserve its natural state. It appears some sellers are even willing to sell at a discounted price for this purpose. However, these properties still bring a premium price.

Coastal lands typically sell per front foot. Commonly quoted prices for coastal lots (less than one acre in total size) for Marinette County, Oconto County, and southern Door County were $1,000 per front foot to $1,500 per front foot. These would include good building sites with limited building limitations. Sites having some building limitations but considered buildable would be slightly below the above range. Commonly quoted prices for coastal lots in northern Door County were $2,000+ per front foot.

For water front properties on rivers and inland lakes, most of these property types were found in Oconto and Marinette County. Interviews indicated that these property types typically sold at a premium of 20 to 25 percent above upland prices. The most commonly offered price range for northern Oconto County and Marinette County was $1,500 per acre to $2,500 per acre. Southern Oconto County would naturally be higher due to its close proximity to Brown County and major employment.

In the following paragraphs, the actual sale data gathered and confirmed from the five county area is considered. For this analysis, there are four distinct land types which include coastal upland, coastal wetland, water front upland, and water front wetland. Each land type is discussed separately.

Coastal Upland. Following is a summary of one pending coastal upland sale and one listing/offer.

COASTAL UPLAND
Summary of Sale Data

Sale	$/Acre	Date	# Ac	Up/Wet	Coast/W.F.	Access	County
64	$36,047	Pe/00	86	upland	coastal	private rd	Door
73	**47,500	List	20	upland	coastal	public rd	Door

** Offer to Purchase Estimated at $650,000 or $32,500 per acre.

Sale 64 is the pending sale of an upland coastal tract in northern Door County for $36,047 per acre or $1,632 per front foot. The sale contains approximately 1,900 feet of frontage along Green Bay and is located near Ellison Bay. The buyer is the County of Door. All funding for this sale is in place and it has a high probability to sell. The buyer indicated the seller was very interested in the property being transferred to public land ownership to protect it from development and preserve its natural state. In fact, the buyer made concessions in the terms of the agreement and price in order for the public ownership. There is reportedly a back up offer from a developer to purchase the property for over $4,000,000 or $46,512 per acre or $2,105 per front foot.

Sale 73 is a current listing and offer to purchase. The property is located just north of the city of Little Sturgeon Bay and contains approximately 20 acres and 1,000 feet of Green Bay frontage. The property is listed for $47,500 per acre or $950 per front foot. There is an offer to purchase the property currently being considered. The listing agent would not disclose the exact offer price, but stated he believed it was a good fair market offer. The listing agent quantified a fair market value for 1,000 feet of frontage in the neighborhood of this sale as being $600 to $700 per front foot. Therefore, the offer is estimated at $650 per front foot or $650,000 or $32,500 per acre.

Based on the above data, the general price level for coastal land in northern Door county is estimated at $35,000 per acre to $50,000 per acre or $1,600 per front foot to $2,500 per front foot for large tracts of land containing approximately 1,000+ feet of coastal frontage. Northern Door County is defined as that area of Door County located north of Sturgeon Bay.

The general price level for southern Door County is estimated at $20,000 per acre to $35,000 per acre or $500 per front foot to $1,000 per front foot for large tracts of land containing approximately 1,000+ feet of coastal frontage. Southern Door County is defined as that area of Door County South of Sturgeon Bay.

For the coastal upland of Brown County, it would be reasonable to expect the general price level to be similar to that of northern Door County ($35,000 per acre to $50,000 per acre) for those areas lying within close proximity to the city of Green Bay and declining as one moves away from the city with the more outlying areas of the county (such as Green Bay Township) being similar to the prices of southern Door County or $20,000 per acre to $35,000 per acre.

For the coastal upland in Oconto County and Marinette County, it would be reasonable to expect the general price level to be something less than that of southern Door County or in the $5,000 per acre to $20,000 per acre price range.

Coastal Wetland. Following is a summary of two coastal wetland sales and one listing/offer.

COASTAL WETLAND
Summary of Sale Data

Sale	$/Acre	Date	# Ac	Up/Wet	Coast/W.F.	Access	County
69	$2,441	4/98	158	wetland	coastal	public rd	Door
71	1,393	1/97	58	wetland	coastal	easement	Brown
72	*2,344	List	64	wetland	coastal	easement	Oconto

* Offer to Purchase by DNR $1,406/Acre

Sale 69 is the purchase of a primarily wetland tract with 2,340 feet of frontage on North Bay of Lake Michigan. The frontage land is low and extremely wet and is not buildable. This sale is located in northern Door County. The property sold for $2,441 per acre.

