Status of the Mass Marking Program in Lake Michigan

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Outline

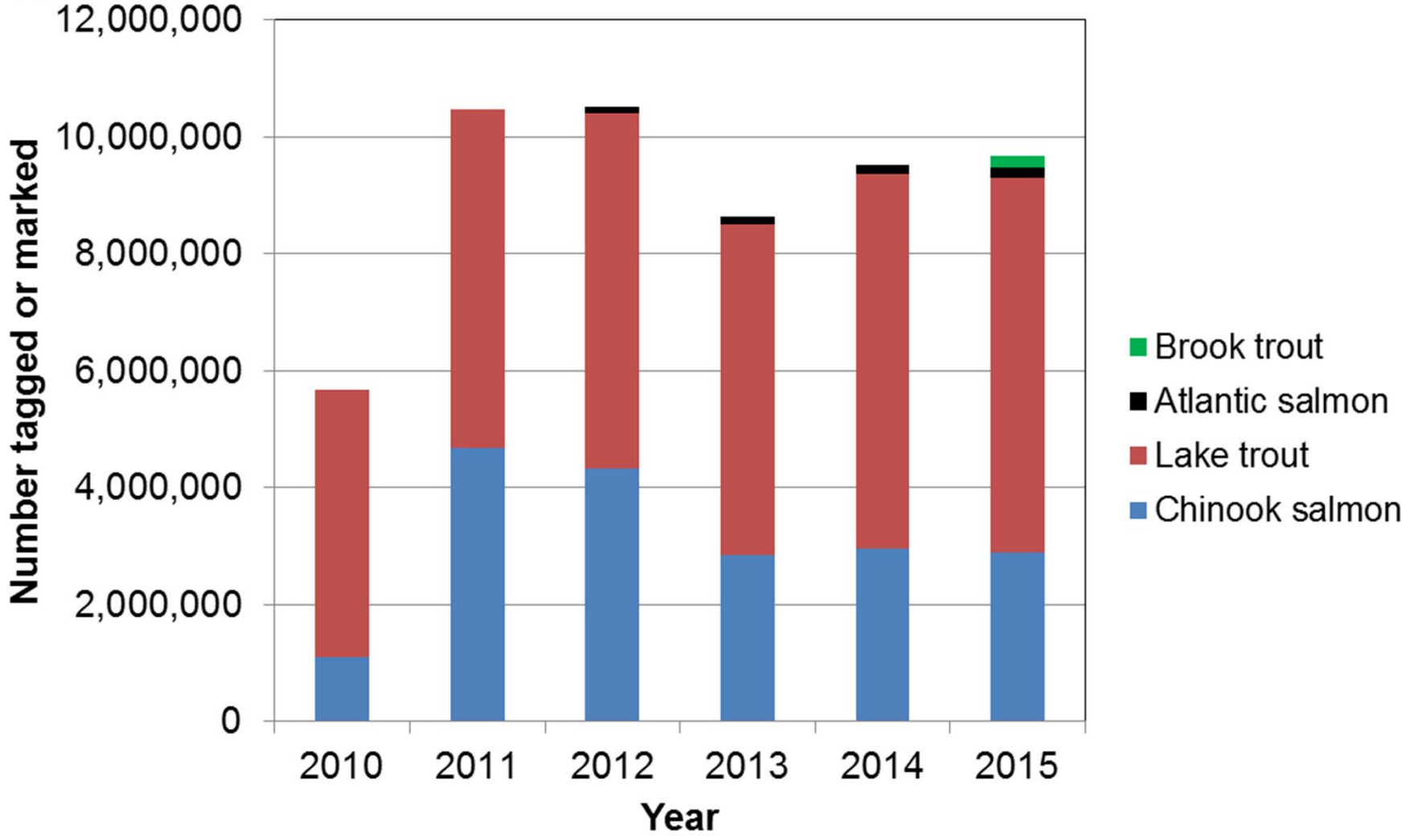
- Program Overview
- Chinook Salmon Results
  - Wild recruitment
  - Post-stocking survival
  - Movement
- Legacy Lake Trout Results
  - Post-stocking survival
  - Movement

Great Lakes Mass Marking Program
FY 2008-2016 Federal (non-base) Funding

Fiscal 2008: $1.7 million for equipment (Approp)
Fiscal 2009: $1.5 million for equipment (Approp)
Fiscal 2010: $1.0 million for operations (Approp); $2.6 million for equipment (GLFWRA/GLRI)
Fiscal 2011-14: $1.5 million/year for operations (GLRI)
Fiscal 2015: $1.0 + 0.5 million for operations (GLRI)
Fiscal 2016: $0.8? million + 0.6? for operations (GLRI)

This program is NOT funded by the U.S. Fish and Wildlife Service budget!

Number of fish by species tagged/marked by the Great Lakes Fish Tag and Recovery Lab, 2010-2015



Tagging schedule in 2015

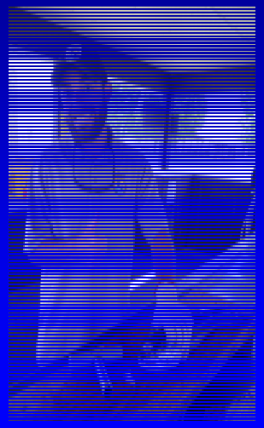
Agency	Hatchery	Dates	Species	Number of fish	Run hours	Mean length mm
ILDNR	Jake Wolf	Mar 11 - 15	Chinook	257,996	312	96
INDNR	Mixsawbah	Mar 18 - 21	Chinook	203,123	232	83
WIDNR	Kettle Moraine	Mar 30 - Apr 1	Chinook	176,113	183	71
MIDNR	Wolf Lake	Mar 23 - 27	Chinook	248,961	290	84
WIDNR	Wild Rose	Apr 7 - 14	Chinook	643,852	668	76
MIDNR	Thompson (ADCWT)	Apr 29	Chinook	53,233	63	81
MIDNR	Thompson (AD only)	Apr 30 - May 4	Chinook	411,761	423	81
MIDNR	Platte River	Apr 22 - 30	Chinook	973,758	1061	80
	Total Chinook salmon			**2,968,797**	**3232**	
MIDNR	Marquette	July 9 - 12	Lake trout	218,849	267	86
USFWS	Pendills Creek	Aug 4 - Sept 2	Lake trout	1,152,182	166	96
USFWS	Jordan River	Aug 5 - Sept 26	Lake trout	2,393,846	3391	88
USFWS	Iron River	Sep 23 - Oct 5	Lake trout	1,268,064	1390	92
USFWS	Allegheny	Aug 19 - Sept 13	Lake trout	1,111,754	1368	87
USFWS	Eisenhower	Sep 16-20	Lake trout	245,130	329	98
	Total Lake trout			**6,389,825**	**8405**	
MIDNR	Platte River (ADCWT)	Jul 14 - 18	ATS	190,170	312	84

Tag Recovery and Data Field Operations

Data collection, data archiving, tag recovery, tag extraction, and ageing wild fish

- Hired technicians to work with states
  - 2 Milwaukee, WI
  - 1 Zion, IL
  - 2 Charlevoix, MI
  - 2 Michigan City, IN
  - 2 Sturgeon Bay, WI
  - 2 Alpena, MI
  - 2 Lake Ontario

Tag Recovery and Bio Data Field Operation



Collected Data on each fish:

- Species
- Capture date and location (management unit and grid)
- Length, weight, sex and maturity
- Fin-clip status
- Presence/absence of CWT
- Lamprey wounding (A and B rating system)
- Year class/age by CWT or calcified structure
- Collection method (e.g., tech, angler return)
- Interview source (i.e., angler, charter, tournament)
- Sample bias

Collected in 2014 – 2016 for related studies

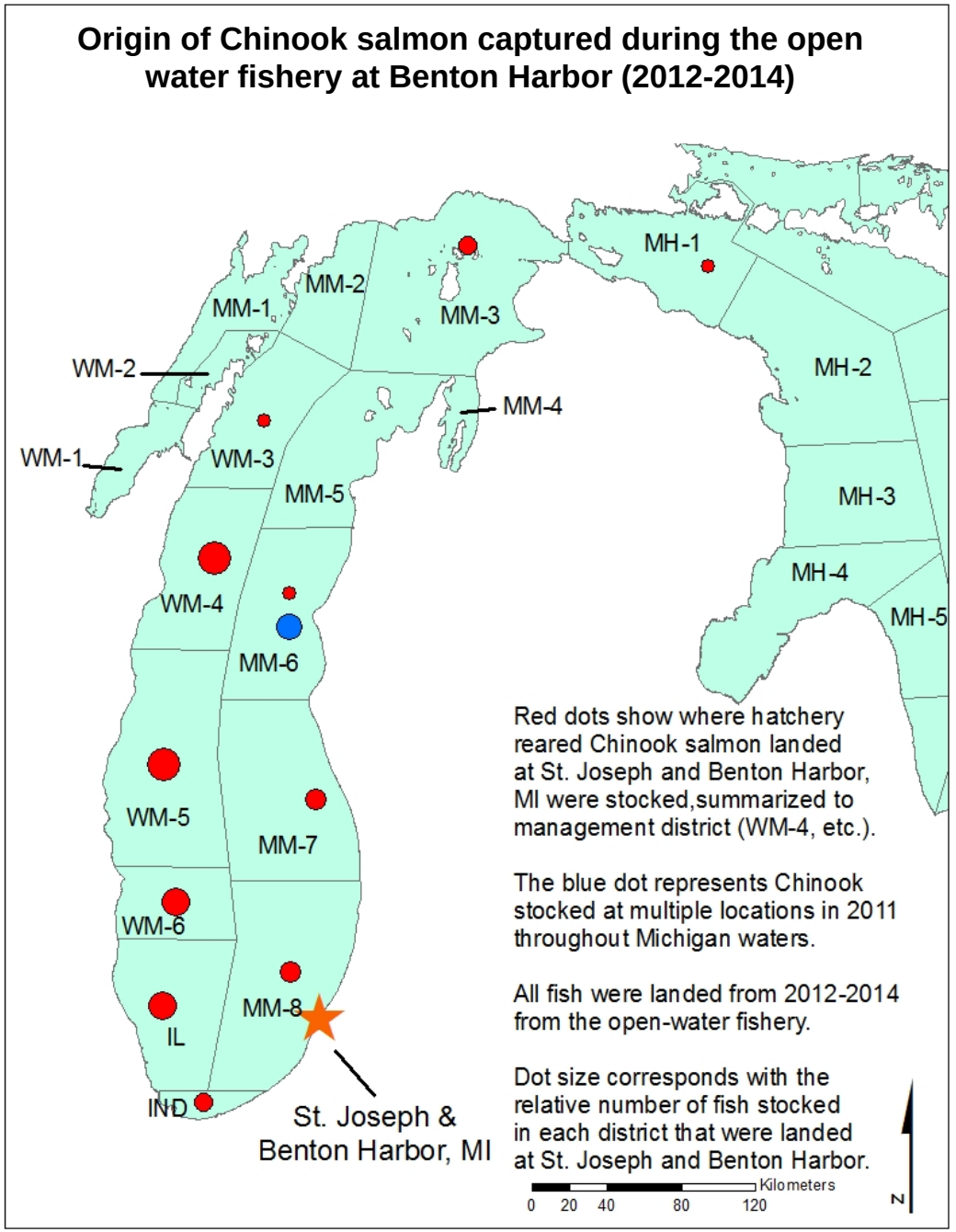
- Muscle tissue (stable isotopes)
- Belly tissue (fatty acid analysis)
- Stomachs (gut content analysis)

Tag Extraction and Reading

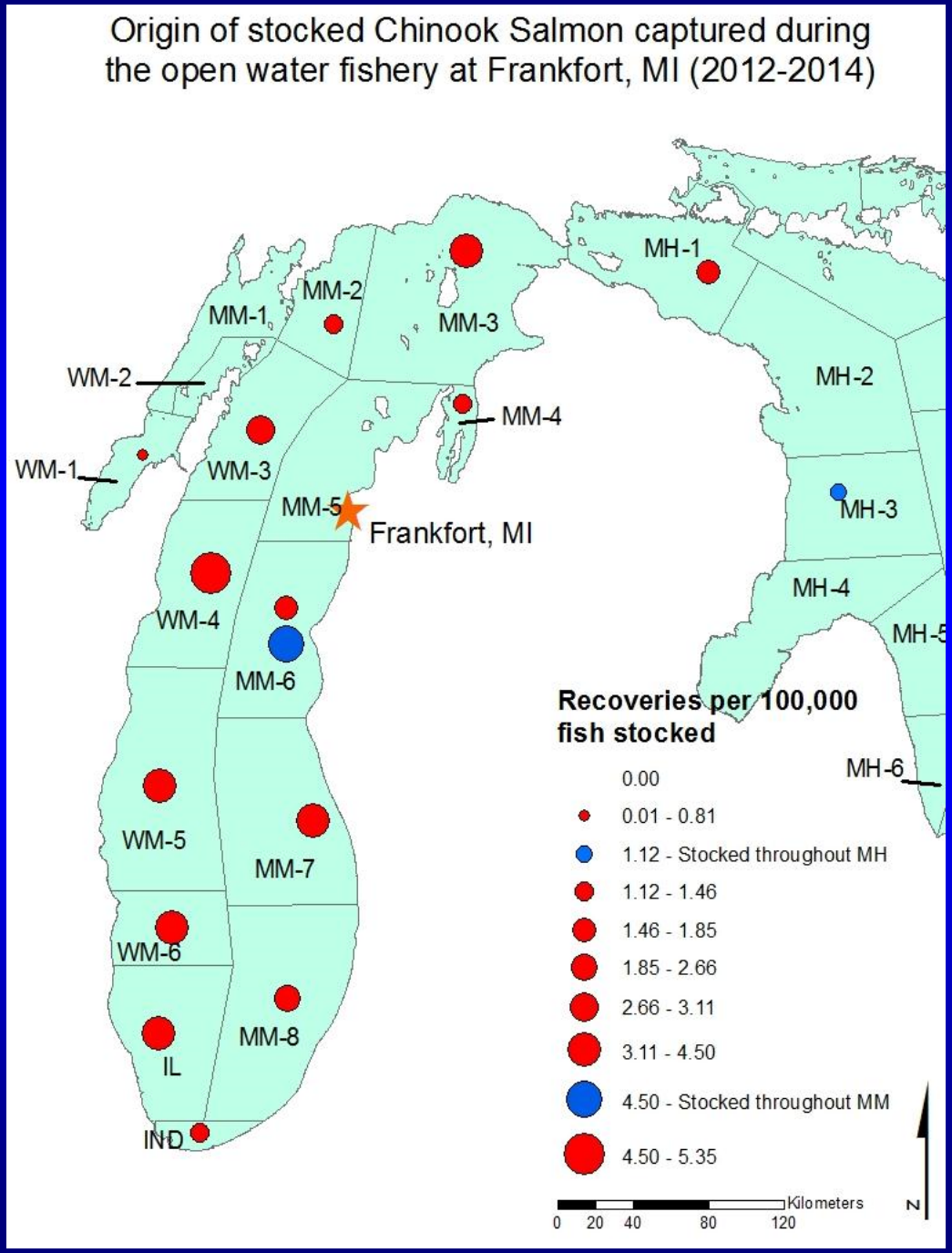
- Over 65,000 snouts (15,560 in 2015) have been processed, with more than 60,000 CWTs recovered through January 2016.

Tag recovery and read	92.1%
No tag detected	5.5%
Tag lost at extraction	1.3%
Tag damaged and not readable	<0.1%
Tag lost at reading	0.6%
Tag lost, found and read	0.5%

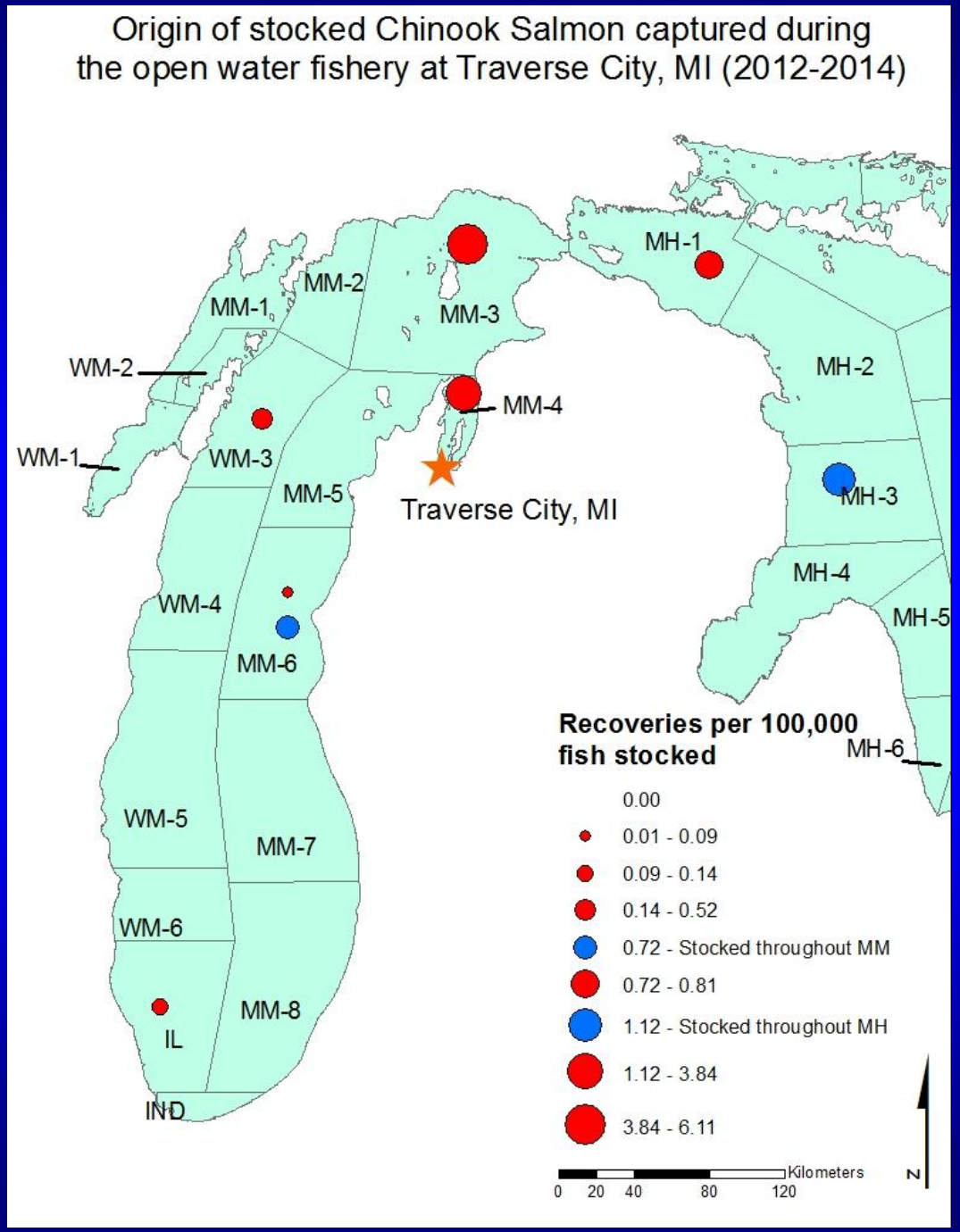
Chinook Salmon Captured at St Joseph/Benton Harbor, MI



