Bay of Green Bay National Estuarine Research Reserve Site-Selection Criteria

The site-selection criteria are designed to help states evaluate and select new estuarine research reserve sites for consideration within the national system. The criteria provided in this guidance fully support the guiding principles of site selection as described in §921.11 of the Reserve System regulations. However, additional criteria or modifications are allowed, in consultation with the Office for Coastal Management, to reflect regional differences in the ecological characteristics of the habitats to be considered or other factors. In addition, the relative "values" placed upon the criteria can also be modified as appropriate.

The Bay of Green Bay NERR designation seeks to engage with Tribal Governments as priority partners in the Site-Selection Process. To this end, the Site Evaluation Committee will reach out to Tribal Nations in Wisconsin and Tribal Nations in Michigan and invite contributions to the Site-Selection Process. This may include sharing historical, cultural, and scientific data. Input and data requests will be made by the Site Evaluation Committee with help facilitating requests from the Wisconsin Tribal Conservation Advisory Council and Jeff Mears, WTCAC Executive Director and Site Evaluation Committee member. Invitations for engagement will be directed to tribal leaders, the Tribal Historic Preservation Officers, and the environmental department of each Tribal Nation. Additional resources for data collection may include the University of Wisconsin-Green Bay First Nation's Studies program, the Great Lakes Indian Fish & Wildlife Commission, and the Wisconsin Tribal Conservation Advisory Council, among other potential sources of information.

The Bay of Green Bay Estuary is a large, dynamic, and complex system to the extent that its characterization would be incomplete if not focused on the large and complex gradients that define it. For this reason, the intent of the Site-Selection Process is to capture two important gradients within the Green Bay Estuary: the disturbance gradient from minimally impacted habitats to areas recently restored, and the south-to-north gradient capturing morphologic, estuarine, and trophic conditions driven by the hypereutrophic waters of the Fox-Wolf watershed in the south and the oligotrophic waters entering the bay from Lake Michigan (Klump et al, 2018).

Regarding the disturbance gradient, the Bay of Green Bay NERR Site-Selection committees recognize that federal legislation mandates the selection of minimally impacted sites for inclusion in the designation, but it is the intent of the committees to select a gradient of habitats from a disturbance perspective. To capture a disturbance gradient, the Bay of Green Bay NERR should include a combination of habitats that include areas minimally impacted by existing or historical anthropogenic disturbances, habitats that were previously impacted and then restored, and habitats that have a high value for restoration. Like many areas of the Great Lakes, Green Bay has experienced significant human disturbance over time, with recent investment in restoration over the last 30 years. To capture the south-to-north gradient, the Bay of Green Bay NERR should include a combination of habitats and adjacent waters spanning from hypereutrophic waters heavily influenced by eutrophic river systems towards oligotrophic waters more heavily influenced by Lake Michigan characteristics. The inclusion of sites that capture trophic and disturbance gradients will provide a rich platform to advance the science of freshwater estuaries in a changing world.

To fully realize the above and to capture the true characterization of the Green Bay Estuary, a scenario approach should be considered that compares single, two, or three-component site configurations and their ability to capture these defining gradients. The Site-Selection committees recognize that selecting a multi-component reserve will have to be weighed against the increased logistical and management costs of such a design.

Finally, a few notes on the application of criteria:

It is recommended that criterion 1.8 *Balanced Ecosystem Composition*, and possibly 4.2 *Publicly Owned Lands and Feasibility of Land Acquisition*, be applied at a secondary stage of evaluation to the entire proposed area of the NERR, rather than individual reserve components.

It is recommended that in the application of criterion, *3.3 Availability and Accessibility for Target Audiences*, relevant stakeholders and experts are consulted to help the Site Evaluation Committee consider a broad range of accessibility issues, including physical safety and perceptions of safety and inclusivity for all potential NERR stakeholders.

There are historical and cultural sites within the Green Bay estuary that may inform the management and oversight of NERR areas. Before the boundaries of the Bay of Green Bay NERR are drawn, the Site-Selection Committees will review assessments of historical tribal lands and the potential for associated changes in land management in the future.

The criteria fall into seven major categories:

1. Environmental Representativeness
2. Value of the Site for Research, Monitoring, and Resource Protection
3. Suitability of the Site for Education and Interpretation
4. Acquisition and Management Considerations
5. Natural Resource and Build Infrastructure Resilience to Climate Change Impacts
6. Partnership Building

Works Cited

Klump, J.V. et al. 2018. Green Bay, Lake Michigan: A proving ground for Great Lakes restoration. Journal of Great Lakes Research 44, 825-828. https://doi.org/10.1016/j.jglr.2018.08.002

1. Environmental Representativeness: Ecosystem and Ecological Characteristics

1.1 Ecosystem Diversity. This is a measure of the diversity of ecosystem types present within the boundaries of the site. This criterion assumes that sites that have a high diversity of major ecosystem types are of higher relative "value" for protection and management than those with low ecosystem diversity (unless the ecosystem in consideration is rare or unique: see "Uniqueness of Natural Communities").

The WDNR has adopted a landscape classification system that divides the state into 16 ecologically similar regions, or Ecological Landscapes, based on factors such as climate, geology, and vegetation. For classifying natural communities within these Ecological Landscapes, the WDNR uses the Wisconsin Natural Heritage Inventory (NHI) community classification system. The NHI system is part of a standardized national system for describing vegetative communities.

This criterion only considers natural communities as "representative" of this landscape if the WDNR has indicated that they occur near Northern or Central Lake Michigan Coastal Ecological Landscape.

Evaluation of this criterion will rely on the best professional judgment of Site Evaluation Committee members and potential supplemental analysis using aerial photography, topographic maps, NHI records, and other existing resources.

Representative Natural Communities by Ecosystem Type (a description of these communities is available in Appendix A) -

<u>Ecosystem Type I – Upland/Inland</u>

1. Alvar
2. Boreal Forest
3. Great Lakes Barrens
4. Northern Dry Forest
5. Northern Dry-Mesic Forest
6. Northern Mesic Forest
7. Open Bog
8. Southern Dry-mesic Forest
9. Southern Mesic Forest
10. Talus Forest

<u>Ecosystem Type II - Transitional</u>

1. Alder Thicket
2. Bedrock Shore
3. Boreal Rich Fen
4. Dry Cliff
5. Forested Seep
6. Floodplain Forest
7. Great Lakes Beach
8. Great Lakes Dune
9. Great Lakes Alkaline Rockshore
10. Great Lakes Ridge and Swale
11. Great Lakes Shore Fen
12. Interdunal Wetland
13. Moist Cliff
14. Northern Hardwood Swamp
15. Northern Tamarack Swamp
16. Northern Wet-mesic Forest

17. Northern Wet Forest
18. Northern Sedge Meadow
19. Shrub-carr
20. Southern Sedge Meadow
21. Wet-Mesic Prairie

Ecosystem Type III - Aquatic

1. Emergent Marsh
2. Floating-leaved Marsh
3. Lake--Shallow, Hard, Seepage
4. Riverine Mud Flat
5. Stream--Slow, Hard, Warm
6. Submergent Marsh
7. Wild Rice Marsh

Ecosystem Type IV – Other

1. Bird Rookery
2. Migratory Bird Concentration Site

3 Points	The site has a high diversity of ecosystem composition, i.e., it contains at least two representative upland natural communities, three representative transitional natural communities, and two representative aquatic or other natural communities.
2 Points	The site has a moderate diversity of ecosystem composition, i.e., it contains at least one representative upland natural community, two representative transitional natural communities, and one representative aquatic or other natural community.
1 Point	The site has a low diversity of ecosystem composition, i.e., it contains at least one representative natural community from each of the three main ecosystem groups.
0 Points	The site has a very low diversity of ecosystem composition, i.e., it does not contain at least one representative natural community from each of the three main ecosystem groups.

1.2 Natural Community Diversity.
This is a measure of the diversity of representative natural community types present within the boundaries of the site (see criterion 1A for a list of representative natural community types in the Northern or Central Lake Michigan Coastal Ecological Landscape). This criterion is based on the assumption that sites that have a high diversity of representative natural community types are of higher relative "value" for protection and management than those with a low diversity of representative natural community types. Evaluation of this criterion will rely on the best professional judgment of Site Evaluation Team members and potential supplemental analysis using aerial photography, topographic maps, NHI records, records and data sets from Tribal Nations and Indigenous peoples and communities, and other relevant existing resources.

3 Points	The candidate site has a high number of representative natural communities present, i.e., it is in the top quarter when the candidate sites are evaluated based upon the number of natural communities present.
2 Points	The site has a moderate number of representative natural communities present, i.e., it is in the top half when the candidate sites are evaluated based upon the number of natural communities present.
1 Point	The site has a low number of representative natural communities present, i.e., it is in the bottom half when the candidate sites are evaluated based upon the number of natural communities present.
0 Points	The site has a very low number of representative natural communities present, i.e., it is in the bottom-quarter when the candidate sites are evaluated based upon the number of natural communities present.

1.3 Uniqueness of Natural Communities.
This criterion is a measure of the presence of **rare or unique natural** communities within a candidate site. This criterion recognizes the importance of emphasizing unique areas in the selection process, in addition to the representativeness of the candidate site in terms of ecosystem and natural community diversity. Unique natural communities are generally defined as a natural community of "limited" known occurrence within the Lake Michigan Subregion of the Great Lakes Biogeographic region.

For scoring, unique natural communities are specifically defined as communities that have been identified by the Natural Heritage Inventory Program as Wisconsin and/or **globally critically imperiled or rare with a ranking of G1-G3 and/or S1-S3** (https://dnr.wi.gov/topic/EndangeredResources/Communities.asp) See https://dnr.wisconsin.gov/sites/default/files/topic/NHI/NHIWorkingList.pdf for the key to Global and State Element Rank Definitions.

Evaluation of this criterion will rely on the best professional judgment of Site Evaluation Team members, existing NHI records, and potential supplemental analysis using aerial photography, topographic maps, and other existing resources.

