

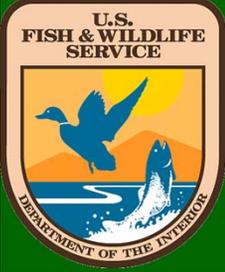


U.S. Fish and Wildlife Service

Lake Michigan Lake Trout Management and Restoration

Mark E. Holey
Project Leader

Green Bay Fish and Wildlife Conservation Office
US Fish and Wildlife Service

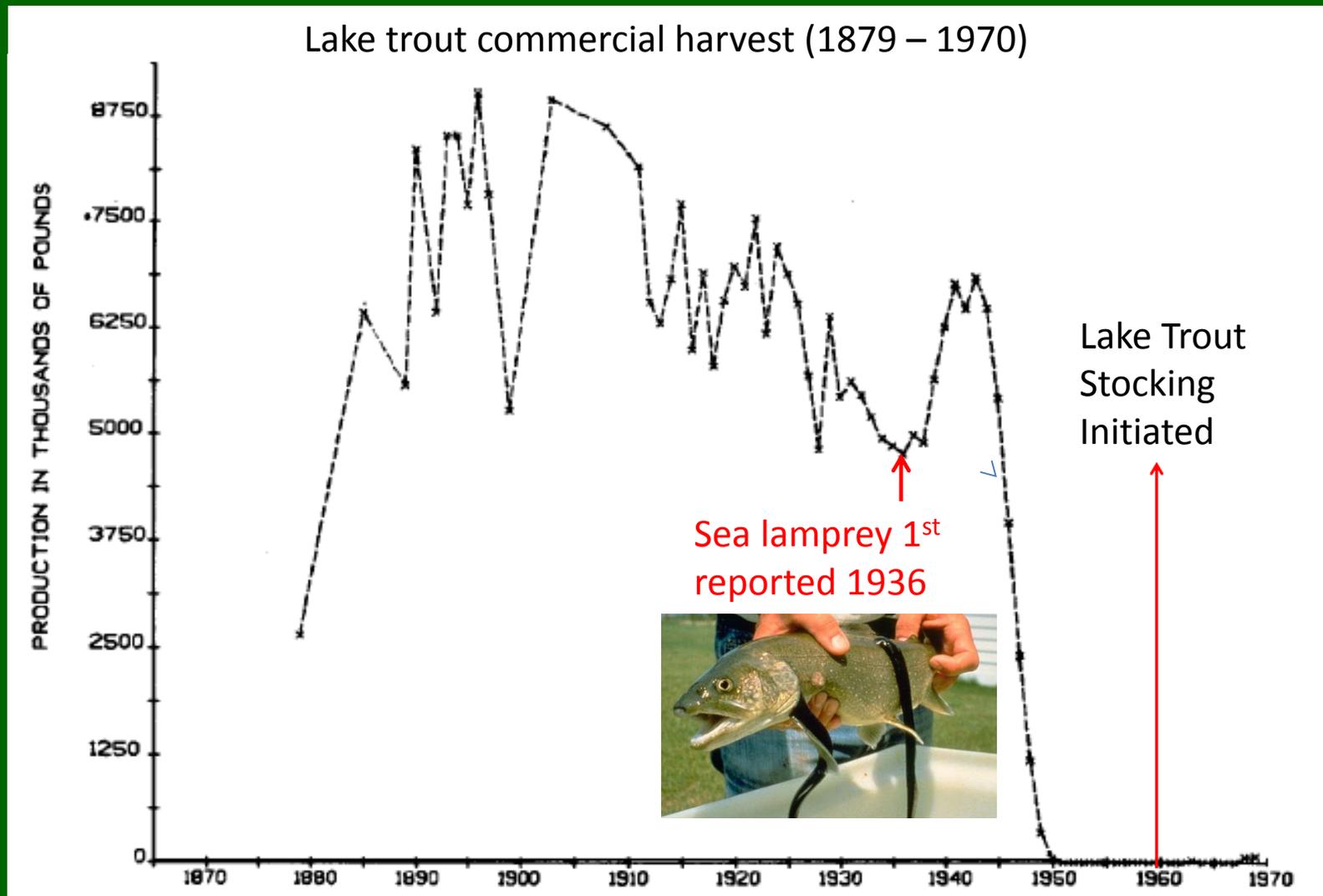


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Topic Outline

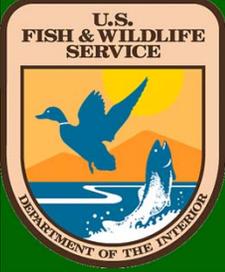
- Brief history and review of management responses to the collapse of lake trout
- Impediments to restoring lake trout
- FWS actions to remediate impediments
- Status of Evaluation Objectives & Wild Lake Trout
- Lake Trout Movement and Sport Fisheries
- Adjusting to a Changing Forage

Lake Michigan lake trout populations extirpated by 1956



Wells and McClain (1973)

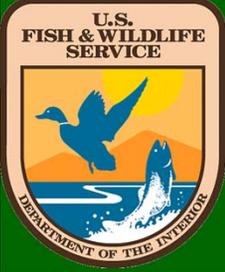
Alewives first appearance in Lake Michigan 1949
Sea lamprey control program established in 1955
Chinook salmon first introduced in 1967



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Timeline of Lake Trout Collapse and Government Response

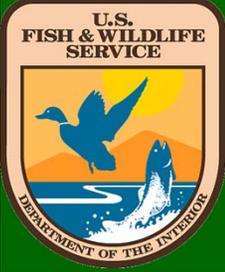
- 1936 First Lamprey in Lake Michigan
- 1946 Congress: passed Investigation and Eradication of Predatory Sea Lamprey of the GL
- 1949 USFWS ordered to find hatchery locations
- 1951 Pendills; 1965 Jordan; 1984 Iron River
- 1952 first lake trout stocked – Lake Superior
- 1956 Lake Michigan lake trout extirpated
- 1956 Great Lakes Fishery Commission established



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Lake Trout Restoration Strategies

- 1959 First lake trout stocked in LM
- 1985 First Lake Trout Restoration Plan
- 2003 Review of Impediments
- 2008 LMTC Restoration Guide
- 2011 Implementation Strategy



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Impediments to Lake Trout Restoration

Lakewide Populations Too Low

Too Few Stocked, Survival Too Low

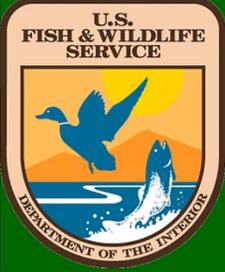
Inappropriate Stocking Practices

Stocking in Wrong Places

Limited Genetic Diversity

Poor Early-Life Stage Survival

Thiamine Deficiency, Predation



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Impediments to Lake Trout Restoration

Too Few Stocked
Stocking in Wrong Places



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LMC Stocking Priorities Refocused

1985: 5.8 mil target

2011: 3.66 mil target

2.74 mil interim target

1st Priority Sites = 69%

N. Lake Michigan 1,440,000 Y

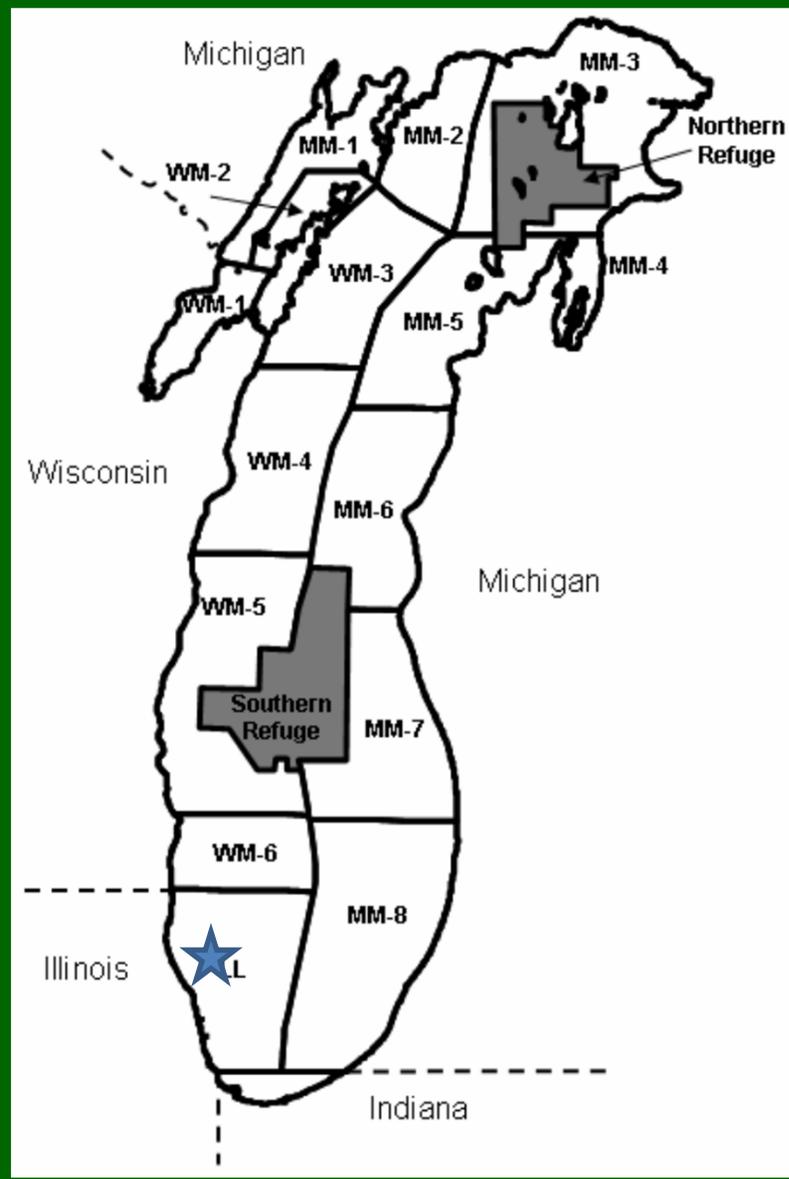
S. Refuge/Julian's 720,000 Y

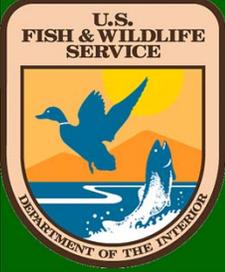
2nd Priority Sites 950,000 Y

550,000 FF

3,110,000 Y

550,000 FF





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LMC Stocking 2nd Priority Sites

