Restoring the health of the Green Bay ecosystem under a changing climate: Modeling land use, management, and future outcomes

July 21, 2015

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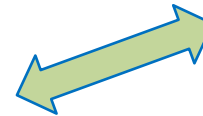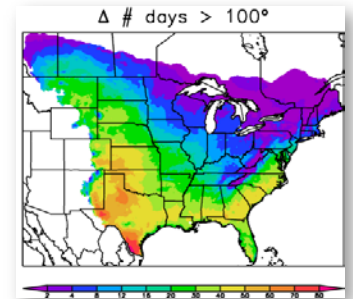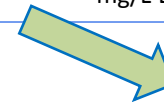
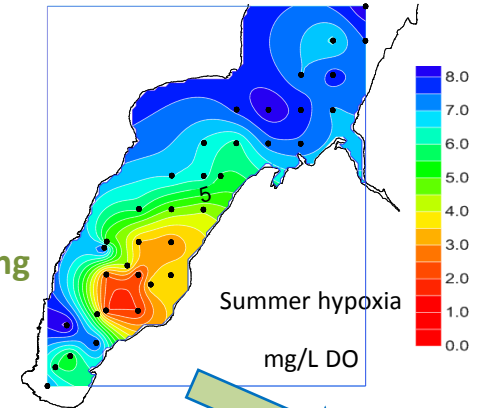# The Problem: A highly stressed ecosystem

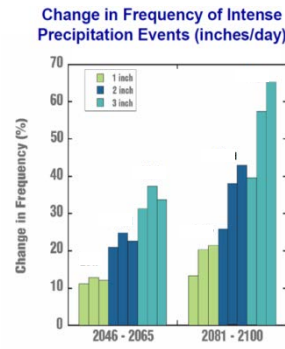**excessive loading of nutrients & sediments =** *the major ecological problem*

Chl fluor ug/L
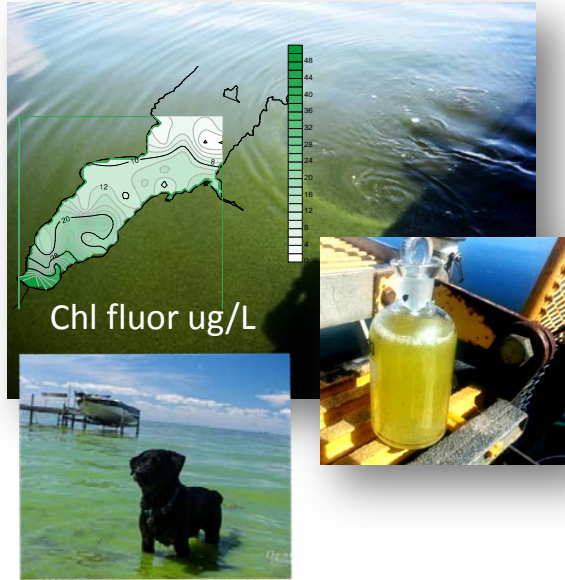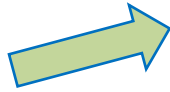
Green Bay at Dyckesville
July 4, 2014 *Stephen Deadman*

Efficient trapping

Summer hypoxia

mg/L DO

Severe climate susceptibility
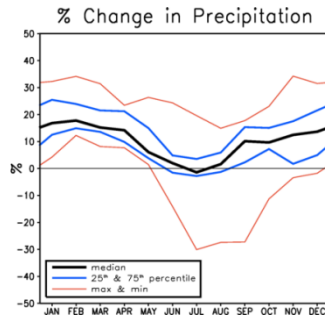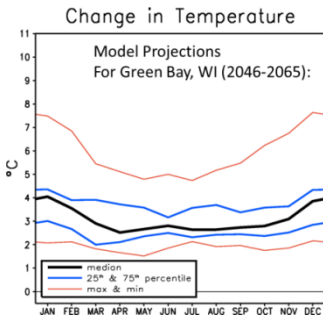
= **unknown future**
Δ **drivers** ⇒ **worsening**

✓ *Nutrient Loads* – strongly event driven and related to landscape conditions - agricultural activities are the biggest factors

Trends in Fox River TP Export to Green Bay and WWTP Discharges

5 of last 7 years >600 MT

(Data Sources: Fox R. Loads: D. Robertson, USGS; Discharge data: WDNR; graph by UWGB)

Goal → develop integrated ecosystem approach – link bay to its watershed & the watershed to its people and their activities