Wisconsin and/or Globally Critically Imperiled, Imperiled, or Vulnerable Natural Communities

Ecosystem Type I – Upland/Inland

- Alvar – critically imperiled in Wisconsin and vulnerable globally (G3 and S1)
- Boreal Forest – imperiled in Wisconsin and vulnerable globally (G3 and S2)
- Great Lakes Barrens –critically imperiled in Wisconsin and imperiled globally (G2 and S1)
- Northern Dry Forest – vulnerable in Wisconsin and vulnerable globally (G3? and S3)
- Northern Dry-Mesic Forest – apparently secure in Wisconsin and vulnerable globally (G4 and S3)
- Southern Dry-mesic Forest – vulnerable in Wisconsin and apparently secure globally (G4 and S3)
- Southern Mesic Forest – vulnerable in Wisconsin and vulnerable globally (G3? and S3)
- Talus Forest – critically imperiled in Wisconsin and apparently secure globally (G4G5, S1)

Ecosystem Type II – Transitional

- Northern Wet-Mesic Forest – vulnerable in Wisconsin and vulnerable globally (G3 and S3S4)
- Southern Sedge Meadow– vulnerable in Wisconsin and apparently secure globally (G4 and S3)
- Bedrock Shore – vulnerable in Wisconsin and vulnerable globally (G3G4 and S2)
- Boreal Rich Fen – imperiled in Wisconsin and apparently secure globally (G4G5 and S2)
- Floodplain Forest – vulnerable in Wisconsin and vulnerable globally (G3 and S3)
- Forested Seep - imperiled in Wisconsin, global rank not yet determined (GNR and S2)
- Great Lakes Alkaline Rockshore – imperiled in Wisconsin and vulnerable globally (G3 and S2)
- Great Lakes Beach – imperiled in Wisconsin and vulnerable globally (G3 and S2)
- Great Lakes Dune – imperiled in Wisconsin and vulnerable globally (G3 and S2)
- Great Lakes Ridge and Swale – imperiled in Wisconsin and vulnerable globally (G3 and S2)
- Great Lakes Shore Fen – imperiled in Wisconsin, global rank not yet determined (GNR and S2)
- Interdunal Wetland – critically imperiled in Wisconsin and imperiled globally (G2? And S1)
- Northern Sedge Meadow – vulnerable in Wisconsin and apparently secure globally (G4 and S3)
- Northern Tamarack Swamp – vulnerable in Wisconsin and apparently secure globally (G4 and S3)
- Wet-mesic Prairie – imperiled in Wisconsin and imperiled globally (G2 and S2)

Ecosystem Type III – Aquatic

- Wild Rice Marsh – vulnerable in Wisconsin and vulnerable globally (G3G4 and S3)

Ecosystem Type IV – Other

- Migratory Bird Concentration Site – unrankable in Wisconsin due to lack of information or conflicting information about status or trends and vulnerable globally (G3 and SU)

3 Points	The site contains five or more “unique” natural communities within its boundaries
2 Points	The site contains three or four “unique” natural communities within its boundaries
1 Point	The site contains one or two “unique” natural communities within its boundaries
0 Points	The site contains no "unique" natural communities within its boundaries.

1.4 Significant Faunal and Floral Support.

This is a measure of the degree to which a site supports significant faunal and/or floral components. This criterion focuses on a site's contribution toward supporting the suite of significant faunal and/or floral components listed below. The list of components includes groups of organisms that are known to be dependent upon freshwater estuary habitats for their entire life cycle or a crucial part of their life cycle. Evaluation of this criterion will rely on the best professional judgment of Site Evaluation Committee members, NHI data regarding occurrences of rare species, and potential supplemental faunal and floral data from government agencies, universities, and other sources. The Site Evaluation Committee may add to this list floral and faunal components of high cultural value.

Faunal and Floral Components

- Ephemeral Ponds
- Native Fish Spawning and/or Nursery Grounds
- Migratory Birds and/or Waterfowl
- Bird Nesting and/or Roosting Areas
- Critical Mammal Habitat
- Non-Game Animals (amphibians, reptiles, mussels, etc.)

- State or Federally Listed Species (animal or plant - including candidate species)

3 Points	The candidate site supports or serves as an important site for a wide range of the faunal and floral components listed above (4 of 6) and/or is an extremely important site for any threatened or endangered species.
2 Points	The site supports or serves as an important site for a moderate range and diversity of the significant faunal and floral components listed above (3 of 6).
1 Point	The site supports or serves as an important site for one or two of the significant faunal and floral components listed above.
0 Points	The site does not support significant faunal and floral components.

1.5 Geomorphologic Integrity and Uniqueness.
This is a measure of the integrity of the geomorphologic processes important to the ecology of the site, and the uniqueness of the geomorphologic features present at the site. This criterion attempts to consider both surface and subsurface geologic features and processes that may be important or unique within a site, particularly as they affect associated biotic habitats. Additionally, geomorphic features could be unique because of their cultural significance. A high level of geomorphic integrity means that natural geomorphic processes are largely unimpacted by anthropogenic changes. Evaluation of this criterion will rely on the best professional judgment of Site Evaluation Committee members, and, when possible, will be supported through a review of existing sources of information.

Examples of Geomorphological Processes and Possible Anthropogenic Impacts

- Groundwater-surface water interactions altered by pumping
- Seasonal or interannual beach dynamics altered by hardening shorelines
- Manipulation of water levels via diking
- Shoreline sediment inputs and transport impacted by structures

Examples of Unique Geomorphologic Features

- Coastal Features (e.g. spits, baymouth bars, and/or tombolos)
- Reefs
- Cliffs
- Rocky shore
- Waterfalls
- Bluffs
- Glacial features (e.g. moraines, drumlins, and eskers)
- Islands
- Ridges and Swales
- Peatlands

3 Points	The site has excellent geomorphologic integrity and several unique geomorphologic features.
2 Points	The site has high geomorphologic integrity but few unique geomorphologic features or the site has moderate geomorphologic integrity but several unique geomorphologic features.
1 Point	The site has moderate geomorphologic integrity and few unique geomorphologic features.

0 Points The site has limited geomorphologic integrity and limited unique geomorphologic features.

1.6 Extent of Bay of Green Bay Intrusion and Seiche Influence.
This criterion recognizes the importance of Great Lakes water intrusion and seiche influence on freshwater estuary structure and function. The criterion assumes that sites with observable, frequent Bay of Green Bay intrusion and seiche influence will best demonstrate the associated physicochemical gradients (e.g., specific conductivity, nutrient, turbidity, temperature and DO) that are intrinsic to freshwater estuaries. Evaluation of this criterion will rely on the best professional judgment of Site Evaluation Committee members, and, when possible, will be supported through a review of existing sources of information.

3 Points The site has significant Bay of Green Bay intrusion and seiche influence and/or exhibits a unique gradient of mixing bay and tributary waters.

2 Points The site has moderate Bay of Green Bay intrusion and seiche influence and/or exhibits a moderate gradient of mixing bay and tributary waters.

1 Point The site has minimal Bay of Green Bay intrusion and seiche influence and/or exhibits minimal gradient of mixing bay and tributary waters.

0 Points The site has no Bay of Green Bay intrusion and seiche influence and/or exhibits no gradient of mixing bay and tributary waters.

1.7 Degree of Anthropogenic Disturbance and Ecological Integrity.
This is a measure of the degree to which the site and its surrounding area exhibit impacts from existing or historic anthropogenic disturbances (e.g., development, channelization, agriculture, silviculture) and invasive species. A site's restoration potential to achieve ecological integrity is an important consideration in the application of this criteria. Restoration potential may include enhancing hydrologic and habitat integrity. Evaluation of this criterion will rely on the best professional judgment of Site Evaluation Committee members and, where possible, will be supported by existing land use data and other sources of information.

3 Points The site and surrounding area are minimally impacted by existing or historical anthropogenic disturbances and invasive species.

2 Points The site and surrounding area are moderately impacted by existing or historical anthropogenic disturbances and/or invasive species, have been restored to return ecological integrity, or have great potential for restoration to return ecological integrity.

1 Point The site and surrounding area are significantly impacted by existing or historic anthropogenic disturbances and/or invasive species, but important rehabilitation opportunities exist.

0 Points The site and surrounding area are significantly impacted by existing or historic anthropogenic disturbances and/or invasive species, and few rehabilitation opportunities exist.

1.8 Balanced Ecosystem Composition.
This is a measure of the relative composition of ecosystem types within the boundaries of a reserve. This criterion assumes that reserves with a balanced proportion of ecosystem types are of higher relative "value" for protection and management. High, moderate, and low values are assigned to sites that contain variations in the proportions of all three ecosystem types. A value of zero is assigned to a site that is dominated by one ecosystem type or contains less than three ecosystem types. When applying criteria, there should be consideration of variability in lake levels and the potential need for a greater proportion of transitional habitat to accommodate changing lake levels.

This criterion is to be applied at a secondary stage of evaluation to the entire proposed area of the NERR, rather than individual reserve components.

3 Points	The site contains representative upland, transitional, and aquatic habitats in relatively equal proportions (i.e., the areal cover of any one ecosystem type not less than 25 percent of the total area).
2 Points	The site contains representative upland, transitional, and aquatic habitats, with the areal cover of transitional not less than 20% and upland or aquatic not less than 10 percent of the total area.
1 Point	The site contains representative upland, transitional, and aquatic habitats, with the areal cover of any one type less than 10 percent of the total area.
0 Points	The site contains representative upland, transitional, and aquatic habitats, with the areal cover of two types being less than 10 percent of the total area or the site consists of habitats from only one or two of the three major ecosystem type.

2. Value of the Site for Research, Monitoring, and Resource Protection

2.1 Value of Site for Research.

This is a measure of the research opportunities presented by the site's characteristics. The assumption is that a site with representative, unique, and highly diverse characteristics will provide greater research, monitoring, and resource protection opportunities than one lacking these characteristics. Ratings generated for these factors under previous selection criteria can be used as a guide for rating this overall factor. Consideration of cultural knowledge may help guide the application of this criterion.

3 Points	The site has (1) a high diversity of ecosystem/natural community types, (2) a high number of unique natural communities, (3) supports significant fauna and flora, (4) excellent geomorphologic integrity and uniqueness, (5) significant Bay of Green Bay intrusion and seiche influence, (6), minimal disturbance or invasive species threats, (7) exhibits significant potential for estuarine restoration research, (8) high cultural value related to ecosystem types and functions
2 Points	The site has four or five of the eight above
1 Point	The site has two or three of the eight above
0 Points	The site has one or none of the eight above

2.2 Previous Research and Monitoring Efforts.

This is a measure of the degree to which the site has been used for past research and monitoring, including considerations of the diversity of inquiry and availability of documentation, e.g., peer-reviewed papers, grey literature, inventory reports). The assumption is that an area with previously established research and monitoring interests, including from Tribal Nations and Indigenous peoples and communities, offers greater opportunity for future projects than an area that has not sparked such an interest in the past.

3 Points	The site has a long history of well-documented research and monitoring projects on a wide variety of topics. Data is readily available.
2 Points	The site has had major and well-documented research and monitoring efforts generating data that is readily available. It has not had a long history of research and monitoring.
1 Point	The site has had only minor research and monitoring projects generating limited data (e.g., inventories) that may be difficult to obtain.
0 Points	The site has no known history of research and monitoring.

2.3 Suitability of Site for Environmental Monitoring.
Research Reserves are ideally and uniquely suited to conduct large-scale and long-term environmental monitoring. The site should be well suited for developing monitoring programs aligning with the existing NERRS System-Wide Monitoring Program (SWMP) and with locally driven issues. As an example of monitoring suitability considerations, the site should allow tracking of short-term variability and long-term changes in estuary waters to understand how human activities and natural events can change ecosystems. This may include the suitability of the site to serve as a reference area for assessing resource trends. It should allow the collection of long-term data on water quality and weather at frequent time intervals. The SWMP currently measures physical, biological, and chemical water quality indicators, nutrients, and the impacts of weather on estuaries.

