

# Report on Mass Marking Program Activities

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New Franken WI

Lake Michigan Technical Committee Meeting  
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A Joint Strategic Plan for Management of Great Lakes Fisheries



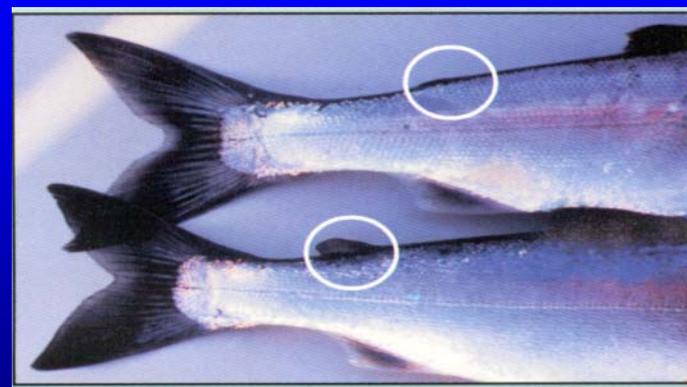
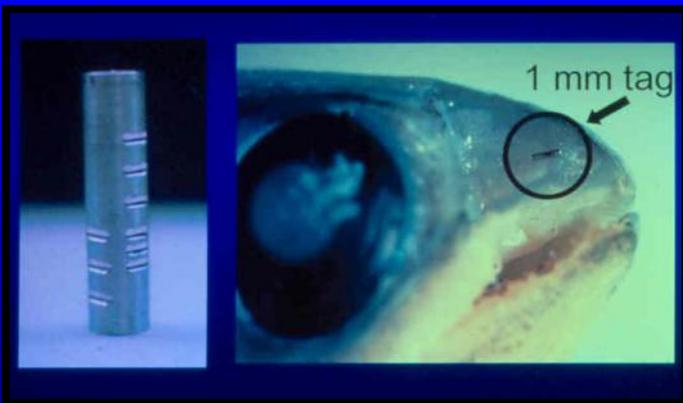
Great Lakes  
Fishery  
Commission

# Project History

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



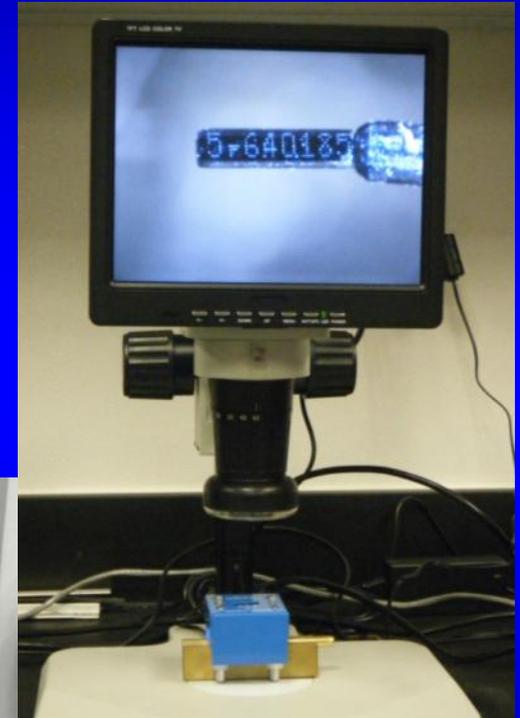
- Lake trout tagging began in 2010, followed by Chinook salmon in 2011



- 16 million Chinook salmon and 28.5 million lake trout tagged thus far

# Project History

- Over 50,000 snouts have been processed, with more than 46,000 CWTs recovered



# Objectives

- Update the LMTC on 2014 tagging and recovery activities
- Preliminary analysis of return data:
  - Estimate Chinook salmon and lake trout wild reproduction
  - Assess contributions of stocked Chinook to the lake wide fishery
  - Evaluate overall and seasonal movement patterns of Chinook
- Provide information on other Mass Marking related studies



# 2014 Tagging and Marking Activities



## Total numbers of Chinook salmon tagged and project completion dates by hatchery in 2014

Hatchery	Agency	Number tagged	Date completed
Jake Wolf	Illinois Department of Natural Resources	265,547	3/16/2014
Mixsawbah	Indiana Department of Natural Resources	202,713	3/22/2014
Kettle Moraine Springs	Wisconsin Department of Natural Resources	102,657	4/2/2014
Wild Rose	Wisconsin Department of Natural Resources	721,454	4/17/2014
Wolf Lake	Michigan Department of Natural Resources	236,178	4/2/2014
Platte River	Michigan Department of Natural Resources	978,800	4/30/2014
Thompson (ADCWT)	Michigan Department of Natural Resources	46,797	4/24/2014
Thompson (AD only)	Michigan Department of Natural Resources	399,668	4/29/2014
<b>Total :</b>		<b>2,953,814</b>	

## Tag/clip success for Chinook in 2013

Hatchery	Agency	Initial % tagged and clipped	Final % tagged and clipped
Jake Wolf	Illinois Department of Natural Resources	99.3	97.0
Mixsawbah	Indiana Department of Natural Resources	99.3	97.3
Kettle Moraine	Wisconsin Department of Natural Resources	99.0	95.0
Wild Rose	Wisconsin Department of Natural Resources	99.4	99.3
Wolf Lake	Michigan Department of Natural Resources	99.3	98.5
Platte River	Michigan Department of Natural Resources	99.2	97.4
Thompson	Michigan Department of Natural Resources	97.7	93.2

Tag loss at large is about 2% (AD fish with no CWT)



## Total numbers of lake trout tagged and project completion dates by hatchery in 2014

Hatchery	Agency	Number tagged	Date completed
Marquette State Hatchery	Michigan DNR	225,000	7/20/2014
Jordan River National Fish Hatchery	US Fish and Wildlife Service – Region 3	2,509,771	9/23/2014
Pendill’s Creek National Fish Hatchery	US Fish and Wildlife Service – Region 3	1,151,631	8/25/2014
Iron River National Fish Hatchery	US Fish and Wildlife Service – Region 3	1,356,485	10/1/2014
Allegheny National Fish Hatchery	US Fish and Wildlife Service – Region 5	1,169,119	9/12/2014
<b>Total :</b>		<b>6,412,006</b>	

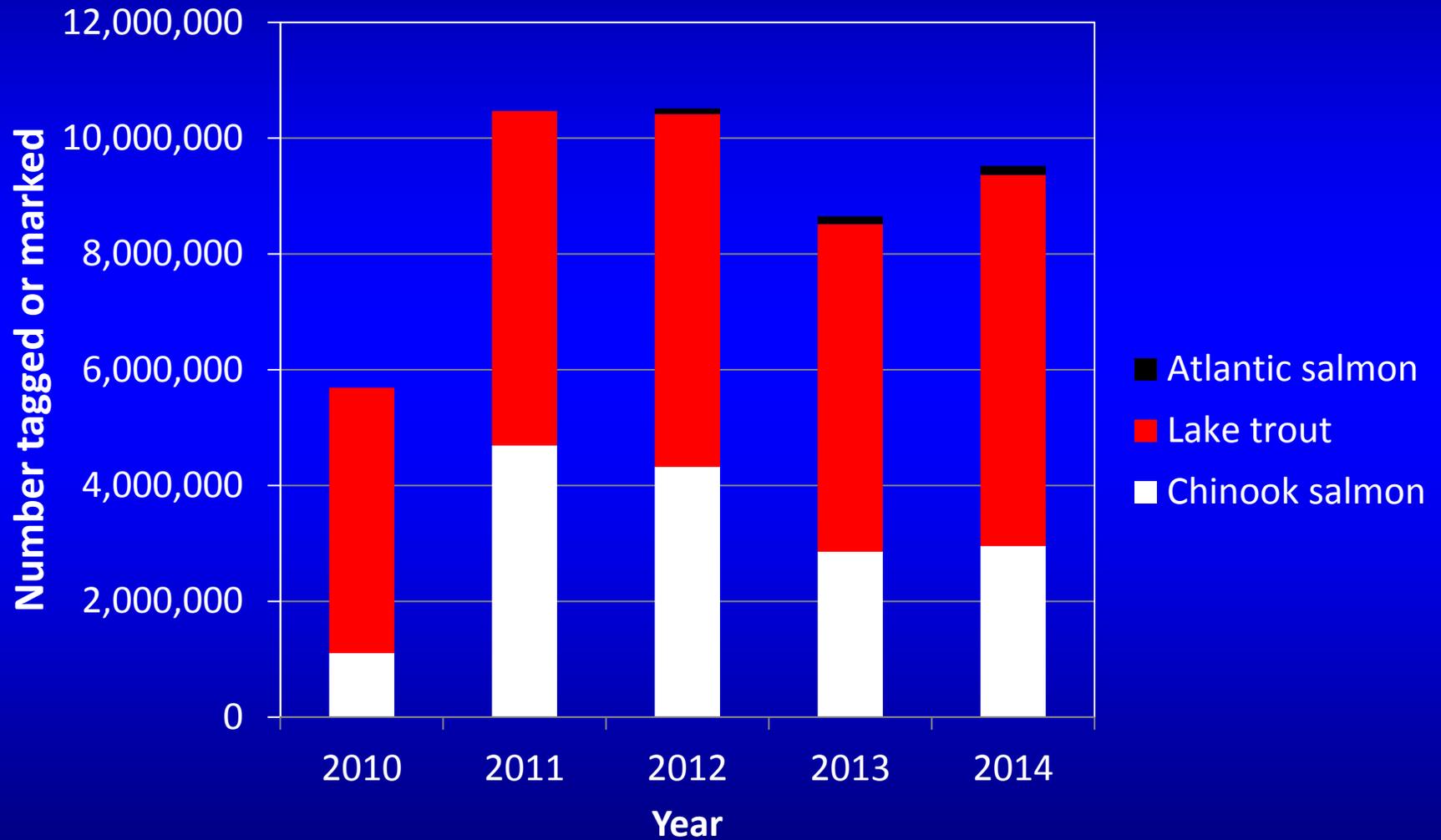


## Tag/clip success for lake trout in 2013

Hatchery	Agency	Initial % tagged and clipped	Final % tagged and clipped
Marquette	Michigan Department of Natural Resources	98.6	96.5
Jordan River	US Fish and Wildlife Service	99.4	95.2
Pendills Creek	US Fish and Wildlife Service	99.4	96.2
Iron River	US Fish and Wildlife Service	99.2	94.8
Allegheny	US Fish and Wildlife Service	98.9	97.4