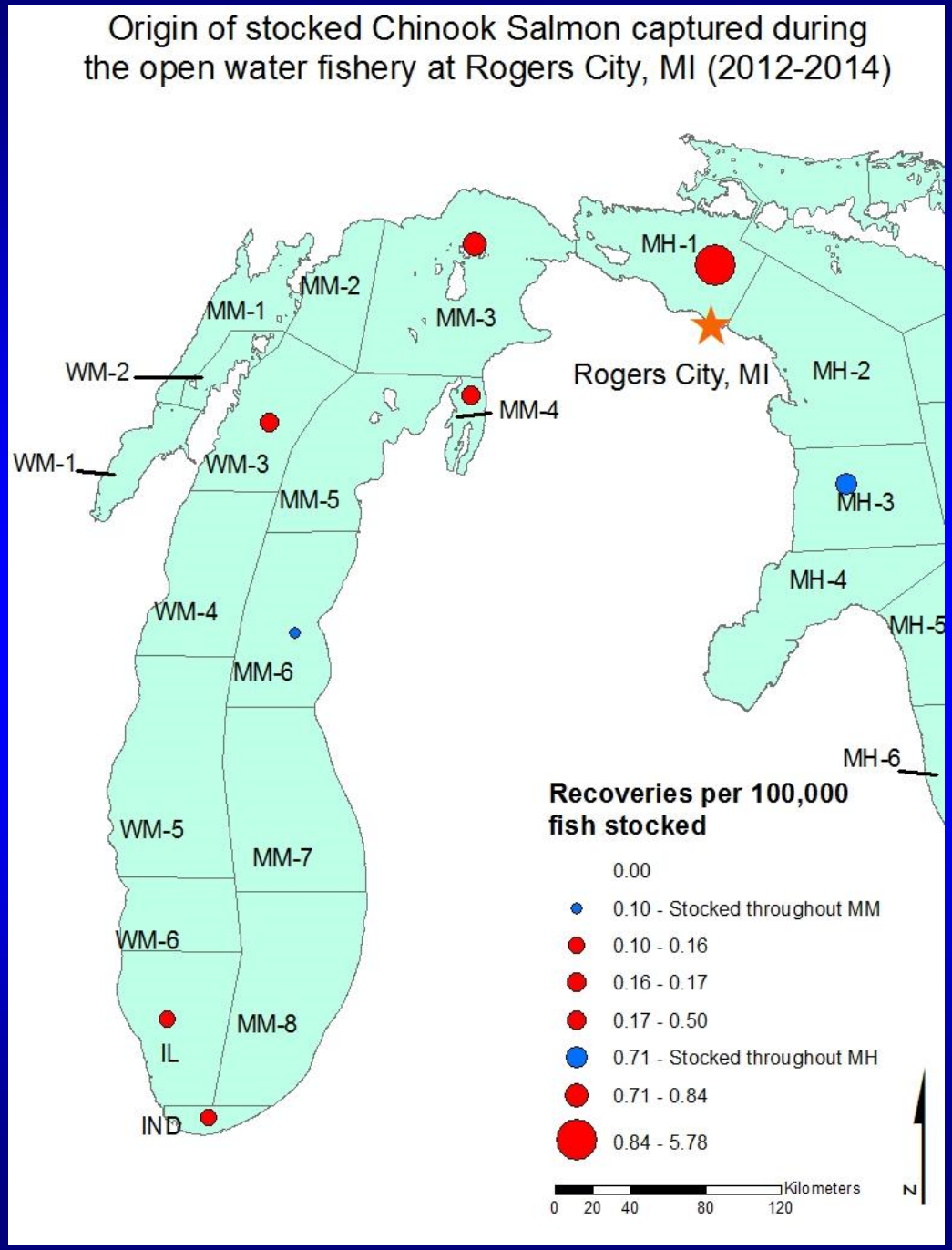
Chinook Salmon Captured at Frankfort, MI



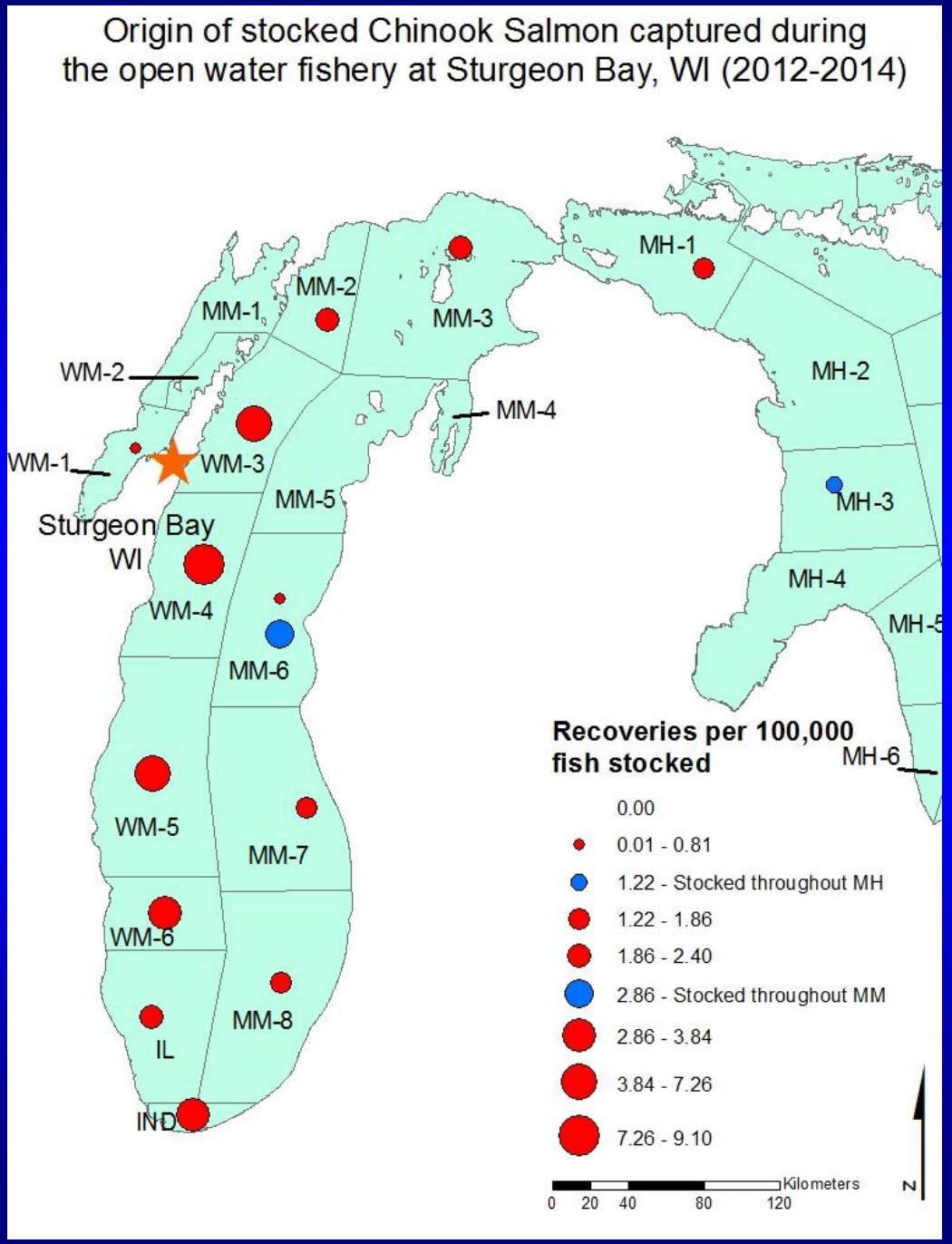
Chinook Salmon Captured at Traverse City, MI



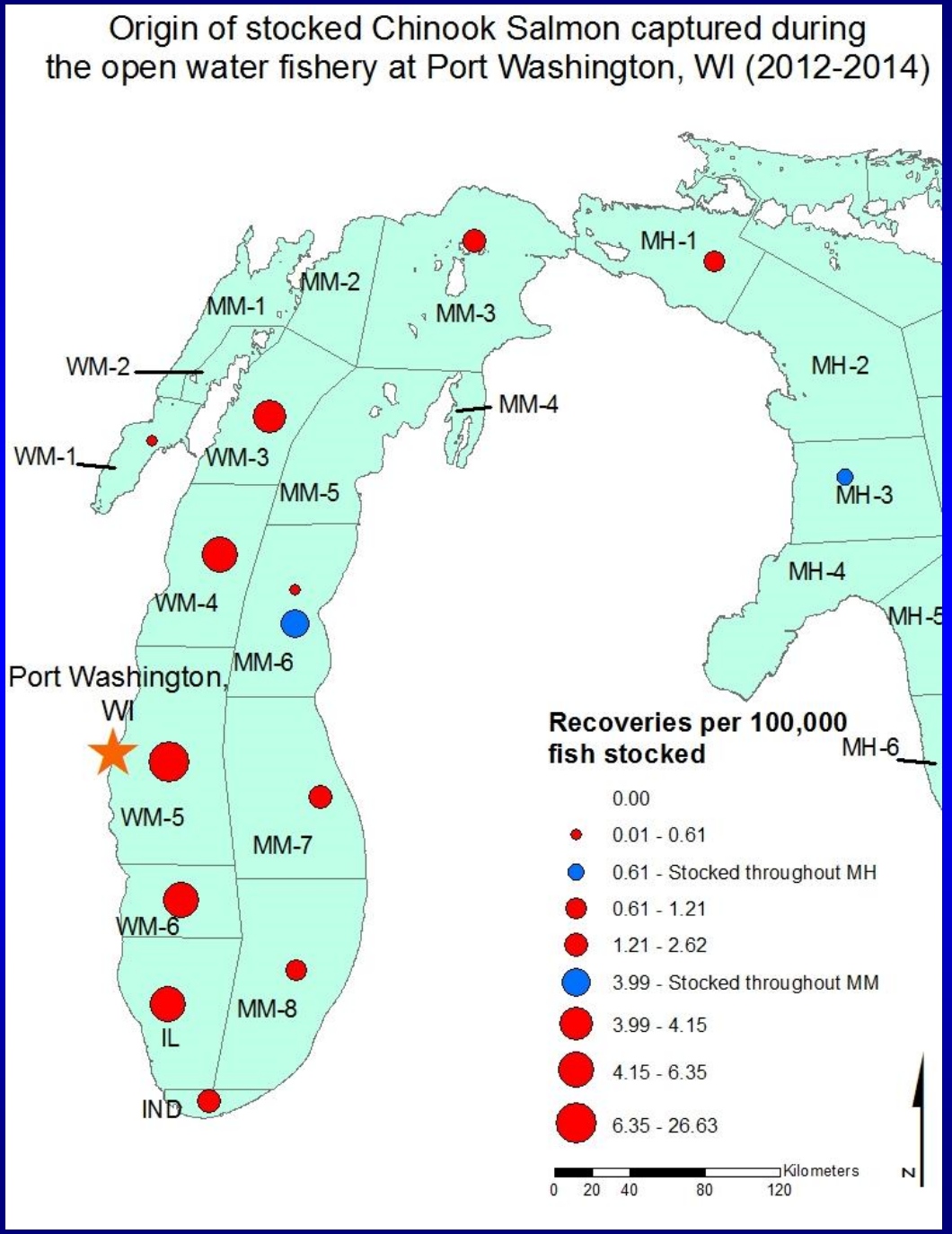
Chinook Salmon Captured at Rogers City, MI



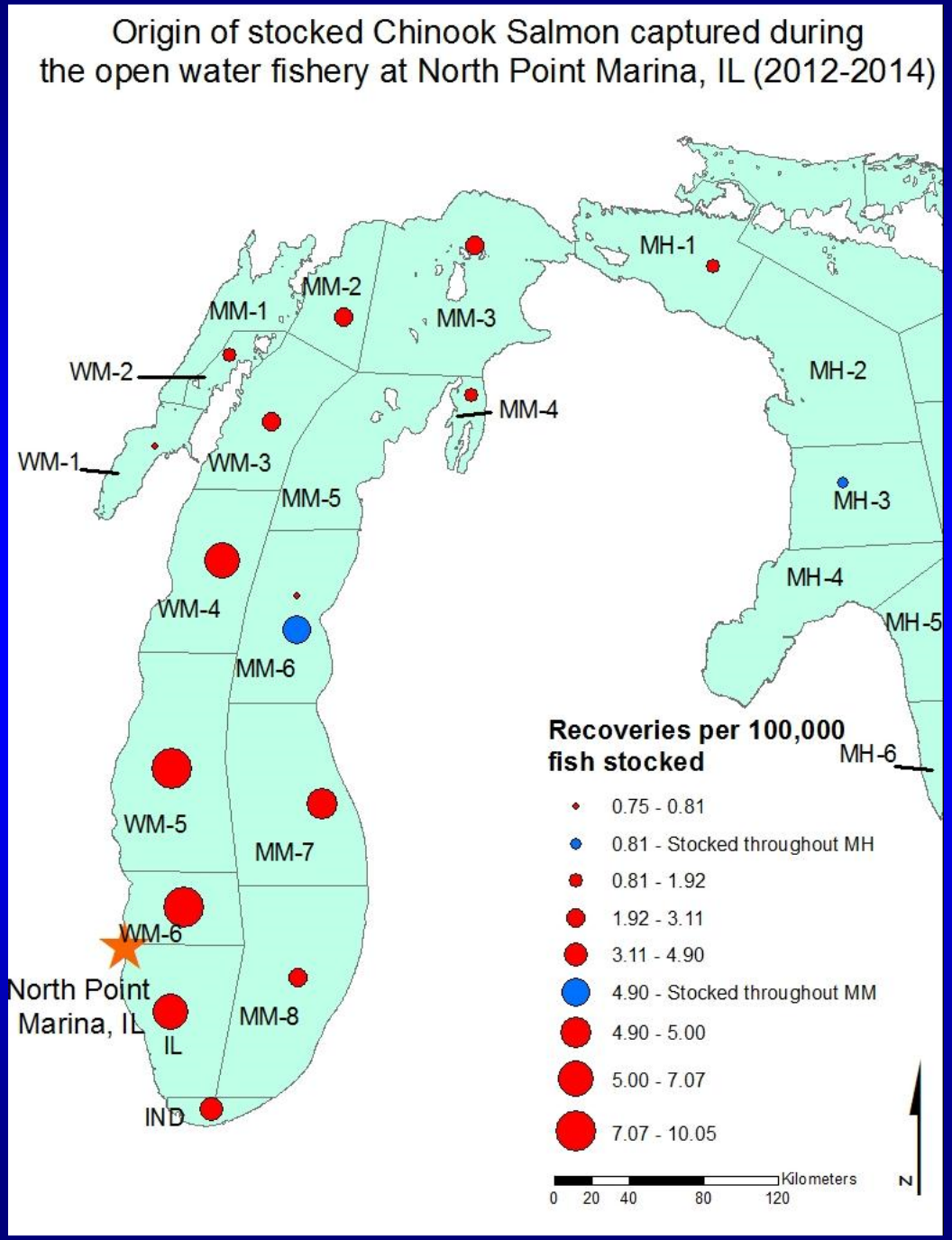
Chinook Salmon Captured at Sturgeon Bay, WI