Considerations for this criterion should also include the accessibility of the site for monitoring equipment installation, maintenance, and data download, and the overall logistical ease or difficulty presented by a site for environmental monitoring programs.

3 Points	The site is ideally suited for providing environmental data to assess short-term variability and/or long-term resource trends or ecological characteristics for a wide range of needs.
2 Points	The site is adequate for providing environmental data to assess short-term variability and/or long-term resource trends or ecological characteristics for a wide range of needs.
1 Point	The site is marginal for providing environmental data to assess short-term variability and/or long-term resource trends or ecological characteristics for a wide range of needs.
0 Points	The site is unsuitable for providing environmental data to assess short-term variability and/or long-term resource trends or ecological characteristics for a wide range of needs.

2.4 Ability to Address Key Local, State, Regional, and Global Coastal Management and Research Issues.
This is a measure of the degree to which the site and its watershed are appropriate for investigating issues relevant to coastal management at the local, state, regional, and global levels. Solutions to these issues may require either the application of land management practices or habitat manipulations to perform meaningful research and assessment. The Site Evaluation Committee will seek a diversity of perspectives to understand community concerns related to management and research issues. This may include concerns related to issues of cultural value. As such, the site or its watershed should offer both adequate managed areas plus areas where demonstration projects and habitat manipulations can be accommodated to study many of the coastal management issues. The assumption is that a site where coastal management issues arise and can be addressed will be of greater value from a resource protection standpoint than sites where these issues do not arise. The significant issues for Lake Michigan include, but are not limited to:

- wetlands protection, restoration, rehabilitation, and mitigation
- shoreline erosion
- effects of lake-level changes on coastal ecosystems
- commercial and/or recreational fisheries
- control and effects of excess runoff and other hydrologic modifications (e.g., ditching, tile drains)
- waterfowl and other wildlife management
- best management practices to limit impacts from agricultural, or urban development activities (e.g., stormwater runoff and quality)
- best management practices for habitat protection and/or management (e.g., fire management)

- human dimensions of resource use and management
- best methods to control invasive species
- emerging and legacy contaminants
- effects of pollutants and sedimentation on water quality
- prehistoric and early historic settlement and land use
- watershed impacts on tributary systems, coastal zones, and offshore waters of Lake Michigan
- effects of hardening of shorelines and coastal development (dikes, rip-rap, sea-walls)
- resource stewardship and sustainability
- protection and restoration of habitat for rare species

3 Points	The site is highly appropriate for investigating coastal management issues.
2 Points	The site is appropriate for investigating coastal management issues.
1 Point	The site is minimally appropriate for investigating coastal management issues.
0 Points	The site is not appropriate for investigating coastal management issues.

3. Suitability of the Site for Training, Education, and Interpretation

3.1 Value of Site for Environmental Education and Interpretation Programs. Sites with existing education programs likely have the necessary infrastructure in place to further expand their programs, thus it is valuable to rate sites based on the presence of these programs. The potential for education and interpretation program development should be considered as well based on the diversity and quality of educational and interpretive program opportunities. Existing sites with a long history of education and interpretation programming and sites with the potential for future environmental education and interpretation programming should receive equal consideration.

3 Points	The site has a long history of education and interpretation, and/or the site offers excellent potential for future education and interpretation program development.
2 Points	The site has a good but short history of education and interpretation but is otherwise well suited for education/interpretation program development, and/or the site offers good potential for future education and interpretation program development.
1 Point	The site has had only a minor amount of education and interpretation being conducted, and/or the site offers fair potential for future education and interpretation program development.
0 Points	The site offers no significant potential for education and interpretation program development.

3.2 Variety and Quality of Training and Educational/Interpretive Opportunities. The degree to which a site can provide a well-rounded education program addressing key coastal management issues. The site should be well-suited for conducting outreach programs related to the topical research occurring at the site and other NERR facilities, with the ability to emphasize each of the following:

1. Ecology (lake, stream, wetland, terrestrial, plant, and animal)
2. Coastal and freshwater estuary natural resource management
3. Geology and soil science
4. History and culture
5. Tribal significance, both current and historical
6. Sustainability (environment, economy, culture)
7. Climate change
8. Watershed health and water quality
9. Wetland health, functionality, diversity, and management
10. Best management practices for mitigation, restoration, and rehabilitation

3 Points	The site has numerous different educational and training opportunities in many of these areas.
2 Points	The site has several significantly different educational and training opportunities.
1 Point	The site has few significant opportunities for education and training in these areas or is only suitable in some areas.
0 Points	The site is not well suited for education or training in the majority of these areas.

3.3 Availability and Accessibility for Target Audiences. No matter how well-suited a site may appear for education and interpretation programs, it will be of limited educational value if the site cannot be accessed or utilized by the target audiences. The site should be accessible to target audiences and offer a safe environment for conducting educational/interpretive programs. Accessibility includes consideration for both physical access to the site(s) and the safety and inclusivity of underrepresented groups accessing the site(s). Thus, the value of a site correspondingly increases with an increase in the accessibility and usability of the site for the target audiences listed below. Consideration will also be made for sites that may not be accessible at the time of site selection but could be made accessible if a road was improved, signage erected, a boardwalk built, etc. Data sets that may be helpful to the application of this criterion may include the EPA's Environmental Justice Screening and Mapping tool, demographic data, and information on transportation infrastructure.

- Cultural and tribal communities (schools and members), including Michigan tribes accessing the islands
- Underrepresented groups, particularly in visiting nature
- Kindergarten through high school (K-12) students, including homeschoolers
- College students (community college, undergraduate, and graduate)
- Teachers and informal/formal educators
- Coastal decision-makers
- Coastal user groups
- General public
- Visitors to the region/eco-tourists
- Academic and agency scientists
- Resource agency technical staff
- Business community members

3 Points	The site provides a suitable, safe, and accessible environment to provide educational/interpretive programming to many of the target audiences who are available to utilize it.
2 Points	The site is suitable for educational/interpretive programming, but only to a limited number of target audiences because of accessibility or safety concerns.
1 Point	Only a few target audiences can utilize the site for educational/interpretive programs due to minimal target audience accessibility or safety concerns.
0 Points	Target audiences are either unavailable or cannot utilize the site due to lack of accessibility or safety concerns.

4. Land Ownership and Management Considerations

Facilities and Proximity

4.1 Land Ownership. This is a measure of the degree to which the site is divided (e.g., divided into only a few parcels or owned by many individuals). The assumption is that a candidate site with fewer property owners will be easier to manage. Preference for having fewer owners, or fewer levels of government (city, state, county) ownership because of ease of land management and coordination.

3 Points	The site is relatively undivided, or relatively easily managed between multiple owners
2 Points	The site is divided by a limited number of property owners.
1 Point	The site is divided by a moderate number of property owners.
0 Points	The site is divided, with many property owners, many levels of government, and/or multiple private property owners that may be difficult to manage

4.2 Publicly Owned Lands and Feasibility of Land Acquisition. This is a measure of the degree to which the land within the site is currently owned by the state, federal government, or local governments, or conservation groups and land trusts, and the degree to which adjacent lands could be included in the site The assumption is that the degree of management needed to maintain the site in conditions compatible with the mission of the Bay of Green Bay NERR increases with publicly owned land and lands managed by conservation groups. The likelihood of including adjacent non-public lands increases when these lands are within a regional or local protection plan.

3 Points	The vast majority of the site is currently publicly owned and/or managed by conservation groups/land trusts and, if adjacent lands for potential acquisition exist, these adjacent lands are part of a published protection plan. For example, lands within the Wisconsin DNR's West Shore Management Plan expansion area.
2 Points	The majority of the site is publicly owned and/or managed by conservation groups/land trusts and, if adjacent lands for potential expansion exist, these adjacent lands have broad support from local, regional, or state entities (including conservation groups and land trusts) for future protection. For example, Land Legacy Report, WWAP.
1 Point	The majority of the site is publicly owned and/or managed by conservation groups/land trusts, while adjacent lands for potential expansion exist, these adjacent lands do not have established or verified support from local, regional, or state entities (including conservation groups and land trusts) for future protection.
0 Points	Less than 50% of the site is publicly owned and/or managed by conservation groups/land trusts, and adjacent lands for potential expansion do not exist.

4.3 Availability of Facilities. The degree to which there are existing facilities or potential sites for future facilities that can be used by staff, researchers, classes and training groups (e.g., administrative building space, dormitories, labs, interpretive centers, trails, boardwalks, boat ramps, etc.). The assumption is that due to limited NERR construction funds and state matching funds, a candidate site with existing facilities can meet the objectives of the NERRS Program sooner and more completely than a site without existing

facilities.

3 Points	The site has established structures and facilities either on-site or near the site which can be used for reserve activities.
2 Points	The site has limited established structures and/or facilities that can be used for reserve activities, and there is excellent potential for the development of facilities.
1 Point	The site has no established structures or facilities, but there is excellent potential for the development of facilities for reserve activities.
0 Points	The site has no established structures or facilities, and there is limited potential for on-site development facilities for reserve activities.

4.4 Proximity and Accessibility of Site to Researchers, Educators, and Resource Management Decision Makers. This is a measure of (1) the relative proximity of the site to population centers, K-12 schools, research and education institutions, and resource management agencies that may routinely utilize the site and (2) the adequacy of the roads and/or points for boat access at the site. The underlying assumption is that the proximity and accessibility of the site will enhance its utilization for education, research, monitoring, and resource protection purposes. Note: 'Day' is defined here as a school/workday and 'day trip' is defined as fits within a school day.

3 Points	The candidate site can be utilized by a substantial number of researchers, educators, and management decision-makers during a single-day trip. There are good roads and/or points for boat access at the site.
2 Points	The candidate site is somewhat isolated. If utilization requires an overnight stay, accommodation is readily available. There are adequate roads and/or points for boat access at the site.
1 Point	The candidate site is relatively isolated without reasonable accommodations nearby for an overnight stay. There are limited roads and/or points for boat access at the site.
0 Points	The candidate site is extremely isolated and accommodations to utilize the site are not available. There are inadequate or no roads and/or points for boat access at the site.

Management Considerations

4.5 Managed Land and Water Access. This is a measure of the degree to which land and water access to the site support visitation and recreational value. The degree of access is based on points of access (present and proposed), size, geography, proximity to adjacent residential development, and present management practices and controls. The assumption is that the integrity and security of a potential NERR site can be better maintained with a higher level of management of land and water access. With the NERR, it is understood that at some sites managing access points is ideal, such as areas with threatened or endangered species. At other sites, such as the visitor center or areas for education, easier access is preferred.