Wisconsin Waters

Yearlings

Sturgeon Bay 50,000

Kewaunee 50,000

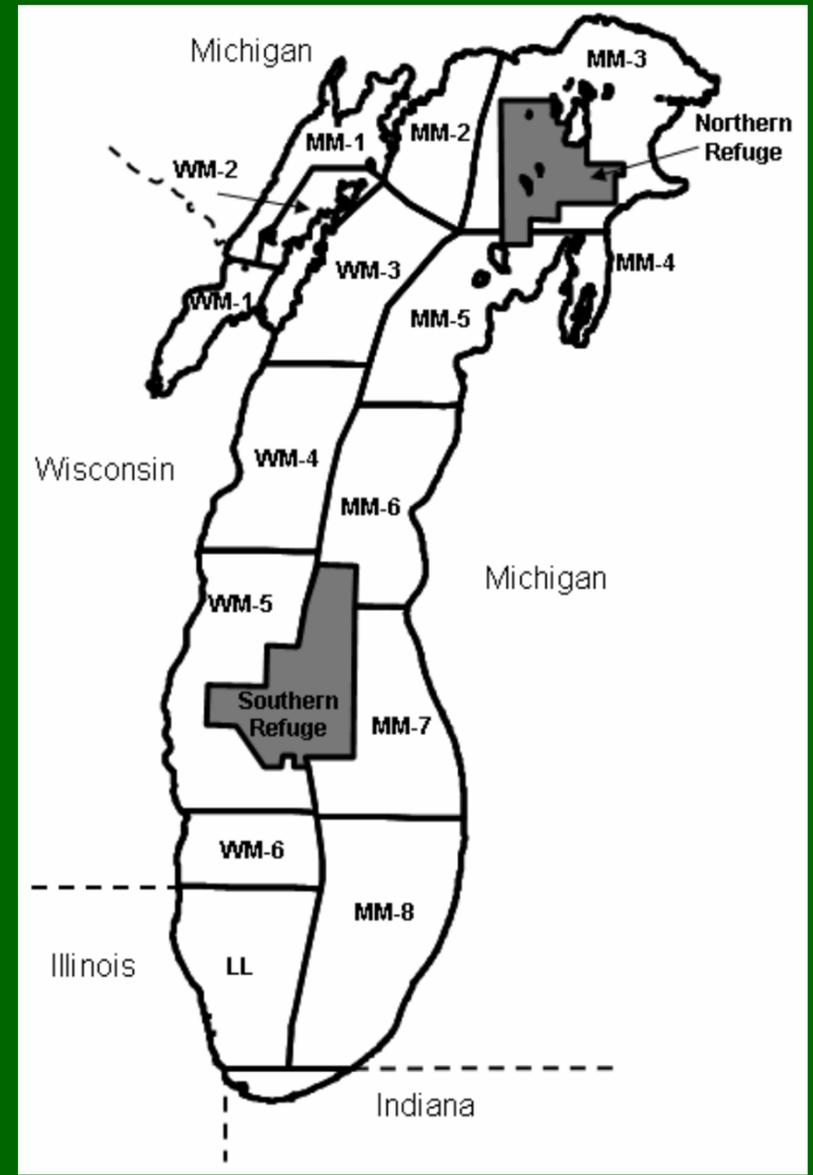
Wind Point 50,000

Fall Fingerlings

Kewaunee 100,000

Manitowoc 100,000

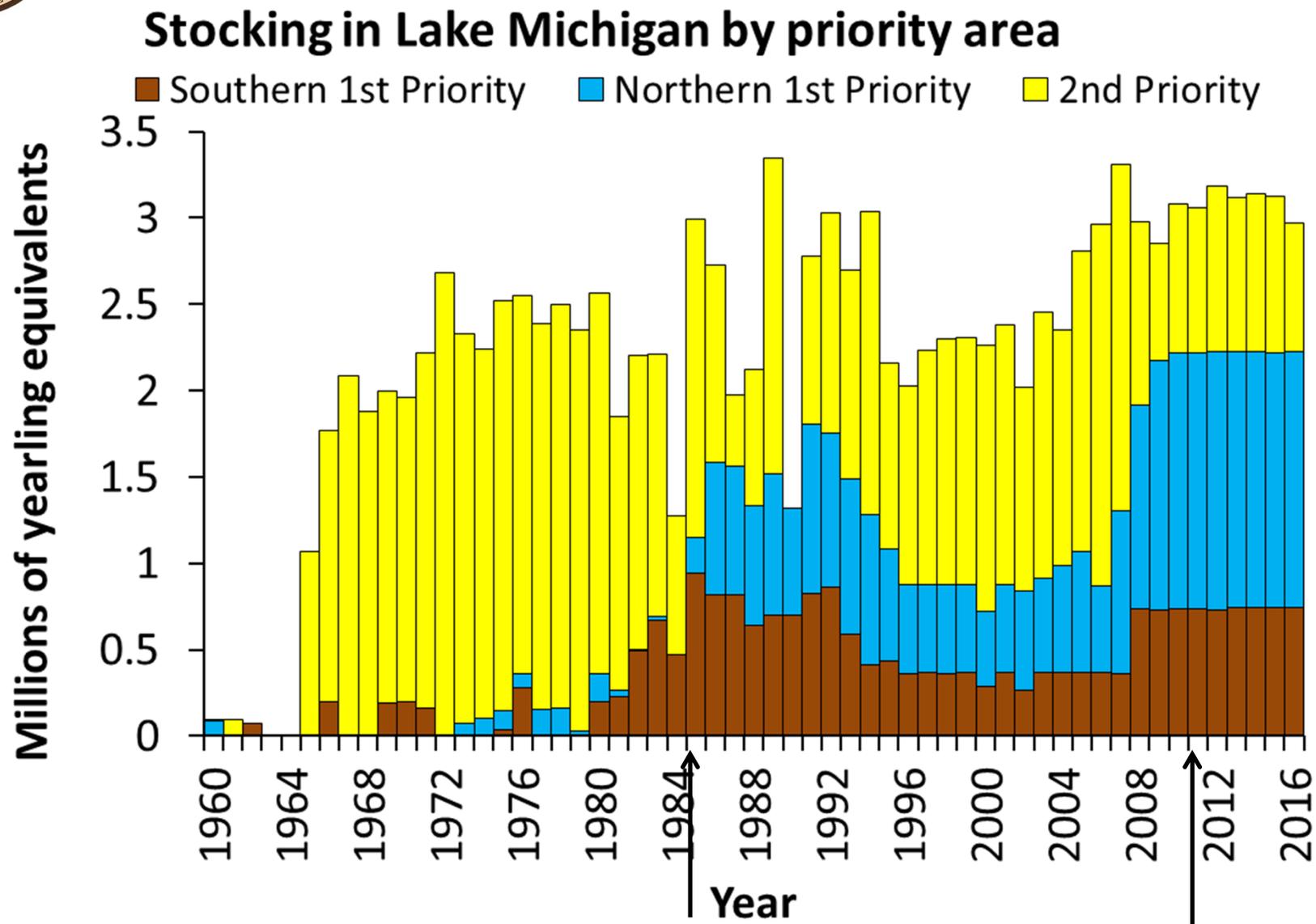
Wind Point 50,000

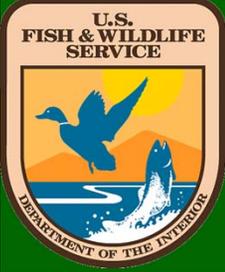




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LMC Stocking Priorities - Location

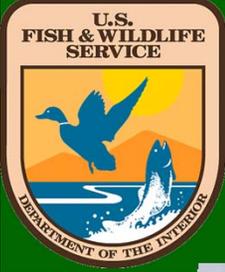




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Impediments to Lake Trout Restoration

Stocking in Wrong Places
Survival Too Low



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Offshore Stocking - Vessels





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M/V Spencer F. Baird Offshore Stocking



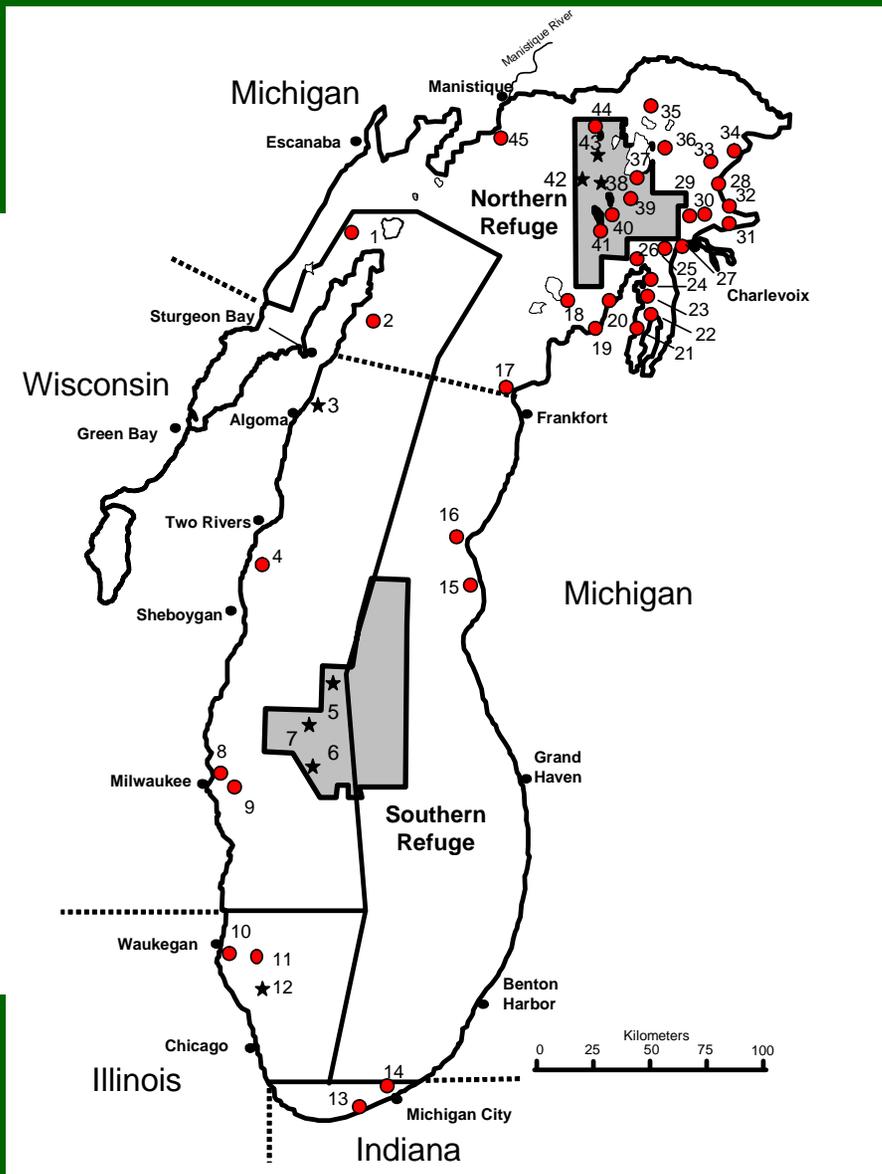
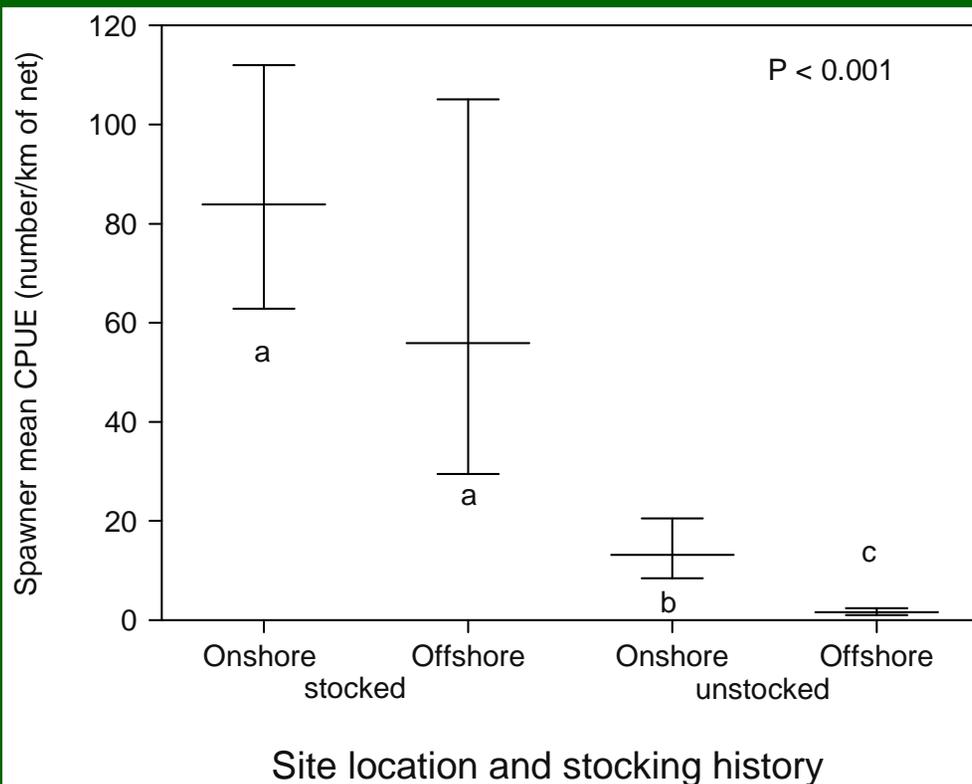
2016: 2.67 million offshore (93%) in Lake Michigan



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Specific Site Stocking Justified

Boat Stocked in 2016 = 93.5%

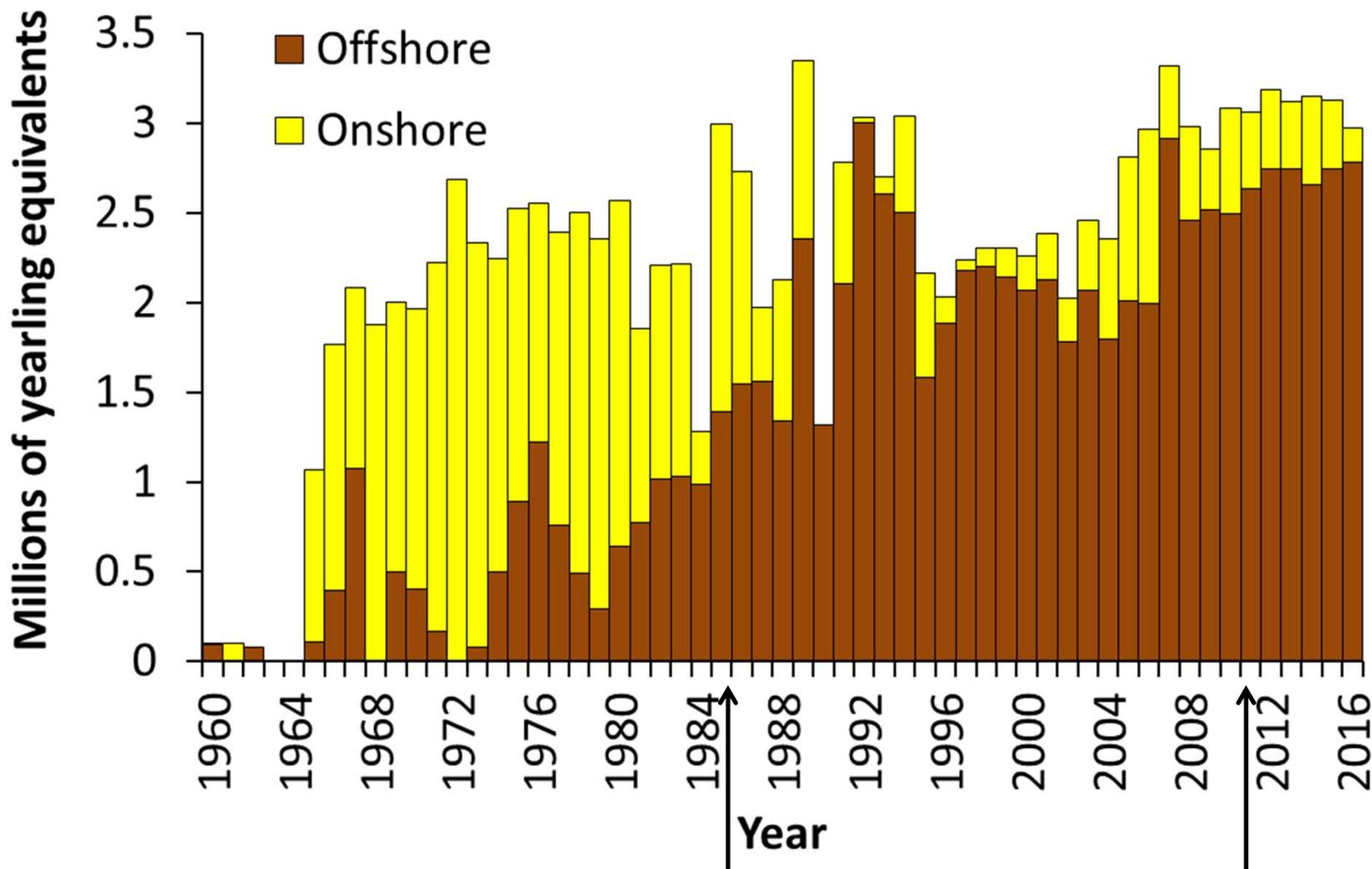


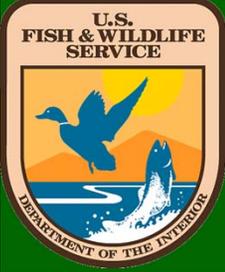


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Refocused Stocking Locations

Offshore vs onshore stocking in Lake Michigan

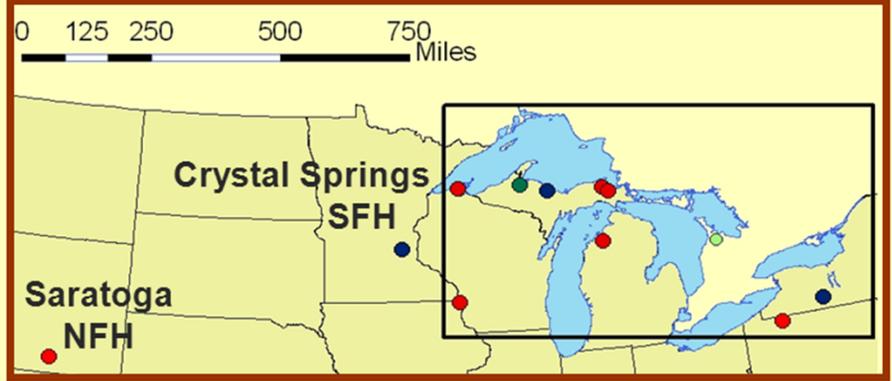




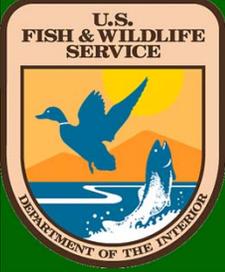
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Impediments to Lake Trout Restoration

