Naturalized Pacific Salmon in the Great Lakes: Have We Lost Control?

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Great Lakes Fishing

- Economic driver
- Collaborative management
- Joint Strategic Plan

History of Great Lakes Salmonines

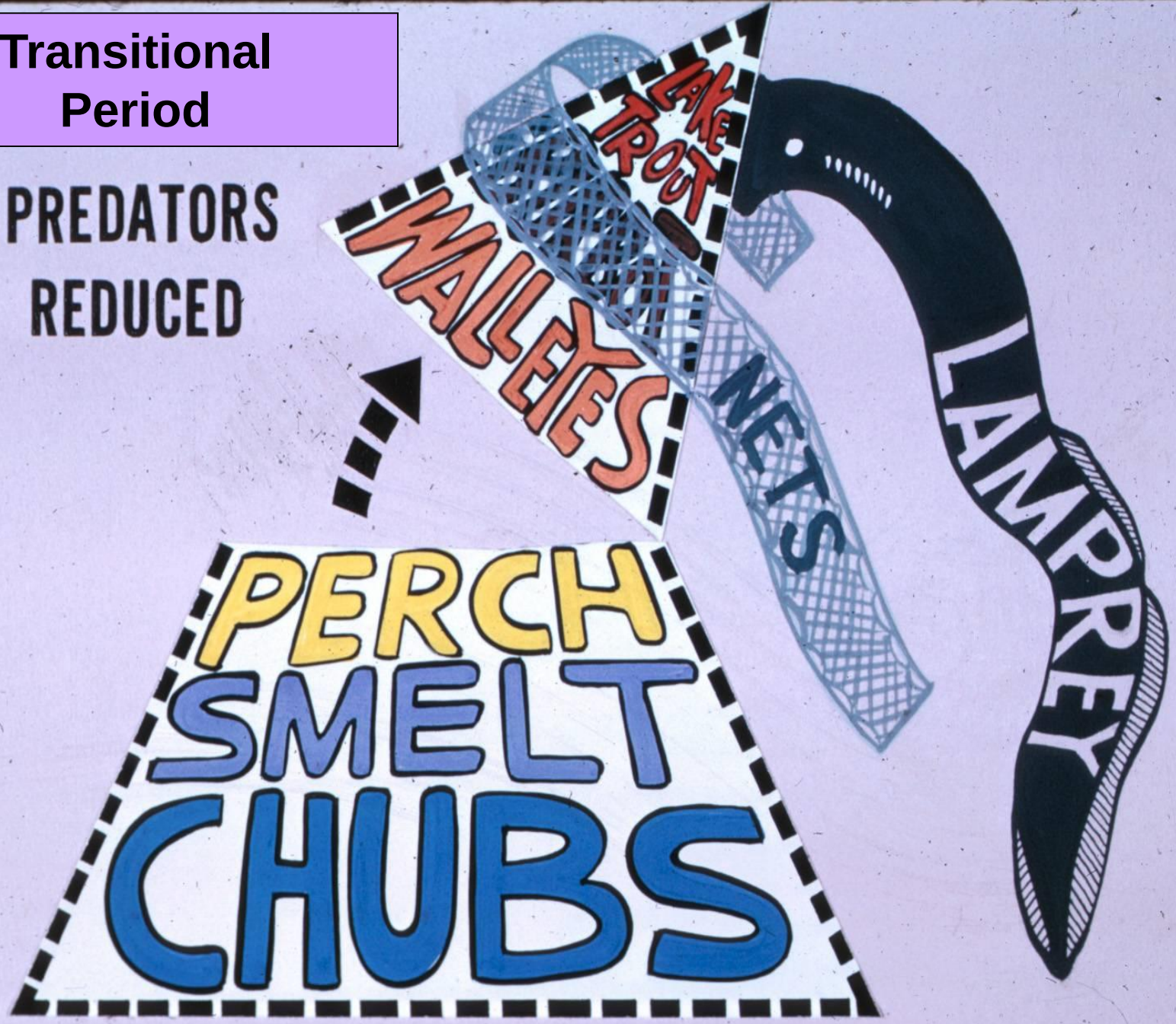
- Three periods including:
  - Indigenous (pre-1850)
  - Transitional (1850-1960)
  - Recent (~1960 to present)

Indigenous to Transitional Period

LAKE TROUT
BURBOT
WALLEYES
PERCH
CHUBS

A BALANCED POPULATION

Transitional Period



Start of the Recent Period

ALEWIFE EXPLOSION

PREDATORS GONE

The Salmonines

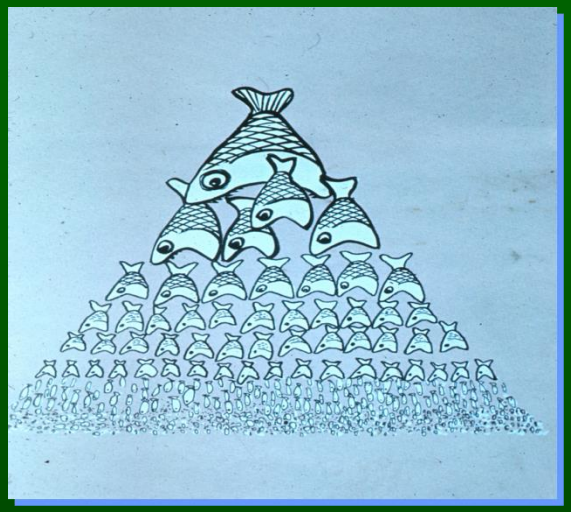
Brown Trout

Coho Salmon

Chinook Salmon

Steelhead

History of Great Lakes Salmonines

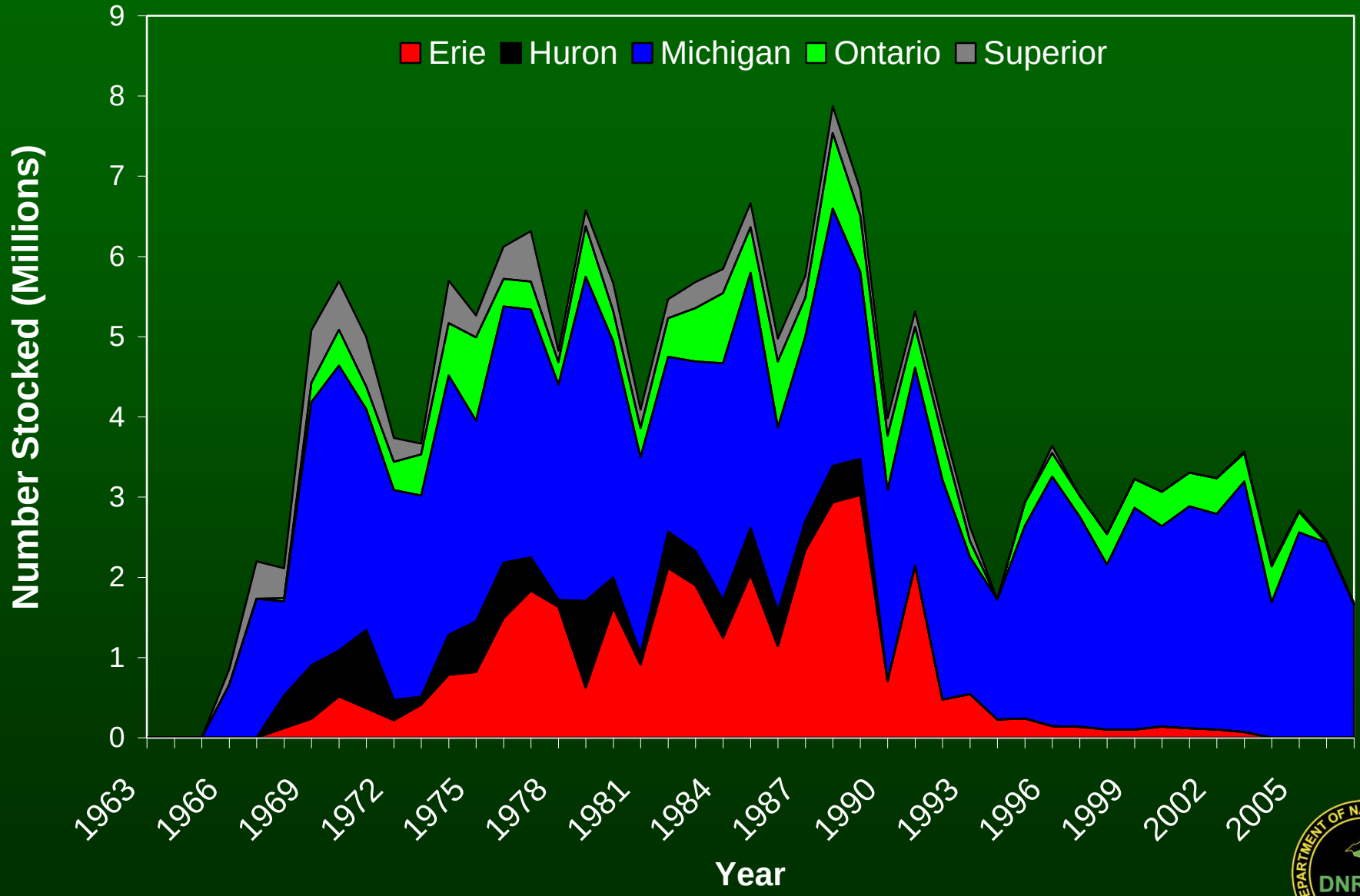


- Three periods including:
  - Indigenous (pre-1850)
  - Transitional (1850-1960)
  - Recent (~1960 to present)
- Ecosystem-level bio-manipulation to restore a healthy food web and fishery