Sale 71 is the sale of a wetland peninsula with 4,434 feet of frontage on Green Bay for $1,393 per acre. This tract contained easement access and is not buildable.

Sale 72 is a listing of a 64 acre tract in southern Oconto County for $2,344 per acre. This tract contains poor easement access and is not buildable. DNR offered to purchase this property for $1,406 per acre but was refused.

The three sales indicate a general price level for coastal wetland of $1,393 per acre to $2,441 per acre. These sites are generally considered not buildable, however, the highest priced sale (Sale 69) contains some land that is slightly higher and may support a building. This may have had a positive effect on price.

Based on the above data, the general price level of coastal wetland is estimated at $1,500 per acre to $2,000 per acre. This price level is for tracts having no building potential. A site containing some small area capable of supporting a building will be positively affected and could contain a substantially higher price.

Water Front Upland. Following is a summary of water front upland sales in Oconto County and Marinette County.

WATER FRONT UPLAND
Summary of Sale Data

Sale	$/Acre	Date	# Ac	Up/Wet	Coast/W.F.	Access	County
65	$1,983	10/99	47	upland	water front	public rd	Oconto
66	1,570	8/99	207	upland	water front	public rd	Marinette
67	2,188	7/99	80	upland	water front	public rd	Oconto
68	1,539	6/99	90	upland	water front	public rd	Oconto
70	1,754	3/98	61	upland	water front	public rd	Marinette

The price range of water front upland tracts ranges from $1,539 per acre to $2,188 per acre. The low end of the price range is represented by the sales located the greatest distance from the city of Green Bay (northern Oconto County and Marinette County).

Based on the sale data on the previous page, the general price level for water front tracts in southern Oconto County or areas with a similar driving distance to Green Bay is estimated at $2,000 per acre to $2,500 per acre. The general price level of water front tracts in the more outlying areas of northern Oconto County and Marinette County is estimated at $1,500 per acre to $2,000 per acre.

Water Front Wetland. Following is a summary of one water front wetland sale.

WATER FRONT WETLAND
Summary of Sale Data

Sale	$/Acre	Date	# Ac	Up/Wet	Coast/W.F.	Access	County
33	$1,429	10/99	56	wetland	water front	public rd	Outagamie

This sale contains no building potential. The property contains a small area of higher ground, however, the higher ground is somewhat waterlocked, therefore, the property is considered not buildable. The property was purchased for recreation and is bisected by the Embarrass River. The river creates a very scenic setting and adds to the recreational appeal over pure wetland tracts. The added appeal is reflected in the price paid for the property. Typical wetland tracts in Outagamie County have a general price level of $1,000 per acre to $1,250 per acre. This indicates a premium was paid for Sale 33 of 14.3 percent to 42.9 percent. Therefore, a typical premium for a water front wetland tract is estimated at 20 to 30 percent over wetland prices depending on the quality of the water frontage.

Conclusions. The general prices of coastal land and water front land are highly sensitive to a number of factors. Some of the factors that affect price are size, location, wetness, potential for building site, amount of water frontage, utilities, access, proximity to town, etc. Prices for these properties can be very site specific. **The reader is warned that the above estimated price levels are very general and should not be relied on in estimating the value of a specific property. In the market analysis of coastal lands and water front tracts, sale data is very limited, therefore, the reliability of the conclusions is very limited.** The general price levels above are for land in unincorporated areas or not included in any municipality. Prices within a municipality could be significantly different.

PART IV

CERTIFICATIONS
&
QUALIFICATIONS
&
LETTER OF ENGAGEMENT

CERTIFICATION

I certify that, to the best of my knowledge and belief:

- the statements of fact contained in this report are true and correct.
- the reported analyses, opinions, and conclusions are limited only by the reported assumptions and limiting conditions, and are my personal, unbiased professional analyses, opinions, and conclusions.
- I have no present or prospective interest in the property that is the subject of this report, and I have no personal interest with respect to the parties involved.
- I have no bias with respect to the property that is the subject of this report or to the parties involved with this assignment.
- my engagement in this assignment was not contingent upon developing or reporting predetermined results.
- my compensation is not contingent on an action or event resulting from the analysis, opinions, or conclusions in, or use of , this report.
- my analyses, opinions, and conclusions were developed, and this report has been prepared, in conformity with the Uniform Standards of Professional Appraisal Practice.
- no one provided significant professional assistance to the person signing this report.
- the reported analyses, opinions, and conclusions were developed, and this report has been prepared, in conformity with the requirements of the Code of Professional Ethics and the Standards of Professional Appraisal Practice of the Appraisal Institute.
- the use of this report is subject to the requirements of the Appraisal Institute relating to review by its duly authorized representatives.