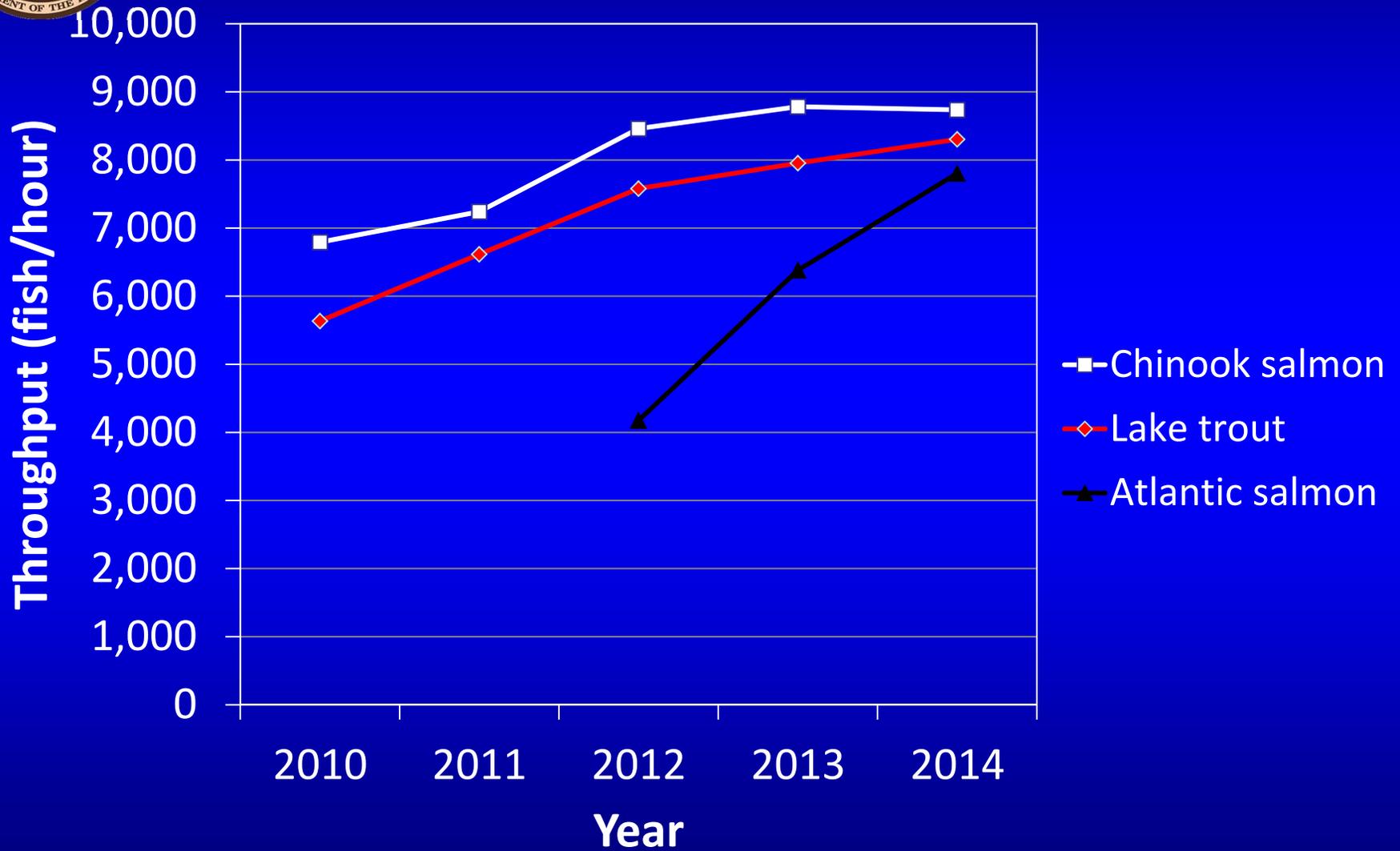


## Number of fish by species tagged/marked by the U.S. Fish and Wildlife Service





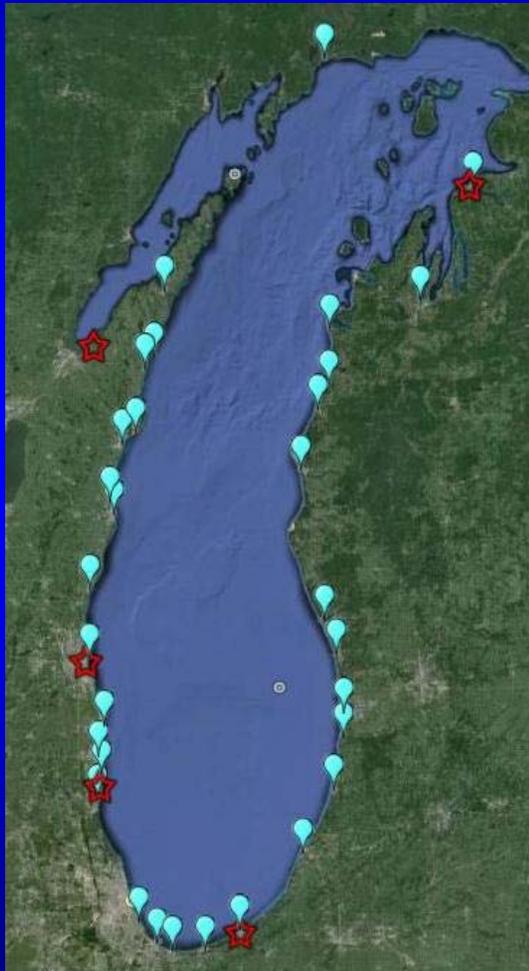
## Average throughput (fish/hour) by species



# 2014 Recovery Activities



## Assistance with data collection, data archiving, tag extraction, and ageing wild fish



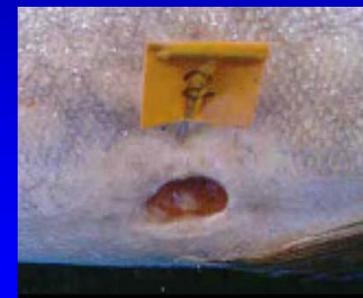
Hired technicians to work with states

- 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 Sampling Network

## Tag Recovery and Bio Data Collection





## Number of fish by species examined by USFWS staff for CWTs from Lake Michigan and Lake Huron during 2014

State of Landing	Chinook Salmon	Lake Trout	Steelhead / Rainbow	Coho Salmon	Atlantic Salmon	Brown Trout	Total
Wisconsin	5004	1242	2223	779	0	583	9831
Michigan – L. Huron	277	621	94	6	31	1	1034
Michigan – L. Mich.	5051	1535	93	42	1	35	6757
Illinois	937	41	3	2	0	1	984
Indiana	1178	963	414	584	0	37	3176
<b>Total</b>	<b>12447</b>	<b>4402</b>	<b>2827</b>	<b>1413</b>	<b>32</b>	<b>657</b>	<b>21782</b>
Number of fish with no clip	7097 (60.0%)	903 (20.6%)	1914 (83.5%)	1381 (99.6%)	29 (90.6%)	598 (91.4%)	
Number with CWT	4,244 (35.9%)	424 (9.7%)	110 (4.8%)	0 (0%)	1 (3.1%)	3 (0.5%)	