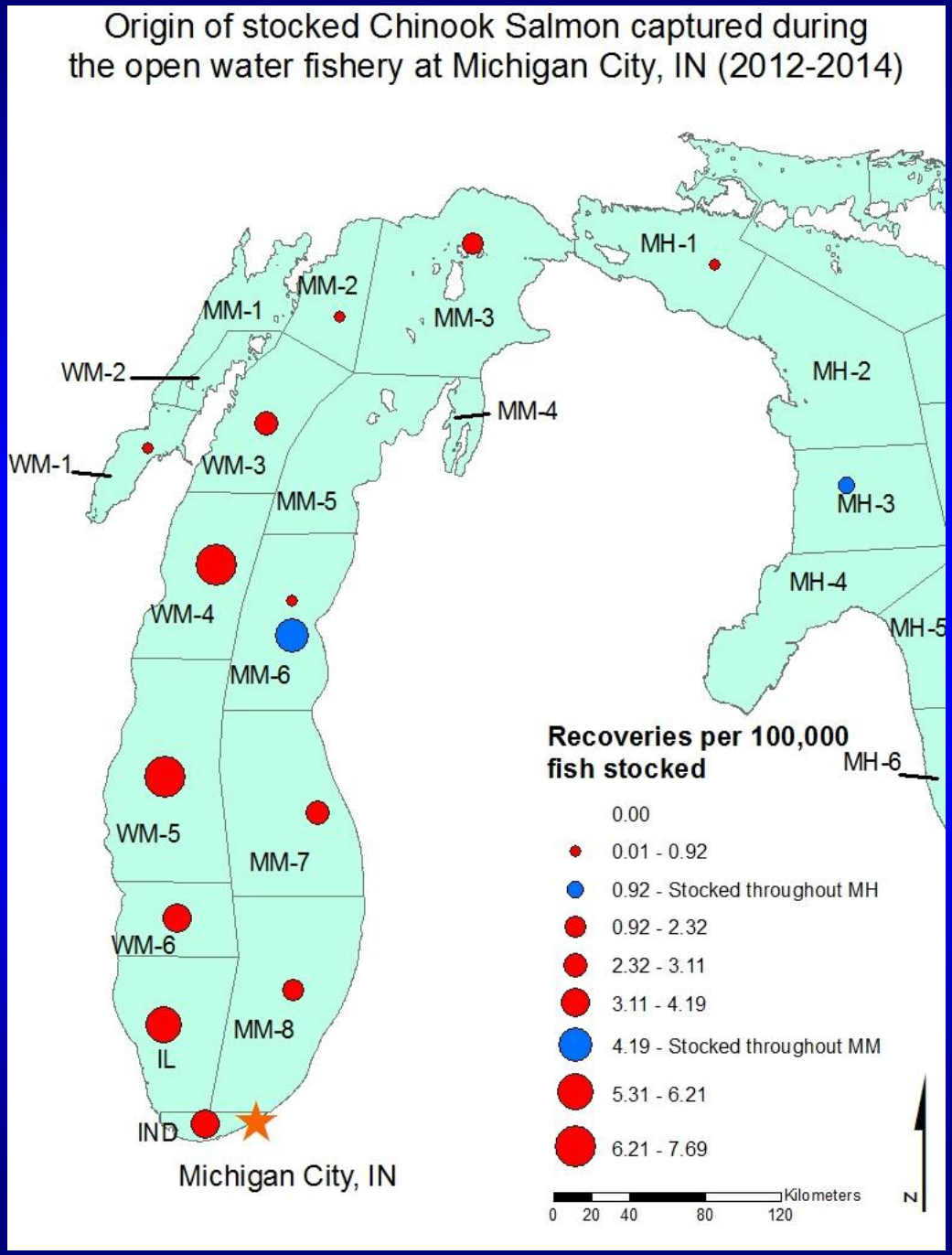
Chinook Salmon Captured at Port Washington, WI



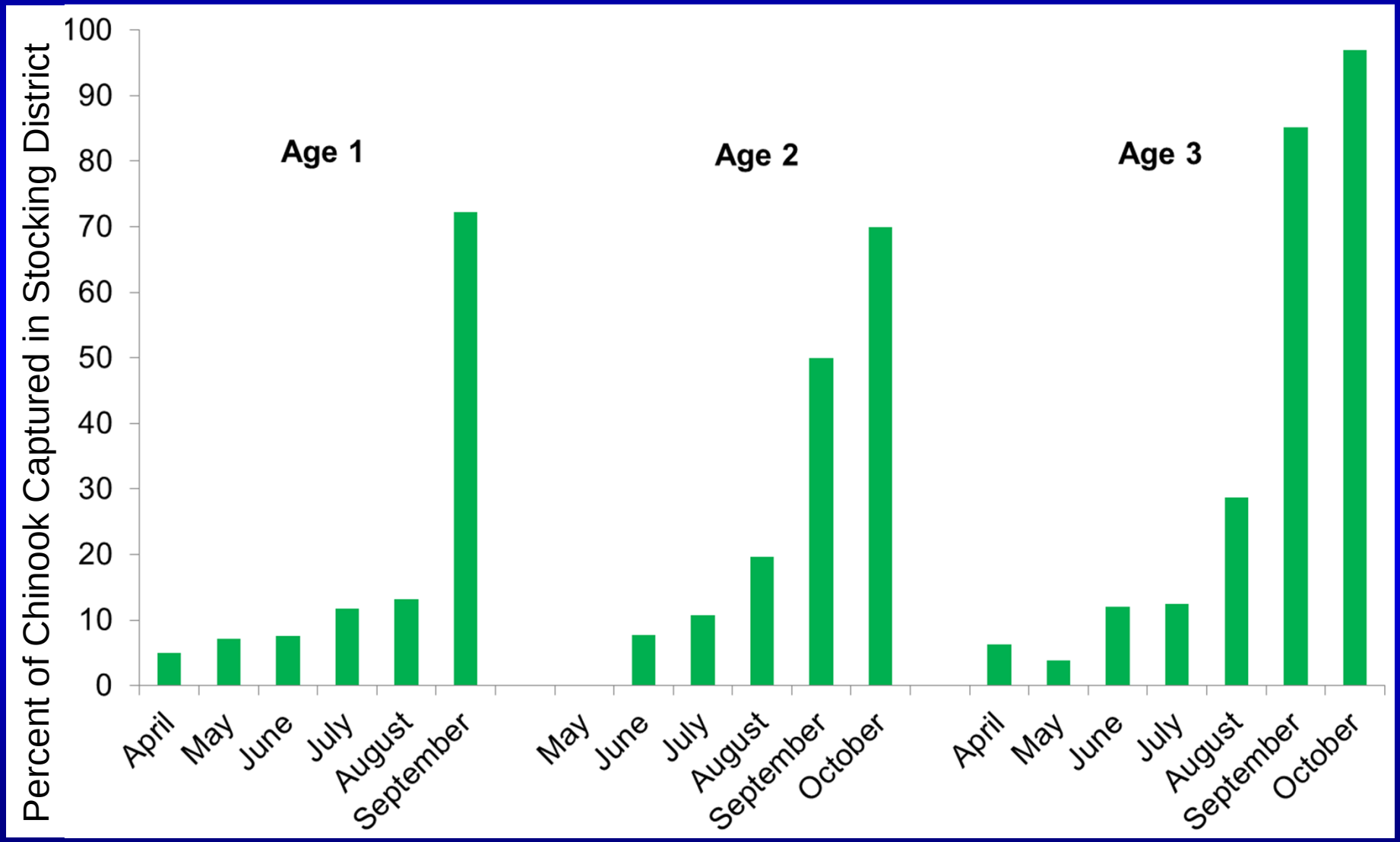
Chinook Salmon Captured at North Point Marina, IL



Chinook Salmon Captured at Michigan City, IN



Capture of Chinook salmon in stocking district by month
2011 Year Class Only



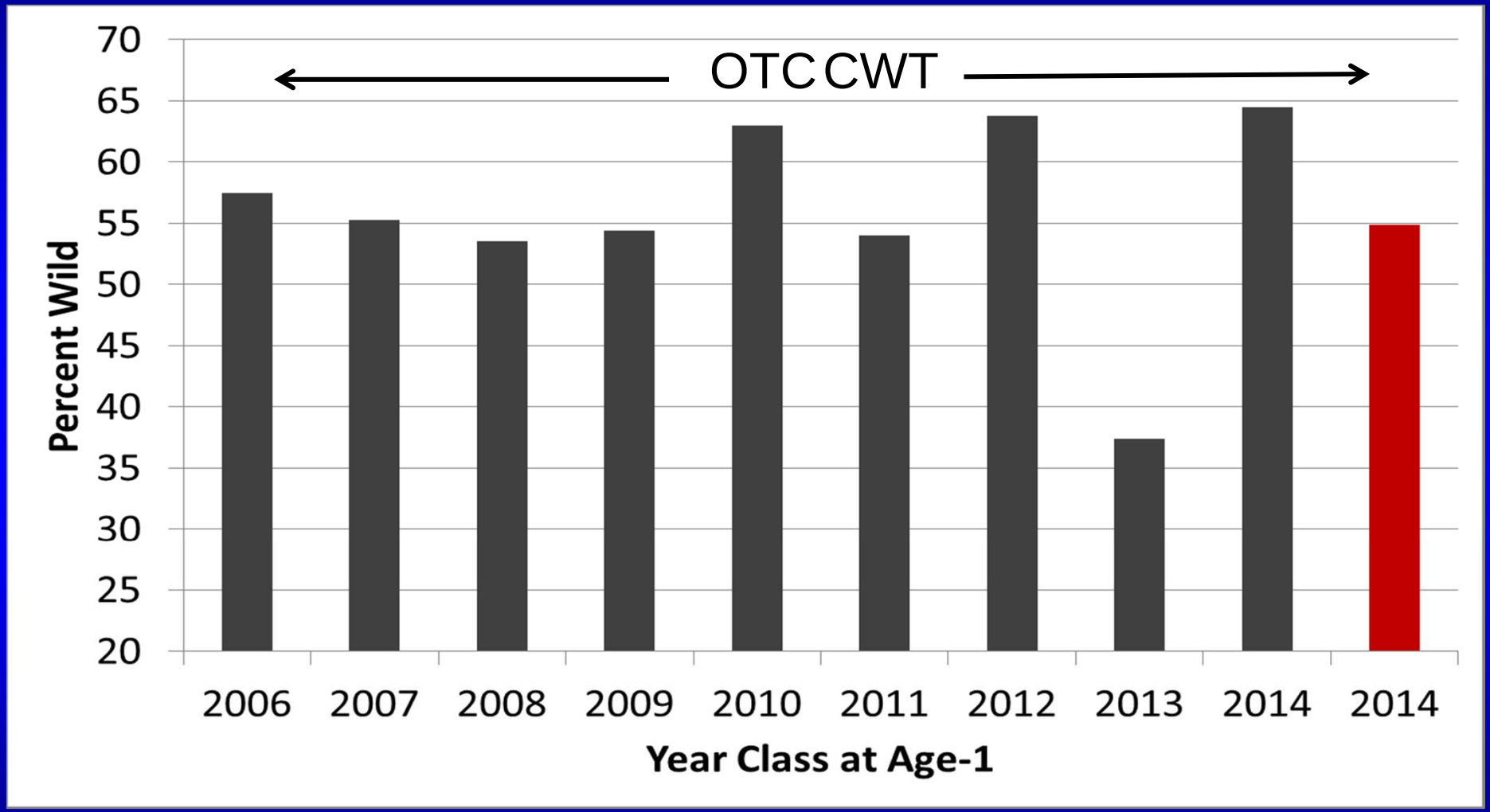
Movement of Stocked Chinook salmon between lakes Huron and Michigan

Fish sampled from April-August , 2012-2014

Lake stocked	Total recovered	Number recovered from lake where stocked	Percent movement
Michigan	5,877	5,701	3%
Huron	815	85	90%
	6,692		

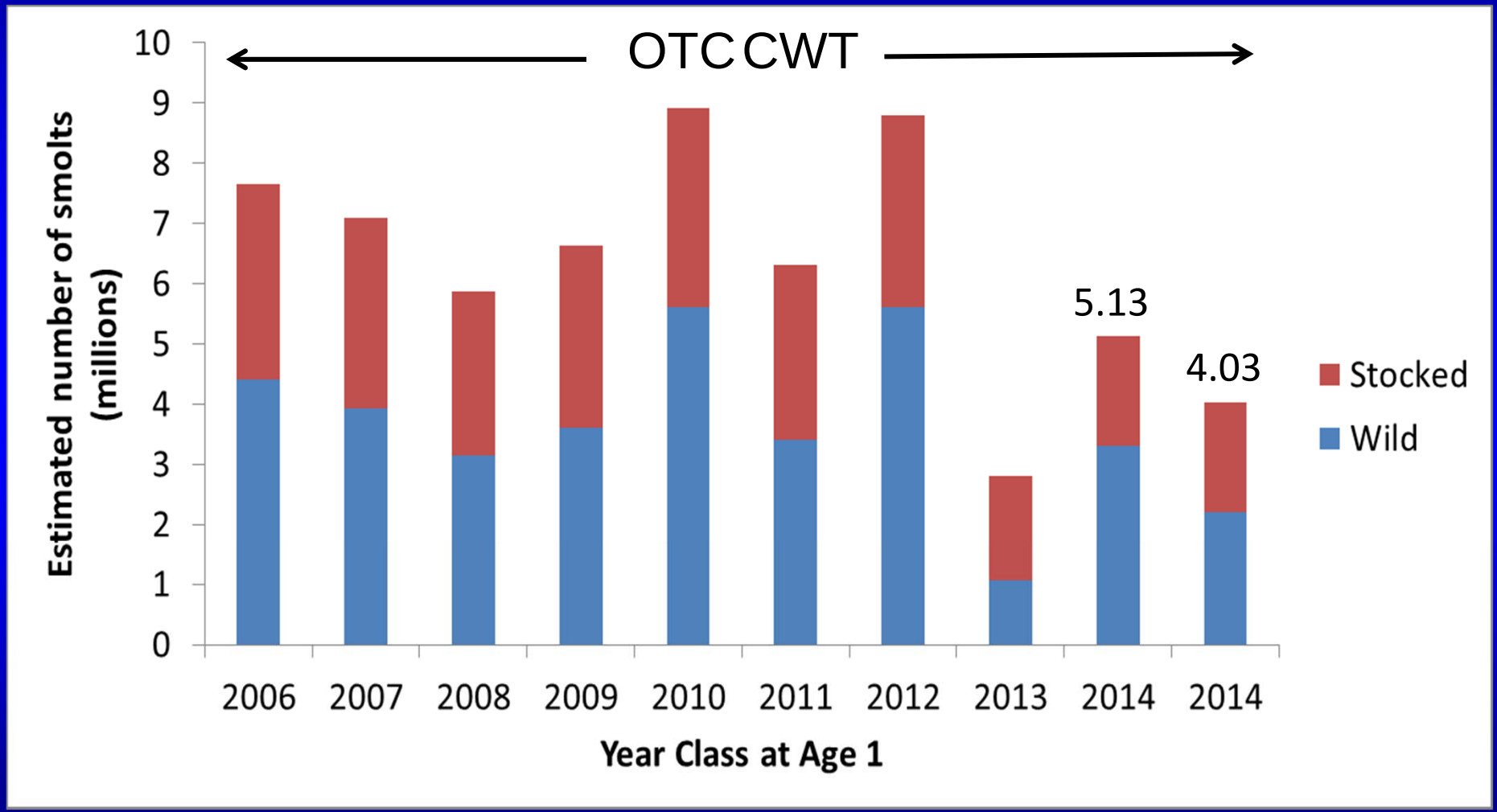
Percent wild recruitment of Chinook Salmon

2006–2014 year classes



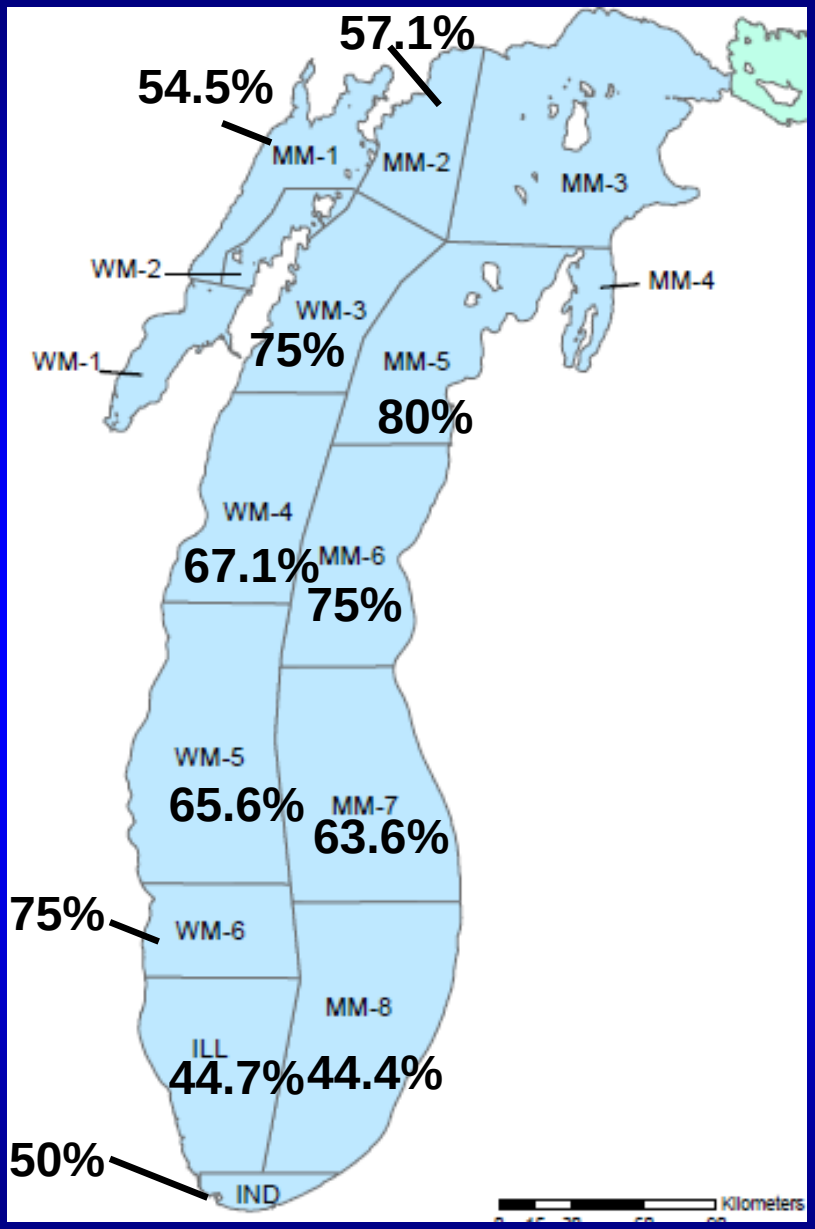
Recruitment estimates of Chinook Salmon at age 1

