

**Patterns and processes for freshwater fish
distribution in northeastern National Parks:
inventory, monitoring, and a model of
governing processes**

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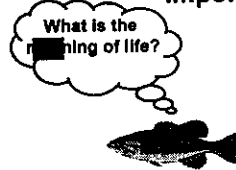
Talk outline

- Approach
- Questions for 2000
- Objectives, Progress in 1999
- Yellow Perch
- Assemblage
- Ontogenetic Niche Shift
- Multiple Predators
- Monitoring
 - Overview
 - Specifics

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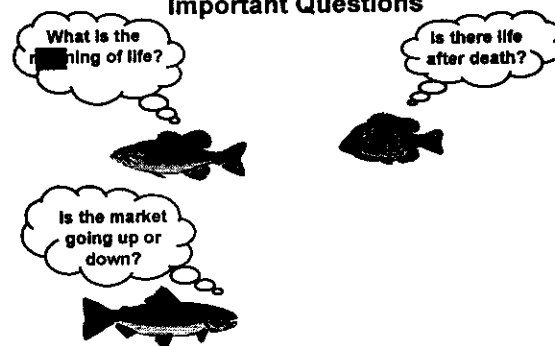
Important Questions

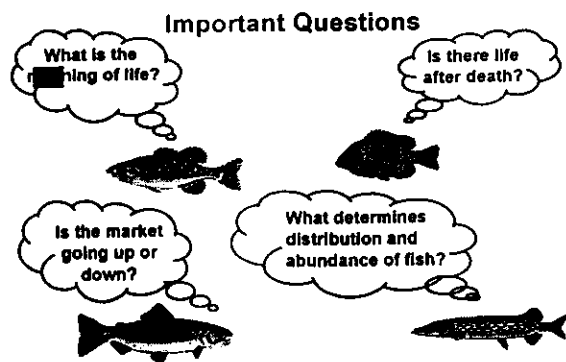


Important Questions

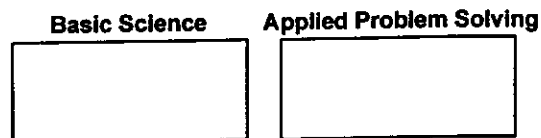


Important Questions



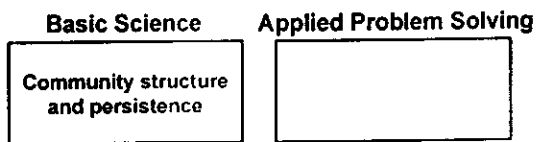


Approach



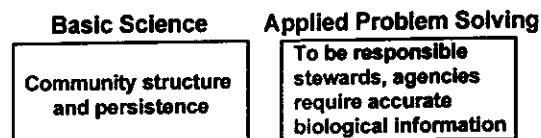
Research Area

Approach



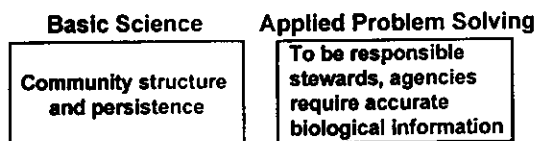
Research Area

Approach



Research Area

Approach

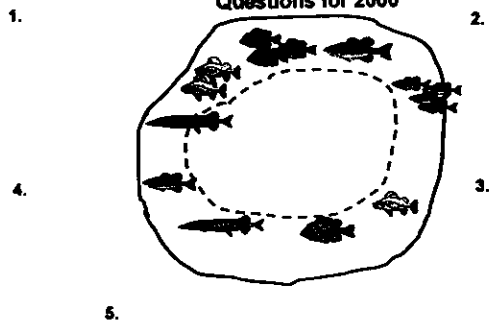


Research Question

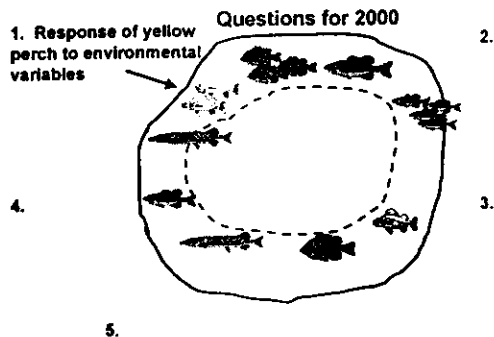
What processes structure freshwater fish communities?

What Structures Fish Communities?

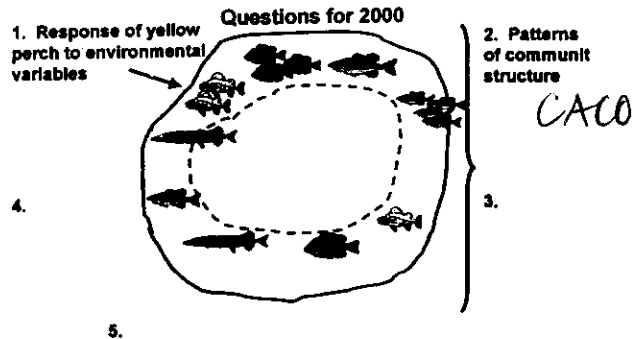
Questions for 2000



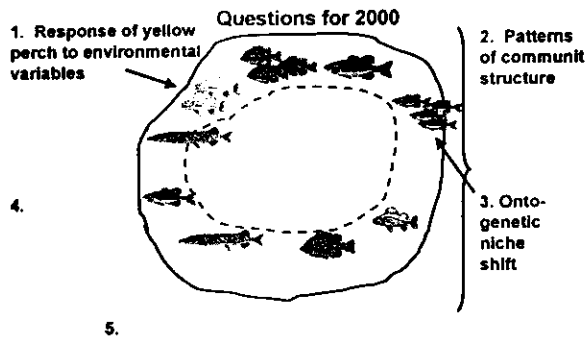
What Structures Fish Communities?



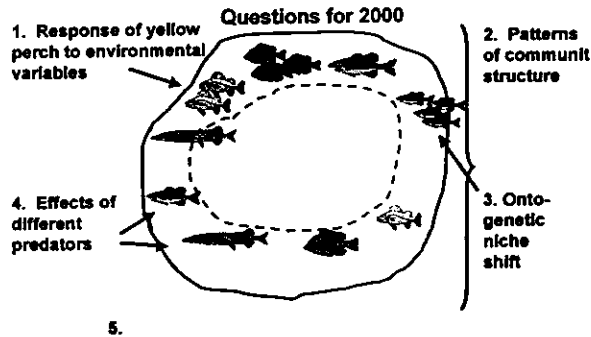
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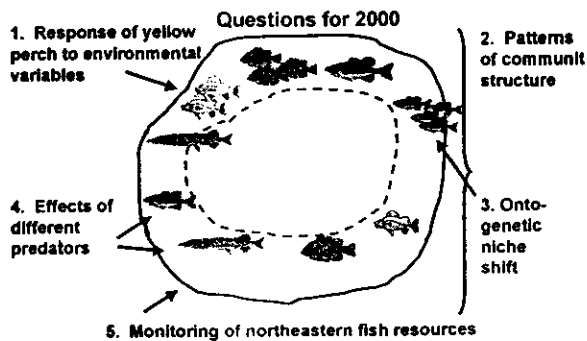
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1999

National Park Service Objectives - 2

- *Sample prey resources
 - Zooplankton species
 - Benthos
- *Construct model of governing processes
- *Test and evaluate appropriate protocols for long-term monitoring

why are fish there

*to predict community structure
be able to detect change*

Progress - Summer of 1999

- * Developed fish sampling protocols

1999

National Park Service Objectives - 1

- *Determine composition of fish communities at northeastern National Parks and Historical Sites
e.g., resident and migratory fish
- *Compile existing information on physical factors, morphometry, and landscape features that may affect aquatic resources especially fish
- *Compile historical records
e.g., fish stocking, resource surveys, harvest, etc

1999

Objectives for the Summer of 1999

- *Document patterns within the ponds
- *Compare patterns across ponds

Progress - Summer of 1999

- * Developed fish sampling protocols
- * Sampled all ponds with 6 gear types-
Extensive and Intensive sampling

Progress - Summer of 1999

- Developed fish sampling protocols
- Sampled all ponds with 6 gear types-
Extensive and intensive sampling
- Seined all ponds again within 7 days
Snapshot

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Snapshot
- Collected data on physical factors in all ponds

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Progress - Summer of 1999

- Developed fish sampling protocols
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Snapshot
- Collected data on physical factors in all ponds
- Collected zooplankton in all ponds
- Developed techniques for benthos and
diet sampling

Progress - Summer of 1999

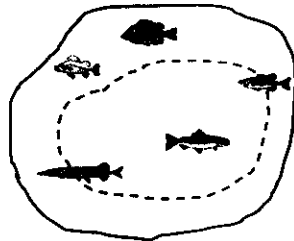
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- Collected data on physical factors in all ponds
- Collected zooplankton in all ponds
- Developed techniques for benthos and
diet sampling
- Spent 2 days at all NHS' identifying aquatic
resources

Cape Cod National Seashore Kettle Ponds

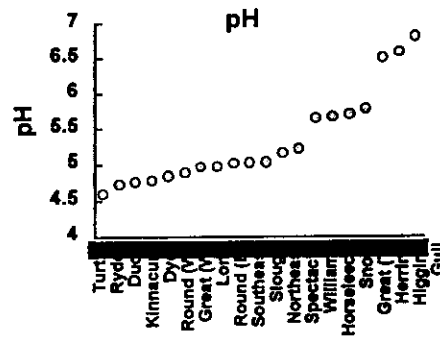
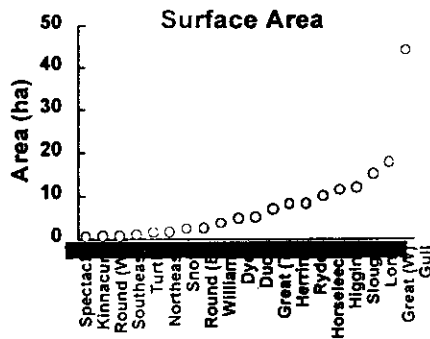
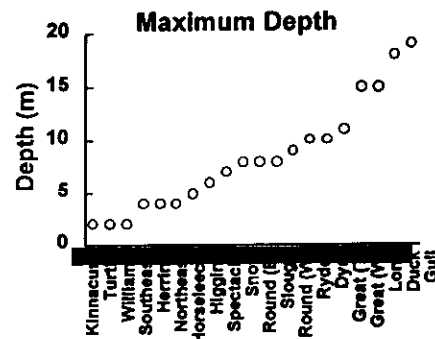


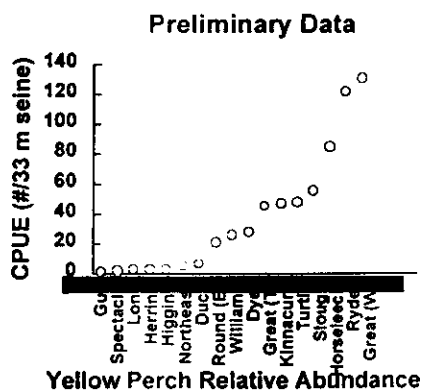
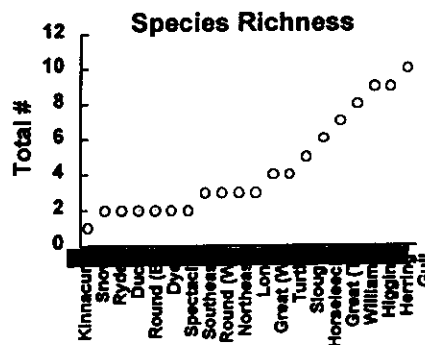
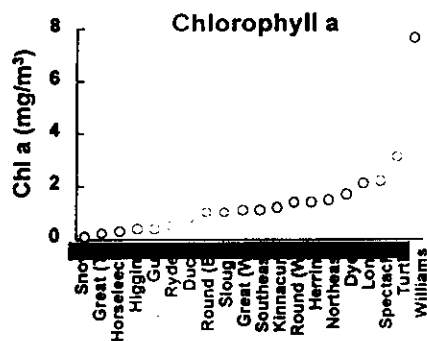
What did we find?

- 14 species in 20 kettle ponds
- Mostly inshore or littoral



	Brown	Rainbow	Eel	Herring	Pickeral	Sm. Bass	W. Sucker	W. Perch	G. Shiner	Lg. Bass	Bullhead	Sunfish	Killifish	Y. Perch
Gull	x	x												
Higgins			x	x		x		x		x	x	x	x	x
Herring			x	x						x	x	x	x	x
Williams			x	x				x	x	x	x	x	x	x
Turtle					x					x	x	x	x	x
Great (W)					x					x	x	x	x	x
Great (T)						x				x	x	x	x	x
Horseleech							x	x		x		x	x	x
Round (W)									x			x	x	x
Snow									x			x	x	x
Slough										x	x	x	x	x
Long											x	x	x	x
Northeast											x	x	x	x
Southeast											x	x	x	x
Ryder												x	x	x
Round (E)													x	x
Dyer													x	x
Spectacle													x	x
Duck													x	x
Kinnacum													x	x





Yellow Perch Relative Abundance

1999 National Park Service Objectives - 1

- *Determine composition of fish communities at northeastern National Parks and Historical Sites e.g., resident and migratory fish

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- Ongoing
- *Determine composition of fish communities at northeastern National Parks and Historical Sites e.g., resident and migratory fish

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- *Determine composition of fish communities at northeastern National Parks and Historical Sites e.g., resident and migratory fish
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National Park Service Objectives - 2

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 - Benthos

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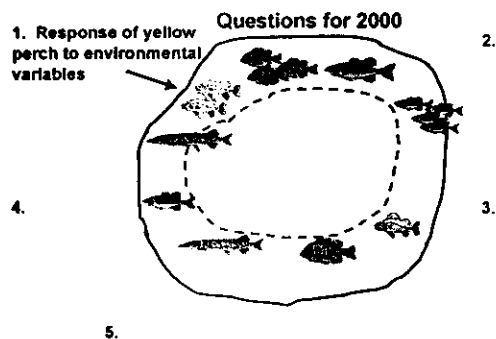
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What Structures Fish Communities?