Biogeochemical models

Benthic Oxygen Flux (mmol O$_2$ h^{-1})
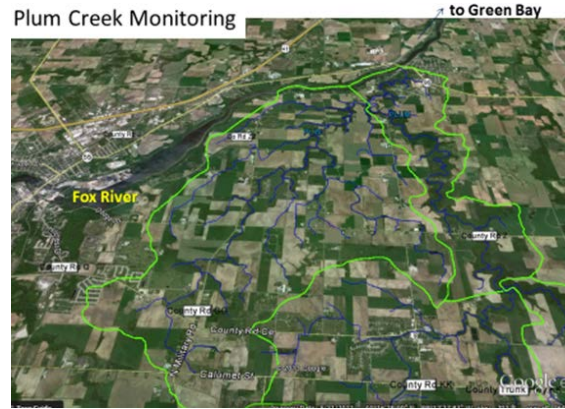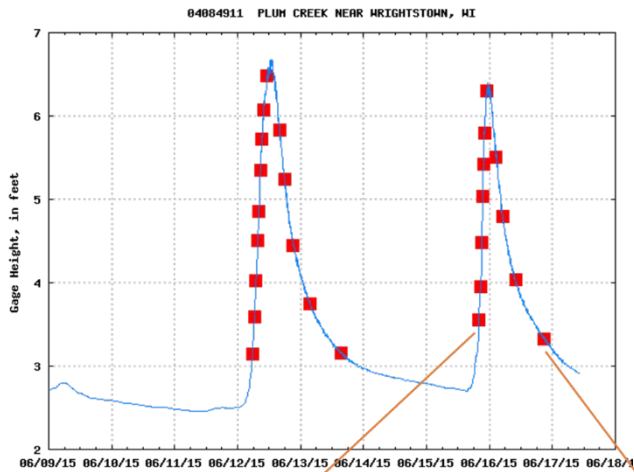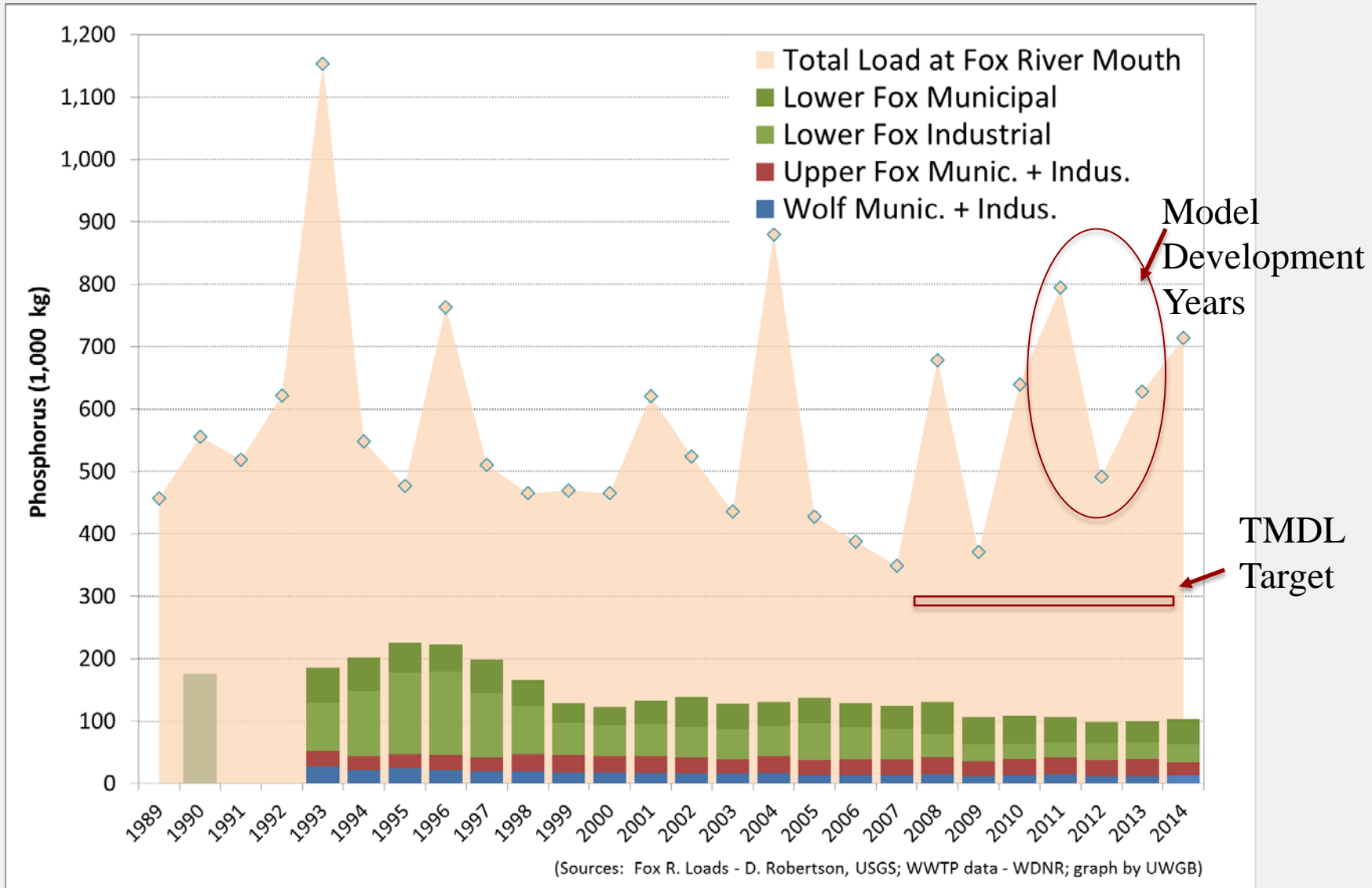
[O$_2$] mg/l
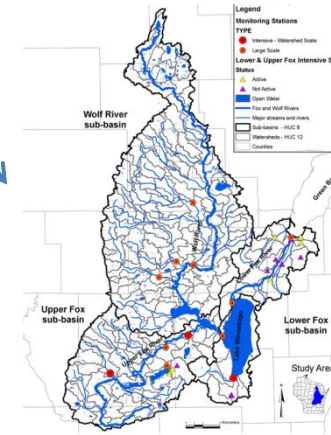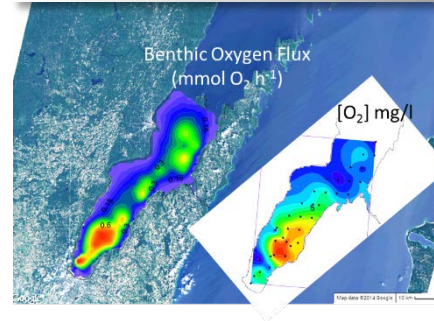
Watershed loading models

Hydrodynamic models

Down-scaled Climate models
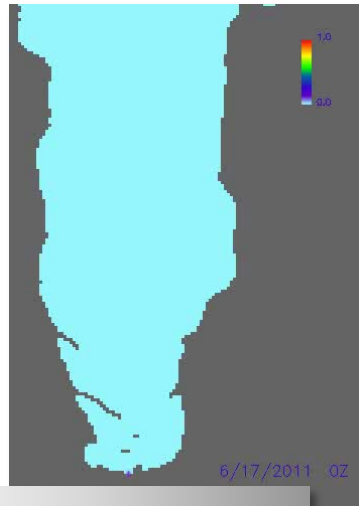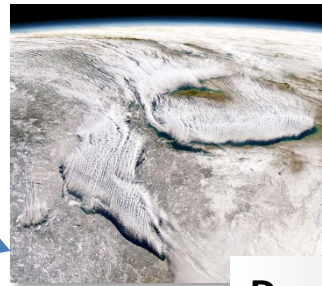
- ❖ Provide input to management on **future conditions** for developing **adaptation** strategies
- ❖ Assess the **efficacy of BMP** implementation throughout the watershed
- ❖ Assess **target levels** for loading abatement necessary to meet water quality goals in the **future.**
- ❖ Create user friendly tools to **visualize, inform and guide** management and to increase awareness & encourage **behavioral change** by the public & stakeholders at large