Limited Genetic Diversity



- National Fish Hatchery
- State Fish Hatchery
- Tribal Fish Hatchery
- OMNR Fish Culture Station
- Wild Donor Stock



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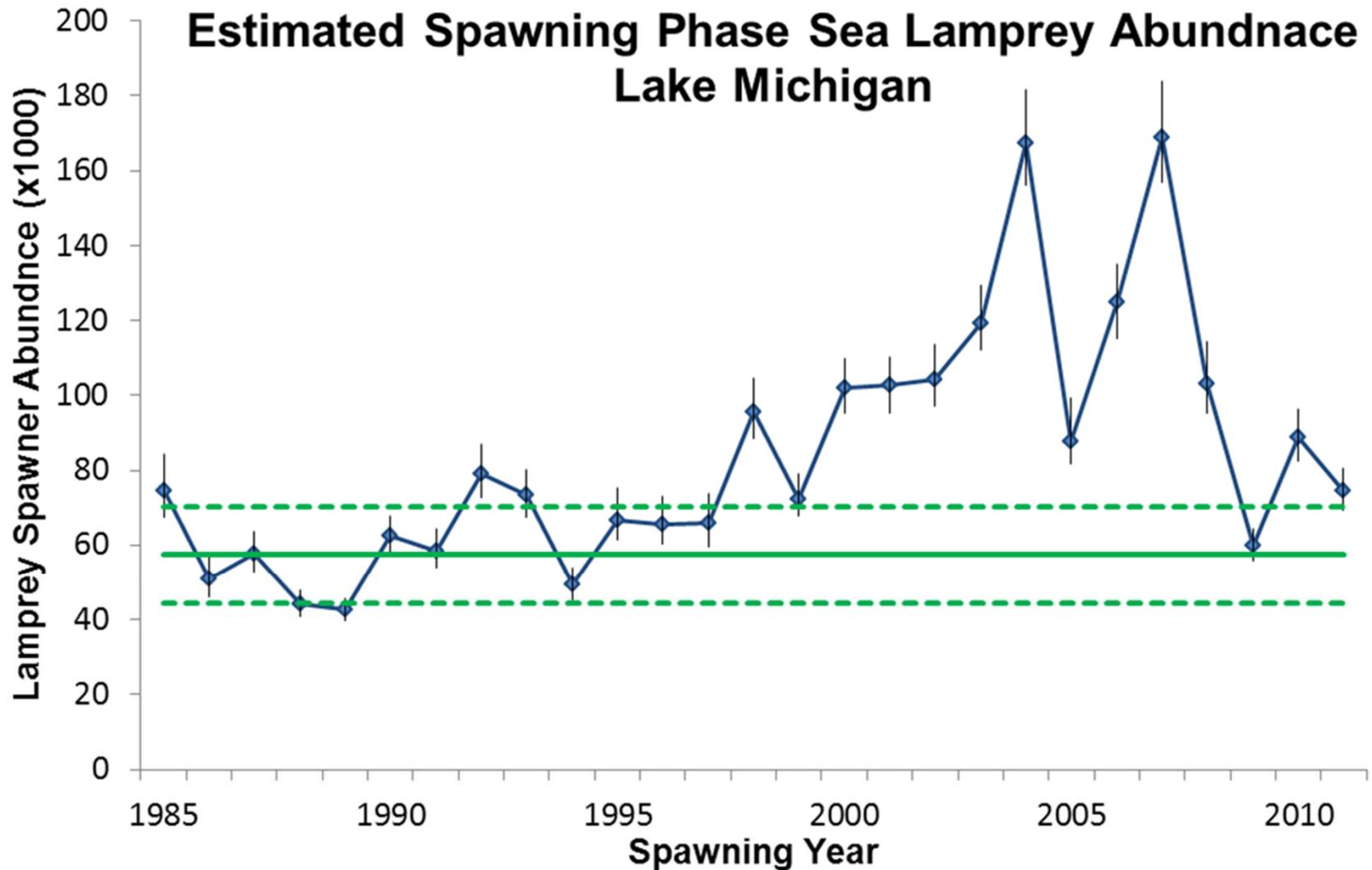
Impediments to Lake Trout Restoration

Survival Too Low
Thiamine Deficiency



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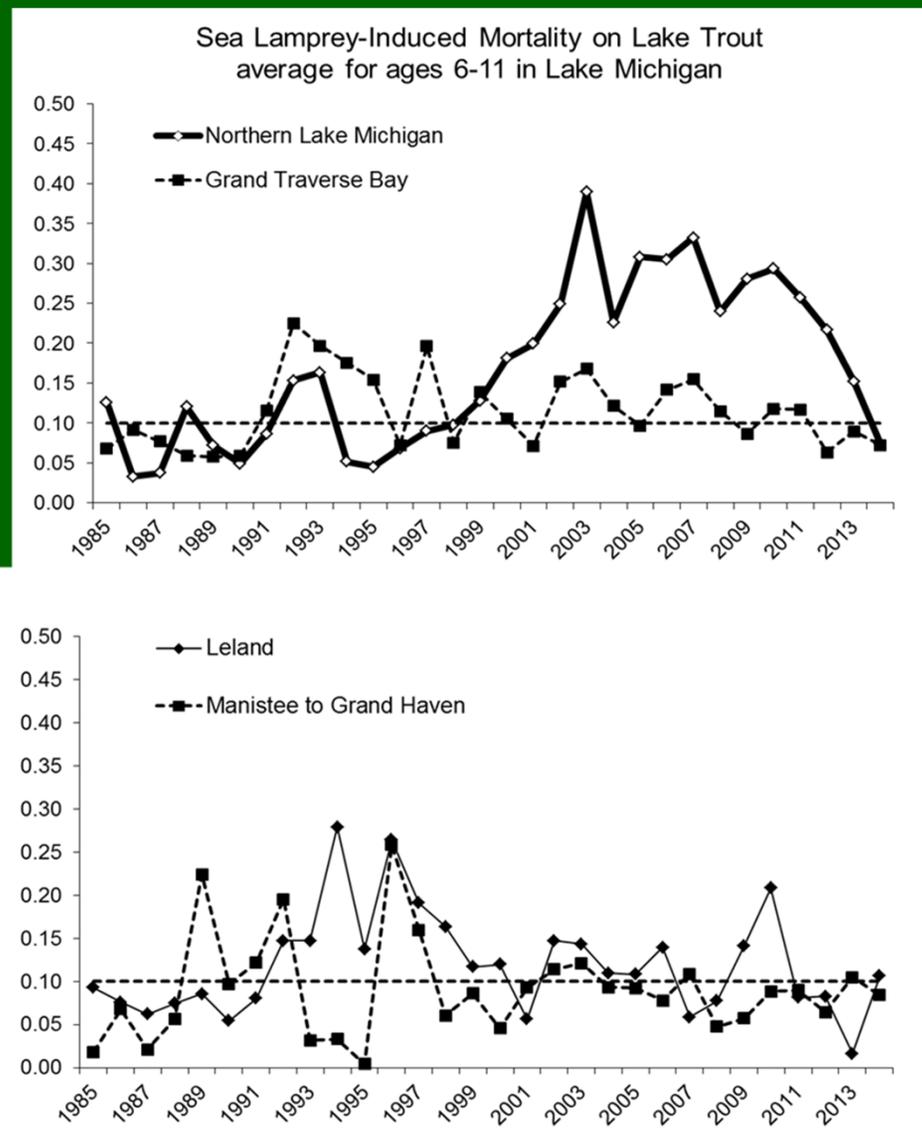
Sea Lamprey Abundance at Target





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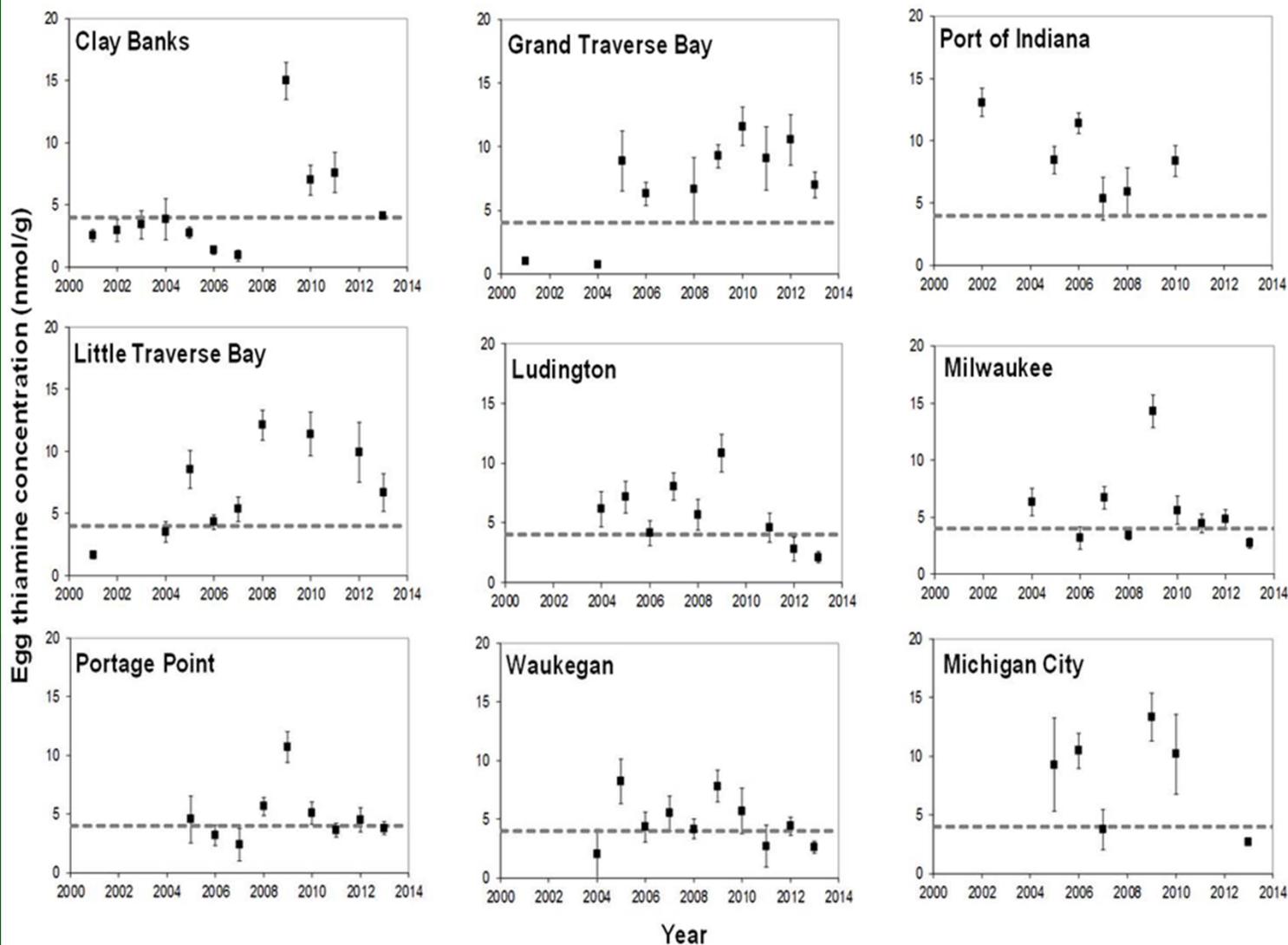
Sea Lamprey Mortality At Target

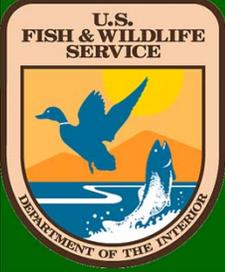




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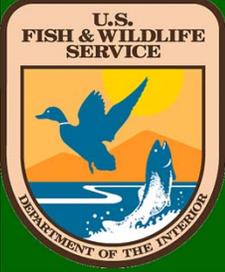
Thiamine Levels Near Target





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LMC Implementation Strategy Evaluation Objectives



