

**Experimental Manipulation of Entire Watersheds through BMPs:
Nutrient Fluxes, Fate and Transport and Biotic Responses in
Downstream Systems**

Joseph C. Makarewicz
SUNY Brockport (Lead Institution)
Isidro Bosch and Robert Simon
SUNY Geneseo
Tony Vodacek,
Rochester Institute of Technology
Nate Herendeen
Cornell Cooperative Extension

Livingston County Soil and Water
Conservation District
Livingston County Planning
Department
Livingston County Farm Service

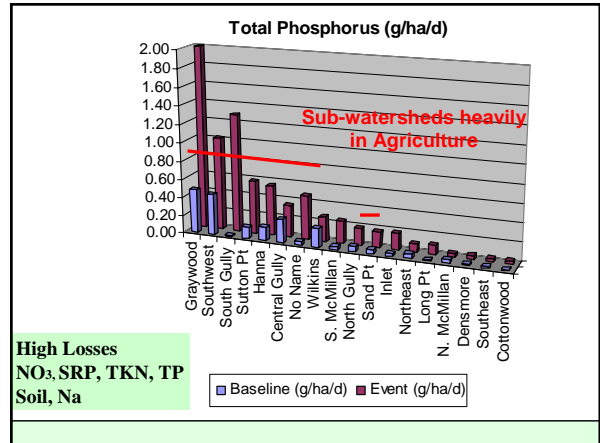
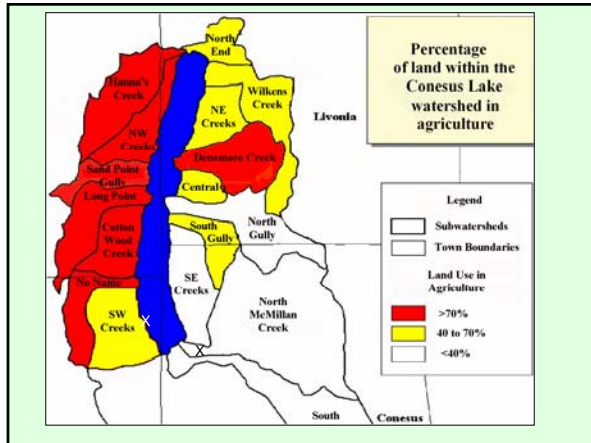


Supported by USDA
Cooperative State Research, Education and Extension Service:
Nutrient Science for Improved Watershed Management
Region 2 Environmental Protection Agency

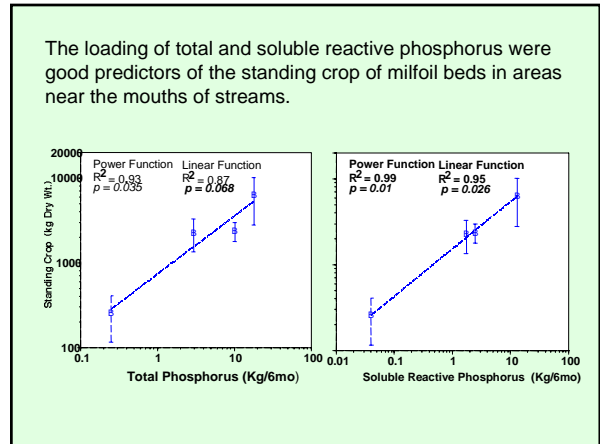
**Experimental Manipulation of Entire Watersheds
through BMPs: Nutrient Fluxes, Fate and Transport and
Biotic Responses in Downstream Systems**

Goals

1. To demonstrate, through the experimental watershed approach, that implementation of BMPs in agricultural dominated watersheds will preserve soil and reduce nutrient loss from a series of sub-watersheds.
2. To evaluate the impact of instituted BMPs by considering the impacts on the down stream lake community on the watershed scale.
3. To evaluate the fate and transport of nutrients over space and time.



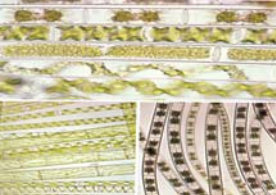
Excessive growth of filamentous algae on or around milfoil beds is related to loss of nutrients from watersheds heavily used in agriculture. The surface area measurements we obtain by GPS are multiplied by biomass quadrat measures to estimate the standing crops of milfoil at each site.