NOTE: As of the date of this report, the author has completed the requirements of the continuing education program of the Appraisal Institute.

Steven L Ritter

May 12, 2000

Author	Date of Market Study

QUALIFICATIONS OF STEVEN L. RITTER, MAI

EDUCATION	Central Missouri State University - Warrensburg, MO Bachelor of Science in Business Administration - 12/90 Major: Finance
	Seminars and Continuing Education
05/23/00	Standards of Professional Practice – Update (USPAP) Kansas City, MO
04/19/00	Federal Land Exchanges Phoenix, AZ
	Appraisal Institute
04/04/97	I410-Standards of Professional Practice Part A (USPAP) Kansas City, MO
10/13/94	540-Report Writing Denver, CO
10/06/94	530-Advanced Sales Comparison Denver, CO
09/24/94	550-Advanced Applications Overland Park, KS
03/26/94	520-Highest and Best Use and Market Analysis Athens, GA
11/13/93	210-Residential Case Study Overland Park, KS
05/01/93	II420-Standards of Professional Practice, Part B(USPAP) Overland Park, KS
04/29/93	I410-Standards of Professional Practice, Part A (USPAP) Overland Park, KS
04/24/93	II510-Advanced Income Capitalization Overland Park, KS
11/07/92	1BA-Capitalization Theory and Techniques, Part A St. Louis, MO
07/18/92	1A2-Basic Valuation Procedures San Jose, CA
10/19/91	1A1-Real Estate Appraisal Principles Boulder, CO
	American Society of Farm Managers and Rural Appraisers
08/19/97	A12-Code of Ethics Bloomington, IL
06/02/97	A30-Advanced Rural Appraisal Denver, CO
05/02/97	A29-Highest & Best Use Seminar Colorado Springs, CO
04/29/97	A25-Eminent Domain Colorado Springs, CO
03/08/97	A20-Principles of Rural Appraisals Colorado Springs, CO
	U.S. Department of HUD
11/10/94	Valuation Single Family Appraisal & Loan Processing Kansas City, MO
PROFESSIONAL AFFILIATIONS	Appraisal Institute - MAI Number 11150 American Society of Farm Managers and Rural Appraisers ARA Candidate Number 750
CERTIFIED	Missouri Certified General Real Estate Appraiser RA 002684 Ohio State Certified General Appraiser CG49900002

QUALIFICATIONS OF STEVEN L. RITTER, MAI

EXPERIENCE	COMMERCIAL, FARM, & RESIDENTIAL APPRAISER - February 1993 to Present Ritter Appraisals 2118 Royal Street, Suite B Harrisonville, MO 64701 COMMERCIAL APPRAISER - December 1990 to February 1993 Appraisal Associates 1009 Baltimore Avenue Kansas City, MO 64105

084615

State of Missouri

Department of Economic Development
Division of Professional Registration
Missouri Real Estate Appraisers Commission

REAL ESTATE APPRAISER

3 YEAR EXPIRATION JUNE 30, 2000 PAID THROUGH JUNE 30, 2000
ORIGINAL CERTIFICATE/LICENSE NO. RA 002684

STATE CERTIFIED GENERAL REAL ESTATE APPRAISER

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Letter of Engagement

[not available]

Part V – Addenda

Sale Data Sheets

[not available]

SOURCES

[1]*The Dictionary of Real Estate Appraisal*, American Institute of Real Estate Appraisers, 1984, page 123.

[2]*The Appraisal of Real Estate*, Tenth Edition, Appraisal Institute, 1992, Page 171.

[3]*The Appraisal of Real Estate*, Tenth Edition, Appraisal Institute, 1992, Page 171.