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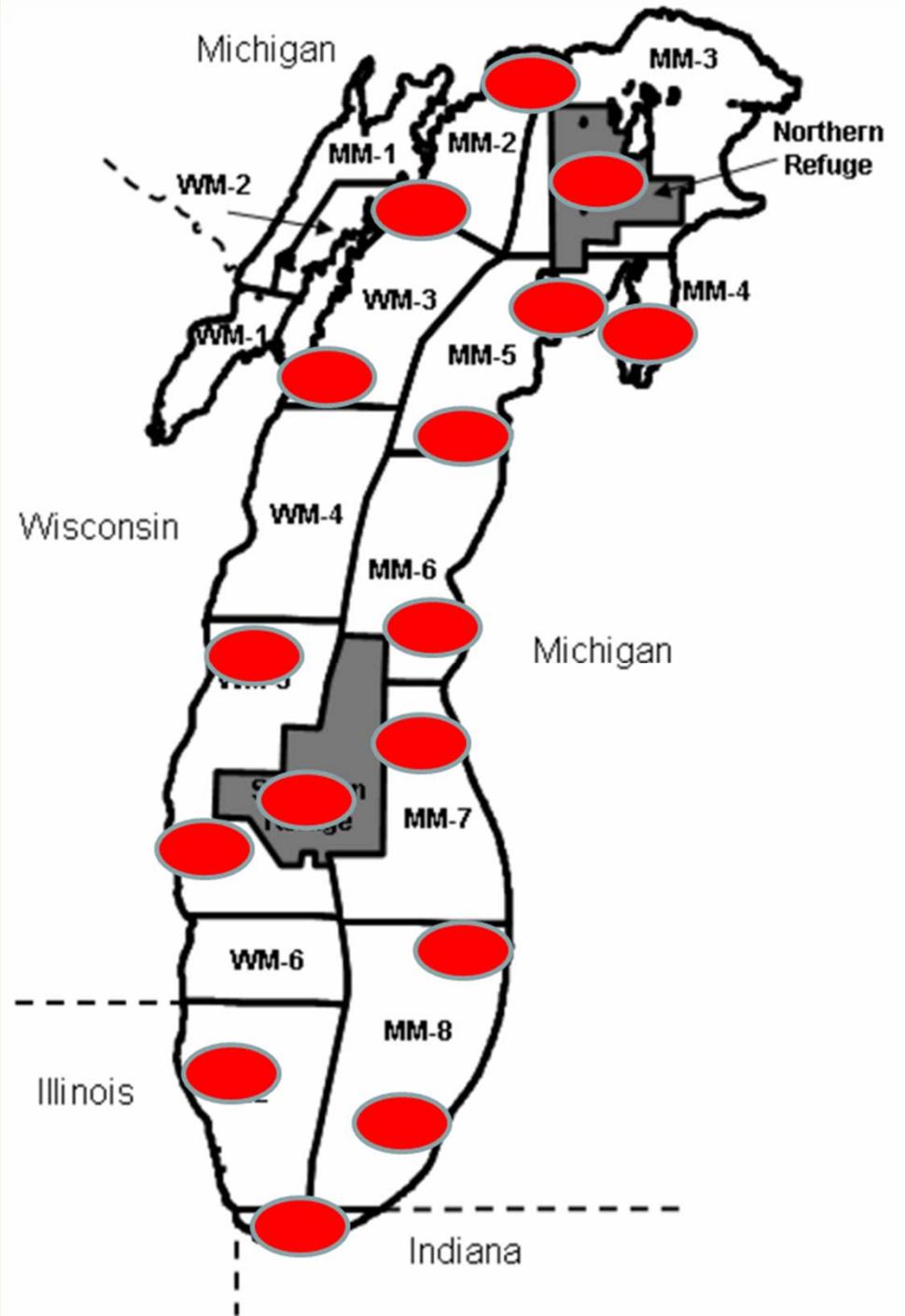
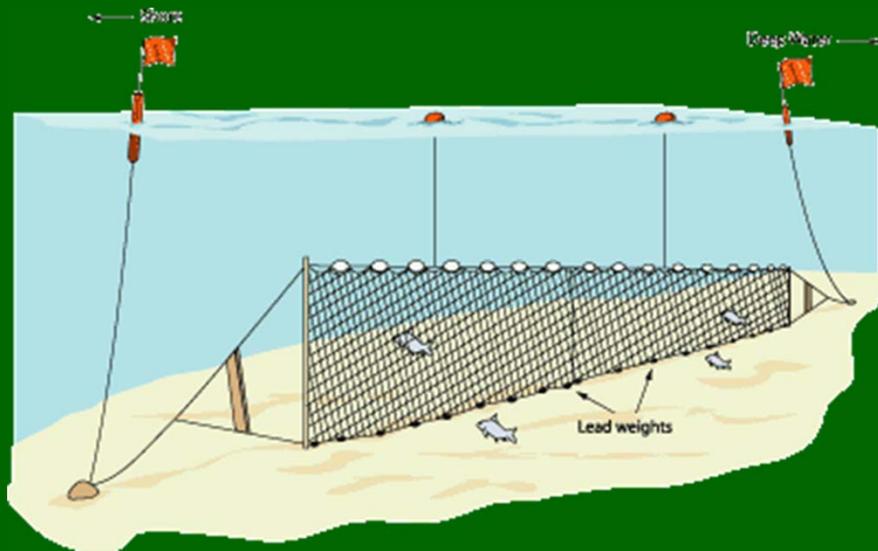
LMC Implementation Strategy Evaluation Objectives

- **Objective 1:** Increase the average catch-per-unit-effort (CPUE) to >25 lake trout 1000 feet of graded mesh gill net (2.5-6.0 inch) overnight set lifted during spring assessments pursuant to the lakewide assessment in MM-3, WM-5, and at Julian's Reef by 2019.



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Lakewide Assessment Program Spring Gill Net Surveys

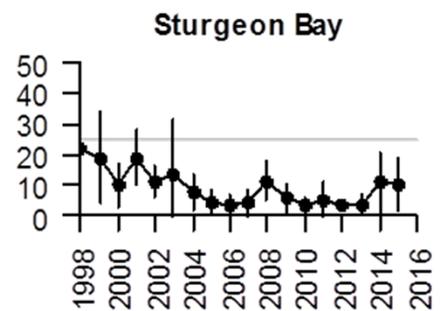
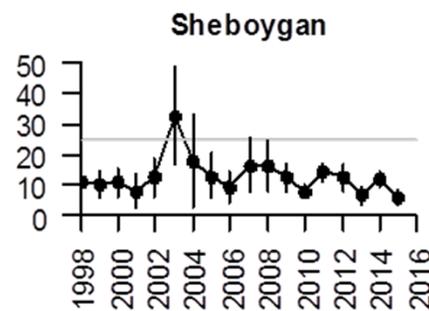
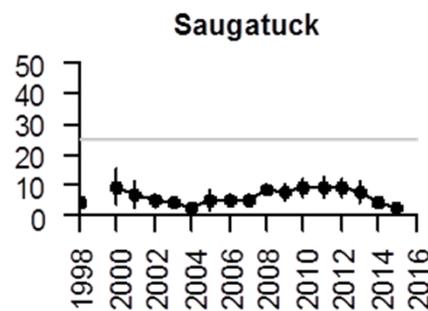
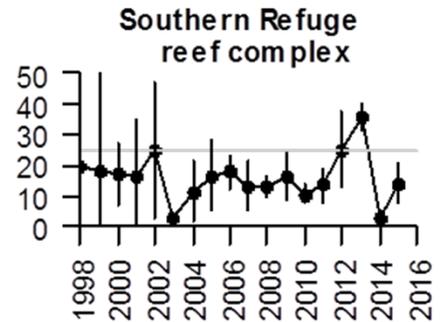
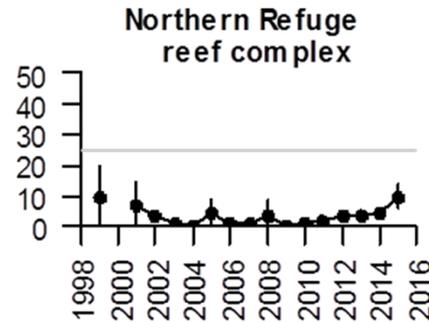
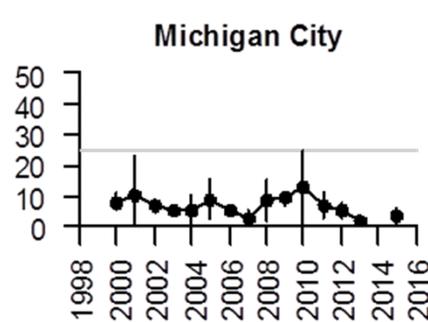
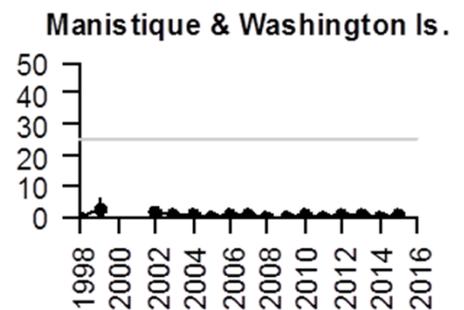
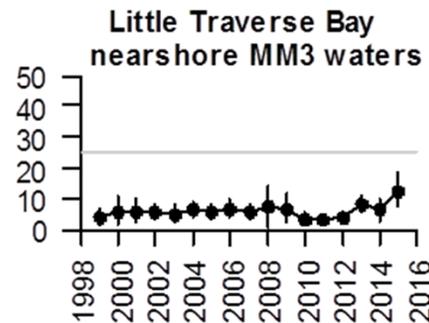
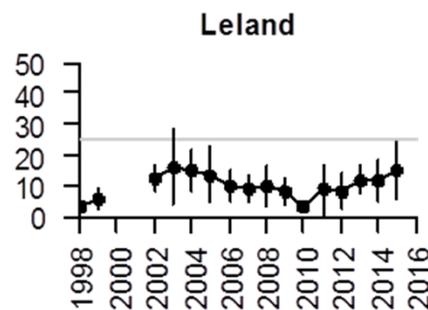
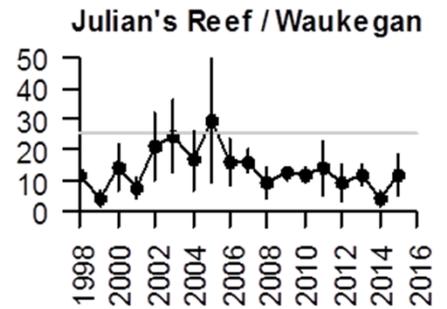
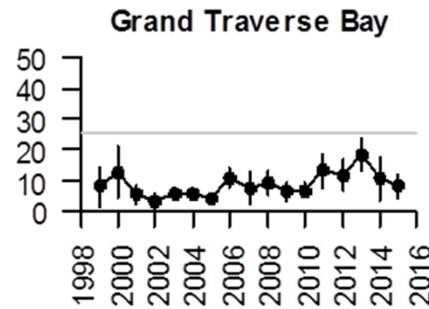
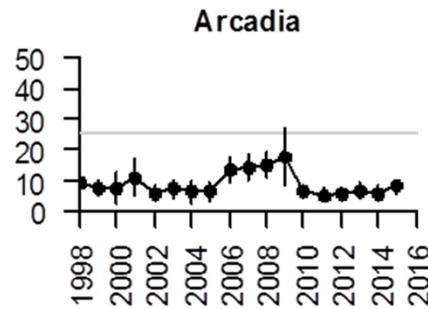


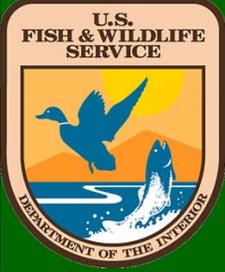


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Spring Assessment Catch Rates

Number of lake trout caught per 1000 ft of gill net





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LMC Implementation Strategy Evaluation Objectives

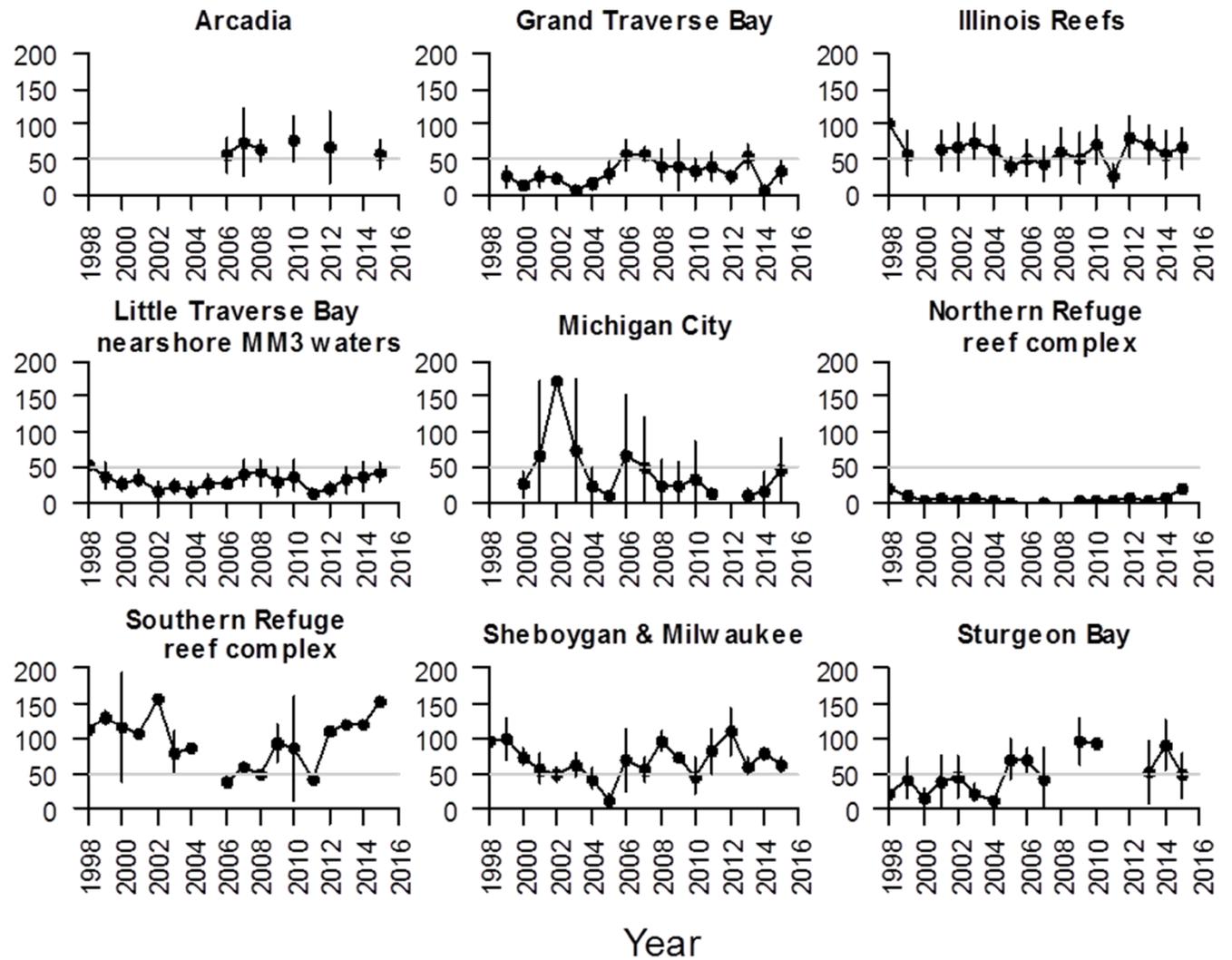
Objective 2: Increase the abundance of adults to a minimum catch-per-unit-effort of 50 fish per 1000 feet of graded mesh gill net (4.5-6.0 inch) gill net fished on spawning reefs in MM3, WM5, and at Julian's Reef by 2019.