Evaluating patterns and processes of community structure along a gradient of variables: the changing role of yellow perch

Mike Carey

Advisor

Dr. Martha Mather

Committee

Dr. Jack Finn
Dr. Ben Letcher



Mass Cooperative Fish and Wildlife Research Unit
Department of Natural Resources Conservation
National Park Service

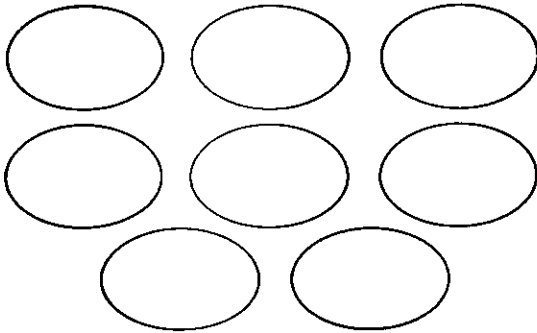
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2. Questions:
Conceptual
Research
3. The Ecologically interesting perch.
4. What patterns are possible?
5. What processes are possible?
(What,Why,Prediction examples)
6. Specific questions
7. Methods
8. Schedule
9. Potential analysis

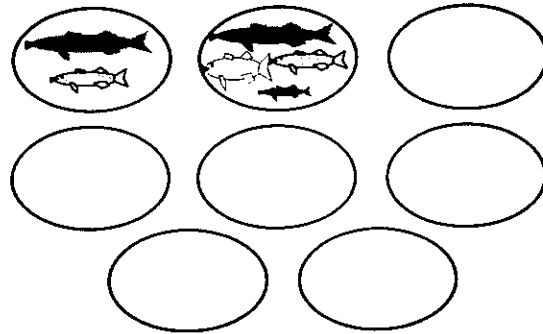
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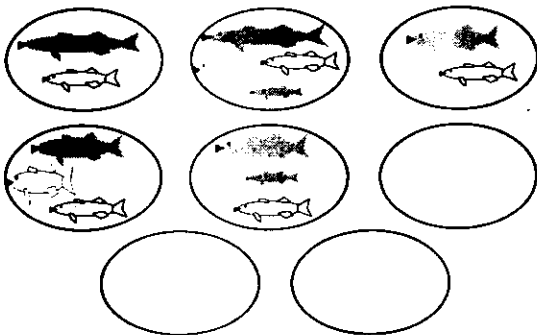
Different fish communities are possible



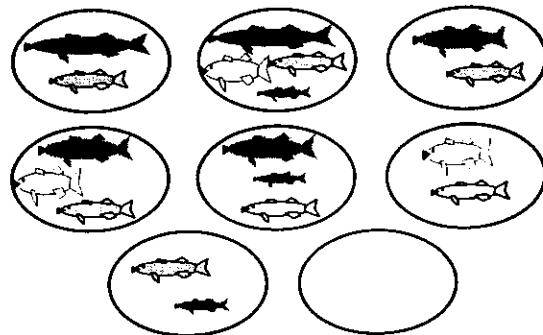
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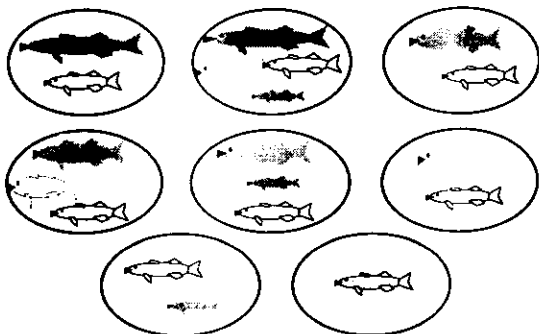
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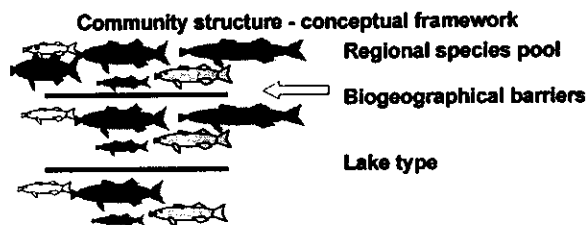
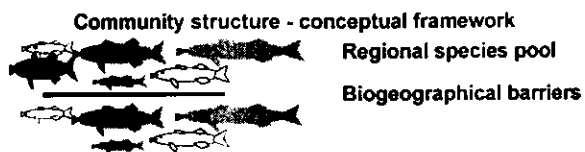
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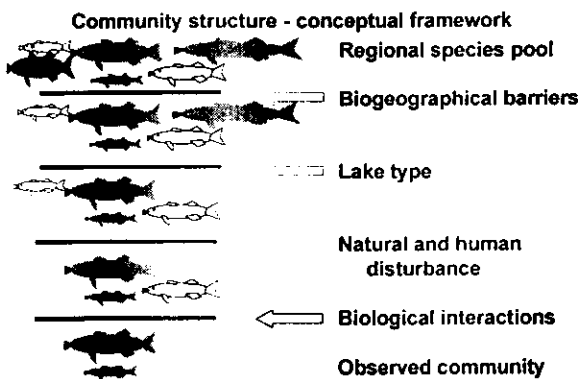
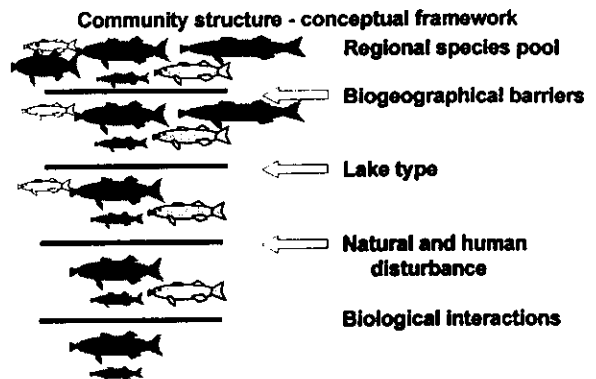
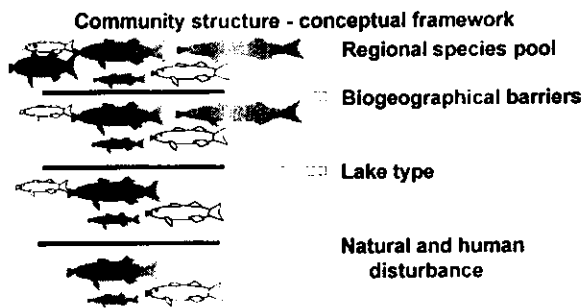


Different fish communities are possible



Community structure - conceptual framework





Why do we see different patterns of fish community structure?

Why do we see different patterns of fish community structure?

What do we know?

Why do we see different patterns of fish community structure?

What do we know?

(1) Consensus does not exist on which factors are most important.

Why do we see different patterns of fish community structure?

What do we know?

(1) Consensus does not exist on which factors are most important.

(2) Q: If we ask the same question in the same way in similar systems, do we get the same answer?

A: Don't know because we don't ask the same question in the same way or define what is or is not similar.

Why do we see different patterns of fish community structure?

What do we know?

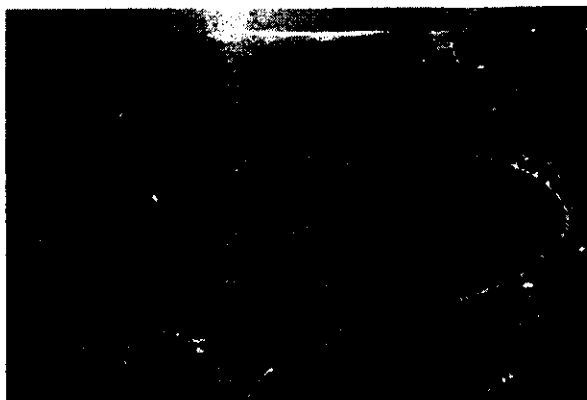
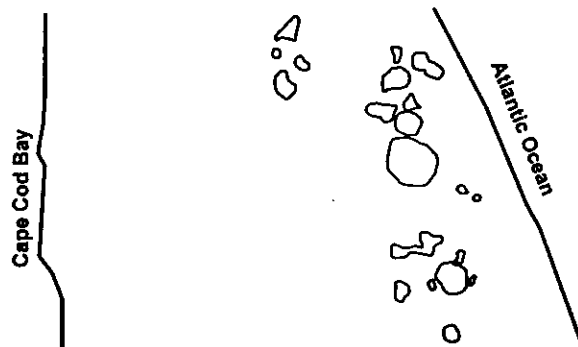
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A: Don't know because we don't ask the same question in the same way or define what is or is not similar.

(3) The kettle ponds are an ideal system to test a subset of these environmental and biotic factors in a standardized way.

Cape Cod National Seashore Kettle Ponds



Ponds are similar

Ponds are similar

- (1) Within 10 miles
- (2) Glacial origin (kettle)
- (3) Groundwater fed
- (4) Small

Ponds are similar
(Comparing apples with apples)

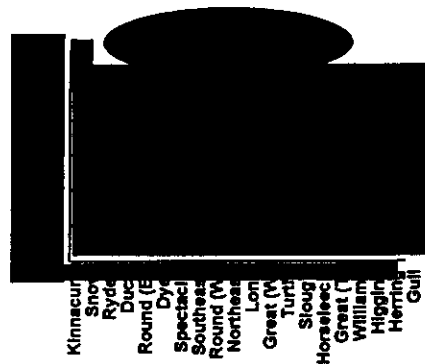
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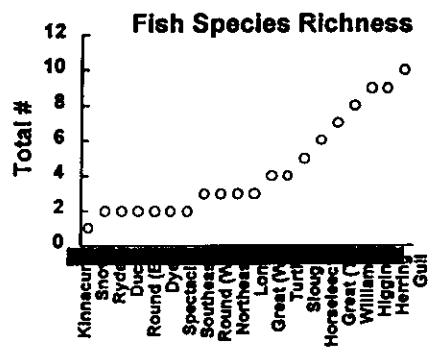
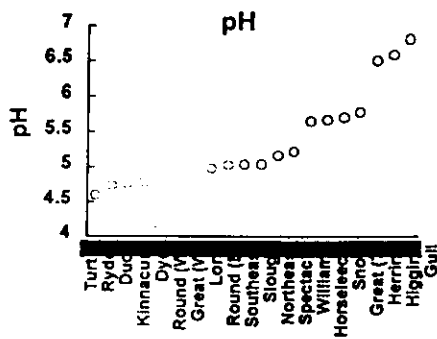
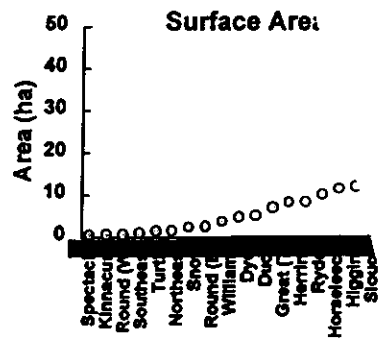
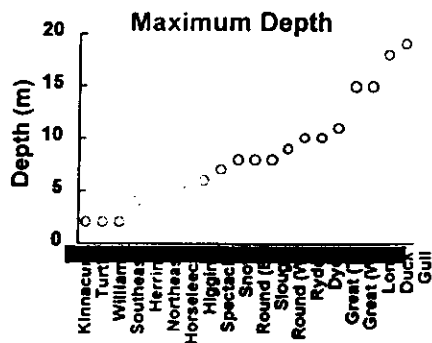
Yet differences exist

Ponds are similar
(Comparing apples with apples)

Yet differences exist

Vary along a gradient for many features





Possible approaches

	Experimental	Comparative	Case study
Hypothesis testing			
Controls			
Treatments			
Replicates			
Independence			
Multiple experimental units			

	Possible approaches		
	Experimental	Comparative	Case study
Hypothesis testing	y		
Controls	y		
Treatments	y		
Replicates	y		
Independent units	y		
Multiple experimental units	y		

	Possible approaches		
	Experimental	Comparative	Case study
Hypothesis testing	y		y
Controls	y		n
Treatments	y		n
Replicates	y		n
Independent units	y		n
Multiple experimental units	y		n

	Possible approaches		
	Experimental	Comparative	Case study
Hypothesis testing	y	y	y
Controls	y	y/n	n
Treatments	y	y/n	n
Replicates	y	y/n	n
Independent units	y	y	n
Multiple experimental units	y	y	n

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Conceptual question:

What structures fish communities?

Conceptual question:

What structures fish communities?

- To broad of a question to be testable in this timeframe.

Conceptual question:

What structures fish communities?

- To broad of a question to be testable in this timeframe.
- Need to focus on a component of system.

Conceptual question:

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Research Questions:

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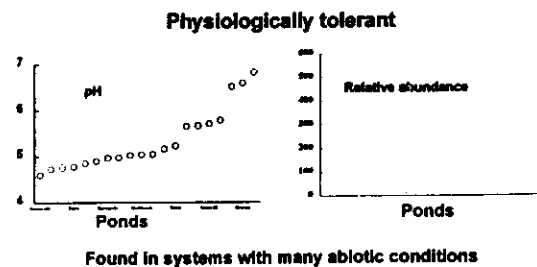
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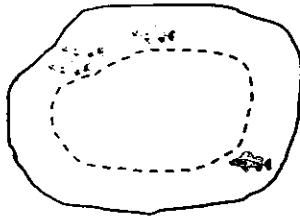
Why yellow perch is interesting ecologically?

Why yellow perch is interesting ecologically?



Why yellow perch is interesting ecologically?

Primarily littoral zone



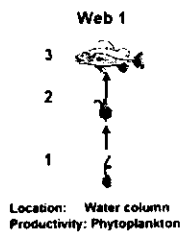
Good for focus of littoral zone community

Why yellow perch is interesting ecologically?

Generalist

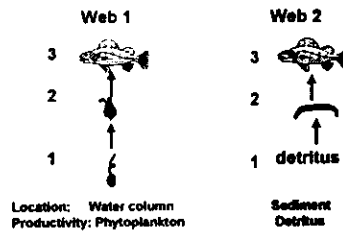
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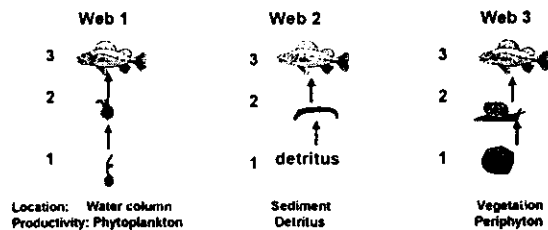
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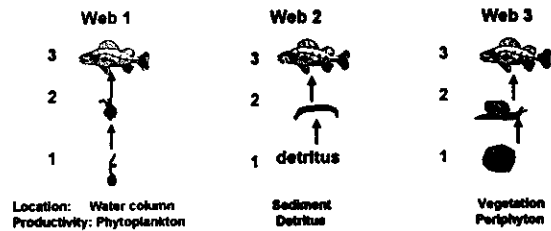
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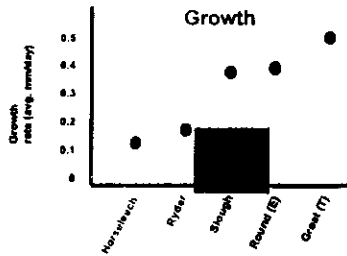
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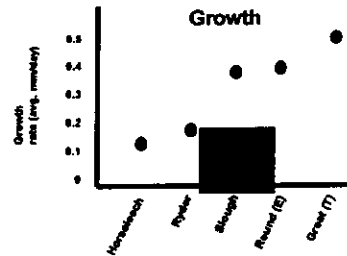


Ideal to test for effect of different food webs.

Why yellow perch is interesting ecologically?



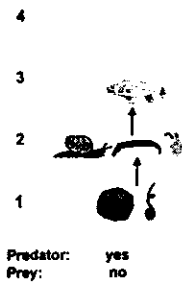
Why yellow perch is interesting ecologically?



Growth is an integrator of ecological conditions.
Variable across systems
Ideal to test role of a variety of mechanisms.