3 Points	The site has many access points to maximize utilization while also being able to manage and minimize disturbance of sensitive areas.

2 Points The site has some distance from existing development, and a limited number of access points. Historically, site access has not been managed, but site access may be managed in the future for disturbance of sensitive areas.

1 Point The site is not very isolated from existing development and will be difficult to manage due to a large number of access points and/or the size of the area. Historically, site access has not been managed, and it is unclear whether it can be managed in the future.

0 Points Site access cannot be managed due to a large number of access points, lack of historical controls, the size of the areas, and/or dense adjacent land development.

4.6 Compatibility with Existing Management Practices and Uses. This is a measure of the degree to which foreseeable management practices implemented under a NERR Program, such as monitoring or habitat restoration for research purposes, might conflict with existing management practices (e.g., habitat manipulations, best management practices) and/or consumptive and non-consumptive uses. The assumption is that sites with fewer conflicts are more likely to maintain both public support and the integrity of the site.

Notes: 1. Consumptive use refers to hunting, fishing, harvesting, etc. 2. The NERR designation is non-regulatory and will **not** introduce new restrictions on hunting, fishing, boating, commercial boat traffic, etc.

3 Points The existing or foreseeable management plans and/or practices of the NERR site would not conflict with any existing management practices or consumptive and non-consumptive uses of the site.

2 Points The existing or foreseeable management plans and/or practices of the NERR site could create minor restrictions on existing management practices or consumptive and non-consumptive uses of the site.

1 Point The existing or foreseeable management plans and/or practices of the NERR site could create moderate restrictions on the existing management practices or consumptive and non-consumptive uses of the site.

0 Points The existing or foreseeable management plans and/or practices of the NERR site could create significant restrictions on the existing management practices or consumptive and non-consumptive uses of the site.

4.7 Compatibility with Adjacent Land Use. This is a measure of the potential conflicts between management practices on a NERR site with land-use practices on adjacent lands. It is also a measure of the adequacy of land use regulations, or other efforts to sustain the site's resources for long-term research, education, and resource protection. The assumption is that a candidate site with compatible land-use practices on adjacent lands is more likely to maintain the integrity of the reserve. Potential conflicts could include mining activities, gas and oil extraction, extensive urban development, or land uses deemed as conflicting by the Bay of Green Bay Site-Selection committees.

3 Points 10% or less of the land adjacent to the site is currently used for activities that might impact the site and/or be incompatible with the operation of a possible NERR.

2 Points 10 to 25% of the land adjacent to the site is currently used for activities that might impact

the site and/or be incompatible with the operation of a possible NERR.

1 Point — 25 to 50% of the land adjacent to the site is currently used for activities that might impact the site and/or be incompatible with the operation of a possible NERR.

0 Points — Greater than 50% of the land adjacent to the site is currently used for activities that would have negative impacts on a possible NERR and would lead to conflicts.

4.8 Future Development Plans. This is a measure of the potential level of future development in areas on or adjacent to a candidate site that would impact the site. The assumption is that a candidate site with minimal to no development plans on-site and on adjacent lands is more likely to maintain the integrity of the reserve. Even more so than the previous factor, this issue involves the degree to which adjacent lands are currently being used and/or may be attainable as buffer areas for the NERR. Evaluating this criterion may require talking to communities and land-use planners about future uses of area lands, and the potential to designate buffer areas around a site.

3 Points — A large percentage (more than 75%) of the land adjacent to the site is currently undeveloped and/or is, for whatever reason, very unlikely to be developed in the near future (e.g., consisting of marginally developable property, such as wetlands or public lands which could be obtained as a buffer).

2 Points — A moderate percentage (between 50-75%) of the land adjacent to the site is currently undeveloped and/or is not likely to be developed in the near future.

1 Point — A small to moderate percentage (25-50%) of the land adjacent to the site is currently undeveloped and/or is not likely to be developed in the near future, with limited levels of development on other lands nearby.

0 Points — A large percentage (more than 75%) of the land adjacent to the site is developed and the area is likely to continue to be developed in the future.

5. Natural Resource and Built Infrastructure Resilience to Climate Change

Impacts Natural Resources

A changing climate is resulting in a variety of impacts that differ based on geography and conditions within geography. Reserves are designated as 'representative estuarine ecosystems' for 'long-term protection … to ensure a stable environment for research.' (15 CFR 921.1) Planning for the impacts of climate change and other anthropogenic or natural perturbations is imperative to ensure these systems can remain representative estuaries within their biogeographic region.

5.1 Coastal resilience research. How suitable is the site (and hydrologic basin where it is found) to support research on coastal resilience including both natural, cultural, and social systems? This includes how climate change may amplify impacts of land-use change, increases in the vulnerability of the habitats of the site (and hydrologic basin) to relative lake level fluctuations, and climate change impacts. Research focuses include adaptations of natural, cultural, and social systems to climate change impacts, including restoration and protection projects.

3 Points	The site (and hydrologic basin) demonstrates high value in researching adaptation of natural, cultural, and social systems to climate change and lake level fluctuations including research on adaptations that reduce vulnerability
2 Points	The site (and hydrologic basin) demonstrates moderate value in researching adaptation of natural, cultural, and social systems to climate change and lake level fluctuations including research on adaptations that reduce vulnerability.
1 Point	The site (and hydrologic basin) demonstrates low value in researching adaptation of natural, cultural, and social systems to climate change and lake level fluctuations including research on adaptations that reduce vulnerability.

5.2 Preservation of key ecological functions and services. This criterion focuses on the ecosystem's ability to be resilient, to be able to 'absorb impacts without significant changes in condition or functioning' (NOAA's Next Generation Strategic Plan, 2010). This includes the capability of the system to respond and recover from significant threats with minimum damage and the ability to maintain ecological function, the integrity of the ecological unit, and provide ecosystem services. See reports from the Wisconsin Initiative on Climate Change Impacts (WICCI) for climate change scenarios and projections: https://wicci.wisc.edu/wp-content/uploads/wicci-report-to-governors-task-force.pdf (July 2020)
http://www.cleanwisconsin.org/wp-content/uploads/2014/06/2011_WICCI-Report.pdf (2011)

3 Points	Ecosystem is resilient and adaptable under high impact climate change and lake level fluctuations scenarios given the current understanding of vulnerability.
2 Points	Ecosystem is resilient and adaptable under medium impact climate change and lake level fluctuations stressor/threat scenarios.
1 Point	Ecosystem is unlikely to be resilient and adaptable under medium/low climate change and

lake level fluctuations stressor/threat scenarios.

0 Points Ecosystem is vulnerable and not resilient under any climate change and lake level fluctuations scenarios.

5.3 Ability to accommodate habitat shifts. This criterion focuses on the ability to accommodate shifts in habitat as bay water level, inundation, or other climate-induced change occurs. Is there sufficient ability of the system to accommodate these shifts and to provide habitat connectivity in cases of climate-drive migration? Additionally, is there an ability to acquire land further up the watershed to allow for the maintenance of an ecological unit? This includes consideration for future expansion of the NERR boundary.

3 Points Site boundaries (i.e, the core and buffer areas) allow for habitat migration and several areas adjacent to the boundary provide an option for expansion to accommodate habitat shifts and boundary expansion.

2 Points Site boundaries allow for some habitat migration and some areas adjacent to the boundary provide an option for expansion to accommodate habitat shifts and boundary expansion.

1 Point Site boundaries allow for little habitat migration and little to no areas adjacent to the boundary provide an option for expansion to accommodate habitat shifts and boundary expansion.

0 Points Site boundaries do not allow for habitat migration and there are no areas adjacent to the boundary that provides an option for expansion to accommodate habitat shifts and boundary expansion.

Infrastructure and Access

A changing climate is resulting in a variety of impacts that differ based on geography and conditions within geography. Reserves are designated to ensure a stable platform for research, address significant coastal management issues, enhance public awareness and understanding and promote the use of the reserve areas consistent with the purposes outlined. Access to infrastructure that supports these purposes is key to achieving the mission of the reserve system.

5.4 Facility Resilience. This criterion focuses on the expected vulnerability of existing facilities (including visitor centers, labs, storage facilities) proposed for use by the reserve to remain viable and accessible taking into account the most relevant climate change stressors in the locale. This accounts for adaptive strategies that are and/or may be in place to mitigate anticipated stressors.

3 Points Facility(ies) resilient and adaptable under high impact climate change and lake level fluctuations scenarios, given current understanding of vulnerability.

2 Points Facilities resilient and adaptable under medium impact climate change and lake level fluctuations stressor/threat scenarios.

1 Point Facilities are unlikely to be resilient and adaptable under medium/low impact climate change and lake level fluctuations stressor/threat scenarios.

0 Points	Facilities vulnerable and not resilient under any climate change and lake level fluctuation scenarios.

5.5 Public Access Resilience. This criterion focuses on the ability to access the resources of the reserve. This includes access to water via docks and boat launches, access to interpretive and educational experiences via trails, pavilions, amphitheaters, as well as access to existing recreational and professional opportunities in the resource.

3 Points	Public access infrastructure is resilient and adaptable under high-impact climate change and lake level fluctuations scenarios, given the current understanding of vulnerability.
2 Points	Public access infrastructure resilient and adaptable under medium impact climate change and lake level fluctuations and stressor/threat scenarios.
1 Point	Public access infrastructure unlikely to be resilient and adaptable under medium/low impact climate change and lake level fluctuations and stressor/threat scenarios.
0 Points	Public access infrastructure vulnerable and not resilient under any climate change and lake level fluctuations scenarios.

6. Partnership Building

Partnerships should be relevant and aid the program in achieving its goals, reaching target audiences, and developing and delivering key messages. They increase the resilience of the reserve and its ability to work with the local community to address climate change and impacts from other important stressors. Partnerships can increase the ability to address research needs and gaps, reach education and public engagement goals, and provide access to facilities and field opportunities. Institutional partnerships can also provide administrative services, support leveraging of resources, and reduce program costs. These organizations or third parties can also assist with fund-raising, grant development and management, and management of program income (ex. Friends Groups and NERRA). The strength of the reserve's partnerships and potential for partnerships will be evaluated based on the following:

6.1 Potential to develop partnerships. This criterion focuses on the site's ability to create new partnerships and strengthen existing partnerships to achieve reserve goals, reach target audiences, develop and deliver key messages, and address relevant coastal management issues. This can be demonstrated by potential partner interest, geography, etc. with a focus on the outcomes of the partnership, not the number or name of organizations. This will be measured by the following metrics:

- Existing MOUs or agreements explaining shared resources such as facilities and salaries
- Memberships of key individuals to professional organizations such as the National Marine Educators Association, Society of Wetland Scientists, other state professional organizations, research organizations, local or regional consortiums, etc.
- Recent history of key personnel participation in multi-institutional grants, publications, and projects
- Letters from existing informal partners about past projects, their outcomes, and organizational structure
- Letters from potential partners focusing on how the partner could complement or contribute to the reserve goals. This letter should include information such as historical context for partnership and their vision for contributing to the reserve mission.

