Fish Ecology
Lake and Stream Leaders Institute
July 31, 2015
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From a terrestrial standpoint, what are the unique challenges and opportunities associated with life in water?

Challenges:
- Viscosity
- Low oxygen (lakes)
- Low light levels
- Rapid H2O movement (streams)

Opportunities:
- Floating
- Vertical movement (lakes)
- Downstream transport (streams)

Consider your favorite Michigan aquatic animal. Does it live in all lakes and streams in Michigan? Why or why not?

Lake Zonation

Stream Order

FIGURE 1.33 A drainage network illustrating stream order classification for a fourth-order watershed.
Overview of lake and stream fishes:
- size
- habitat
- feeding habits
- reproductive characteristics

Fish: Benthivores, Planktivores, and Piscivores
- Northern Pike
- Alewife
- Sculpin
- Bluegill

Most fish species share the same general life cycle:
- Eggs
- Larvae
- Adults
- Juveniles

Spawning strategies:
- nesting
- demersal
- pelagic

Hatch size varies (~3-15 mm TL)
- Small hatch - starvation
- Large hatch - predation

Age at maturity varies widely among species.

And even within species!!
- Bluegill
- Three reproductive strategies of males
  - Bulls, sneakers, and female mimics (cuckholders)
How many fish species are in a lake or stream?

Fish species number typically increases with lake size.

Bachmann et al. 1996
CIFAS 53:842-855
65 Florida lakes

How much fish biomass is in a lake?

Ney 1996 TAFS

Number of Fish Species per Lake

Michigan
Median: 15 spp

VM netting
Median: 13 spp

Michigan
Median: 12 spp

VM netting
Median: 10 spp

Total No. of SPP and 5 most prevalent fish species

Iowa
VM netting
N<46
BG-96%
LMB-96%
Ch. Cat-91%
Bl. CP-89%
Wh. CP-61%

VM shocking
N<107
BG-98%
LMB-89%
Ch. Cat-89%
Bl. CP-88%
Wh. CP-75%

Michigan
VM netting
N<88
YP-89%
LMB-82%
BG-79%
NP-76%

VM shocking
N<114
YP-86%
LMB-87%
BG-79%
NP-76%

What are typical fish community types?

- Shallow lakes, no connections
- Shallow lakes, with connections
- Stratified lakes, with deep water oxygen
- Stratified lakes, with oxygen depletion
- Fishless lakes

Fish Communities:
shallow lake, no connection

- Typically < 2.5m mean depth
- Water column isothermal...no cold water
- Prone to low oxygen under winter ice

Clear state:

Turbid state:
Fish Communities: shallow lake, no connection

- Who predominates? - plantivores and benthivores that tolerate low oxygen but have relatively few anti-predation adaptations

Umbridae (e.g., mudminnow)

rivers.oreumich.edu/ www311/aqfish.html

Fish Communities: shallow lake, WITH connection

- Winterkill less likely: littoral piscivores, littoral planktivores, benthivores and detritivores predominate.

Esocids
- Northern pike

Centrarchids
- Largemouth bass

Cyprinids
carp

muskellunge
pumpkinseed

Fish Communities: Stratified lakes WITH deepwater oxygen

- Inshore littoral areas tend to be warm and oxygenated, with relatively high benthic production and rooted vegetation.
- Surface pelagic waters (epilimnion) tend to be warm, light, and oxygenated.
- Deep waters tend to be cooler and darker, but with year-round oxygen (>4 mg/l; 4°C).

Percids (coolwater)
- Walleye (piscivore, low light)

Coregonids
- Cisco also herrings (planktivores)

Salmonids (coldwater)
- Lake trout (piscivore)

Yellow Perch (planktivore, piscivore)
Sculpin (benthivore)

Fish Communities: Stratified lakes WITHOUT deepwater oxygen

- Inshore littoral areas tend to be warm and oxygenated, with high production. May be turbid or may have rooted vegetation.
- Surface pelagic waters (epilimnion) tend to be warm and oxygenated...but with high nutrients, production, and relatively low water clarity.
- Deep waters tend to be cooler and darker. High algal biomass decomposes on the bottom, leads to oxygen depletion in the summer.