[4]*The Appraisal of Real Estate*, Tenth Edition, Appraisal Institute, 1992, Page 171.

[5]*The Appraisal of Real Estate*, Tenth Edition, Appraisal Institute, 1992, Page 171.

[6]*The Appraisal of Real Estate*, Tenth Edition, Appraisal Institute, 1992, Page 171.

Appendix K — Detailed Restoration Cost Analysis

This appendix describes how the land acquisition, restoration, and maintenance cost elements of the preferred restoration alternative were calculated. A description of the calculation of the costs for a program of improvements in recreational facilities is also provided because this activity is also being considered as a restoration alternative by the Co-trustees.

These cost elements are the focus of this appendix because they are based on applications of the unit and standard time data costing methodologies (see Table 3.17 of the RCDP). The remaining cost elements are based on applications of the factor and indirect rate application methodologies, whose values are described in detail in Chapter 3 of the RCDP.

Wetland restoration

It is assumed that wetland restoration will take place on lands with hydric soils that are currently in agricultural production. Because land prices vary dramatically across counties, the price of several categories of land was estimated in Brown, Door, Marinette, Oconto, and Outagamie counties by Ritter Appraisals, Inc. Details of the sources of information and results of this land price analysis are contained in Appendix J.

The average per acre sale price of agricultural land in the studied counties ranged from $785 for continuing agricultural use in Marinette County to $6,833 for diverting use in Brown County. The average, county-specific costs for agricultural land are presented in Table K.1.

Within each county, agricultural land prices for diverting use are higher than for continuing use, with the highest prices in the counties experiencing the most rapid development.

The Co-trustees will use a weighted per-acre price developed from the average price from all agricultural land sales (continuing and diverted uses) within each county that borders Green Bay, which is where the wetlands restoration will be focused, to estimate the land acquisition cost for wetland restoration. The weights used to calculate the average cost will reflect the distribution of agricultural land on hydric soils in each county covered by the analysis that borders Green Bay. The average per-acre cost resulting from this weighting and incorporated in the RCDP, rounded to two significant figures, is presented in Table K.2.

Table K.1. Average sale price of agricultural lands in select counties surrounding Green Bay.

County	Number of sales	Total acres sold	Average price ($/acre)
Continuing agricultural use			
Brown	10	648	1,839
Door	20	671	1,058
Marinette	22	828	785
Oconto	38	1,645	891
Outagamie	17	1,227	1,323
Diverting use			
Brown	16	633	6,833
Door	3	65	1,549
Marinette	5	163	1,042
Oconto	18	524	1,926
Outagamie	5	265	3,234
Average across continuing and diverting use			
Brown	26	1,281	4,307
Door	23	736	1,102
Marinette	27	991	827
Oconto	56	2,169	1,141
Outagamie	22	1,492	1,682

Table K.2. Weighted average cost of agricultural land for restoration to wetland.

County	Acreage with potential for wetland restoration[a]	Percentage of agricultural lands with potential for wetland restoration[a]	Average agricultural land price in county[b] ($/acre)	$ contribution to weighted average agricultural land price ($/acre)
Brown	15,941	60	4,307	2,568
Door	6,888	26	1,102	284
Marinette	1,436	5	827	44
Oconto	2,472	9	1,141	105
Weighted average (rounded to 2 significant digits)				**3,000**

a. Defined as land classified as agricultural use that lies on hydric soils.

b. Average of the continuing and diverting use averages shown in Table K.1.

Restoring former wetlands on agricultural lands with hydric soils generally requires reestablishing the natural hydrologic flows by removing and/or disabling installed drainage structures and replanting and/or reseeding to return the mix of plants native to wetland ecosystems. Estimates of the cost of the physical restoration of wetlands were developed for the Co-trustees by Hey and Associates, a firm specializing in wetland restoration (see Appendix E). Table K.3 presents per-acre cost estimates for wetland restoration actions that are expected to be required in the Green Bay area and that the Co-trustees will incorporate in preparing a final claim.

Table K.3. Costs for the restoration of former wetlands currently in agricultural production.