# Preliminary Analysis of Return Data

# Estimated Contribution of Wild Lake Trout to the Fishery

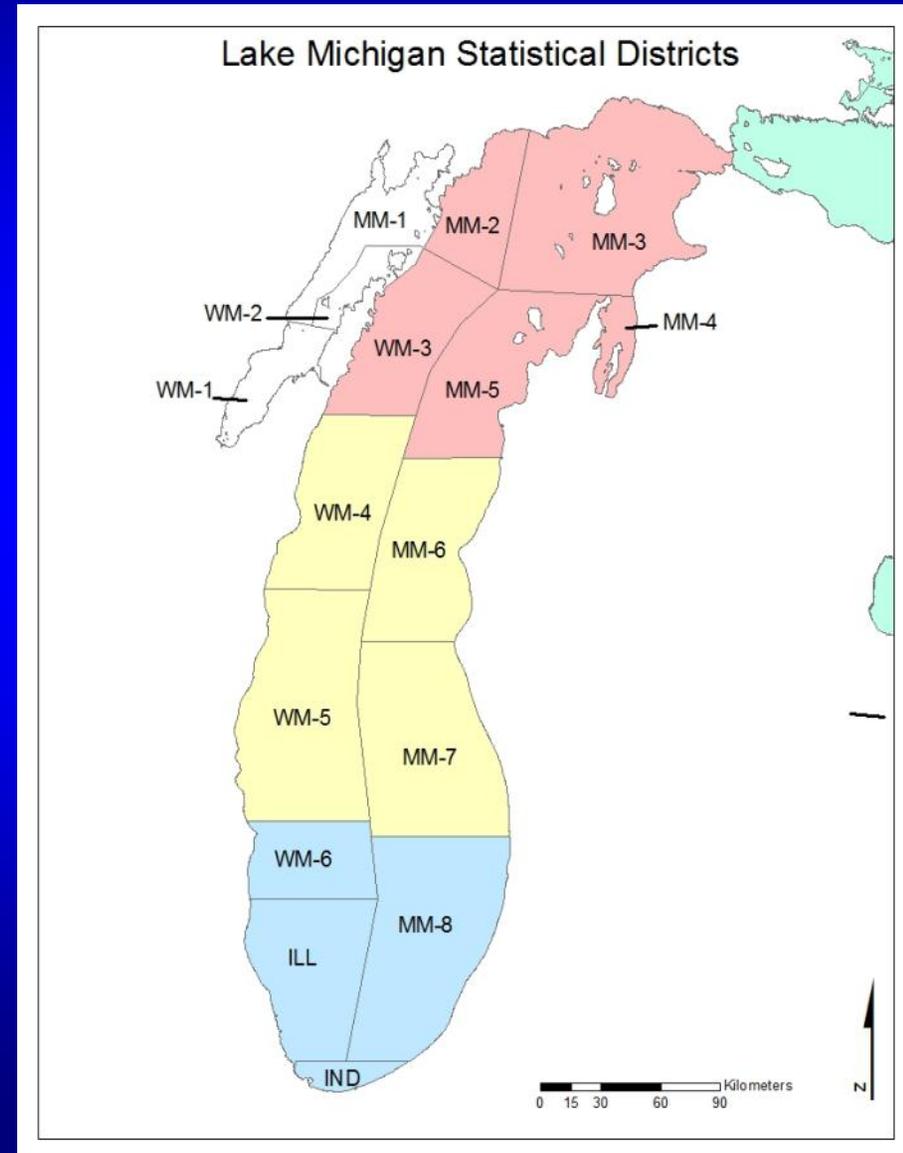




# Wild Lake Trout Estimates



- Calculated the percent of lake trout recovered in 2014 that had no fin clip
- Grouped values by latitude





# Wild Lake Trout Estimates



- Calculated the percent of lake trout recovered in 2014 that had no fin clip

## Southern Districts

District	% Not Clipped
WM6	36.5% (n=255)
ILL	39.0% (n=41)
IND	18.8% (n=860)
MM8	15.0% (n=314)

## Middle Districts

District	% Not Clipped
WM4	9.2% (n=229)
WM5	18.8% (n=847)
MM6	14.3% (n=491)
MM7	8.2% (n=536)

## Northern Districts

District	% Not Clipped
WM3	0.0% (n=17)
MM2	0.0% (n=11)
MM3	3.3% (n=90)
MM4	2.0% (n=51)
MM5	12.8 % (n=188)

## Lake Huron

District	% Not Clipped
MH1	67.0% (n=112)
MH2	44.0% (n=191)
MH3	47.3% (n=224)
MH5	52.3% (n=65)
MH6	44.8% (n=29)

# Estimated Contribution of Wild Chinook Salmon to the Fishery

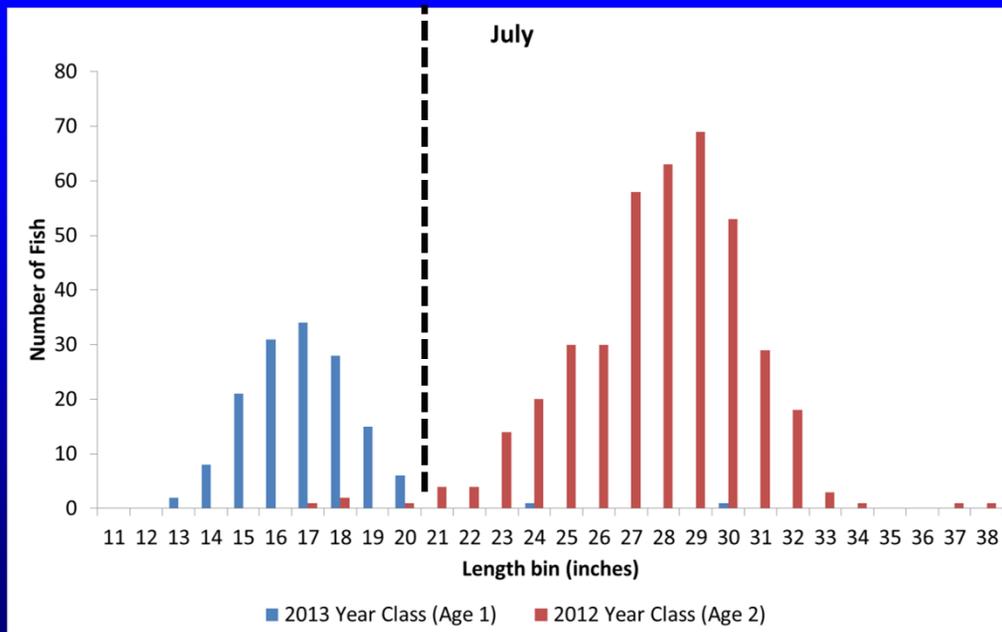




# Wild Chinook Salmon - Methods



- “Stocked” fish had an adipose fin clip or a CWT
- “Wild” fish had no fin clip and no CWT
- Only head hunter recovered fish from 2014 total whole haul and partial whole haul samples were included
- Assigned wild fish to the 2013 year class based on length-frequency distributions of known age fish developed for each sample month
- Applied proportions to lengths where Age 1 and Age 2 fish overlapped



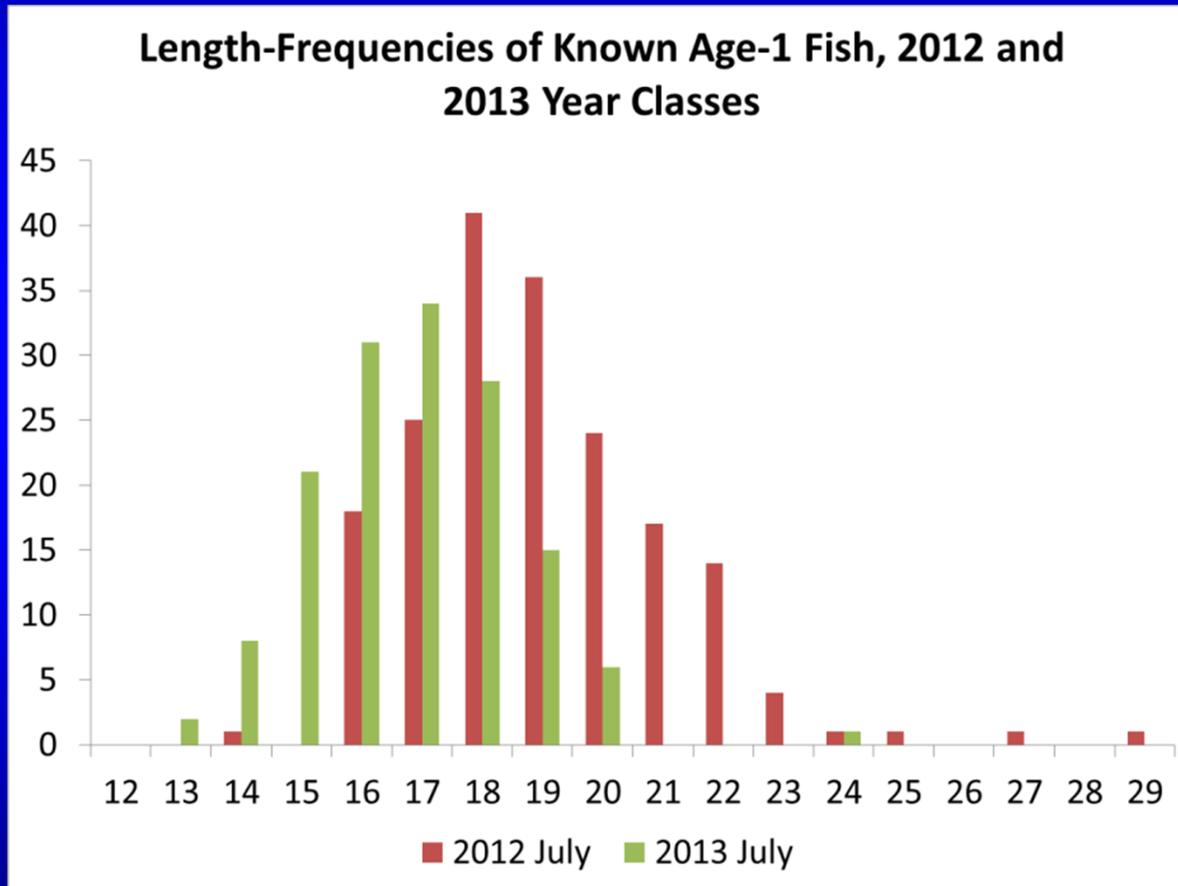
Month	Age-1 Cutoff
April/May	$\leq 18''$
June	$\leq 19''$
July	$\leq 20''$
August	$\leq 21''$
Sept/Oct	$\leq 22''$