Project Goal	Stakeholders and End Users
Development of a Linked Modeling System for Green Bay	Scientific Research and Technical Service Providers (academics, agency researchers, private science and engineering firms)
Capacity to assess efficacy of remediation actions (TMDL, P-rule) to meet restoration goals (current and future climate)	**Regulatory** • WDNR • MichDNR • EPA **Management** • WDNR (LFR TMDL and AOC leaders) • EPA • County (Port and conservation) • Oneida Tribe • ACoE • USFWS • NGOs (**TNC,** FWWA, AGL) • MSDs (GBMSD) • NRCS
Understandable information about the variability and state of the GB System (current and future climate)	• Management agencies • Outreach Professionals • NGOs • Public • US Congressman

Implementing Adaptive Management*

Goals and Objectives
Plan Formulation
Implementation requirements

Implement regulation plans
(other actions?)

Adaptive Management

Continuous, iterative, systematic process

Institutional

Plan

Act

Collaboration

Adjust

Monitor

Learn

Evaluate
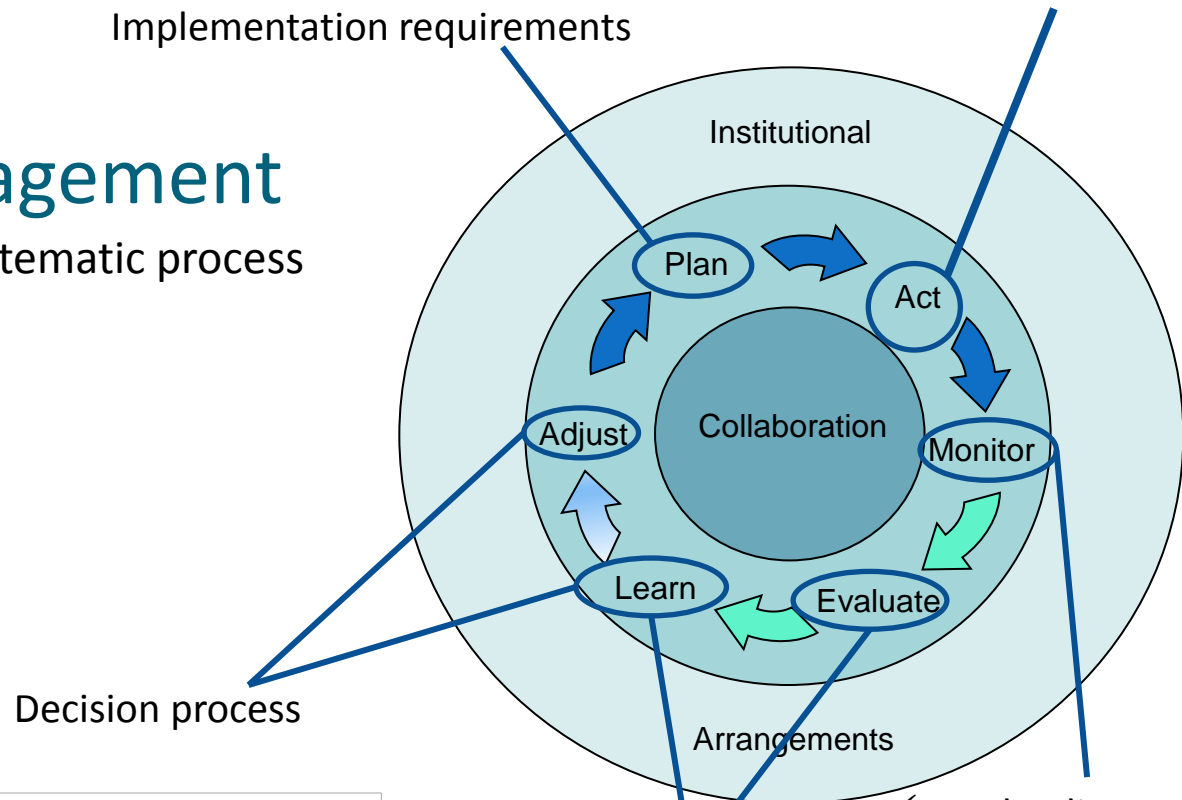
Arrangements

Decision process

Modelling of
system responses

✓ Hydroclimate
✓ Physical system changes
• Economic impacts
✓ Environmental impacts

Adaptive Management   Continuous, iterative, systematic process

Institutional

Plan

Act

Adjust

Collaboration
End Users

Monitor

Learn

Evaluate

Arrangements
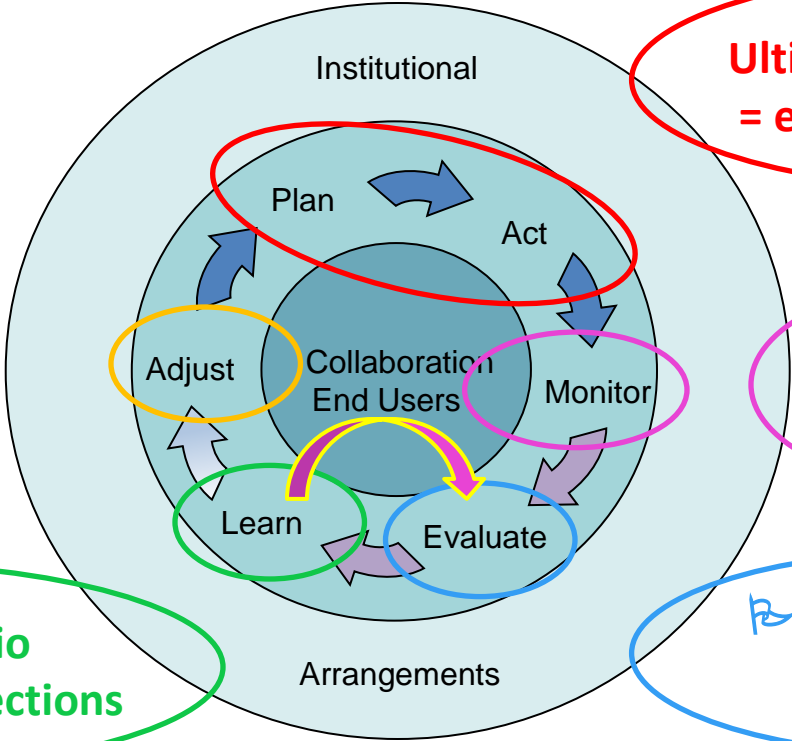
**Ultimate goal & outcome
= environmental restoration**