2006-2014 year classes



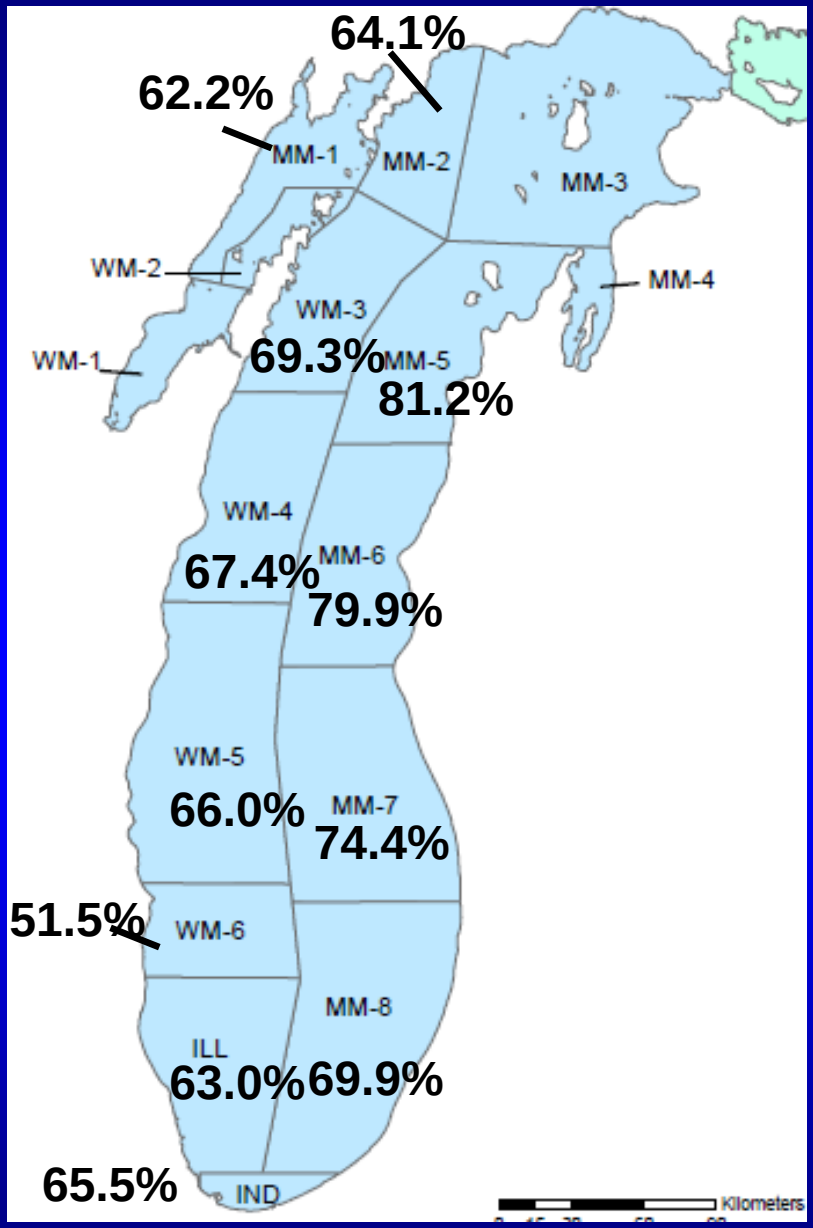
Percent Wild Chinook salmon 2014 yearclass at age 1 by Stat District

Overall 64.4% wild

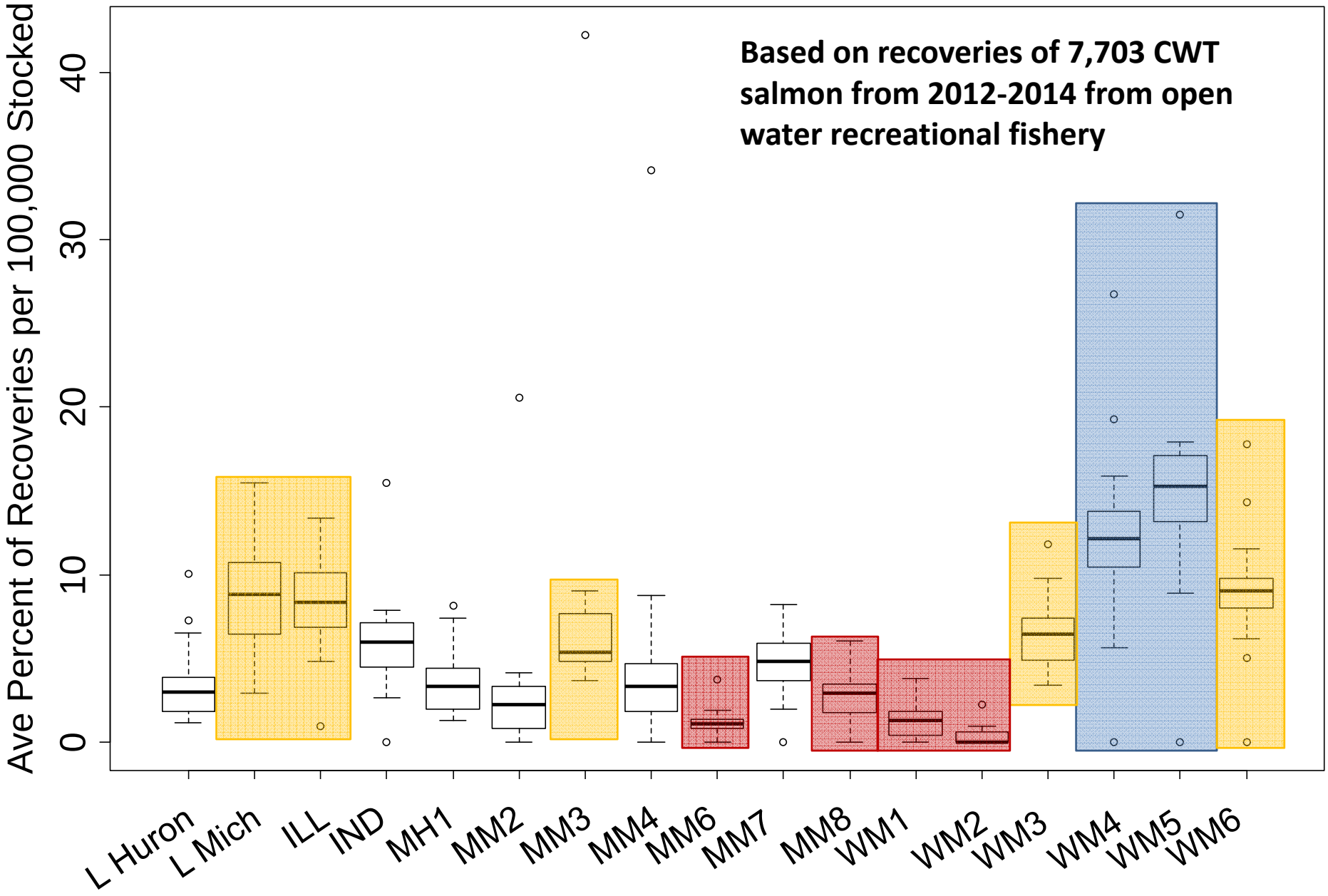


Percent Wild Chinook salmon all yearclasses in 2015 by Stat District

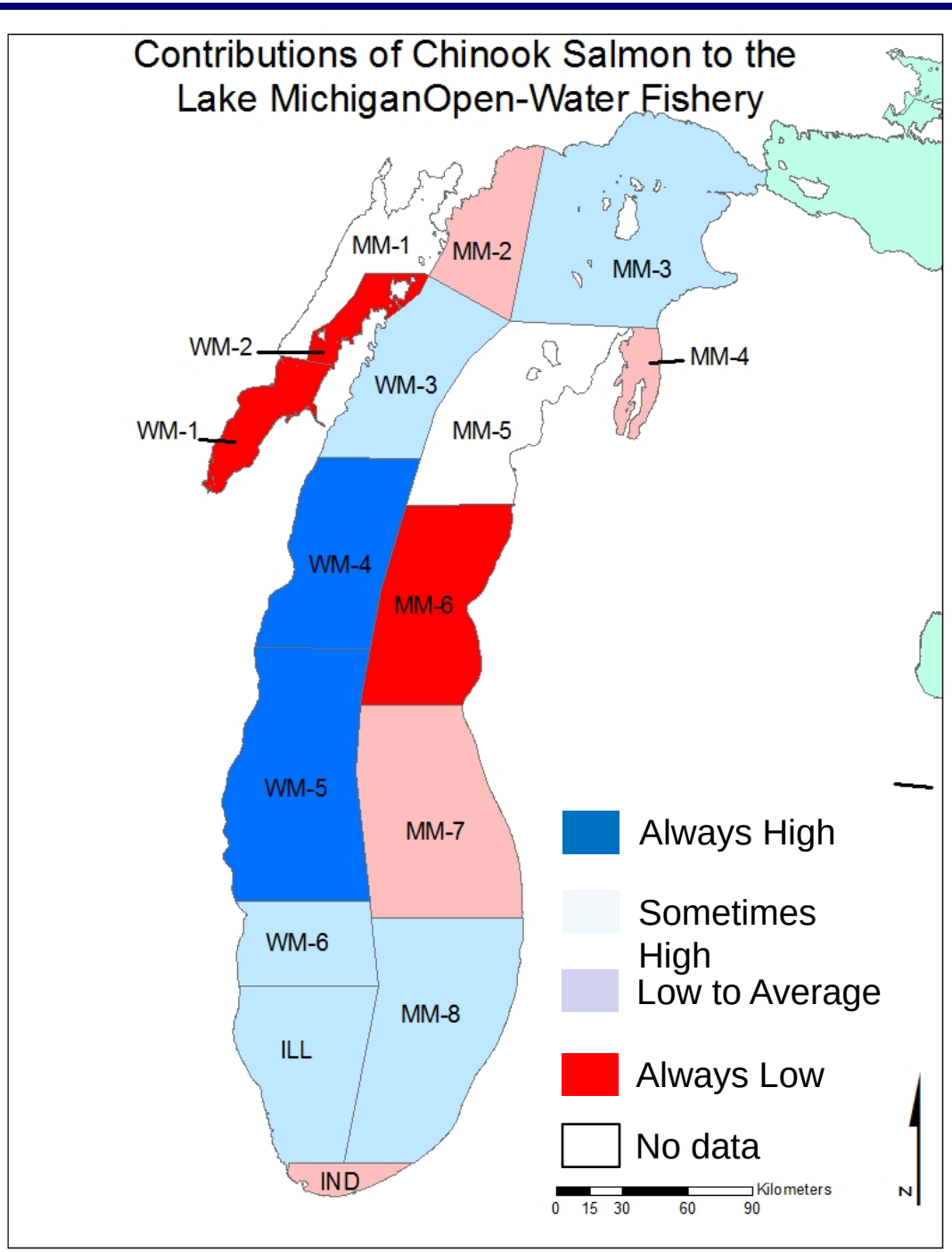
Overall 69.2% wild



Relative survival among statistical districts



Summary of post-stocking survival Chinook salmon by district



Summary for Chinook salmon results

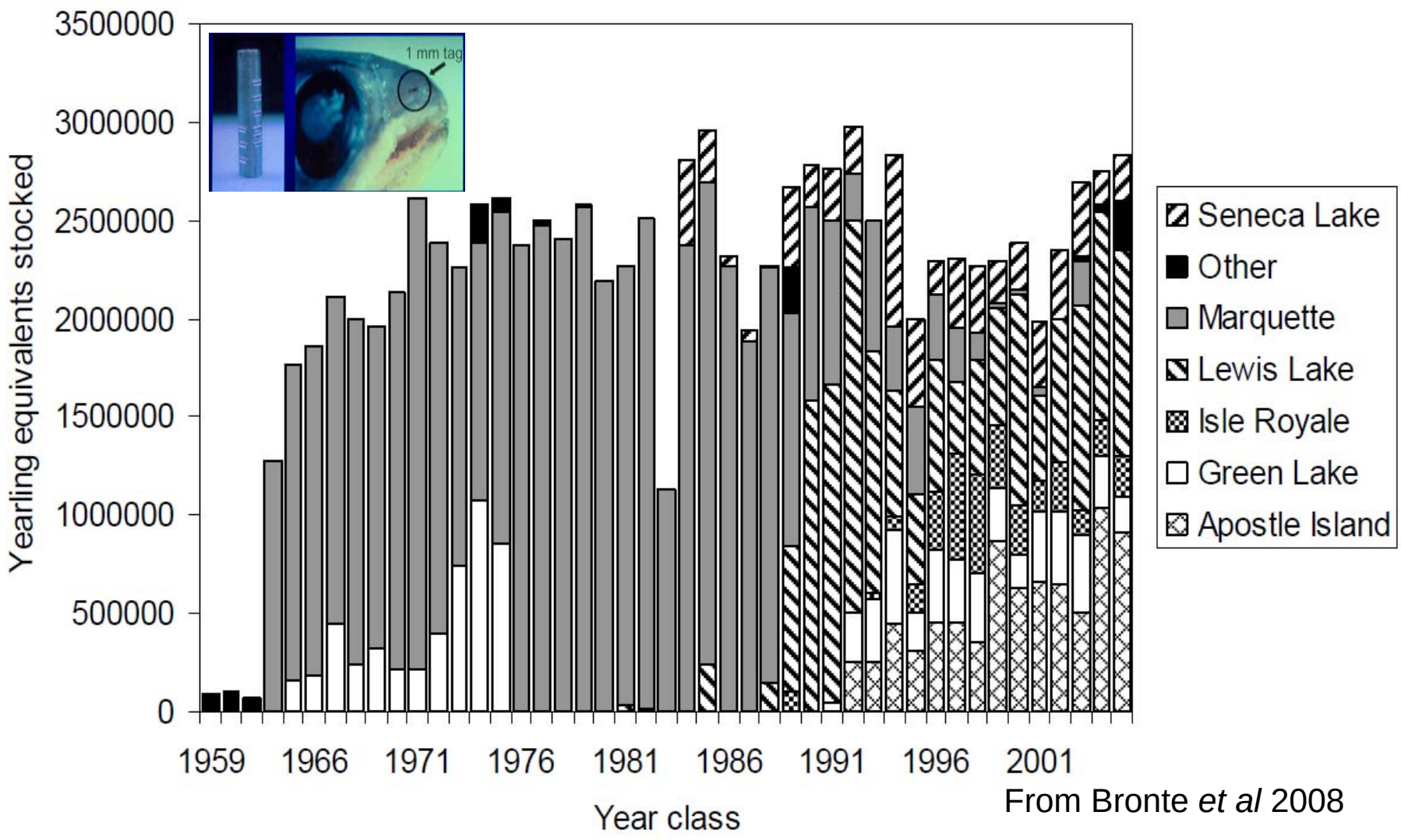
1) Lake-wide mixing of Chinook salmon during the feeding season
2) Chinook salmon stocked in Lake Huron feed in Lake Michigan and most are caught there.
3) Chinook salmon travel great distances, but have high fidelity to stocking district in autumn
4) Chinook salmon wild recruitment varies over space and time; weaker 2013-2014 year classes
5) Post-stocking survival of Chinook salmon appears greatest on the western shore of Lake Michigan

Factors affecting post-stocking survival of lake trout stocked in Lake Michigan, USA

Matthew S Kornis[1], Ted J Treska[1], Dale Hanson[1], Mark E Holey[1], Charles P Madenjian[2], David Boyarski[3], Erik Olsen[4], Kevin Donner[5], Barry Weldon[6], Brian Breidert[7], Steven Robillard[8], Jory Jonas[9], and Charles R Bronte[1]

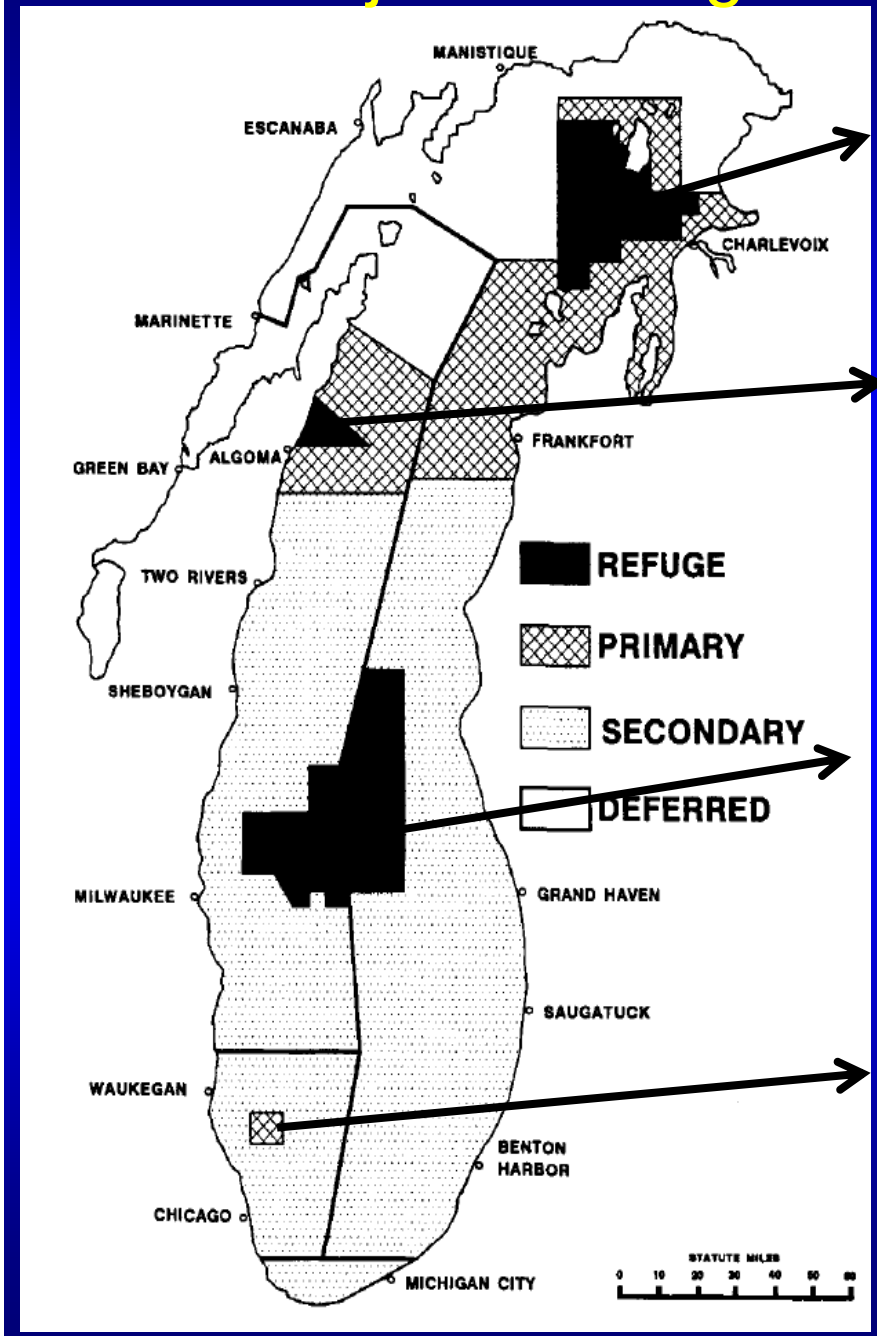
[1]US Fish and Wildlife Service, New Franken, WI
[2]US Geological Survey, Great Lakes Science Center, Ann Arbor, MI
[3]Wisconsin Department of Natural Resources, Sturgeon Bay, WI
[4]Grand Traverse Band of Ottawa and Chippewa Indians, Nat Res Dept, Suttons Bay, MI
[5]Little Traverse Bay Band of Odawa Indians, Natural Resources Dept, Harbor Springs, MI
[6]Little River Band of Ottawa Indians, Natural Resources Dept, Manistee, MI
[7]Indiana Department of Natural Resources, Michigan City, IN
[8]Illinois Department of Natural Resources, Des Plaines, IL
[9]Michigan Department of Natural Resources, Charlevoix, MI