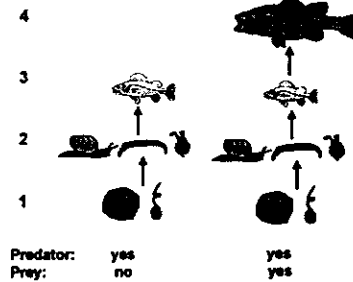
Why yellow perch is interesting ecologically?

Importance as predator



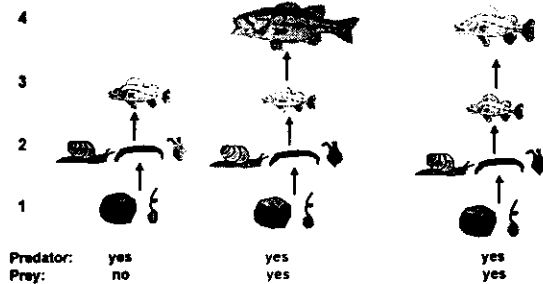
Why yellow perch is interesting ecologically?

Importance as predator



Why yellow perch is interesting ecologically?

Importance as predator



Why yellow perch is interesting ecologically?

Smaller gape



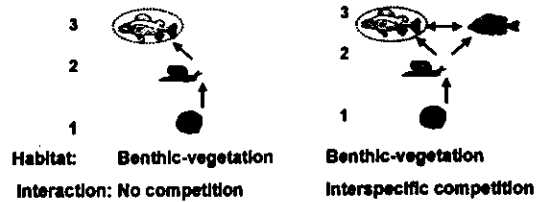
More sensitive to prey size structure
Prone to stunting/strong intraspecific competition

Why yellow perch is interesting ecologically?

Variable competition may occur for limited resources

Why yellow perch is interesting ecologically?

Variable competition may occur for limited resources

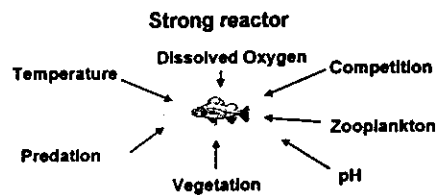


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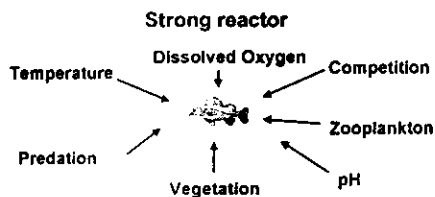
Strong reactor



Why yellow perch is interesting ecologically?



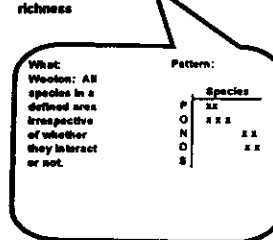
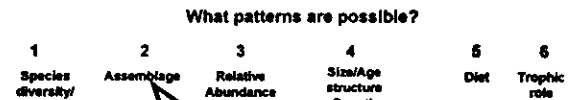
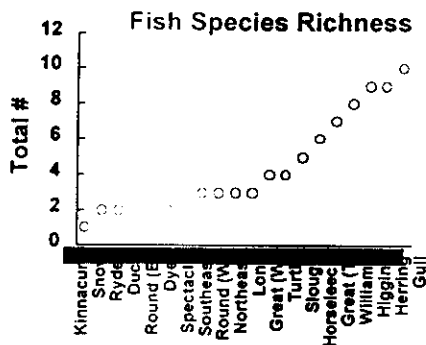
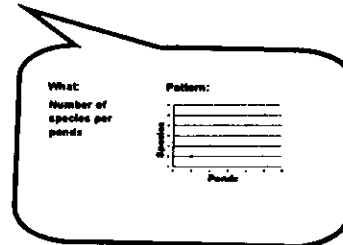
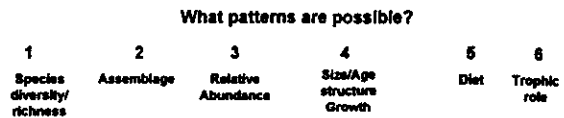
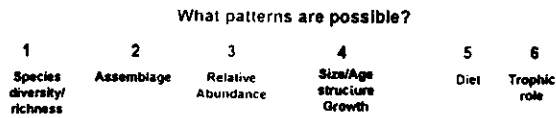
Why yellow perch is interesting ecologically?



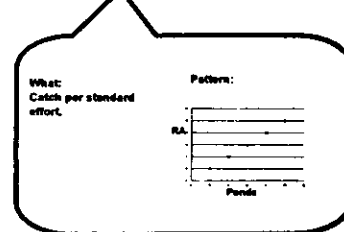
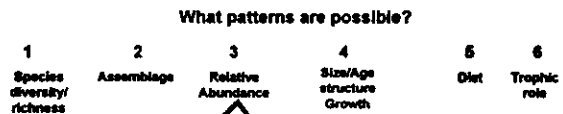
Influenced by a range of biotic and abiotic variables at different scales, thus is a good indicator of processes influencing community structure

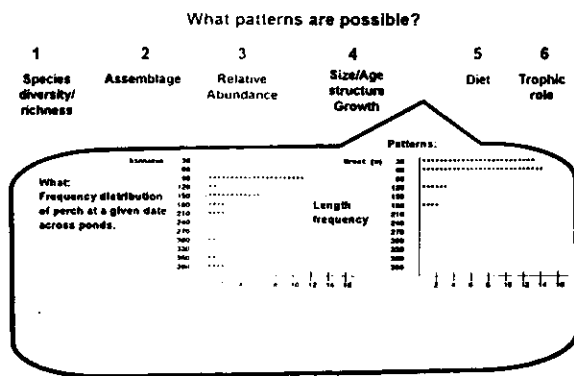
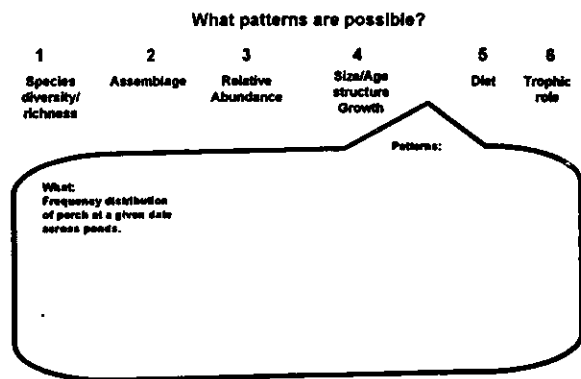
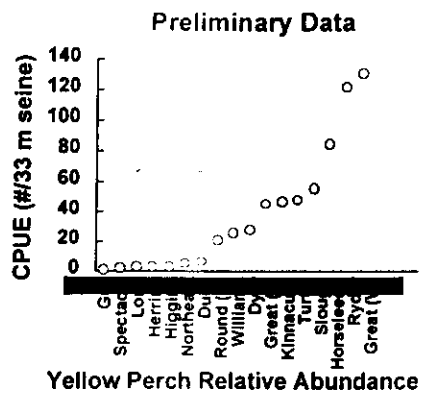
Outline

1. Background
2. Questions:
Conceptual
Research
3. The Ecologically interesting perch.
4. What patterns are possible? ←
5. What processes are possible?
(What, Why, Prediction examples)
6. Specific questions
7. Methods
8. Schedule
9. Potential analysis



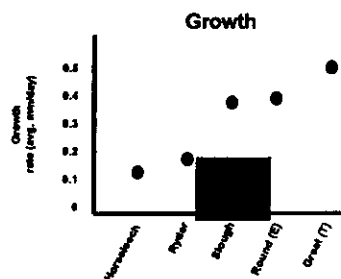
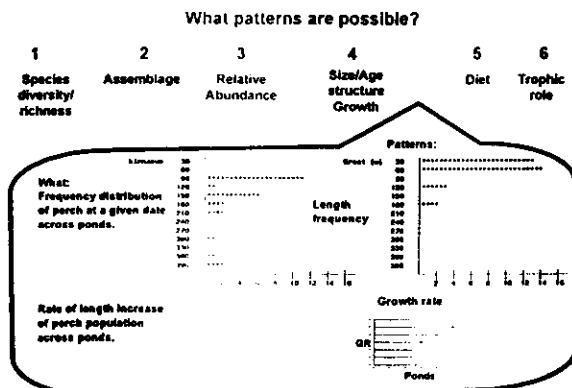
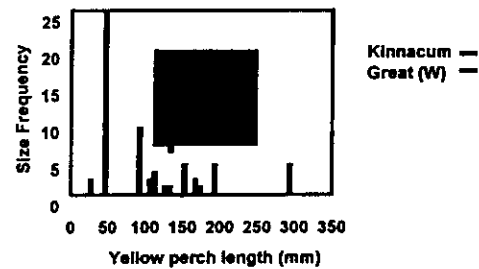
	Brown	Rainbow	Eel	Herring	Pickrel	Sm. Bass	W. Sucker	W. Perch	G. Shiner	Lg. Bass	Bullhead	Sunfish	Killifish	Y. Perch
Gull	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Higgins			x	x	x	x	x	x	x	x	x	x	x	x
Herring			x	x	x	x	x	x	x	x	x	x	x	x
Williams			x	x	x	x	x	x	x	x	x	x	x	x
Turtle					x	x	x	x	x	x	x	x	x	x
Great (W)					x	x	x	x	x	x	x	x	x	x
Great (T)					x	x	x	x	x	x	x	x	x	x
Horseleech					x	x	x	x	x	x	x	x	x	x
Round (W)					x	x	x	x	x	x	x	x	x	x
Snow					x	x	x	x	x	x	x	x	x	x
Slough					x	x	x	x	x	x	x	x	x	x
Long					x	x	x	x	x	x	x	x	x	x
Northeast					x	x	x	x	x	x	x	x	x	x
Southeast					x	x	x	x	x	x	x	x	x	x
Ryder					x	x	x	x	x	x	x	x	x	x
Round (E)					x	x	x	x	x	x	x	x	x	x
Dyer					x	x	x	x	x	x	x	x	x	x
Spectacle					x	x	x	x	x	x	x	x	x	x
Duck					x	x	x	x	x	x	x	x	x	x
Kinnacum					x	x	x	x	x	x	x	x	x	x

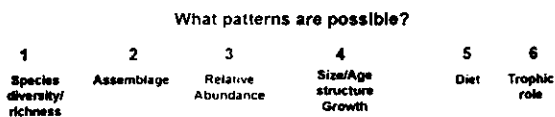
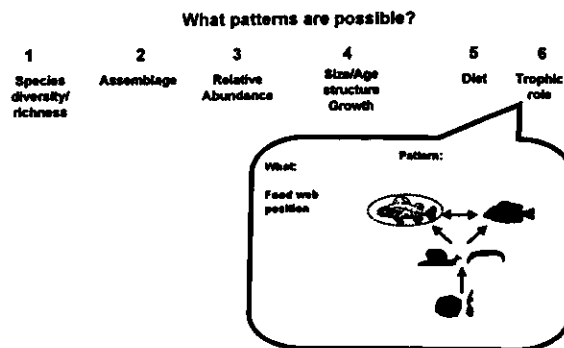
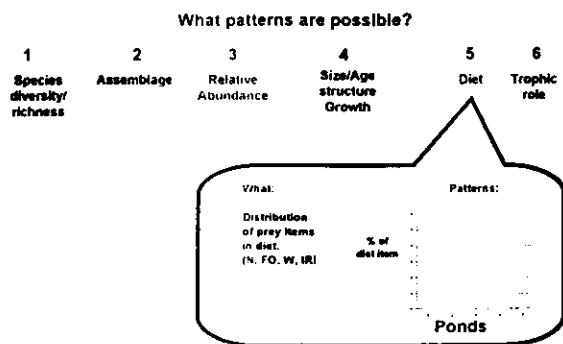




Preliminary Data

Size frequency of yellow perch for two different pond types

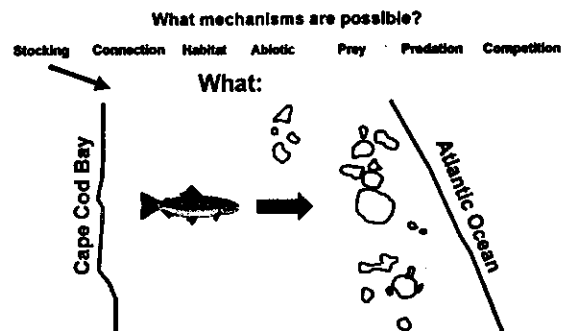
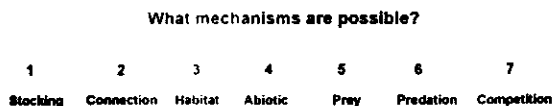


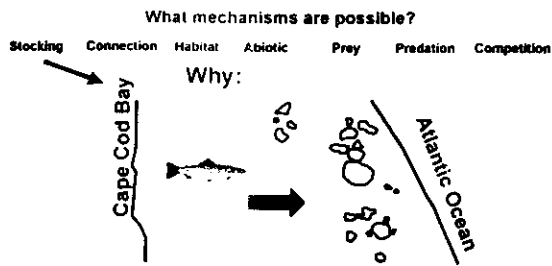


⇒ Useful to measure.