Type of activity	Specific activity	Average cost of restored wetland ($/acre)
Removal/disabling of existing	Drain tile investigation	14
Drainage structures	Drain tile abandonment/disabling	500
	Ditch plugging	47
Restoration of wetland	Seeding and planting	2,000
Vegetation	Herbicide application	75
Total (rounded to 2 significant digits)		**2,600**

The cost estimates shown in Table K.3 reflect the following assumptions that were developed for use in applying the cost estimates to the Green Bay region (V. Mosca, Hey and Associates, personal communication, 2000):

- Average per-acre cost estimates from the range of values presented are used.
- Both drain tile investigation/removal and ditch plugging costs are required because both systems were typically used to convert wetlands to agricultural use around Green Bay.
- The cost for disabling one acre of drain tiles is $2,000.
- For every acre of agricultural land where drainage structures are removed, four acres of land will realize the hydrologic benefits.
- An experienced crew can plug ditches that drain 7.5 acres in one day.
- Sites will require a mixture of wetland plant seeding and planting.
- Initial herbicides application will be required on one-half of the restored acres.

Wetland preservation

Three distinct types of wetland areas — coastal wetlands, natural area wetlands, and inland wetlands around urban areas — are under consideration for purchase as part of the wetland preservation component of the preferred restoration alternative. In addition, wetland preservation will involve purchasing buffering lands at a 1 buffer acre to 9 preserved acres ratio for coastal wetlands.

Land acquisition costs for these wetland categories were estimated in the same fashion as was used above with regard to agricultural lands that would be purchased for wetland restoration. Specifically, the county-specific average prices for various land categories developed in Appendix E were weighted to create an area average cost using GIS-based estimates of the distribution of the land class.

Following this approach, an average price per acre of inland wetlands was used in the RCDP to estimate the land acquisition cost for wetlands to be preserved around urban areas. The average county prices and population-based weighting shares used to develop the area average price for wetland acres around urban areas to be preserved, rounded to two significant figures, are presented in Table K.4.

Table K.4. Weighted average cost of wetlands for preservation around urban areas.

County	Census tracts in upper 50th percentile for population growth across the counties	Weighting share (%)	Average cost of inland wetlands ($/acre)	Contribution to weighted average cost ($/acre)
Brown	46	87	1,350	1,172
Door	1	2	1,050	20
Marinette	3	6	900	51
Oconto	3	6	1,000	57
Total	**53**	**100**		**1,300 (rounded)**

The same inland wetland price information was used to develop an average price for natural area wetlands that might be preserved. The Nature Conservancy provided information on the distribution of its “portfolio sites” around Green Bay, which was then used to weight the inland wetland costs for this wetland preservation category. Noting that roughly half of these portfolio sites were located in Door County, with the other half spread between Marinette and Delta (Michigan) counties, a weighted average cost of $1,000 per acre was calculated after rounding the sum of the weighted Door ($525) and Marinette ($450) contributions to two significant figures.

A comparison of sales prices for waterfront wetlands (i.e., wetlands along streams, rivers, lakes, or Green Bay) and inland wetlands concluded that waterfront wetlands sell for roughly 20% to 30% more than inland wetlands (see Appendix J). Therefore, the average price for coastal wetlands was estimated using the county-specific average per acre costs of inland wetlands presented in Table K.4 increased by the average of the price premium range (25%). These average costs are then weighted by the distribution of currently undisturbed coastal wetlands in the counties covered in Appendix J that border Green Bay (this excludes Outagamie county). The county costs, weighting values, and the calculated weighted average cost per acre for coastal wetlands, rounded to two significant figures, is presented in Table K.5.

Table K.5. Weighted average cost of coastal wetlands for preservation.

County	Currently undisturbed coastal wetlands (acres)	Weighting share (%)	Average cost of inland wetlands ($/acre)	Contribution to weighted average cost ($/acre)
Brown	2,406	17	1,688	293
Door	3,927	28	1,313	371
Marinette	1,309	9	1,125	106
Oconto	6,238	45	1,250	562
Total	**13,881**	**100**		**1,300 (rounded)**

Wetland maintenance

In addition to the restoration and preservation actions, ongoing maintenance work consisting of a mix of prescribed burns and mowing is assumed to be required for both restored and preserved wetlands so that they achieve and/or maintain their expected level of ecological service benefits. Assuming maintenance activities will consist of an equal application of prescribed burning and mowing on one-half of the restored/preserved acres every three years, the annualize wetland maintenance cost is $30 per acre (Table K.6).

