Quantifying Relationships between Fish Assemblages and Nearshore Habitat Characteristics of the Niagara River

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Habitat Enhancement & Restoration: an Investment

- Habitat enhancement & restoration actions are investments in the health of the Niagara River & the ecosystem services it provides to the community
Habitat Enhancement & Restoration Process

Goal → Objective

Evaluation ↔ Information Base

Problem Identification ↔ Actions

Management Environment
Building on Previous & Ongoing Research

- Muskellunge depend upon particular habitats for spawning & nursery
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- Muskellunge depend upon particular habitats for spawning & nursery
- Spawning muskellunge select sites with vegetation & mixed sand/mud substrates, never observed using finer silt substrates

Crane et al. in progress
Building on Previous & Ongoing Research

- Age-0 muskellunge feed on particular prey species, especially banded killifish, cyprinids, & darters

Kapuscinski et al. 2012, NAJFM
Building on Previous & Ongoing Research

- Fish assemblages differ along habitat gradients at muskellunge nursery sites

Kapuscinski & Farrell 2013, JGLR
Rudd Dominate Trap-net Catches
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2007-2008
- 49% of total catch
- 6,887 of 14,131 fish, 17 per 24 hr net soak
- Brown bullhead = 1,903 or 13% of total catch

Kapuscinski et al. 2012, NAJFM
Rudd Diet

Month: May, June, July, Aug, Nov

- Mean proportion by weight
- Macrophytes
- Algae
- Fish
- Leech

Graph showing the proportion of diet items by month.
Proposed Project Objectives

• Objective 1: Develop a model to predict occurrences of Niagara River fishes from habitat characteristics
  – a: Predict the occurrence of age-0 muskellunge from habitat characteristics
  – b: Predict the occurrence of native and non-native fishes from habitat characteristics
Proposed Project Objectives

• Objective 1: Develop a model to predict occurrences of Niagara River fishes from habitat characteristics

• Objective 2: Quantify prey selection by age-0 muskellunge
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• Objective 1: Develop a model to predict occurrences of Niagara River fishes from habitat characteristics
• Objective 2: Quantify prey selection by age-0 muskellunge
• Objective 3: Monitor nearshore fish assemblages
Objective 1a: Model Occurrence of Age-0 Muskellunge

- Purpose
  - Develop models that predict the occurrence (relative probability of presence) of age-0 muskellunge from habitat characteristics of the upper Niagara River
Objective 1b: Model Occurrence of Native & Non-native Fishes

• Purpose
  – Develop models that predict the occurrence (relative probability of presence) of native & non-native fishes from habitat characteristics of the upper Niagara River
Objective 1a & b: Species Occurrence Modeling

• Methods
  – Conduct surveys of physical habitat & vegetation characteristics at nearshore sites, including existing restoration sites
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• Methods
  – Conduct surveys of physical habitat & vegetation characteristics at nearshore sites, including existing restoration sites
  – Collect fishes by seining
  – Develop models that identify (1) high quality habitat for age-0 muskellunge & other native fishes, & (2) lower quality non-native fish habitat
  – Models can be applied in a spatially explicit manner & projected on maps in GIS
Objective 1a & b: Species Occurrence Modeling

- Utility
  - Prioritize areas for protection…most effective restoration practice is conservation!
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  – Identify areas needing habitat enhancement & restoration (if GIS layers are available)
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  – Identify areas needing habitat enhancement & restoration (if GIS layers are available)
  – Guide designs of habitat enhancement projects, maximizing benefits to native spp. & minimizing benefits to non-natives
Ex: Prioritizing Protected Areas

Kremen et al. 2008
Ex: Conservation of Stream Fishes

Endries 2012
Objective 2: Quantify Prey Selection by Age-0 Muskellunge

• Purpose
  – Determine if age-0 muskellunge feed selectively among prey species
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• Purpose
  – Determine if age-0 muskellunge feed selectively among prey species
  – Identify mechanisms driving selective feeding (e.g., capture efficiency, caloric content, anti-predator defenses or behavior, etc.)
Objective 2: Quantify Prey Selection by Age-0 Muskellunge