Outline

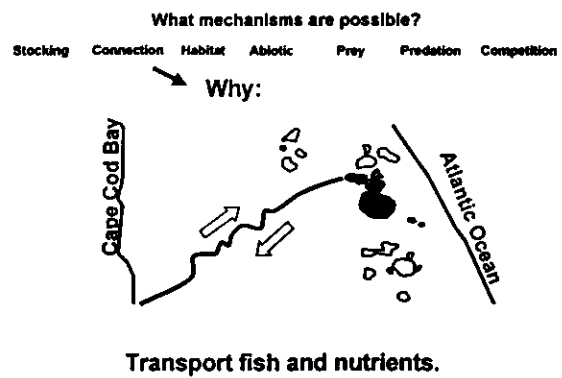
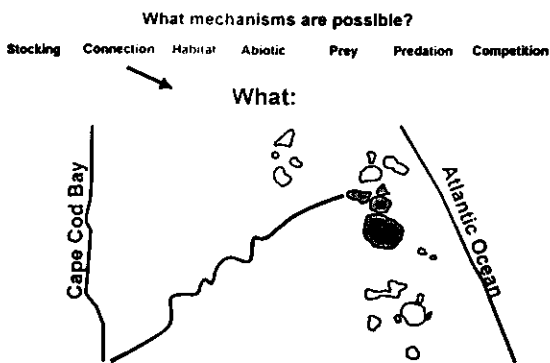
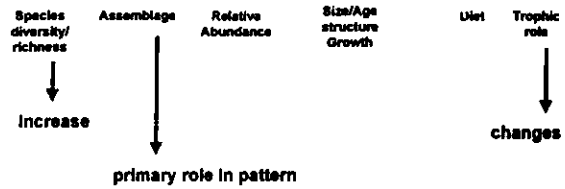
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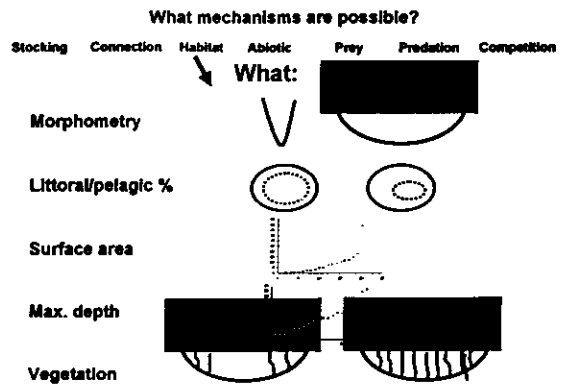
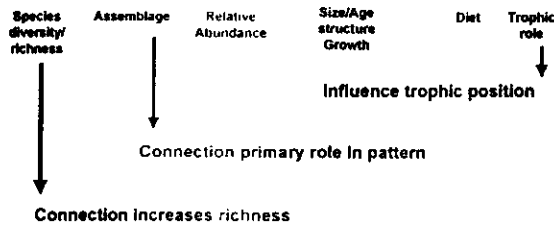


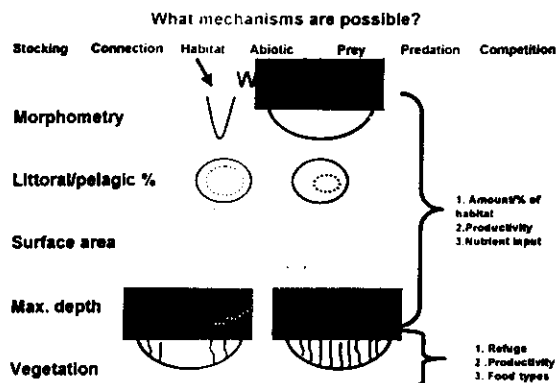
Influence species composition

Potential mechanisms and responses of yellow perch across systems

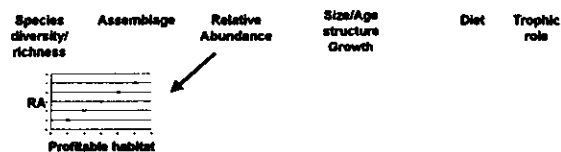


Potential mechanisms and responses of yellow perch across systems

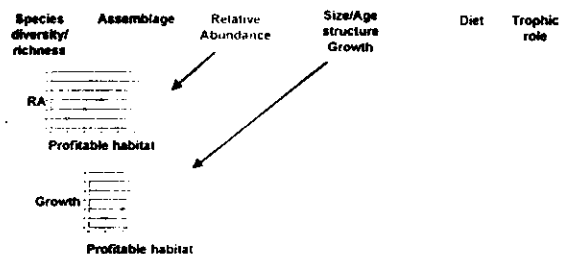




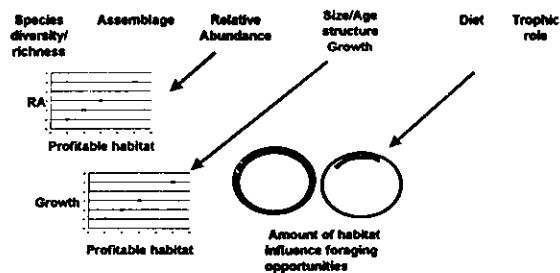
Potential mechanisms and responses of yellow perch across systems



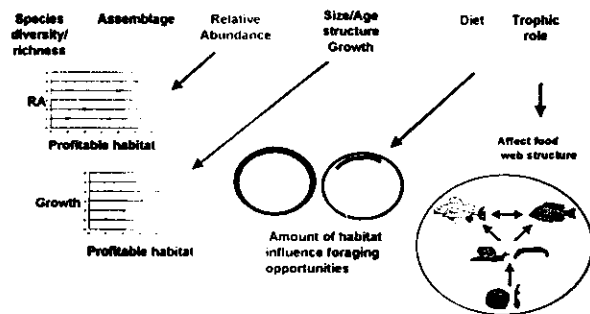
Potential mechanisms and responses of yellow perch across systems



Potential mechanisms and responses of yellow perch across systems

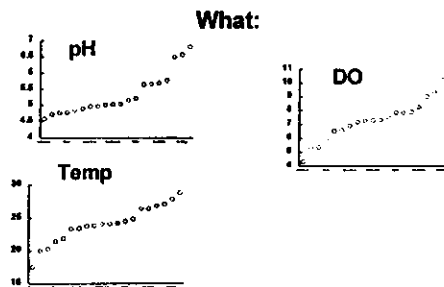


Potential mechanisms and responses of yellow perch across systems



What mechanisms are possible?

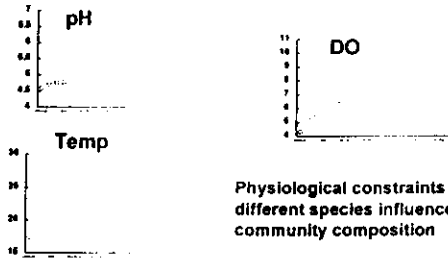
Stocking Connection Habitat Abiotic Prey Predation Competition



What mechanisms are possible?

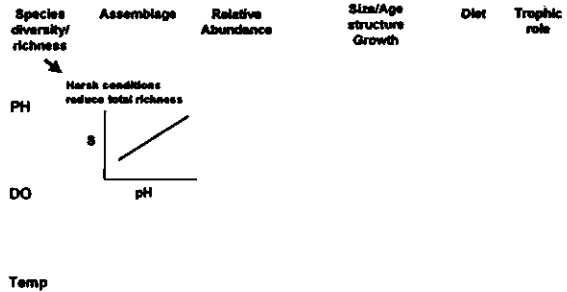
Stocking Connection Habitat Abiotic Prey Predation Competition

Why:



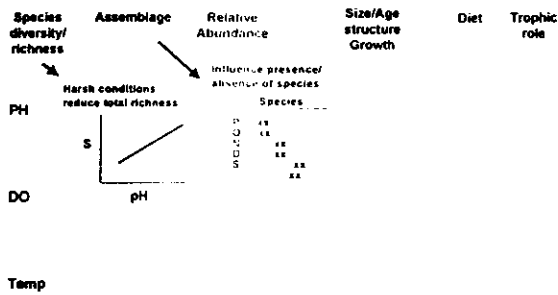
Potential mechanisms and responses of yellow perch across systems

Abiotic Variables



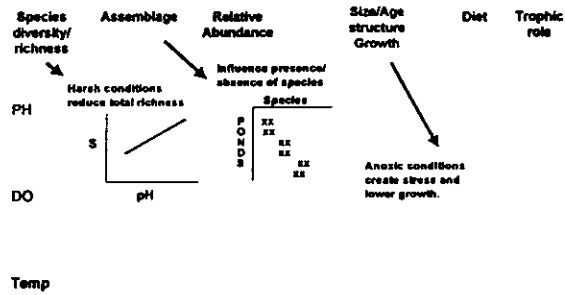
Potential mechanisms and responses of yellow perch across systems

Abiotic Variables



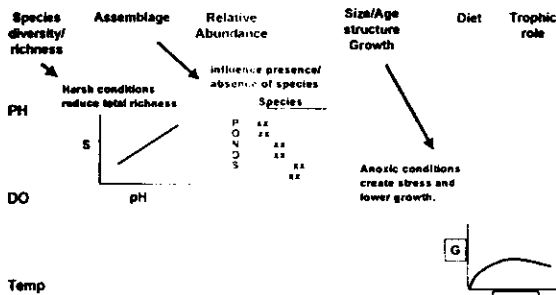
Potential mechanisms and responses of yellow perch across systems

Abiotic Variables



Potential mechanisms and responses of yellow perch across systems

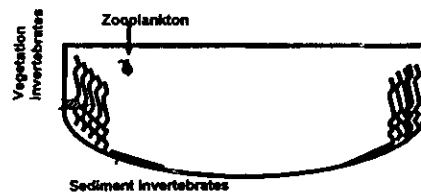
Abiotic Variables



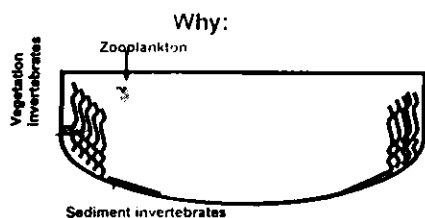
What mechanisms are possible?

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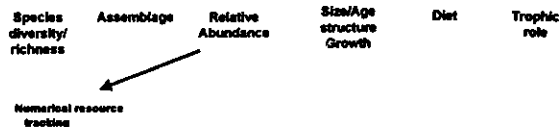


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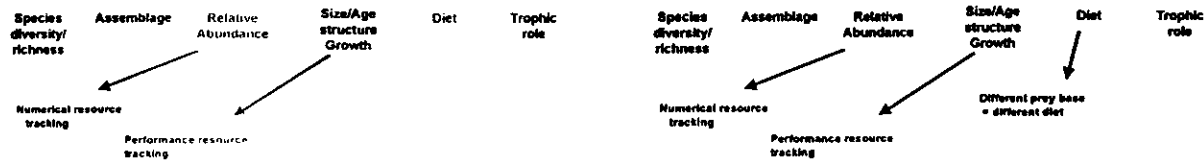


Different prey resources = different growth rates

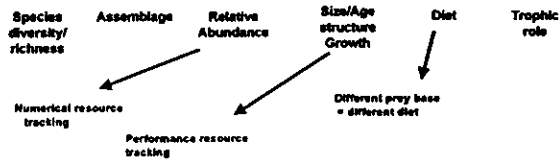
Potential mechanisms and responses of yellow perch across systems
Prey Resources



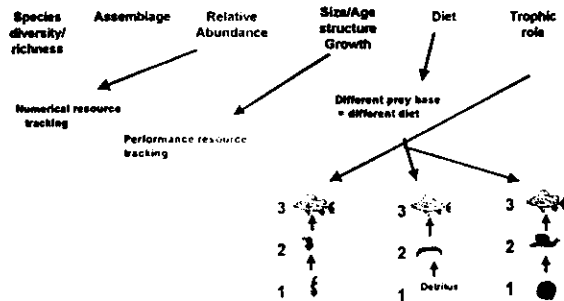
Potential mechanisms and responses of yellow perch across systems
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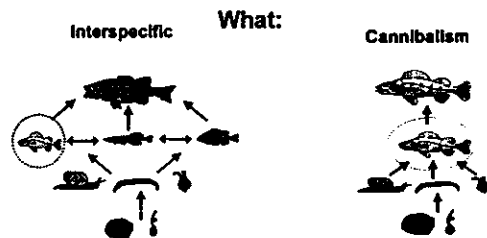
Potential mechanisms and responses of yellow perch across systems
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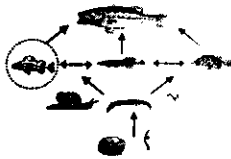
What mechanisms are possible?
Stocking Connection Habitat Abiotic Prey Predation Competition



What mechanisms are possible?

Stocking Connection Habitat Abiotic Prey Predation Competition

Interspecific Why:



Cannibalism



Size refuge different for different predator species
Different predators affect growth and survival differently

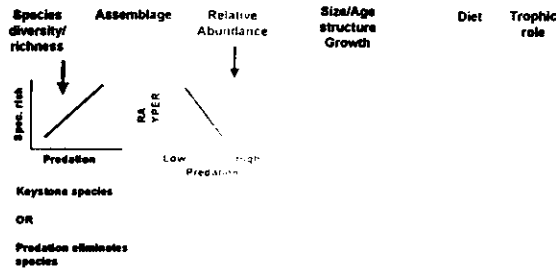
Potential mechanisms and responses of yellow perch across systems

Predation



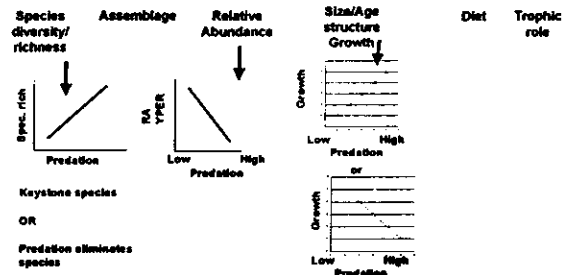
Potential mechanisms and responses of yellow perch across systems

Predation



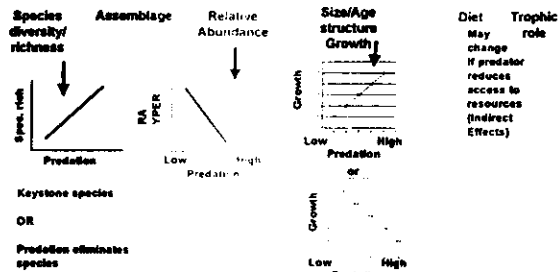
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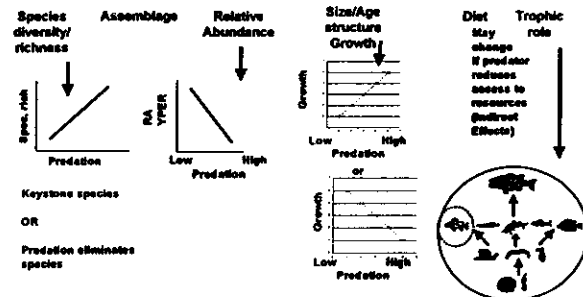
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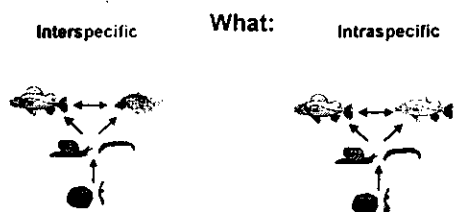


Potential mechanisms and responses of yellow perch across systems

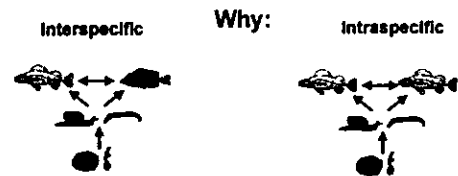
Predation



What mechanisms are possible?
 Stocking Connection Habitat Abiotic Prey Predation Competition

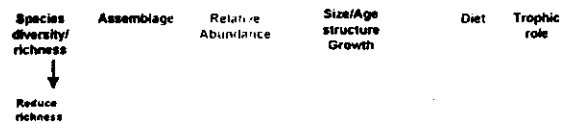


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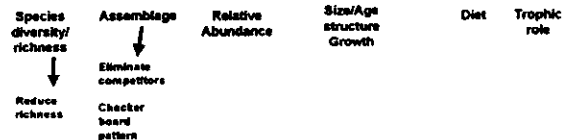


Competition affects growth rates and community structure

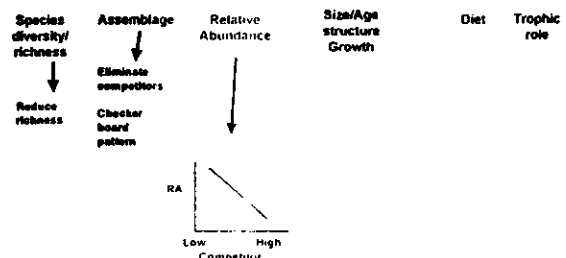
Potential mechanisms and responses of yellow perch across systems
 Interspecific competition