For the RCDP, the Co-trustees determined the appropriate per-acre wetland restoration maintenance cost would pay for 25 years of annualized maintenance expenditures and produce a balance of $0 at the end of the twenty-fifth year while accounting for expected price inflation and interest earnings on balances carried through time. The price inflation and interest earnings assumptions were incorporated into the estimating as follows:

- Maintenance expenditures will incorporate an annual price inflation rate of 3.17% consistent with the observed annual rate of increase in the Consumer Price Index from 1985 to 1999 (U.S. Bureau of Labor Statistics, 2000).

- Interest earnings will be calculated by multiplying remaining maintenance balances at the end of each year by the June 2000 Treasury bill rate of 5.23% (HUD, 2000).

Incorporating these assumptions and satisfying the above conditions consistent with the use of the standard time data methodology results in the present value maintenance costs per acre of restored and preserved wetland are presented in Table K.6.

Table K.6. Expected maintenance costs for restored and preserved wetlands.

Maintenance activity	Estimate of required frequency	Annualized maintenance cost per restored wetland acre	Equivalent present value maintenance cost per restored wetland acre
Prescribed burning and mowing	An equal combination of the two activities every three years	$30	$590

Finally, the coastal wetland preservation strategy currently requires the purchase of uplands that surround the valuable wetlands to provide a buffer against potential future development and to help ensure the existing hydrology remains undisturbed. The weighted average cost for these buffering upland acres are based on the average price of agricultural land presented in Table K.2 weighted by the same shares used to determine the average cost for coastal wetlands presented in Table K.5. Agricultural land was assumed to provide the buffer for coastal wetlands because the coastal uplands reviewed in Appendix J represent a unique land type, which generally terminates in a cliff at the water's edge and is therefore not representative of the type of land that would buffer a coastal wetland. Following this procedure, the average weighted cost for coastal uplands, rounded to two significant digits, is $1,600 per acre.

Vegetative buffer strip installation

In developing vegetative buffer strips, the Co-trustees will follow a program of securing permanent conservation easements for the lands adjacent to identified waterways. The Brown County Land Conservation Department currently successfully incorporates this strategy for their vegetative buffer strip program. The costs for vegetative buffer strip installation incorporated in the RCDP are developed based on the Brown County Land Conservation Department's project experience.

Because vegetated buffer strips are developed with the use of permanent conservation easements, there is no transfer of property ownership and thus no reflection of the market price of the land that is converted. However, the Brown County Land Conservation Department offers landowners a $500 per acre incentive payment to help facilitate land conversion out of agricultural production and into vegetated buffer strips (W. Hafs, Brown County Land Conservation Department, personal communication, 2000). Unlike other counties around Green Bay, Brown County land ordinances require vegetated buffer strips along selected waterways. However, the ordinance alone has not proven sufficient, so the landowner incentive payments are also used. Based on this experience, we assume that the $500 incentive payment represents a reasonable estimate of the effective land acquisition cost for developing vegetative buffer strips in the counties around Green Bay.

As with restoring wetlands, the installation of effective vegetative buffer strips requires an initial level of physical activity and periodic maintenance activity. Table K.7 presents the typical activities and associated per-acre costs required to install vegetative buffer strips claim (W. Hafs, Brown County Land Conservation Department, personal communication, 2000). These are the costs that are incorporated in the RCDP and that will be used by the Co-trustees in preparing a final claim.

Table K.7. Costs for conversion of agricultural land to vegetated buffer strips.

Activity	Cost ($/acre)
Stone removal	25
Plowing	25
Harrowing (two passes)	30
Drilling for seeding	20
Initial mowing	15
Seed	75
Boundary marking	45
Total (rounded to 2 significant digits)	**240**

The maintenance of vegetated buffer strips is assumed to involve annual mowing and periodic work reseeding the buffer strip and removing concentrated flow paths that have developed through the buffer over time. Table K.8 presents information on the expected frequency and cost of the maintenance activities for vegetated buffer strips (W. Hafs, Brown County Land Conservation Department, personal communication, 2000) along with the calculated per-acre present value maintenance cost that satisfies the same time, price inflation, and interest earning conditions set out above for calculating the present value per-acre maintenance expense with wetlands restoration.

Table K.8. Expected maintenance costs for installed vegetative buffer strips.