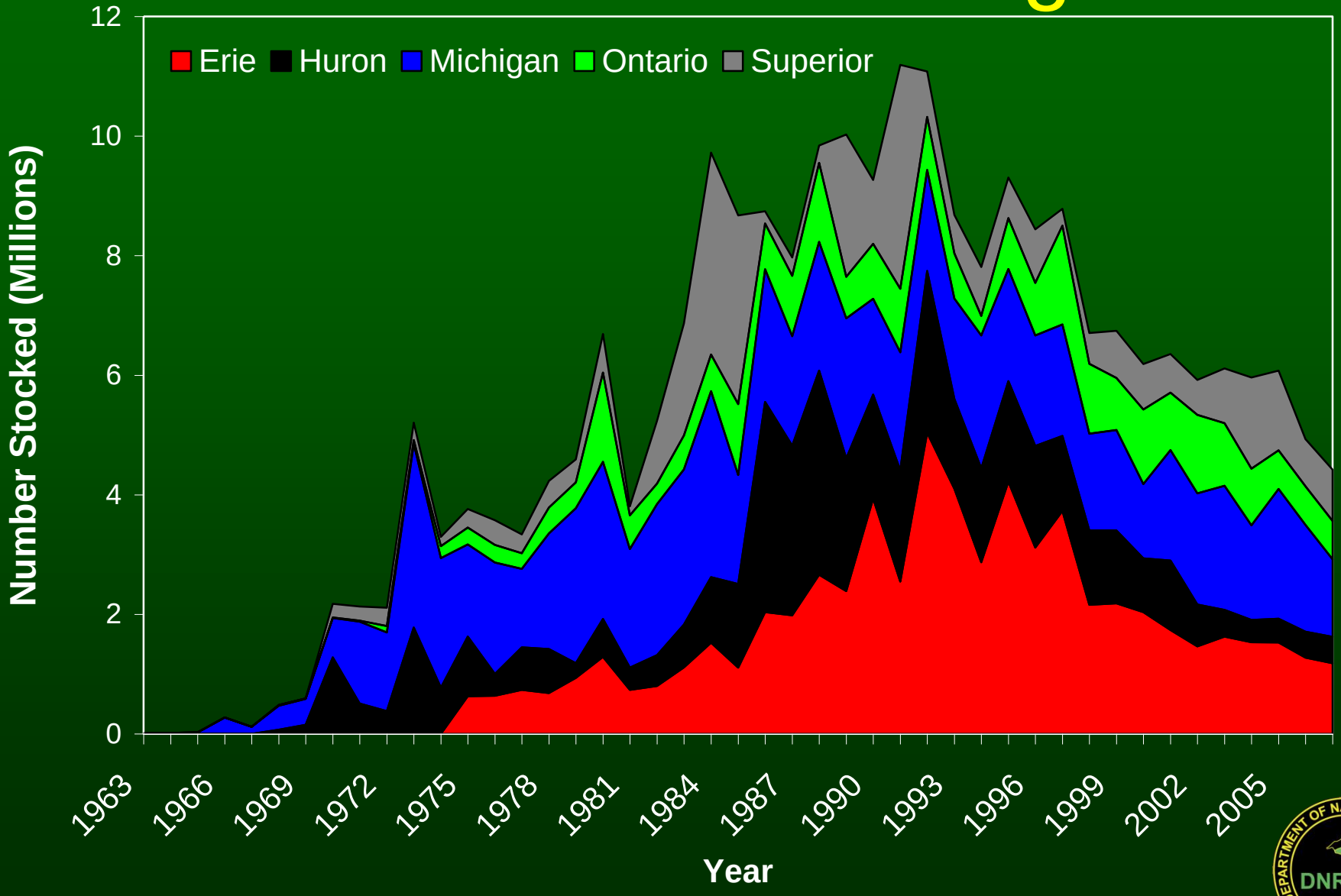
Ecosystem Biomanipulation: Unintended Consequences

- The Cane toad, introduced to Australia as a biological control of the cane beetle; went horribly wrong.
- The Nile perch, a voracious predator, was introduced to Lake Victoria to consume prey fish. The Nile perch has eliminated over 100 species of native cichlid fishes.
- Grass Carp in the U.S.

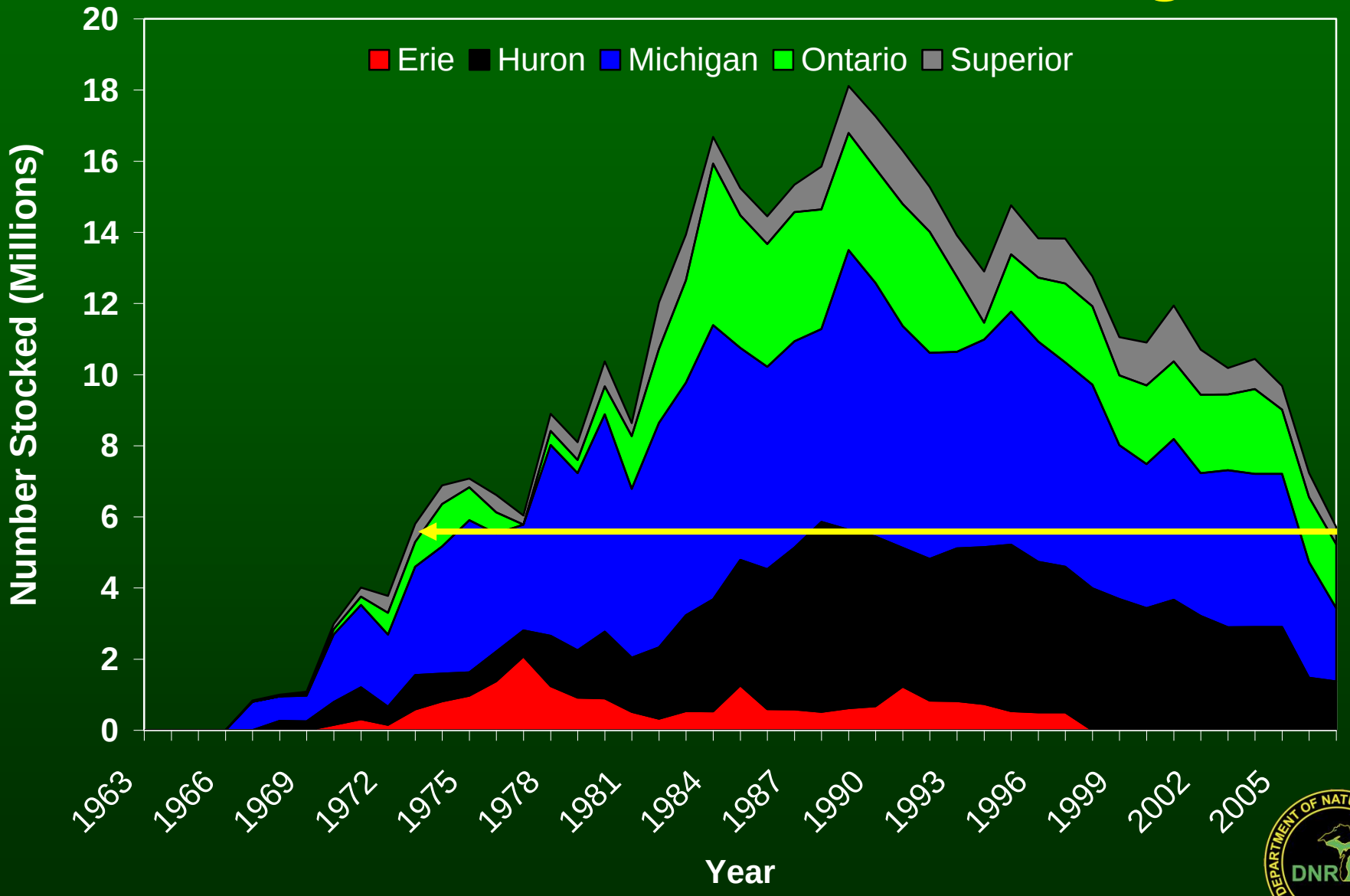
Coho Salmon Stocking



Steelhead Stocking



Chinook Salmon Stocking



Summary of Fisheries Policies

- Stocking of salmon in response to invasive species peaked mid-1980s to mid-1990s, but declined recently
- Recognition of ecosystem limits in all lakes; new invasive species altering the lakes and fishery
- How do we respond to a complex and rapidly changing ecosystem if stocking is limited?
- Naturalized salmonines was one of our management goals, but have we lost control?