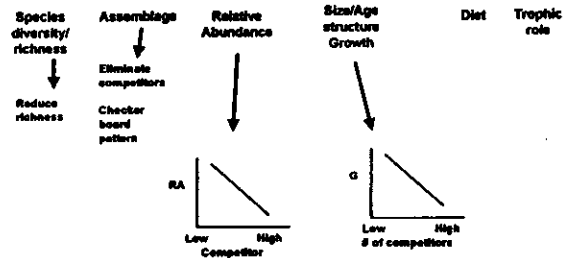
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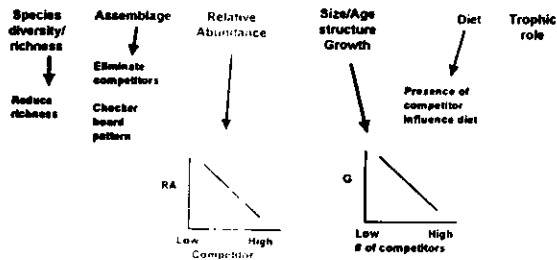
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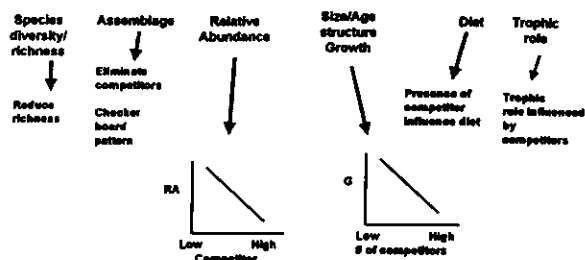
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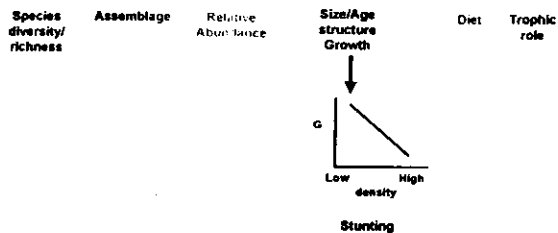
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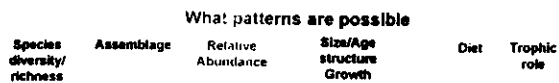


Potential mechanisms and responses of yellow perch across systems
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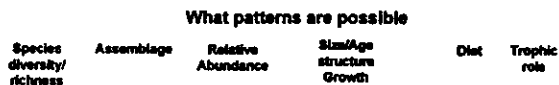


Summary

Summary

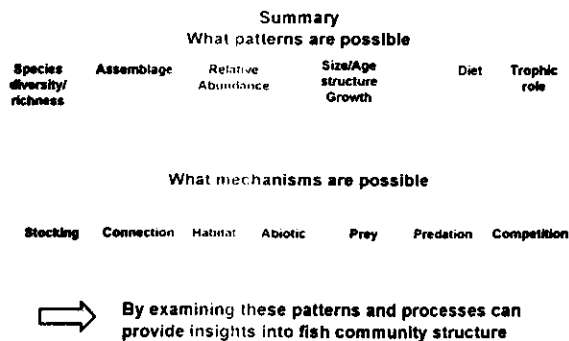


Summary



What mechanisms are possible

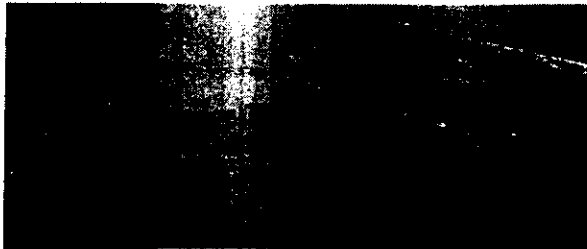
Stocking Connection Habitat Abiotic Prey Predation Competition



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Question: Evaluating patterns and processes of community structure along a gradient of variables: the changing role of yellow perch



Question: Evaluating patterns and processes of community structure along a gradient of variables: the changing role of yellow perch

Specific Questions

Question: Evaluating patterns and processes of community structure along a gradient of variables: the changing role of yellow perch

Specific Questions

- What patterns of yellow perch occur across a gradient of environmental and biotic variables?

Question: Evaluating patterns and processes of community structure along a gradient of variables: the changing role of yellow perch

Specific Questions

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- What processes influence yellow perch across a gradient of environmental and biotic variables?

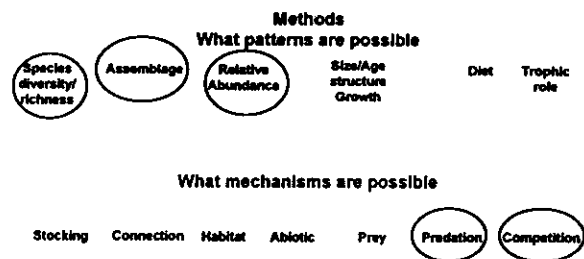
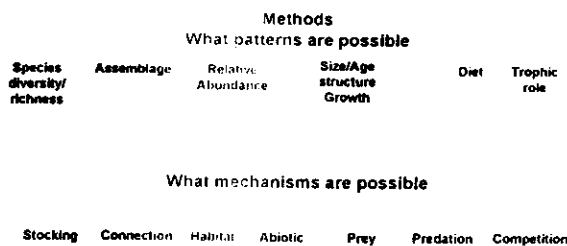
Question: Evaluating patterns and processes of community structure along a gradient of variables: the changing role of yellow perch

Specific Questions

- What patterns of yellow perch occur across a gradient of environmental and biotic variables?
- What processes influence yellow perch across a gradient of environmental and biotic variables?
- How does a gradient of environmental and biotic variables alter the response of a generalist across systems?

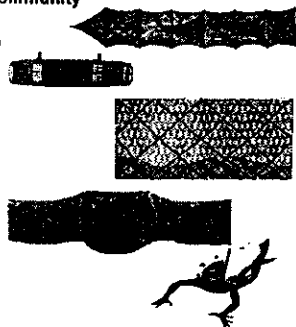
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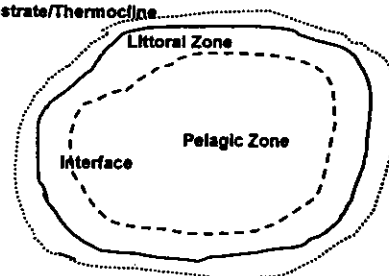
Kettle Pond Sampling Protocol

- Fish Community**
- **Objective:** Determine species composition, assemblage, relative abundance, and size frequency of the fish community across systems
 - **Protocol:**
 - Survey littoral zone to identify acceptable habitats for each gear
 - From these choose sites randomly for each gear type
 - Fyke net (3 nets 6-8 hrs.)
 - Minnow trap (12 traps 6-8 hrs.)
 - Trammel net (3 transect casts 4 hrs)
 - Beach seine (2 33m sites)
 - Snorkel transect (1 100m transect)
 - **Reference:** LTER- Northern Temperate lakes annual fish survey.



Methods

Littoral Zone: Near shore
Pelagic Zone: Open Water
Interface: Substrate/Thermocline

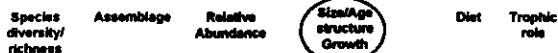


Methods



Methods

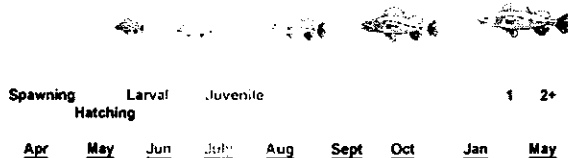
What patterns are possible



What mechanisms are possible

Stocking Connection Habitat Abiotic Prey Predation Competition

Yellow perch Life History



Kettle Pond Sampling Protocol

Yellow perch 1+ growth

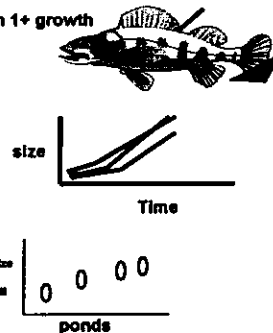
- Objective: Determine growth rates for age-1 and older yellow perch

Protocol:

- Individual tags
 - Individually mark
 - Capture individuals early in season. Mark, take length and weight.
 - Recapture.
- Scales
 - Remove scales at end of season recording length and weight.
 - Use length at age comparison focusing on age-1 perch

Reference:

- Fisheries Techniques



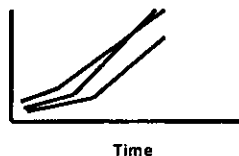
Kettle Pond Sampling Protocol

Yellow perch age-0 growth

- Objective: Determine growth rates for age-0 yellow perch

Protocol:

- Remove 20 juveniles twice. Once after fish entered littoral zone and once at end of season.
- Take length and weight.
- Preserve for Otolith analysis of daily growth rings.



Methods

What patterns are possible



What mechanisms are possible

Stocking Connection Habitat Abiotic Prey Predation Competition

Kettle Pond Sampling Protocol

Yellow perch 1+ diet

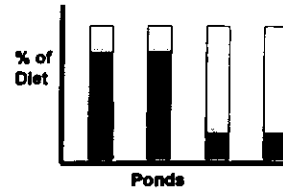
- Objective: Determine diet composition of yellow perch across a gradient of resources and trophic interactions
- Protocol:
 - Stomach pump at least 20 age-1 perch per system.
 - Use fish from beach seine first, then passive gear.
 - Wash bottle
 - Place fish in clove oil
 - Pump stomach into filter with distilled water



Kettle Pond Sampling Protocol

Yellow perch age-0 diet

- Objective: Determine diet composition for age-0 yellow perch
- Protocol:
 - Sacrifice perch sample across systems.
 - Dissect stomach under scope.
- Reference: Hrabik, Carey, Webster, in review



Methods

What patterns are possible

Species diversity/richness	Assemblage	Relative Abundance	Size/Age structure Growth	Diet	Trophic role
----------------------------	------------	--------------------	---------------------------	------	--------------

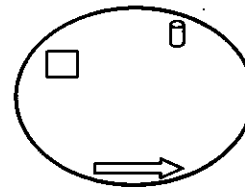
What mechanisms are possible

Stocking Connection **Habitat** Abiotic Prey Predation Competition

Kettle Pond Sampling Protocol

Vegetation

- Objective: Determine the stem density, vegetation area, distribution of vegetation, species composition, and biomass.
- Protocol:
 - Visual transect: 1/3 of circumference in 100m segments using random starting points. Record substrate every 8 m. (% of circumference that is vegetated and distribution)
 - Quadrat: 10 random sites. (Stem density)
 - Stovepipe: 3-5 random sites
- Reference: McPeck, 1998.



Methods

What patterns are possible

Species diversity/richness	Assemblage	Relative Abundance	Size/Age structure Growth	Diet	Trophic role
----------------------------	------------	--------------------	---------------------------	------	--------------

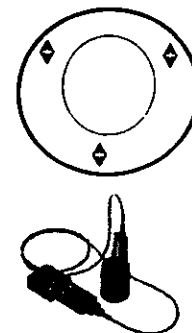
What mechanisms are possible

Stocking Connection Habitat **Abiotic** Prey Predation Competition

Kettle Pond Sampling Protocol

Abiotic

- Objective: Record pH, dissolved oxygen, temperature, and conductivity simultaneously with the fish collection.
- Protocol:
 - Randomly choose 3 littoral sites at 2m depth.
 - Record pH, dissolved oxygen, temperature, and conductivity at 0, 1, and 2m depth.
 - Sample water column at deep hole of pond simultaneously with littoral sampling on August and September sampling dates for comparison with other pelagic studies.
- Reference: Tonn and Magnuson 1982, Rahel 1984



Kettle Pond Sampling Protocol

Morphometry

- **Objective:** Determine maximum depth, surface area, amount of littoral habitat and littoral/pelagic % for each pond
- **Protocol:**
 - Use CaCo information for maximum depth and surface area.
 - Use GIS data of CaCo to determine littoral/pelagic %.

- **Reference:** Tonn and Magnuson 1982, Rahel 1984.

Methods **What patterns are possible**

Species diversity/richness Assemblage Relative Abundance Size/Age structure Growth Diet Trophic role

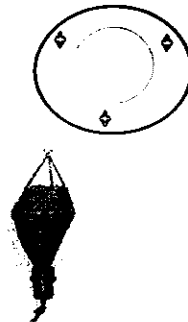
What mechanisms are possible

Stocking Connection Habitat Abiotic **Prey** Predation Competition

Kettle Pond Sampling Protocol

Zooplankton

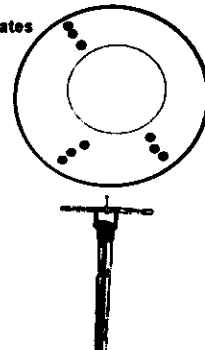
- **Objective:** Determine presence/absence, relative abundance, and biomass of invertebrates in the water column of the littoral zone
- **Protocol:**
 - Choose 3 random sites in the littoral zone ~2m
 - Take 3 vertical tows at each site with Wisconsin Net
- **Reference:**
 - Balcer, Mary D., Nancy L. Korda, and Stanley I. Dodson. 1984.
 - Pennak, R.W. 1989.
 - Thorp and Covich



Kettle Pond Sampling Protocol

Sediment invertebrates

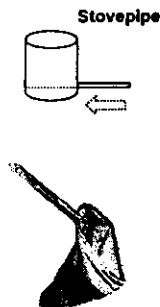
- **Objective:** Determine species composition, relative abundance, and biomass of invertebrates associated with the sediment of the littoral zone
- **Protocol:**
 - Choose 3-5 random sites in the littoral zone
 - Take a core sample at 0.5, 1, and 2m.
 - Sieve core sample through 100µm
- **Reference:** Gale, W.F. 1971.
 - Hudson, P.L. 1970.
 - Merril, R.W. and K.W. Cummins 1996.
 - Milbrink, G., and T. Wiederholm. 1973.
 - Peterson, C.G. and C.H.A. Fernando. 1971.