Lake trout stocking in Lake Michigan



From Bronte *et al* 2008

Major stocking locations of CWT lake trout



Northern Refuge

Clay Banks

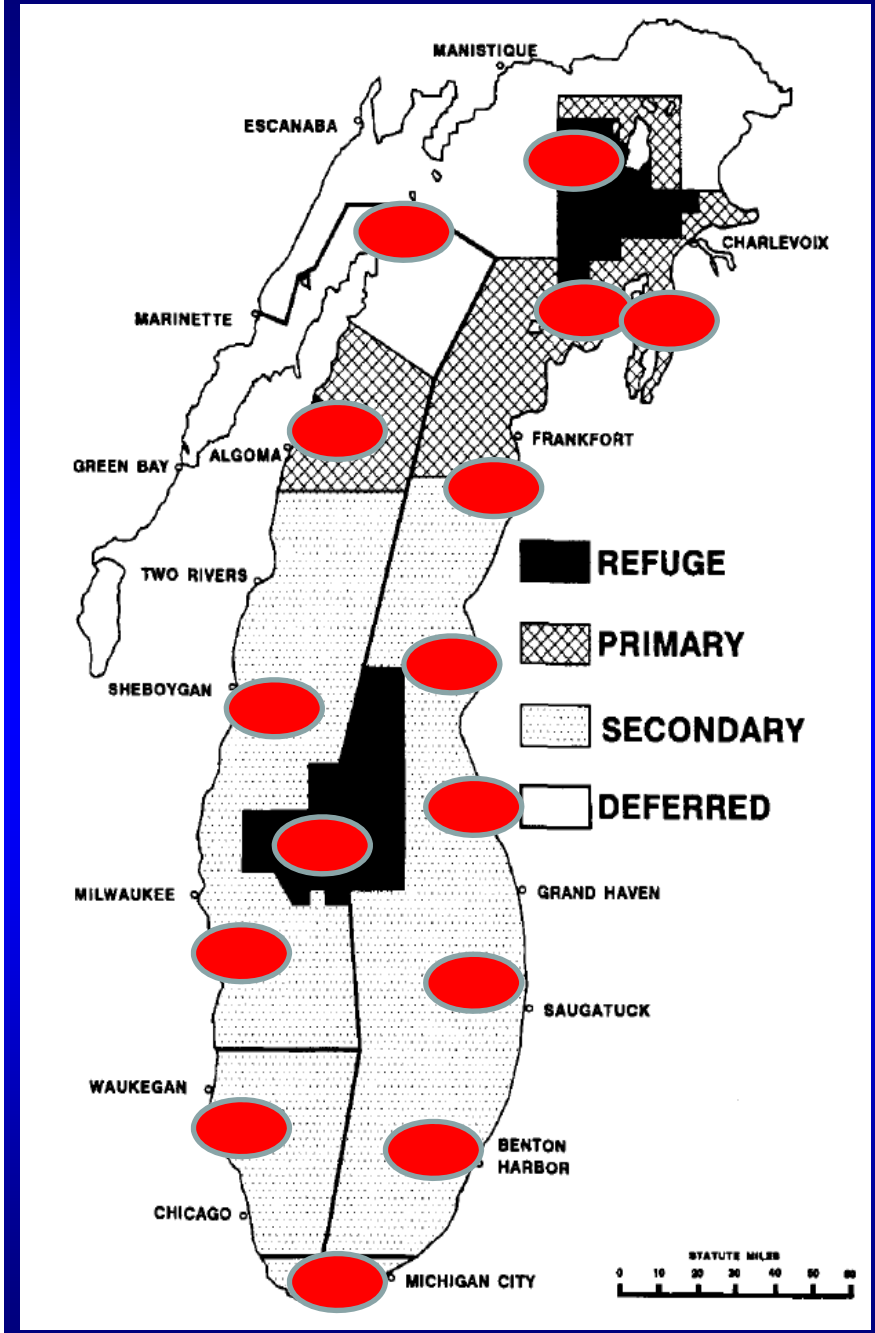
Southern Refuge

Julian's Reef

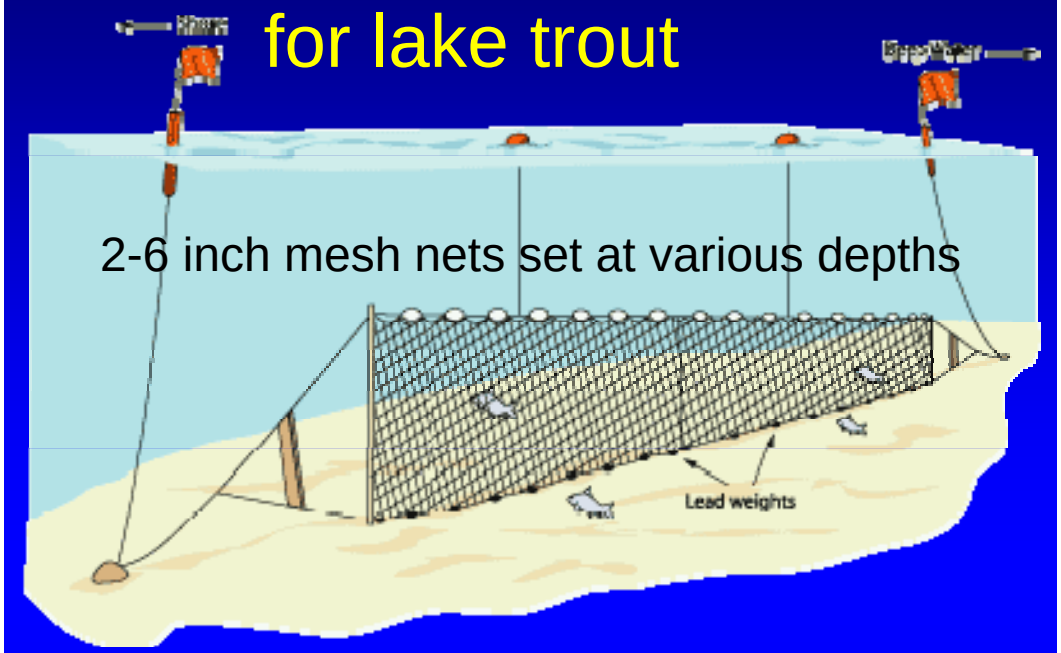
- Analysis focused on four stocking locations that were considered historically important
- Evaluating survival of 5 strains of lake trout

Lewis Lake, Green Lake; Isle Royale, Apostle Islands; Seneca Lake

- 1994-2003 year classes recovered during 1998-2014



Spring gill net assessment for lake trout

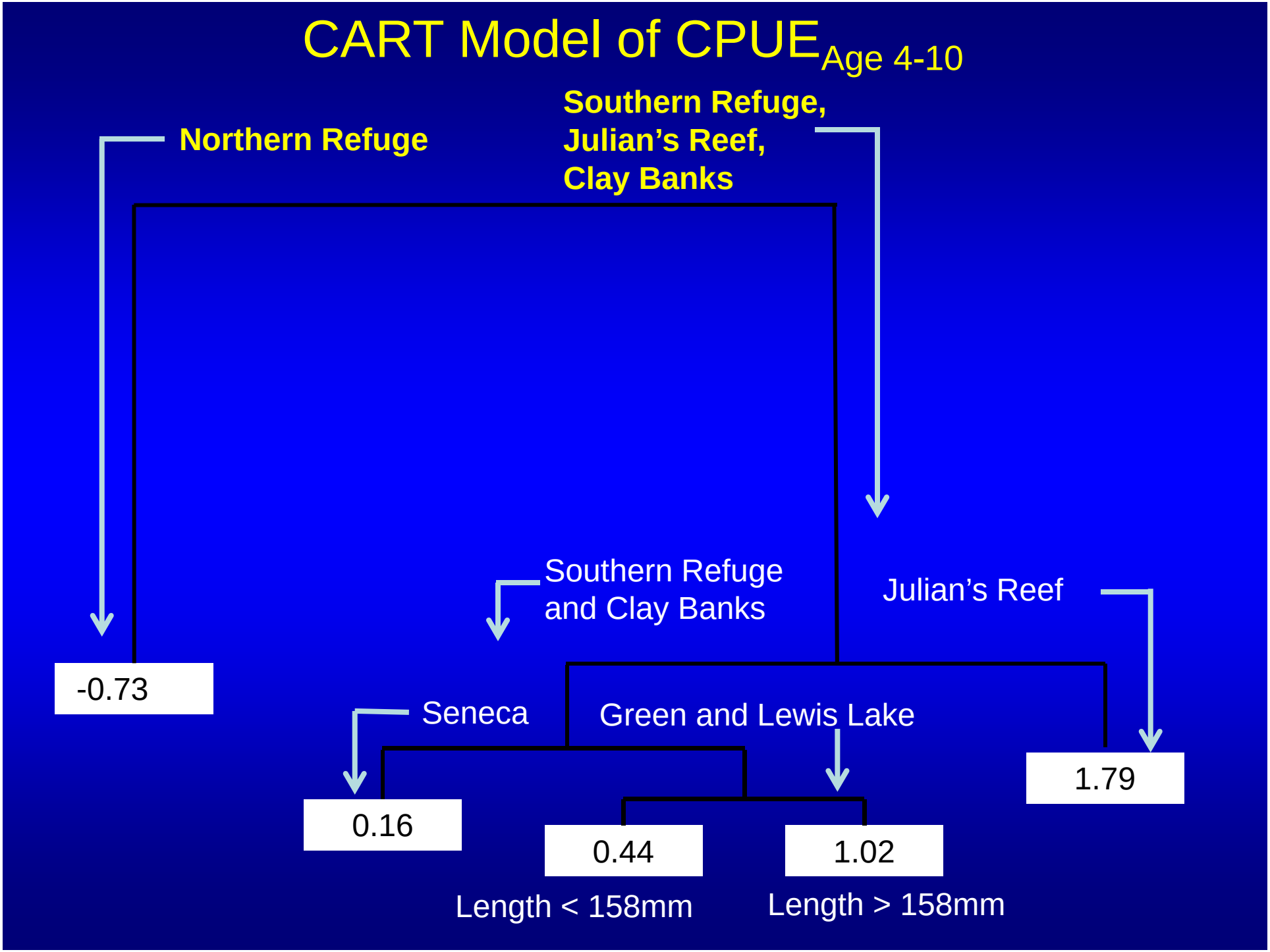


2-6 inch mesh nets set at various depths

Relative abundance
Age composition
Recover CWT fish
Sea lamprey wounding

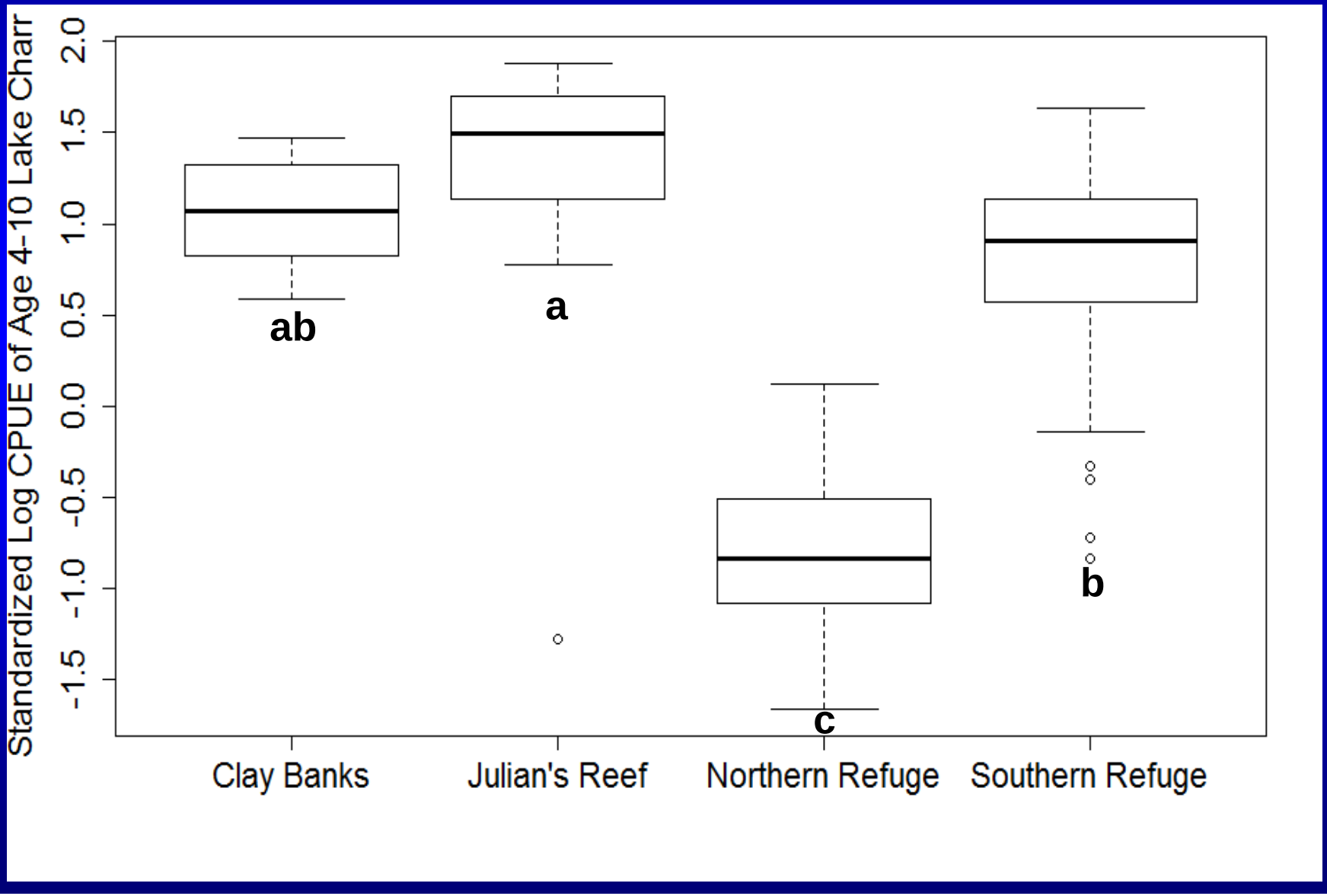
Evaluating Post-Stocking Survival – Response Variable

- CWT tag lots were the unit of replication
- Recoveries (CPUE) from spring assessment gill net catches corrected for year- and district-specific sampling effort, and for number of fish stocked
- For each tag lot, CPUEs at Ages 4 – 10 were pooled (modal ages)
- $CPUE_{Age\ 4\text{-}10}$ was standardized within each year class to remove inter-annual variability and served as our response variable
- Potential predictor variables: stocking location, strain, length at stocking, condition at stocking, and predator density at stocking
- Classification and Regression Tree (CART) analysis followed by node-specific ANOVAs and Tukey-Kramer procedures to determine those predictor variables that explained most of the variability in $CPUE_{Age\ 4\text{-}10}$


CART Model of CPUE Age 4-10
Northern Refuge
Southern Refuge, Julian's Reef, Clay Banks
Southern Refuge and Clay Banks
Julian's Reef
-0.73
Seneca
Green and Lewis Lake
1.79
0.16
0.44
1.02
Length < 158mm
Length > 158mm