3 Points	The candidate site has strong potential to develop and strengthen new and existing partnerships of high quality evidenced by metrics stated above.
2 Points	The candidate site has potential for new partnerships of good quality to develop.
1 Point	The candidate site has potential for partnership development.
0 Points	The candidate site has insignificant potential for partnerships.

6.2 Internal NOAA Partnerships.
This is a measure of the number and quality of partnerships with other NOAA entities that already exist within a program or that have the potential to develop based on common goals, geographic proximity, etc. The assumption is that a candidate site with a high diversity of existing partnerships and partnership potential will have opportunities to leverage support and create sustainable programs more so than one with fewer partnerships. Some examples include Sea Grant, Coastal Programs, Marine Sanctuaries, Weather Service, Climate Office, and other line offices of NOAA. This will be measured by the following metrics:

- Existing MOUs or agreements explaining shared resources such as facilities and salaries
- Recent history of key personnel participation in grants, publications, and projects with NOAA

3 Points	The candidate site has a history of NOAA partnerships and there is strong potential to develop and strengthen new and existing ones of high quality evidenced by the metrics stated above.
2 Points	The candidate site has several partnerships in place and there is potential for new partnerships of good quality to develop.
1 Point	The candidate site has potential for partnership development.
0 Points	The candidate site has insignificant potential for partnerships.

6.3 Diversity of Partnerships. This is a measure of the ability to reach diverse audiences through existing partnerships or potential partnerships based on common goals and geographic proximity. The assumption is that a candidate site with a high diversity of existing partnerships and partnership potential will have opportunities to leverage support and create sustainable programs more so than one with fewer partnerships. These partnerships should increase the candidate site's ability to address relevant coastal management issues, address research needs and gaps, and reach diverse audiences. These partner organizations should range in diversity such as federal agencies (ex. National Estuary Programs, National Wildlife Refuges, National Parks), Tribal and local governments, state agencies and parks, local organizations (Marine Labs and Land Trusts), NGOs, and umbrella groups (national, regional or local). These partnerships should help bridge the gap between the NERRS and new audiences that the NERRS has not typically engaged (e.g. urban audiences) or that could help the NERRS become more effective at reaching intended audiences (e.g. national municipal association to facilitate reaching local officials). The focus of these partnerships should be the outcomes, not the number or name of organizations. This will be measured by the following metrics:

- Existing MOUs or agreements explaining shared resources such as facilities and salaries
- Recent history of key personnel participation in multi-institutional grants, publications, projects
- Letters from existing informal partners about past projects, outcomes, and organizational structure
- Letters from potential partners focusing on how the partner could complement or contribute to the reserve goals. This letter should include historical context and vision for partnership contributing to the reserve mission.

3 Points	The candidate site has many diverse partnerships and there is strong potential to develop and strengthen new and existing ones of high quality evidenced by metrics stated above.
2 Points	The candidate site has several diverse partnerships in place and there is potential for new partnerships of good quality to develop.
1 Point	The candidate site has potential for partnerships.
0 Points	The candidate site has insignificant potential for partnerships.

7. Institutional Commitment

Strong institutional commitment from a state or university partner often can provide valuable resources and services for reserve operation and success. This can be a helpful criterion to consider during the nomination and designation process. These commitments can take various forms including real dollars and in-kind services and can help meet cost-share requirements. Institutional commitment can be a good indicator of program success and sustainability. Note: The Bay of Green Bay NERR Site-Selection committees may decide that these criteria should be evaluated entirely by the NERR Site Coordination Committee.

7.1 Financial Support. This sub-criterion focuses on the direct financial support a state or university partner will commit to the reserve. Partners can provide salary support for reserve staff, shared positions, a reduction in overhead costs, and the engagement of volunteers in reserve programs and activities that can be quantified and used as match funding.

3 Points	Institutional commitment of financial support for personnel and funding (i.e. reduced overhead or volunteer hour match funding) will enhance reserve capacity.
2 Points	Institutional commitment of financial support for personnel and funding will enhance reserve capacity moderately.
1 Point	Institutional commitment of financial support is minimal and will do little to enhance reserve capacity.
0 Points	Institutional commitment of financial support is non-existent

7.2 In-kind Services. This sub-criterion focuses on the in-kind services to which state and university partners or third parties (e.g., Friends Groups, NERRA) often can commit. Support for facilities (e.g., infrastructure, equipment, vehicles) includes maintenance and repair and access to field and laboratory capabilities including coastal research laboratories and sampling platforms (i.e., boats, buoys, and labs). Support for administrative services can also be provided, such as personnel support, lab services, grant preparation and management, management of program income, reduced program costs, and fundraising.

3 Points	Institutional commitments of in-kind services that include each of the following: facilities, personnel, grant administration. Third-party support is established or probable and fills a need not provided by the partner.
2 Points	Institutional commitments of in-kind services that include support or services in two of the following: facilities, personnel, grant administration. Third-party support is possible and fills a need not provided by the partner.
1 Point	Institutional commitment of in-kind services is minimal and limited to one or two of the following: facilities, personnel, grant administration. Third-party support is unlikely or minimal.
0 Points	Institutional commitment of in-kind services is non-existent.

Appendix A

Brief Description of the Representative Natural Communities Used in the Detailed Selection Criteria

Compiled from: Epstein E, Judziewicz E, and Spencer E. 2002. Wisconsin Natural Heritage Inventory recognized natural communities – working document. Madison (WI): Wisconsin Department of Natural Resources. http://dnr.wi.gov/topic/EndangeredResources/Communities.asp

Epstein, E.E. 2017. Natural communities, aquatic features, and selected habitats of Wisconsin. Chapter 7 in *The ecological landscapes of Wisconsin: An assessment of ecological resources and a guide to planning sustainable management*. Wisconsin Department of Natural Resources, PUB-22-1131H 2017, Madison. Source: https://p.widencdn.net/exmng9/1805Ch7

Alder Thicket

These wetlands are dominated by thick growths of tall shrubs, especially speckled alder (*Alnus incana*). Among the common herbaceous species are Canada bluejoint grass (*Calamagrostis canadensis*), orange jewelweed (*Impatiens capensis*), several asters (*Aster lanceolatus*, *A. puniceus*, and *A. umbellatus*), boneset (*Eupatorium perfoliatum*), rough bedstraw (*Galium asprellum*), marsh fern (*Thelypteris palustris*), arrow-leaved tearthumb (*Polygonum sagittatum*), and sensitive fern (*Onoclea sensibilis*). This type is common and widespread in northern and central Wisconsin, but also occurs in the southern part of the state.

Alvar

This rare community consists of areas of thin, discontinuous soil overlying horizontal beds of limestone or dolomite in the vicinity of Great Lakes shorelines. These communities support an unusual blend of boreal and prairie species, which appear to be relics of the cold period following the last glaciers and of the warmer, drier period that followed. They are characterized by relatively low tree cover and a distinctive biota which includes elements of rock pavement, prairie, savanna, and boreal forest communities. Among these are regional endemics, some of which are globally very rare. This community type is much more common and better developed in Michigan and Ontario than in Wisconsin. Small coniferous and deciduous trees such as northern white-cedar (*Thuja occidentalis*), balsam fir (*Abies balsamea*), pines (*Pinus* spp.), oaks (*Quercus* spp.), aspens (*Populus* spp.), and paper birch (*Betula papyrifera*) are scattered among an assemblage of species that can include big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), Indian grass (*Sorghastrum nutans*), and wood lily (*Lilium philadelphicum*), as well as shoreline plants such as silverweed (*Potentilla anserine*) and dwarf lake iris (*Iris lacustris*). Alvars are home to an unusual set of wildlife species as well, including the loggerhead shrike and a large number of distinctive invertebrates such as leaf-hoppers and land snails.

Bedrock Shore

Wave-splashed bedrock shoreline ledges are best developed on sandstone in the Apostle Islands of Lake Superior. Stunted trees of northern white-cedar (*Thuja occidentalis*), paper birch (*Betula papyrifera*), showy mountain-ash (*Sorbus decora*) and green alder (*Alnus viridis*) are often present in crevices. Common herbs are tickle grass (*Agrostis hyemalis*), fireweed (*Epilobium angustifolium*), and Canada goldenrod (*Solidago canadensis*), but the flora often includes unusual plants such as bird's-eye primrose (*Primula mistassinica*), brook lobelia (*Lobelia kalmii*), and three-toothed cinquefoil (*Sibbaldiopsis tridentata*).

Bird Rookery

A Bird Rookery is an area where more than one pair of birds nest in a group. The number of nests can vary from just a few to hundreds and can include one to many different species of birds. Sites can include rare and non-rare species. The breeding time will vary based on the species present at the site. Rookeries are typically located in inaccessable locations including forests, shrub communities, wetlands adjacent to water (lakes, rivers or streams), and islands. These sites are important as large numbers of breeding individuals can be found in a single place.

Boreal Forest

In Wisconsin, mature stands of this forest community are dominated by white spruce (*Picea glauca*) and balsam-fir (*Abies balsamea*), often mixed with white birch (*Betula papyrifera*), white cedar (*Thuja occidentalis*), white pine (*Pinus strobus*), balsam-poplar (*Populus balsamifera*) and quaking aspen (*Populus tremuloides*). Mountain-ash (*Sorbus* spp.) may also be present. Common understory herbs are large-leaved aster (*Aster macrophyllus*), bluebead lily (*Clintonia borealis*), Canada mayflower (*Maianthemum canadense*), wild sarsaparilla (*Aralia nudicaulis*), and bunchberry (*Cornus canadensis*). Most Wisconsin stands are associated with the Great Lakes, especially the clay plain of Lake Superior, and the eastern side of the northern Door Peninsula on Lake Michigan. Of potential interest from the perspectives of vegetation classification and restoration, white pine had the highest importance value of any tree in the Lake Superior region, as recorded during the original land survey of the mid-1800’s.