Chinook Salmon Stocking and Harvest in Lake Michigan

Stocking (millions of smolts)

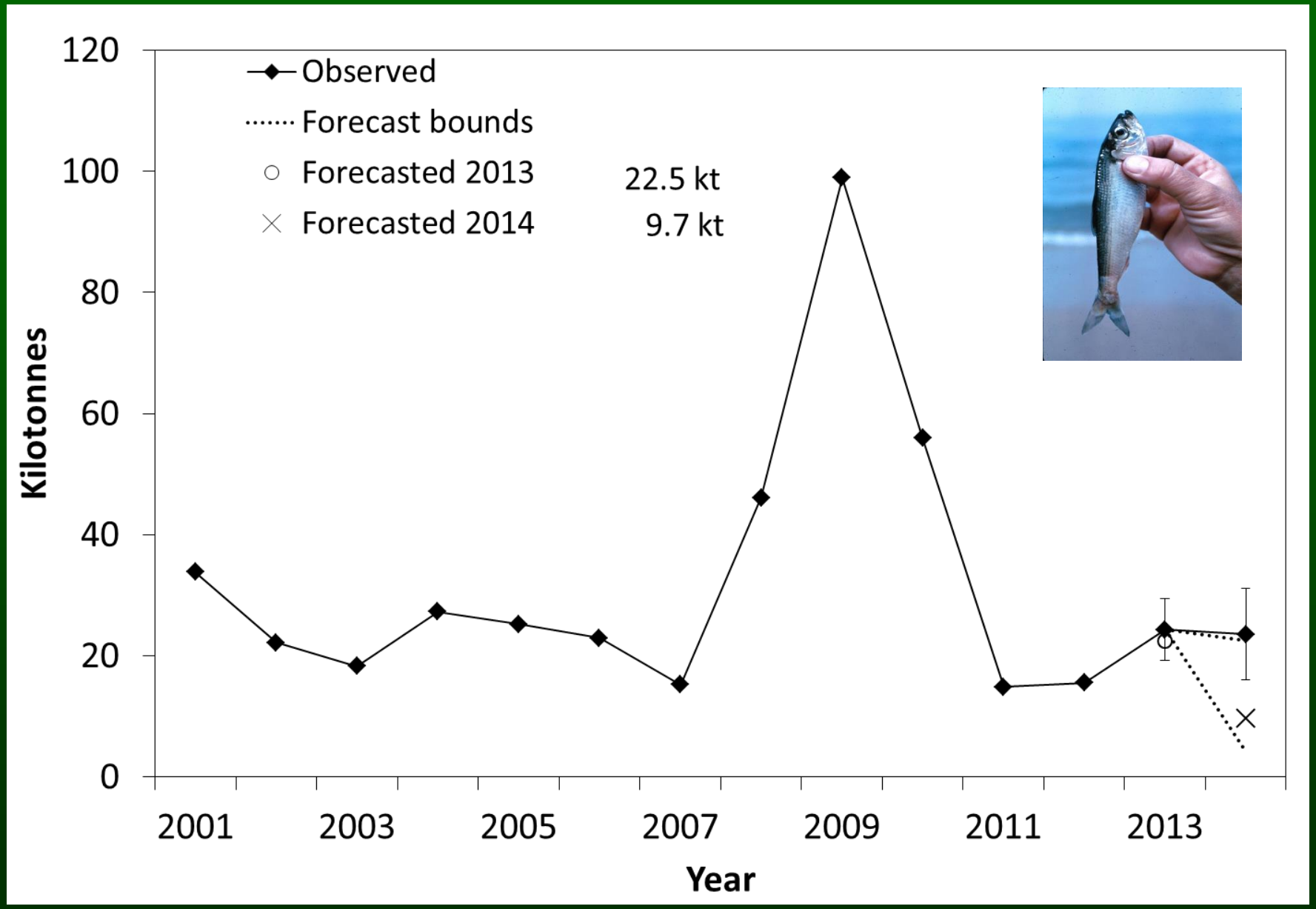
0 1 2 3 4 5 6 7 8 9

Harvest (millions of pounds)

0 2 4 6 8 10 12

1965 1970 1975 1980 1985 1990 1995 2000 2005 2010

Adult Alewife Biomass, 2001-2014

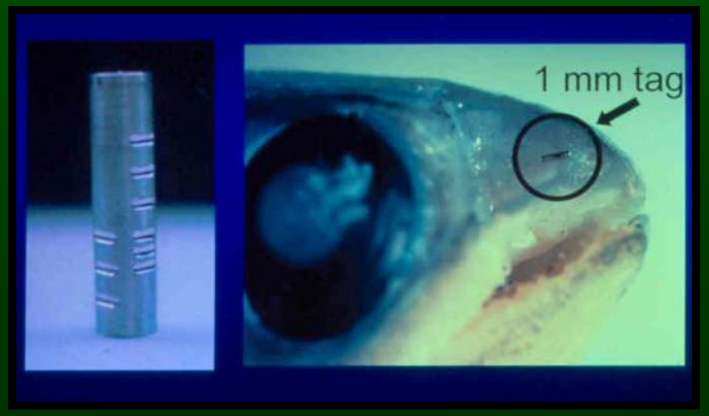


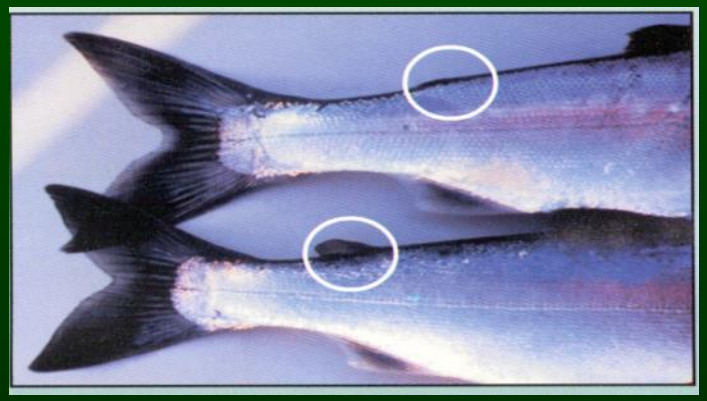
Warner, D.M. et al. 2015 Lake Michigan Committee Report.

Mass-Marking Project

- Coordinated, basin-wide, multi-agency tagging and recovery effort requested by the CLC to enhance understanding of Great Lakes salmonine fisheries

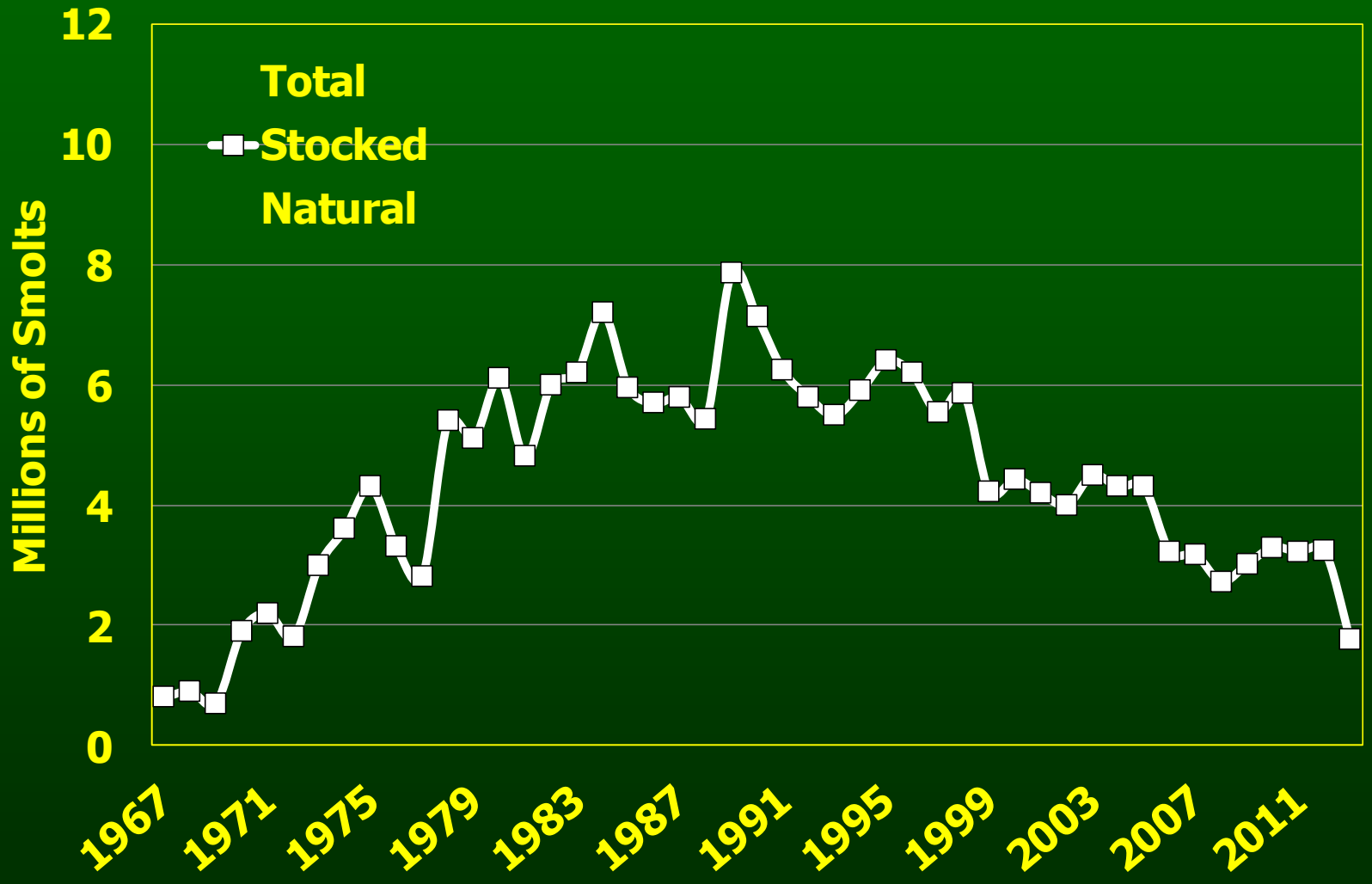
- Lake trout tagging began in 2010; Chinook salmon in 2011





