The Interactive Ecology of Atlantic Salmon and Smallmouth Bass: Competition for Habitat?

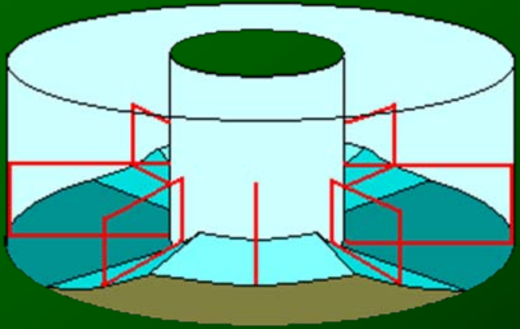
Gus Wathen [1], Stephen Coghlan [1], Joseph Zydlewski [1,2], Joan Trial [3]

[1] University of Maine Department of Wildlife Ecology
[2] USGS Maine Cooperative Fish and Wildlife Research Unit
[3] Maine Department of Marine Resources

Three-pronged approach:

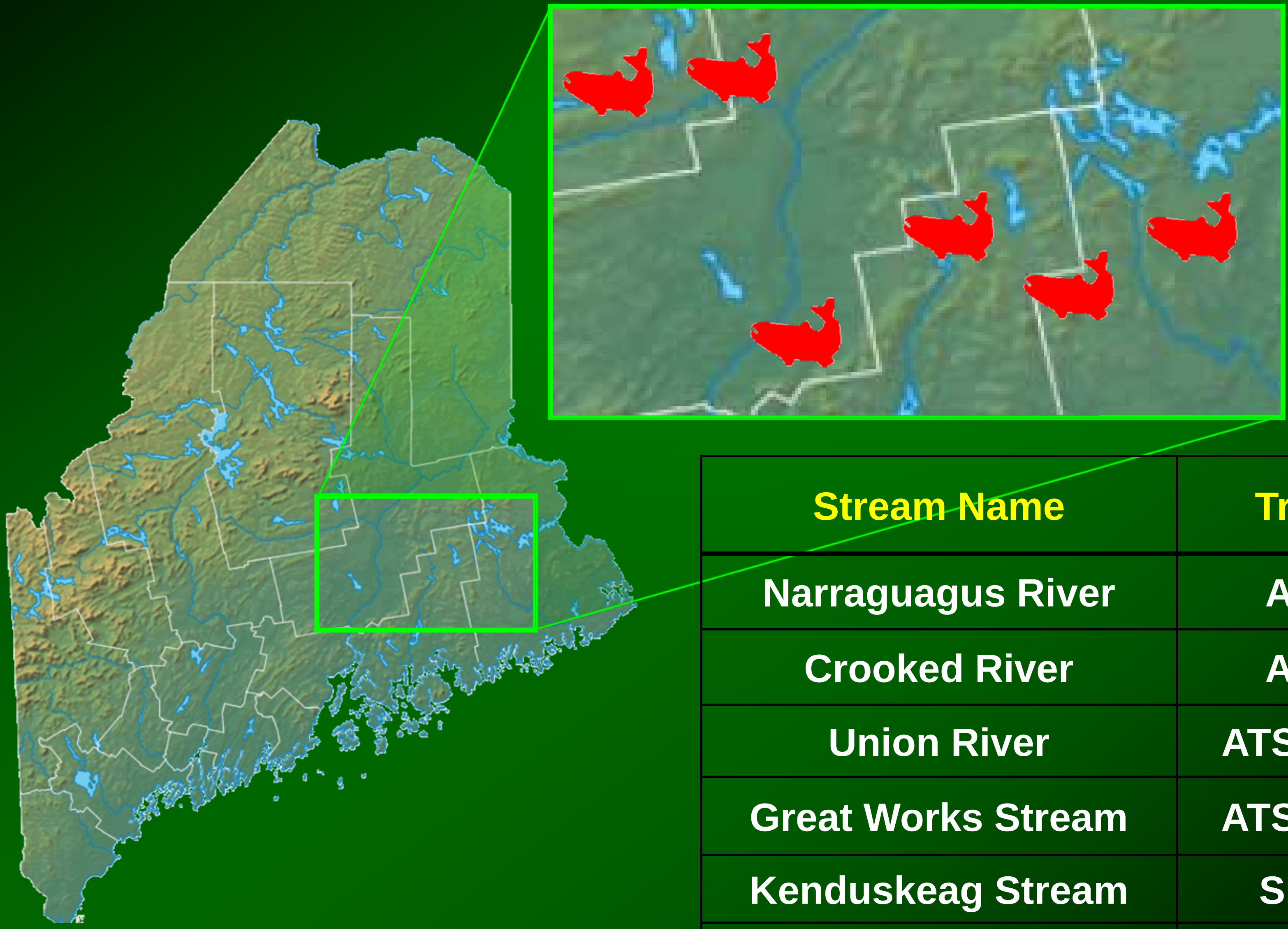
Open Observations

Simulated Stream



Controlled Invasion Experiment

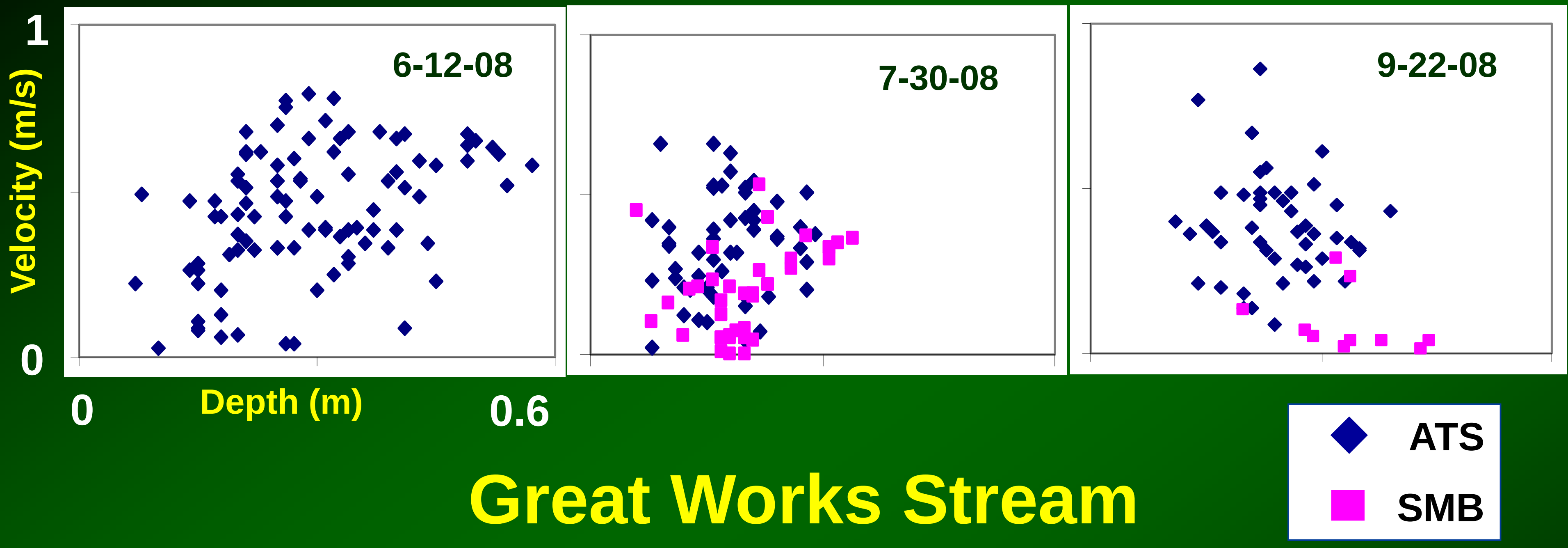
Open-system observations



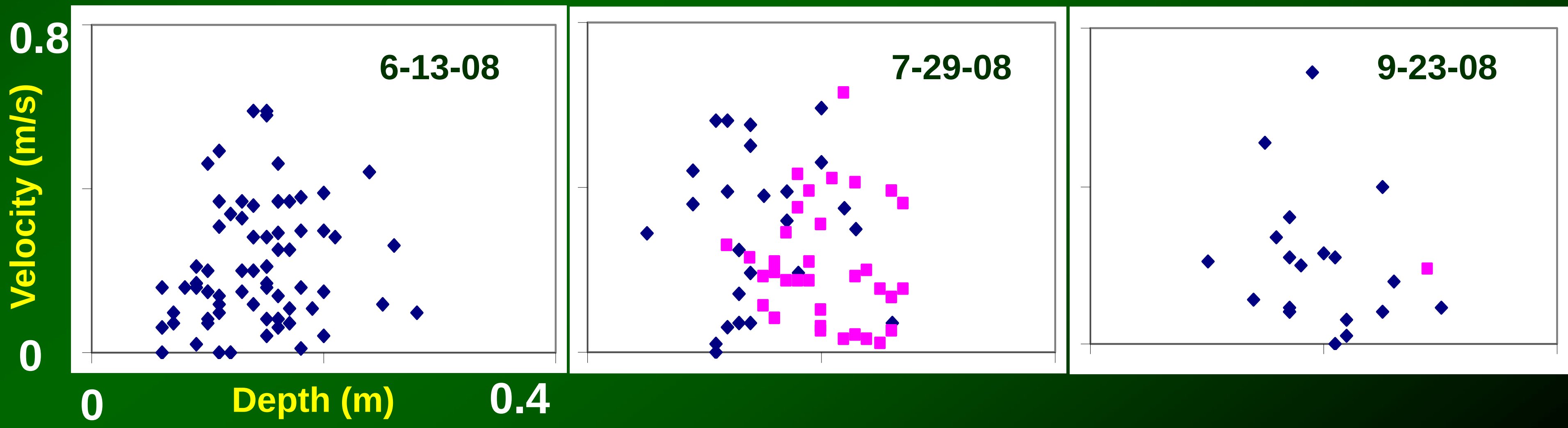
Stream Name	Treatment
Narraguagus River	ATS only
Crooked River	ATS only
Union River	ATS and SMB
Great Works Stream	ATS and SMB
Kenduskeag Stream	SMB only
Schoodic Stream	SMB only