⚑**Management
Analysis
Tools**

**leveraged previous
field studies**

⚑ **Model scenario
development & projections**

⚑**Model construction
& verification**

Internal reiteration

⚑ **MWC support**

Significant Outputs:

✓ Fox-Wolf R. **watershed models** useful to target areas for mitigation and assess alternatives under projected climate

✓ Operational **Green Bay hydrodynamic and biogeochemical models** -- of river plume propagation, resuspension, and particle fate in the AOC and of nutrient, phytoplankton, and oxygen dynamics in the bay under existing and projected climate

6/17/2

Corrected SOD mmol O2/m2
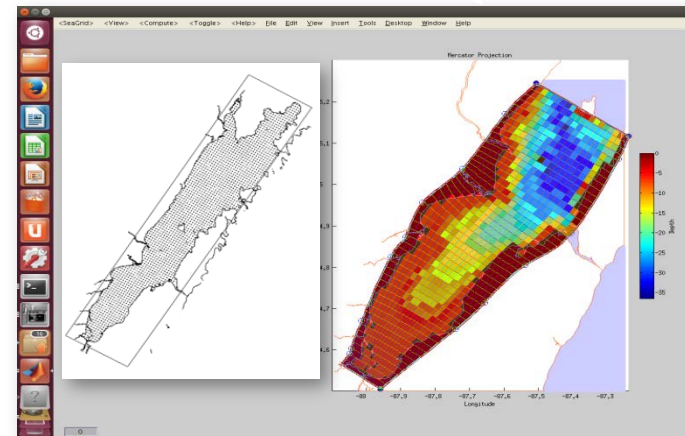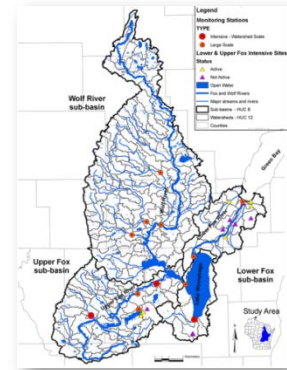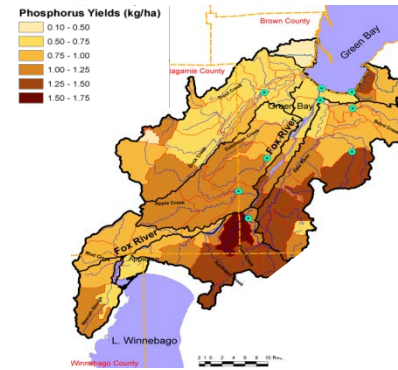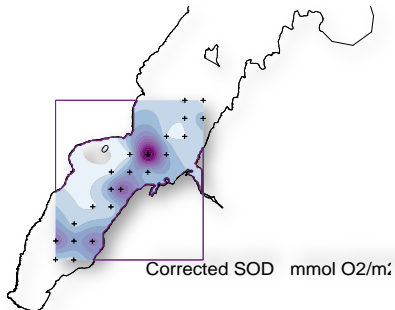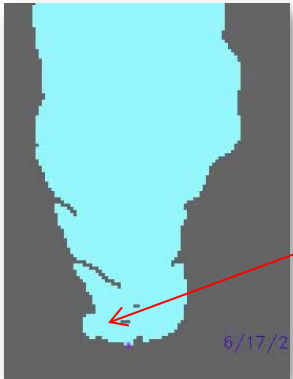
✓ **Linked watershed-biogeochemical-hydrodynamic modeling framework** (EFDC-A2EM) -- assess external and internal nutrient loadings, loading criteria and ecological endpoints under current and future climate (ongoing)

• **Management Analysis Tool** (MAT) and model visualizations for end users that illustrate loading and bay responses to land management options and climate change. (pilot workshops planned for Sept 9; HOW Conf session)