- 16 million Chinook salmon and 28.5 million lake trout tagged

Estimated Chinook Salmon Recruitment in Lake Michigan, 1967-2013



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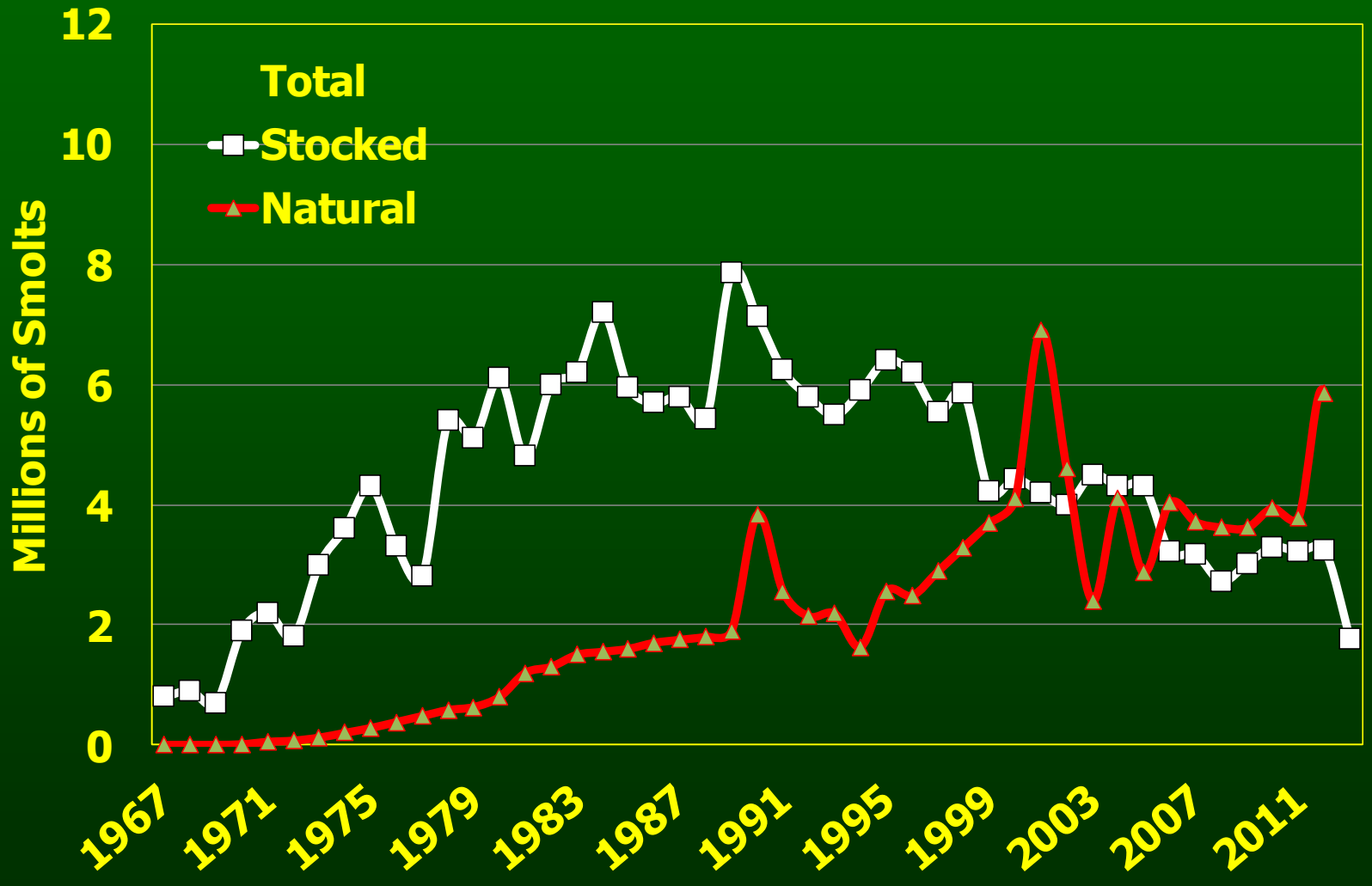

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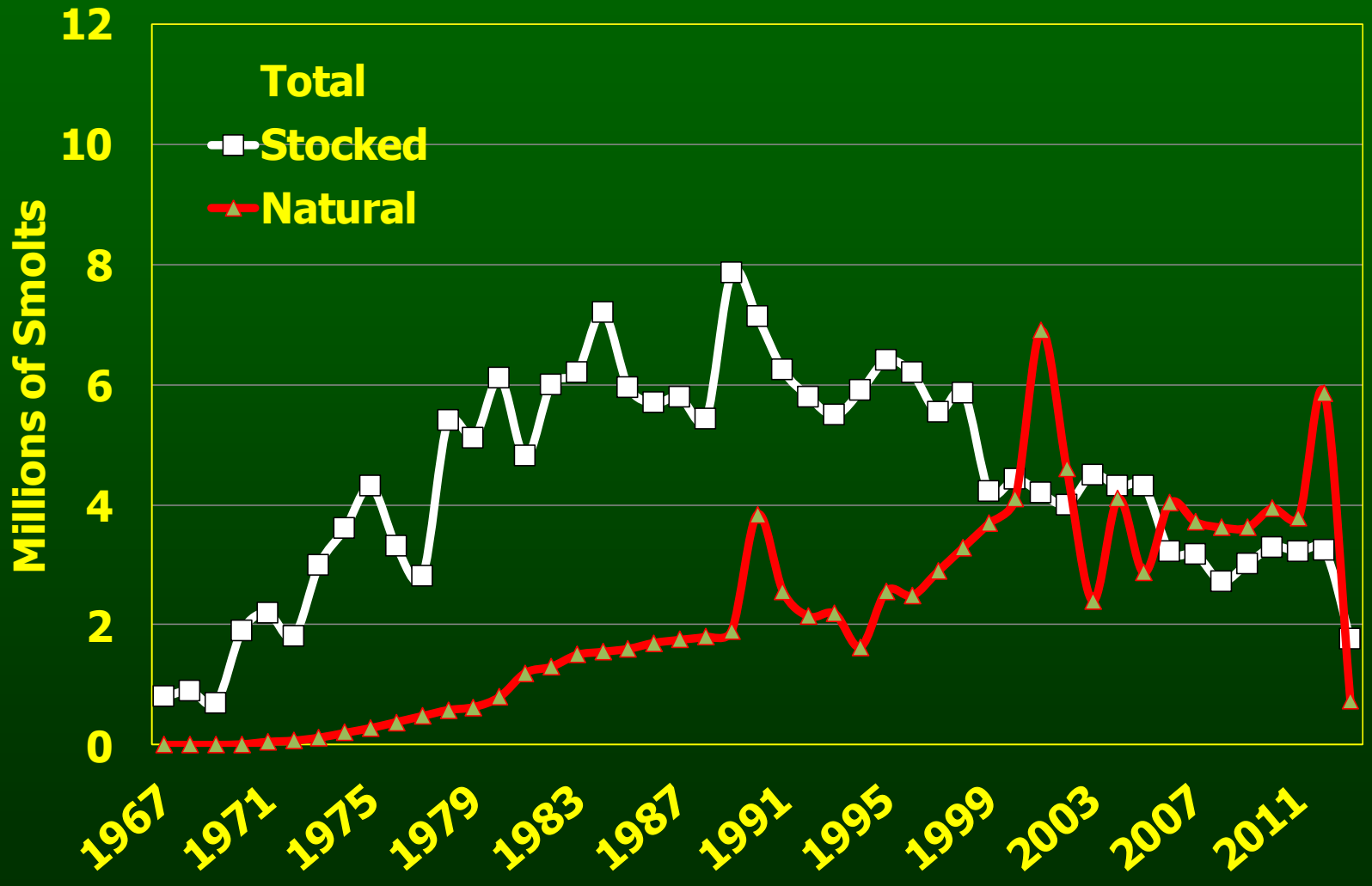