First Node in Tree – Effect of stocking location

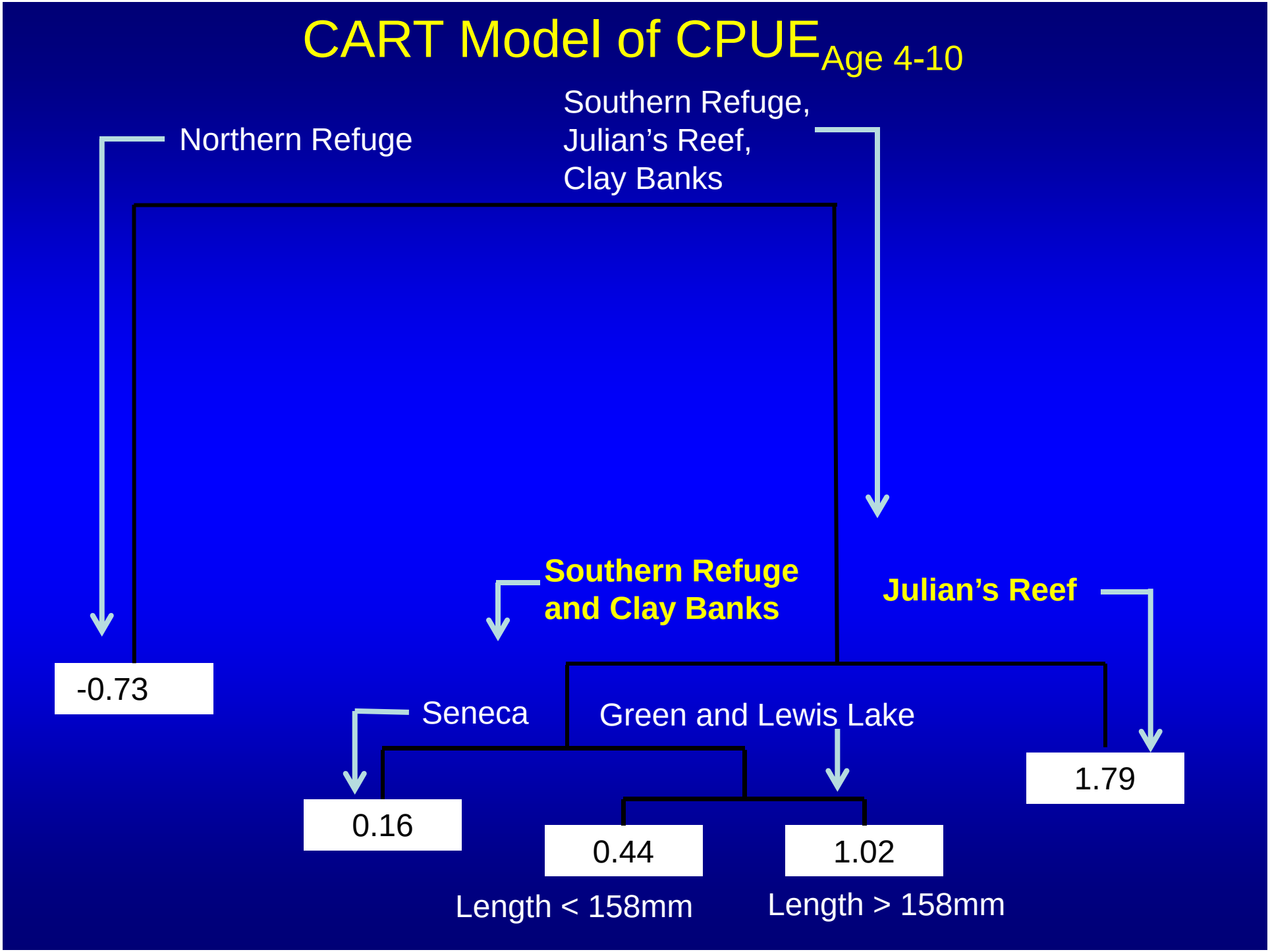
Northern Refuge CPUE lower than all other locations (*p* <0001); Southern Refuge < Julians Reef (*p* = 0003)



Total mortality estimates for lake trout by location

Stocking location	Ages	Annual mortality
Northern Refuge	6-9	79%
Clay Banks	6-9	41%
Southern Refuge	6-9	38%
Julian's Reef	6-9	30%

Higher morality in the north from fishing and sea lamprey.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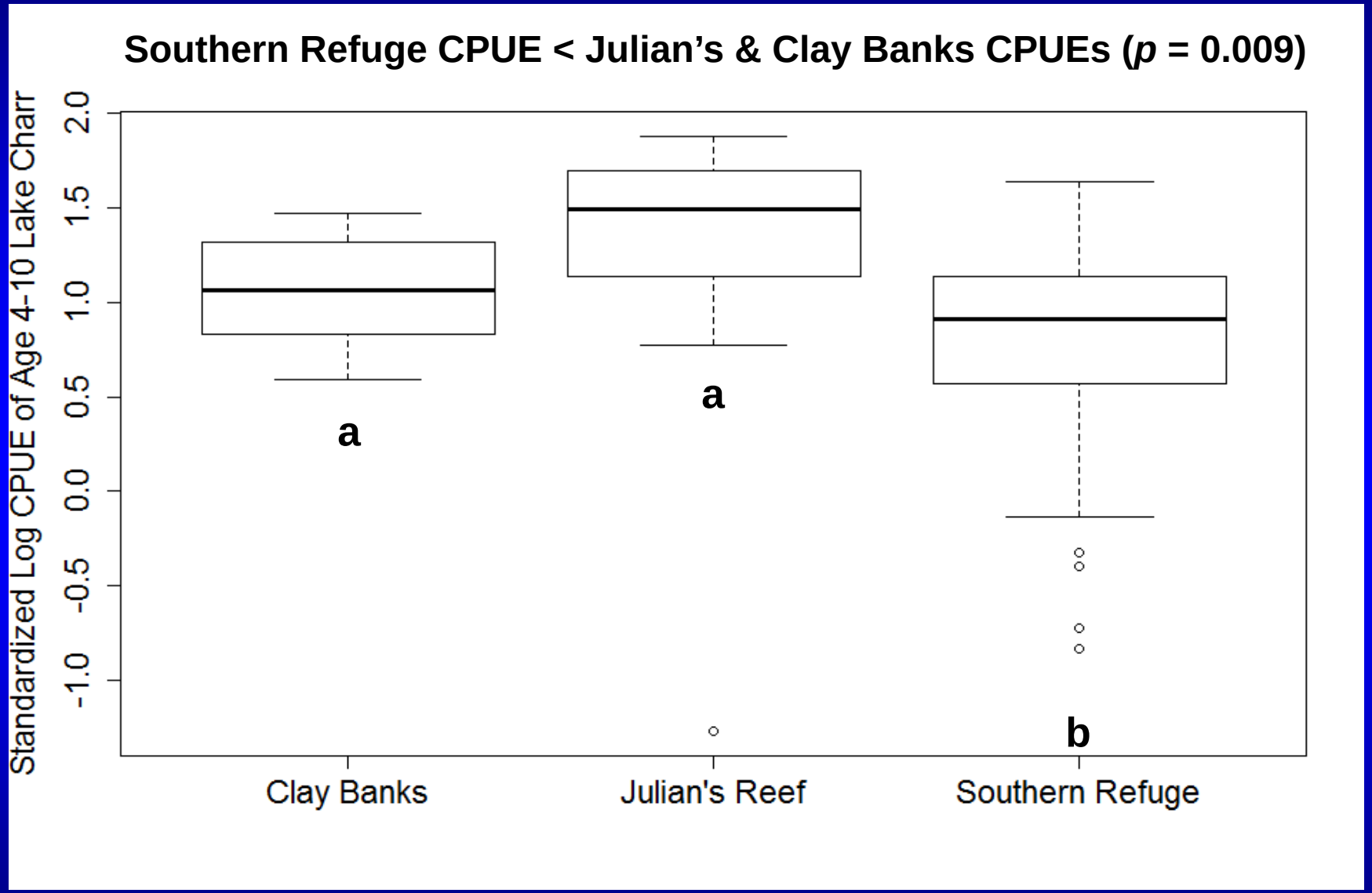
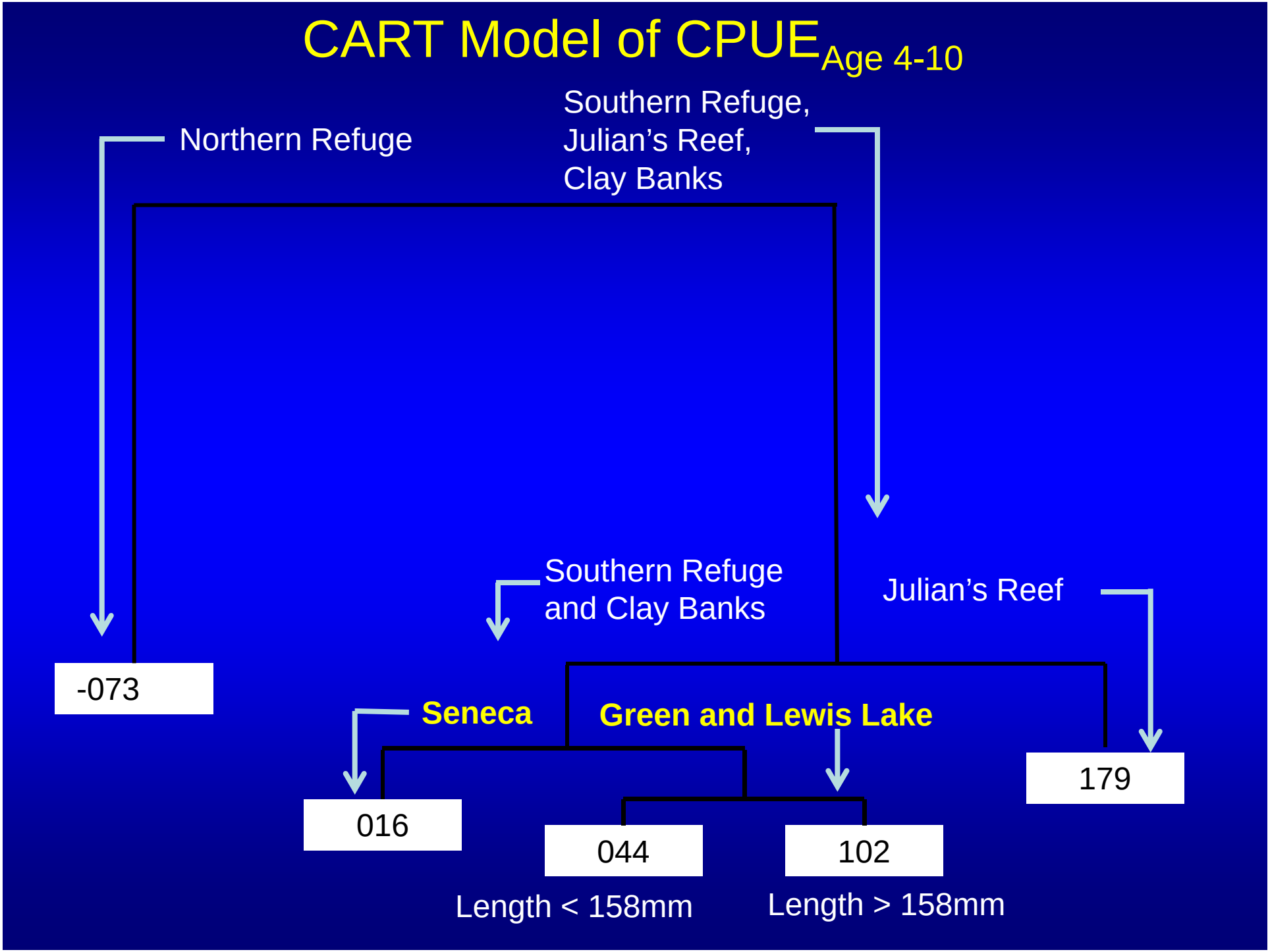
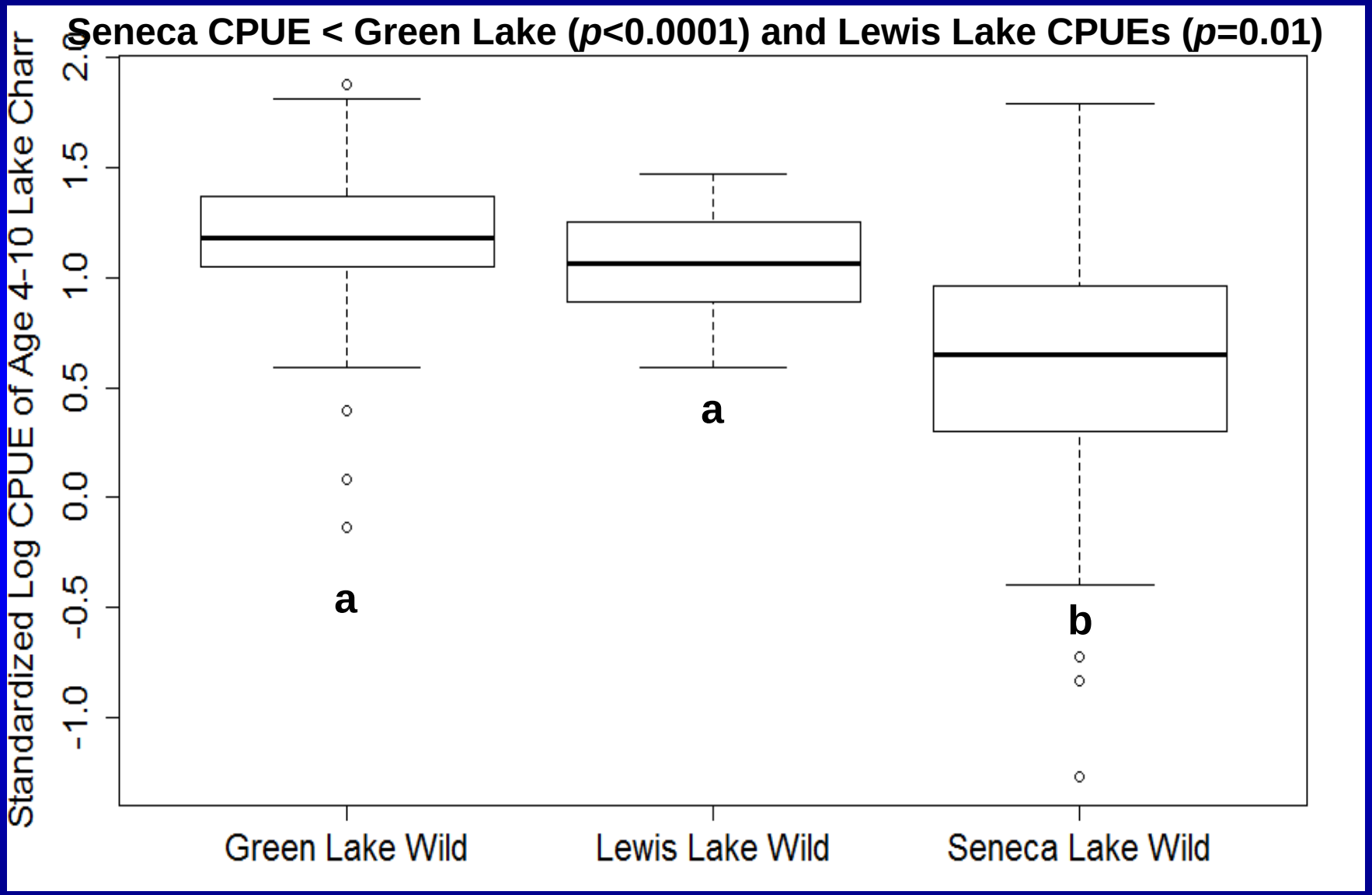
Second Node in Tree – Julian's Reef CPUE is highest