DRAFT
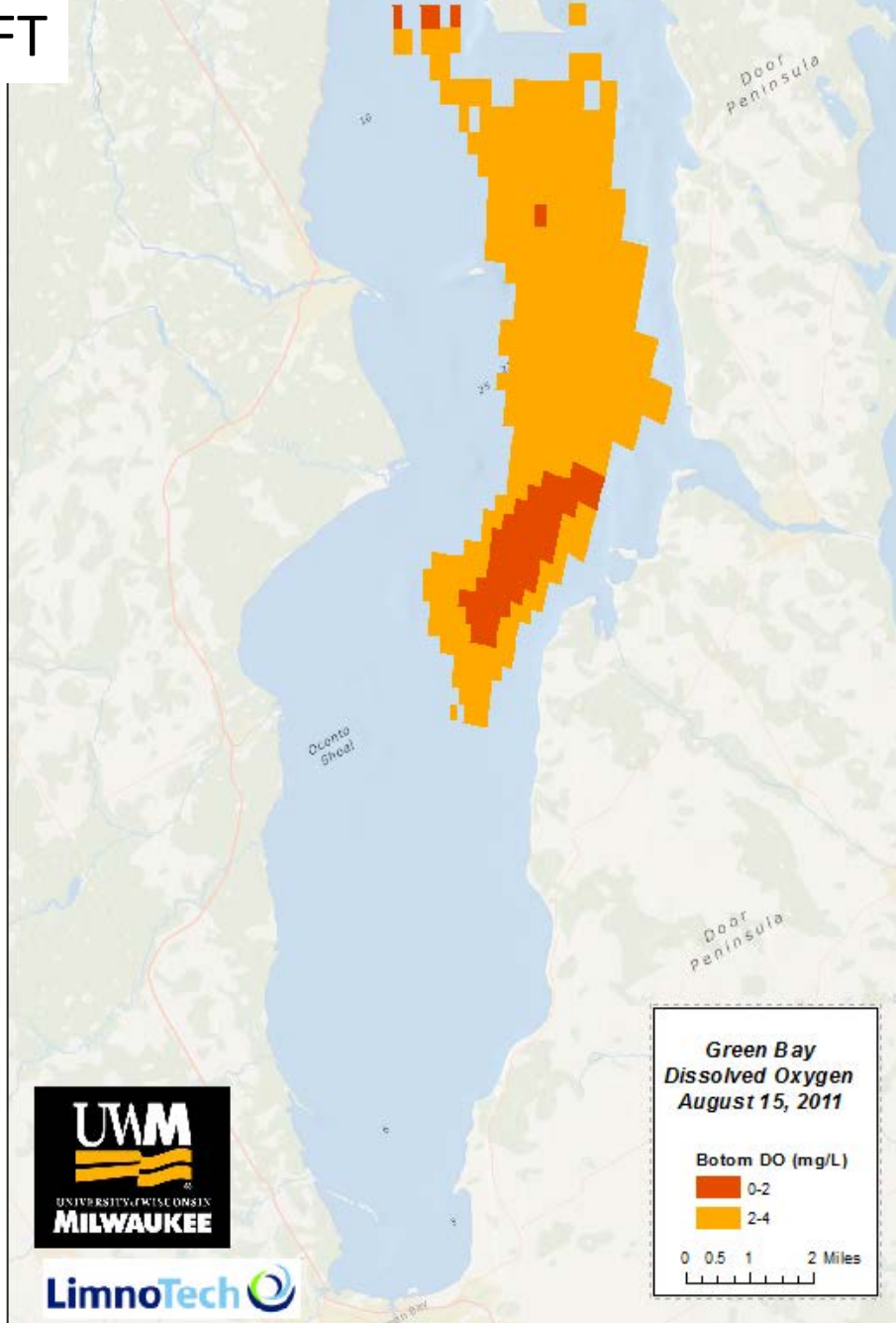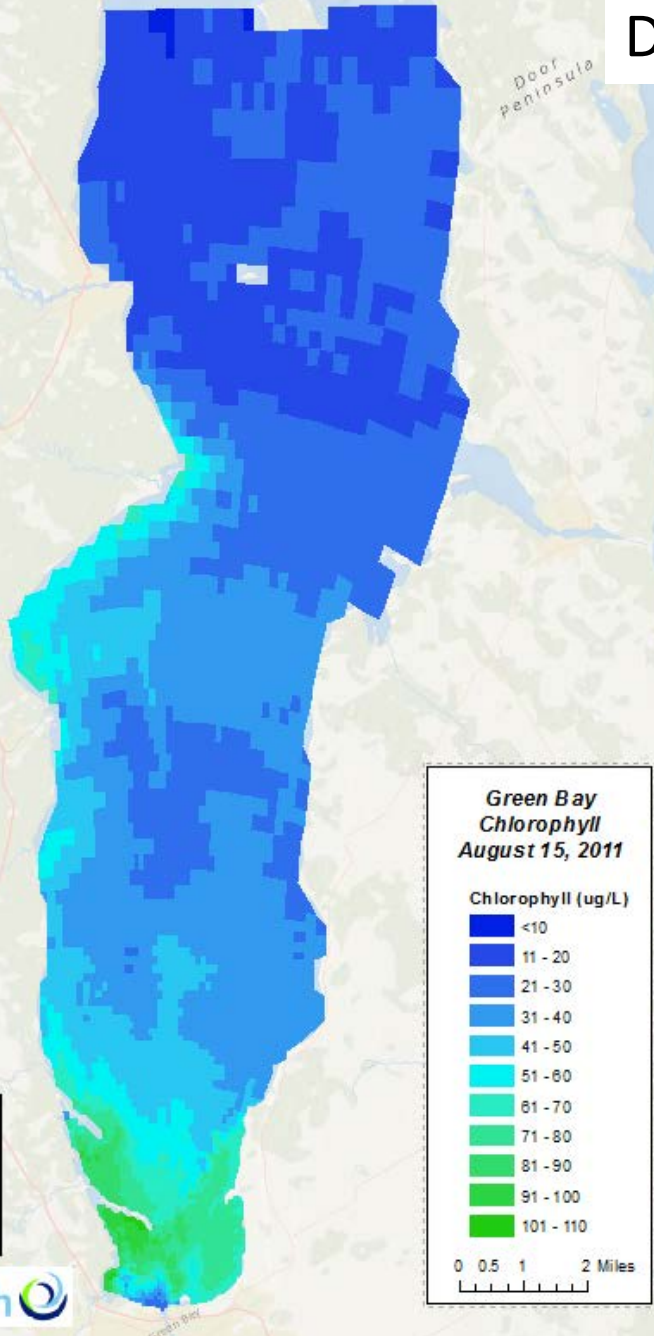
Green Bay Chlorophyll August 15, 2011

Chlorophyll (ug/L)
- <10
- 11 – 20
- 21 – 30
- 31 – 40
- 41 – 50
- 51 – 60
- 61 – 70
- 71 – 80
- 81 – 90
- 91 – 100
- 101 – 110

0   0.5   1   2 Miles

UWM
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MILWAUKEE

LimnoTech

Green Bay Dissolved Oxygen August 15, 2011

Botom DO (mg/L)
- 0-2
- 2-4

0   0.5   1   2 Miles

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LimnoTech

End User BMPs are being modeled at the local watershed scale to inform selection of basin wide scenarios to meet bay load response targets