Maintenance activity	Estimate of required frequency	Annualized cost[a] ($/acre)	Equivalent present value cost[b] ($/acre)
Mowing	Annual	15	
Reseeding and removal of concentrated flow paths through the VBS	Every five years	40	
Total		**55**	**1,100**

a. Maintenance costs for reseeding and removal of concentrated flow paths through the VBS were annualized by taking the average of the reported per-acre costs for the maintenance cycle and dividing by 5.
b. This value has been rounded to two significant digits for use in the RCDP.

Conservation tillage

In this appendix, the cost of concern for implementing a conservation tillage program is the annual per-acre payment that will be made to a farmer satisfying a contractually specified post-planting crop residue target combined with an estimate of the annual per-acre costs for administering the program. This combined annual per-acre cost will then be multiplied by the number of years of payment it is assumed needs to be received in order to induce a permanent change in tillage practices among farmers.

Currently, per-acre payments to farmers under contract that achieve a post planting crop residue standard of 30% range from $15 to roughly $19 (P. VanAirsdale, Winnebago County Land Conservation Department; R. Burton, Outagamie County Land Conservation Department, personal communication, 2000). The administrative costs associated with inspecting the fields to evaluate post-planting crop residue and provide instruction and guidance to the farmers are estimated to range from $1 to $2 per acre (R. Burton, Outagamie County Land Conservation Department, personal communication, 2000). As a result, the average annual per-acre cost of a conservation tillage program is assumed to be $19 for the RCDP, combining the average of the observed payment and administrative costs.

Conservation tillage programs are administered through contracts with individual farmers that specify the number of years that payment can be received for reaching a specified post-planting crop residue standard (generally 30%). The terms of these contracts range from eligibility for 6 years of payments in areas funded under Wisconsin's Priority Watershed Program to 3 years for areas in Winnebago County outside defined priority watersheds. Reflecting that there is uncertainty regarding the length of time required to induce a permanent change in tillage practices, the RCDP assumes eligibility will be established for receiving 4 years of payments within a 5 year time frame, with any area restrictions on eligibility most likely at the watershed level.

These conditions incorporate the lower end of the range of potential years of payments but allow farmers to miss the target in one year without losing a year of potential payments. This should increase the incentive to participate in the program, especially because the administrative costs are designed to provide the educational and implementation support resources that will help farmers who miss the target ensure they do not have a similar failure in subsequent years. As a result, the rounded cost for the conservation tillage program is estimated to be $75 per acre eventually placed under contract. This cost adequately reflects the slight discounting that would occur with payments in future years combined with four possible payments per enrolled acre.

Recreational facilities improvements

The annual cost of improving recreational facilities in the Green Bay drainage area will be calculated by applying the factor methodology to a baseline cost intended to reflect the annual public expenditures for the provision of parks and recreational facilities provided by counties and state parks in the Green Bay area. The counties and state parks listed in Table K.9 were combined in this process to create the baseline cost. The locations of these counties and parks are shown in Figure K.1.

Table K.9. Counties and state parks whose annual budgets are included in the estimate of current costs for parks in the Green Bay area.

Counties	State parks
Wisconsin	
Brown	Copper Culture
Calumet	Heritage Hill
Door	High Cliff
Kewaunee	Newport
Manitowoc	Peninsula
Marinette	Point Beach (State Forest)
Oconto	Potowatomi
Outagamie	Rock Island
Shawano	Whitefish Dunes
Winnebago	
Michigan	
Delta	Fayette
Menominee	Indian Lake
	J.W. Wells
	Palms Brook

These counties and state parks were chosen because they fall within the geographic scope of the Co-trustees' TVE assessment. City parks were not included since the TVE is focused more on the value of the services provided by resource-based parks such as county and state parks rather than the types of services provided by most city parks. When available, budget information from both 1999 and 2000 was averaged so that the impact of unusual expenditures (e.g., a significant one-time capital expenditure) would be reduced. Accepted rather than proposed budgets were used when both values were available, and net expenditures rather than gross expenditures were used so that the final financial burden on public institutions of providing these resources is reflected.