# Wild Chinook Salmon - Methods



- Lower length cutoffs for the 2013 year class – slower growth consistent with cold 2013/2014 winter and delayed 2014 spring

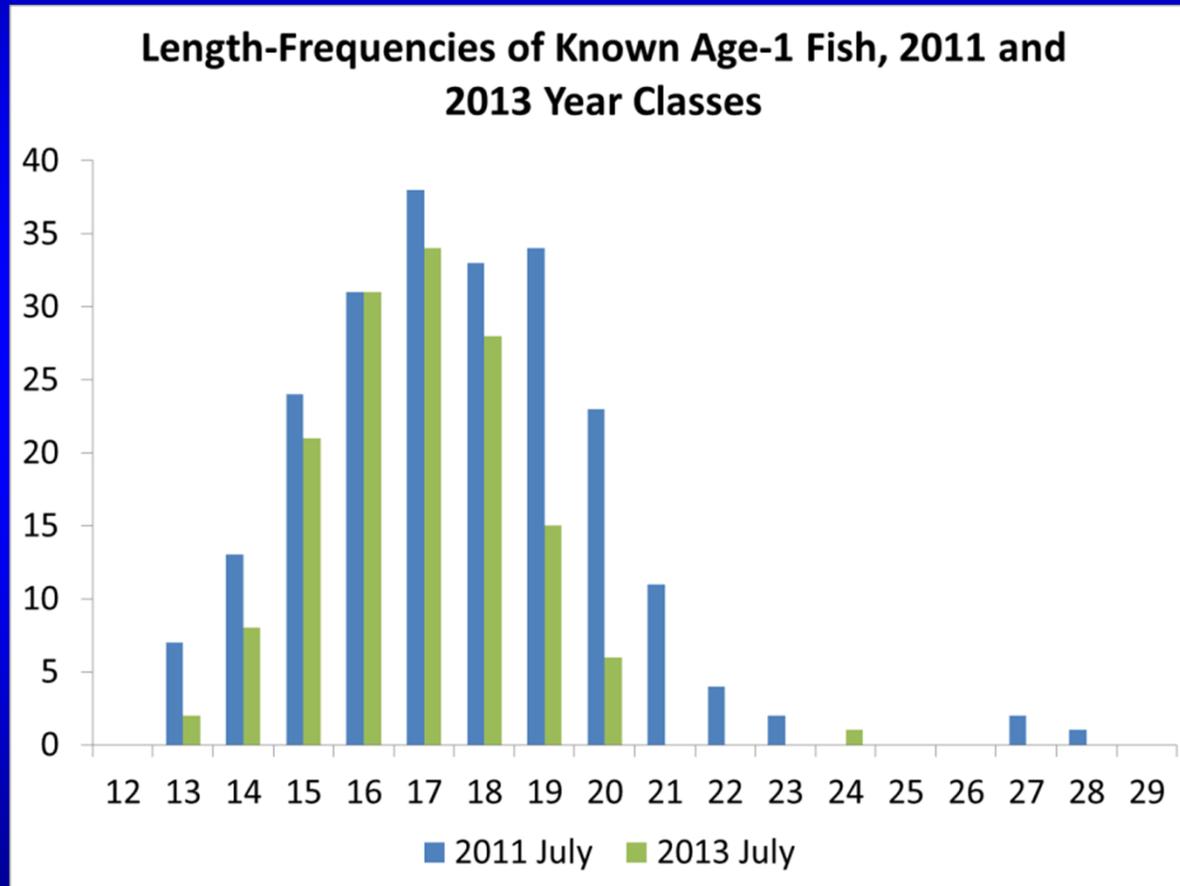




# Wild Chinook Salmon - Methods



- 2013 year class comparable to 2011 year class in growth





# Wild Chinook Salmon - Methods



- Calculated the percent of wild fish:
  - At Age 1 for the 2013 year class
  - For all Chinook salmon collected during the 2014 recovery season (mostly Age 1, 2 and 3).

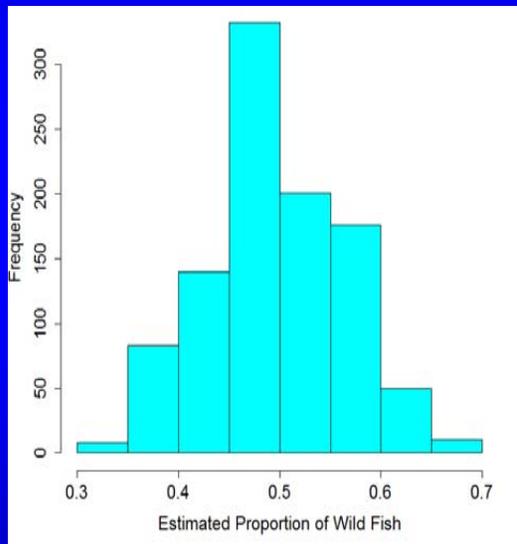


# Wild Chinook Salmon - Methods

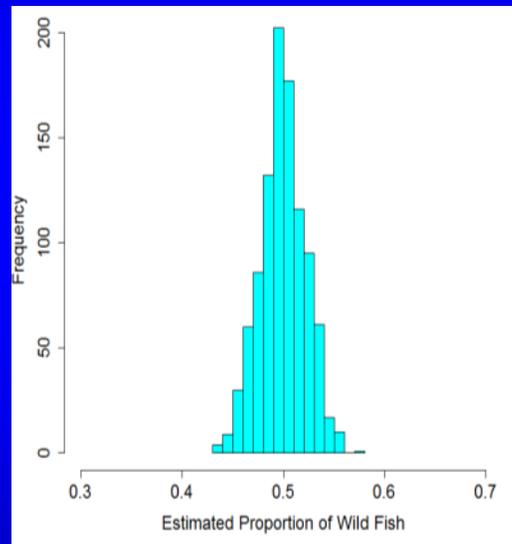


- Determined 95% confidence intervals by randomly drawing 1000 samples of sample size  $n$  (where  $n$  = the number of Chinooks recovered in a given lake, jurisdiction, or statistical district) from a simulated dataset where the wild contribution was known to be 50%.

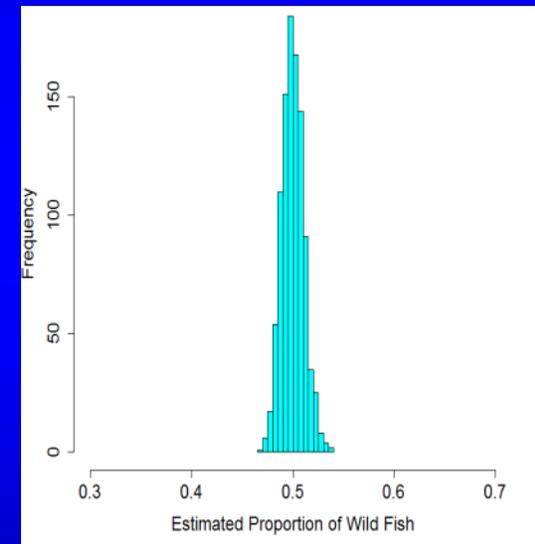
$N = 50$  fish



$N = 500$  fish



$N = 2000$  fish



- 95% C.I. =  $\mu \pm 1.96\sigma$



# Wild Chinook Salmon - Results



## 2013 Year Class at Age 1

Grouping	% Wild $\pm$ 95% C.I.
<i>Lakes</i>	
Lake Huron	61.7 $\pm$ 25.4
Lake Michigan	37.4 $\pm$ 3.9
<i>Jurisdictions</i>	
Illinois	47.8 $\pm$ 15.2
Indiana	51.9 $\pm$ 20.2
Michigan – L. Mich	47.9 $\pm$ 7.4
Michigan – L. Huron	61.7 $\pm$ 25.4
Wisconsin	30.8 $\pm$ 5.0

## 2011, 2012 and 2013 Year Classes, All Ages, 2014 Recoveries

Grouping	% Wild $\pm$ 95% C.I.
<i>Lakes</i>	
Lake Huron	55.4 $\pm$ 6.4
Lake Michigan	59.8 $\pm$ 0.7
<i>Jurisdictions</i>	
Illinois	56.4 $\pm$ 3.2
Indiana	65.6 $\pm$ 3.8
Michigan – L. Mich	69.3 $\pm$ 1.3
Michigan – L. Huron	55.4 $\pm$ 6.4
Wisconsin	48.3 $\pm$ 1.4

\* Yellow highlighted boxes had lower Age 1 wild recruitment relative to the % wild of all ages classes