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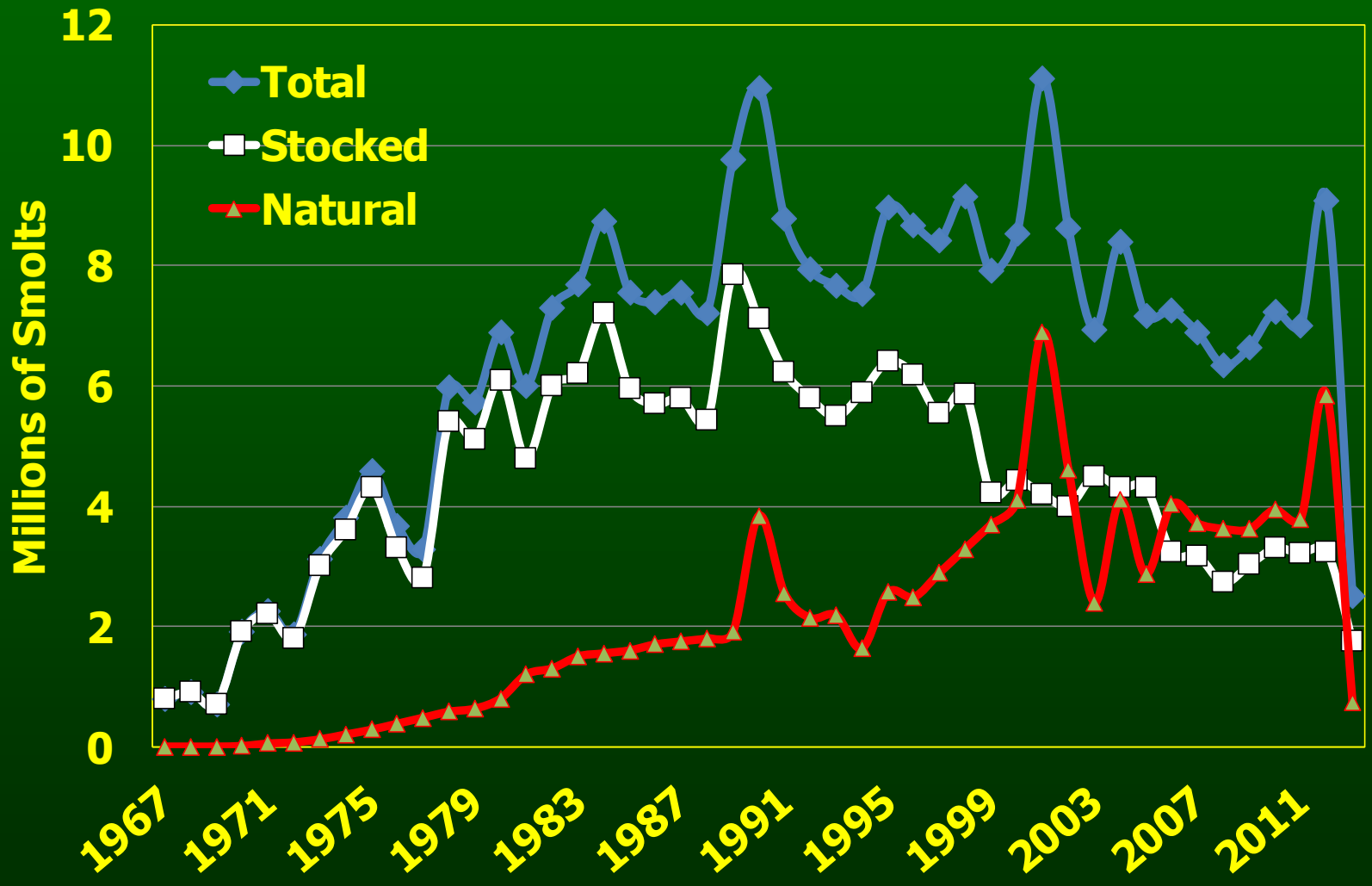
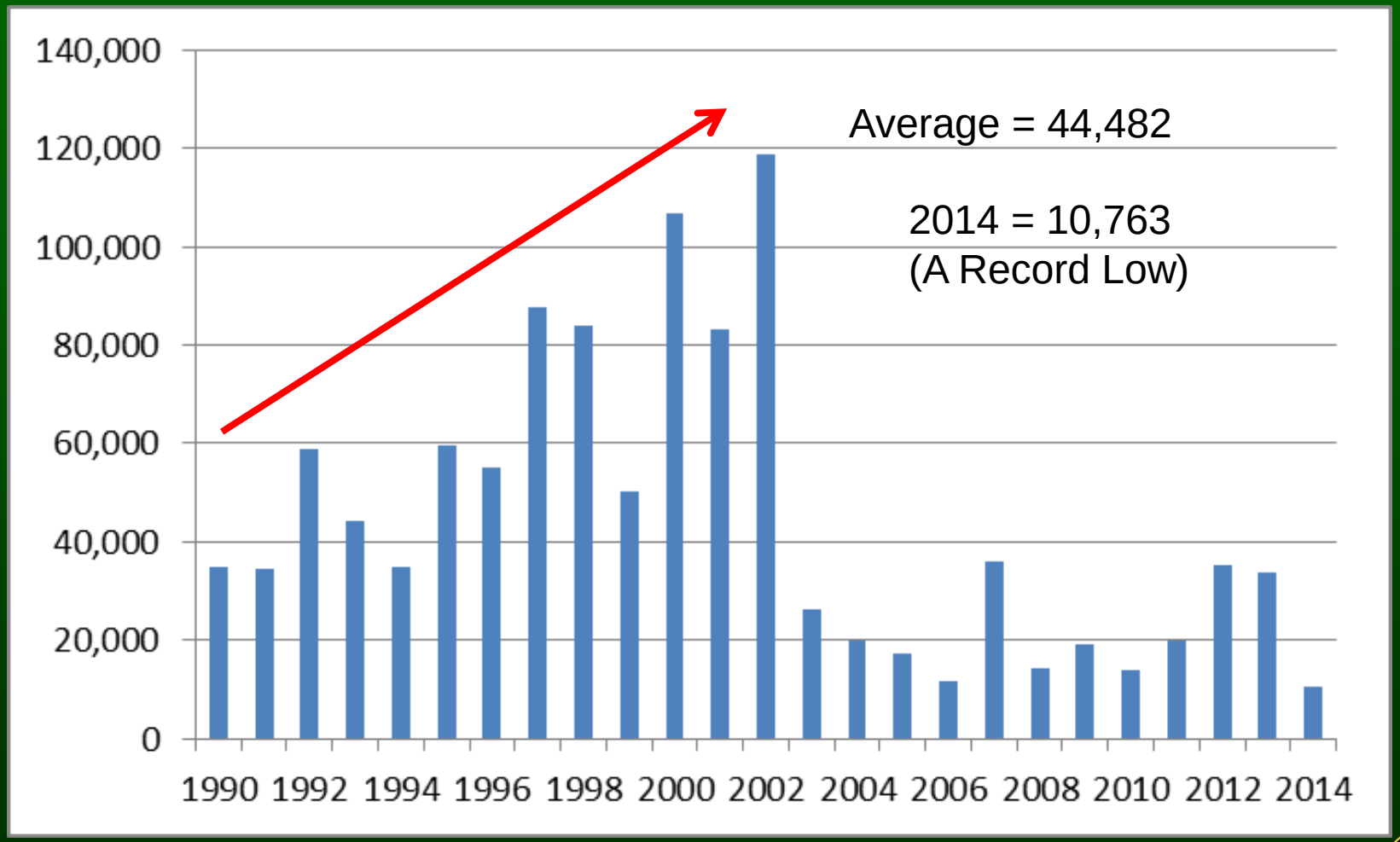


Coho Salmon Returns to the Lower Platte Weir, 1990-2014



Exploring Life History Characteristics of Naturalized Versus Stocked Pacific Salmon: Implications for the Fishery

