THE LOWER FOX RIVER watershed monitoring program

Phosphorus Forms and Fate in the Lower Fox River Watershed

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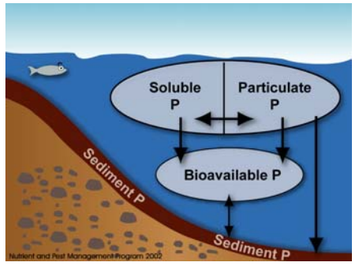
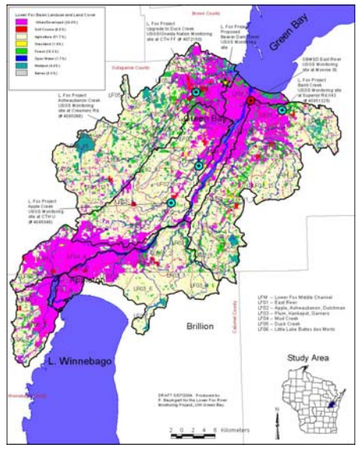
Study Overview and Background

- The effectiveness of some phosphorus reductions strategies such as grass filter strips and detention basins may depend on whether phosphorus is in the dissolved or particulate phase as it leaves the source area.
- Dissolved phosphorus (DP) is the phosphorus that passes through a 0.45 um filter when a water sample is filtered. Total P is comprised of DP + particulate P. Ortho-P (PO_4^-) is the dominant form of DP.
- Understanding the form in which P leaves source areas and is transported by streams is critical for predicting the fate of P using computer simulation models.
- This study (Phase 3) was initiated to answer questions related to P forms in runoff by tracking the ratio between DP and total phosphorus from farm, to channel/ditch, and to stream using targeted sampling throughout the flow path.



Background

- Early modeling efforts in the Fox-Wolf Basin (NEWWT modeling with SWRRB,;1993) assumed 10 to 30% of TP in dissolved form from ag. source areas and only 11% in Lower Fox Basin.
- Fox-Wolf Basin 2000 (1999-2002) monitored tributaries to assess/validate SWAT model predictions. Found that proportion of dissolved P assumed in models not supported by data.
- NRDA SWAT modeling effort of Fox-Wolf Basin (2000) --- reapportioned particulate-P to increase dissolved P from Ag to about 30% from default.
- Further analysis of existing datasets was initiated in PHASE 1.



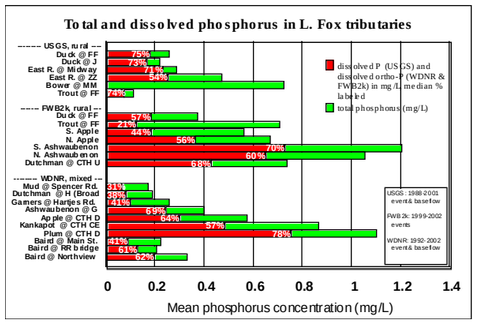
Land Use in the Lower Fox River Watershed

PHASE 1: CONCENTRATION Analysis - Dissolved/Total Phosphorus Ratios in Lower Fox Streams