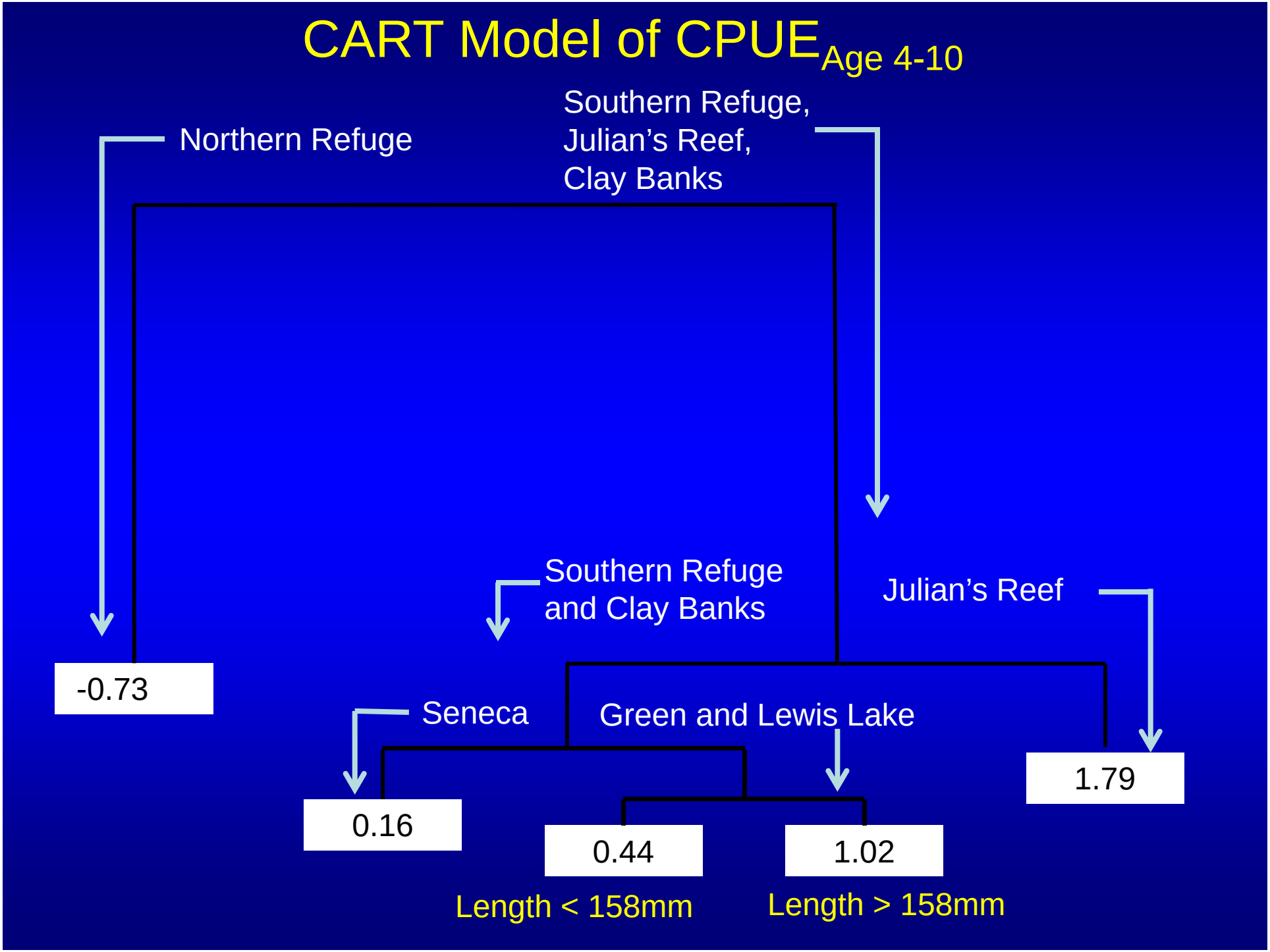


CART Model of CPUE$_{\text{Age 4-10}}$



Third Node – Strain effect in Southern Refuge and Clay Banks

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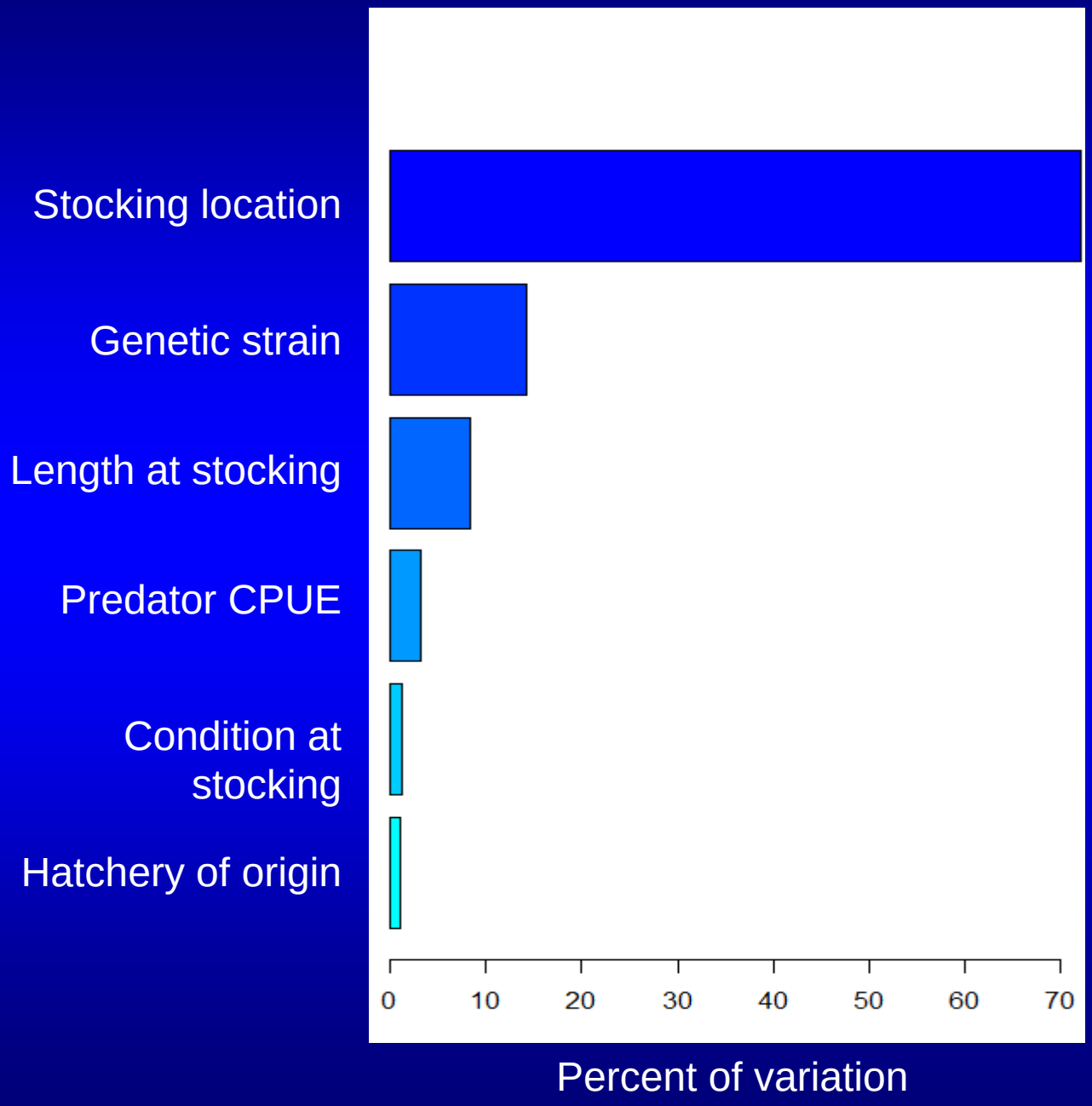
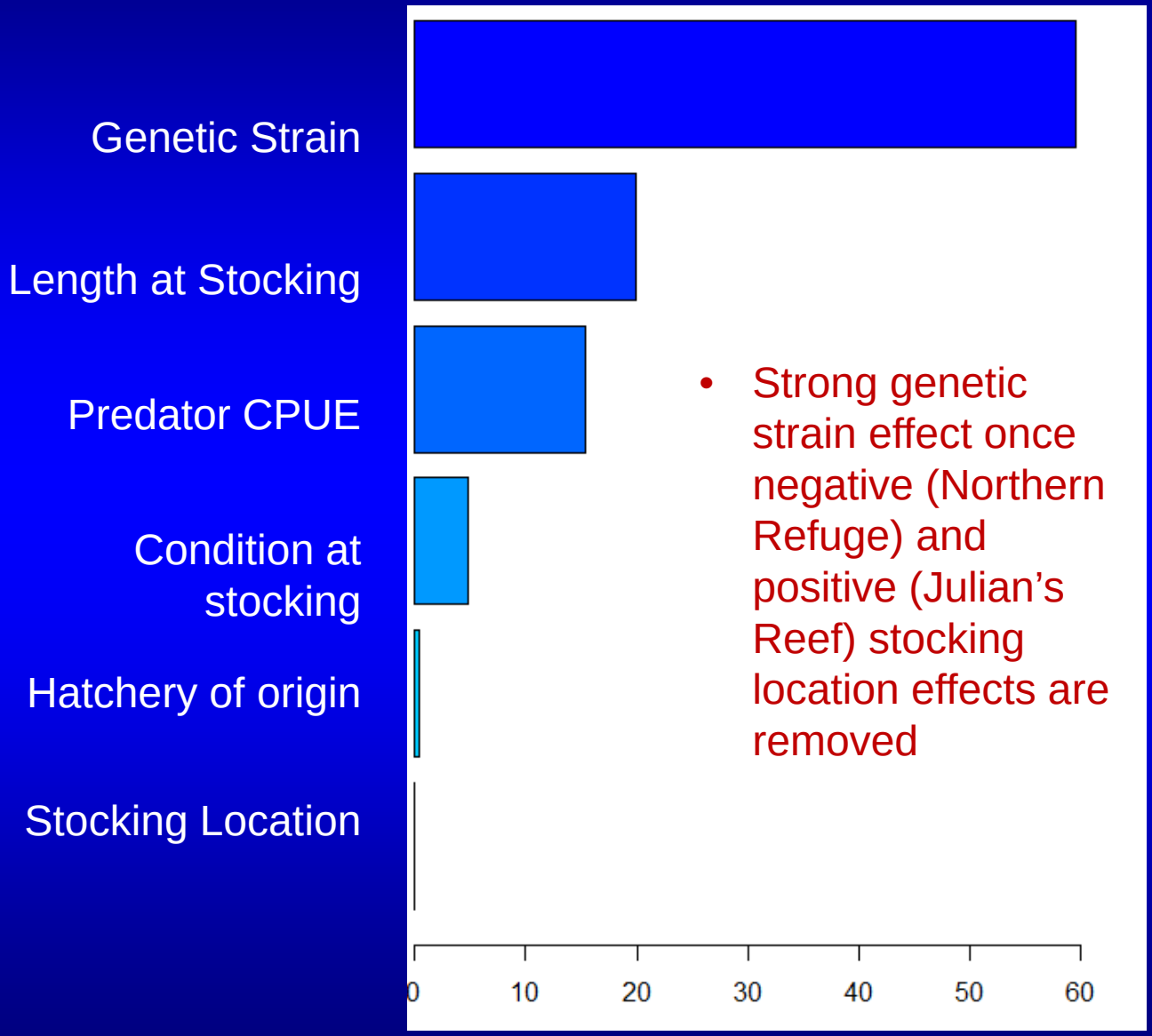
Southern Refuge, Julian's Reef, Clay Banks
Southern Refuge and Clay Banks
Julian's Reef
Seneca
Green and Lewis Lake
-0.73
0.16
0.44
1.02
1.79
Length < 158mm
Length > 158mm

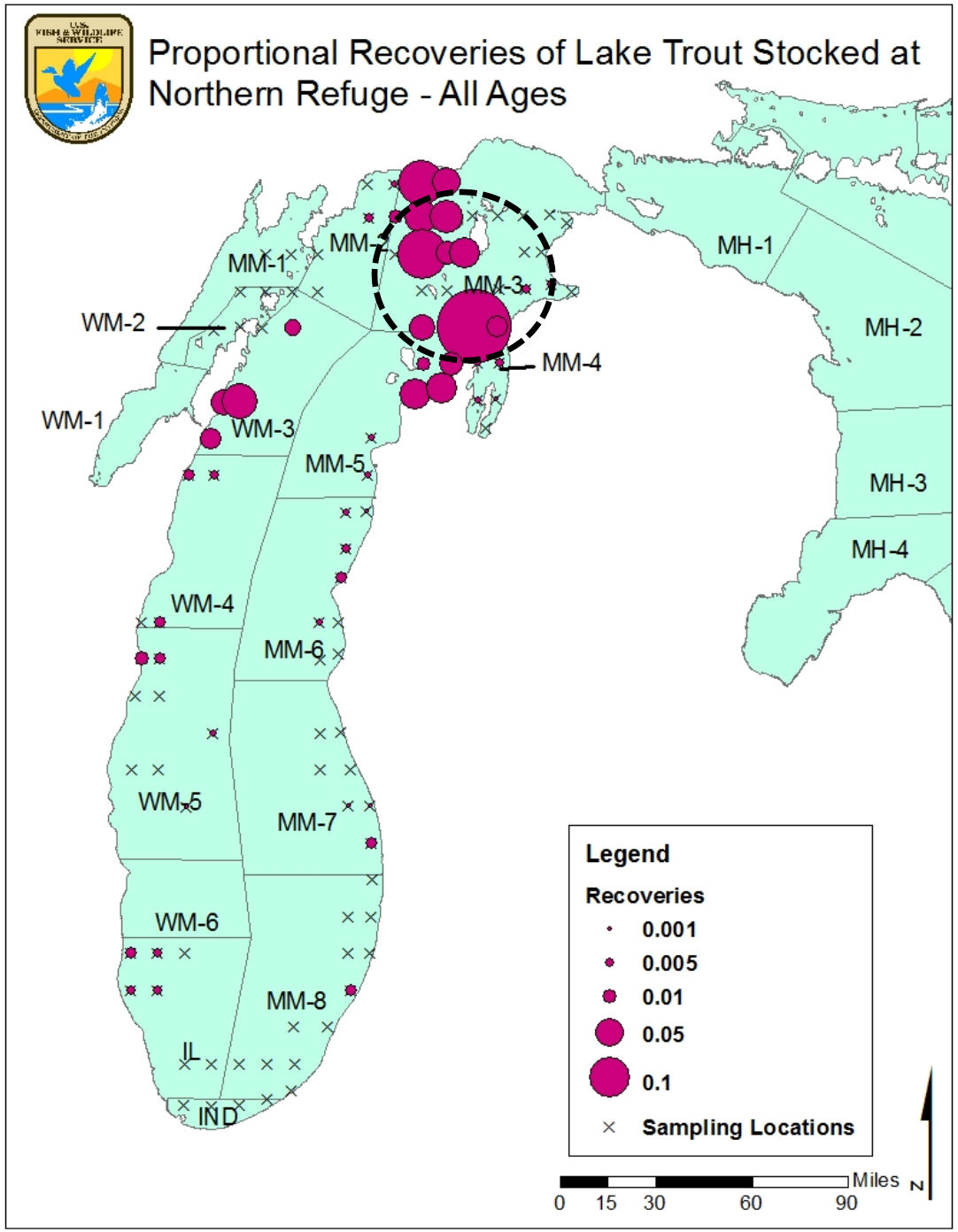
Variation of CPUE explained by each variable

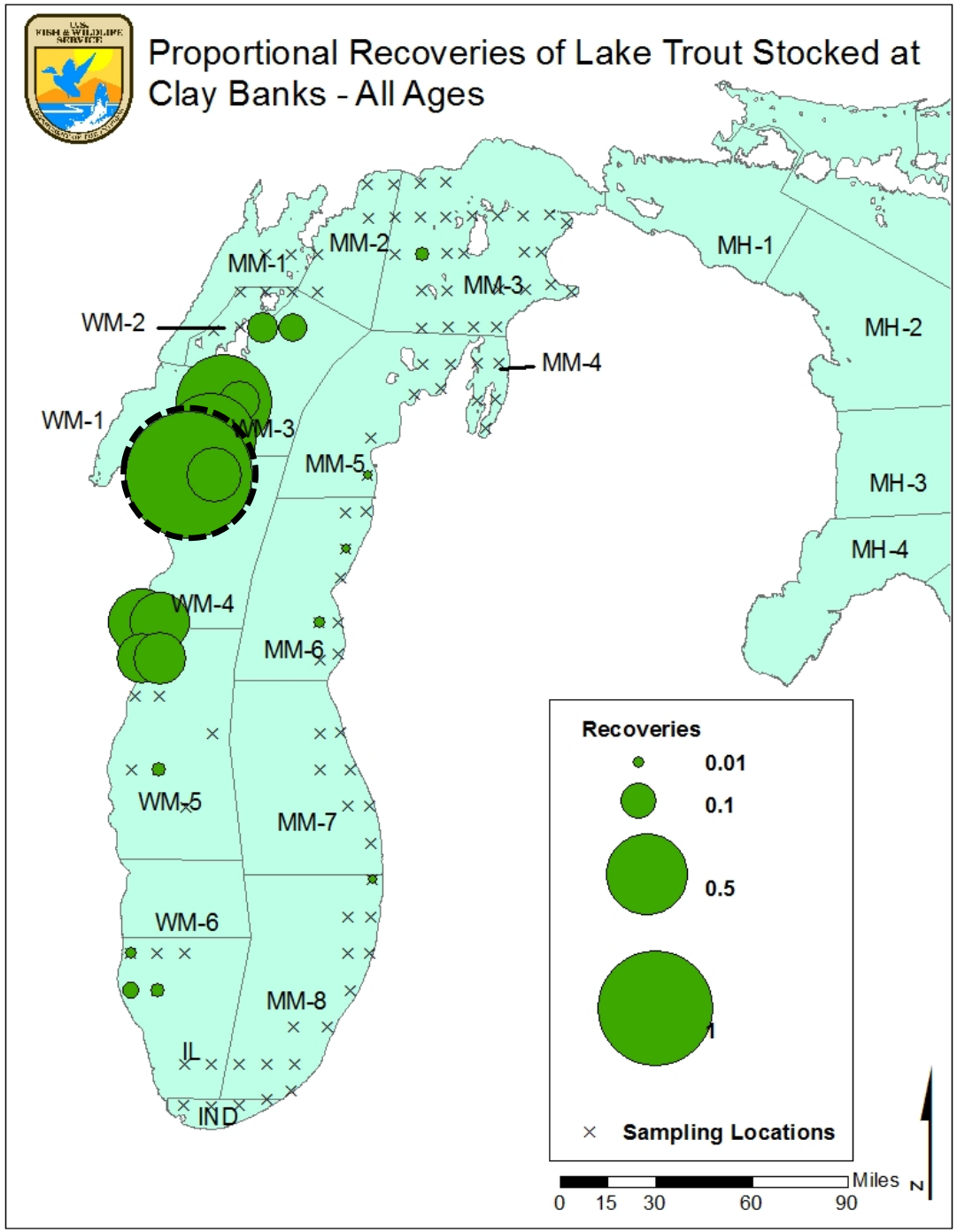


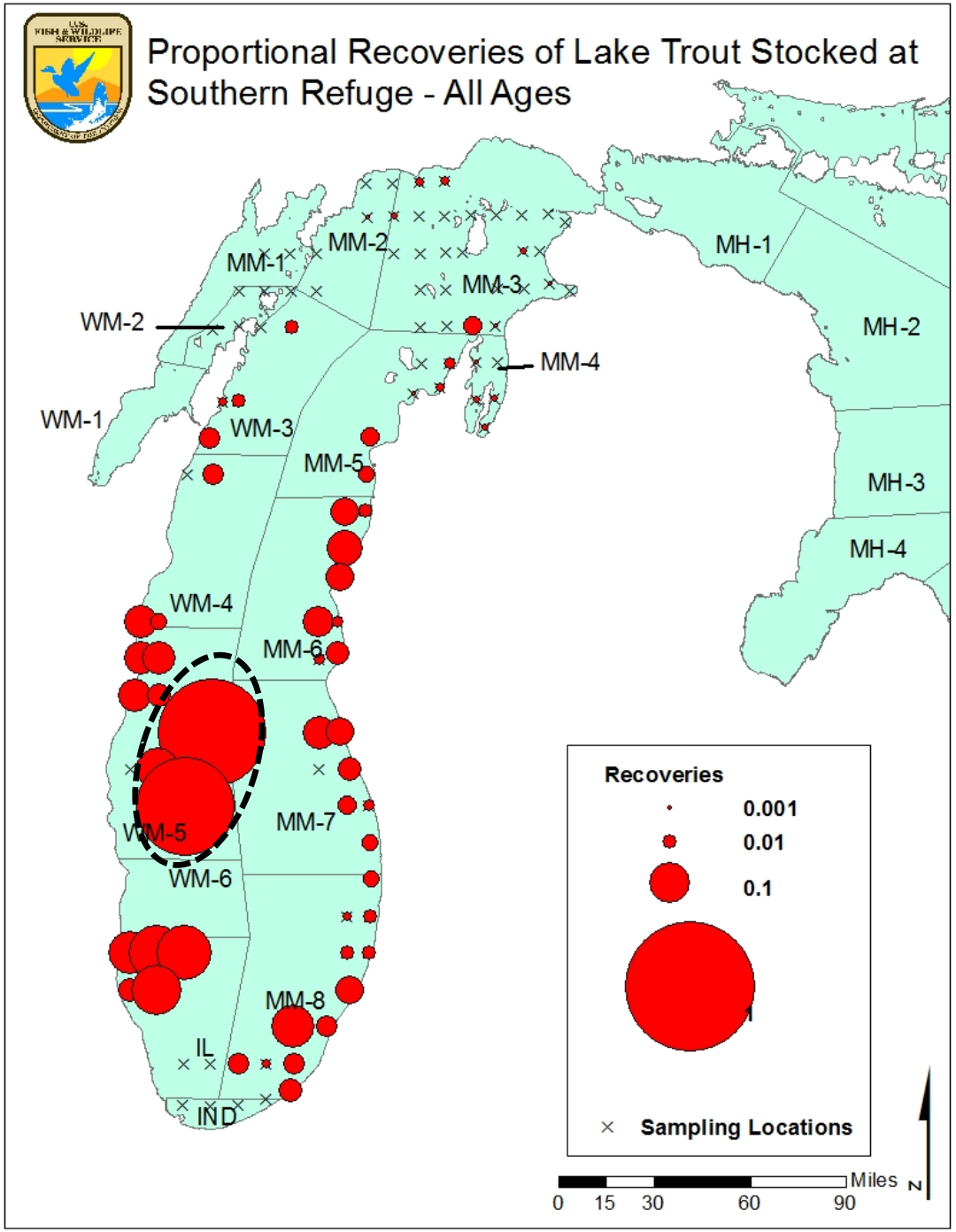
Variation of CPUE explained by each variable Northern Refuge and Julian's Reef Excluded