F

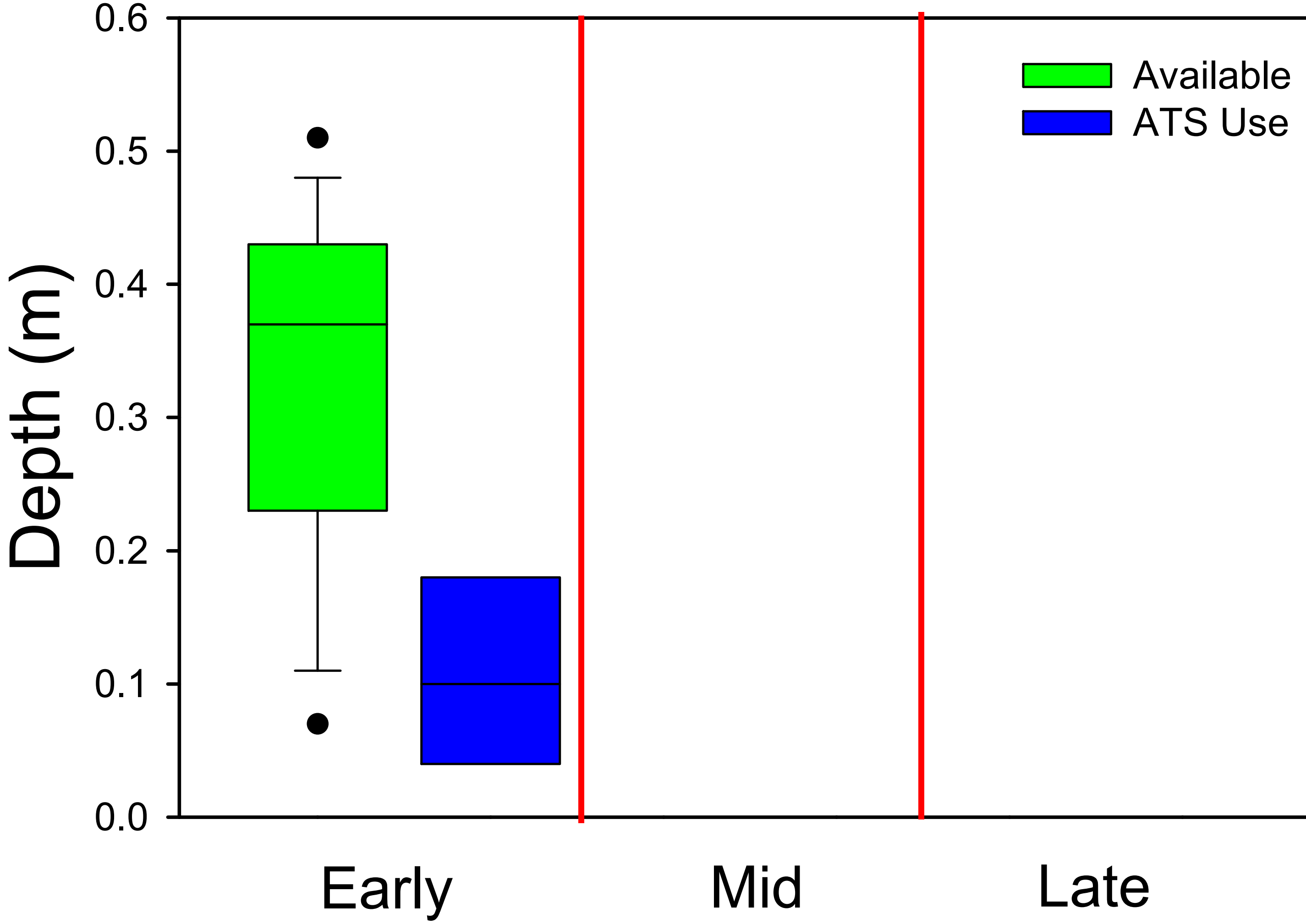
Union River



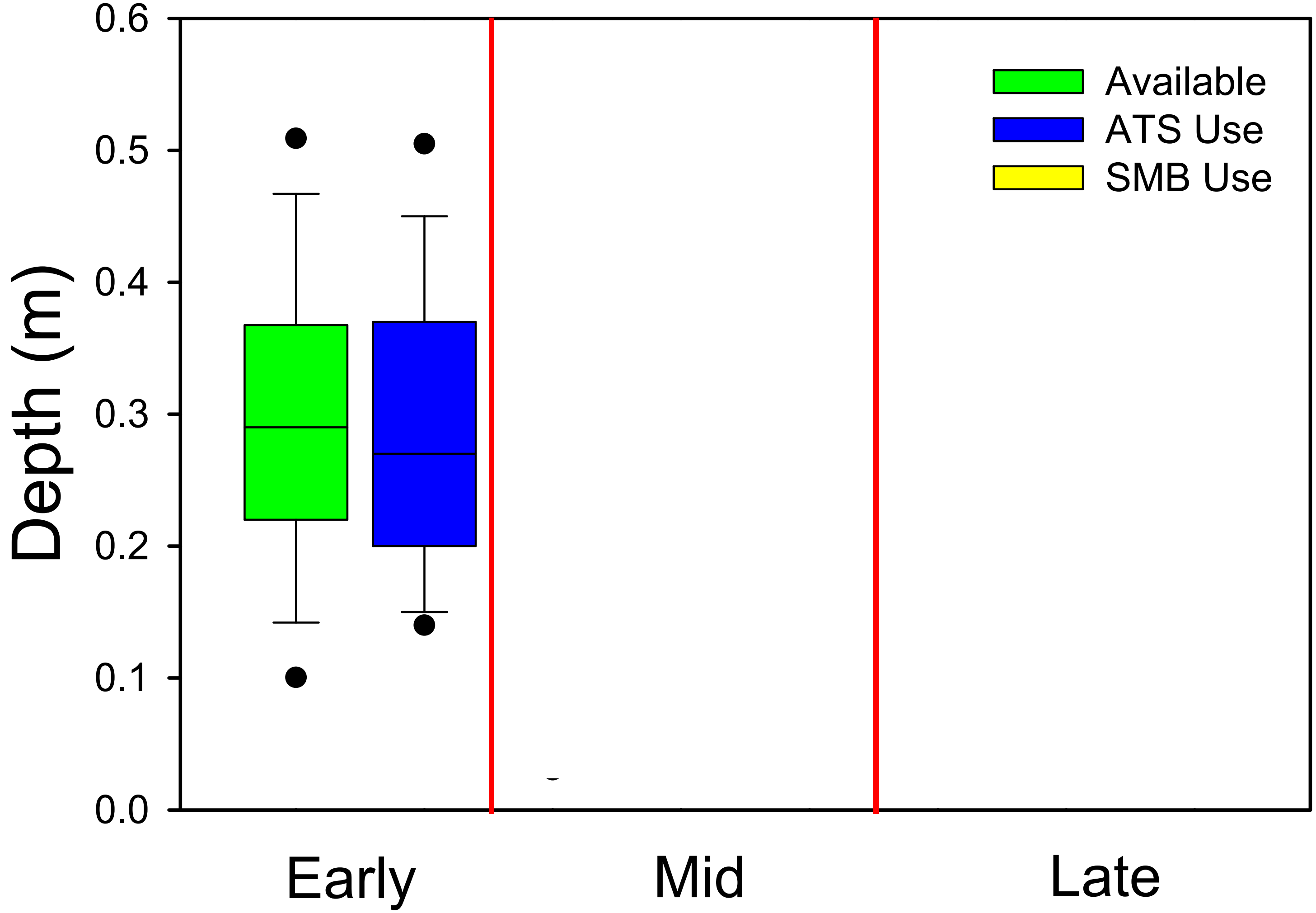
Great Works Stream



ATS Only



ATS + SMB

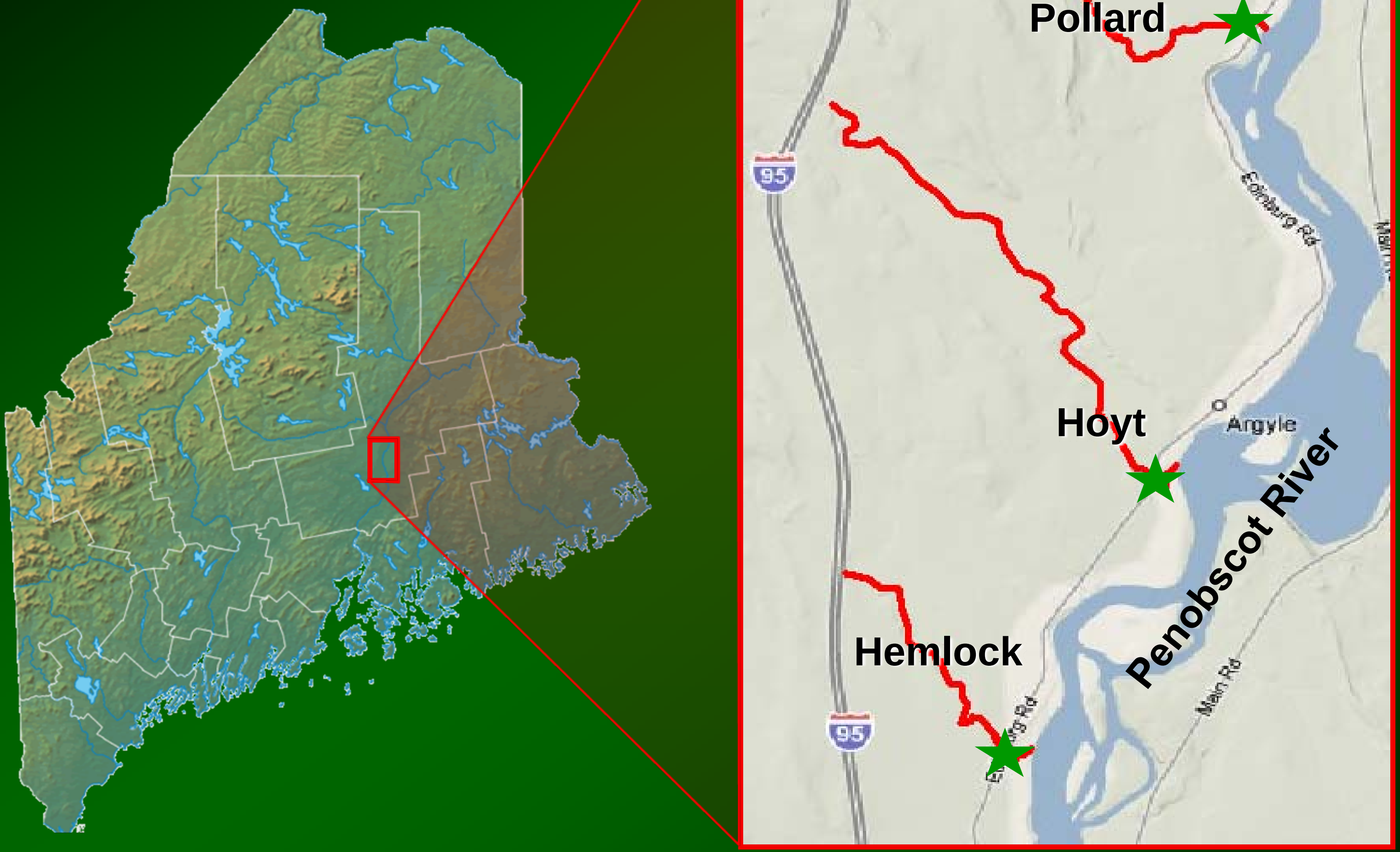


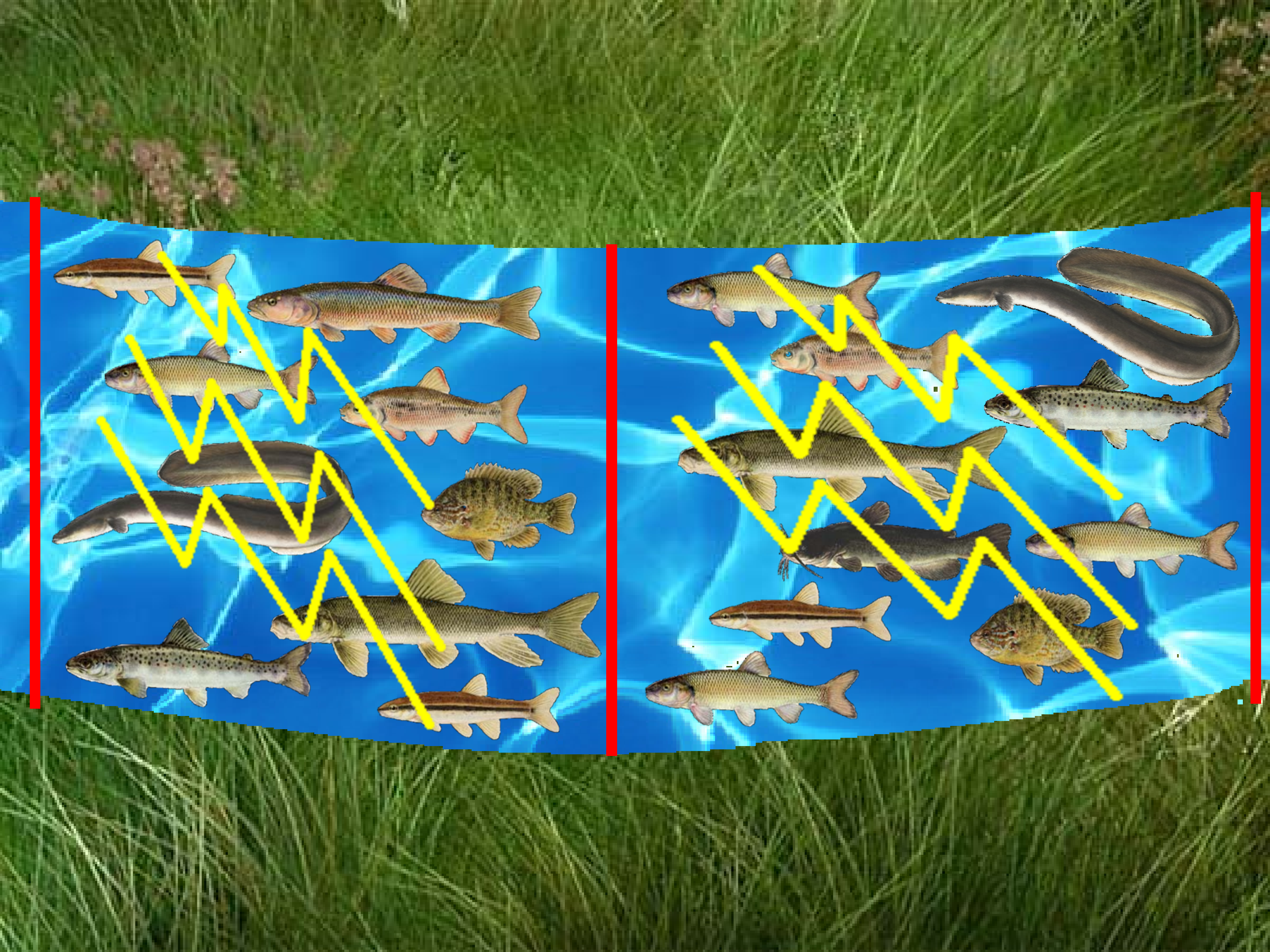
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Depth (m)
Available
ATS Use
SMB Use
Early
Mid
Late

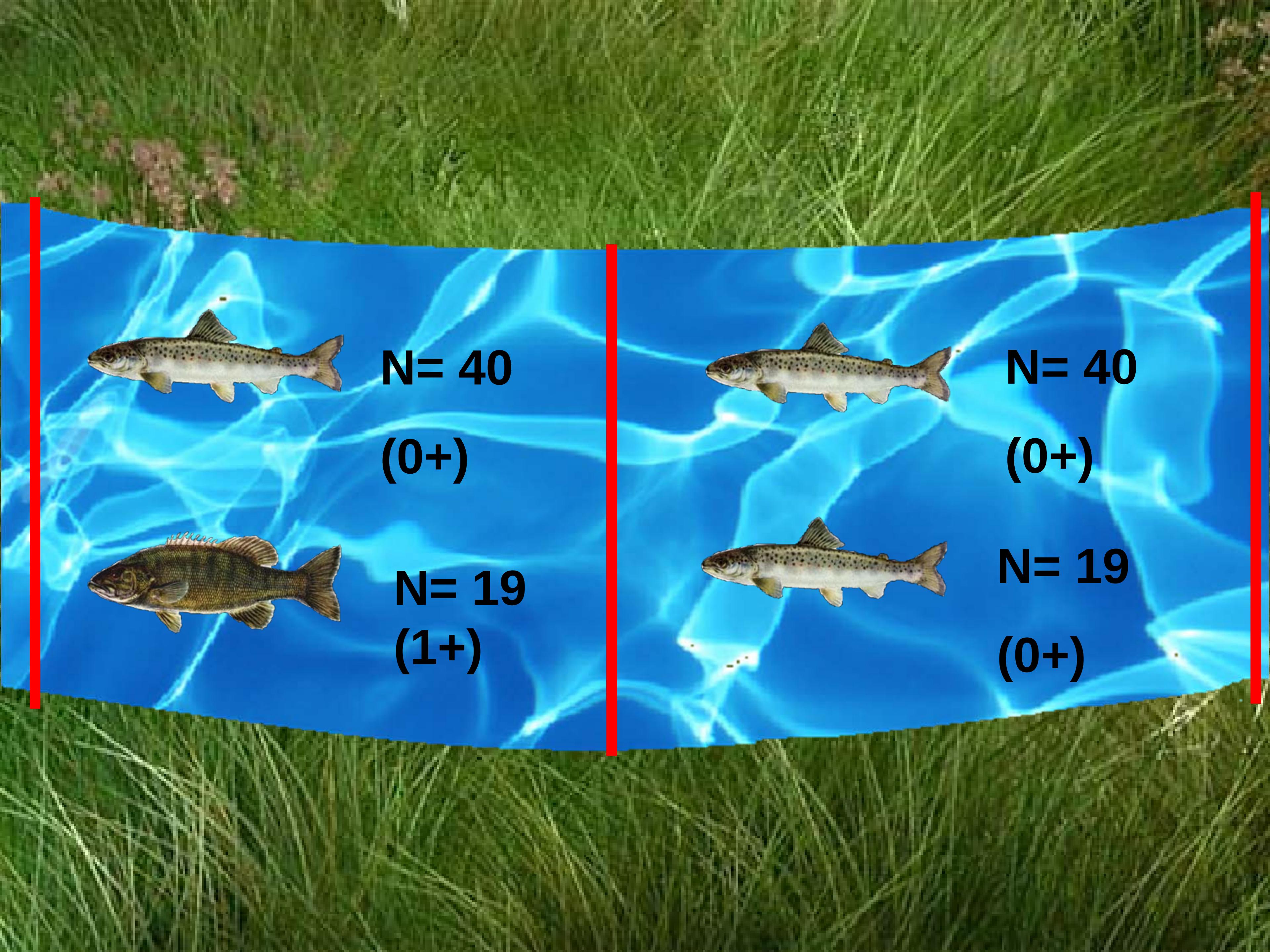
Summary

- ATS and SMB overlap in meso- and micro-habitat use during mid to late summer
- The presence of SMB may cause ATS to utilize shallower water than they would normally select
- Only 0+ SMB were detected in study reaches
- Repeated in summer 2009