Kettle Pond Sampling Protocol

Vegetation invertebrates

- **Objective:** Determine species composition, relative abundance, and biomass of invertebrates associated with the emergent vegetation of the littoral zone
- **Protocol:**
 - Choose 5 random sites
 - Stovepipe sampler
 - Sweep net
 - Standardized area (1m²) for each sample
 - Process or freeze samples to sieve, count, and weight.
- **Reference:**
 - Downing, John A. and Cyr, Helene. 1985.
 - Downing, John A. and F.H. Rigler, eds. 1984.
 - Edmundson, W.T. and G.G. Winberg, eds. 1971.
 - McPeck, Mark C. 1996

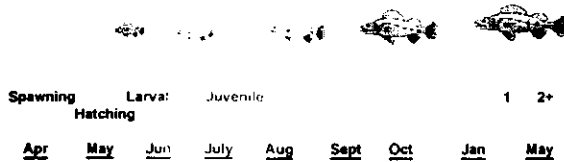


Outline

1. Background
2. Questions:
 - Conceptual
 - Research
3. The Ecologically Interesting perch.
4. What patterns are possible?
5. What processes are possible? (What, Why, Prediction examples)
6. Specific questions
7. Methods
8. Schedule
9. Potential analysis



Yellow perch Life History



	Spawning	Hatching	Larval	Juvenile								
				early summer	late summer							
Months	Apr	May	Jun	July	Aug	Sept	Oct	Jan	May			
Sampling:												
Fish community					X							
Perch age-1												
growth					X							
diet					X							
Perch age-2												
growth					X							
diet					X							
Abiotic (Ldo, pH, c)					X							
Morphometry					X							
Vegetation					X							
Zooplankton					X							
Zoosediment					X							
Zoovegetation					X							
Food Web					X							
Question 1					X							

	Spawning	Hatching	Larval	Juvenile								
				early summer	late summer							
Months	Apr	May	Jun	July	Aug	Sept	Oct	Jan	May			
Sampling:												
Fish community					X	X						
Perch age-1												
growth					X	X						
diet					X	X						
Perch age-2												
growth					X	X						
diet					X	X						
Abiotic (Ldo, pH, c)					X	X						
Morphometry					X							
Vegetation					X							
Zooplankton					X	X						
Zoosediment					X	X						
Zoovegetation					X	X						
Food Web					X							
Question 1					X							

	Spawning	Hatching	Larval	Juvenile								
				early summer	late summer							
Months	Apr	May	Jun	July	Aug	Sept	Oct	Jan	May			
Sampling:												
Fish community				X	X	X						
Perch age-1												
growth				X	X	X						
diet				X	X	X						
Perch age-2												
growth				X	X	X						
diet				X	X	X						
Abiotic (Ldo, pH, c)				X	X	X						
Morphometry					X							
Vegetation					X							
Zooplankton				X	X	X						
Zoosediment				X	X	X						
Zoovegetation				X	X	X						
Food Web					X							
Question 1					X							

Outline

1. Background
2. Questions:
 - Conceptual
 - Research
3. The Ecologically interesting perch.
4. What patterns are possible?
5. What processes are possible?
 - (What, Why, Prediction examples)
6. Specific questions
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Potential Analysis

Potential Analysis

- 1) Principal Components Analysis
To reduce number of environmental factors

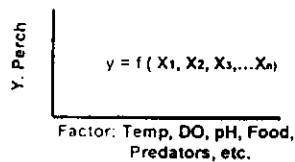
Potential Analysis

- 1) Principal Components Analysis
To reduce number of environmental factors
- 2) Multiple regression



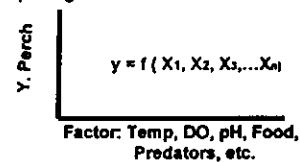
Potential Analysis

- 1) Principal Components Analysis
To reduce number of environmental factors
- 2) Multiple regression



Potential Analysis

- 1) Principal Components Analysis
To reduce number of environmental factors
- 2) Multiple regression

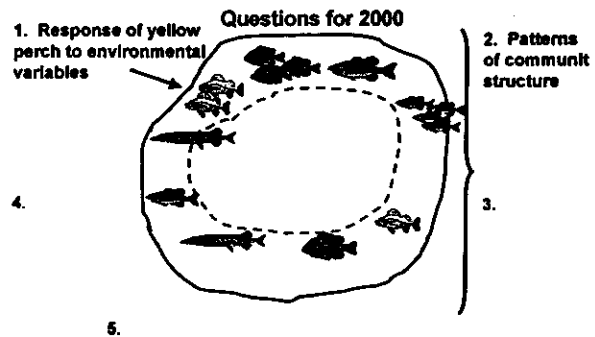


- 3) Akaike Information Criterion for model selection
Burham, K. and Anderson, D. 1999.
Model selection and inference. Springer-Verlag

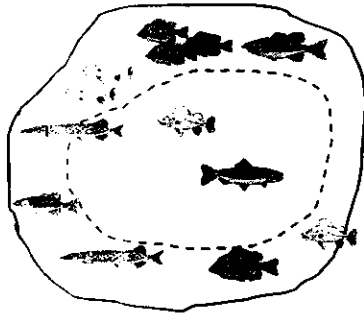
Talk outline

- Approach
- Questions for 2000
- Objectives, Progress in 1999
- Yellow Perch
- Assemblage
- Ontogenetic Niche Shift
- Multiple Predators
- Monitoring
 - Overview
 - Specifics

What Structures Fish Communities?



Question 2: What fish are there and why?



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- Do discrete, repeatable, fish assemblages exist?

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- Do discrete, repeatable, fish assemblages exist?
- Do these patterns change with the response variable measured?
 - Presence/absence
 - Relative abundance
 - Size
 - Growth

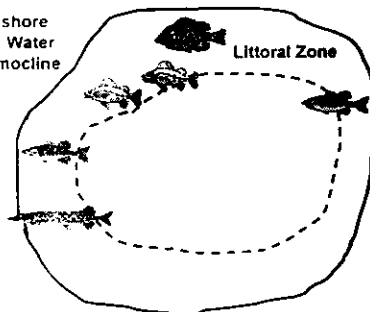
Question 2: What fish are there and why?

- Do discrete, repeatable, fish assemblages exist?
- Do these patterns change with the response variable measured?
 - Presence/absence
 - Relative abundance
 - Size
 - Growth
- What is the relationship between the environmental and biotic factors of the kettle ponds and the fish community structure?

Question 2: What fish are there and why?

Methods

Littoral Zone: Near shore
Pelagic Zone: Open Water
Interface: Thermocline



What fish are there and why?

Methods

Possible Gears:

Littoral:
 Fyke Net
 Minnow Trap
 Beach Seine
 Electrofish
 Snorkel
 Cast net
 Trammel Net
 Exp. Gill Net

What fish are there and why?

Methods

Possible Gears:

Littoral:

Fyke Net
Minnow Trap
Beach Seine
Electrofishing
Snorkel
Cast net
Trammel Net
Exp. Gill Net

Gear Design

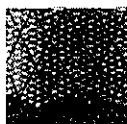


Gear: Minnow Trap

Purpose: Sample littoral zone

Sample Design: Four traps will be set near fyke net at depth of the first hoop. Three other traps will be set at 0.5, 1.5, and 2 meter depths.

Gear Design



Gear: Trammel Net

Purpose: Survey large fish at the thermocline/substrate interface.

Sample Design: Net is anchored at depth of 2 m, extended fully, and anchored in pelagic zone. Set at dusk.

Gear Design



Gear: Fyke Net

Purpose: Sample large and small fish in the littoral zone

Sample Design: Net is set at dusk and allowed to fish at night.

Gear Design



Gear: Beach Seine

Purpose: Sample smaller fish in the littoral zone

Sample Design: Seine is fished for 100 m broken into 33 m sections. Transects done at night.

Gear Design



Gear: Snorkel Survey

Purpose: Survey small and large fish in the littoral zone and thermocline/substrate interface.

Sample Design: Two 100 m transects at depths of 1 meter and 3 meters.

What fish are there and why?
Fish Collection Methods

<u>Gear</u>	<u>Number</u>	<u>Duration</u>	<u>Site</u>
Fyke Net	3-5	6-8 h	Random
Minnow Trap	12	6-8 h	Random
Trammel Net	3	~ 4-6 hrs	Random
Beach Seine	2		Random o 'seizable'
Snorkel	1 x 100 m		Random

What fish are there and why?
Methods

<u>Pond Variables:</u>	<u>Location</u>	<u>When</u>
Water Quality pH, DO, Temp,	Littoral	Simultaneously with fish
Conductivity	"	CaCo
Morphometry	"	Ongoing
Vegetation, substrate	"	Ongoing

What fish are there and why?
Methods

<u>Food Web:</u>	<u>Site</u>	<u>When</u>
Zooplankton	3 x littoral	Simultaneously with fish
Benthic	3-5 vegetation 3-5 sediment	Simultaneously with fish

Horiba meter, Arcview, vertical tow, grab sampler

Question 2. What fish are there and why?
Question 2: Yellow perch distribution and abundance
Question 3: Largemouth bass ontogenetic niche shift

<u>Months</u>	<u>Apr</u>	<u>Spring</u> <u>May</u>	<u>Jun</u>	<u>Summer</u> <u>July</u>	<u>Aug</u>	<u>Fall</u> <u>Sept</u>	<u>Oct</u>	<u>Winter</u> <u>Nov</u>	<u>Dec</u>
Sampling:									
Fish									
Community				X		X			
Prey				X		X			
Predators				X		X			
Yellow perch									
LM Bass									
Zooplankton				X		X			
Invertebrates				X		X			
Abiotic				X		X			
Morphometry				X					

What fish are there and why?
Analysis

Classify fish and lakes using covariance/correlations among multiple variables

What fish are there and why?
Analysis

Classify fish and lakes using covariance/correlations among multiple variables

Multivariate techniques

Principal Component Analysis

To ordinate lakes on basis of environmental factors

Detrended Correspondence Analysis

Identify lakes having similar fish assemblages

MANOVA

To examine interrelationships between assemblage type and environmental factors

Multiple Regression

To examine relationship between species richness and lake environments

(Rahel, F. 1984; Tonn and Magnuson, 1982)

Precedents

Rahel, F. 1984. Factors structuring fish assemblages along a bog lake successional gradient.
Ecology 65: 1276-1289.

43 lakes

Northern Wisconsin

20 fish species

12 environmental factors

Question: What factors structure fish assemblages along a bog lake successional gradient?

Rahel 1984 - Fish assemblages

Fish species	1	2	3	4	5	6	7	8		20
Lake										
1		X	X	X						
2		X	X	X						
3		X	X	X						
4					X	X				
5					X	X				
6							X	X	X	
7							X	X	X	
...										
43										

Rahel 1984 - Fish assemblages

Fish species	1	2	3	4	5	6	7	8		20
Lake										
1	X	X	X							
2	X	X	X							
3	X	X	X							
4				X	X					
5				X	X					
6						X	X	X		
7						X	X	X		
...										
43										

Assemblage 1 - Centrarchids

Assemblage 2 - Umbra-Perca

Assemblage 3 - Cyprinids

Via multivariate techniques

Rahel 1984 - Lake groupings

Principal Component
I II II

Percent variance

Variable 1-% hard substrate
Variable 2-% vegetated
Variable 3-% distance to road
Variable 4-% Surface area

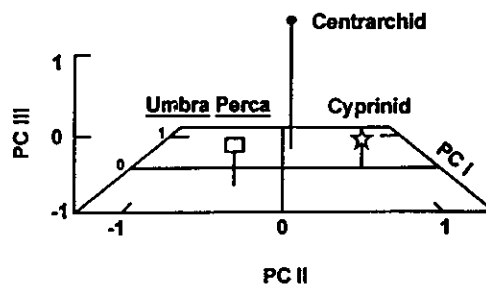
Variable 5-% alkalinity
Variable 6-% pH

Maximum depth

Rahel 1984 - Lake groupings

	Principal Component	
Percent variance	I	II
	32	24
Variable 1-% hard substrate	0.88	
Variable 2-% vegetated	0.84	
Variable 3-% distance to road	-0.83	
Variable 4-% Surface area	0.77	
Variable 5-% alkalinity		0.92
Variable 6-% pH		0.90
Maximum depth		0.77

Rahel 1984 - Fish-environmental relationships



Rahel 1984 - Punchline

- (1) Centrarchids
Inhabit wide range of pH's providing
winter anoxia does not occur
- (2) Cyprinids
Low winter oxygen if pH is high
- (3) Umbra-Perca
Low winter oxygen and low pH

Status of kettle ponds analysis

Status of kettle ponds analysis

- In progress
- Scheduled AFS presentation, 8/00

Cape Cod National Seashore Kettle Ponds



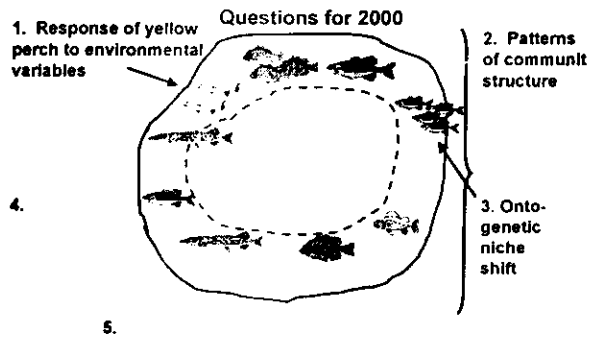
	Brown	Rainbow	Eel	Herring	Pickering	Sm. Bass	W. Sucker	W. Perch	G. Shiner	Lg. Bass	Bullhead	Sunfish	Killifish	Y. Perch
Gull	x	x	x	x				x		x	x	x	x	x
Higgins			x	x		x		x		x	x	x	x	x
Herring			x	x				x		x	x	x	x	x
Williams			x	x				x		x	x	x	x	x
Turtle											x	x		x
Great (W)											x	x		x
Great (T)									x		x	x	x	x
Horseleech								x		x		x	x	x
Round (W)									x			x		x
Snow									x					
Slough										x	x	x	x	x
Long											x	x	x	x
No-theast											x	x	x	x
Southeast											x	x	x	x
Ryder												x		x
Round (E)													x	x
Dyer													x	x
Spectacle													x	x
Duck													x	x
Kinnacum														x

Talk outline

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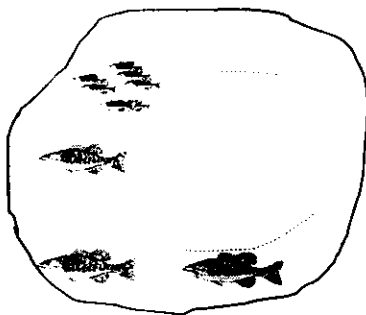
What Structures Fish Communities?



Black Bass (*Micropterus* sp)



Bass habitats



Largemouth Bass (*Micropterus salmoides*)



Habitat:	<u>Littoral</u>	<u>Pelagic</u>	<u>Interface</u>	
	X		X	
Food:	<u>Fish</u>	<u>Crustaceans</u>	<u>Insects</u>	<u>Snails</u>
	X	X	X	

Largemouth Bass (*Micropterus salmoides*)



Habitat:	<u>Littoral</u>	<u>Pelagic</u>	<u>Interface</u>	
	X		X	
Food:	<u>Fish</u>	<u>Crustaceans</u>	<u>Insects</u>	<u>Snails</u>
	X	X	X	

Months March April May June July Aug. Sept. ----- March

Life
History:

Diet:

Largemouth Bass (*Micropterus salmoides*)



Habitat:	<u>Littoral</u>	<u>Pelagic</u>	<u>Interface</u>	
	X		X	
Food:	<u>Fish</u>	<u>Crustaceans</u>	<u>Insects</u>	<u>Snails</u>
	X	X	X	

Months March April May June July Aug. Sept. ----- March

Life History: Eggs Hatch Juv ----- YOY ----- 1 yr.
laid

Diet:

Largemouth Bass (*Micropterus salmoides*)



Habitat:	<u>Littoral</u>	<u>Pelagic</u>	<u>Interface</u>						
	X		X						
Food:	<u>Fish</u>	<u>Crustaceans</u>	<u>Insects</u>	<u>Snails</u>					
	X	X	X						
Months	March	April	May	June	July	Aug.	Sept.	----	March
Life History:		Eggs laid	Hatch	Juv	-----	YOY	-----	1 yr.	
Diet			Zoop	- Inverts	- Fish				

Largemouth Bass (*Micropterus salmoides*)



Habitat:	<u>Littoral</u>	<u>Pelagic</u>	<u>Interface</u>						
	X		X						
Food:	<u>Fish</u>	<u>Crustaceans</u>	<u>Insects</u>	<u>Snails</u>					
	X	X	X						
Months	March	April	May	June	July	Aug.	Sept.	----	March
Life History:		Eggs laid	Hatch	Juv	-----	YOY	-----	1 yr.	
						<u>Ontogenetic niche shift</u>			
Diet						Zoop	- Inverts	- Fish	

Question 3: Is there variation in the timing of the ontogenetic niche shift of YOY largemouth bass across systems?