Lower Fox Basin data summary of dissolved/total phosphorus ratios

USGS Water Quality Data from streams in the Lower Fox River Subbasin --- Phosphorus (samples collected during low flow and events)						---- average concentration ---				
	Years	area (km2)	# of total P samples	# of diss. P samples	# diss./total P ratios	total P mg/L p00665	dissolved P mg/L p00666	ortho-P diss. mg/L p00671	---- diss.olved/total P percentage --- average %	median % flow weig
Duck Creek @ CTH FF	1980-2001 *	276	396	258	255	0.26	0.18	0.14	71%	75% 63%
Duck Creek @ Seminary Rd.	1980-2001 *	244	60	61	59	0.22	0.16	0.14	72%	73% 70%
East River @ Midway Rd.	1993-1997	122	26	26	26	0.29	0.23	0.22	73%	71% 69%
East River @ CTH ZZ	1994-1995		15	13	13	0.47	0.25	0.24	55%	54% 43%
Bower Creek @ MM	1990-1997	36	795			0.73	N/A	N/A	N/A	N/A N/A
Trout Creek @ CTH FF ***	1997-2001	39	33 **	33	33	**0.11**	0.07	**0.06**	**70%**	**74%** 53%
Fox-Wolf Basin 2000 & Baumgart, grab samples collected from ALL events; low, moderate and high, rainfall not always uniform (1999-2002)										
	Years	area (km2)	# of total P samples	# of ortho-P samples	# ortho-P/total P ratios	total P mg/L		ortho-P diss. mg/L	mean ortho-P%	median ortho-P%
Duck @ CTH FF	1999-2002	276	22	10	10	0.37		0.18	54%	57%
Trout @ CTH FF	1999-2002	39	29	14	14	**0.71**		**0.12**	**24%**	**21%**
South Apple upstream of confluence	1999-2002	84.0	34	18	18	0.56		0.18	44%	44%
North Apple upstream of confluence	1999-2002	28.0	30	15	15	0.67		0.36	57%	56%
South Ashwaubenon @ Noah Rd	1999-2002	15.5	27	12	11	1.20		0.73	61%	70%
North Ashwaubenon @ CTH U	1999-2002	8.8	29	12	12	1.05		0.65	59%	60%
Dutchman @ CTH U	1999-2002	20.7	29	10	10	0.73		0.42	61%	68%
WDNR, grab samples collected during events and low flow periods										
	Years	area (km2)	# of total P samples	# of ortho-P samples	# ortho-P/total P ratios	total P mg/L		ortho-P diss. mg/L	mean ortho-P%	median ortho-P%
Mud @ Spencer Rd.	1992-1999	26.9	22	22	22	0.17		0.07	33%	31%
Dutchman @ CTH H (Broadway St.)	1992-1999	77.4	24	24	24	0.19		0.08	41%	38%
Garners @ Hartjes Rd.	1992-1999	29.3	23	23	23	0.26		0.10	40%	41%
Ashwaubenon @ CTHG	1992-1999	68.9	22	22	22	0.40		0.24	61%	69%
Apple @ CTH D	1992-1999	135.7	25	24	25	0.57		0.30	56%	64%
Kankapot @ CTH CE	1992-1999	64.8	24	25	24	0.87		0.48	53%	57%
Plum @ CTH D	1992-1999	54.9	25	26	25	1.10		0.75	68%	78%
Baird @ Main St.	2001-2002		36	36	36	0.22		0.09	38%	41%
Baird @ RR bridge	2001-2002		36	36	36	0.20		0.13	57%	61%
Baird @ Northview	2001-2002		28	28	28	0.33		0.19	58%	62%

Large fraction of phosphorus is dissolved in streams. Fraction generally lower in urban areas.

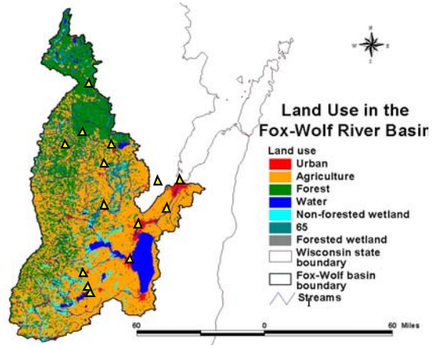


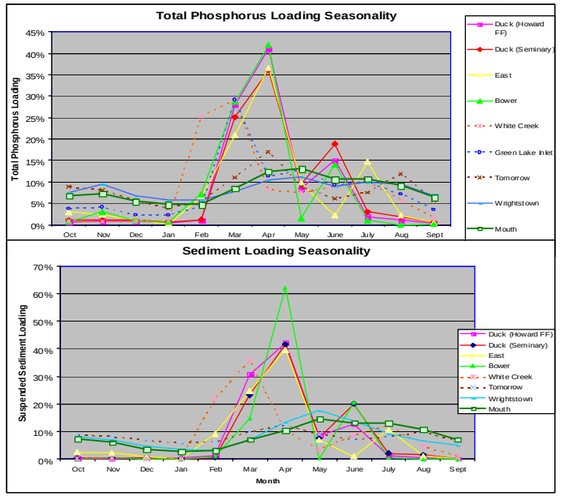
PHASE 1 CONCLUSION: Conduct PHASE 2 to determine whether phosphorus loads follow same trend as concentrations.