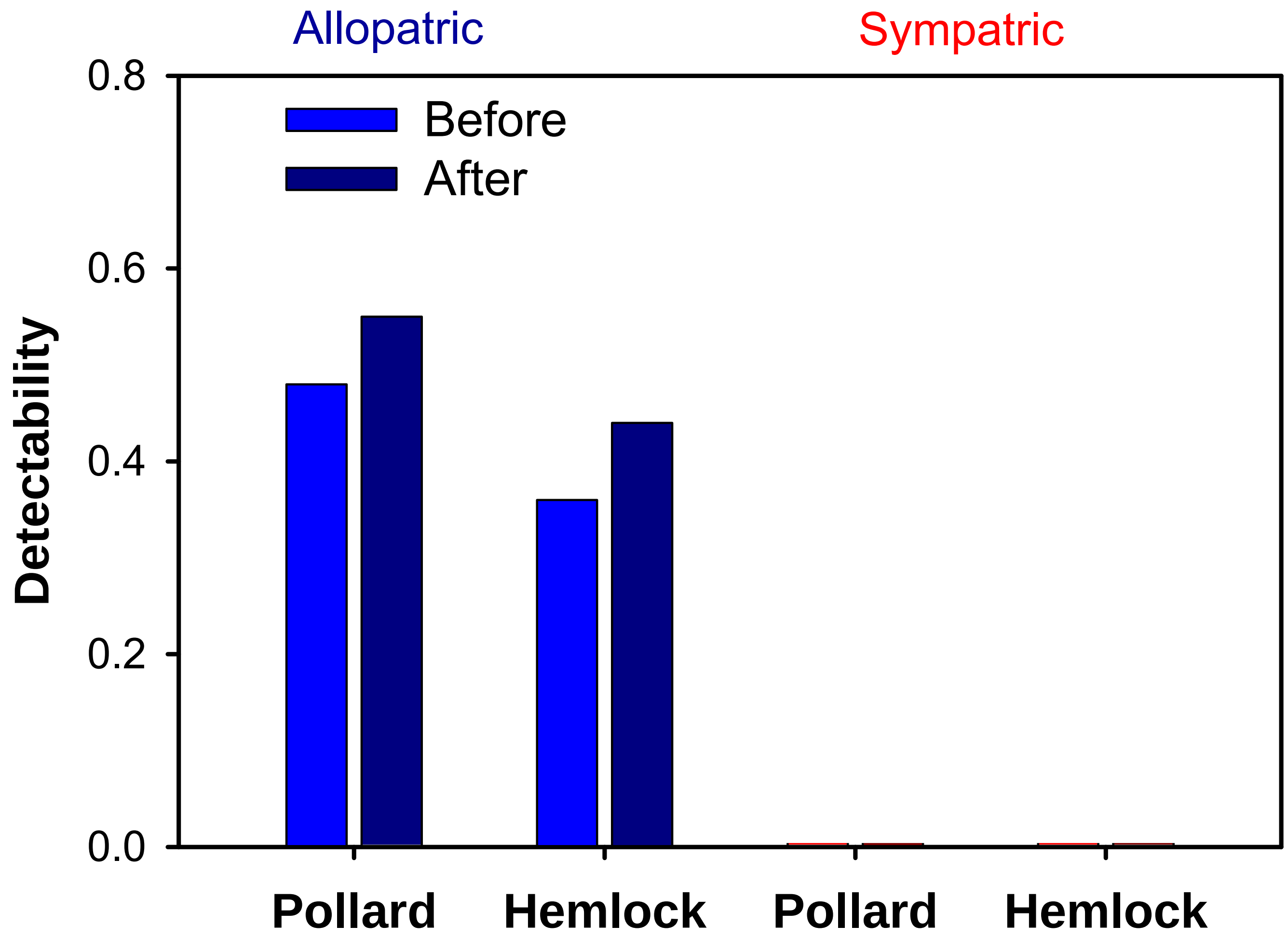
Controlled Invasion






N= 40
(0+)
N= 19
(1+)
N= 40
(0+)
N= 19
(0+)

Detectability of ATS Before and After 2nd Introduction



$$\text{Detectability} = \frac{\text{\# observed during snorkel}}{\text{est \# w/3-pass removal}}$$

Summary

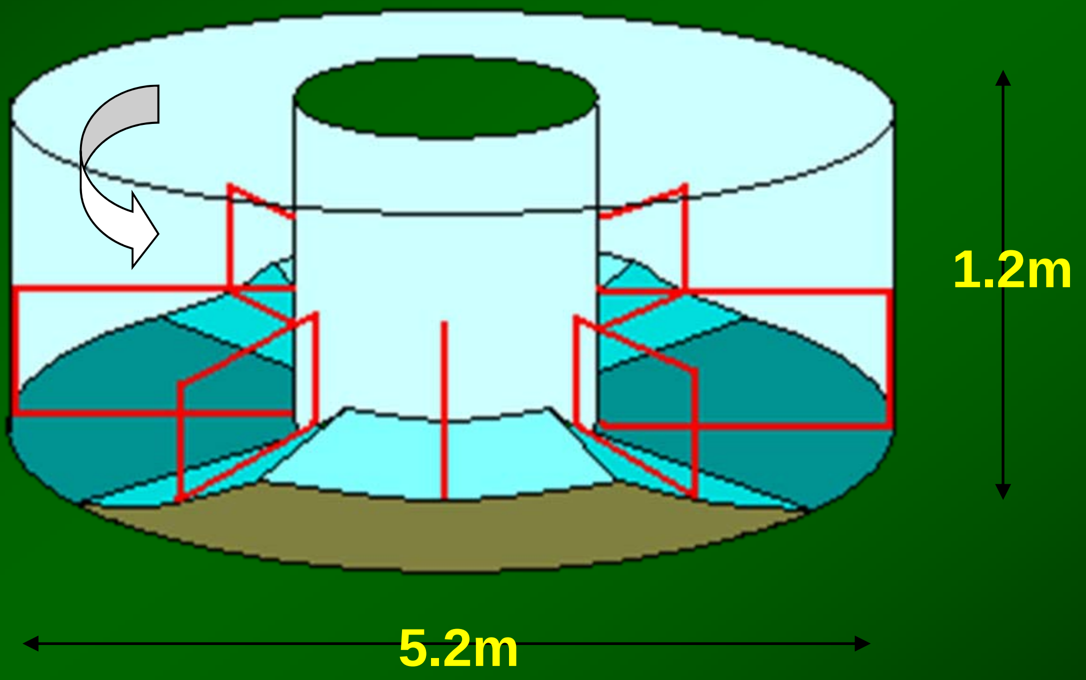
- Did not detect a change in ATS habitat use in the presence of 1+ SMB
- Significant decrease in detectability of ATS in the presence of SMB
- Indicates habitat shift by "non-detected" ATS – hiding behavior
- Repeated in 2009 using 0+ SMB

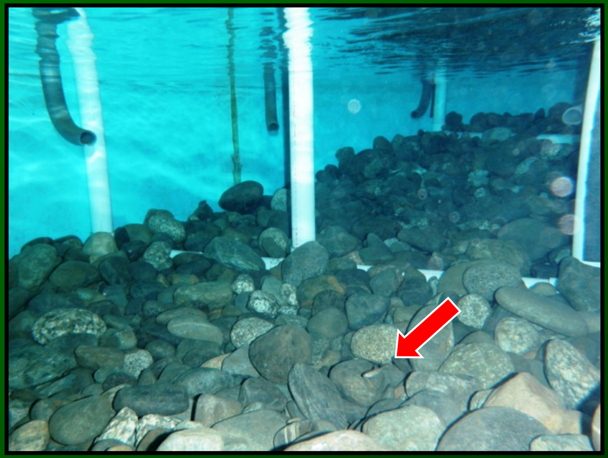
The Annular Tank: A Simulated Stream

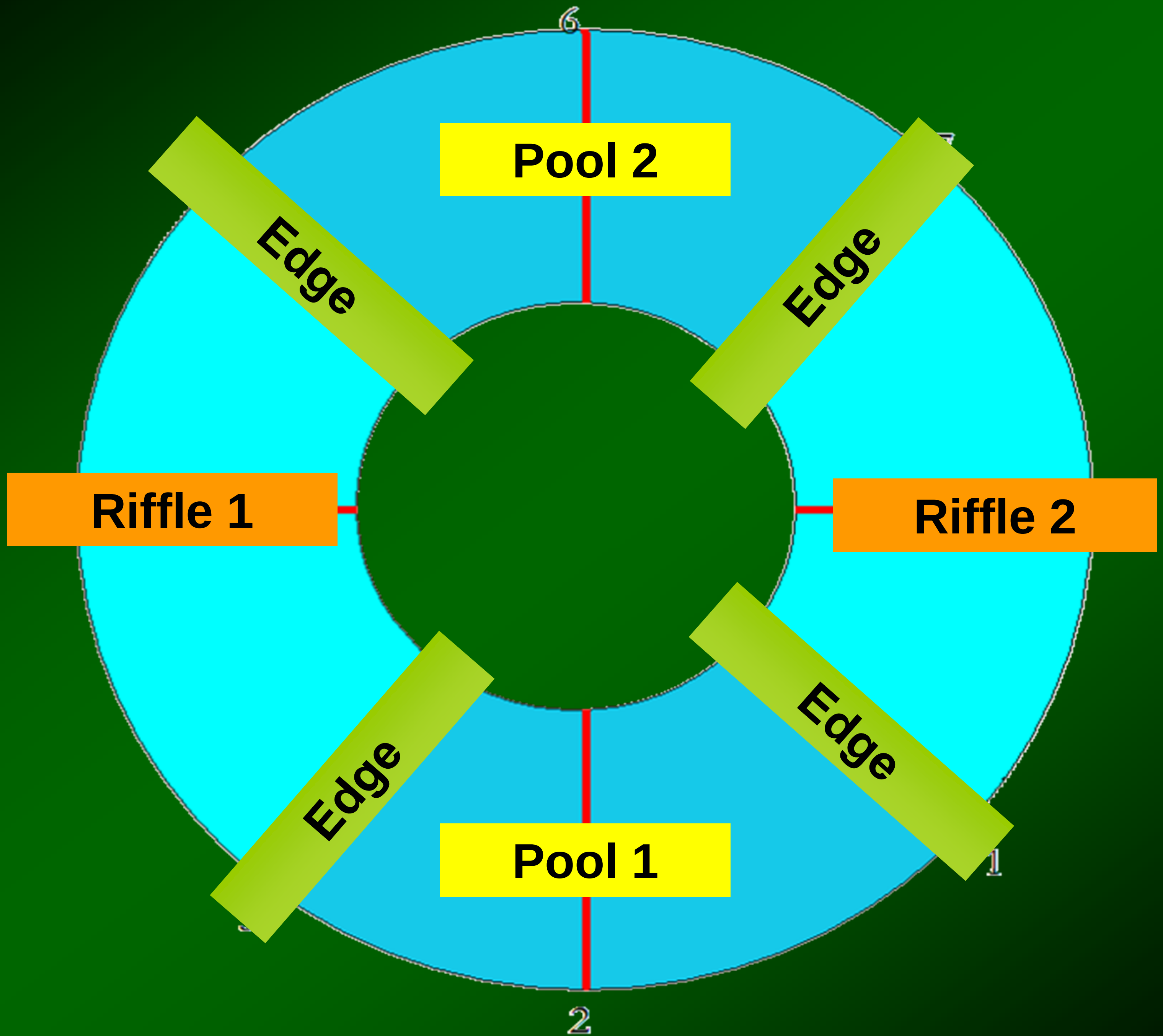
- **Mean velocities:**
  Pool = 0.06 m/s
  Riffle = 0.18 m/s

- **Mean Depths:**
  Pool = 48 cm
  Riffle = 17 cm

- **8 equally spaced PIT tag antennae**






6
Pool 2
Edge
Edge
Riffle 1
Riffle 2
Edge
Edge
Pool 1
1
2

Experimental Design

Test 1: Interspecific Competition

Prior residents:

Invaders:

Test 2: Interspecific Competition

Prior residents:

Invaders:

Test 3: Intraspecific Competition

Prior residents:

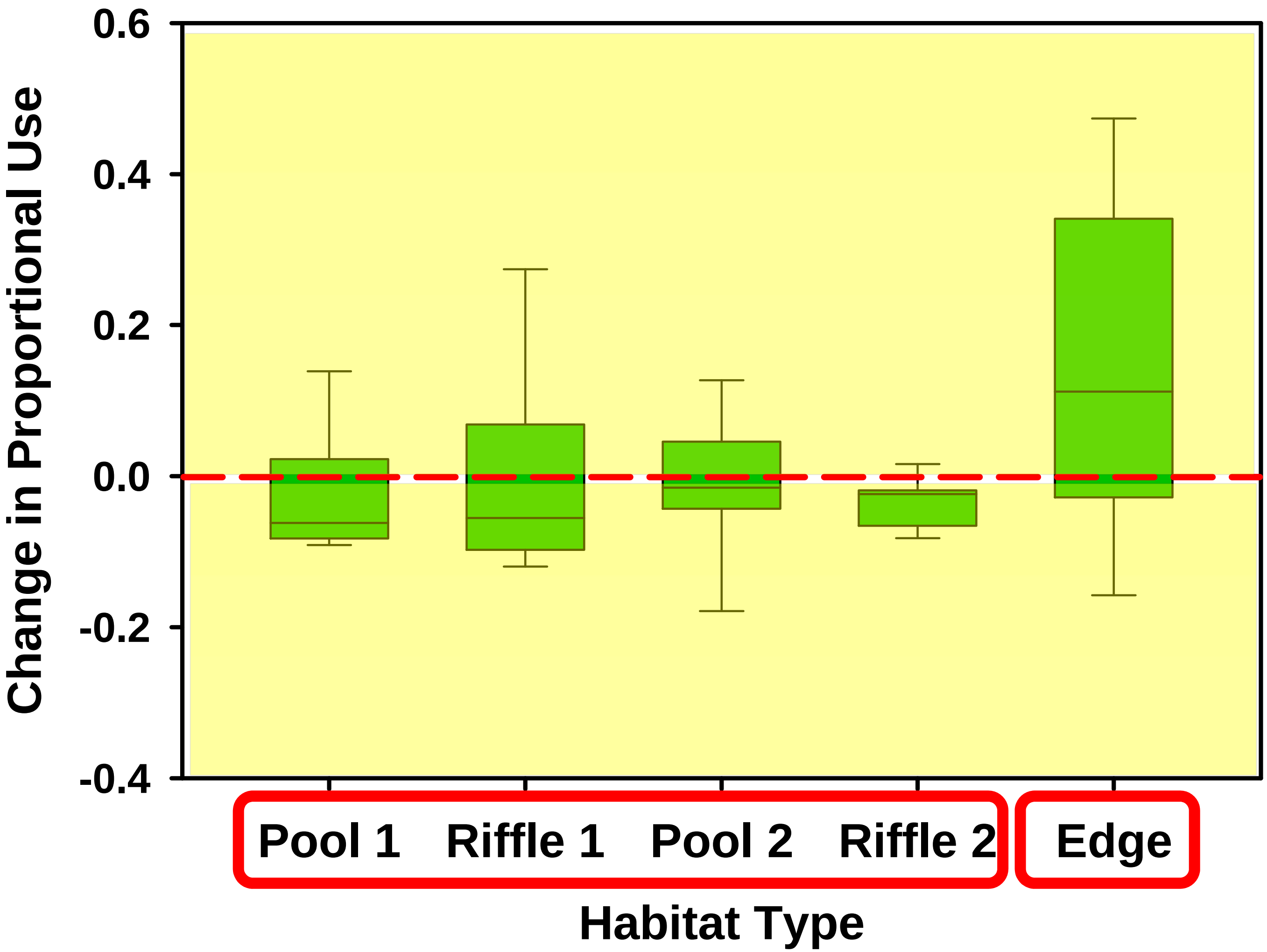
Invaders:

Test 4: Intraspecific Competition

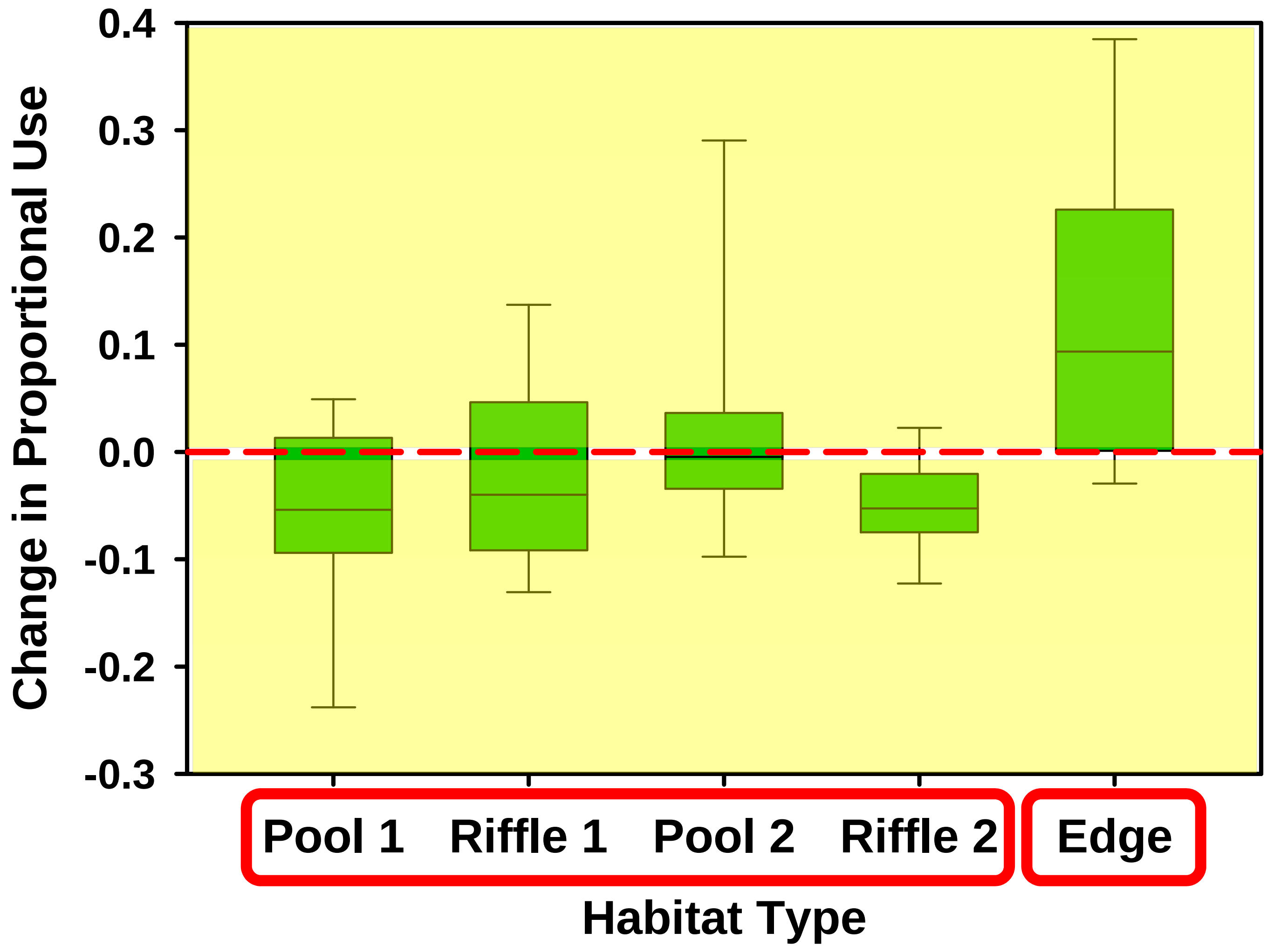
Prior residents:

Invaders:

Change in ATS habitat use when ATS is "invader"



Change in ATS habitat use when SMB is "invader"



Summary

- “Resident” fish shifted in their habitat use after the introduction of “invasive” fish.
- No distinction in use and shifts between species
- Several replicates through 2009

Response of resident fishes to barrier removal in Sedgeunkedunk Stream

Stephen M. Coghlan Jr.[1], *Cory Gardner*[1,2], *Joseph Zydlewski*[1,2]

[1]University of Maine Department of Wildlife Ecology
[2]Maine Cooperative Fisheries and Wildlife Research Unit

1865 THE UNIVERSITY OF MAINE

USGS science for a changing world

NOAA

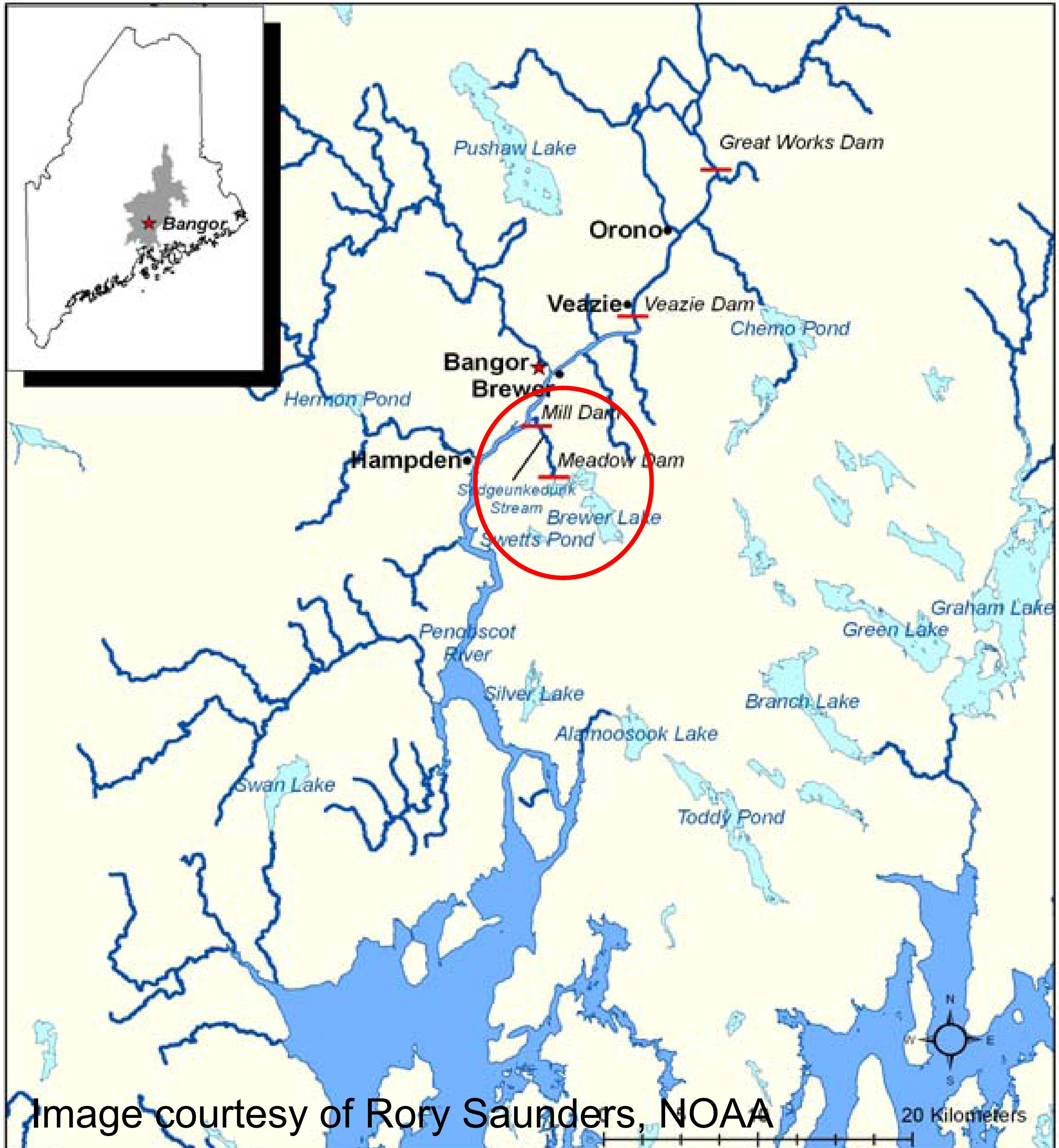
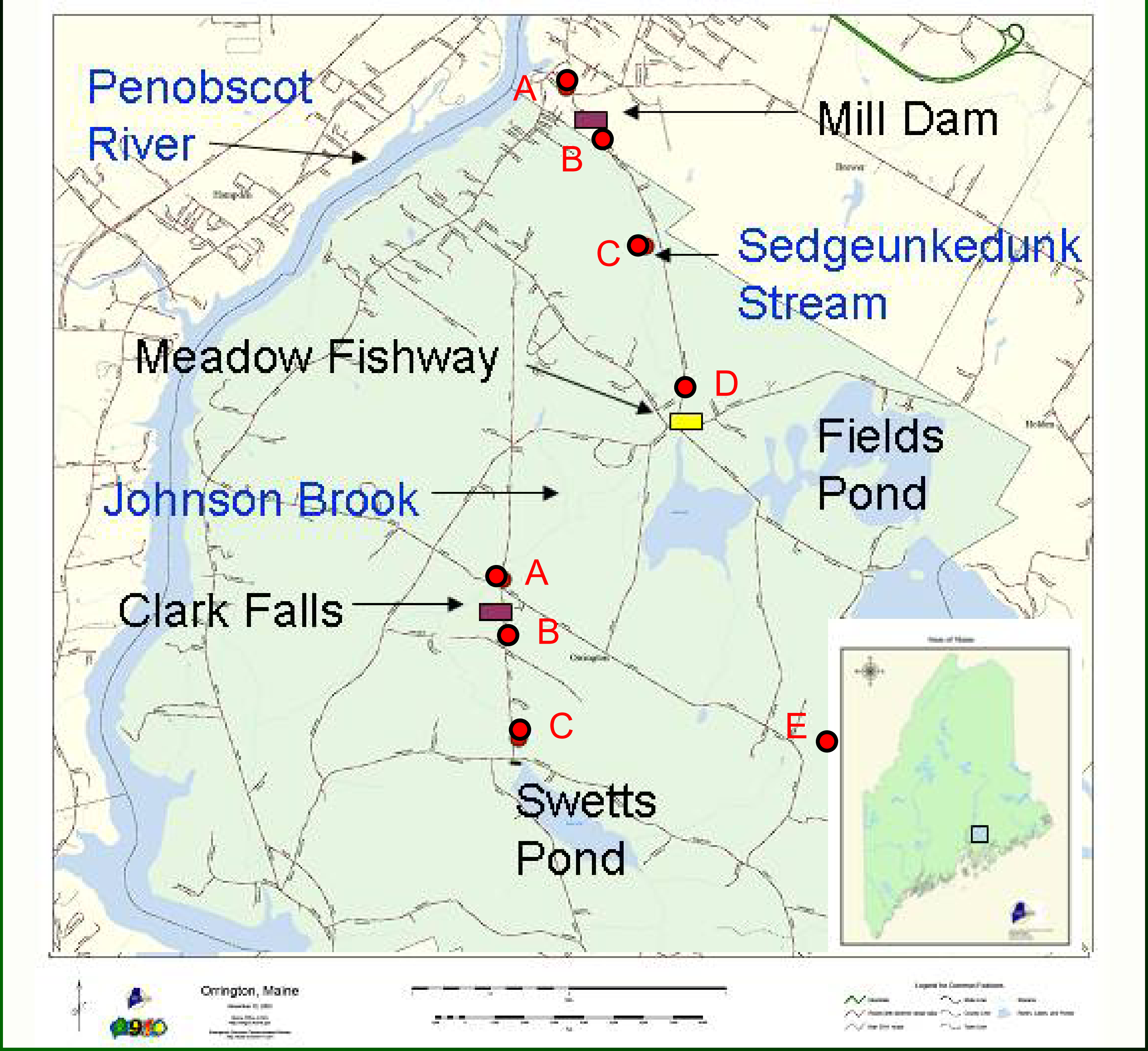