# Wild Chinook Salmon - Results



Recovery District	% Wild $\pm$ 95% C.I. (2013 Age 1)	% Wild $\pm$ 95% C.I. (All 2014 Recoveries)
MH1	59.2 $\pm$ 25.7	48.7 $\pm$ 7.3
ILL	47.8 $\pm$ 15.2	56.4 $\pm$ 3.2
IND	51.9 $\pm$ 20.2	65.6 $\pm$ 3.8
MM2	20.0 $\pm$ 31.4	72.4 $\pm$ 8.4
MM3	Sample size too low ( $n=1$ )	60.6 $\pm$ 17.2
MM4	Sample size too low ( $n=1$ )	66.7 $\pm$ 9.6
MM5	44.1 $\pm$ 12.7	80.8 $\pm$ 3.1
MM6	42.4 $\pm$ 17.4	74.1 $\pm$ 2.4
MM7	67.4 $\pm$ 15.8	62.1 $\pm$ 2.5
MM8	48.3 $\pm$ 18.5	59.4 $\pm$ 3.4
WM1	0.0 $\pm$ 24.7	56.4 $\pm$ 9.1
WM3	14.9 $\pm$ 16.3	42.8 $\pm$ 3.4
WM4	21.3 $\pm$ 9.3	41.6 $\pm$ 2.4
WM5	38.0 $\pm$ 7.1	51.9 $\pm$ 2.1
WM6	51.0 $\pm$ 16.3	54.8 $\pm$ 4.6

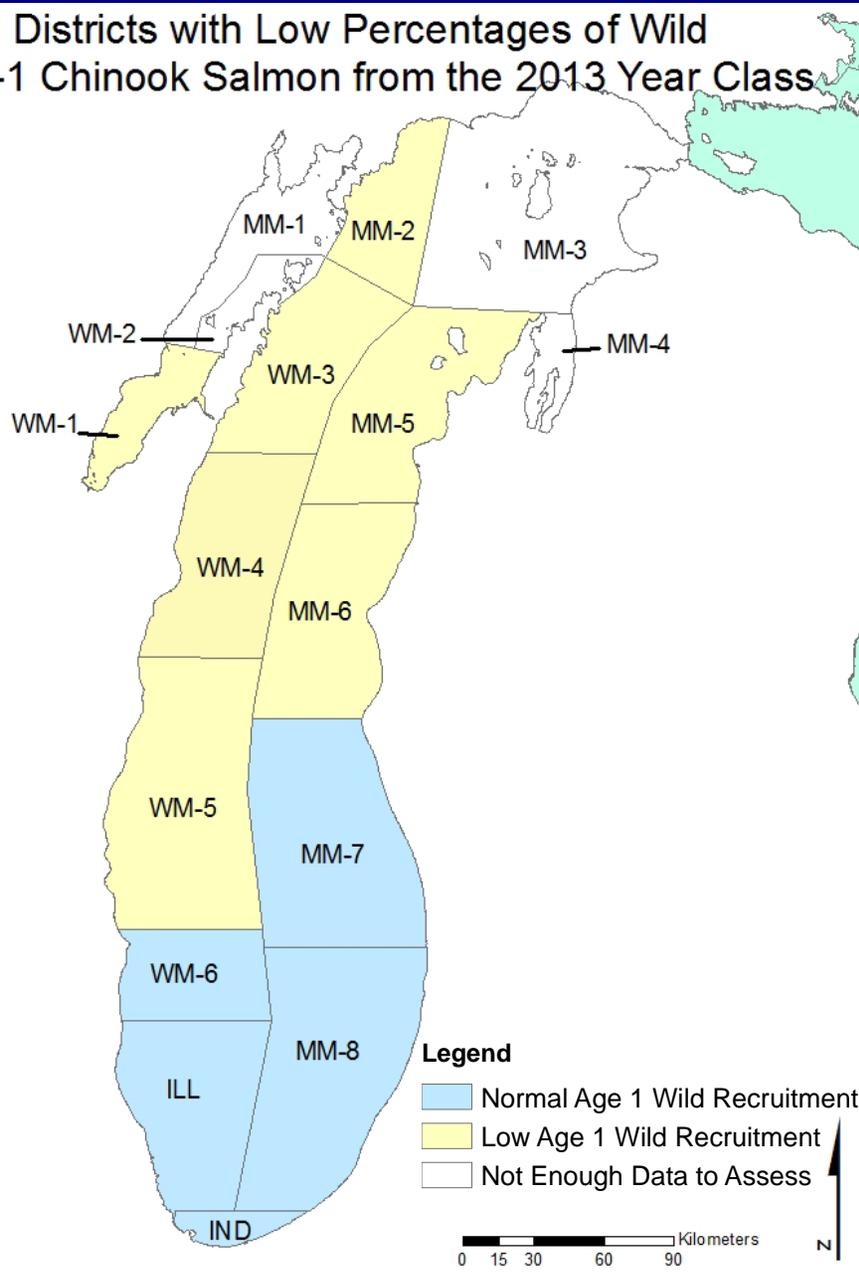
\* Yellow highlighted boxes had lower Age 1 wild recruitment relative to the % wild of all ages classes



# Wild Chinook Salmon - Results



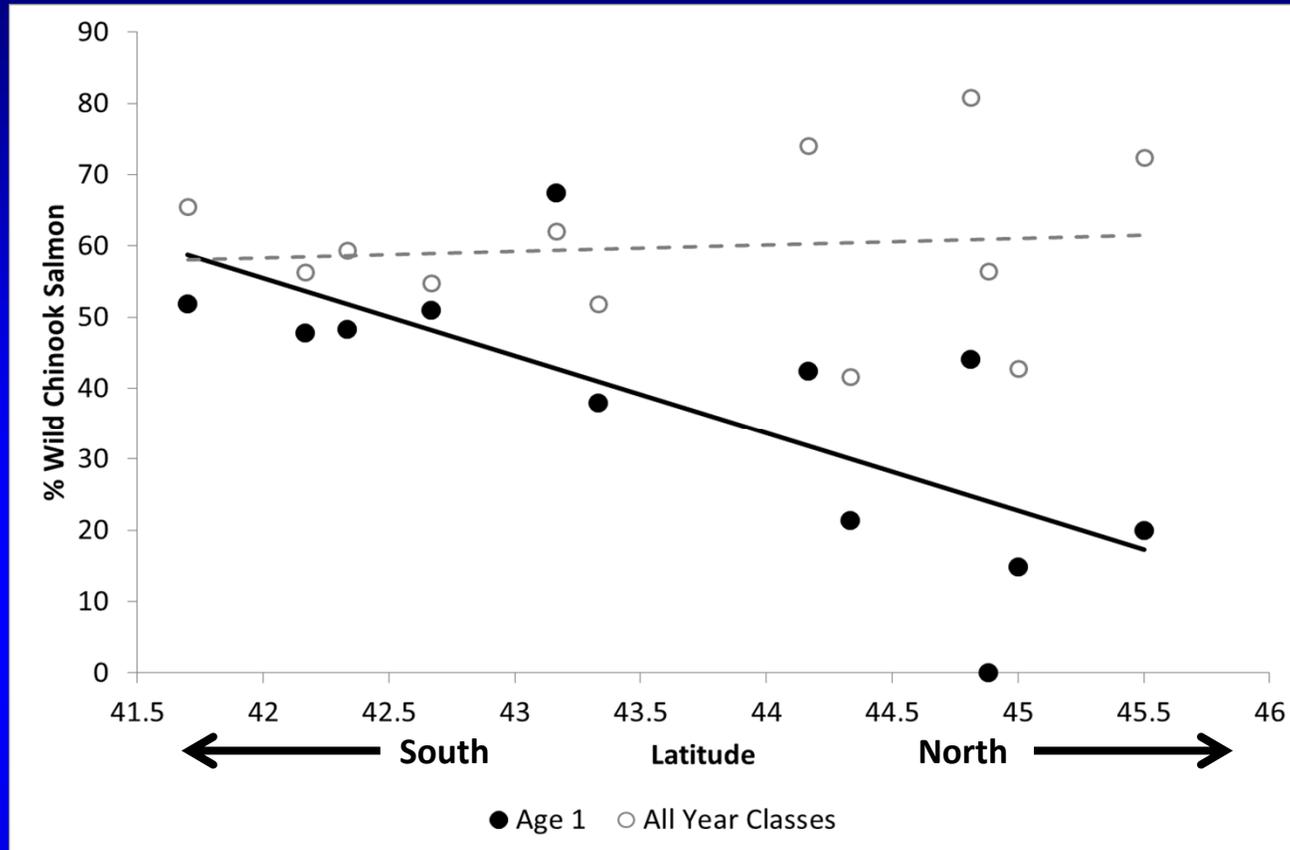
Districts with Low Percentages of Wild Age-1 Chinook Salmon from the 2013 Year Class



- Average wild recruitment in southern Lake Michigan
- Below average wild recruitment in northern Lake Michigan