- Ontogenetic niche shift definition
-Change in habitat/diet associated with size

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-Change in habitat/diet associated with size
- Why does it matter?
-If the shift is to piscivory, fish grow faster; bigger is better
-Bass that shift earlier have better winter survival

Question 3: Is there variation in the timing of the ontogenetic niche shift of YOY largemouth bass across systems?

- Ontogenetic niche shift definition
-Change in habitat/diet associated with size
- Why does it matter?
-If the shift is to piscivory, fish grow faster; bigger is better.
-Bass that shift earlier have better winter survival.
- Why do we care?
-The timing of the ontogenetic niche shift affects survival i.e. recruitment and overwinter.
-As a top predator and competitor, bass survival affects the entire community.

	Brown	Rainbow	Eel	Herring	Pickarel	Sm. Bass	W. Sucker	W. Perch	G. shiner	Lg. Bass	Bullhead	Sunfish	Killifish	Y. Perch
Gull	x	x												
Higgins														
Herring														
Williams														
Turtle														
Great (W)														
Great (T)														
Horseleech														
Round (W)														
Snow														
Slough														
Long														
Northeast														
Southeast														
Ryder														
Round (E)														
Dyer														
Spectacle														
Duck														
Kinnacum														

Question 3: Is there variation in the timing of the ontogenetic niche shift of YOY largemouth bass across systems ?

- Does the timing of the ontogenetic niche shift of largemouth bass vary across systems?
- What causes the timing of this shift to vary?
- What are the consequences of these differences in the timing of the ontogenetic niche shift for size, growth, survival, and recruitment of largemouth bass?

Why might bass shift to piscivory earlier in some ponds?

Across pond differences in

- Time of spawning
- Density of competitors
- Food
 - Zooplankton
 - Benthic invertebrates
- Vegetation (amount, type)

Largemouth Bass Ontogenetic Niche Shift

Months March April May June July Aug. Sept. ---- March

Life History: Eggs Hatch Juv.-----YOY----- 1 yr.
laid

Diet:

Critical Events:

Largemouth Bass Ontogenetic Niche Shift

Months March April May June July Aug. Sept. ---- March

Life History: Eggs Hatch Juv.-----YOY----- 1 yr.
laid

Diet: -----Invertebrates-----Fish----

Critical Events:

Largemouth Bass Ontogenetic Niche Shift

Months March April May June July Aug. Sept. ---- March

Life History: Eggs Hatch Juv.-----YOY----- 1 yr.
laid

Diet: -----Invertebrates-----Fish----

Critical Events: -----Food-----
Invertebrates Fish
Type and Availability
-----Density-----
-----Predation-----
-----Abiotic-----

Largemouth Bass Ontogenetic Niche Shift

Months March April May June July Aug. Sept. ---- March

Life History: Eggs Hatch Juv.-----YOY----- 1 yr.
laid

Diet: -----Invertebrates-----Fish----

Critical Events: -----Food-----
Invertebrates Fish
Type and Availability
-----Density-----
-----Predation-----
-----Abiotic-----



Question 3: Is there variation in the timing of the ontogenetic niche shift of YOY largemouth bass across systems ?

Months	Apr	Spring May Jun	Summer July Aug	Fall Sept Oct	Winter Nov Dec
Sampling:					
Fish					
Community			X	X	
Prey			X	X	
Predators			X	X	
Yellow perch			X	X	
LM Bass			X X X X	X X	
Zooplankton			X	X	
Invertebrates			X	X	
Abiotic			X	X	
Morphometry			X	X	

Question 3: Is there variation in the timing of the ontogenetic niche shift of YOY largemouth bass across systems ?

Possible Gears:

Littoral:

Fyke Net
Minnow Trap
Beach Seine
Electrofishing
Snorkel
Cast net
Trammel Net
Exp. Gill Net

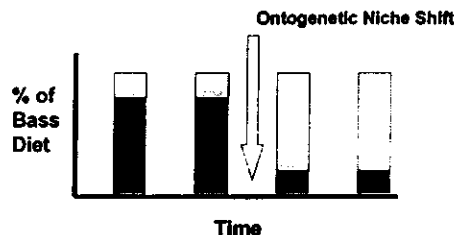
Question 3: Is there variation in the timing of the ontogenetic niche shift of YOY largemouth bass across systems ?

Methods

Gear: Beach seine: 3 x 33m random sites
Schedule: 2 ponds x night
Start July 1 every 10-14 days
Fish Data: Record length, weight.
Sacrifice 5 fish per pond for die (syringe gastric lavage)
Prey: Zooplankton in littoral zone (N=3)
macroinvertebrates (N=5)
Fish prey (seine)
Environmental factors: Temperature
Morphometry
Vegetation

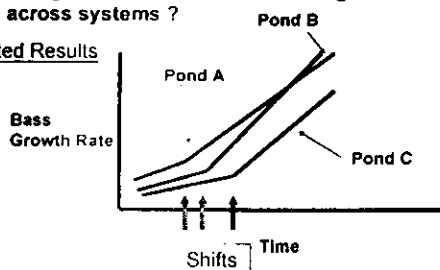
Question 3: Is there variation in the timing of the ontogenetic niche shift of YOY largemouth bass across systems ?

Anticipated Results



Question 3: Is there variation in the timing of the ontogenetic niche shift of YOY largemouth bass across systems ?

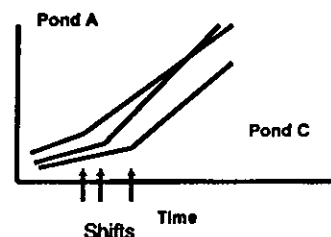
Anticipated Results



Question 3: Is there variation in the timing of the ontogenetic niche shift of YOY largemouth bass across systems ?

Analysis

Bass Growth Rate



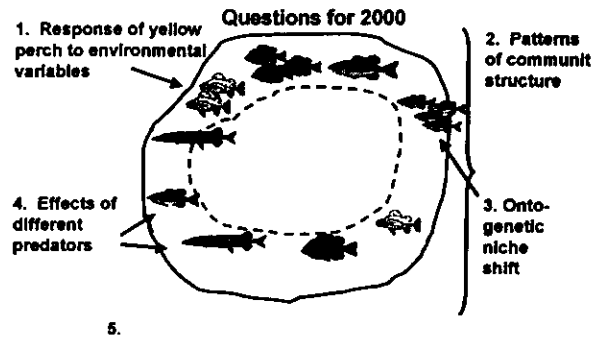
Multiple Regression Analysis
To examine relationship between timing of Ontogenetic shift and environmental factors

Talk outline

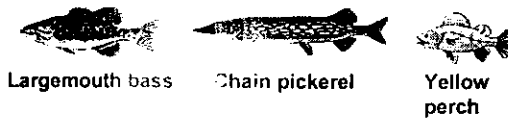
- Approach
- Questions for 2000
- Objectives, Progress in 1999
- Yellow Perch
- Assemblage
- Ontogenetic Niche Shift
- Multiple Predators
 - Monitoring
 - Overview
 - Specifics



What Structures Fish Communities?

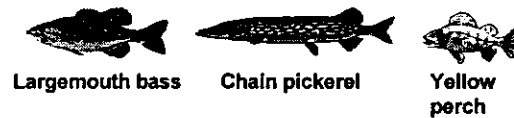


Different predators



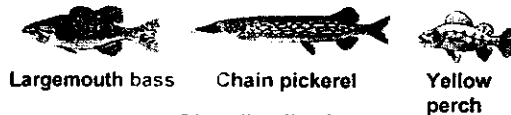
Different predators

have different



Different predators

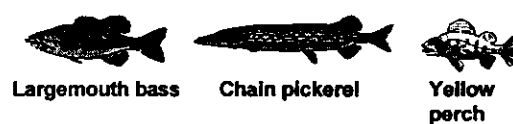
have different



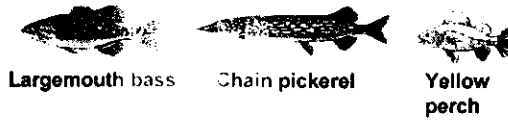
- Size distributions
- Gape sizes
- Habitat preferences
- Abundances

Different predators

may differentially affect prey



Different predators
may differentially affect prey



- Size
- Abundance
- Habitat use

Specific Question 4:

What is the effect of different fish predators on prey size, relative abundance, and habitat use?



	Brown	Chain pickerel	Yellow perch	W. Sucker	W. Perch	G. Shiner	Lg. Bass	Bullhead	Sunfish	Killifish	Y. Perch
Gull	x										
Higgins											
Herring											
Williams											
Turtle											
Great (W)											
Great (T)											
Horseleech											
Round (W)											
Snow											
Slough											
Long											
Northeast											
Southeast											
Ryder											
Round (E)											
Dyer											
Spectacle											
Duck											
Kinnacum											

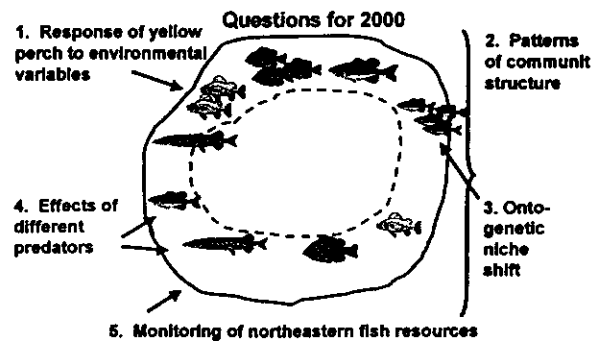
Question 4: What is the effect of different fish predators on prey size, relative abundance, and habitat use?

Months	Apr	Spring May	Jun	Summer July	Aug	Fall Sept	Oct	Winter Nov	Dec
Sampling:									
Fish									
Community				X		X			
Prey				X		X			
Predators				X		X			
Yellow perch				X		X			
LM Bass				X		X			
Zooplankton				X		X			
Invertebrates				X		X			
Abiotic				X		X			
Morphometry				X		X			

Talk outline

- Approach
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What Structures Fish Communities?



Talk outline

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Monitoring of northeastern fish communities

What is monitoring?

Long term sampling of a resource that provides baseline information by looking at indicators that will detect patterns and trends.

Monitoring of northeastern fish communities

Some Other Names for Monitoring

- Survey
- Inventory
- Evaluation
- Assessment

Monitoring of northeastern fish communities

What can monitoring be used for?

Usually framed in the context of the conservation or restoration of a resource and the human impacts that are effecting this resource.

Monitoring of northeastern fish communities

Applied Problems

- Invading Species
- Dam removal
- Water removal
- Fish Passage
- Stocking
- Aquaculture

Monitoring of northeastern fish communities

Examples of some current monitoring

1. Annual Pond Monitoring Program
2. National Atmospheric Deposition Program

Monitoring of northeastern fish communities

How can monitoring be used to promote better use of resources?

By detecting trends and patterns in resources, the baseline data obtained through monitoring could provide information that may influence and even improve management decisions as well as further scientific research.

Monitoring of northeastern fish communities

Problems associated with monitoring

A. Technical Problems

1. Time limitations.
2. Money limitations.
3. Tradeoffs (different goals).

B. Predictive limitations

1. Incomplete information.
2. Biased information.

C. Other Issues

1. Can't monitor everything, everywhere.
2. Aquatic resources are rarely integrated into an ecosystem view.
3. Long-term may mean waiting for info.

Monitoring of northeastern fish communities

Potential Solutions

1. Better predictive capabilities (i.e. models, before/after monitoring).
2. View resources in an ecosystem context.
3. Use representative systems with the potential for generalization to similar systems.

Monitoring of northeastern fish communities

In Conclusion

1. Monitoring is not a cure but a piece of the puzzle.
2. The "uncertainty" issue.

Talk outline

- *Approach
- *Questions for 2000
- *Objectives, Progress in 1999
- *Yellow Perch
- *Assemblage
- *Ontogenetic Niche Shift
- *Multiple Predators
- *Monitoring
 - *Overview
 - *Specifics



Monitoring of northeastern fish communities Steps

Monitoring of northeastern fish communities

Steps

- Set goals

Monitoring of northeastern fish communities

Steps

- Set goals
- Identify responses of interest

Monitoring of northeastern fish communities

Steps

- Set goals
- Identify responses of interest
- Identify habitats of interest

Monitoring of northeastern fish communities

Steps

- Set goals
- Identify responses of interest
- Identify habitats of interest
- Identify target community

Monitoring of northeastern fish communities

Steps

- Set goals
- Identify responses of interest
- Identify habitats of interest
- Identify target community
- Identify relevant natural and anthropogenic effects

Monitoring of northeastern fish communities

Steps

- Set goals
- Identify responses of interest
- Identify habitats of interest
- Identify target community
- Identify relevant natural and anthropogenic effects
- Identify sampling gear for each habitat

Monitoring of northeastern fish communities

Steps

- Set goals
- Identify responses of interest
- Identify habitats of interest
- Identify target community
- Identify relevant natural and anthropogenic effects
- Identify sampling gear for each habitat
- Map habitats within each site

Monitoring of northeastern fish communities

Steps

- Set goals
- Identify responses of interest
- Identify habitats of interest
- Identify target community
- Identify relevant natural and anthropogenic effects
- Identify sampling gear for each habitat
- Map habitats within each site
- Randomly sample fish within @ habitat

Monitoring of northeastern fish communities

Steps

- Set goals
- Identify responses of interest
- Identify habitats of interest
- Identify target community
- Identify relevant natural and anthropogenic effects
- Identify sampling gear for each habitat
- Map habitats within each site
- Randomly sample fish within @ habitat
- Write protocols for continued assessment

Monitoring of northeastern fish communities

Steps

Set goals

- Identify "what fish are there"
- Identify response, sampling scheme, and schedule to detect changes in "what fish are there"

Monitoring of northeastern fish communities

Steps

Identify responses of interest

- | | |
|----------------------|------------------|
| • Presence/Absence | • Biomass |
| • Species Diversity | • Food Webs |
| • Species Richness | • Growth Regimes |
| • Relative Abundance | • Size Structure |