As with the estimated maintenance costs for the components of the preferred restoration alternative already reviewed, it is assumed that the annual payment required to provide a percentage increase in recreational facilities will be received over a period of 25 years. Following the standard time data methodology, the cost of this program will be expressed as a

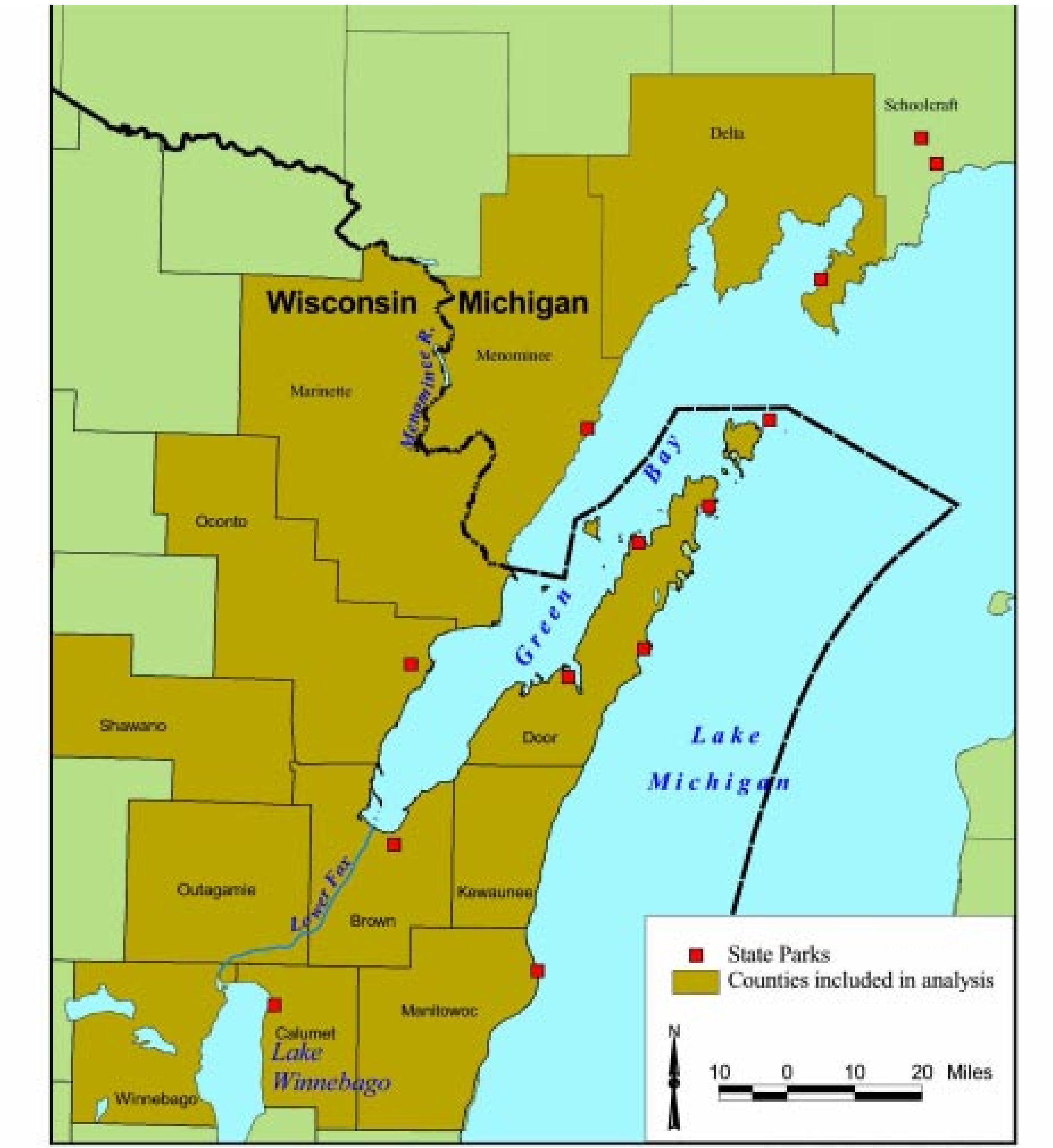

Figure K.1. Locations of counties and state parks used for estimating current park facility budgets.

present value where the undiscounted annual payment size is determined by the percentage increase in recreational facilities that is targeted (i.e., the chosen factor). This annual payment will then be adjusted upward to account for the expected impacts of price inflation using the same consumer price index-based rate applied to the maintenance cost elements previously discussed and where the discount rate used to complete the present value calculations will be 3% to reflect the social rate of time preference incorporated in this NRDA consistent with the Department's NRDA recommendations (U.S. DOI, 1995).

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