Biotic Interactions and Habitat

Paul Cunningham
Bureau of Fisheries Management
High inter-lake variability between Chlorophyll and TP

Chlorophyll varies between ~10 and 220 ug/l

For TP=200 ug/l
Stable States in Shallow Lakes

Clear State
- clear water
- low algal biomass
- high macrophyte biomass
- Piscivores dominate

Turbid State
- murky water
- high algal biomass
- sparse macrophytes
- Planktivores/benthivores dominate
SHALLOW LAKE: NON-STRATIFIED, < 7 m DEEP, > 4 ha

- One third of WI lake acres, > 300k ac
- WI’s largest, Winnebago @ 137,708 ac
- Large littoral zone area (>50% criteria)
- Aquatic plants = Heart of ecosystem
- Exist in turbid or clear water state
- Water column stays mixed
- User expectations often unrealistic
Effect of SAV on the chlorophyll and TP relationship

Bayley et. al. 2007
Effect of SAV on the chlorophyll and TP relationship

Bayley et. al. 2007
Effect of SAV on the chlorophyll and TP relationship

Bayley et. al. 2007
Effect of SAV on the chlorophyll and TP relationship

Bayley et. al. 2007
Shallow Lake Ecology

(From Scheffer et al. 1993)
Shallow Lake Ecology

Plants
- Small Rosettes
- Submersed Flexous
- Submersed Shrubs
- Emergents

NUTRIENT POOR
NUTRIENT RICH
CLEAR
TURBID

(From Scheffer et al. 1993)
Shallow Lake Ecology

(Northern Pike
Bass
Bluegill
Pumpkinseed
Yellow Perch)

(Crappies
Carp
Black Bullhead)

Nutrient Poor

Nutrient Rich

Clear

Turbid

(From Scheffer et al. 1993)
Inter-quartile ranges are benchmarks for quick evaluations of survey data. Catch rates within the inter-quartiles = **normal** for Class 3 lakes. Catch rates outside the inter-quartiles = **unusual**.

**Fish Community: Assessment by Analogy**

Trends in Largemouth Bass Abundance – Park Lake

Fall Electrofishing surveys; 46 Lakes
Clear-water State

Piscivores

Planktivores/Benthivores

Zooplankton grazing

Algae biomass

Aquatic plant biomass

Sediment Resuspension

Turbid-water State

N. Hansel-Welch & M.B. Butler, 199
Cladocerans, or water fleas “vacuum” the algae from lake water. When they are abundant, the water is more clear.

If conditions are unfavorable, i.e. zooplanktivorous fish like bluegill are abundant, refuge absent, the lake water remains turbid from algae.
Mechanical cutting.
Boat damage.
Herbicide use or accidental runoff.
Heavy grazing by high density of native or introduced species.
Raising of the water level to place plants at lower light intensities.

- Destruction of zooplankton activity by pesticides or toxins.
- Reduction of piscivorous fish to zooplanktivorous fish ratio by deoxygenation in summer/winterkill.
- Overfishing of large fish so that small size classes are favoured.
Thresholds
Biomanipulation
Big Muskego Lake -- Chlorophyll A

Chlorophyll A (μg/L) vs Year

Chl A Threshold

YEAR

Bioturbation
Nearshore Fish and Wildlife Habitat: Human Impacts, Obvious Remedies, Difficult Choices

Paul Cunningham
Bureau of Fisheries Management
Domestication of Wisconsin Lakes

Courtesy of MN DNR
Wisconsin’s Ecoregions

Northern Lakes and Forests

Cabins and Corn (some)

Driftless

Cabins

Cows

Concrete

Southeastern

Cabins

Corn

Till Plains

Concrete

Context is Critical

Essential Habitat

- Littoral zone
- Tributary areas
- Adjacent shoreland
Features of Littoral Zone Habitat

• Vegetation
• Substrate
• Woody Cover
• Overhanging Bank Cover
• Depth and Depth Gradients
1940 Housing Density by Partial Block Group

Voss, et al.
Applied Population Laboratory
University of Wisconsin, Madison
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Comparisons of Undeveloped and Developed Shorelands, Northern Wisconsin

Joan Elias & Mike Meyer
What's Happened To Shoreland Plants?