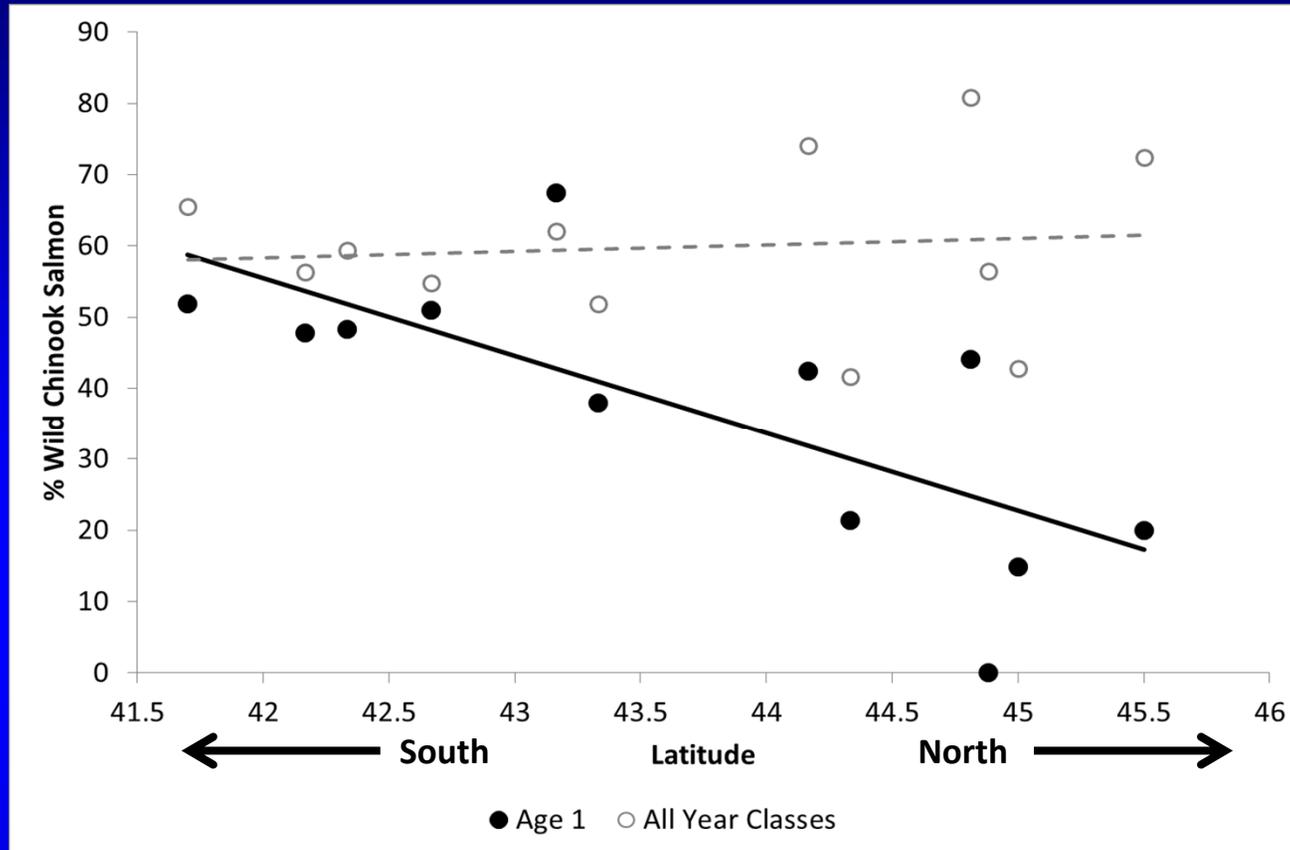
# Wild Chinook Salmon - Results



- Age 1 wild recruitment (2013 YC) was negatively related to latitude ( $p = 0.008$ ,  $R^2 = 0.53$ )
- % wild for all ages pooled was not related to latitude ( $p = 0.76$ ,  $R^2 = 0.01$ )
- Paired t-tests suggest below average Age 1 wild recruitment in northern Lake Michigan ( $p = 0.001$ ) but not southern Lake Michigan ( $p = 0.13$ )



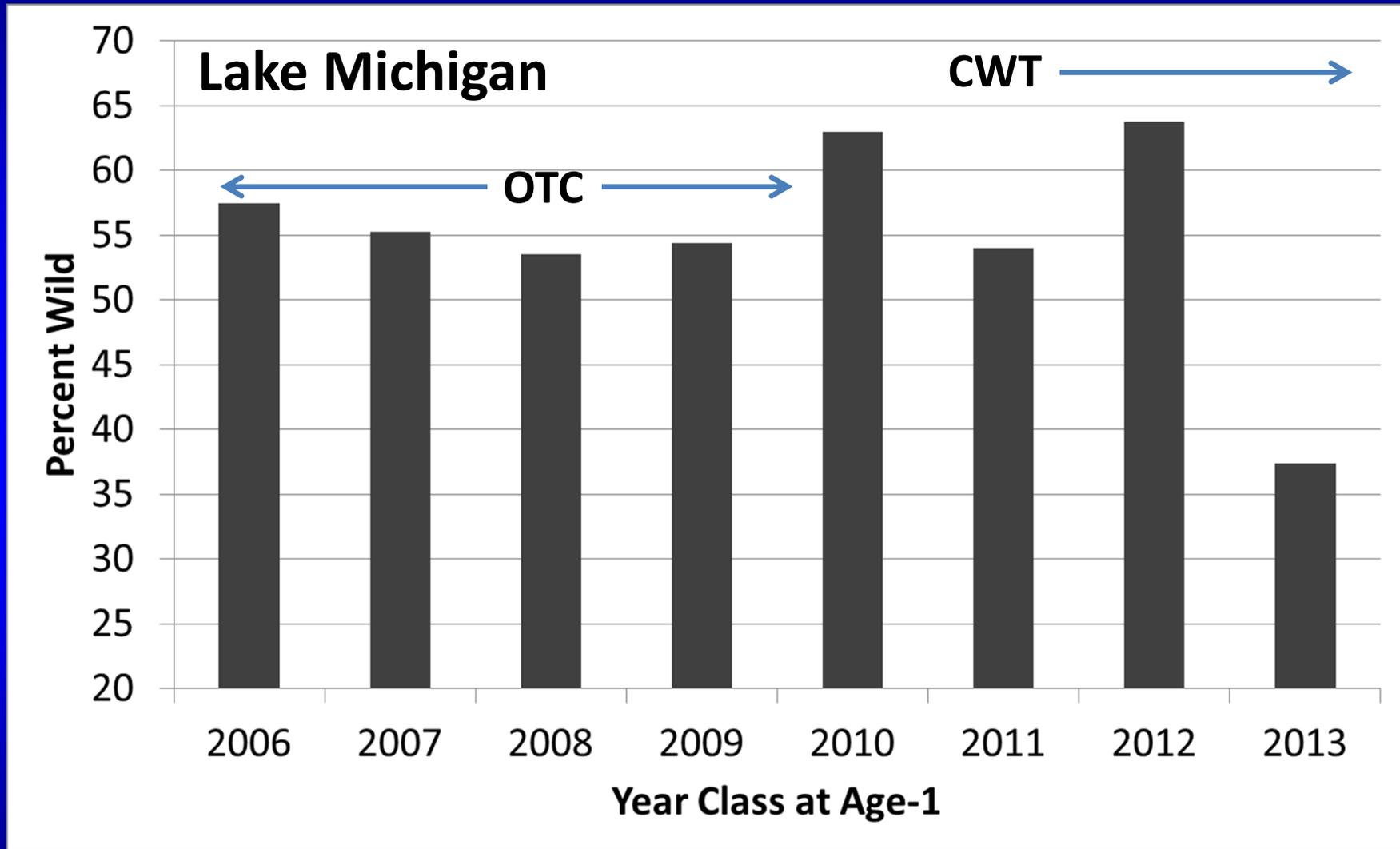
# Wild Chinook Salmon - Results



- Age 1 wild recruitment (2013 YC) was negatively related to latitude ( $F_{1,10} = 11.1, p = 0.008, R^2 = 0.53$ )
- % wild for all ages pooled was not related to latitude ( $F_{1,10} = 0.09, p = 0.76, R^2 = 0.01$ )
- Paired t-tests suggest below average Age 1 wild recruitment in northern Lake Michigan ( $t_6 = 5.7, p = 0.001$ ) but not southern Lake Michigan ( $t_4 = 1.9, p = 0.13$ )



# Wild Chinook Salmon - Results





# Wild Chinook Salmon - Results



- Estimates for Lake Michigan equate to 734,000 wild smolts in 2013 (down from 5.8 million for the 2012 year class)
- Total 2013 recruitment estimate of 2.5 million (down from 9.1 million in 2012), the lowest level since 1972
- Possible contributing factors:
  - Cold 2013/2014 winter reduced survival to Age 1
  - Cold winter reduced growth, resulting in more angler throw-backs
  - Low water levels and warm water temperature during the 2012 fall run
  - Low production of YOY alewives in 2013

Recovery Year	Percent of all stocked fish that were Age 1	Percent of all wild fish that were Age 1
2013	22.5%	20.2%
2014	9.0%	2.5%