Boreal Reach Fen

Boreal rich fen is a rare open peatland community of northern Wisconsin that is associated with glacial moraines, or less commonly, outwash landforms, in which the underlying substrate includes calcareous materials. Like many other northern peatlands, nutrient levels are low, but pH is significantly higher than in the poor fen and open bog communities and influences the plant composition. Sphagnum mosses are of lesser importance in this type than are the so-called "brown" mosses (e.g., from the genera Campylium, Drepanocladus, or Scorpidium). Characteristic vascular plants may include woolly sedge (*Carex lasiocarpa*), twig-rush (*Cladium mariscoides*), white beak-rush (*Rhynchospora alba*), beaked bladderwort (*Utricularia cornuta*), rushes (*Juncus* spp.), Hudson Bay cotton-grass (*Scirpus hudsonianus*), rush aster

(*Symphyotrichum boreale*), and buckbean (*Menyanthes trifoliata*). The most nutrient-rich boreal-rich fens occur on the Door Peninsula, which is underlain by calcareous bedrock and mantled with calcareous till. Here, in addition to the species mentioned above, the open peatlands may support species such as coast sedge (*Carex exilis*), linear-leaved sundew (*Drosera linearis*), brook lobelia (*Lobelia kalmii*), grass-of-Parnassus (*Parnassia glauca*), shrubby cinquefoil (*Dasiphora fruticosa*), hair beak-rush (*Rhynchospora capillacea*), and tufted bulrush (*Trichophorum cespitosum*). The proximity of carbonate-enriched bedrock is almost certainly among the factors responsible for the composition of the boreal-rich fens in this region. Shrub phases of this community also occur, in which shrubby cinquefoil (*Dasiphora fruticosa*), bog birch (*Betula pumila*), sage willow (*Salix candida*), and speckled alder (*Alnus incana*) may be present in significant amounts, and collectively form the dominant plant cover.

Dry Cliff

These dry vertical bedrock exposures occur on many different rock types, which may influence species composition. Scattered pines, oaks, or shrubs often occur. However, the most characteristic plants are often the ferns, common polypody (*Polypodium vulgare*) and rusty woodsia (*Woodsia ilvensis*), along with herbs such as columbine (*Aquilegia canadensis*), harebell (*Campanula rotundifolia*), pale corydalis (*Corydalis sempervirens*), juneberry (*Amelanchier* spp.), bush-honeysuckle (*Diervilla lonicera*), and rock spikemoss (*Selaginella rupestris*).

Ephemeral ponds

Ephemeral ponds are small fishless pools with impeded drainage, usually in forest landscapes, that hold water for a short time following snowmelt and spring rains but typically dry out by mid-summer. They flourish with productivity during their brief existence. Ephemeral ponds, also referred to as vernal pools, provide critical breeding habitat for invertebrates and many amphibians such as wood frogs and several salamanders, because they lack the fish that would typically prey on them, their egg masses and tadpoles. They also provide feeding, resting, and breeding habitat for songbirds and a source of food for many mammals and contribute in many ways to the biodiversity of a woodlot, forest stand, and the larger landscape. Common wetland plants found in ephemeral ponds include yellow water crowfoot, mermaid weed, Canada bluejoint grass, floating manna grass, spotted cowbane, smartweeds, orange jewelweed, and sedges. Trees adjacent to ephemeral ponds provide a variety of benefits such as maintaining cool water temperatures, preventing premature drying, and contributing to the food web. The annual input of leaves from these trees help provide a detritus-based food source for a variety of invertebrates.

Emergent Marsh

These open, marsh, lake, riverine and estuarine communities with permanent standing water are dominated by robust emergent macrophytes, in pure stands of single species or in various mixtures. Dominants include cat-tails (*Typha* spp.), bulrushes (particularly *Scirpus acutus*, *S. fluviatilis*, and *S. validus*), bur-reeds (*Sparganium* spp.), giant reed (*Phragmites australis*), pickerel-weed (*Pontederia cordata*), water-plantains (*Alisma* spp.), arrowheads (*Sagittaria* spp.), and the larger species of spikerush such as (*Eleocharis smallii*).

Emergent Marsh - Wild Rice

This open community is an emergent macrophyte type, with wild rice (*Zizania aquatica* or *Z. palustris*) as the dominant species. The substrate usually consists of poorly consolidated, semi-organic sediments. Water fertility is low to moderate, and a slow current is present. Wild rice beds have great cultural significance to native peoples and are important wildlife habitats.

Forested Seep

Forested seeps are shaded seepage areas with active spring discharges in hardwood forests that may host a number of uncommon to rare species. The overstory dominant is frequently black ash (*Fraxinus nigra*), but yellow birch (*Betula allegheniensis*), American elm (*Ulmus americana*), and many other tree species may be present, including conifers such as hemlock (*Tsuga canadensis*) and white pine (*Pinus strobus*). The groundlayer includes groundwater-loving species such as skunk cabbage (*Symplocarpus foetidus*), water-pennywort (*Hydrocotyle americana*), marsh blue violet (*Viola cucullata*), swamp saxifrage (*Micranthes pennsylvanica*), golden saxifrage (*Chrysosplenium americanum*), golden ragwort (*Packera aurea*), silvery spleenwort (*Deparia acrostichoides*), and several uncommon sedges (*Carex scabrata* and *C. prasina*). Most documented occurrences are in the Driftless Area or along major rivers flanked by steep bluffs.

Floodplain Forest

This is a lowland hardwood forest community that occurs along large rivers, usually streams order 3 or higher, that flood periodically. The best development occurs along large rivers in southern Wisconsin, but this community is also found in the north. Canopy dominants may include silver maple (*Acer saccharinum*), river birch (*Betula nigra*), green ash (*Fraxinus pennsylvanica*), hackberry (*Celtis occidentalis*), swamp white oak (*Quercus bicolor*), and cottonwood (*Populus deltoides*). Northern stands are often species-poor, but balsam-poplar (*Populus balsamifera*), bur oak (*Quercus macrocarpa*), and box elder (*Acer negundo*) may replace some of the missing "southern" trees. Buttonbush (*Cephalanthus occidentalis*) is a locally dominant shrub and may form dense thickets on the margins of oxbow lakes, sloughs and ponds within the forest. Nettles (*Laportea canadensis* and *Urtica dioica*), sedges, ostrich fern (*Matteuccia struthiopteris*) and gray-headed coneflower (*Rudbeckia laciniata*) are important understory herbs, and lianas such as Virginia creepers (*Parthenocissus* spp.), grapes (*Vitis* spp.), Canada moonseed (*Menispermum canadense*), and poison-ivy (*Toxicodendron radicans*) are often common. Among the striking and characteristic herbs of this community are cardinal flower (*Lobelia cardinalis*) and green dragon (*Arisaema dracontium*).

Great Lakes Alkaline Rockshore

Great Lakes alkaline rockshore is a community that develops on creviced, wave-splashed, horizontal or gently sloping exposures of dolomite bedrock that dip toward Lake Michigan. These occur only along the Lake Michigan shoreline of the northern Door Peninsula, and on the margins of some of the Grand Traverse Islands to the north. This is the same bedrock that forms the Niagara Escarpment, which forms

prominent cliffs on the west side of the Peninsula. The extent of the exposed rock is dependent on Lake Michigan water levels and large expanses of this habitat may be either inundated or exposed during a given year. Characteristic flora of this community includes shrubs ninebark (*Physocarpus opulifolius*) and shrubby cinquefoil (*Dasiphora fruticosa*), and herbs silverweed (*Potentilla anserina*), birds-eye primrose (*Primula mistassinica*), grass-leaved goldenrod (*Euthamia graminifolia*), brook lobelia (*Lobelia kalmii*), gentians (*Gentiana spp., Gentianopsis* spp.), grasses-of-Parnassus (*Parnassia* spp.), Indian paint-brush (*Castilleja coccinea*), low calamint (*Clinopodium arkansanum*), and many sedges and rushes. Plants endemic to the Great Lakes shores are significant components in some stands. Because this community type is geographically restricted to those portions of the Lake Michigan coast with dolomite shoreline, it is, and has always been, rare here. There is often a narrow zone of rank herbs and tall shrubs just inland of the exposed dolomite pavement, sometimes occupying a ridge of cobbles, gravel, or a low ledge.

Great Lakes Barrens

In Wisconsin, this variant of pine savanna is known from only one sandy site on Lake Superior. The dominant trees in this open stand are wind- and fire-deformed trees, red pines (*Pinus resinosa*) with white pine (*P. strobus*) also present. The understory consists of dense growths of lichens with scattered thickets of common juniper (*Juniperus communis*), early blueberry (*Vaccinium angustifolium*) and huckleberry (*Gaylussacia baccata*). Other common plants are hairgrass (*Deschampsia flexuosa*), ticklegrass (*Agrostis hyemalis*), false-heather (*Hudsonia tomentosa*), and bearberry (*Arctostaphylos uva-ursi*).

Great Lakes Beach

This beach community usually occurs in association with active dune systems. The beaches of the Great Lakes are extremely dynamic features, strongly influenced by water level changes and storm events. They support a suite of very specialized organisms, although unprotected shorelines may be entirely unvegetated. The plant species found in this community include (along Lake Michigan) seaside spurge (*Euphorbia polygonifolia*) and American sea-rocket (*Cakile edentula*).

Great Lakes Dune (formerly called Lake Dune)

The dominant plant in these semi-stabilized, open dunes along Great Lakes shorelines, is usually the sand-binding marram grass (*Ammophila breviligulata*). Frequent associates are common juniper (*Juniperus communis*), Canada wild-rye (*Elymus canadensis*), false-heather (*Hudsonia tomentosa*), beach-pea (*Lathyrus japonicus*), beach wormwood (*Artemisia campestris*), sand cherry (*Prunus pumila*), and various willows (*Salix* spp.). Two plants endemic to the Great Lakes region, pitcher's thistle (*Cirsium pitcheri*) and Lake Huron tansy (*Tanacetum huronense*; possibly now extirpated in Wisconsin), occur in this community along Lake Michigan.

Great Lakes Ridge and Swale

Great Lakes ridge and swale is a community complex comprised of a series of alternating communities associated with dry ridges and wet swales. While Great Lakes dune, northern dry forest, northern sedge meadow, and alder thicket may also occur separately near the Great Lakes, the defining feature of a ridge and swale complex is the repeating series of narrow linear bands of uplands alternating with wetlands running parallel to the shoreline or following the curve of an embayment of the Great Lakes.

Great Lakes Shore Fen (formerly called Coastal Fen)

This open peatland community occurs primarily along Great Lakes shorelines, especially near the mouths of estuarine streams. The floating sedge mat is composed mostly of woolly sedge (*Carex lasiocarpa*); co-dominants are sweet gale (*Myrica gale*) and bogbean (*Menyanthes trifoliata*). The following herbs are common in this diverse, circumneutral, nutrient-rich community: twigrush (*Cladium mariscoides*), marsh horsetail (*Equisetum fluviatile*), a spikerush (*Eleocharis elliptica*), intermediate bladderwort (*Utricularia intermedia*), marsh bellflower (*Campanula aparinoides*), narrow-leaved willow-herb (*Epilobium leptophyllum*), water-parsnip (*Sium suave*), and bog willow (*Salix pedicellaris*). Coastal fens are distinguished from open bogs and poor fens (which may adjoin them in the same wetland complex) by the lack of Sphagnum spp. mosses, higher pH, and direct hydrologic connection to the Great Lakes. They are distinguished from rich fens by the absence of indicator species such as linear-leaved sundew (*Drosera linearis*), grass-of-parnassus (*Parnassia glauca*), false asphodel (*Tofiedia glutinosa*) and a spikerush (*Eleocharis rostellata*).