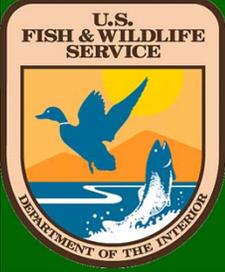


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Fall Assessment Catch Rates

Number of lake trout caught per 1000 ft of gill net





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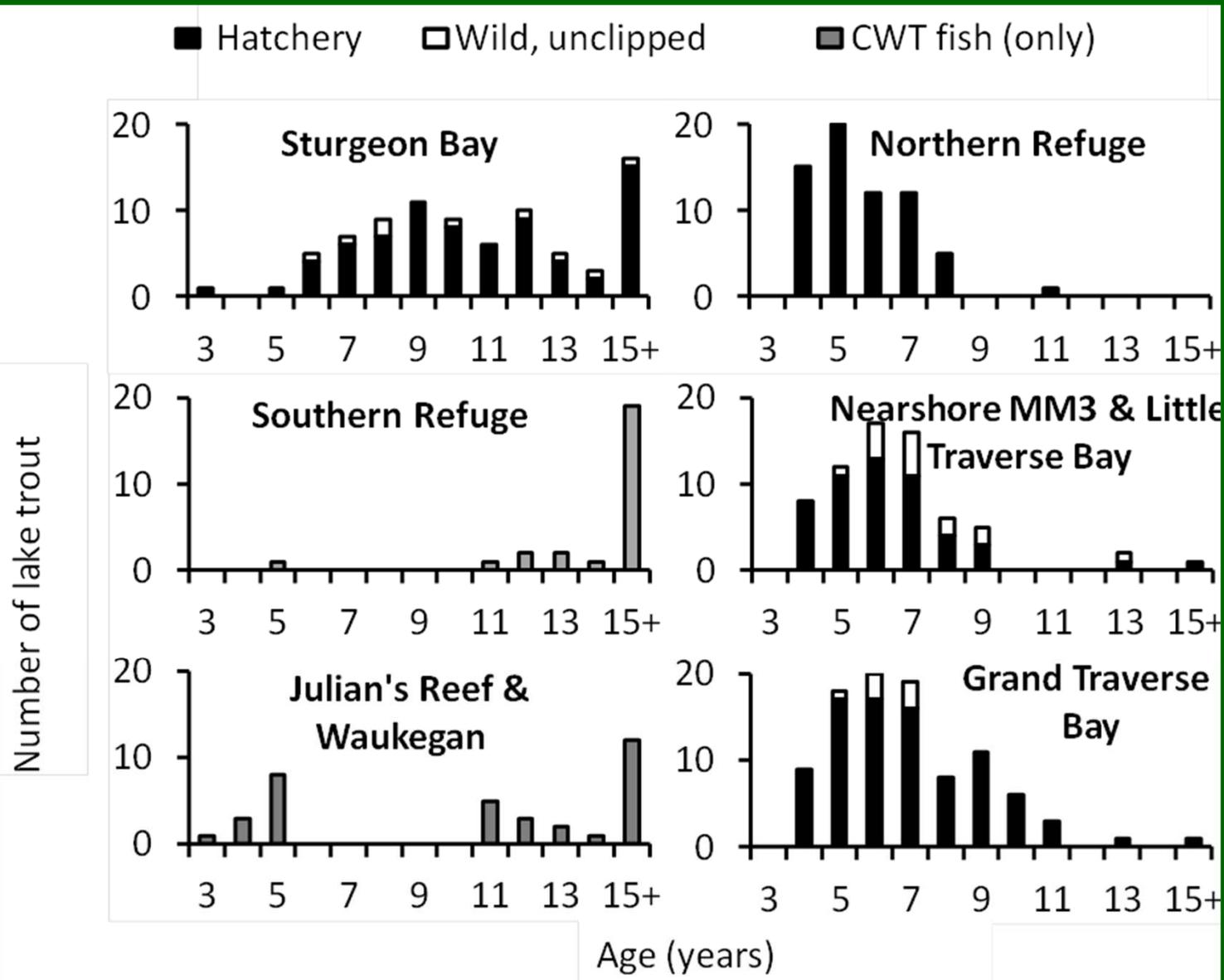
LMC Implementation Strategy Evaluation Objectives

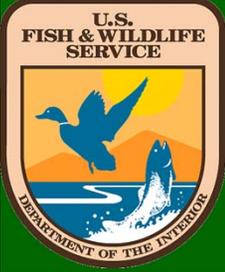
Objective 3: Significant progress should be achieved towards attaining spawning populations that are at least 25% females and contain 10 or more age groups older than age-7 in first priority areas stocked prior to 2007. These milestones should be achieved by 2032 in areas stocked after 2008.



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Age Composition at Spawning

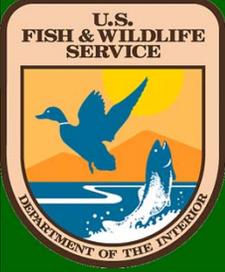




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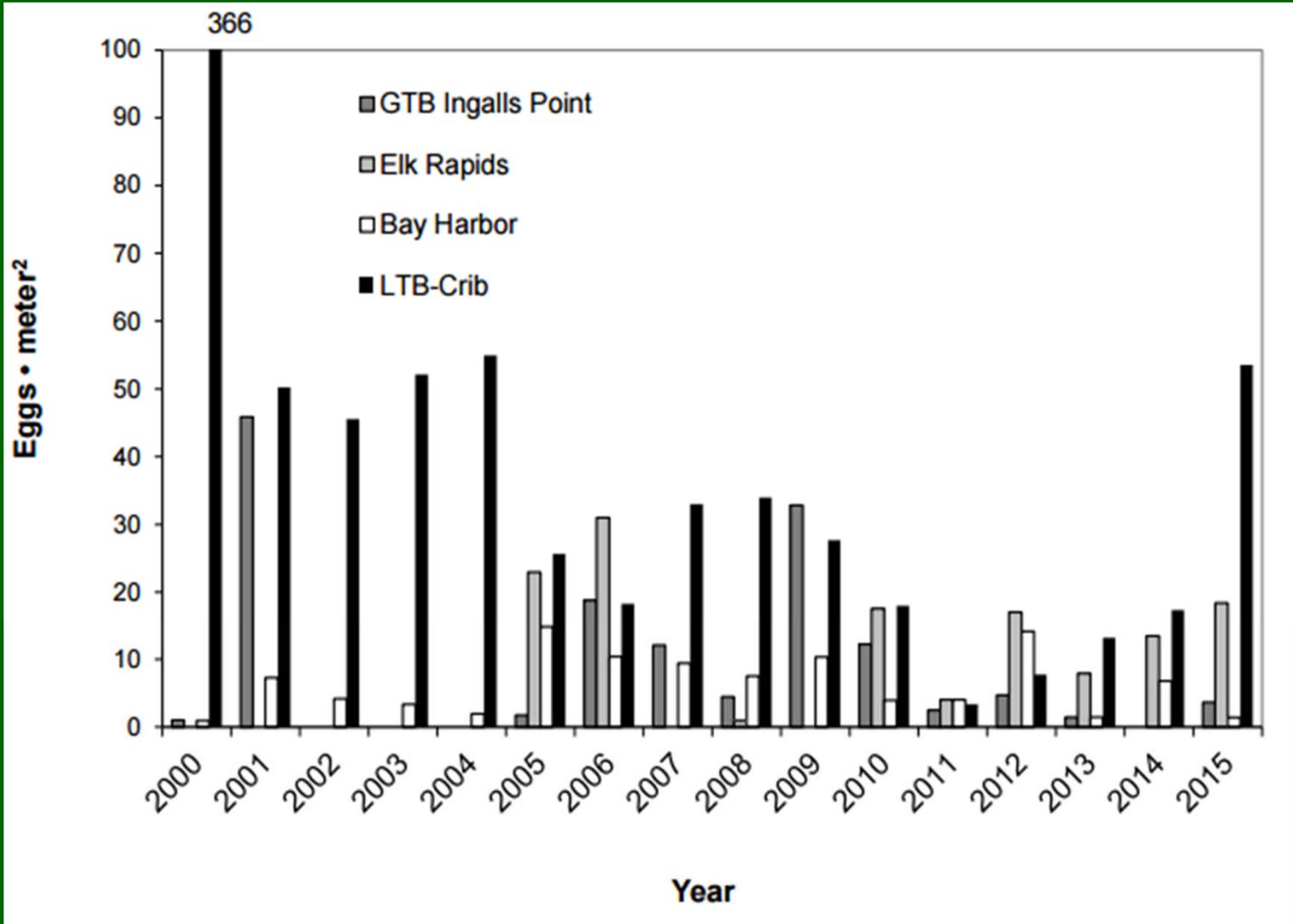
LMC Implementation Strategy Evaluation Objectives

Objective 4: Detect a minimum density of 500 viable eggs/m² (eggs with thiamine concentrations of >4 nmol/g) in previously stocked first priority areas. This milestone should be achieved by 2025 in newly stocked areas.



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Egg Densities at Selected Near Shore Reefs: Below Target

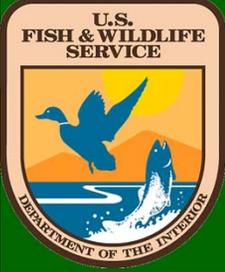




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% Wild Fish Progress Report

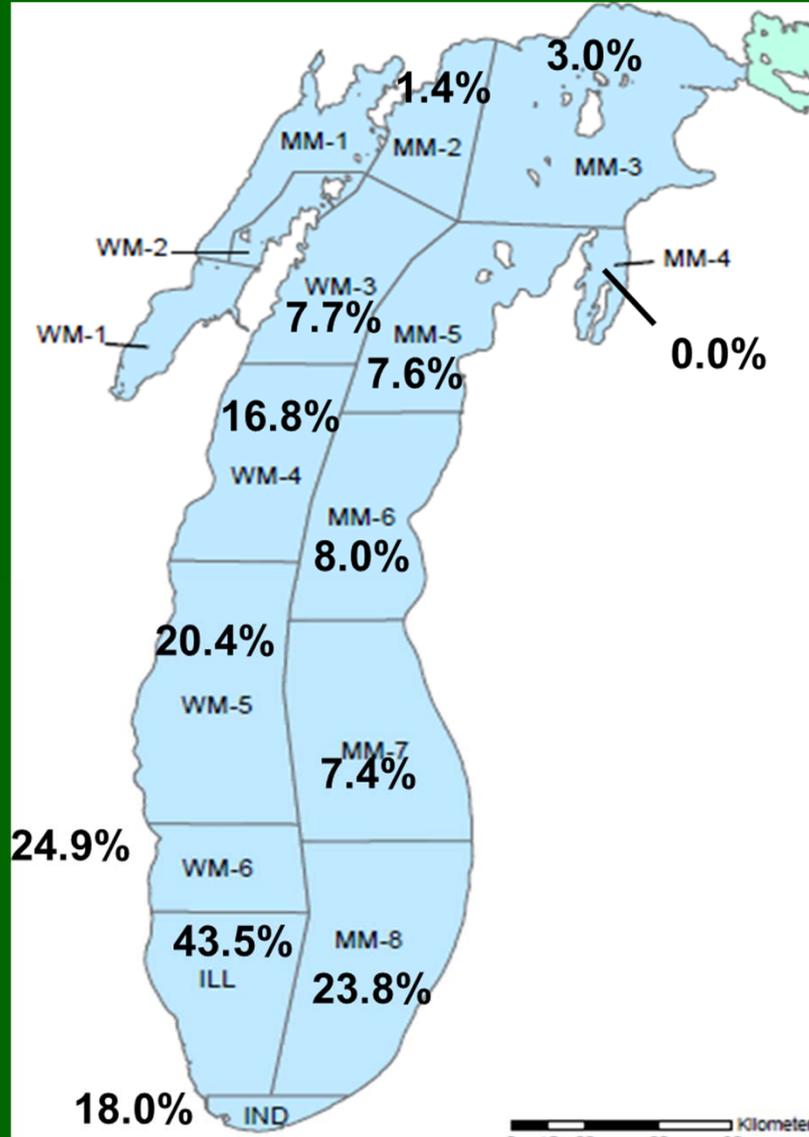


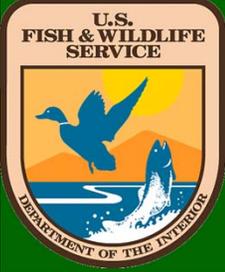


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% Wild Lake Trout in Sport Catches

April – September
2015
Mass Marking





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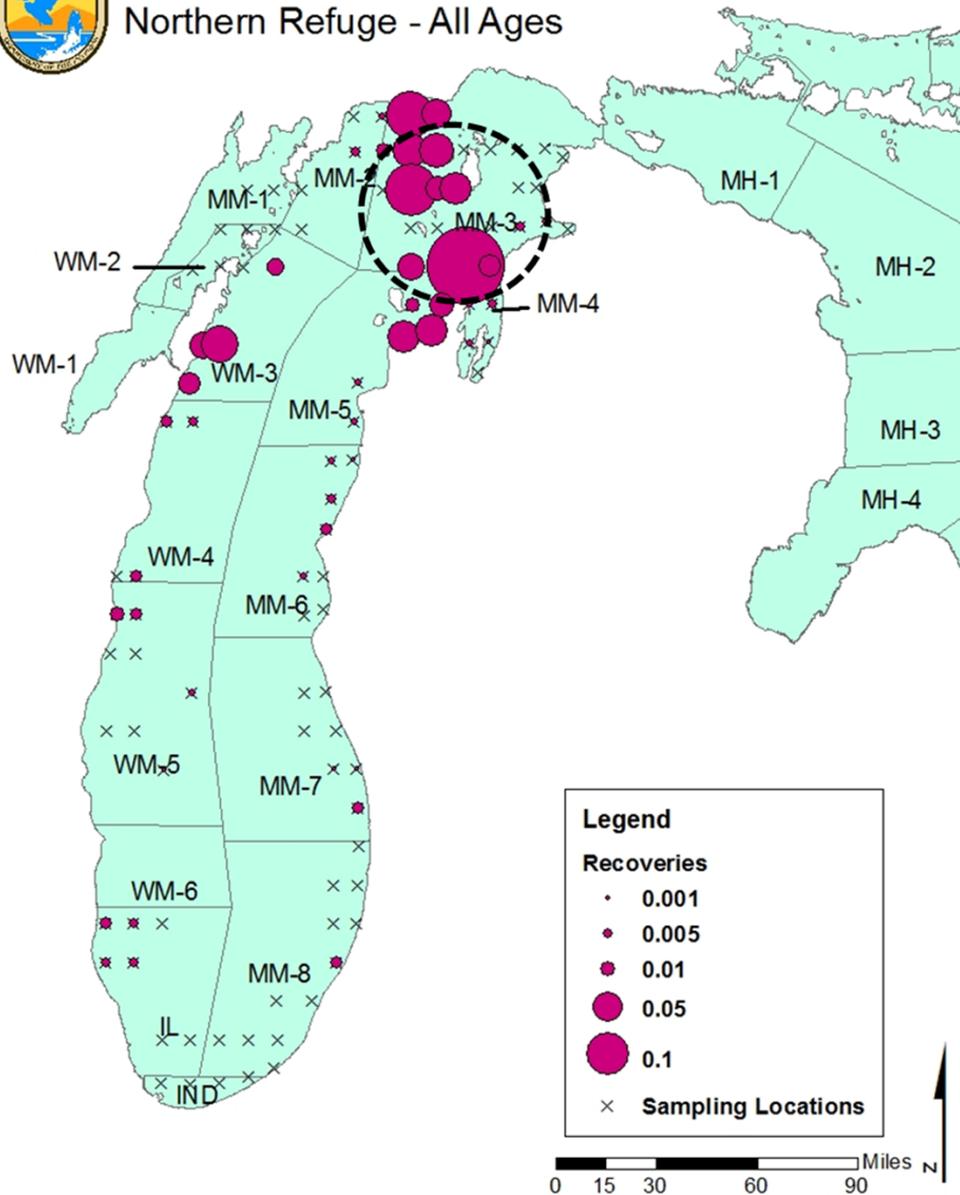
Lake Trout Movement Analysis of Legacy Data