Image courtesy of Rory Saunders, NOAA


Penobscot River
A
Mill Dam
B
Sedgeunkedunk Stream
C
Meadow Fishway
D
Fields Pond
Johnson Brook
A
Clark Falls
B
C
E
Swetts Pond
Orrington, Maine


Sedgeunkedunk Stream
Fish Passage
Project
Meadow Dam prior to fishway construction, August 2008 (photo courtesy of Carl Young)
CAT


Sedgeunkedunk Fishway
Monday 29 September
2008

Sedgeunkedunk - Mill Dam


Mill Dam, 1 day post-removal
August 2009

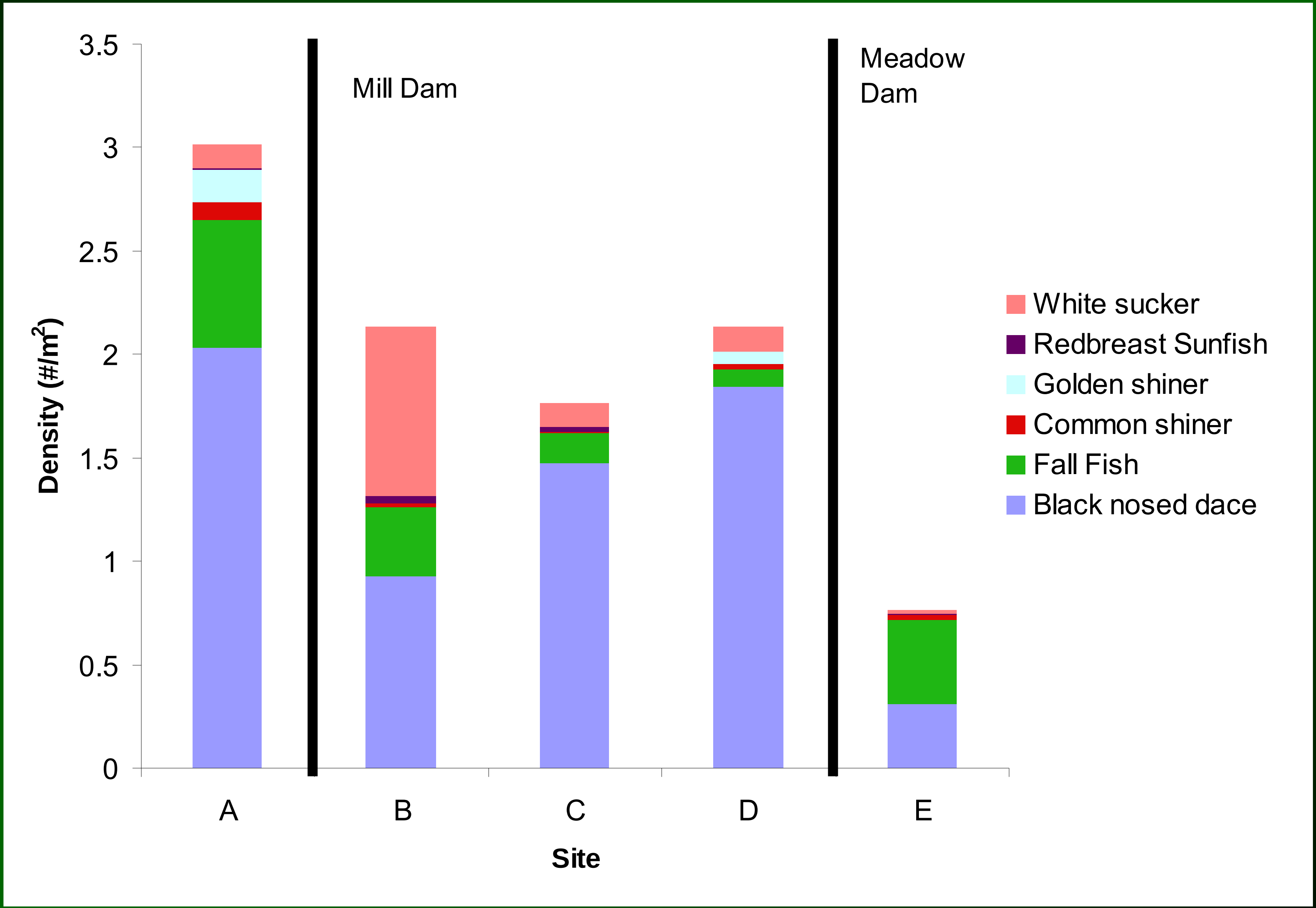
Metrics of interest

- Species richness, diversity
- Abundance (density)
- Body size (biomass)
- Assemblage structure (species composition, size spectrum)

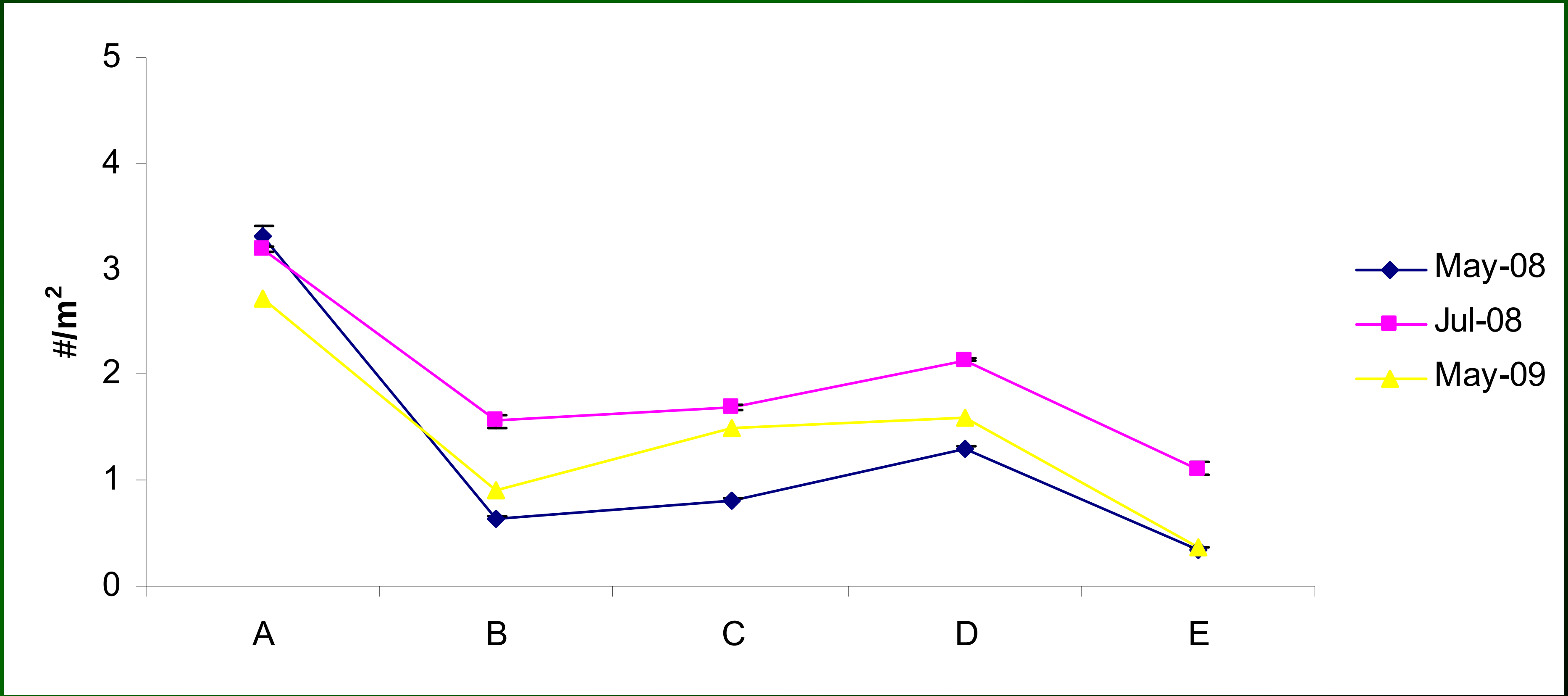
BACI design – comparisons:

- Before / after removal
- Among sites within stream
- Treatment vs. reference

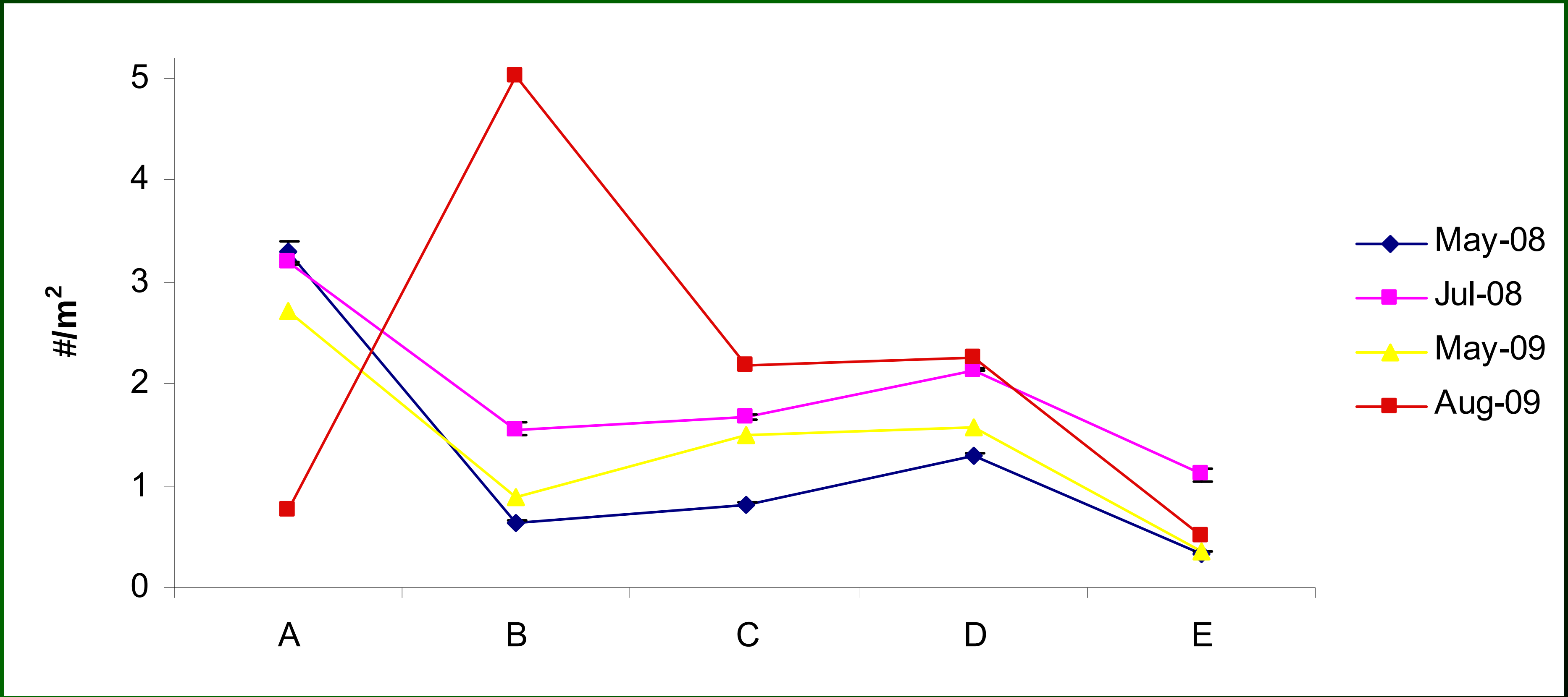
Density – July 2007



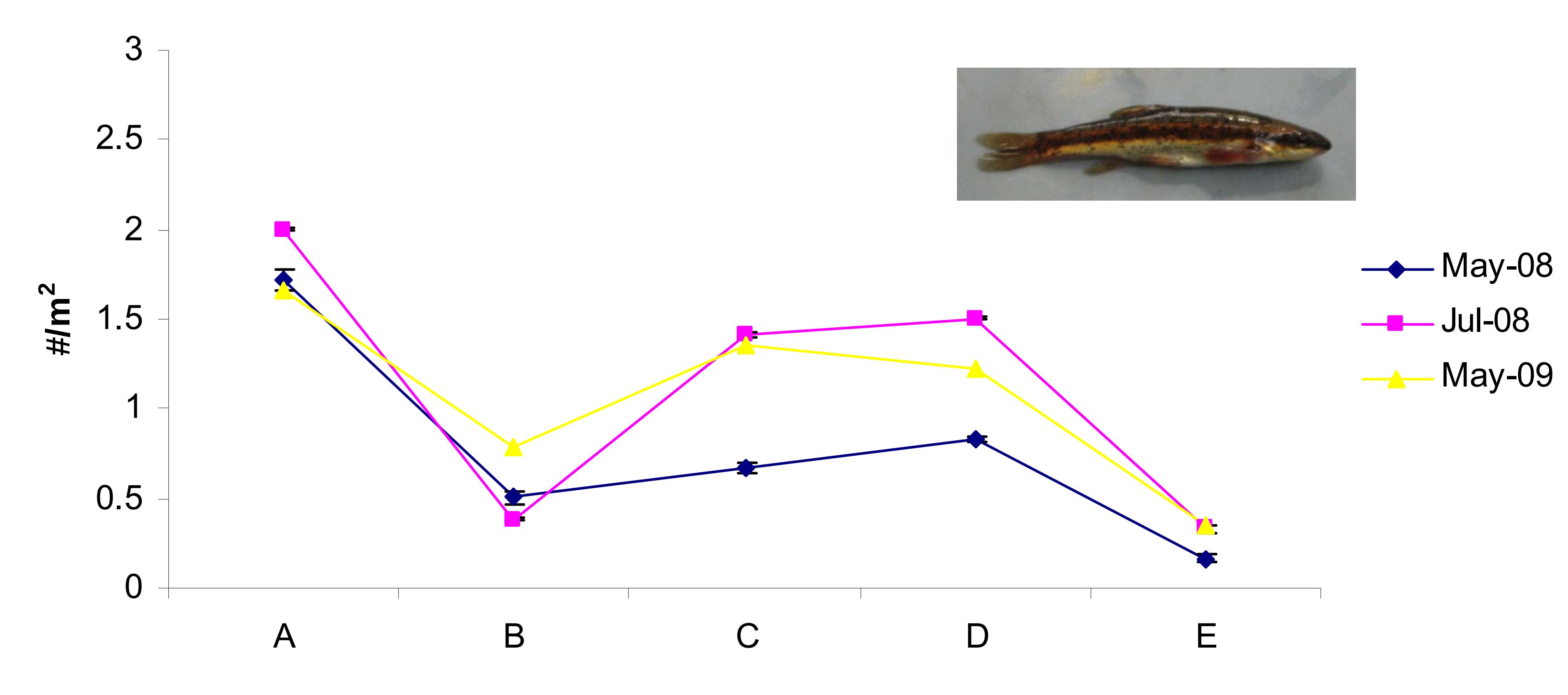
Total density – Pre-removal



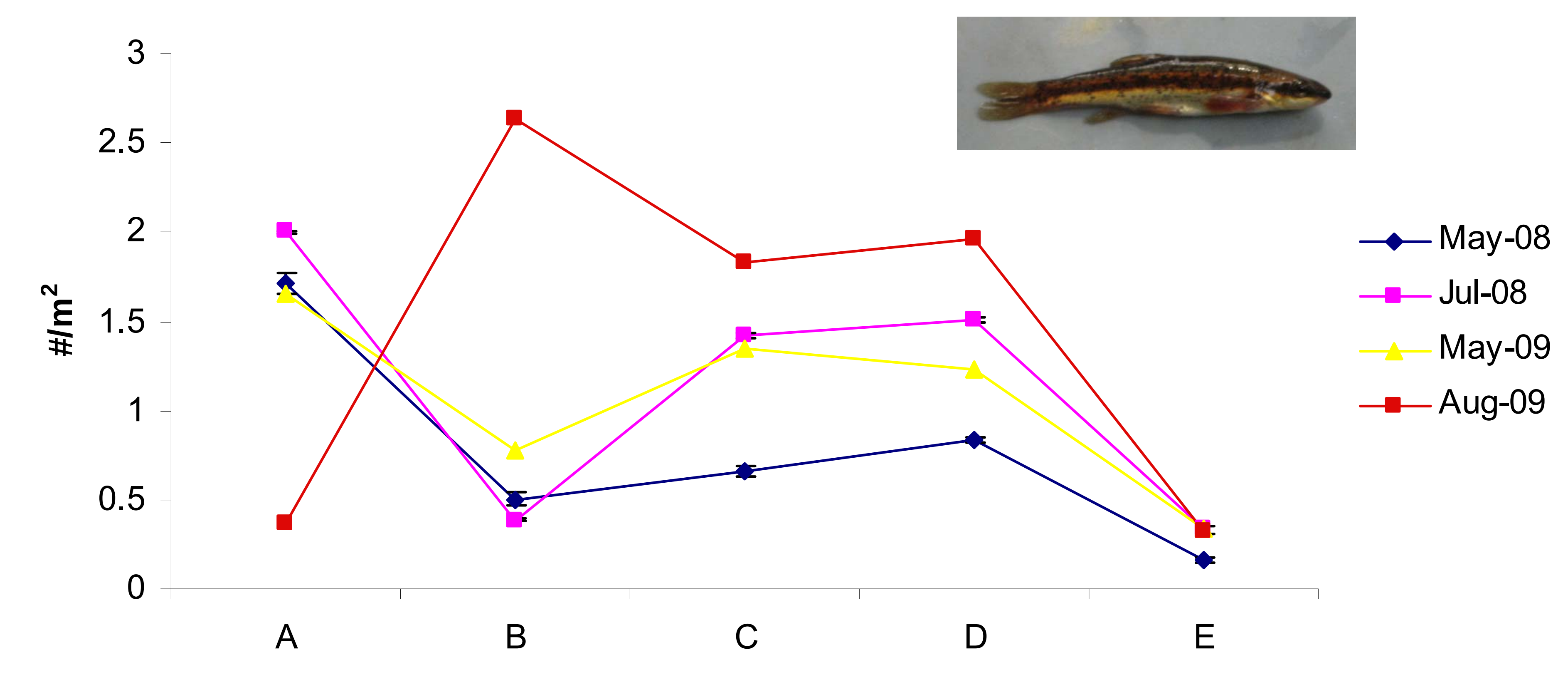
Total density – Post-removal



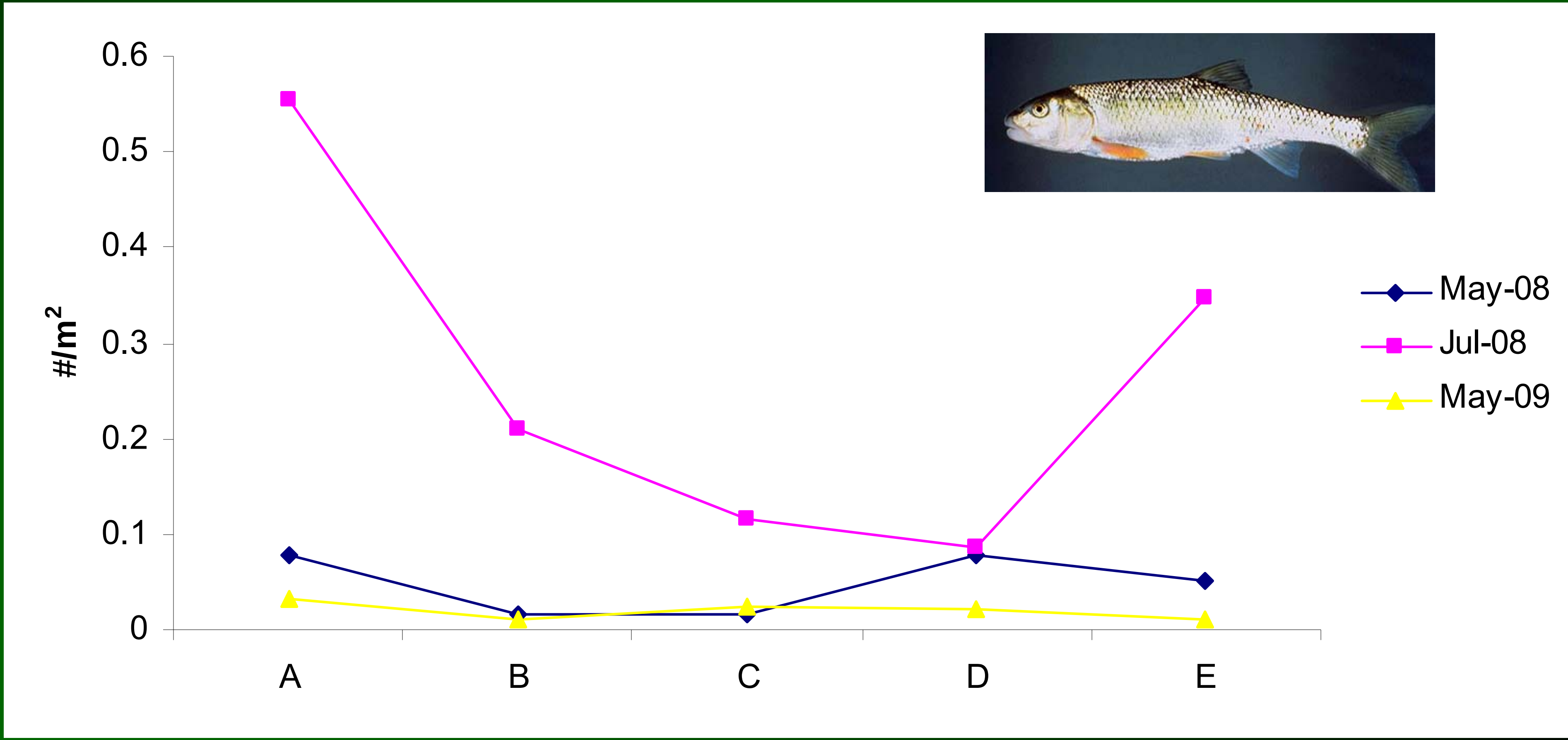
BND density– pre-removal



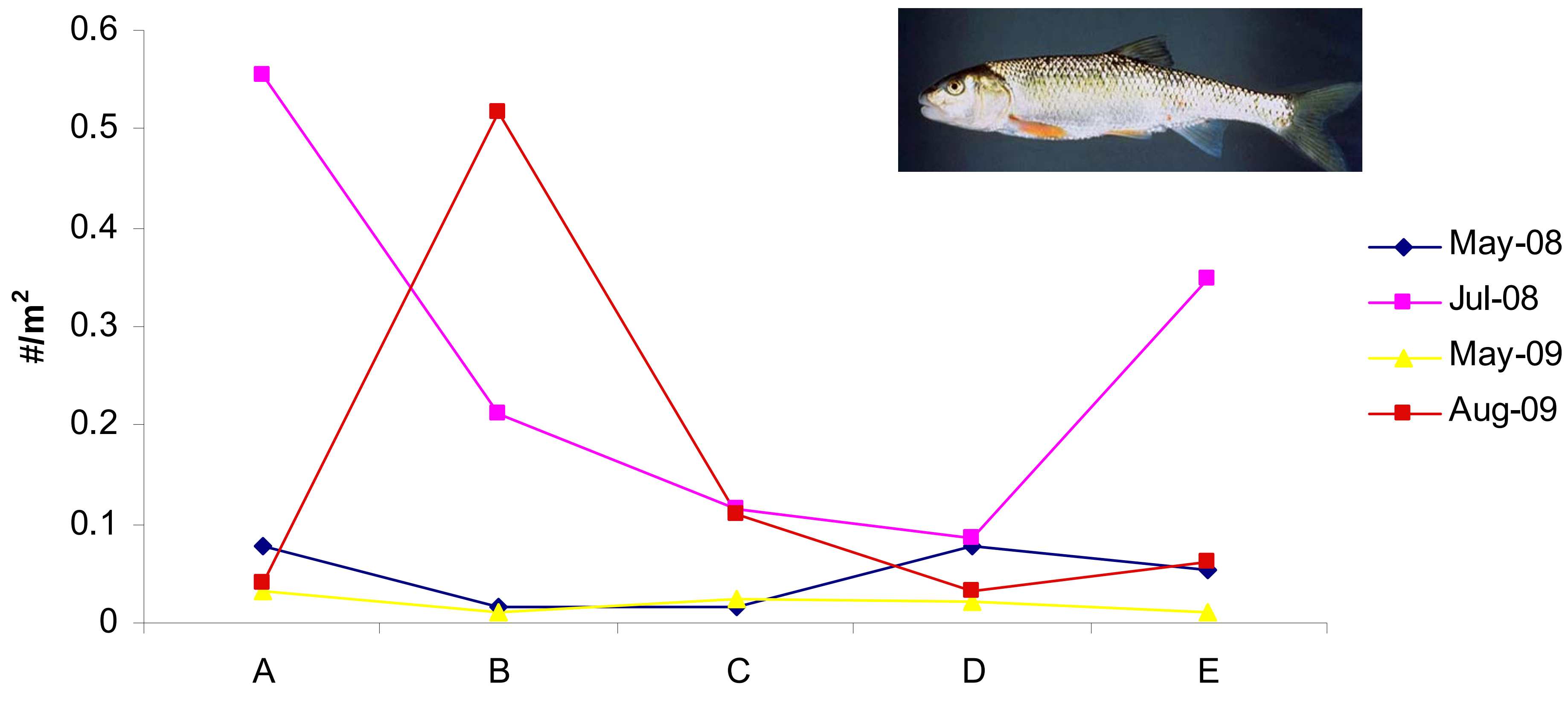
BND density– post-removal



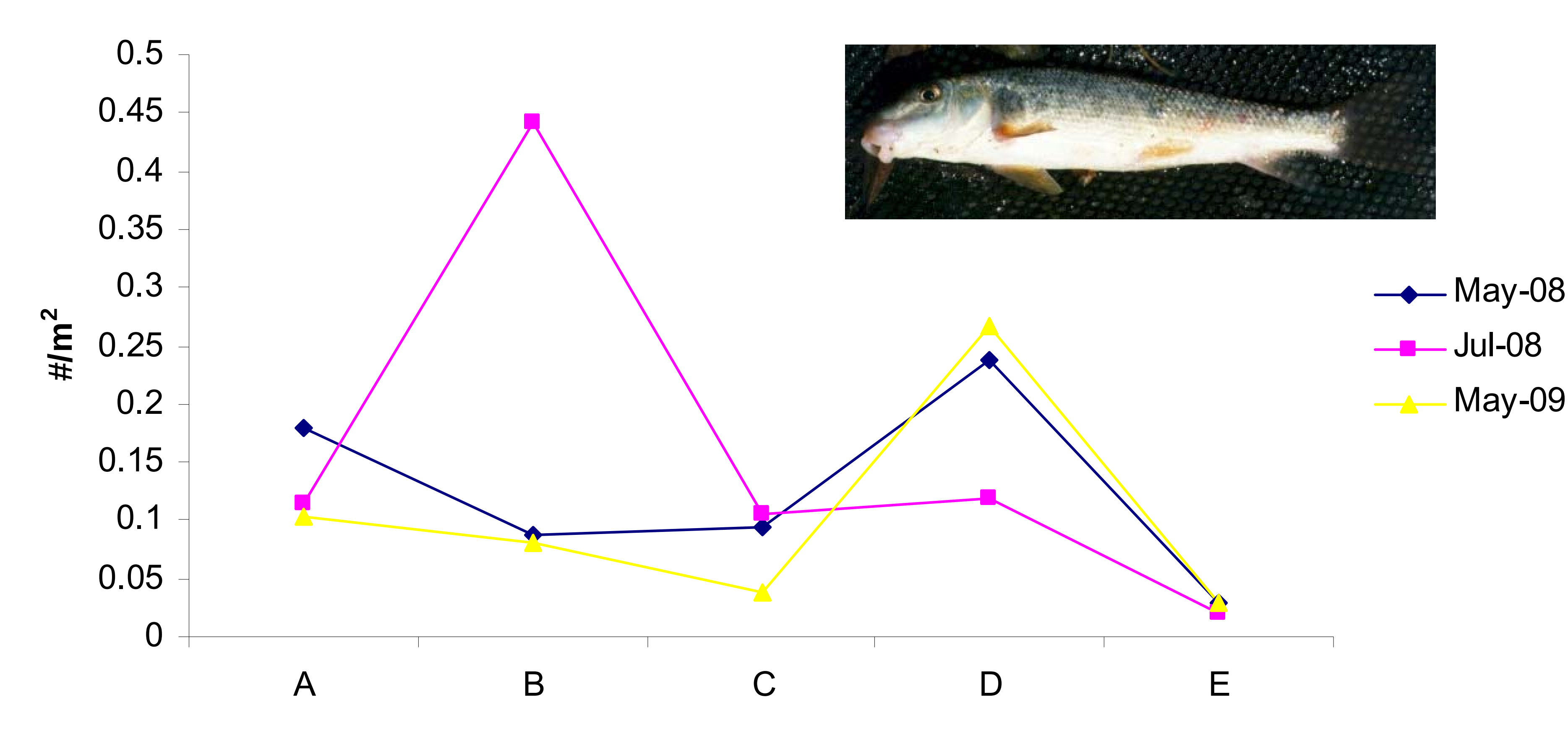
FF density – pre-removal



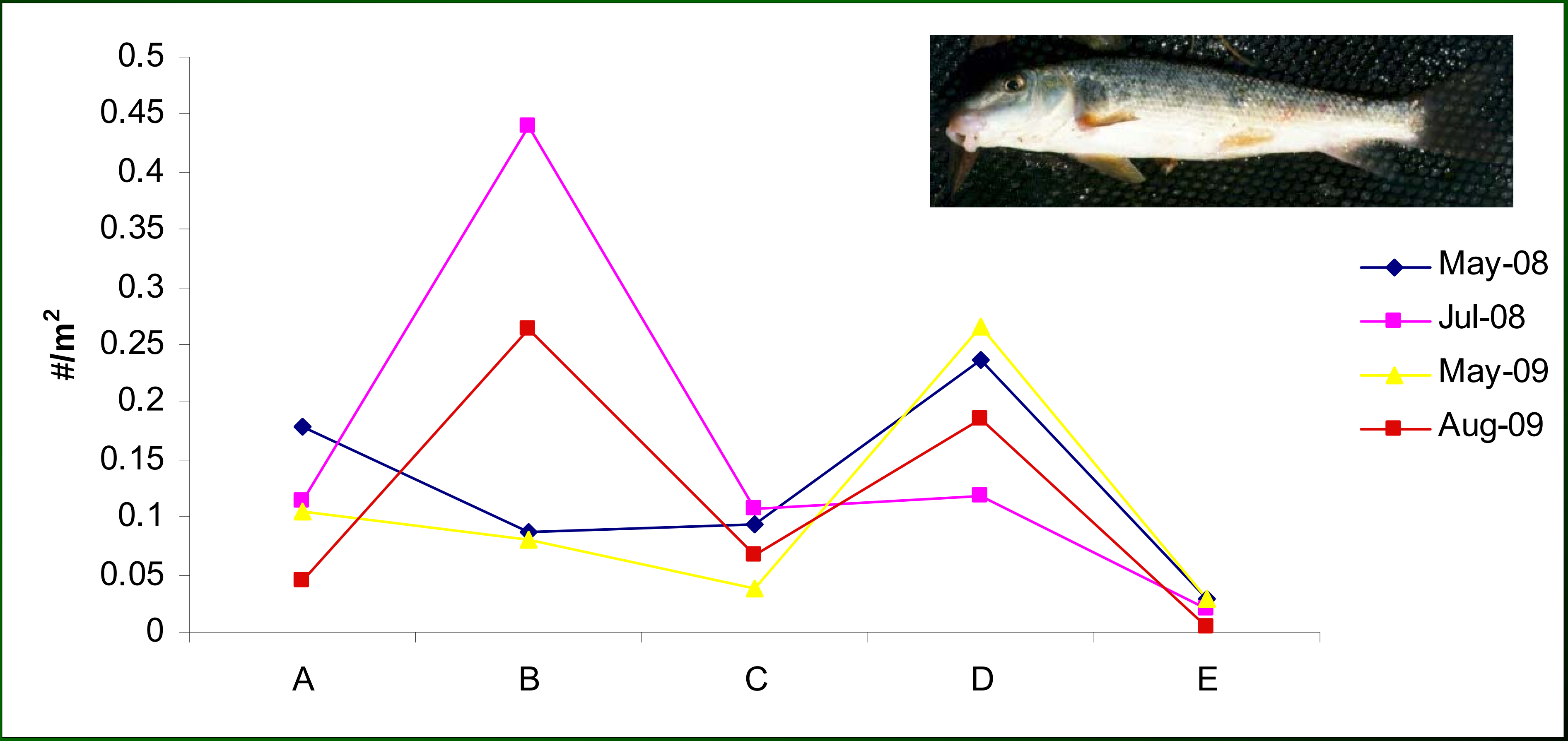
FF density – post-removal



WS density – pre-removal

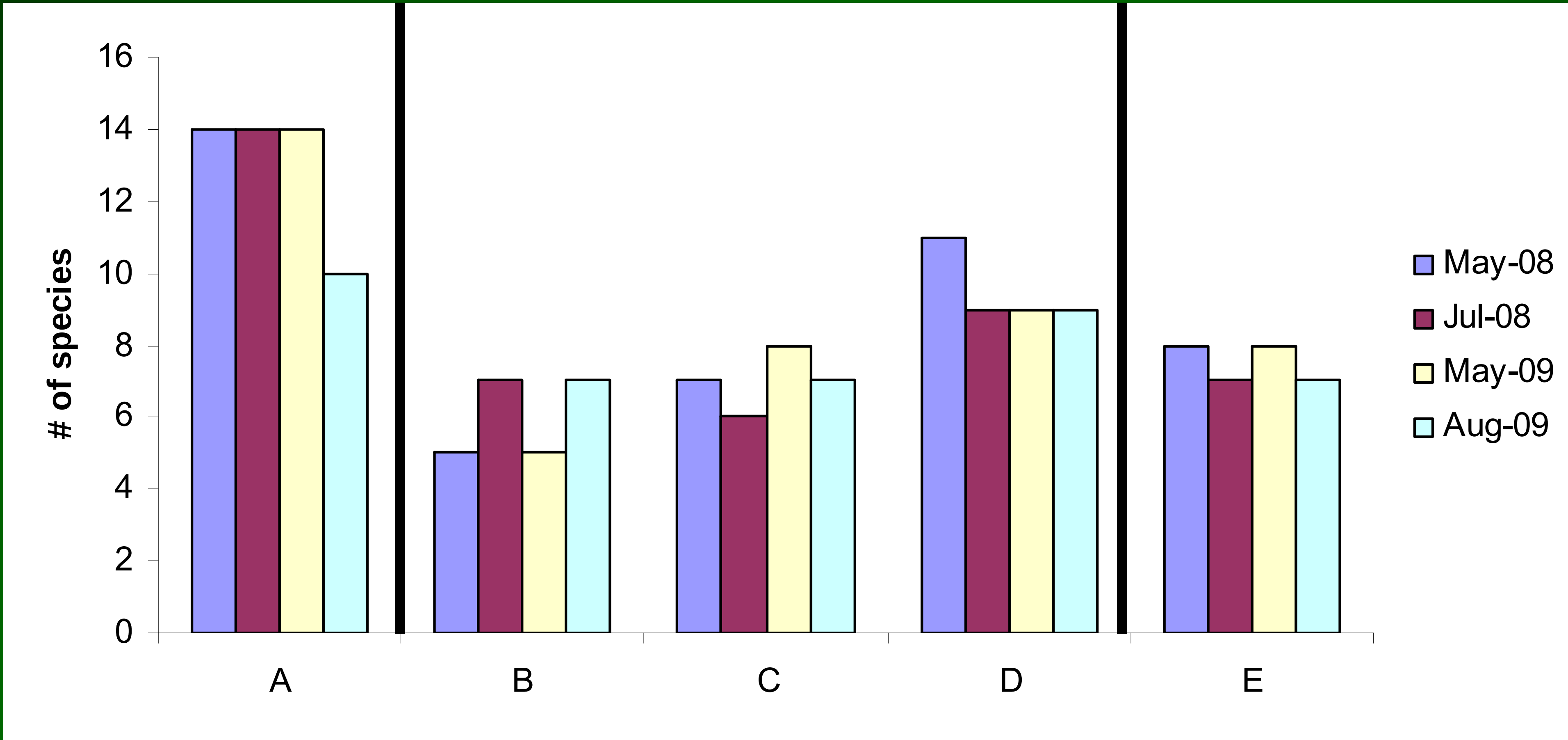


WS density – post-removal



Species richness

- Mill Dam separated richest (downstream) and poorest (upstream) sites
- After removal, richness decreased below and increased above (former) dam



Summary

- Pre-removal: Species richness and abundances were highest below Mill Dam
- Immediate response to dam removal was a drop in species richness and abundance below the dam
- Many fish appeared to move upstream in response to the dam removal
- Collected ATS fry below Mill Dam; collected parr upstream 3 days after dam removal
- Collected alewife YOY(?) below fishway 30 days after Mill dam removal

Barrier removal and range expansion of sea lamprey: quantifying habitat conditioning in Atlantic salmon nursery streams

Stephen M. Coghlan Jr.[1], Silas Ratten[1,2], Cory Gardner[1,2], Joseph Zydlewski[1,2], Kevin Simon[3], Rob Hogg[1,2]

[1]University of Maine Department of Wildlife Ecology
[2]Maine Cooperative Fisheries and Wildlife Research Unit
[3]University of Maine School of Biology and Ecology

A successful day of Atlantic salmon fishing on the Penobscot River in 1926.

FEATURE: ENDANGERED SPECIES

Rory Saunders
Michael A. Hachey
Clem W. Fay