Hardwood Swamp

These are northern deciduous forested wetlands that occur along lakes or streams, or in insular basins in poorly drained morainal landscapes. The dominant tree species is black ash (*Fraxinus nigra*), but in some stands red maple (*Acer rubrum*), yellow birch (*Betula allegheniensis*), and (*formerly*) American elm (*Ulmus americana*) are also important. The tall shrub speckled alder (*Alnus incana*) may be locally common. The herbaceous flora is often diverse and may include many of the same species found in Alder Thickets. Typical species are marsh-marigold (*Caltha palustris*), swamp raspberry (*Rubus pubescens*), skullcap (*Scutellaria galericulata*), orange jewelweed (*Impatiens capensis*), and many sedges (*Carex spp.*). Soils may be mucks or mucky sands.

Interdunal Wetland

Wind-created hollows that intersect the water table within active dune fields along the Great Lakes. These maybe colonized by wetland plants, including habitat specialists that are of high conservation significance. Common members of this wetland community on Lake Superior are twig-rush (*Cladium mariscoides*), species of rushes (especially *Juncus balticus*), pipewort (*Eriocaulon septangulare*), the sedge (*Carex viridula*), ladies-tress orchids (*Spiranthes* spp.) and bladderworts (*Utricularia cornuta* and *U. resupinata*).

Lake—Shallow, Hard, Seepage

Lakes that are Large (>10 acres), Shallow (< 18 feet), Hard (alkalinity > 50 ppm), and Seepage (have no inlet and outlet, and the main water source is from precipitation or runoff). The macroalgae muskgrass (*Chara* spp.) dominates the submerged community of this lake type, along with a variety of pondweeds (*Potamogeton* spp.) and naiads (*Najas* spp.). Where nutrient levels are particularly high, more cosmopolitan species like coon-tail (*Ceratophyllum demersum*) can occur in moderate to high abundance. White and yellow water lilies (*Nymphaea odorata and Nuphar variegata*) are also often present in shallow waters. Associated fish species include golden shiner, black bullhead, yellow bullhead, bluegill, pumpkinseed, and largemouth bass.

Migratory Bird Concentration Site

Migratory Bird Concentration Sites are important resting and feeding areas for birds as they fly between their breeding and wintering grounds. These areas also can be locations where large numbers of migrating birds often become concentrated due to prevailing winds and or water barriers. Sites are used by many different species, both rare and non-rare.

Moist Cliff

This "micro-community" occurs on shaded (by trees or the cliff itself because of aspect), moist to seeping mossy, vertical exposures of various rock types, most commonly sandstone and dolomite. Common species are columbine (*Aquilegia canadensis*), the fragile ferns (*Cystopteris bulbifera and C. fragilis*), wood ferns (*Dryopteris* spp.), rattlesnake-root (*Prenanthes alba*), and wild sarsaparilla (*Aralia nudicaulis*). The rare flora of these cliffs vary markedly in different parts of the state; Driftless Area cliffs might have northern monkshood (*Aconitum noveboracense*), those on Lake Superior, butterwort (*Pinguicula vulgaris*), or those in Door County, green spleenwort (*Asplenium viride*).

Northern Dry Forest

This forest community occurs on nutrient-poor sites with excessively drained sandy or rocky soils. The primary historic disturbance regime was catastrophic fire at intervals of decades to approximately a century. Dominant trees of mature stands include jack and red pines (*Pinus banksiana* and *P. resinosa*) and/or Hill's oak (*Quercus ellipsoidalis*). Large acreages of this forest type were cut and burned during the catastrophic logging of the late 19th and early 20th century. Much of this land was then colonized by white birch (*Betula papyrifera*) and/or quaking aspen (*Populus tremuloides*), or converted to pine plantations starting in the 1920s. Common understory shrubs are hazelnuts (*Corylus* spp.), early blueberry (*Vaccinium angustifolium*) and brambles (*Rubus* spp.); common herbs include bracken fern (*Pteridium aquilinium*), starflower (*Trientalis borealis*), barren-strawberry (*Waldsteinia fragarioides*), cow-wheat (*Melampyrum lineare*), trailing arbutus (*Epigaea repens*), and members of the shinleaf family (*Chimaphila umbellata*, *Pyrola* spp.). Vast acreages of open "barrens" were also planted to pine, or naturally succeeded to densely stocked “dry” forests.

Northern Dry-Mesic Forest

In this forest community, mature stands are dominated by white and red pines (*Pinus strobus* and *P. resinosa*), sometimes mixed with red oak (*Quercus rubra*) and red maple (*Acer rubrum*). Common understory shrubs are hazelnuts (*Corylus* spp.), blueberries (*Vaccinium angustifolium* and *V. myrtilloides*), wintergreen (*Gaultheria procumbens*), partridge-berry (*Mitchella repens*); among the dominant herbs are wild sarsaparilla (*Aralia nudicaulis*), Canada mayflower (*Maianthemum canadense*), and cow-wheat (*Melampyrum lineare*). Stands usually occur on sandy loams, sands or sometimes rocky soils.

Northern Mesic Forest

This forest complex covered the largest acreage of any Wisconsin vegetation type prior to European settlement. Sugar maple (*Acer saccharum*) is dominant or co-dominant in most stands, while hemlock (*Tsuga canadensis*) was the second most important species, sometimes occurring in nearly pure stands with white pine (*Pinus strobus*). Beech (*Fagus grandifolia*) can be a co- dominant with sugar maple in the counties near Lake Michigan. Other important tree species were yellow birch (*Betula allegheniensis*), basswood (*Tilia americana*), and white ash (*Fraxinus americana*). The groundlayer varies from sparse and species poor (especially in hemlock stands) with woodferns (especially Dryopteris intermedia), bluebead lily (*Clintonia borealis*), clubmosses (*Lycopodium* spp.), and Canada mayflower (*Maianthemum canadense*) prevalent, to lush and species-rich with fine spring ephemeral displays. After old-growth stands were cut, trees such as quaking and bigtoothed aspens (*Populus tremuloides* and *P. grandidentata*), white birch (*Betula papyrifera*), and red maple (*Acer rubrum*) became and still are important in many second-growth Northern Mesic Forests. Several distinct associations within this complex warrant recognition as communities, and draft abstracts of these are currently undergoing review.

Northern Sedge Meadow

This open wetland community is dominated by sedges and grasses. There are several common subtypes: Tussock meadows, dominated by tussock sedge (*Carex stricta*) and Canada bluejoint grass (*Calamagrostis canadensis*); Broad-leaved sedge meadows, dominated by the robust sedges (*Carex lacustris* and/or *C. utriculata*); and Wire-leaved sedge meadows, dominated by such species as woolly sedge (*Carex lasiocarpa*) and few-seeded sedge (*C. oligosperma*). Frequent associates include marsh bluegrass (*Poa palustris*), manna grasses (*Glyceria* spp.), panicled aster (*Aster lanceolatus*), joy-pye-weed (*Eupatorium maculatum*), and the bulrushes (*Scirpus atrovirens* and *S. cyperinus*).

Northern Tamarack Swamp

Also known as tamarack poor swamp, these weakly to moderately minerotrophic conifer swamps are dominated by a broken to closed canopy of tamarack (*Larix laricina*) and a frequently dense understory of speckled alder (*Alnus incana*), mountain holly (*Ilex mucronata*), winterberry (*Ilex verticillata*), black

chokeberry (*Aronia melanocarpa*), and bog birch (*Betula pumila*). The understory is more diverse than in black spruce swamps and may include more nutrient-demanding species such as black ash (*Fraxinus nigra*). The bryophytes include many genera other than Sphagnum. Stands with spring seepage sometimes have marsh-marigold (*Caltha palustris*) and skunk-cabbage (*Symplocarpus foetidus*) as common understory inhabitants. Northern tamarack swamps are characterized by their moderately minerotrophic soil, canopy dominated by tamarack, and prevalence of tall shrubs, usually with at least 5% cover, often up to 25% cover or more. While tamarack may co-dominate (or even be locally dominant in) black spruce swamps, that community has more acidic soil, a sparse layer of tall shrubs (5% cover or less), and a more continuous carpet of Sphagnum moss.

Northern Wet Forest

These weakly minerotrophic conifer swamps, located in the North, are dominated by black spruce (*Picea mariana*) and tamarack (*Larix laricina*). Jack pine (*Pinus banksiana*) may be a significant canopy component in certain parts of the range of this community complex. Understories are composed mostly of sphagnum (*Sphagnum* spp.) mosses and ericaceous shrubs such as leatherleaf (*Chamaedaphne calyculata*), Labrador-tea (*Ledum groenlandicum*), and small cranberry (*Vaccinium oxycoccos*) and sedges such as (*Carex trisperma* and *C paupercula*). The Natural Heritage Inventory has split out two entities, identified (but not strictly defined) by the two dominant species (see Black Spruce Swamp and Tamarack Swamp).

Northern Wet-Mesic Forest

This forested minerotrophic wetland is dominated by white cedar (*Thuja occidentalis*), and occurs on rich, neutral to alkaline substrates. Balsam fir (*Abies balsamea*), black ash (*Fraxinus nigra*), and spruces (*Picea glauca and P. mariana*) are among the many potential canopy associates. The understory is rich in sedges (*such as Carex disperma and C. trisperma*), orchids (*e.g., Platanthera obtusata and Listera cordata*), and wildflowers such as goldthread (*Coptis trifolia*), fringed polygala (*Polygala pauciflora*), and naked miterwort (*Mitella nuda*), and trailing sub- shrubs such as twinflower (*Linnaea borealis*) and creeping snowberry (*Gaultheria hispidula*). A number of rare plants occur more frequently in the cedar swamps than in any other habitat.

Open Bog

These non-forested bogs are acidic, low nutrient, northern Wisconsin peatlands dominated by Sphagnum spp. mosses that occur in deep layers, often with pronounced hummocks and hollows. Also present are a few narrow-leaved sedge species such as (*Carex oligosperma* and *C. pauciflora*), cotton-grasses (*Eriophorum* spp.), and ericaceous shrubs, especially bog laurel (*Kalmia polifolia*), leatherleaf (*Chamaedaphne calyculata*), and small cranberry (*Vaccinium oxycoccus*). Plant diversity is very low but includes characteristic and distinctive specialists. Trees are absent or achieve very low cover values as this community is closely related to and intergrades with Muskeg. When this community occurs in southern Wisconsin, it is often referred to as a Bog Relict.