Monitoring of northeastern fish communities

Steps

Identify responses of interest

- | | |
|-----------------------------|-------------------------|
| • <u>Presence/Absence</u> | • Biomass |
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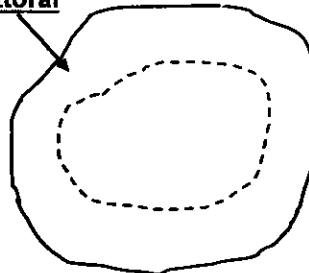
Monitoring of northeastern fish communities

Steps

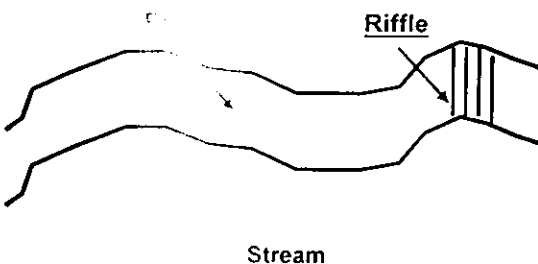
Identify habitats of interest

Identify habitats of interest

Littoral



Identify habitats of interest



Monitoring of northeastern fish communities

Steps

Identify habitats of interest

Lotic

Small stream

Large stream

Lentic

Small pond

Impoundment

Monitoring of northeastern fish communities

Steps

Identify habitats of interest

Lotic

Small stream (riffle/pool)

Large stream (riffle/pool)

Lentic

Small pond (littoral)

Impoundment (littoral)

Monitoring of northeastern fish communities

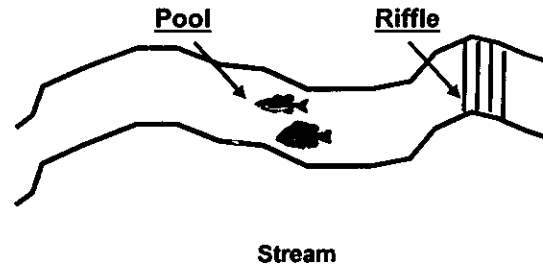
Steps

Identify target community

Target community= all fish



Target community= all fish



Monitoring of northeastern fish communities

Steps

Identify relevant physical responses

Monitoring of northeastern fish communities

Steps

Identify relevant physical responses

- System Morphometry
 - Area
 - Circumference
 - Depth
 - Littoral/Pelagic Ratio
- Connectivity
- Other Landscape Patterns
- Disturbance
- Water Source
 - Ground Water
 - Surface runoff
 - Precipitation
- Substrate
- Aquatic Vegetation
- Coarse Woody Debris
- Temperature

Monitoring of northeastern fish communities

Steps

Identify relevant chemical responses

Monitoring of northeastern fish communities

Steps

Identify relevant chemical responses

- pH
- Alkalinity
- Conductivity
- Dissolved oxygen
- Nutrient loading, N:P
- Toxins
- Salinity
- Turbidity

Monitoring of northeastern fish communities
Steps
Identify relevant anthropogenic responses

Monitoring of northeastern fish communities
Steps
Identify relevant anthropogenic responses

- Historical management strategies
- Visitation
- Cabin density
- Land use
- Riparian condition
- Stocking (Present/Recent)
- Fishing pressure
- Introductions
- Water diversions
- Beaver/deer

Monitoring of northeastern fish communities
Steps
Identify habitat specific gears

Monitoring of northeastern fish communities
Steps
Identify habitat specific gears

Possible Gears:

<u>Pond</u>	<u>Stream</u>
Fyke Net	
Minnow Trap	Minnow Trap
Beach Seine	Beach Seine
Snorkel	Electrofishing
Trammel Net	

Monitoring of northeastern fish communities
Steps
Identify habitat specific gears

Possible Gears:

<u>Pond</u>	<u>Stream</u>
Fyke Net	
Minnow Trap	Minnow Trap
Beach Seine	Beach Seine
Snorkel	Electrofishing
Trammel Net	

Gear Design

Gear:	Fyke Net	
Purpose:	Sample large and small fish in the littoral zone	
Sample Design:	Net is set at dusk and allowed to fish at night.	

Gear Design



Gear: Minnow Trap

Purpose: Sample littoral zone

Sample Design: Four traps will be set near fyke net at depth of the first hoop. Three other traps will be set at 0.5, 1.5 and 2 meter depths.

Gear Design



Gear: Beach Seine

Purpose: Sample smaller fish in the littoral zone

Sample Design: Seine is fished for 100 m broken into 33 m sections. Transects done at night.

Functional Monitoring of Fish Communities on Cape Cod National Seashore Gear Design



Gear: Electrofishing

Purpose: Survey littoral zone.

Data Gained: Littoral zone is surveyed for a range of species & sizes with a focus on smaller fish.

Description: Electrofishing current used to stun fish.

Sample Design: A 100 m transect is walked parallel to shore.

Gear Design



Gear: Trammel Net

Purpose: Survey large fish at the thermocline/substrate interface.

Sample Design: Net is anchored at depth of 2 m, extended fully, and anchored in pelagic zone. Set at dusk.

Gear Design



Gear: Snorkel Survey

Purpose: Survey small and large fish in the littoral zone and thermocline/substrate interface.

Sample Design: Two 100 m transects at depths of 1 meter and 3 meters.

Monitoring of northeastern fish communities Steps

<u>Gear</u>	<u>Number</u>	<u>Duration</u>	<u>Site</u>
Fyke Net	3-5	6-8 h	Random
Minnow Trap	12	6-8 h	Random
Trammel Net	3	~ 4-6 hrs	Random
Beach Seine	2		Random or 'seizable'
Snorkel	1 x 100 m		Random

Monitoring of northeastern fish communities Steps

Sampling Plan-Stream

<u>Gear</u>	<u>Number</u>	<u>Duration</u>	<u>Site</u>
Electrofishing	3	100 m	Riffle Pool
Seine	2	As possible	Pool

Monitoring of northeastern fish communities Steps

Sampling Plan

<u>Abiotic Variables:</u>	<u>Location</u>	<u>When</u>
Water Quality pH, DO, Temp,	Littoral	Simultaneously with fish
Conductivity	"	"
Morphometry Physical habitat	"	As needed
Vegetation, substrate	"	As needed

Monitoring of northeastern fish communities Steps

Sampling Schedule

<u>Months</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>July</u>	<u>Aug</u>	<u>Sept</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>
Sampling:									
Fish									
Community				X.....					
Abiotic				X.....					
Morphometry				X.....					

Monitoring of northeastern fish communities Steps

Sampling schedule considerations

- Year class strength is set by late summer /fall.
- Thus once a year is probably adequate to assess species composition and relative abundance of the fish community.
- Given time limitations, once a year fits well with NHS manager schedules.

Monitoring of northeastern fish communities

- Sample sites in summer (2-6 days/per site)
- Develop protocol for monitoring aquatic resources

Monitoring of northeastern fish communities

- Sample sites in summer (2-6 days/per site)
- Develop protocol for monitoring aquatic resources

1. Roosevelt-Vanderbilt, Hyde Park, NY
2. Saratoga, NY
3. Morristown, Morristown, NJ
4. Marsh Billings Rockefeller, VT
5. St. Gaudens, Cornish, NH
6. Weir Farm, CT
7. Pilgrim Lake, MA
8. Herring/Pamet River, MA
9. Interdunal ponds, MA
10. Minuteman, MA

Monitoring of northeastern fish communities

Steps

Identify habitats

Habitat: Small-moderate streams
Sampling method: Stream electrofishing, seine
NHS: Roosevelt-Vanderbilt, Saratoga, Morristown, Minutemen, St.Gaudens

Habitat: Impoundments - low/no flow
Sampling method: Fyke, minnow, seine
NHS: Saratoga, Marsh-Billings-Rocketteller, Catskill (ROVA), St.Gaudens, Weir Farm

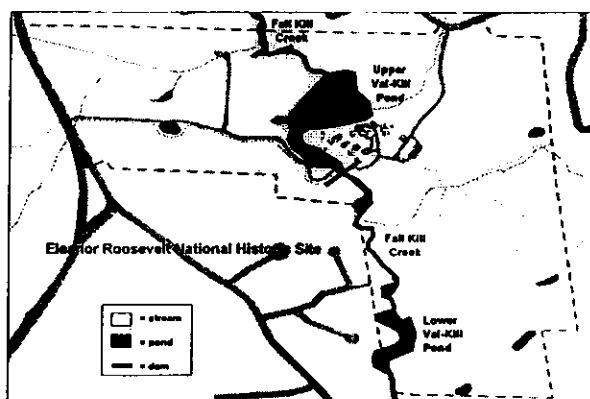
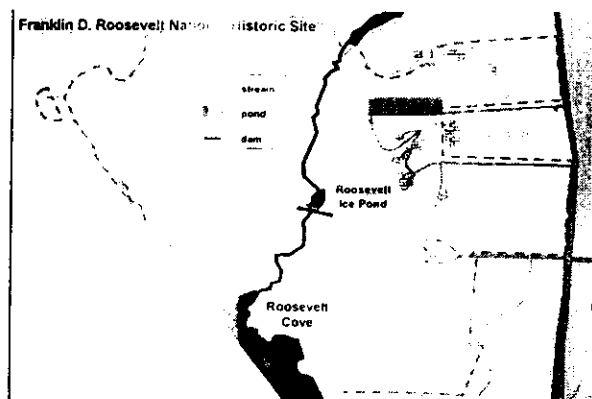
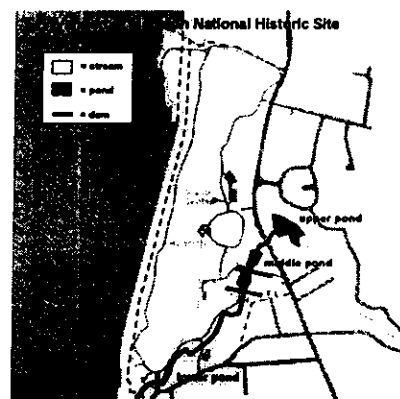
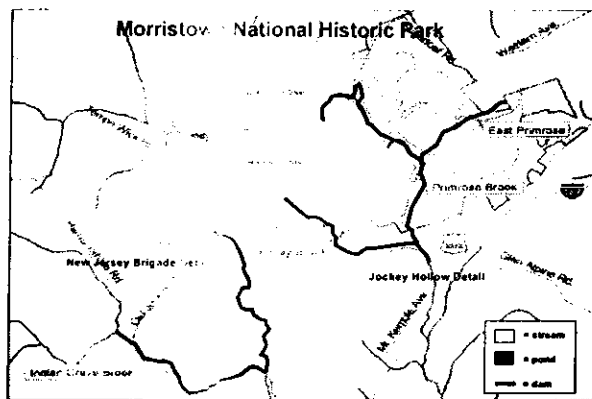
Monitoring of northeastern fish communities

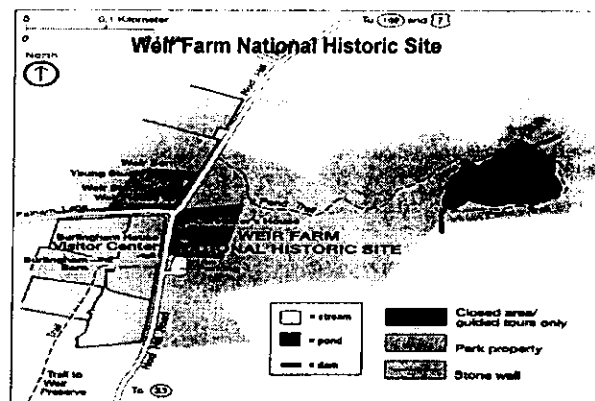
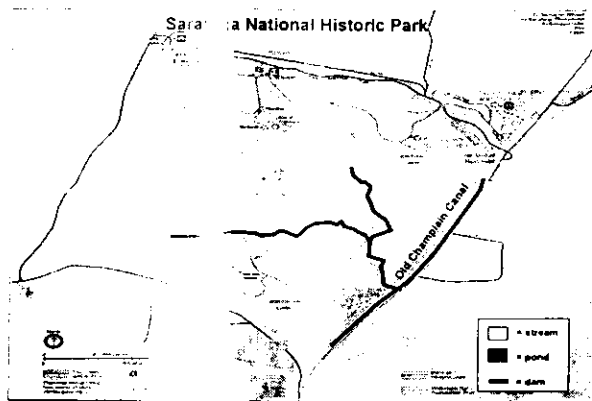
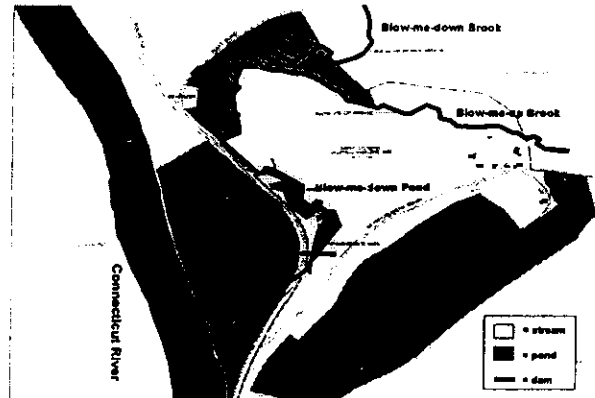
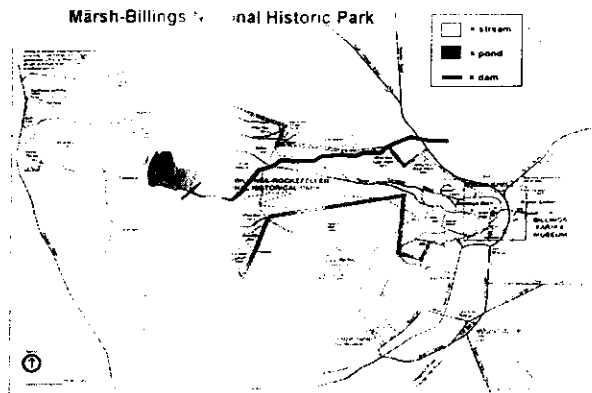
Steps

Identify habitats

Habitat: Impoundments - higher flow
Sampling method: Fyke, minnow, seine
NHS: Roosevelt-Vanderbilt (FDR, Vanderbilt)

Habitat: Natural ponds (kettlefarm)
Sampling method: Fyke, minnow, seine
NHS: Cape Cod National Seashore, Saratoga, St. Gaudens





Monitoring of northeastern fish communities

Steps

Identify habitats

	RO	VA	SA	MO	MBR	SG	MM	WF	CaCo	PL	ID	HR	PR
Lotic													
Small stream	X		X	X	X	X	X						X
Large stream	X	X											
Lentic													
Small pond			X	X			X				X		
Impoundment	X	X	X		X								
Lake									X				

In 2000,

- (a) Physically map all habitats,
- (b) Classify habitats into functional groups,
- (c) Sample a representative group of all habitats to produce a habitat-specific inventory,
- (d) Discuss the sampling protocols and results with park personnel, and
- (e) Modify the monitoring plan to incorporate natural resource managers' comments on feasibility and usefulness.



Applications