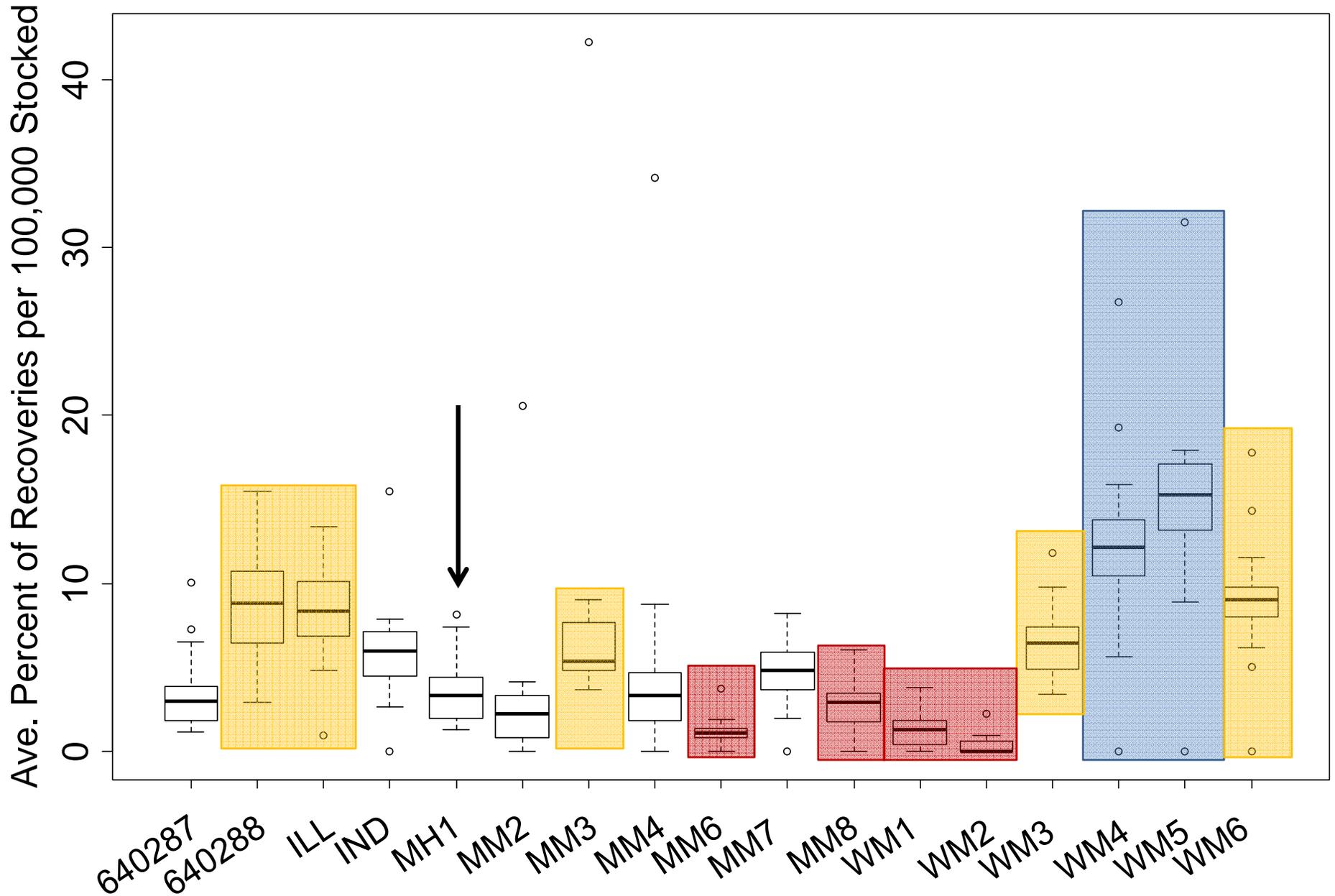
# Estimated Contribution of Stocked Chinook Salmon to the Fishery by Stocking District



## Estimated Contribution of Stocked Chinook Salmon - Methods

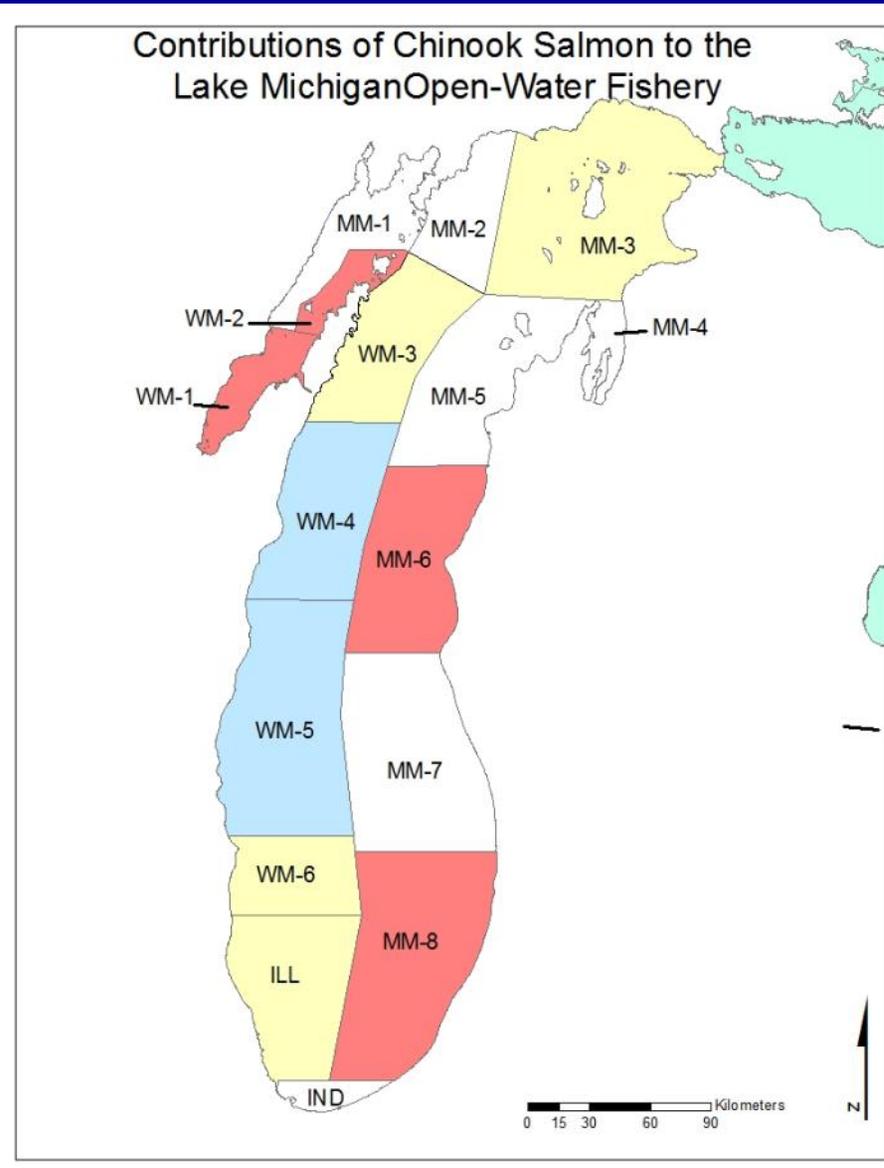
- At each recovery district, we computed the no. of recoveries from each stocking district per 100,000 stocked (headhunters only)
- We then calculated the percentage of fish from each stocking district that was recovered in each recovery district
  - Removes bias associated with different sampling efforts in each recovery district
- Single-factor ANVOA testing effect of stocking district on recovery
- Tukey-Kramer procedures for post-hoc pairwise comparisons among stocking districts

# Estimated Contribution of Stocked Chinook Salmon to the Lake Michigan Open-Water Fishery by Stocking District – All Year Classes

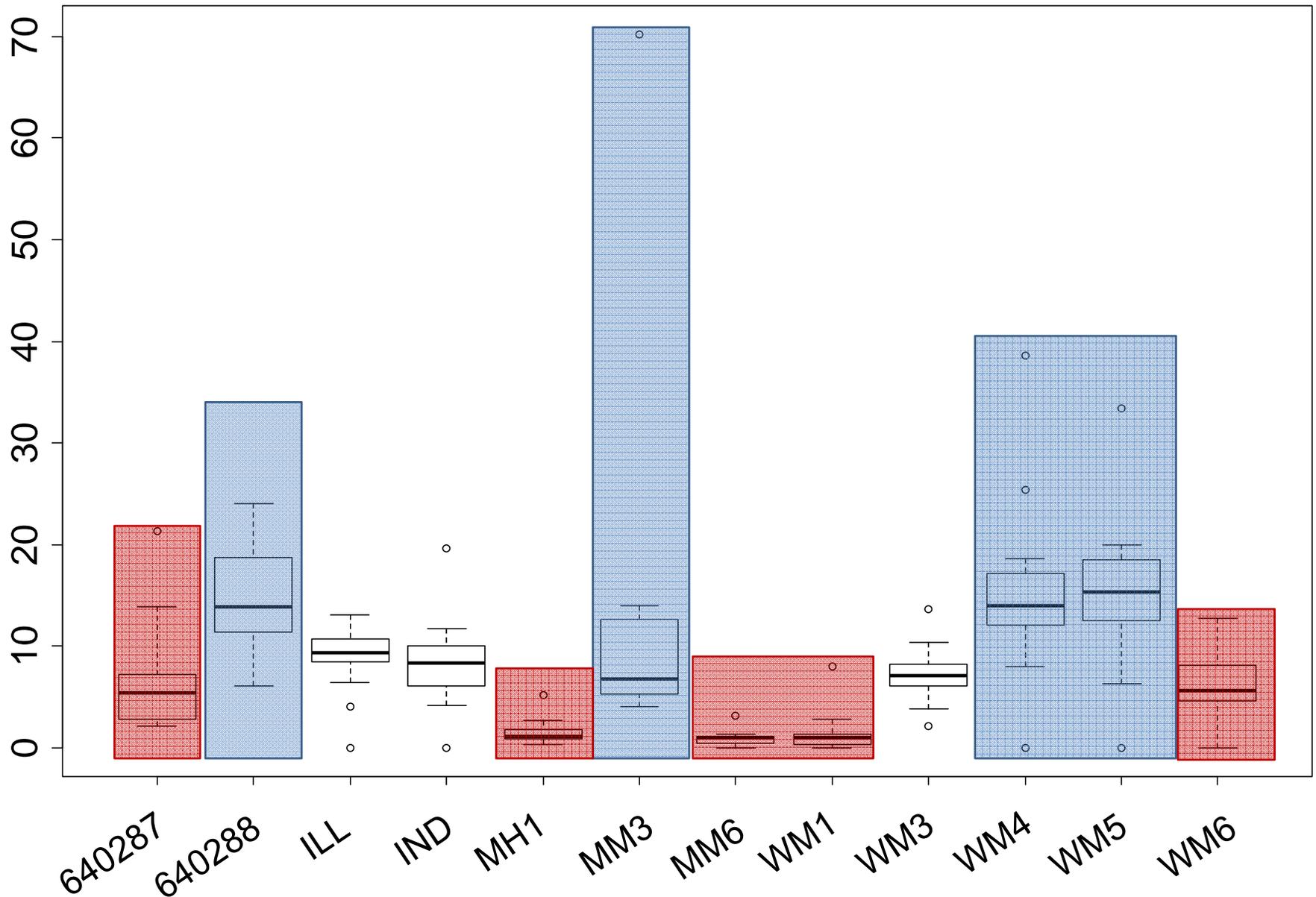


# Estimated Contribution of Stocked Chinook Salmon to the Lake Michigan Open-Water Fishery by Stocking District – All Year Classes