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Proportional Recoveries of Lake Trout Stocked at Northern Refuge - All Ages

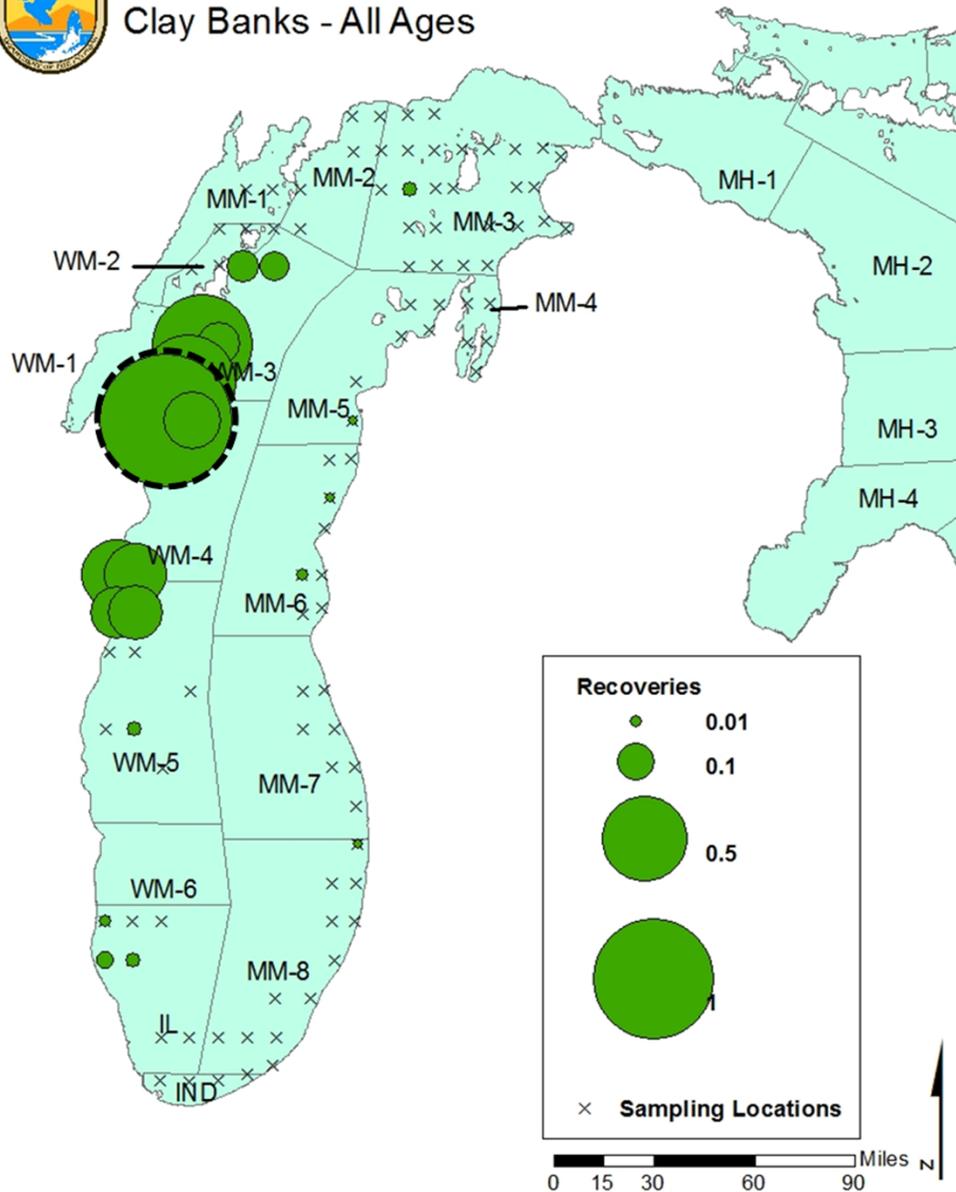


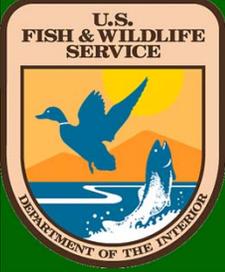


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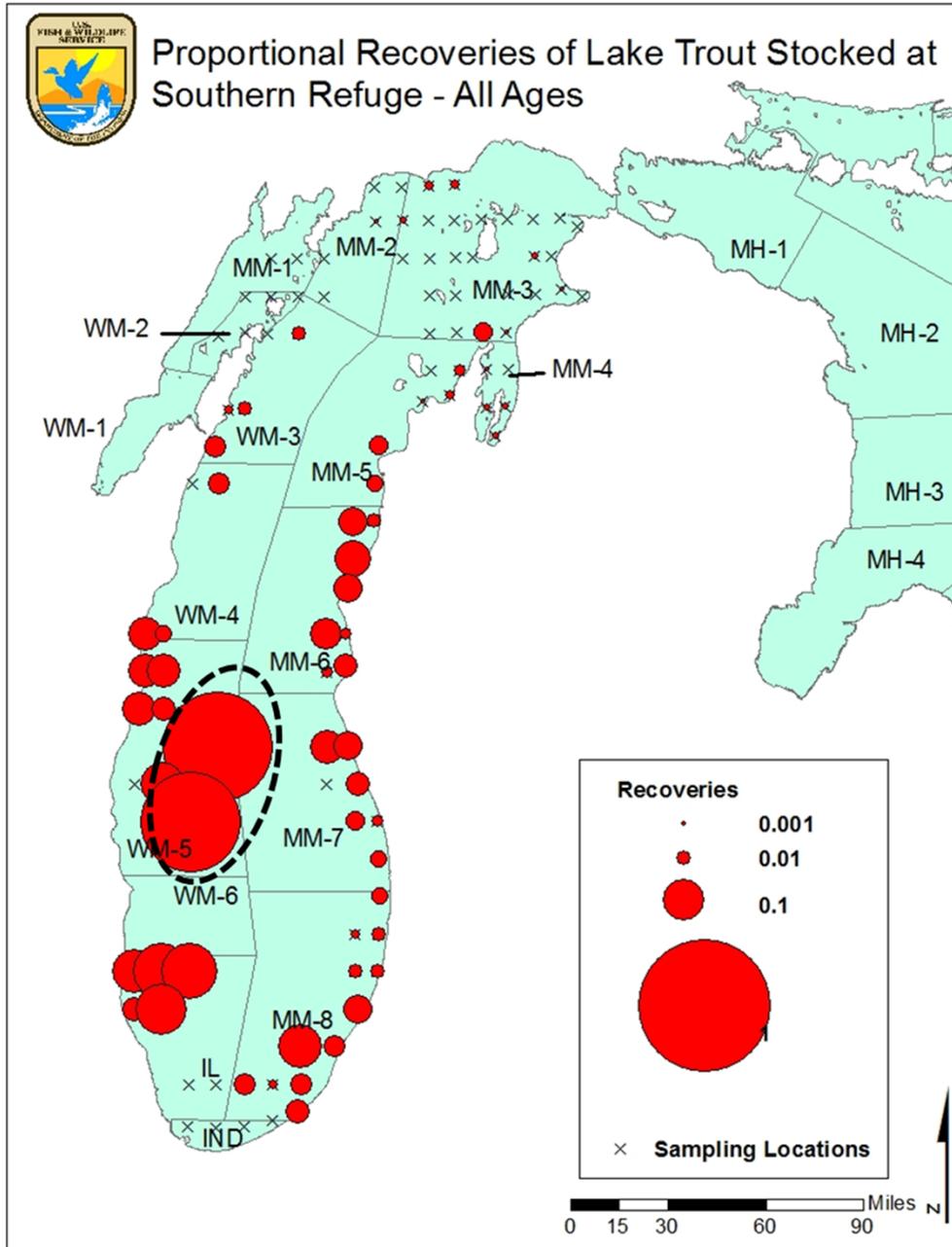


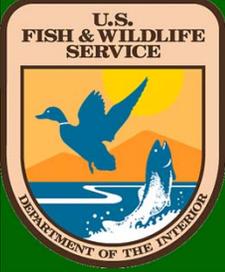
Proportional Recoveries of Lake Trout Stocked at Clay Banks - All Ages





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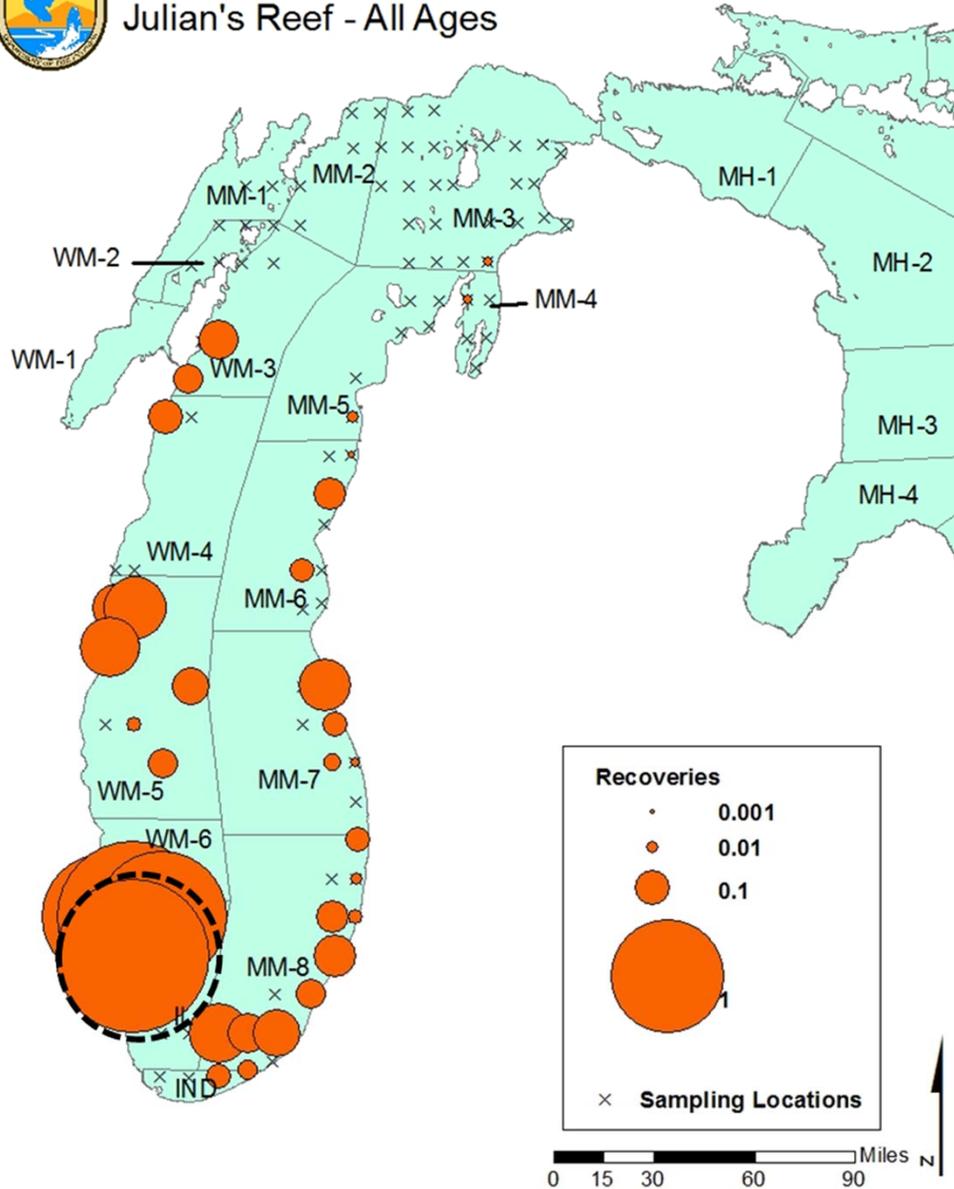




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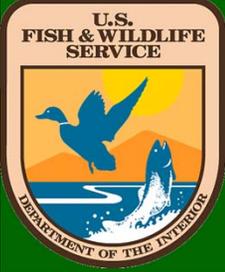
Proportional Recoveries of Lake Trout Stocked at Julian's Reef - All Ages





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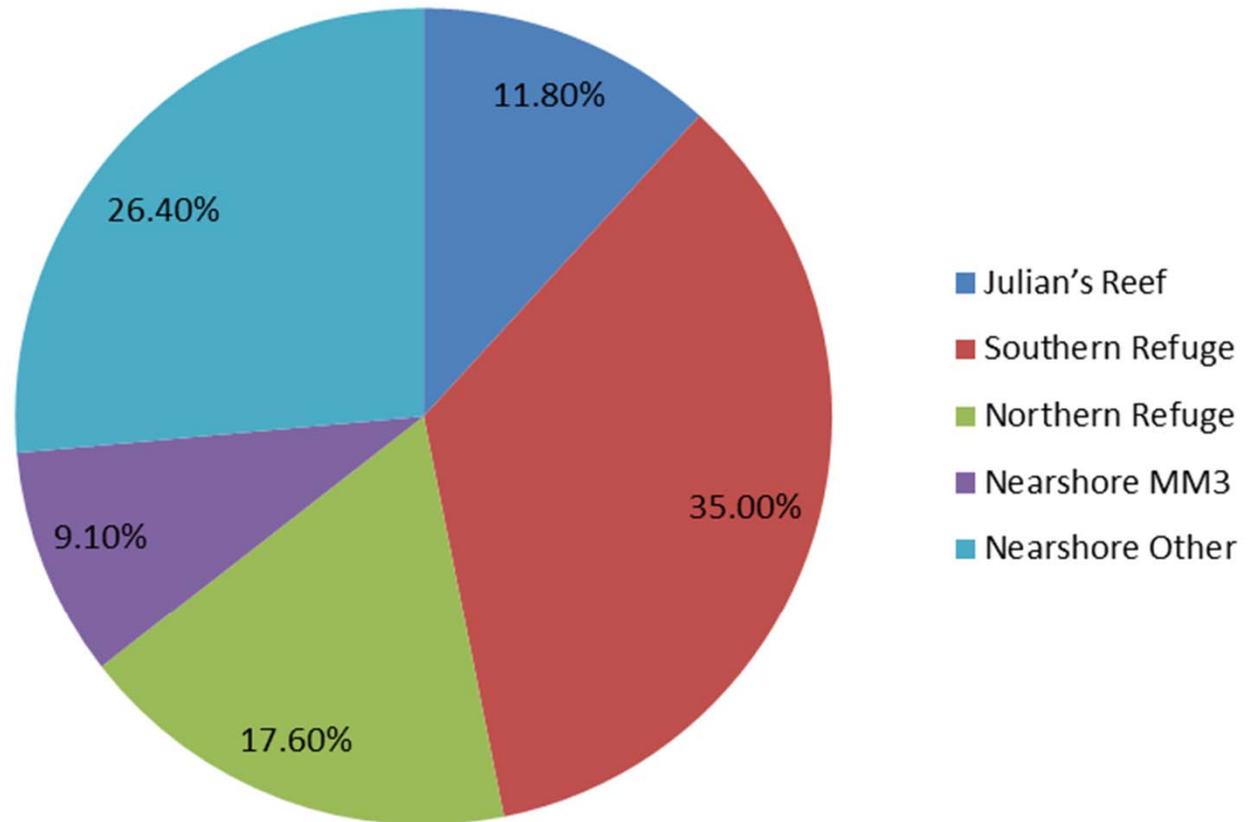
Contribution to Sport Catch by Lake Trout Stocking Location Analysis of Mass Marking Data