Elias and Meyer,
Bank Cover

Type of Modification

Bank Cover (%)

None  Riprap  Sea Wall

PUBL-RS-921-96
Consequences of Lakeshore Development on Emergent and Floating-Leaf Vegetation Abundance

Radomski and Goeman, 2001
Developed shores had less aquatic vegetation.

For each lake lot, 2/3rds of the emergent and floating-leaf vegetation was lost.

Minnesota has lost 20-28% of this vegetation.

Radomski and Goeman, 2001
What’s Happened to Green Frogs

\[ y = 0.0298x^2 - 2.1712x + 41.227 \]

\[ R^2 = 0.2854 \]

(Woodford and Meyer)
Impacts of Lakeshore Development on Tree-falls in North Temperate Lakes

Christensen et al. 199
Impacts of Development on Tree-falls

\[ y = -172.78 \ln(x) + 671.59 \]

\[ R^2 = 0.7164 \]

Christensen et al. 1996
Development Impacts on Fish Growth and Production

Schindler et al. 2000
Development Impacts on Bluegill Growth

Schindler et al. 2000

![Graph showing the relationship between log(Mean growth rate) and Dwelling density (no./km). The graph depicts a decrease in growth rate with increasing dwelling density.](image)
Fish grow ~3X faster in lakes with lots of woody habitat.

From Schindler et al. 2000
Fish Community Responses to a Whole-lake Removal of Coarse Woody Habitat

Greg G. Sass, James F. Kitchell, and Stephen R. Carpenter
Center for Limnology
University of Wisconsin - Madison
Little Rock Lake
Pre-manipulation
2001 – early 2002

Treatment Basin
475 logs/km

Reference Basin
344 logs/km

Curtain
Little Rock Lake
Post-manipulation
Late 2002 - present

Treatment Basin
128 logs/km

Reference Basin
344 logs/km
Yellow Perch Abundance (Population Estimate)

Treat. vs. Ref. Pre- vs. Post-CWH Removal
Development Effects on Nest Site Selection by Largemouth Bass and Black Crappie

Jeffrey Reed

Bergen Lake

Available Habitat
Largemouth Bass Habitat Selection
Black Crappie Habitat Selection

LMB Nest
BLC Nest

Undeveloped
No Dwelling
Dwelling
Heavily Developed
Can Habitat Alteration and Spring Angling Explain Largemouth Bass Nest Success?
Lake Characteristics Influencing Spawning Success of Muskellunge

Rust et al.,
Lake Characteristics Influencing Muskellunge Reproduction

- **Partially Developed**
- **Totally Developed**

**Percent Shoreline**

- Good Reproductive
- Poor Reproductive
Improve Water Clarity
Fish and Wildlife
Habitat
Hold Sediments
Nutrient Cycling
Invertebrates
Aesthetics
Effects of Pier Shading on Near-Shore Aquatic Habitat

Researchers:
Paul Garrison, DNR
Dave Marshall, DNR
Laura Stremick-Thompson, DNR
Patricia Cicero, Jefferson County LWCD
Paul Dearlove, Lake Ripley Mgmt. Dist.
Ecological Effects of Piers on Aquatic Plants

**Mean Biomass**

- **Pier**: 34.6 g
- **Deck**: 7.7 g
- **Control**: 157.2 g

**Mean % Cover**

- **Pier**: 29.4%
- **Deck**: 26.3%
- **Control**: 67.2%
Ecological Effects of Piers on Fish

Mean Catch Rates

Fish Numbers

Pier: 11.2
Control: 38.7
Habitat Changes With Lakeshore Development

- Shrub layer at lake-forest edge
- Bank cover
- Snag trees
- Woody cover & tree-falls in the nearshore
- Subcanopy layers at lake-forest edge
- Emergent and floating leafed plants
- Water Quality
Natural Shoreline Habitat...
Going, ...
Going, ...
Going, ...
Gone......
Well it Doesn’t Have to Be That Way!
The Remedies seem obvious and the stakes are great
➢ Go fishing!
➢ Go to the beach!
➢ Less is more!
➢ Put the mower, chainsaw, rake, weed rake, Herbicides, and fertilizers away!