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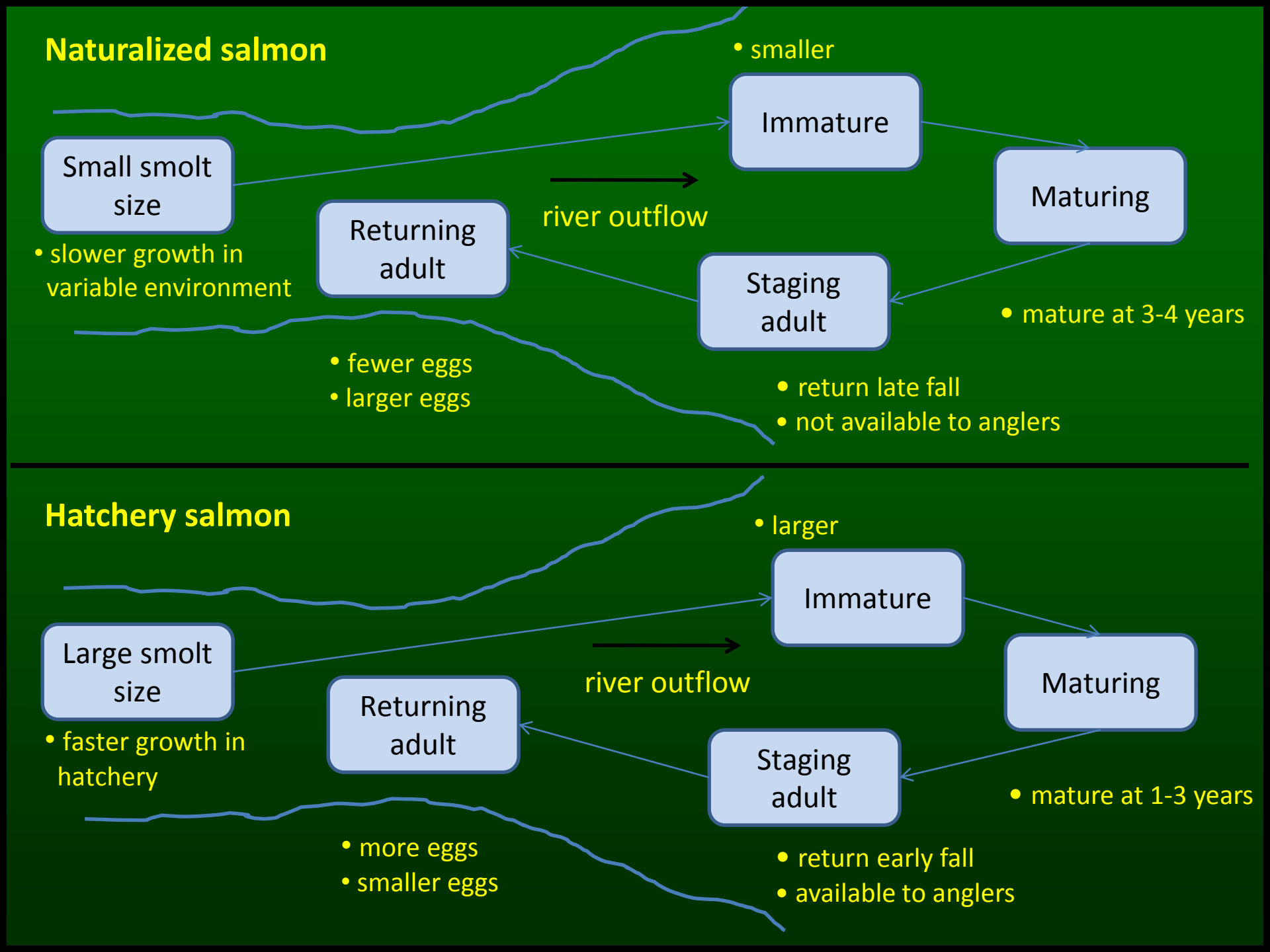
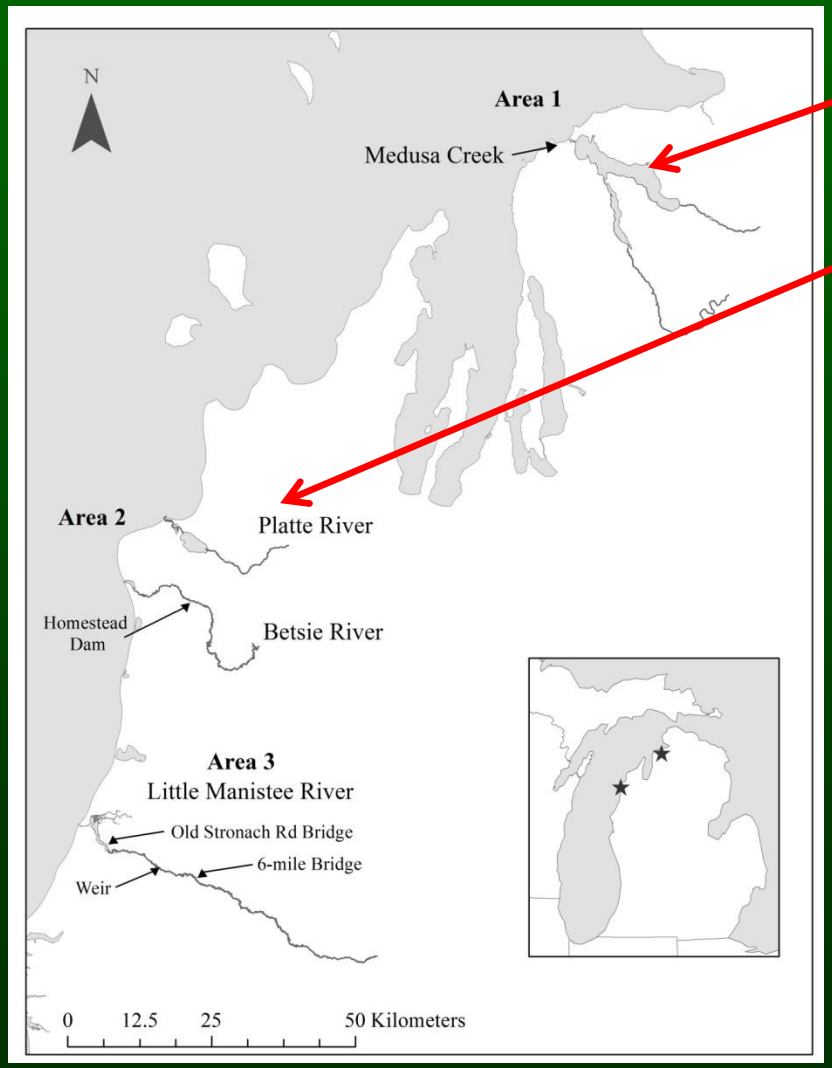
Paris D. Collingsworth, Illinois-Indiana Sea Grant
Great Lakes National Program Office


Naturalized salmon
• smaller
Immature
Small smolt size
Maturing
river outflow
Returning adult
• slower growth in variable environment
Staging adult
• mature at 3-4 years
• fewer eggs
• larger eggs
• return late fall
• not available to anglers
Hatchery salmon
• larger
Immature
Large smolt size
Maturing
river outflow
Returning adult
• faster growth in hatchery
Staging adult
• mature at 1-3 years
• more eggs
• smaller eggs
• return early fall
• available to anglers

Coho Salmon Comparison



- Charlevoix system stocked in 1972-1973
- Platte River stocked every year
- Platte River coho start returning in August
- Charlevoix coho return in December
- Coho naturalized and fluctuating with environmental changes