Metaphyton

- Defined as: littoral algae, neither strictly attached to substrata nor truly suspended
- In Conesus Lake, metaphyton exists in close association with Eurasian Water Milfoil

Zygnema & Spirogyra



Metaphyton at the mouth of the stream draining the Graywood watershed

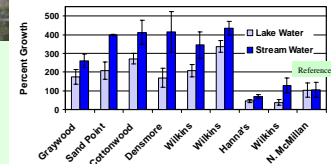


What Effects Metaphyton Growth?

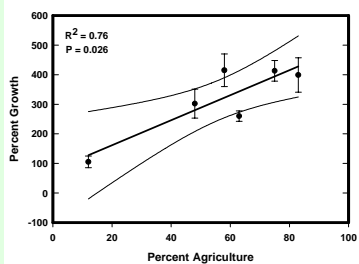
Stream Loading Contributes to Increased Algae Biomass. Nested ANOVA



% Metaphyton Growth in Stream and Lake Water

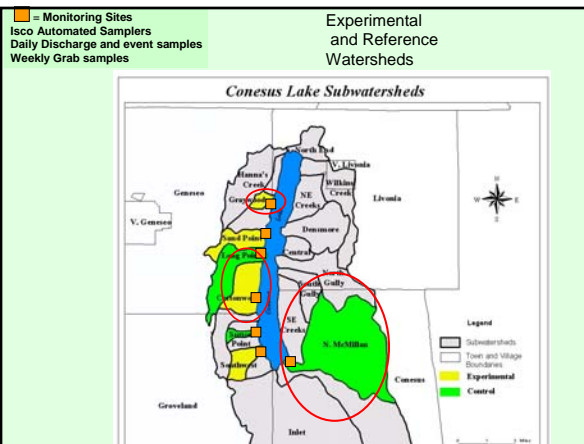


Percent Growth of Metaphyton versus Agricultural Activity in the Watershed



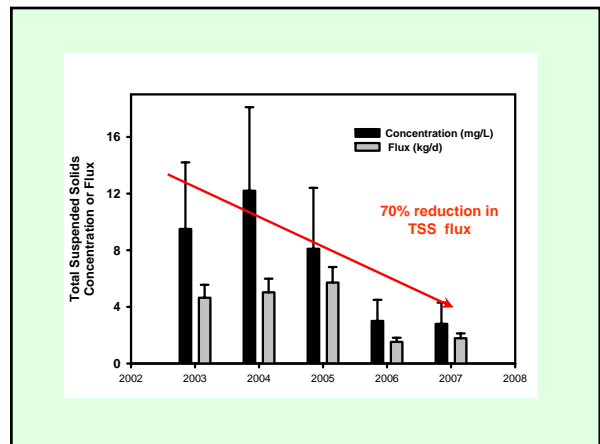
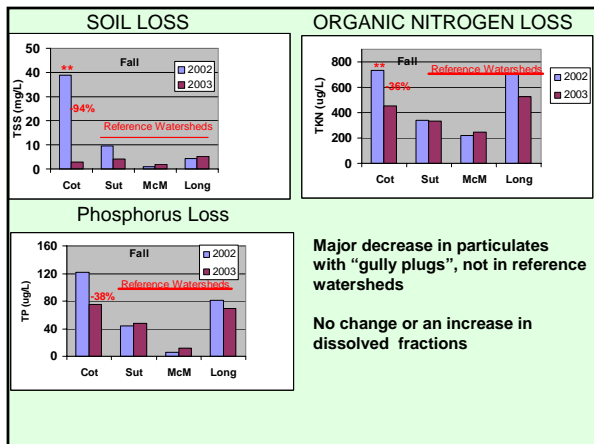
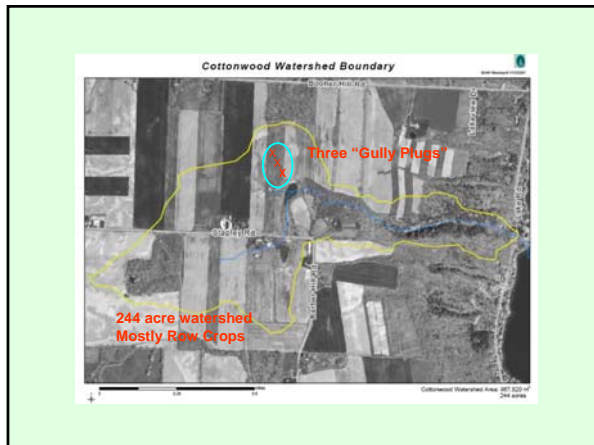
Pre- BMP Results