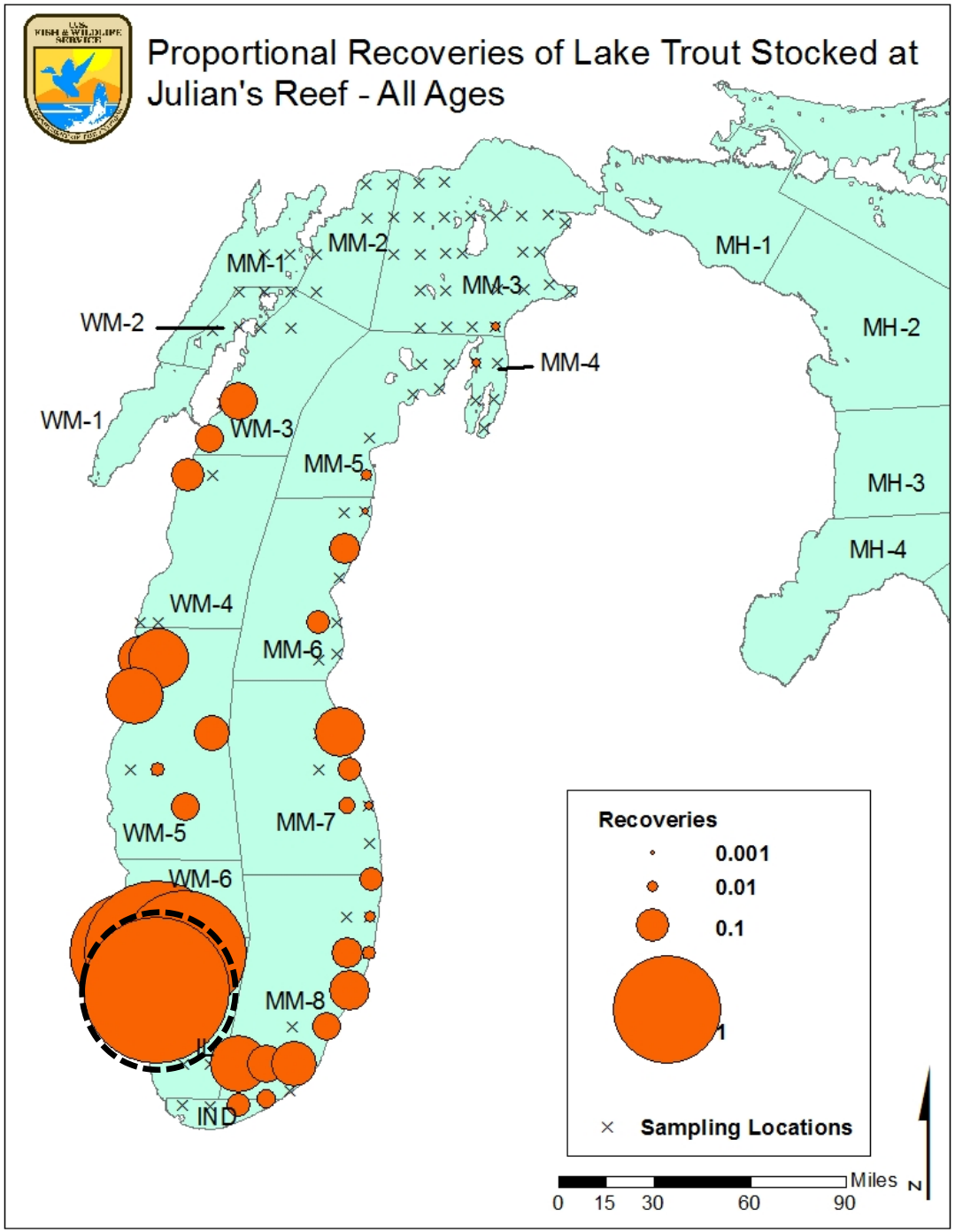


- Strong genetic strain effect once negative (Northern Refuge) and positive (Julian's Reef) stocking location effects are removed

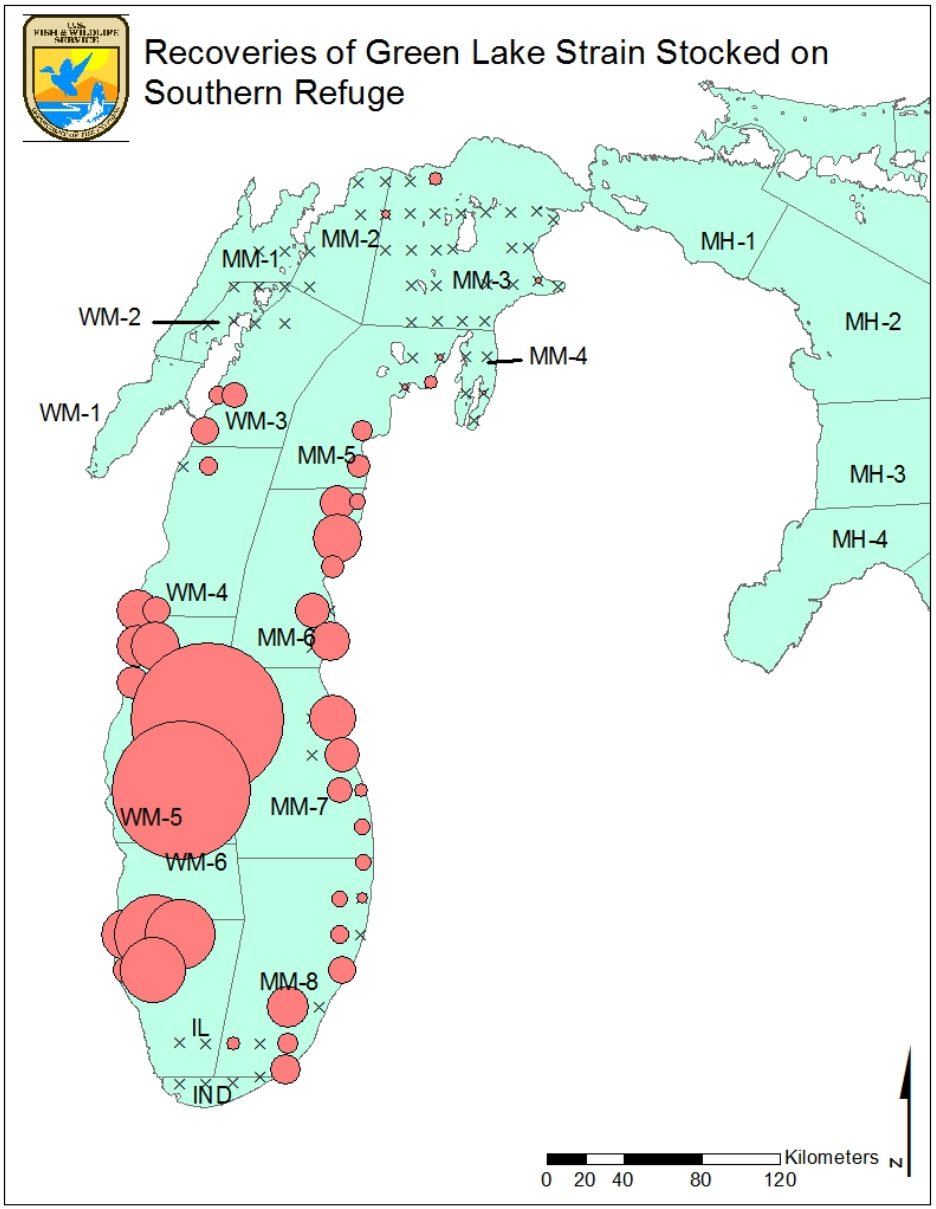

Proportional Recoveries of Lake Trout Stocked at Northern Refuge - All Ages
MM-1
MM-2
MM-3
MM-4
MM-5
MM-6
MM-7
MM-8
WM-1
WM-2
WM-3
WM-4
WM-5
WM-6
MH-1
MH-2
MH-3
MH-4
IL
IND
Legend
Recoveries
0.001
0.005
0.01
0.05
0.1
Sampling Locations
0 15 30 60 90
Miles
N

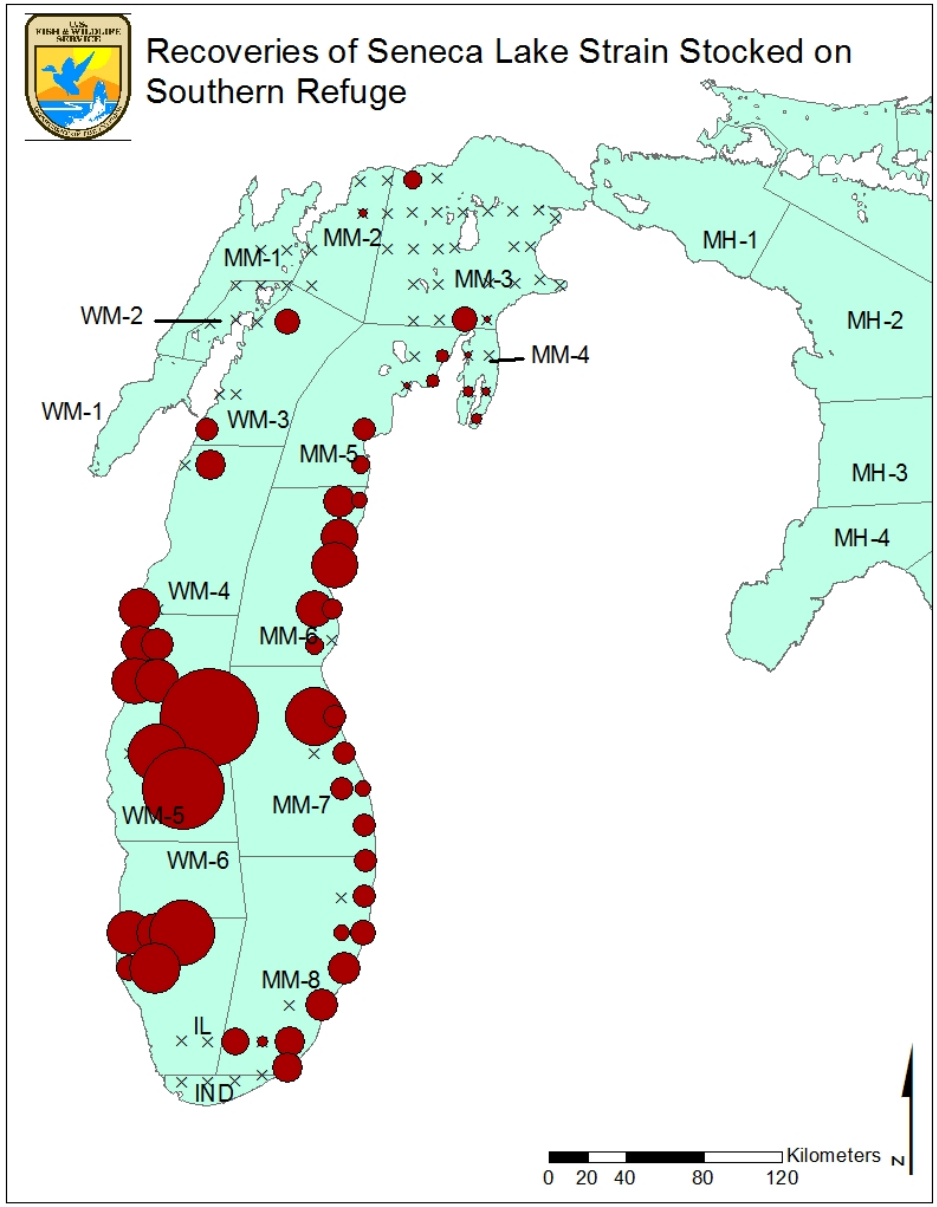

Proportional Recoveries of Lake Trout Stocked at Clay Banks - All Ages
MM-1
MM-2
MM-3
MM-4
MM-5
MM-6
MM-7
MM-8
MH-1
MH-2
MH-3
MH-4
WM-1
WM-2
WM-3
WM-4
WM-5
WM-6
IL
IND
Recoveries
0.01
0.1
0.5
1
Sampling Locations
Miles
0 15 30 60 90
N


Proportional Recoveries of Lake Trout Stocked at Southern Refuge - All Ages
MM-1
MM-2
MM-3
MM-4
MM-5
MM-6
MM-7
MM-8
MH-1
MH-2
MH-3
MH-4
WM-1
WM-2
WM-3
WM-4
WM-5
WM-6
IL
IND
Recoveries
0.001
0.01
0.1
1
Sampling Locations
Miles
0
15
30
60
90
N

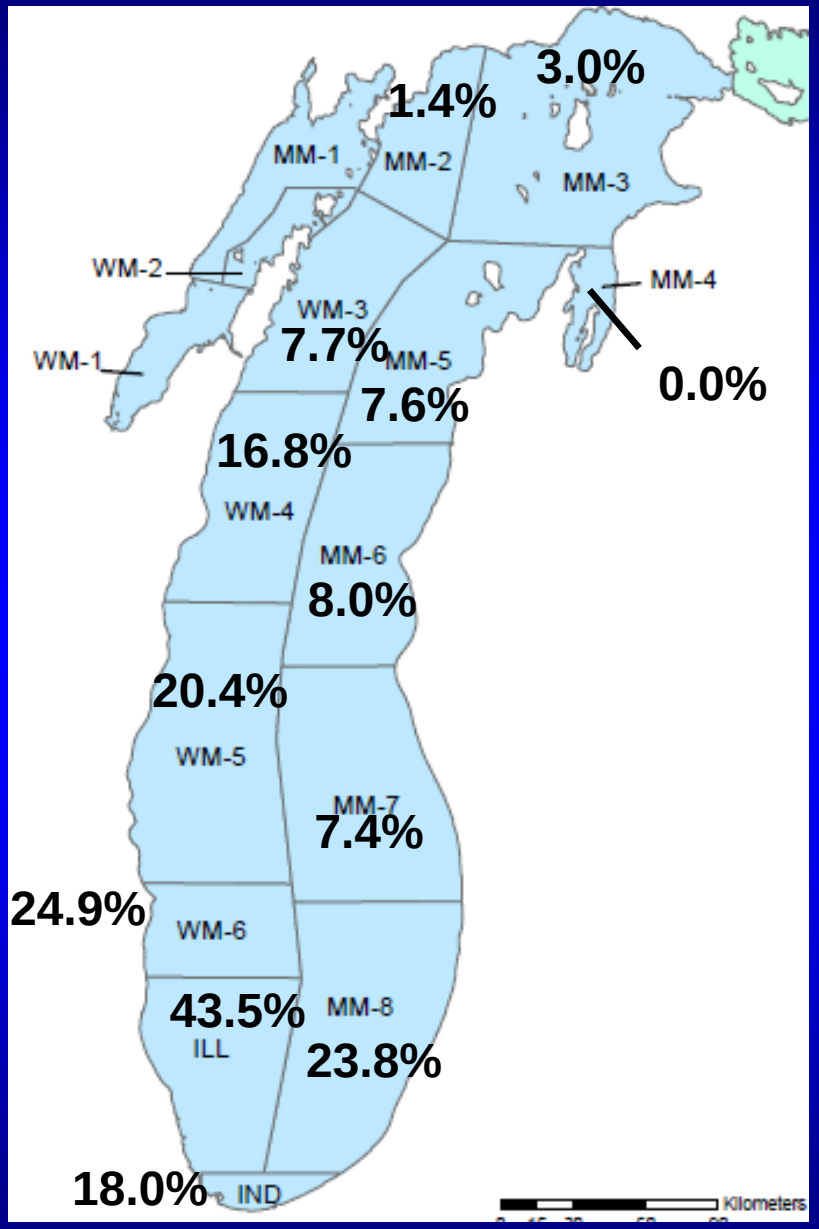

Proportional Recoveries of Lake Trout Stocked at Julian's Reef - All Ages
MM-1
MM-2
MM-3
MM-4
MM-5
MM-6
MM-7
MM-8
WM-1
WM-2
WM-3
WM-4
WM-5
WM-6
MH-1
MH-2
MH-3
MH-4
IND
Recoveries
0.001
0.01
0.1
1
Sampling Locations
Miles
0 15 30 60 90
N

Comparison of the recovery distributions of Green Lake and Seneca Strains stocked at the Southern Refuge





Percent wild Lake Trout in sport catches Apr-Sep 2015



Summary for lake trout results

1) Returns rates were low for all strains in the Northern due to high mortality.
2) Lake Michigan strains (Lewis and Green) did better than Seneca in the south where mortality was low.
3) Size at stocking, stocking condition, and predator density had little to no effect on return rates.
4) Distances moved are greater for populations that have higher densities.
5) Those areas with higher densities and older fish also have more wild fish.