Chinook salmon size and condition at stocking

Jory L. Jonas and Randall M. Claramunt

2001 – 2006 Chinook Year Classes

Swan

Medusa

Little Manistee

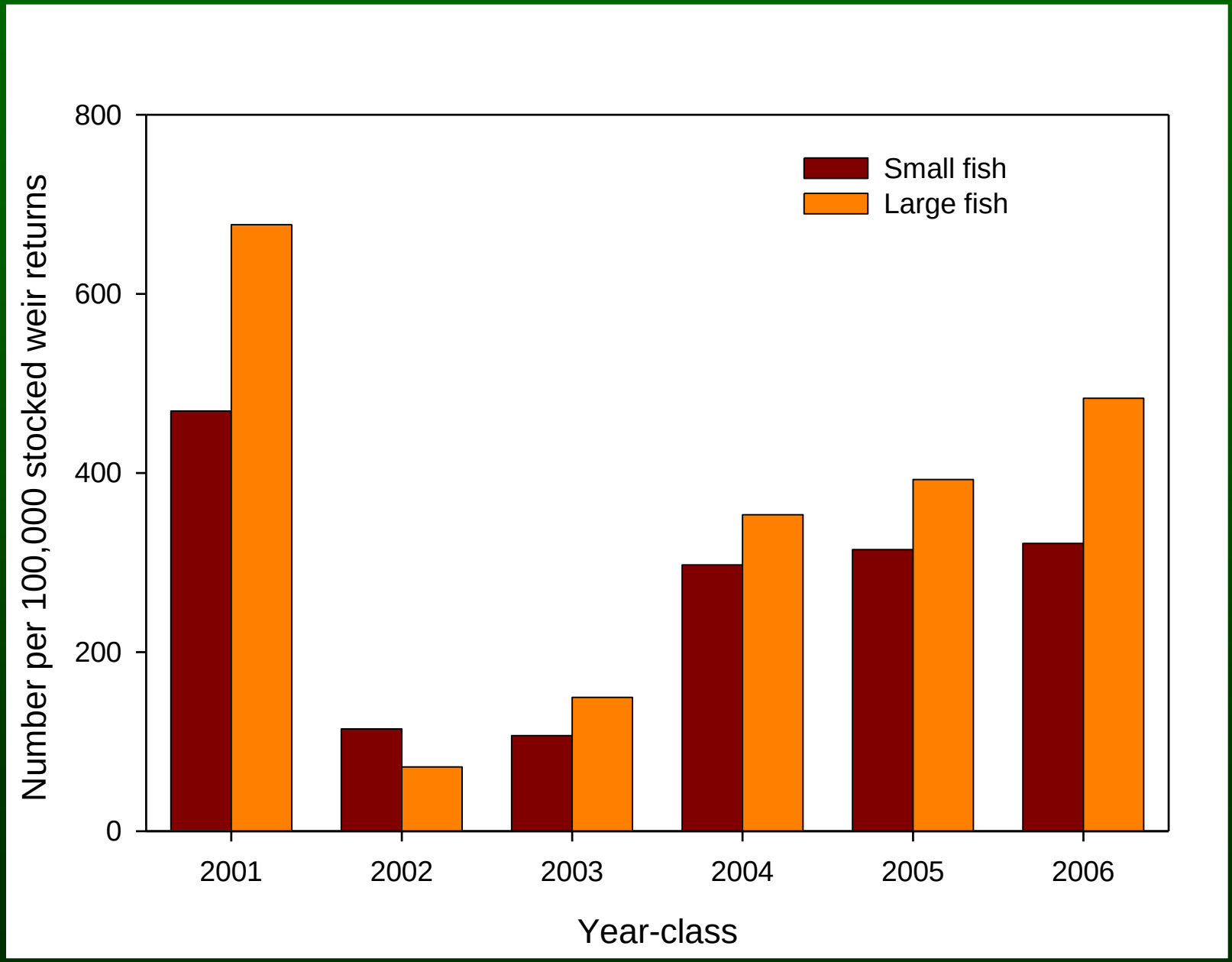
St. Joseph

= Stocking location

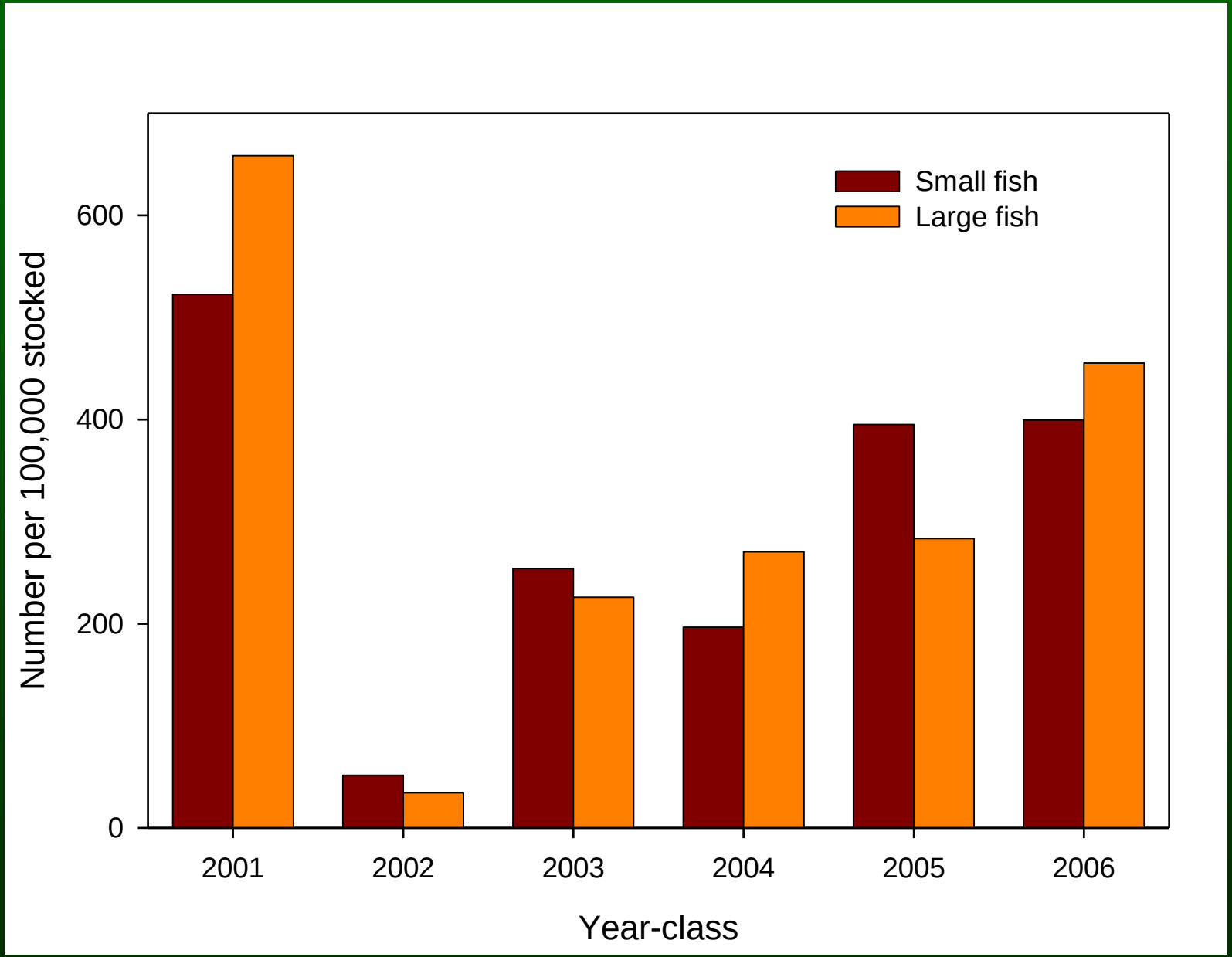
= Harvest weir

= Dams with fish passage

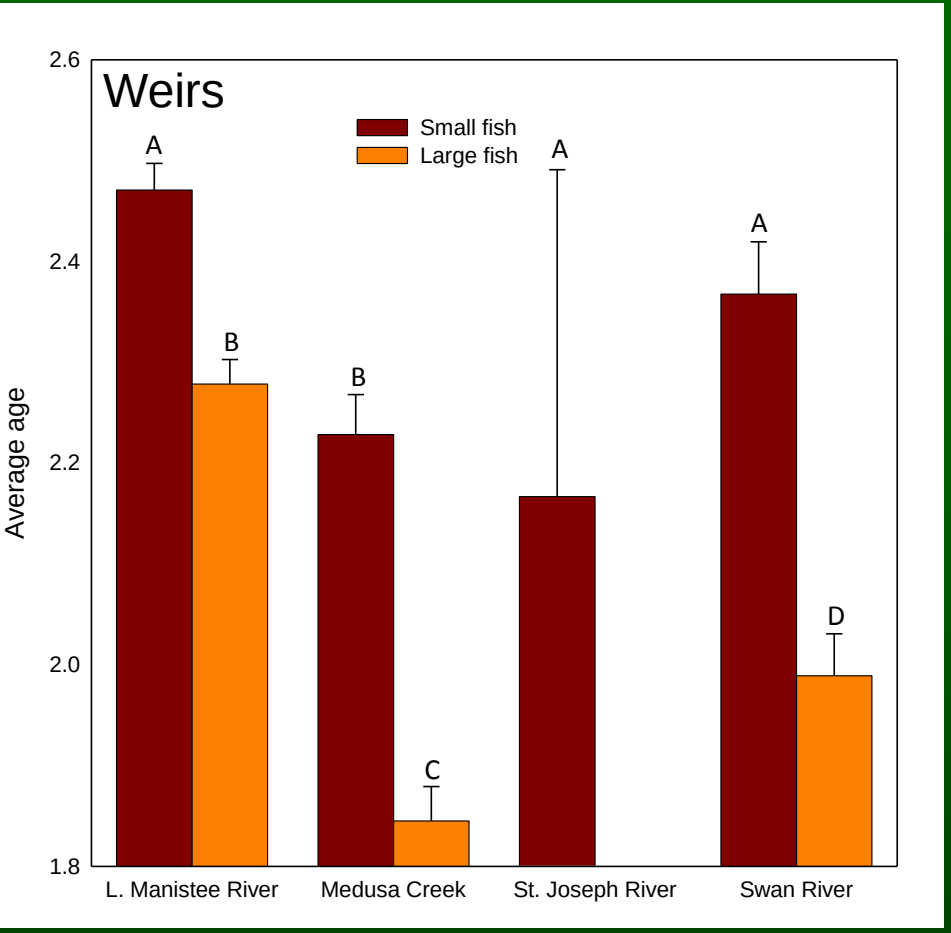
Return to Weirs

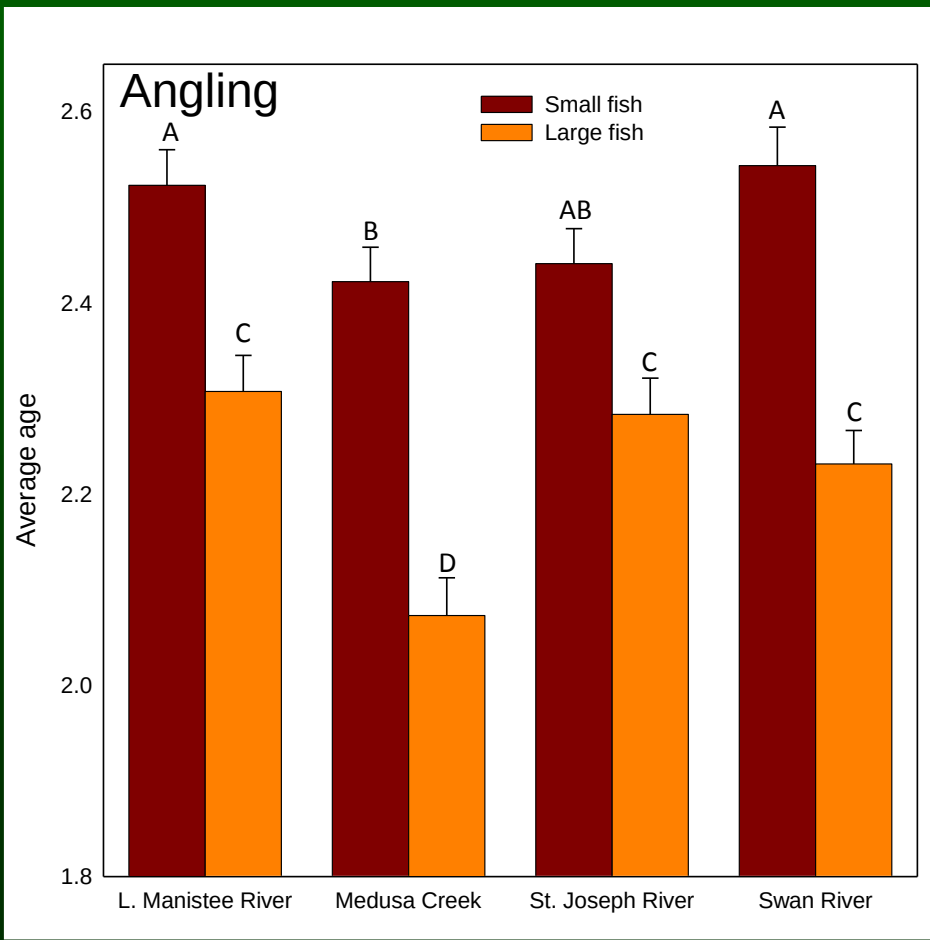


Return to Angling



Average Chinook Age





Small fish matured later and returned to the fishery more because they were in the lake longer.

Naturalized Salmon Summary

- Stocking should be linked with natural reproduction
- Naturalized coho, chinook, and other salmonines widespread and self-sustaining (albeit lower levels; e.g., Pink salmon 1956)
- Marking studies are critical
- Naturalized salmonines appear to be fluctuating with natural feedback mechanisms (spawning habitat or prey availability)

Cautionary Rivets Analogy

(Rivets analogy – Dr. Paul Ehrlich)

- Introduction of non-native species can promote evolutionary diversification among populations of both non-native and native species
- Non-native species may also cause reductions to biodiversity outweighing diversification
- A complete understanding of the net effects of naturalized non-native species on biodiversity in the long term will require consideration of both.