Ag Management Scenarios	Many Combinations
Baseline	90% full inversion tillage (CT), 43 ppm STI
Cash rotation BMP	45% MT, 40% NT
Dairy fields NRCS Standards (reduced soil P)	Reduce Soil P to 25 ppm (50%)
Reduced Till - Dairy	15 - 65% CT and 10 - 40% NT
Cover Cropping after Corn Silage	forage and non-forage CC, up to 75%
Managed Grazing	10-50% of Dairy cropland
Reduced Till + Cover Crop	combinations
Reduced Till + Graze	combinations
Cover Crop + Graze	combinations
Reduced Till + Cover Crop + Graze, With and Without reduced STP, Cash Crop BMPs	Extensive BMP implementation
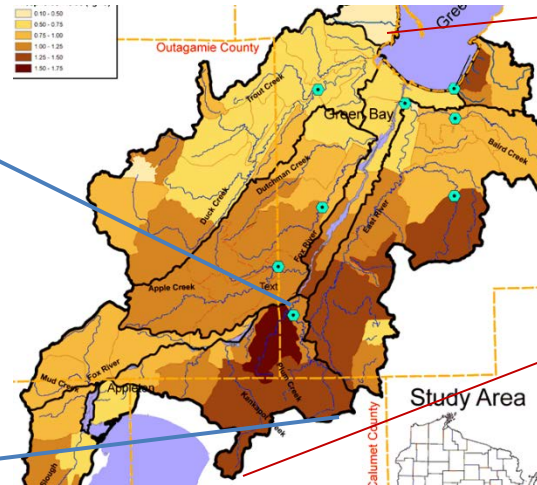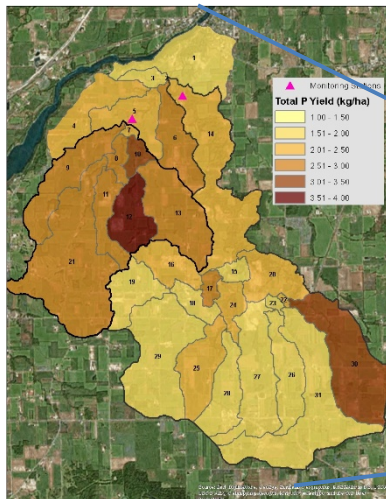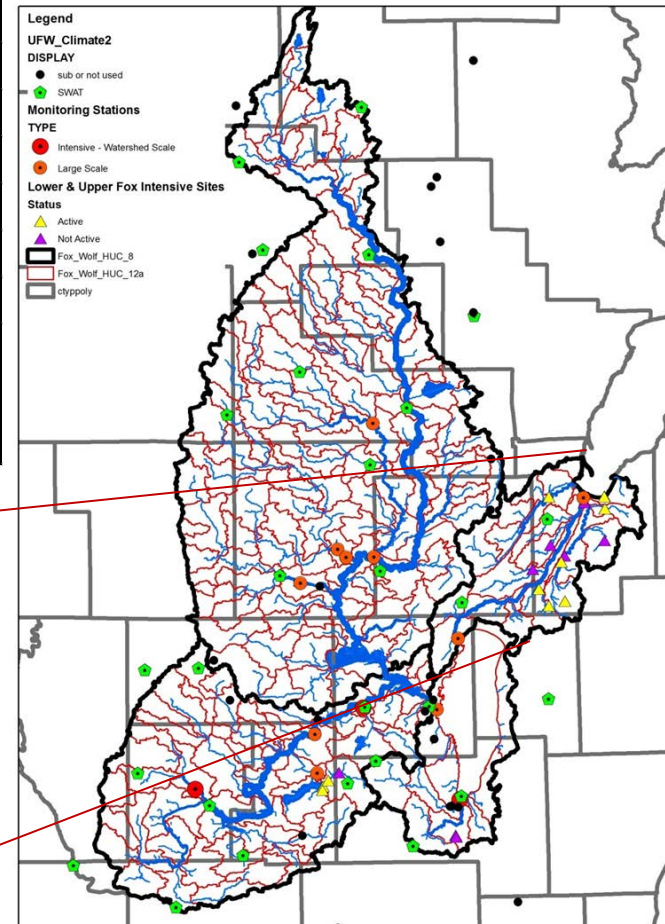
31 modeled sub-basins

Management Analysis Tool (MAT): extract relevant information from the complex watershed-bay models and provide it in a form useful to end users.