PHASE 2: Phosphorus and Sediment LOADS in the Fox-Wolf Basin

Dale Robertson, Research hydrologist
USGS - Wisconsin

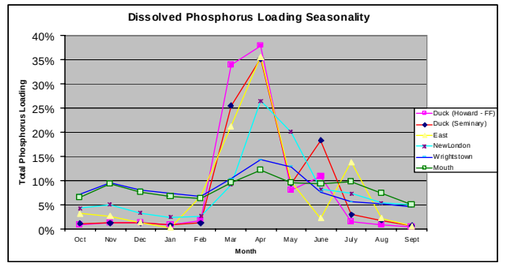
- ***USGS: Constituent Transport Model utilized to Calculate Loads***
  - ***Calibration Period 1985-1999***
    - *Exceptions*
      - ***Mouth – 1988-95 (USGS), 1988-99 (GBMSD) 1988-99 (USGS and GBMSD)***
      - ***Langlade – 1977-87***
      - ***Several shortened on one side***
- ***Computation Period 1988-99 (a few to 2002)***



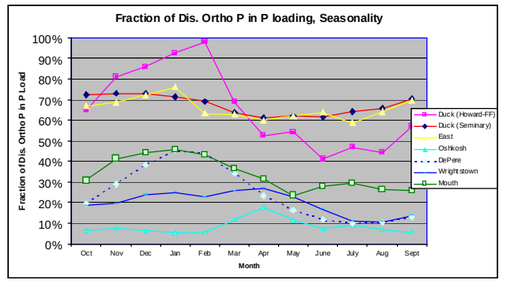


In general, two types of streams (small streams very seasonal and large streams little seasonality).

Also differences between northern & southern streams and event vs. baseflow.



Seasonality in dissolved phosphorus loading is similar to total phosphorus loading



- DP fraction of total P loading generally high, especially in small streams.
- Dissolved fraction highest in fall and winter months.

Site	Fraction DOP	Fraction DP
Duck Howard	50.0%	58.9%
Duck Seminary	62.3%	74.7%
East	56.8%	62.0%
Langlade	27.8%	
NewLondon	37.1%	
Berlin	12.5%	
Oshkosh	6.0%	
Neenah/Menasha	17.4%	
Appleton	26.5%	
Wrightstown	18.2%	
DePere	21.2%	
Mouth	32.0%	

Overall Fraction of Phosphorus as dissolved ortho-phosphorus and dissolved phosphorus (1989-99)

PHASE 2 CONCLUSIONS

- ***Dissolved P fraction highest in fall and winter months.***
- ***In general, dissolved ortho-P makes up large percent of phosphorus loading in smaller streams. Even higher for dissolved phosphorus.***
- ***Largest total & dissolved P load in March & April for streams in L. Fox Subbasin – very seasonal trend***
- ***What does this mean for effectiveness of BMPs (best management practices) for phosphorus control?***

PHASE 3: Phosphorus Forms at Different Spatial Scales
UW-Green Bay, Lower Fox River Monitoring Program

Primary Goal - Water Quality and Load Monitoring:
Compare dissolved phosphorus and total phosphorus at different scales throughout a watershed.

1) Primary study area is Apple Creek watershed. Sampling sites located in streams draining primarily rural land uses.
   - Event grab sampling in <1 sq. mi. watersheds.
   - Compare to USGS continuous monitoring sites.
2) Identify phosphorus and sediment sources at multiple spatial scales.
3) Analyze trends at all sites and relative trends between sites over time.

Initial sampling sites and smallest scale drainage areas shown below. (I- denotes larger integration sites, e.g., I-6)