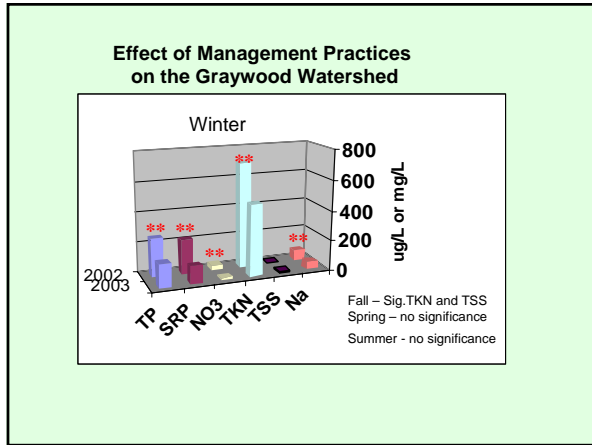
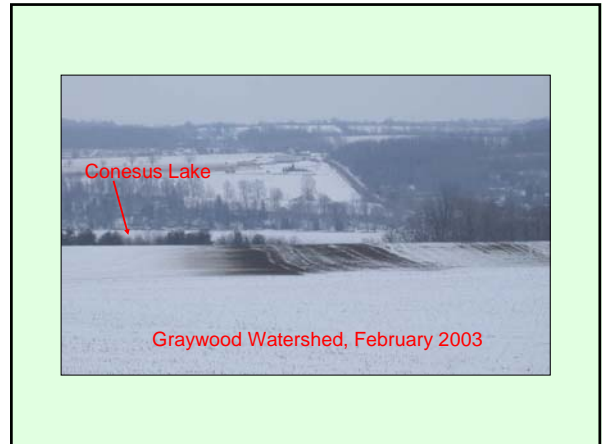
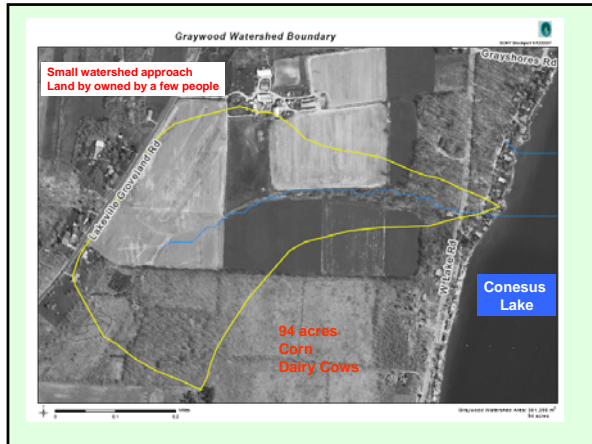
- *Greater loss of nutrients and soils from agricultural watersheds – especially during hydrometeorologic events
- *Elevated levels of NO₃, SRP, TP, TKN and soil in streams
- *Macrophyte beds in lake associated with watersheds in agriculture at stream mouths
- *Macrophyte biomass highly correlated with phosphorus loading
- *Algae biomass at stream mouths stimulated by water (e.g. phosphorus) from watershed
- *Non-agricultural sources of *E. coli* are prevalent during non-events. Geese, rather than dairy cattle, were predominant
- *During events *E. coli* from cattle are prevalent.



What effect do the implemented management plans have on retaining soil and nutrients within the watershed?

1. Discharge measured every second and averaged as daily discharge
2. Water samples weekly, Events composited- rising and descending limbs
3. TKN, SRP, TP, NO₃, TSS
4. ~70 chemistry (mg/L) samples per year for 5 years
5. Calculated daily flux (kg/d)
6. ANCOVA – concentration and flux with discharge as the covariate.