• Methods
  – Collect muskellunge & prey from Niagara River
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- Methods
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  - Conduct feeding trials to quantify selection
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• Methods
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  – Conduct feeding trials to quantify selection
  – Use video to analyze anti-predator behaviors, measurements of prey morphology, & bomb calorimeter to determine mechanisms
Objective 2: Quantify Prey Selection by Age-0 Muskellunge

• Utility
  – Integrate results with knowledge of fish spp.-habitat relationships (Objective 1) to enhance growth & survival of age-0 muskellunge through management actions (e.g., protect high quality habitat or enhance poor habitat)
Objective 3: Monitor Nearshore Fish Assemblages

• Purpose
  – Monitor the relative abundance of fishes at nearshore sites of Buffalo Harbor & the upper Niagara River that are used by muskellunge as nursery areas, continuing a standardized survey that began in 2007
Objective 3: Monitor Nearshore Fish Assemblages

• Methods
  – Conduct a minimum of 4, 30.5 m seine hauls at 10 index sites (2 in BH, 8 in UNR)
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  – Conduct a minimum of 4, 30.5 m seine hauls at 10 index sites (2 in BH, 8 in UNR)
  – Identify & count all fishes
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  – Conduct a minimum of 4, 30.5 m seine hauls at 10 index sites (2 in BH, 8 in UNR)
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  – Examine stomach contents of muskellunge & northern pike
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• Methods
  – Conduct a minimum of 4, 30.5 m seine hauls at 10 index sites (2 in BH, 8 in UNR)
  – Identify & count all fishes
  – Examine stomach contents of muskellunge & northern pike
  – Examine trends in relative abundance data
Objective 3: Monitor Nearshore Fish Assemblages

• Utility
  – Measure response of fishes (i.e., production of young) to ecosystem changes, including habitat enhancements
Age-0 muskellunge

All fishes

Kapuscinski et al. 2013, JGLR
Objective 3: Monitor Nearshore Fish Assemblages

• Utility
  – Measure response of fishes (i.e., production of young) to ecosystem changes, including habitat enhancements
  – Sample rare native species
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- Utility
  - Measure response of fishes (i.e., production of young) to ecosystem changes, including habitat enhancements
  - Sample rare native species
  - Monitor abundances of non-native species & detect new invaders
Links to Restoration of Niagara River

• Standards for ecologically successful river restoration (from Palmer et al. 2005)
  1) Guiding image of dynamic, healthy river
     – Goal dependent upon reliable information base
Links to Restoration of Niagara River

• Standards for ecologically successful river restoration (from Palmer et al. 2005)
  1) Guiding image of dynamic, healthy river
  2) Measurable improvement
    – Restoration targets based on “best” sites
    – Index seining will measure response of fishes
Links to Restoration of Niagara River

- Standards for ecologically successful river restoration (from Palmer et al. 2005)
  1) Guiding image of dynamic, healthy river
  2) Measurable improvement
  3) River must be more resilient & self-sustaining
    - Increasing native spp. = increased biotic resistance to invasion
Links to Restoration of Niagara River

• Standards for ecologically successful river restoration (from Palmer et al. 2005)
  1) Guiding image of dynamic, healthy river
  2) Measurable improvement
  3) River must be more resilient & self-sustaining
  4) Do no lasting harm
    - “Fishery managers must be cautious in their selection of habitat modification choices to avoid favoring undesirable species”
      
      *Jude & DeBoe 1996, CJFAS*
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  1) Guiding image of dynamic, healthy river
  2) Measurable improvement
  3) River must be more resilient & self-sustaining
  4) Do no lasting harm
  5) Rigorous evaluation
    - Identify corrective measures & guide future designs
Deliverables

• Models for predicting occurrences of fishes based on habitat variables
  – Manual for using the model
  – Training sessions for practitioners
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• Data available to public & managers
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  – Manual for using the model
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• Data available to public & managers

• MS thesis & publications in peer-reviewed scientific journals
Leveraging Opportunities

• Partnership with USACE
  – Collection of bathymetry, substrate, & aquatic vegetation data => GIS layers
  – Planning for habitat enhancement projects (3-5?) based on our research findings
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• University of Michigan Water Institute RFP
  – Expand species occurrence modeling effort (Objective 1) to include all Great Lakes connecting channels