Riverine Mud Flat

The riverine mudflat community is best developed within the floodplains of the state's largest, low gradient rivers, especially in central and southwestern Wisconsin. Soil development on the flats and bars is minimal, owing to the frequent flood disturbance. During the growing season these areas are colonized by an assemblage of herbs, and sometimes shrubs and saplings. The mudflats and beaches are highly variable in cover, being basically unvegetated in late spring/early summer transitioning to sparsely covered and eventually to locally dense stands of graminoids and forbs by late summer. Usually, the vegetation is of short stature. Significant floods affect this community annually, which may be accompanied by erosive scouring, sediment deposition, and sometimes (though not always) by shifts in the locations of the bars, mudflats and channels. Colonizing plants tend to be annuals, short-lived perennials, or perennials with light, wind, or water dispersed propagules adapted to quickly colonizing unvegetated substrates. Plants that become established on these newly exposed, somewhat ephemeral habitats, include sedges, grasses, and a few woody species such as sandbar willow (*Salix interior*) and cottonwood (*Populus deltoides*). Short graminoids are initially prevalent, such as some of the "flat sedges", for example (*Cyperus odoratus* and *C. squarrosus*), spike-rushes (*Eleocharis acicularis, E. obtusa, E. palustris*), creeping love grass (*Eragrostis hypnoides*), tufted love grass (*E. pectinacea*), autumn sedge (*Fimbristylis autumnalis*), and small-flowered hemicarpha (*Lipocarpha micrantha*). Other native herbs associated with this assemblage are water star-grass (*Lindernia dubia*), marsh purslane (*Ludwigia palustris*), and moist bank pimpernel (*Lindernia dubia*).

Shore Fen (formerly called Coastal Fen)

This open peatland community occurs primarily along Great Lakes shorelines, especially near the mouths of estuarine streams. The floating sedge mat is composed mostly of woolly sedge (*Carex lasiocarpa*); co-dominants are sweet gale (*Myrica gale*) and bogbean (*Menyanthes trifoliata*). The following herbs are common in this diverse, circumneutral, nutrient-rich community: twigrush (*Cladium mariscoides*), marsh horsetail (*Equisetum fluviatile*), a spikerush (*Eleocharis elliptica*), intermediate bladderwort (*Utricularia intermedia*), marsh bellflower (*Campanula aparinoides*), narrow-leaved willow-herb (*Epilobium leptophyllum*), water-parsnip (*Sium suave*), and bog willow (*Salix pedicellaris*). Coastal fens are distinguished from open bogs and poor fens (which may adjoin them in the same wetland complex) by the lack of Sphagnum spp. mosses, higher pH, and direct hydrologic connection to the Great Lakes. They are distinguished from rich fens by the absence of indicator species such as linear-leaved sundew (*Drosera linearis*), grass-of-parnassus (*Parnassia glauca*), false asphodel (*Tofiedia glutinosa*) and a spikerush (*Eleocharis rostellata*).

Srub-Carr

This wetland community is dominated by tall shrubs such as red-osier dogwood (*Cornus stolonifera*), meadow-sweet (*Spiraea alba*), and various willows (*Salix discolor*, *S. bebbiana*, and *S. gracilis*). Canada bluejoint grass (*Calamagrostis canadensis*) is often very common. Associates are similar to those found in Alder Thickets and tussock-type Sedge Meadows. This type is common and widespread in southern

Wisconsin but also occurs in the north.

Southern Dry-mesic Forest

Southern dry-mesic forests occur on loamy soils of glacial till plains and moraines, and on erosional topography with a loess cap, south of the tension zone. This community type was common historically, although white oak was considerably more dominant than red oak, and the type is still common today. However, to the detriment of the oaks, mesophytic tree species are becoming increasingly important under current management practices and fire suppression policies. Oak forests are succeeding to more mesic species (e.g., central and northern hardwood forest types), or to brush. Red oak (*Quercus rubrum*) is a common dominant tree of this upland forest community type. White oak (*Quercus alba*), American basswood (*Tilia americana*), sugar and red maples (*Acer saccharum and A. rubrum*), white ash (*Fraxinus americana*), shagbark hickory (*Carya ovata*), and wild black cherry (*Prunus serotina*) are also important. The herbaceous understory flora is diverse and includes many species listed under southern dry forest plus jack-in-the-pulpit (*Arisaema triphyllum*), enchanter's-nightshade (*Circaea canadensis*), large-flowered bellwort (*Uvularia grandiflora*), interrupted fern (*Osmunda claytoniana*), lady fern (*Athyrium filix-femina*), tick-trefoils (*Desmodium* spp.), and hog-peanut (*Amphicarpaea bracteata*).

Southern Mesic Forest

This upland forest community occurs on rich, well-drained loamy soils, mostly on glacial till plains or loess-capped sites south of the tension zone. The dominant tree species is sugar maple (*Acer saccharum*), but American basswood (*Tilia americana*), and near Lake Michigan, American beech (*Fagus grandifolia*) may be co-dominant. Many other trees are found in these forests, including those of the walnut family, ironwood (*Carpinus caroliniana*), northern red oak (*Quercus rubra*), red maple (*Acer rubrum*), white ash (*Fraxinus americana*), and slippery elm (*Ulmus rubra*). The understory is typically open, or sometimes brushy with species of gooseberry (*Ribes* spp.) on sites with a history of grazing, and supports fine spring ephemeral displays. Characteristic herbs are spring-beauty (*Claytonia virginica*), trout-lilies (*Erythronium* spp.), trilliums (*Trillium* spp.), violets (*Viola* spp.), bloodroot (*Sanguinaria canadensis*), blue cohosh (*Caulophyllum thalictroides*), may-apple (*Podophyllum peltatum*), and Virginia waterleaf (*Hydrophyllum virginianum*).

Southern Sedge Meadow

Widespread in southern Wisconsin, this open wetland community is most typically dominated by tussock sedge (*Carex stricta*) and Canada bluejoint grass (*Calamagrostis canadensis*). Common associates of relatively undisturbed sedge meadows are other sedges (*e.g., Carex diandra, C. sartwellii*), marsh bellflower (*Campanula aparinoides*), marsh wild-Timothy (*Muhlenbergia glomerata*), American water horehound (*Lycopus americanus*), panicled aster (*Symphyotrichum lanceolatum*), swamp aster (*Symphyotrichum puniceum*), iris (*Iris* spp.), spotted Joe-Pye weed (*Eutrochium maculatum*), marsh fern (*Thelypteris palustris*), and swamp milkweed (*Asclepias incarnate*). Reed canary grass (*Phalaris arundinacea*) may be

dominant in grazed and/or ditched stands, sometimes to the exclusion of virtually all other species. Sedge meadows are most common in glaciated landscapes, where they often border streams or drainage lakes. The southern sedge meadow community occurred with prairie, savanna, and hardwood forest communities, and many of them apparently burned periodically. In the absence of fire, shrubs and trees are able to readily encroach on the open wetlands. Encroachment can be exacerbated when wetlands are drained. Many sedge meadows in southeastern Wisconsin are influenced by alkaline groundwater and occur in complexes with emergent marsh, calcareous fen, wet prairie, wet-mesic prairie, and shrub-carr. Differentiating between these communities can be difficult, as they frequently intergrade.

Stream—Slow, Hard, Warm (Warmwater Streams)

Warmwater streams are flowing waters with maximum water temperatures typically greater than 25 degrees Celsius. They usually have watershed areas less than 500 square miles and mean annual flow rates of less than 200 cubic feet per second. These streams are common statewide, particularly in southeastern and east-central Wisconsin. A rich fish fauna, dominated by warmwater species in the Cyprinidae, Catostomidae, Centrarchidae, and Percidae families can be found in warmwater streams. Streams modified by dams, agricultural drainage, or increased flows due to changes in land cover have lost varying degrees of their pre-development biological productivity and diversity. Improvement work has focused on three main objectives, reducing bank erosion and in-stream sedimentation, restoring a more natural channel morphology and alignment, and increasing in-stream cover.

Submergent Marsh

This herbaceous community of aquatic macrophytes occurs in lakes, ponds, and rivers. Submergent macrophytes often occur in deeper water than emergents, but there is considerable overlap. Dominants include various species of pondweeds (*Potamogeton spp.*) along with waterweed (*Elodea canadensis*), slender naiad (*Najas flexilis*), eel-grass (*Vallisneria americana*), and species of water-milfoil (*Myriophyllum*) and bladderworts (*Utricularia*).

Talus Forest

This description is based on a very limited number of stands examined and should be regarded as preliminary. Talus forest develops on a substrate of quartzite, sandstone, dolomite, rhyolite, and possibly other rock types. Canopy cover ranges from sparse to moderately dense. Tree dominance is variable and can include white pine (*Pinus strobus*), red cedar (*Juniperus virginiana*), paper birch (*Betula papyrifera*), northern white cedar (*Thuja occidentalis*), red pine (*Pinus resinosa*), and others. Among the characteristic understory plants noted to date are shrubs mountain maple (*Acer spicatum*), red-berried elder (*Sambucus pubens*), and bristly sarsaparilla (*Aralia hispida*). Representative herbs include common polypody (*Polypodium vulgare*), wood fern (*Dryopteris marginalis*), walking fern (*Asplenium rhizophyllum*), harebell (*Campanula rotundifolia*), columbine (*Aquilegia canadensis*), fumitory (*Adlumia fungosa*), leaf-cup (*Polymnia canadensis*), and pale corydalis (*Corydalis sempervirens*). Crustose lichens and various mosses

sometimes reach high cover values. Talus forest communities often reflect the composition of the forests in the surrounding landscape but include plants and animals that are adapted to take advantage of the rock substrate, microclimatic conditions such as cold air drainage, and groundwater seepage. These habitat specialists, presumably including some of the mosses and lichens, are likely to be the species that are most restricted to such environments and of the greatest conservation concern.

Wet-mesic Prairie

This herbaceous grassland community is dominated by tall grasses, including big bluestem (*Andropogon gerardii*), Canada bluejoint grass (*Calamagrostis canadensis*), cordgrass (*Spartina pectinata*), and Canada wild-rye (*Elymus canadensis*). The forb component is diverse and includes azure aster (*Symphyotrichum oolentangiense*), eastern shooting-star (*Primula meadia*), saw-tooth sunflower (*Helianthus grosseserratus*), prairie blazing-star (*Liatris pycnostachya*), prairie phlox (*Phlox pilosa*), prairie coneflower (*Ratibida pinnata*), rosinweed and prairie-dock (*Silphium integrifolium and S. terebinthinaceum*), late and stiff goldenrods (*Solidago gigantea and S. rigida*), and Culver's-root (*Veronicastrum virginicum*). This community type was common historically but now is rare. Well over 99% of our tallgrass prairies - including wet-mesic prairies - have been destroyed. Wet-mesic prairies sometimes occurred in large wetland complexes with wet prairies, southern sedge meadows, calcareous fens, and emergent marshes. They were most abundant on level or gently rolling glacial moraine or outwash landforms where there were few natural barriers to wildfire, and where the upland vegetation was composed mostly of fire-dependent communities such as mesic prairies and oak openings.