Saunders is a fishery biologist, NOAA's National Marine Fisheries Service, Orono, Maine and can be reached at Rory.Saunders@noaa.gov. Hachey is an environmental technician, NOAA's National Marine Fisheries Service, Orono, Maine. Fay was a fisheries manager, for the Penobscot Nation, Department of Natural Resources, Indian Island, Maine.

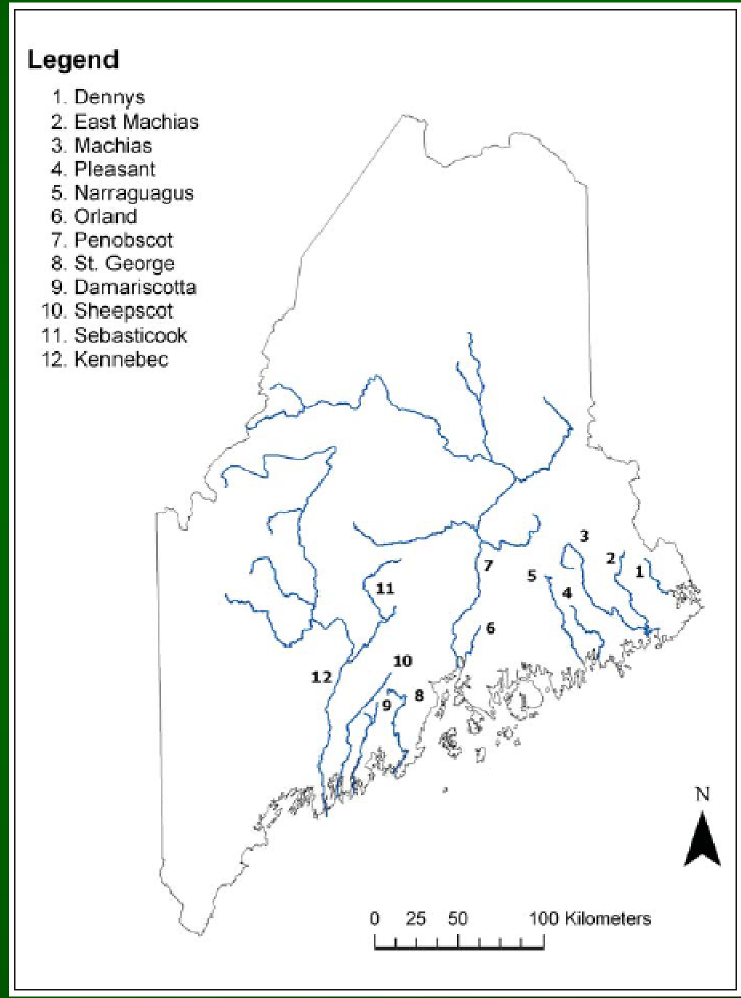
Maine's Diadromous Fish Community: Past, Present, and Implications for Atlantic Salmon Recovery

ABSTRACT: Co-evolved diadromous fishes may play important roles in key life history events of Atlantic salmon (*Salmo salar*) in northeastern U.S. riverine ecosystems. We reviewed available information on the historic and current abundance of alewives (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), rainbow smelt (*Osmerus mordax*), and sea lamprey (*Petromyzon marinus*) for several rivers in Maine. Historically, these diadromous fishes were substantially more abundant and were able to travel much farther inland to spawning and rearing areas in comparison to contemporary conditions. At historic abundance levels, these diadromous fishes likely provided several important functions for Atlantic salmon such as providing alternative prey for predators of salmon (i.e., prey buffering), serving as prey for juvenile and adult salmon, nutrient cycling, and habitat conditioning. Restoring the co-evolved suite of diadromous fishes to levels that sustain these functions may be required for successful recovery of the last native Atlantic salmon populations in the United States.

INTRODUCTION

Maine is now the southern terminus of the range of native Atlantic salmon (*Salmo salar*). By the late 1800s, native populations in the Connecticut, Merrimack, and Androscoggin Rivers had been completely extirpated, shifting the southern terminus of the species' range approximately 2 degrees north in latitude and 4 degrees east in longitude (Colligan et al. 1999). Current restoration efforts in Maine depend on substantial hatchery supplementation. Even with supplementation, however, their demographic status is far from secure (Legault 2005).