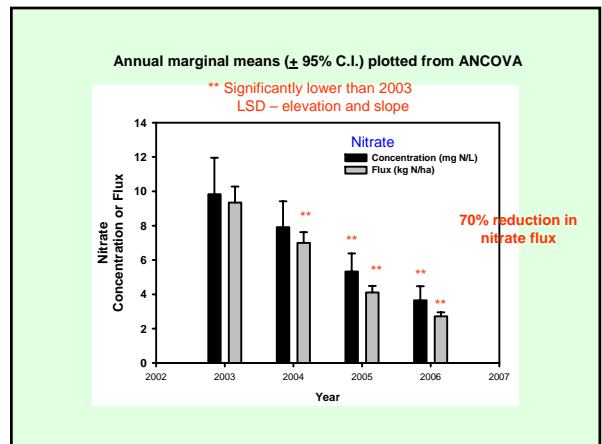
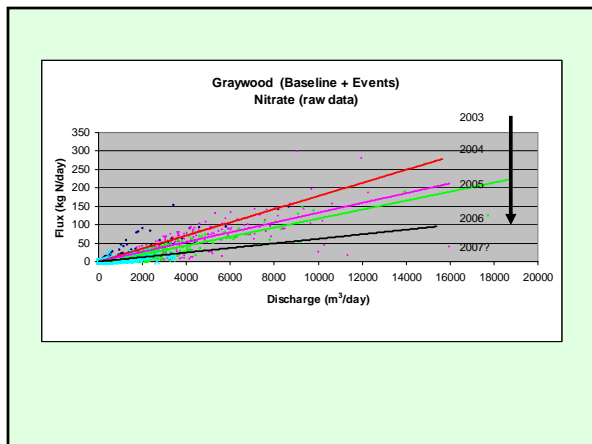


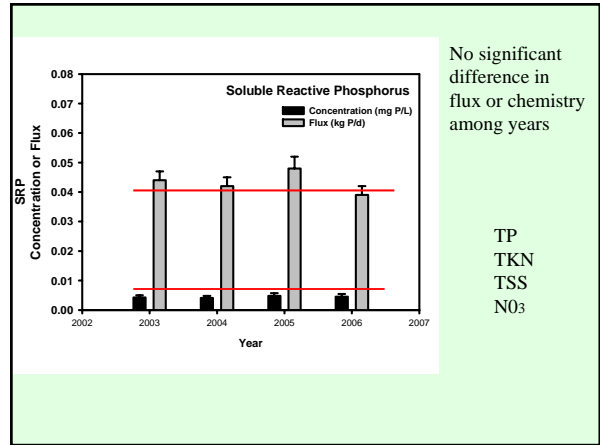
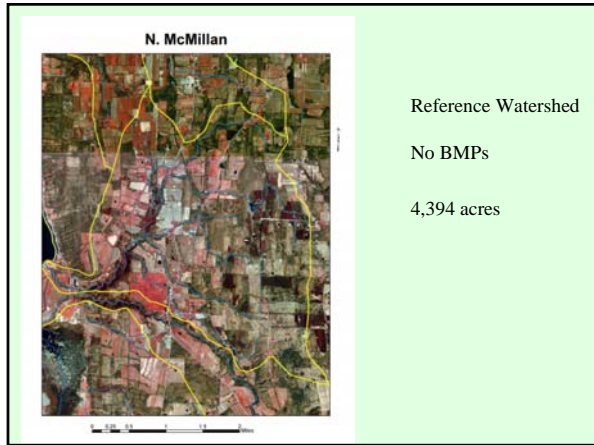
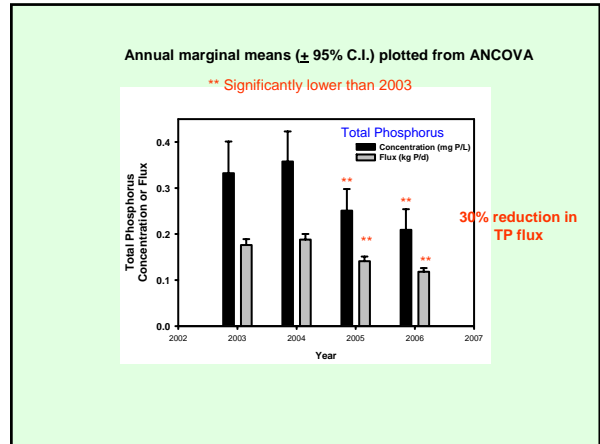
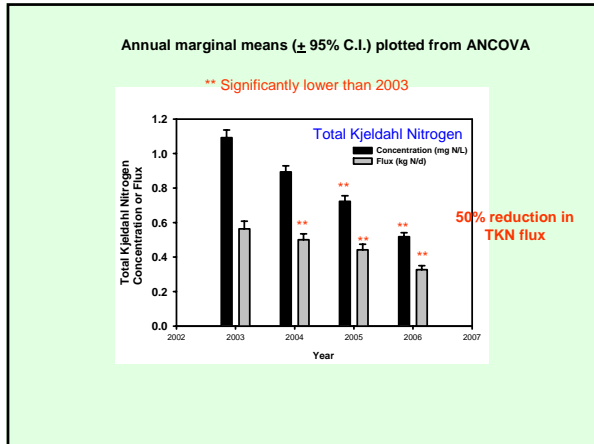
AEM Planning (All Exp. watersheds)