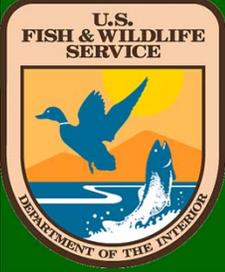


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Sport Catch Lakewide

1st Priority Sites
64.4%

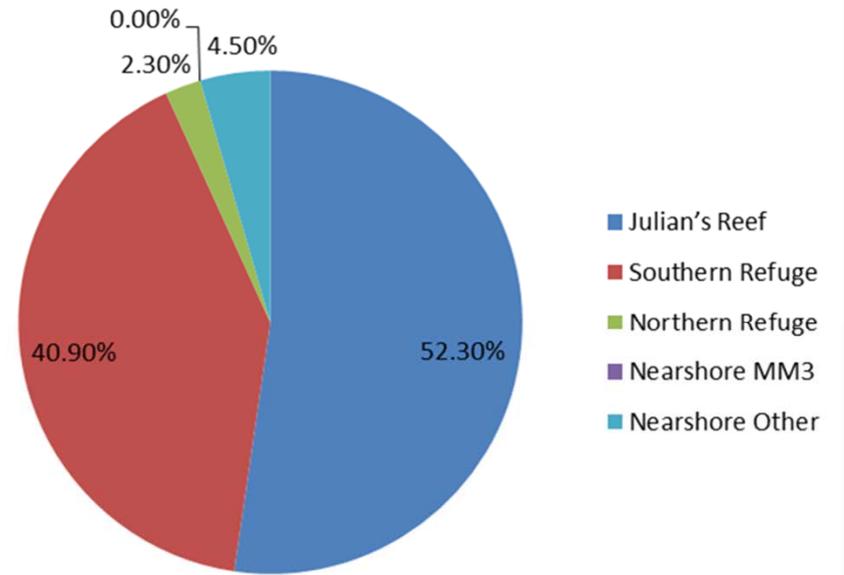
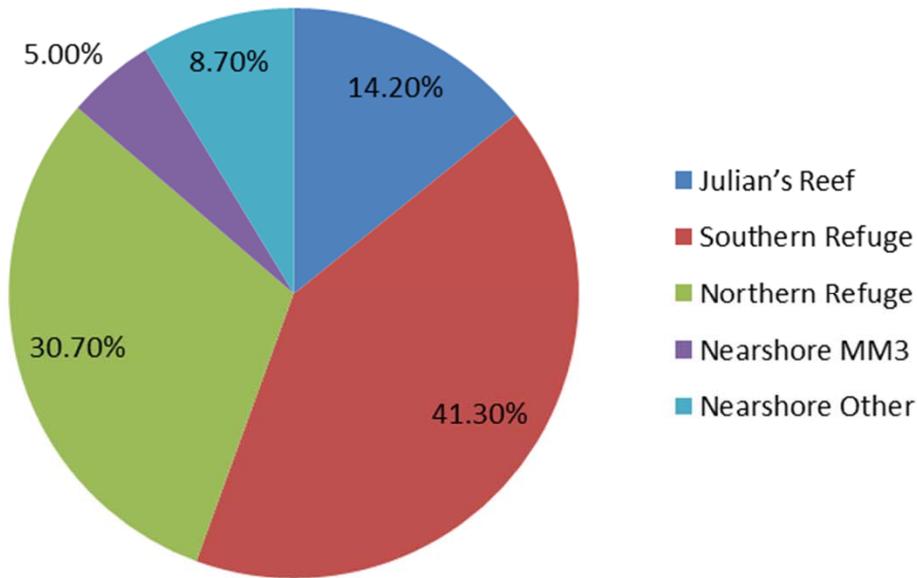




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Wisconsin

Illinois



86.2%

93.2%

From 1st Priority Sites



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Factors Explaining Variability of Lake Trout Survival

Stocking location



Genetic strain



Length at stocking



Predator CPUE



Condition at stocking



Hatchery of origin



Main Question – How are Lake Michigan salmon and trout adjusting to a changing forage base?

Understanding niche partitioning and potential for competition among salmon and trout after shifts in forage abundance is critical to fisheries management.



Coho Salmon



Chinook Salmon



Lake Trout



Steelhead

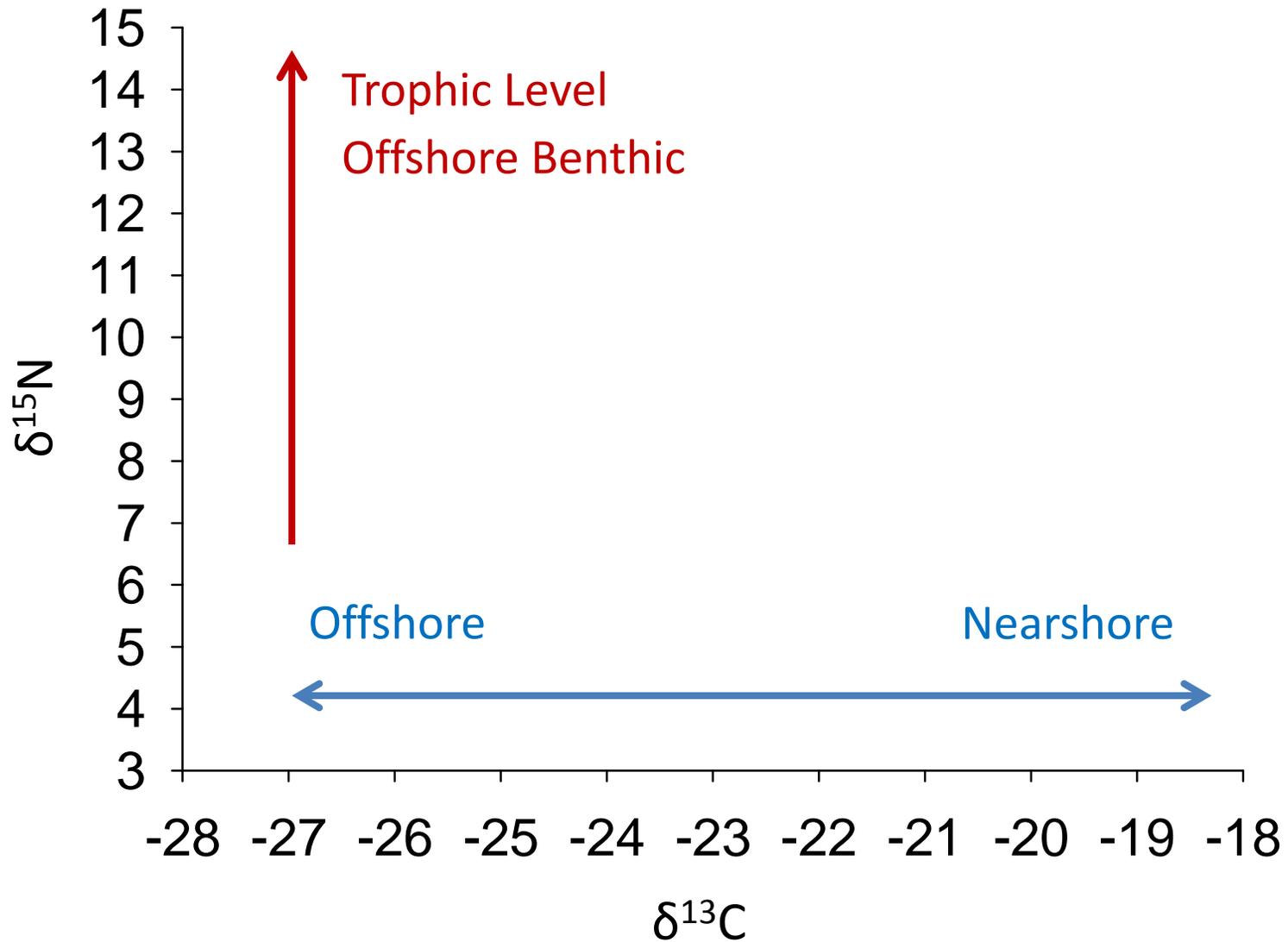


Brown Trout

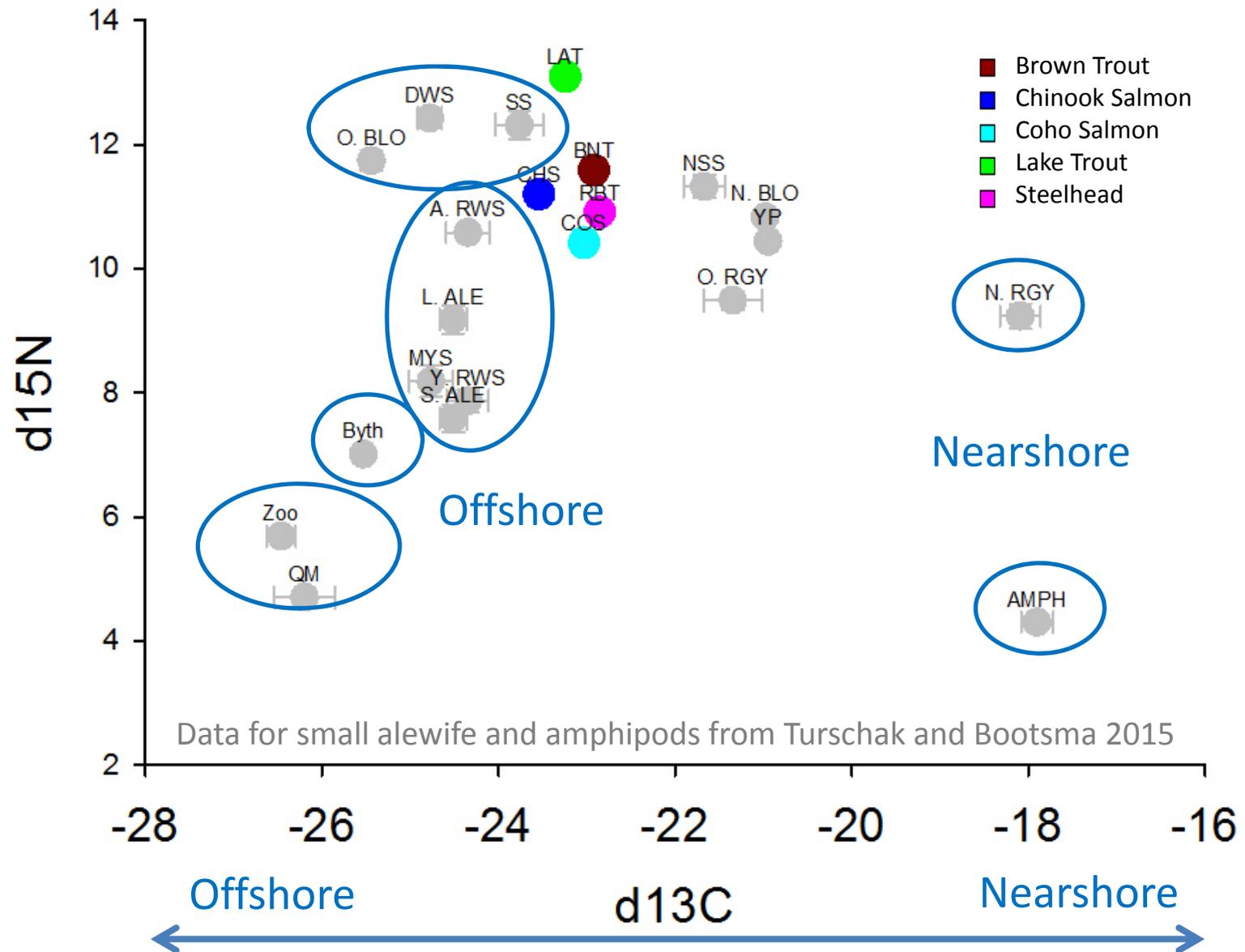
Why stable isotopes?