Example: Huffaker's Orange

- What makes a community stable, persistent over time?
- Initial experiment conducted on a small portion of the orange resulted in predators consuming all prey within a few hours, then starving to death.
- Mites: six-spotted mite-prey, Typhlodromus-predator.

Results: Huffaker's Oranges

- Connected several oranges together with strings, resulting in a longer duration before predators consumed all the prey.
- Continuing to add complexity, he used 250 oranges connected by strings, bridges, jumps, and barriers. This resulted in several oscillations between predator and prey lasting several months.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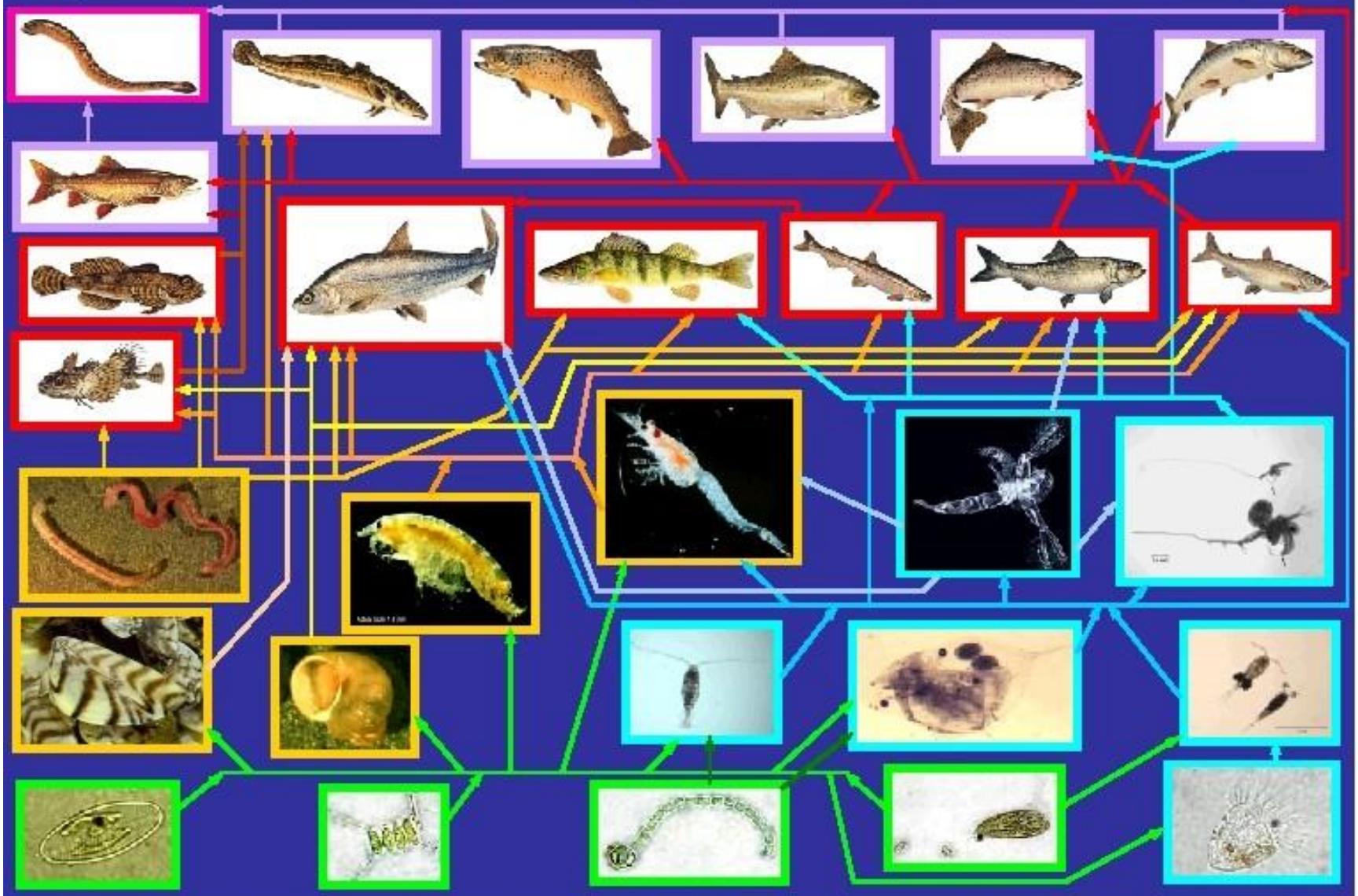
Lake Michigan Food Web



Food Web based on model constructed for "Impact of Exotic Invertebrate Invaders on Food Web Structure and Function in the Great Lakes: a Network Analysis Approach" by Mason, Krause and Ulanowicz—2002

Concluding Thoughts and a Word of Caution

- A complex ecosystem is “stable” over time NOT because the list of species remains the same forever, but because it varies and is complex - not in spite of disturbance, but because of it.
- Expect the unexpected, but how we respond will make a difference!

Thank you!

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