- *Total farm planning
 - *Nutrient Reduction
 - *Runoff reduction
 - *Strip cropping
- *Eliminated winter manure spreading in hydrologically sensitive areas (HSAs) and highly erodable land (HEL)
- *Reduced fertilizer use (\$5,000 year⁻¹) while maintaining yields

Strip Cropping
Nutrient Mgmt

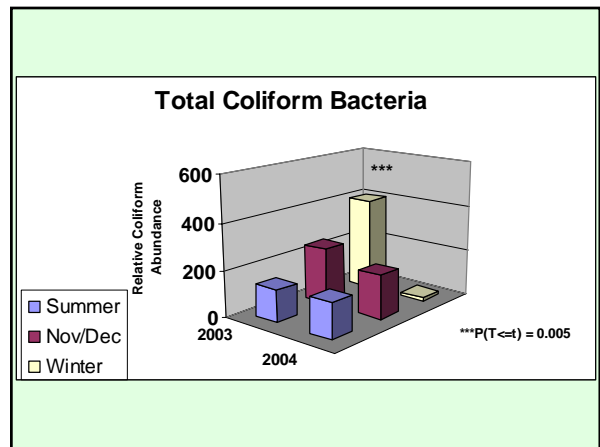
SRP = 210 mg SRP/L
TKN = 1000mg N/L

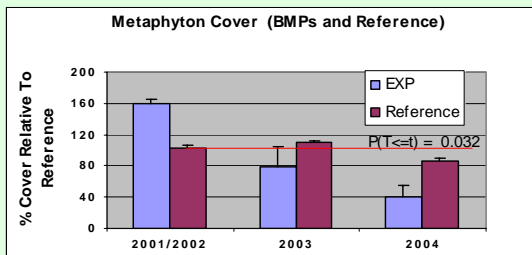




What effect did these management plans have on downstream biotic streams?

Macrophytes?
Bacteria?
Metaphyton?





Summary (preliminary results)

- * Concentration versus flux: Results from ANCOVA analysis are similar
- * Able to better retain nutrients and soils in the watershed with management practices.
- * Able to reduce nutrient (TP, SRP, NO₃, TKN) and soil loss to downstream systems by BMPs.
- * Metaphyton and coliform bacteria were reduced in streams and in the lake in managed watersheds.
- * Macrophytes – some suggestions of a reduction but no significant response yet.

Some Thoughts:

1. Segment analysis to identify sources of pollutants in the watershed.
2. Reduce from a large area, an entire watershed, to a small area of concern.
3. Allows the construction of a priority list to systematically tackle problem areas.
4. If agricultural sources, implement through “Total farm Planning” and/or the AEM process institute management programs as discussed. Bringing Science to the watershed!!
5. Important aspect is identify through monitoring, the success or failure of management plan. If no success, adaptive management becomes a priority - try something else.

Demonstrate to the Great Lakes and Finger Lakes farming community, the utility and effectiveness of the implemented BMPs allowing regional policy makers and managers to develop optimal strategies for improving land usage in watersheds while significantly improving water quality and decreasing abundance of nuisance plant species in downstream ecosystems

Bringing Science to the watershed!!

The collaborative approach provides a mechanism for the farming community to be proactive in watershed issues through education, implementation of BMPs, and by its traditional stewardship of the land it farms.

Monitoring Post- Best Management Plans

SUNY Brockport

- Joe Makarewicz – Organization, Nutrient and hydrologic data
- Ted Lewis - Web, Field and Laboratory work
- Mark Noll - GIS
- Jim Zollweg - Watershed Models
- Sarah Wasson - Graduate Student

SUNY Geneseo

- Sid Bosch - Macrophytes and metaphyton
- Bob Simon - Bacterial abundance -coliforms, BST

Rochester Institute of Technology

- Tony Vodacek - Stream mouth modeling and imagery

Cornell Cooperative Extension

- Nate Herendeen – AEM, Soil analysis, soil nutrient assessment,
- Nancy Glacier outreach

Livingston County SWCD

- Pete Kanouse - Construction, liason

Livingston County Planning

- David Woods and Heather Ferrero - Liason



AEM Planning

Agricultural Environmental Management

- Mandatory on all CAFO sized farms, over 1000 animal units
- Voluntary on dairy/livestock farms with 300 - 999 animal units
- Will be required (voluntary compliance) on all farms with animals by 2009