Percids (coolwater)
- Walleye (piscivore, low light)

Clupeids
- Gizzard Shad also Threadfin Shad omnivores

Salmonids (coldwater)
- Lake trout (piscivore)

Yellow Perch (planktivore, piscivore)
Class 1: High temp., small surface area, intermediate depth
- Warmwater centrarchids
- Yellow bullhead
- Grass pickerel
- Spotted gar
- Lake chubsucker

Class 2: High temp., large surface area, deep
- Bowfin
- Carp
- Channel catfish
- Brook silverside

Class 3: Low temp., large surface area, deep
- Coolwater centrarchids
- Percids
- Coldwater species

Class 4: Moderate temp., small surface area, intermediate depth
- Warmwater centrarchids
- Coolwater species
- Yellow perch
- White sucker

Class 5: Moderate temp., intermediate surface area, intermediate depth
- Brown bullhead
- Bluntnose minnow
- Low oxygen tolerant

Class 6: Low temp., intermediate surface area, intermediate depth
- White sucker
- Percids
- Northern Pike

Ultimate drivers:
- Temperature
- Size
- Depth

Proximate drivers:
- Productivity
- Oxygen
- Habitat diversity
- Thermal structure
- Lake zones

Humans: The Top Predator
How does fishing affect lakes?

- Predators
  - Reduced abundance
  - Reduced size
- Prey fish
  - Increased abundance
- Introduction of non-native species
  - Baitbucket introductions
  - Livewells
  - Stocking

Can fishing affect water clarity?

Trophic Cascades

- A cascade of interactions among members of a food web that lead lakes to exhibit alternative characteristics

Other consequences of fishing

- Trophic triangles
What are other ways humans can affect fish?

- Many ways
  - Already discussed nutrients, fishing

- I will discuss two
  - Residential development
  - Invasive (non-native species)

Lakeshore development

- Houses, condos, resorts, etc
- Riparian alteration
  - Removal of trees
  - Lawns
- Lakeshore manipulation
  - Seawalls
  - Beaches
  - Removal of woody and macrophyte habitat

Key concept

- What happens on land affects what happens in water
  - Aquatic-terrestrial coupling
- How does this happen?
  - Fish directly consume terrestrial items
    - Insects
    - Mammals
  - Terrestrially-derived habitat
  - Coarse woody habitat (CWH)
  - Terrestrially-derived nutrients
    - Influences primary productivity

Habitat alteration

- Removal of CWH
  - CWH abundance strongly affected by residential development
Removal of macrophytes

- Development affects floating-leaf plants the most
- Other growth forms not affected as much.

How does this affect fish?

- Benthic invert diversity reduced
  - Abundance too

Radomski and Goeman 1996

Reduced fish growth

- Significant reductions in fish growth with higher development
- Low development: most of shore undeveloped
- High development: nearly 100% of shore developed

Schindler et al. 2000

Introduced Species

- AKA: Exotic, Nuisance, Invasive, Non-native, nonindigenous
- Estimated cost of introduced species
  - $137,000,000,000 per year (2000)
  - >130 fish species introduced into the US

Introduced Species: Global homogenization

- Largemouth bass
- Smallmouth bass
Introduced species in the Great Lakes

Introduced species

- 63 fish species
  - Established: 33
  - Reported, failed: 16
  - Reported, status uncertain: 14
- 2 decapods
  - Rusty crayfish, Red swamp crayfish (Procambarus clarkii)

Vectors of introduction

- From outside NA:
  - Shipping
  - Aquarium/bait trade
- From inside NA:
  - Canals
  - Bait trade
  - Stocking

Shipping

Canals

- *Morone spp.*
  - Yellow bass, white perch
- *Alosa spp.*
  - Blueback and skipjack herring, alewife

Stocking

- Pacific salmonids
  - 4 successful
  - 2 or 3 failed
- Others: brown trout, common carp
Indirect effects of invasive species

Questions?

Summary

- Aquatic food webs are the net result of numerous factors
  - Within-lake
  - Landscape
- Humans can disrupt (or help) aquatic food webs
  - Conservation of natural shorelines
  - Reduction in harvest of top predators
  - Reduce introductions of non-native species