- Stable isotopes of carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) offer a time-integrated assessment of an animal's diet
 - Gut contents = hours to days
 - Stable isotopes = weeks to months
- Stable isotopes can capture complex interactions and help visualize energy flow through entire communities.
- Method has been commonplace in aquatic ecology for decades, and there are refined tools for comparing niches and estimating diet

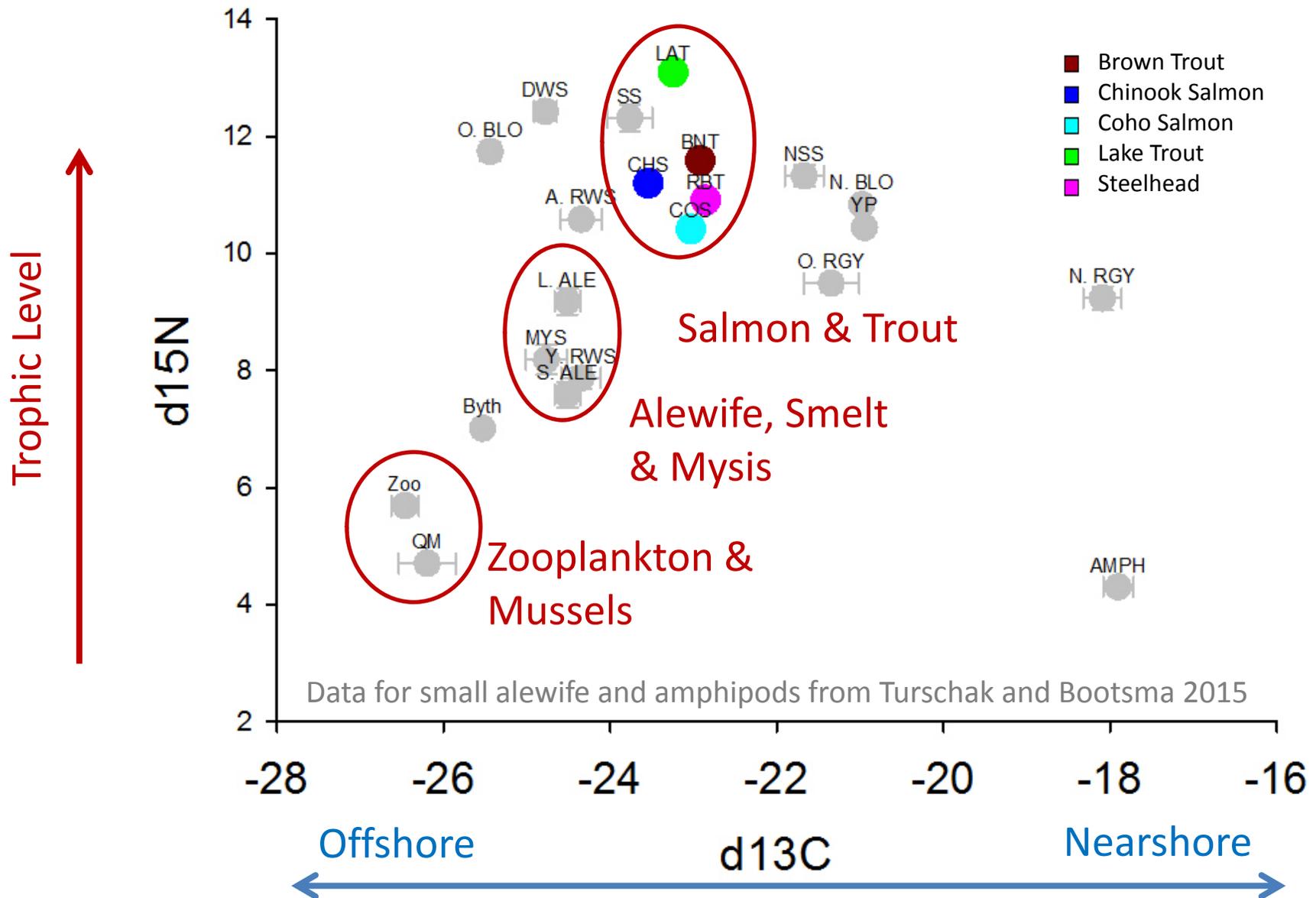
How are C and N stable isotopes interpreted?



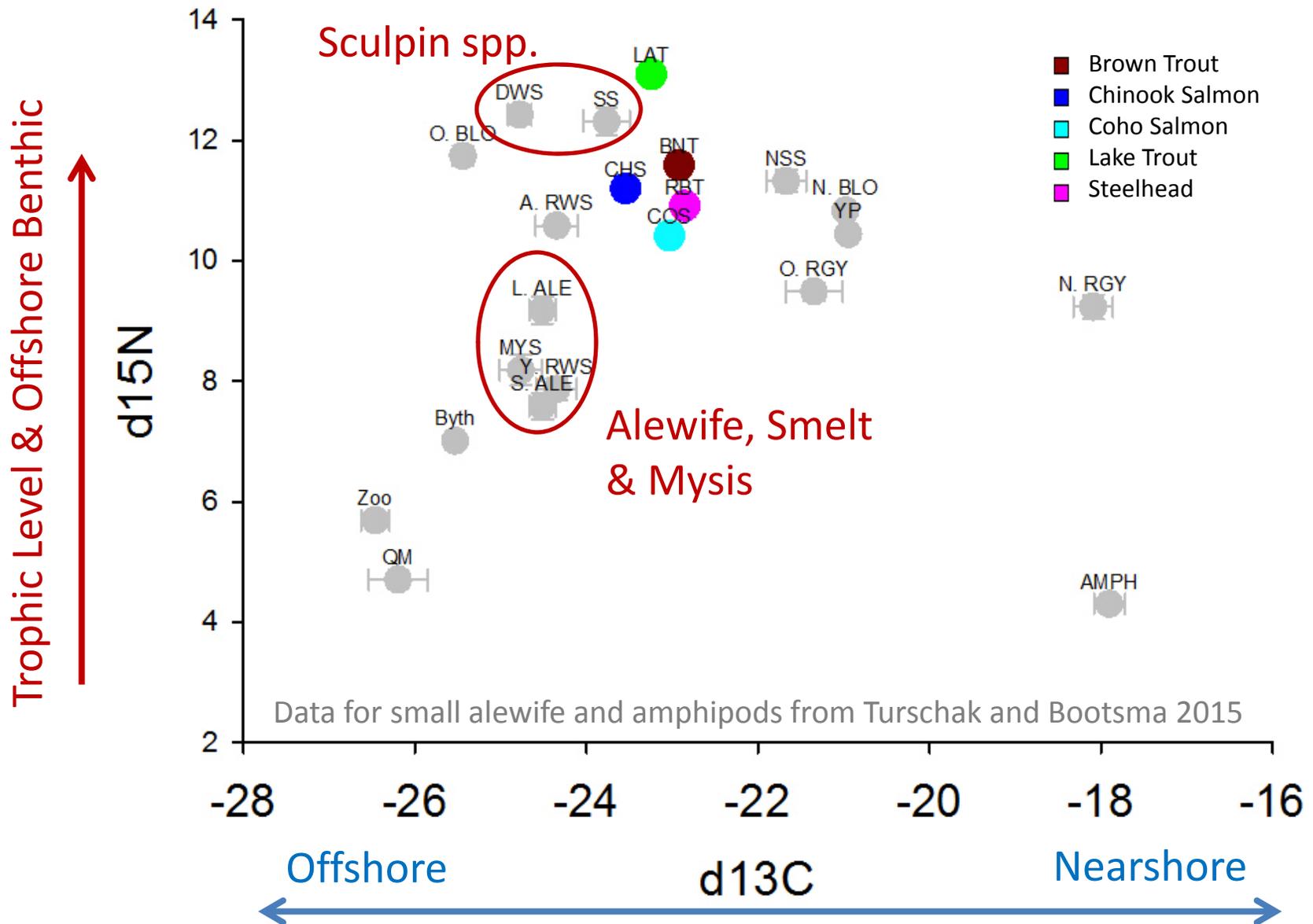
How are C and N stable isotopes interpreted?



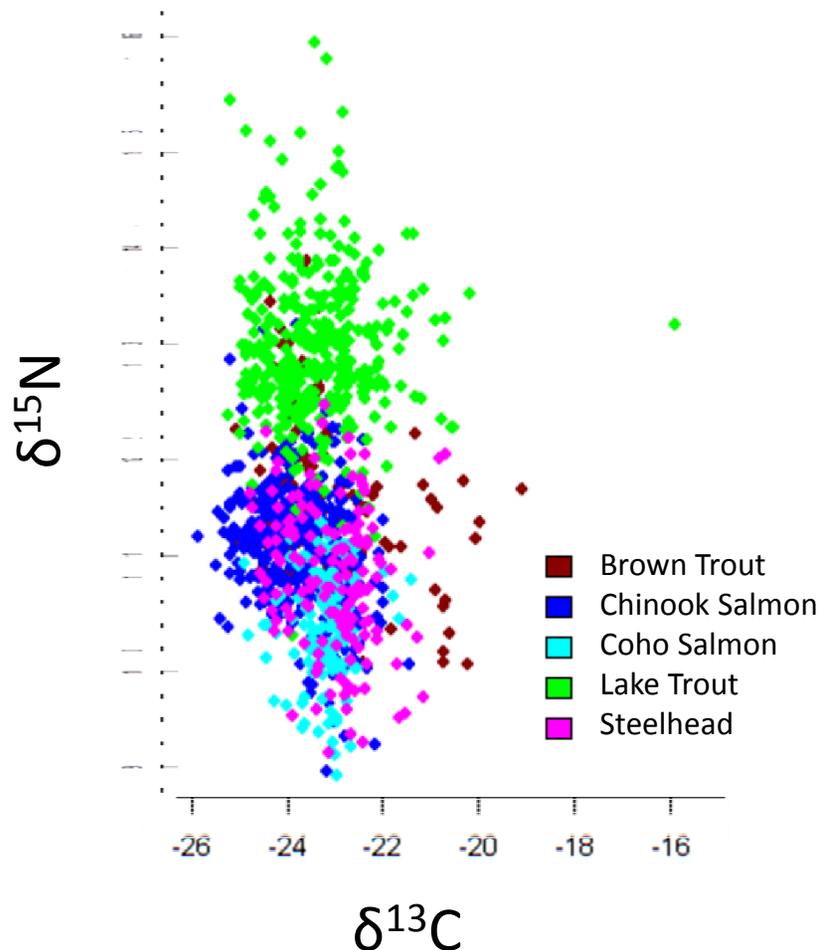
How are C and N stable isotopes interpreted?



How are C and N stable isotopes interpreted?



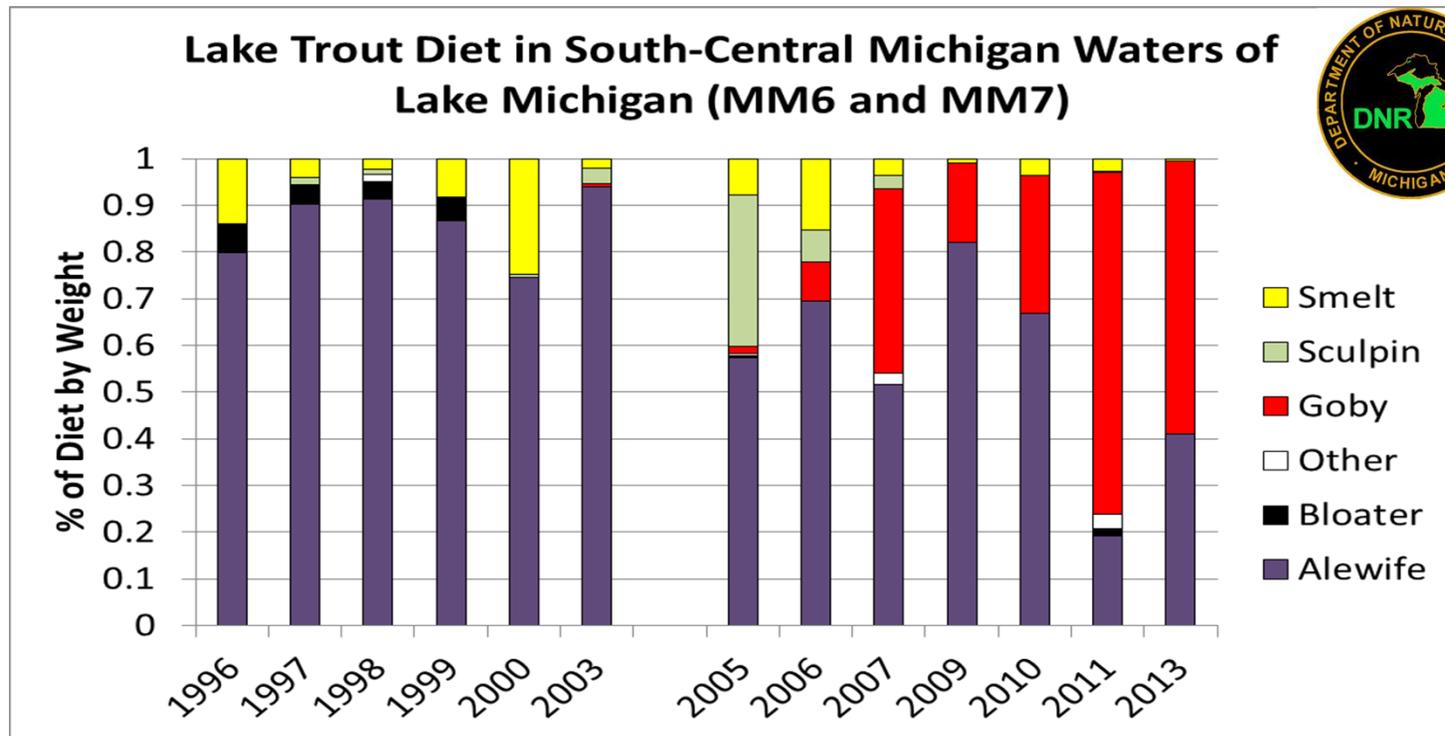
Overlap of Isotope Data Points an Indicator of Diet Overlap and Competition



- What is the probability of drawing a data point from one species from the niche of another?
- E.g., what is the probability of drawing a green dot from the range occupied by blue dots?

Implications for Diet

- The similar niches described for Chinook salmon, coho salmon and steelhead indicate similar feeding locations and diets, probably dominated by alewife and rainbow smelt
- By contrast, the data suggest lake trout are shifting away from alewife and rainbow smelt and toward deepwater and/or benthic forage
- Diet data from MI DNR also demonstrate a shift in lake trout diet away from alewife and toward benthic forage (round goby) over time



How are Lake Michigan salmon and trout adjusting to a changing forage base?

Results suggest competition for declining prey fish will be highest among Chinook salmon, coho salmon, brown trout, and steelhead



Coho Salmon



Chinook Salmon



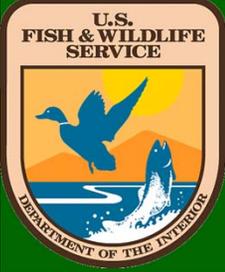
Lake Trout



Steelhead

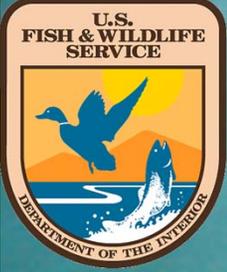


Brown Trout



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Spring Abundance (>25/1000')	Below Target
Fall Abundance (>50/1000')	At or Near Target
Percent Females in Fall (25%)	Above Target
Ten Age Groups at Spawning	50% at target
Egg Deposition (>500/sqm)	Below Target
Egg Thiamine levels	Near or Above Target
%Wild Fish	Good – South/West
Lamprey Induced Mortality	At Target
Contribution to Sport Fishery	Highest - Priority Sites
Changing Prey Base	LAT likely will compete less with Salmon



U.S. Fish and Wildlife Service

Lake Michigan Lake Trout Management and Restoration

Mark E. Holey
Project Leader

Green Bay Fish and Wildlife Conservation Office
US Fish and Wildlife Service

Thank You – Any Questions?