Example: Annual Metric Comparison Between Scenarios
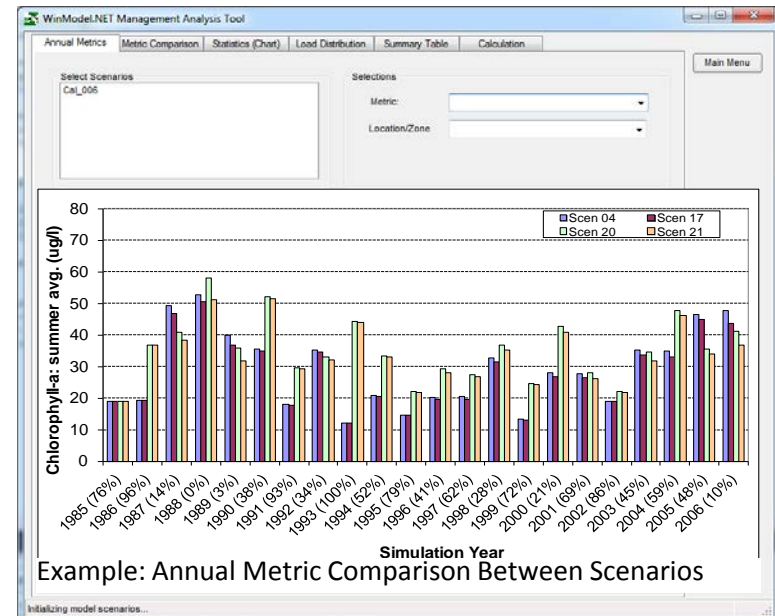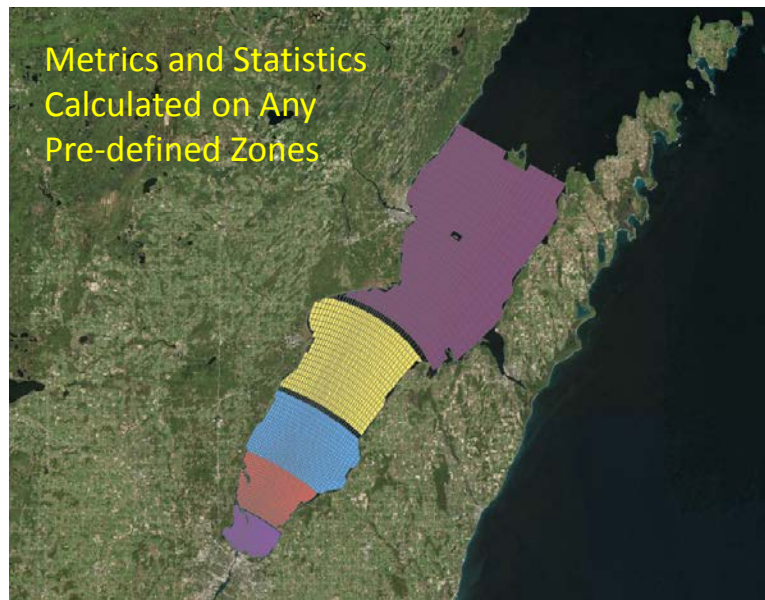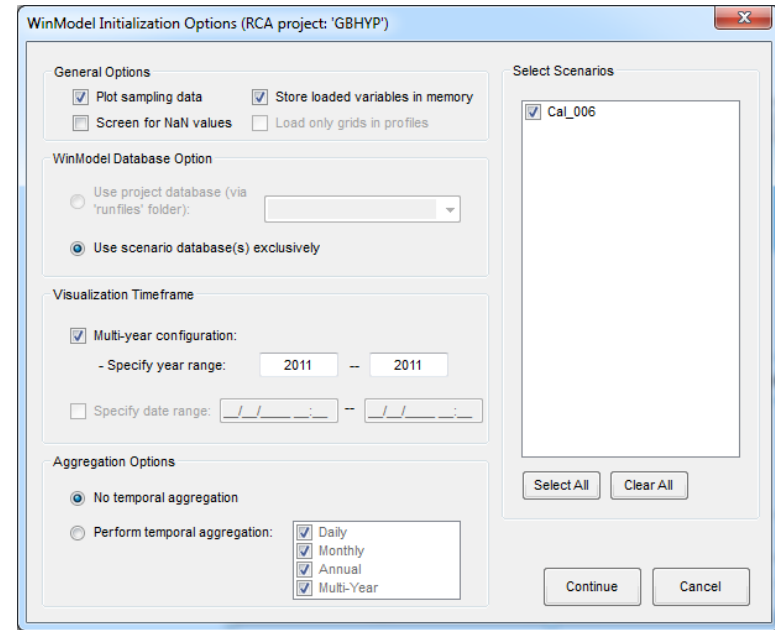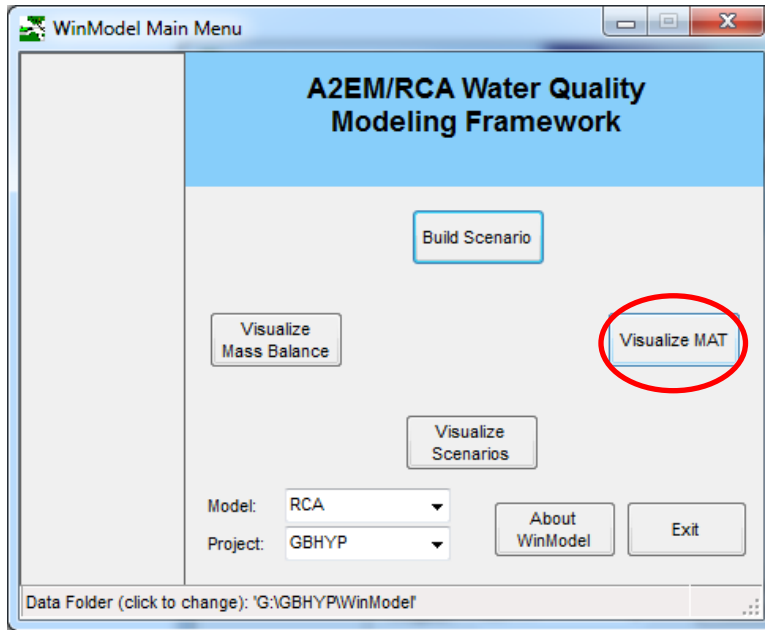
Engaging End Users

- Project Team involves End Users:

  NEW Water, UWEX, Sea Grant, WDNR, AGL, TNC, Oneida Tribe,

- Leverage existing organizations & networks

  - Project personnel are active members of many ongoing efforts ("embedded")
  - Presentations at multiple end user and stakeholder events
  - Solicit input on science needs and outputs
    - In-person

Connections to Larger, Regional Efforts:

- Lower Green Bay and Fox River AOC
  - Eutrophication BUI
  - Cat Island Chain Restoration and related
- LFR TMDL Implementation
  - Educ & Outreach Plan – led by Chad Cook UWEX
  - Ag Runoff Team
- UFR-WR-Lake Winnebago TMDL Development
- GLRI Priority and P Focus Areas (>$10 M)
- Great Lakes Demonstration Farm Network-LFR
- NEW Water/Oneida Adaptive Management Pilot – WPDES
- GLOS
- Others
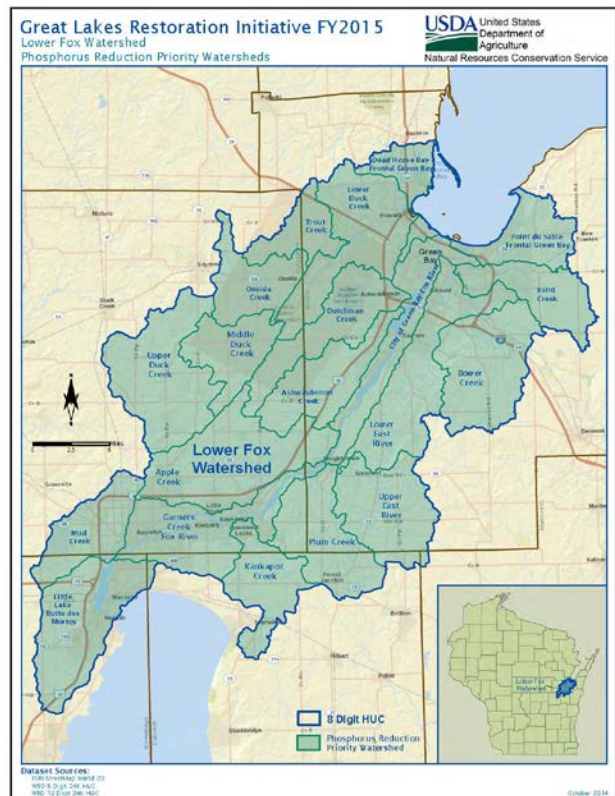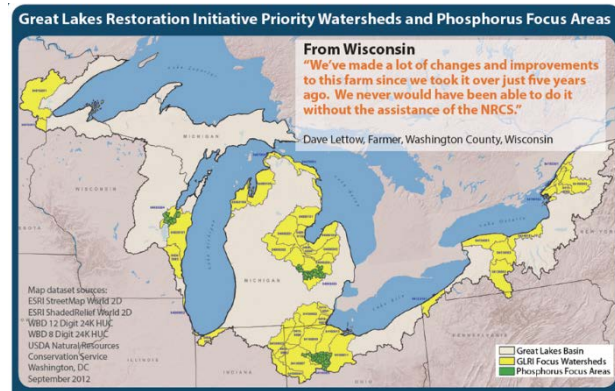
September End User Workshop:
Goals: Present project Outputs, Pilot MAT, Gather Feedback

<u>Target End Users</u>: Management agencies (local, state, federal), Outreach Professionals, NGOs

<u>Project Team Participants and NGO Project Team Affiliates</u> will be key workshop participants.

William Hafs	NEW Water, Director of Environmental Programs;
Jeff Smudde/Erin Wilcox	NEW Water, Watersheds Program Mgr./Water Resources Spec.;
Keith Marquardt	WDNR, Fox-Wolf River TMDL Coordinator;
Michael Finney	Oneida Nation, Eco Services Program Director;
Julia Noordyk	Wisconsin Sea Grant, Water Quality and Coastal Communities Specialist, AOC Outreach Committee;
Chad Cook,	UWEX, Natural Resources Educator, TMDL & AOC Outreach
Mike Grimm	Conservation Ecologist, The Nature Conservancy
Nicole Van Helden	Director of Conservation – Green Bay Watershed, TNC
Olga Lyandres	Research Manager, Alliance for the Great Lakes
Todd Brennan	Watershed Project Manager, Alliance for the Great Lakes
Chris Clayton	Water Quality Program Director, River Alliance of Wisconsin;
Jessica Schultz, Bud Harris	Fox-Wolf Watershed Alliance

HOW Conference, September 29th session: *SCIENCE-BASED RESTORATION OF GREEN BAY*
SoLM Conference, October 28-30: four abstracts have been submitted including one on end user engagement.

Significant Outcomes -
Heightened public awareness & interest →

Pollutants likely to create longest dead zone yet in Green Bay

Mark Hoffman

Grad student Chris Groff (left) and doctoral student Shelby LaBuhn examine a probe retrieved from underwater while aboard the UW-Milwaukee School of Freshwater Sciences's R/V Neeskay last August on Green Bay. Scientists were studying the factors that influence water quality in the bay, including oxygen levels. A longer-lasting dead zone is predicted in the bay this summer.

Phosphorus from fields, urban areas leads to oxygen-deprived stretches

By Lee Bergquist of the Journal Sentinel   April 1, 2015

Tweet 79   f Share 442   8+1 1   ✉ EMAIL   🖨 PRINT   💬 (57) COMMENTS

Video

Green Bay— The tide of nutrients from the Fox River and other tributaries will help create the latest, and most likely, longest-lasting dead zone in Lake Michigan's Green Bay this summer.

The problem is caused by vast amounts of phosphorus and other nutrients that wash from farms and urban landscapes and produce conditions that create oxygen-deprived stretches on the bay.

A Watershed Moment: A... of a 'dead zone'

WisconsinWatch.org   **Donate**   Q

NUTRIENT POLLUTION   *April 1, 2015*

Farmers vow to reduce phosphorus, bane of Green Bay

'I'm part of the problem … But I'm also part of the solution,' dairy farmer says at summit led by U.S. Rep. Reid Ribble

By **Kate Golden**

🔊 Politics   Home » News » Politics

Lawmakers trim Scott Walker's cuts for runoff, public broadcasting

By Patrick Marley and Lee Bergquist of the Journal Sentinel   May 12, 201

Tweet 23   f Share 54   8+1 0   ✉ EMAIL   🖨 PRINT   💬 (221) COMMENTS

Related Coverage

Madison — Republicans on the Legislature's budget committee on Tuesday cut funding for public broadcasting and programs to mitigate farm runoff, but not as deeply as GOP Gov. Scott Walker wanted.

In other action:

Runoff. The committee cut $2.3 million from state programs attacking runoff pollution to lakes, rivers and streams.

The committee made fewer reductions than those targeted by Walker, and both Republican and Democratic members of the panel agreed the runoff demands more attention.

Runoff is the state's most serious water pollution problem. Runoff from farms and other sources has helped to create a large oxygen-depleting dead zone in Green Bay and spurred algae blooms in other waters.

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One of Green Bay's biggest problem is the large phosphorous lead carried by Plum Creek that snakes its way through miles of farmland. Photo By Kevin Fermanich

Ribble entreats stakeholders to "Save the Bay"

By Colleen Kottke Associate Editor

June 29, 2015 | 0 comments

GREEN BAY

Fox River Daily Cumulative Total Phosphorus Load by WY (kg)