The life history of the Atlantic salmon is a complex process that requires unobstructed access between freshwater, estuarine, and marine environments. In these variable ecosystems, an intricate set of events is required for salmon to successfully complete their life cycle. When properly functioning, freshwater ecosystems provide spawning habitat and thermal refuge for adult Atlantic salmon; overwintering and rearing areas for eggs, fry, and parr; and migration corridors for smolts and adults (Bardonnet and Bagliniere 2000). The eggs hatch in late March or April. At this stage, they are referred to as alevin or sac fry. Alevins remain in the redd for about six more weeks and are nourished by their yolk sac until



Brendan J. Hicks · Mark S. Wipfli · Dirk W. Lang
Maria E. Lang

Marine-derived nitrogen and carbon in freshwater-riparian food webs of the Copper River Delta, southcentral Alaska

Incorporation of nitrogen and carbon from spawning coho salmon into the trophic system of small streams: evidence from stable isotopes

Robert E. Bilby, Brian R. Fransen, and Peter A. Bisson

Transfer of Nutrients from Spawning Salmon to Riparian Vegetation in Western Washington

Robert E. Bilby,* Eric W. Beach,[1] Brian R. Fransen, and
Jason K. Walter

*Weyerhaeuser Company, WTC 1A5,
Post Office Box 9777,
Federal Way, Washington 98063-9777, USA*

Peter A. Bisson

*U.S. Forest Service, Pacific Northwest Research Station,
Olympia Forestry Sciences Laboratory,
3625 93rd Avenue Southwest,
Olympia, Washington 98512-9193, USA*

Influence of salmon spawner densities on stream productivity in Southeast Alaska

Mark S. Wipfli, John P. Hudson, Dominic T. Chaloner, and John P. Caouette

Salmon-driven bed load transport and bed morphology in mountain streams

Marwan A. Hassan,[1] Allen S. Gottesfeld,[2] David R. Montgomery,[3] Jon F. Tunnicliffe,[4] Garry K. C. Clarke,[5] Graeme Wynn,[1] Hale Jones-Cox,[1] Ronald Poirier,[1] Erland MacIsaac,[6] Herb Herunter,[6] and Steve J. Macdonald[7]

The effect of salmon redd excavation on stream substrate and benthic community of two salmon spawning streams in Canterbury, New Zealand

M.S. Field-Dodgson
Fisheries Research Division Ministery of Agriculture and Fisheries Christchurch New Zealand

Stream-bed scour, egg burial depths, and the influence of salmonid spawning on bed surface mobility and embryo survival

David R. Montgomery, John M. Buffington, N. Phil Peterson, David Schuett-Hames, and Thomas P. Quinn

Benthic communities of Lake Ontario tributaries : the influence of migratory Pacific salmon

Susan D. Proch

Phosphorus flux due to Atlantic salmon (*Salmo salar*) in an oligotrophic upland stream: effects of management and demography[1]

Keith H. Nislow, John D. Armstrong, and Simon McKelvey

Abstract: Little is known concerning the role of Atlantic salmon (*Salmo salar*) in the transport of nutrients to and from river systems. We used demographic data from the River Bran, an oligotrophic river in Scotland, UK, to construct a budget for the transport of phosphorus (P) and applied it to investigate the effects of management strategies and demographic rates on potential transport. At present, because few adults return to their spawning grounds, salmon export 0.2–0.5 kg P·year^{-1}. In contrast, increasing passage rates to a level sufficient to maintain a population without stocking would likely result in a gain of up to several kilograms per year. However, this effect depended on the retention of adult-derived P, which varies across systems and is poorly known at present. Egg-derived P exceeded that from adults at low (<25%) retention rates but was insufficient on its own to balance losses. Increased marine survival rates also increased the potential for positive P flux, while reduction in egg–smolt survival reduced the magnitude of transport. These results indicate the importance of considering within-river movements of individuals and nutrients and the need to fill critical data gaps in assessing the role of Atlantic salmon in nutrient transport.

Ecology, 60(1), 1979, pp. 8–17

EFFECTS OF THE SPAWNING MIGRATION OF THE ALEWIFE, *ALOSA PSEUDOHARENGUS*, ON FRESHWATER ECOSYSTEMS[1]

ANN GALL DURBIN, SCOTT W. NIXON, AND CANDACE A. OVIATT
Graduate School of Oceanography, University of Rhode Island, Kingston, Rhode Island 02881 USA

Abstract. The influx of large numbers of alewife, *Alosa pseudoharengus*, into relatively small freshwater systems may have a considerable impact upon pre-established food chains and nutrient cycles. We estimate the total nutrient input to Pausacaco Pond, Rhode Island, USA, from alewives amounted to 0.43 g P, 2.7 g N, and 16.8 g C/m^2 over a 2-mo period. This is largely through mortality of the spawning fish, and to a lesser extent through excretion. These inputs were much greater than the eventual nutrient loss to the system through emigration of juvenile fish.

In tank experiments using pond microcosms, the initial response to the addition of the fish was a large phytoplankton bloom and an increase in litter respiration. The phytoplankton bloom was short-lived, and the most lasting effect was an increase in production and respiration in the leaf litter. This increased production in the litter community would support a long lasting supply of insect and benthic invertebrate food for young fish.

The respiration rate of autumn leaves incubated in alewife streams during the migration was significantly higher than that of leaves incubated simultaneously in a stream which had no alewife run. Respiration rates of leaves incubated in the same streams before the arrival of alewives did not differ significantly. The increase in litter respiration, an indication of microbial and invertebrate activity on the leaf surface, was attributed to the additional nutrients supplied by the fish.

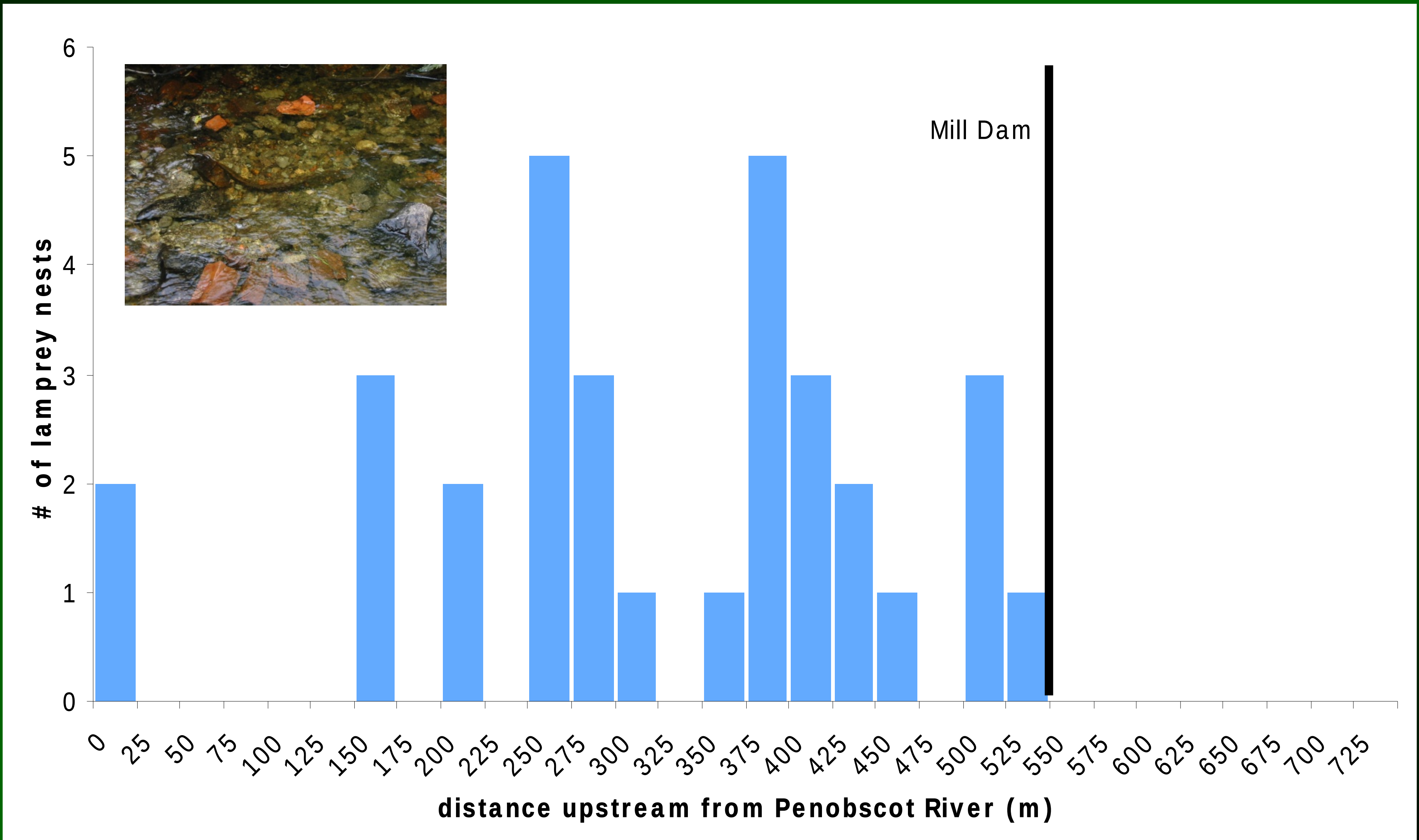
Key words: alewife; Alosa pseudoharengus; *anadromous; fish migration; lakes; litter; microcosm; nutrients; Rhode Island; spawning migration; streams.*

Descriptive:

Population estimate

Distribution of nests

Distribution of nests - 2008



Test hypotheses that:

- Sea lamprey spawning conditions habitat to the benefit of Atlantic salmon
- Habitat quality is higher in reaches accessible to sea lamprey than inaccessible reaches
- Sea lamprey range expands following barrier removal
- Habitat quality improves after barrier removal, throughout watershed

Metrics of habitat quality

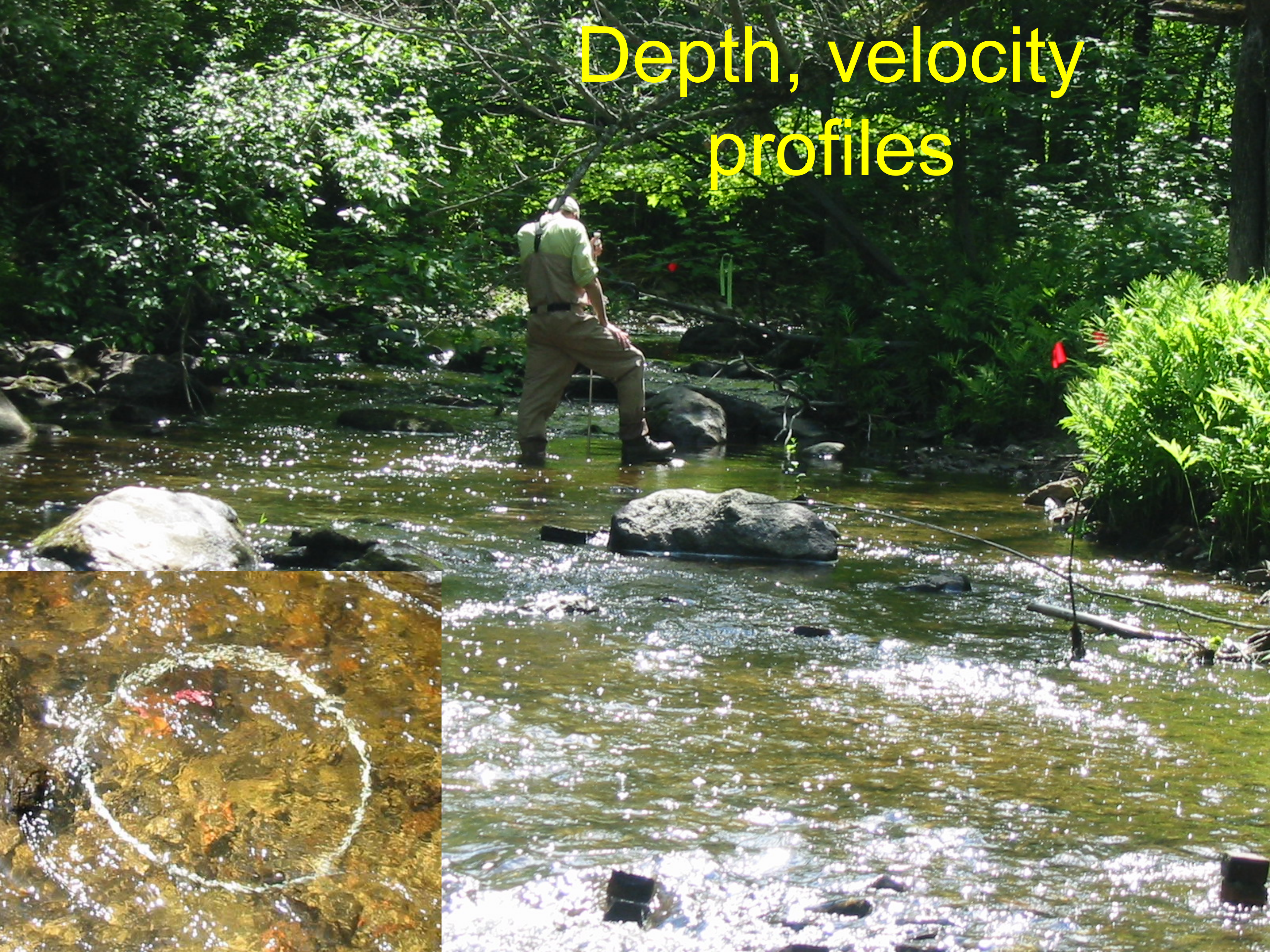
- Permeability, embeddedness, and particle size → spawning habitat
- Depth, velocity, substrate profiles → energetic profitability of foraging habitat for juveniles
- Marine-derived nutrients → invertebrate production, drift → juvenile growth

Experimental BACI design: compare metrics…

- Temporally: before and after
  - seasonally (pre-spawn vs. post-spawn)
  - annually (pre-dam removal vs. post-dam removal)
- Spatially: within and among streams
  - low lamprey density vs. high lamprey density
  - accessible reaches vs. inaccessible reaches
  - lamprey-rich stream vs. lamprey-less stream

ACCESSIBLE
Penobscot River
Mill Dam
NEWLY ACCESSIBLE
Sedgeunkedunk Stream
Meadow Fishway
NOT USED
Fields Pond
Johnson Brook
Clark Falls
INACCESSIBLE
Swetts Pond
Orrington, Maine


Primary productivity, MDNE


Depth, velocity
profiles


Hodgman
Particle size, embeddedness


Fine sediment accumulation


Intragravel permeability


Benthic productivity, drift

Modeling ATS habitat quality

Habitat Suitability Index Models: Nonmigratory Freshwater Life Stages of Atlantic Salmon

by

Jon G. Stanley[1]

National Biological Service
Great Lakes Science Center
1451 Green Road
Ann Arbor, Michigan 48105

and

Joan G. Trial

Maine Department of Inland Fisheries and Wildlife
Fisheries Division
650 State Street
Bangor, Maine 04401

Transactions of the American Fisheries Society 129:1067–1081, 2000

Spatially Explicit Bioenergetic Analysis of Habitat Quality for Age-0 Atlantic Salmon

K. H. Nislow*[1] and C. L. Folt

Department of Biological Sciences, Dartmouth College, Hanover, New Hampshire 03755, USA

D. L. Parrish

Vermont Cooperative Fish and Wildlife Research Unit,[2] School of Natural Resources, University of Vermont, Burlington, Vermont 05405, USA


June 1, 2009


June 4 – July 15, 2009


Any questions?