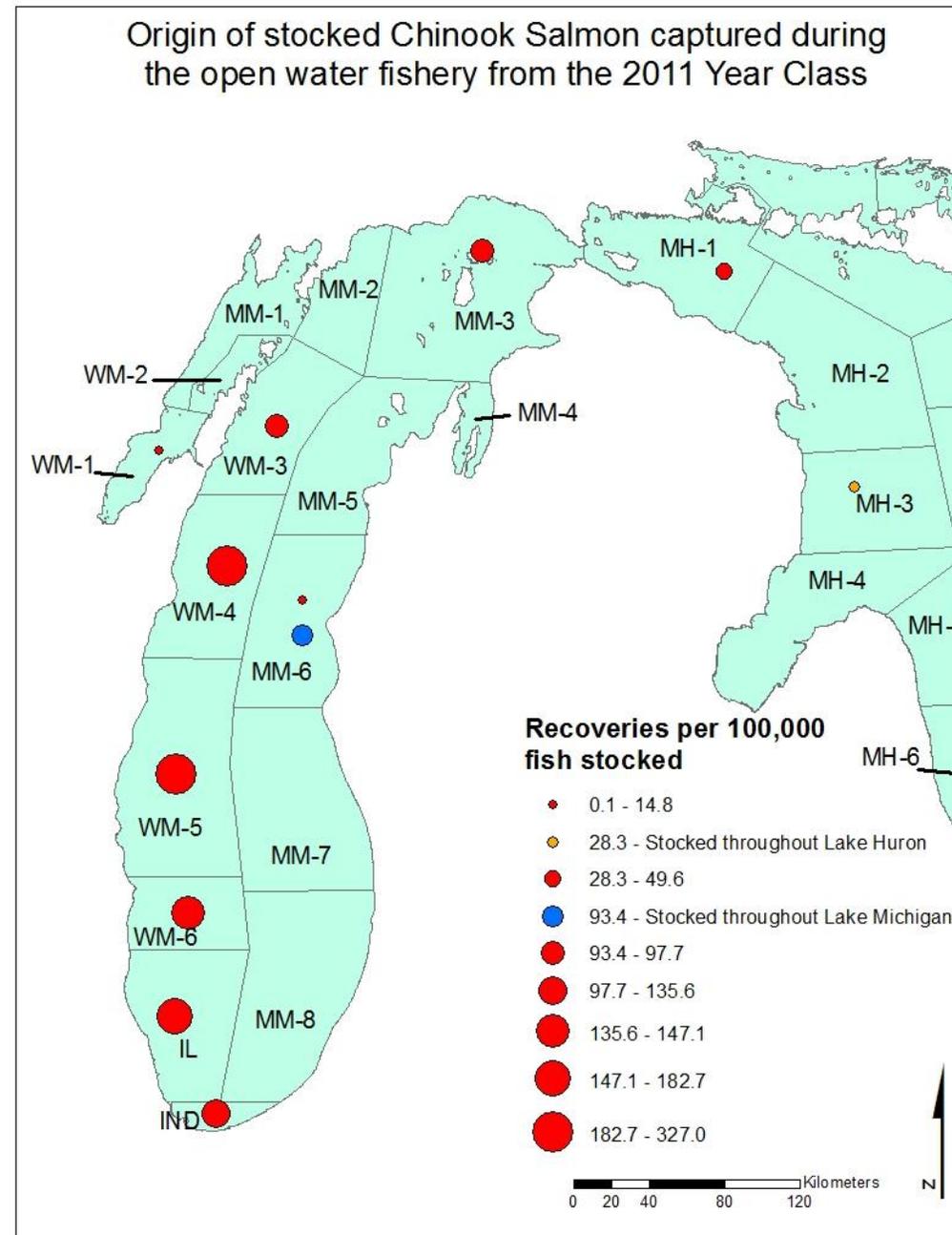
Stocking District	Adj. Number Stocked
WM4	749,340
WM5	716,089
640288	978,662
ILL	708,820
MM3	474,601
WM3	578,577
WM6	572,248
MM6	1,155,689
MM8	379,403
WM1	371,654
WM2	82,773



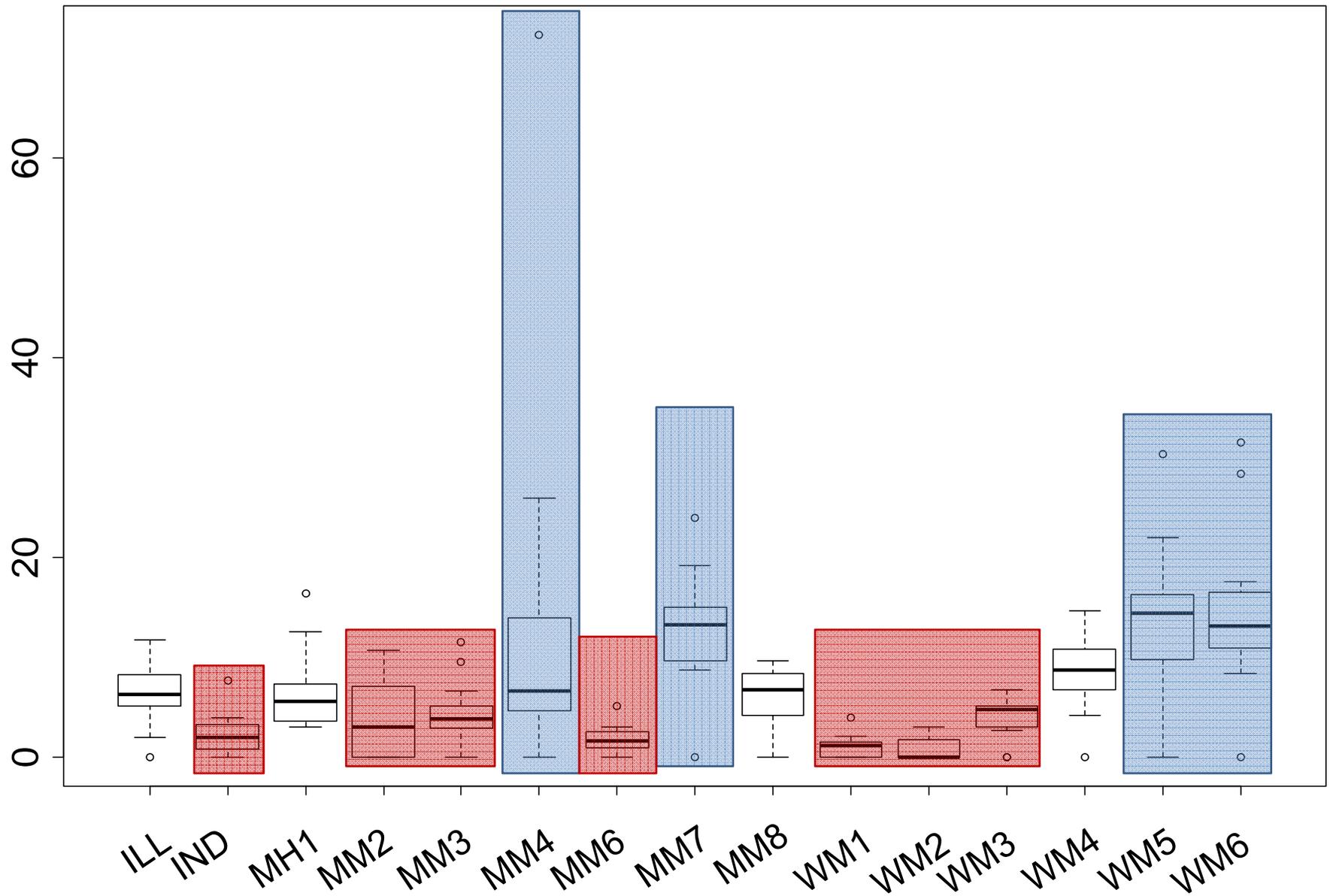
# 2011 Year Class: Estimated Contribution the Lake Michigan Open-Water Fishery by Stocking District



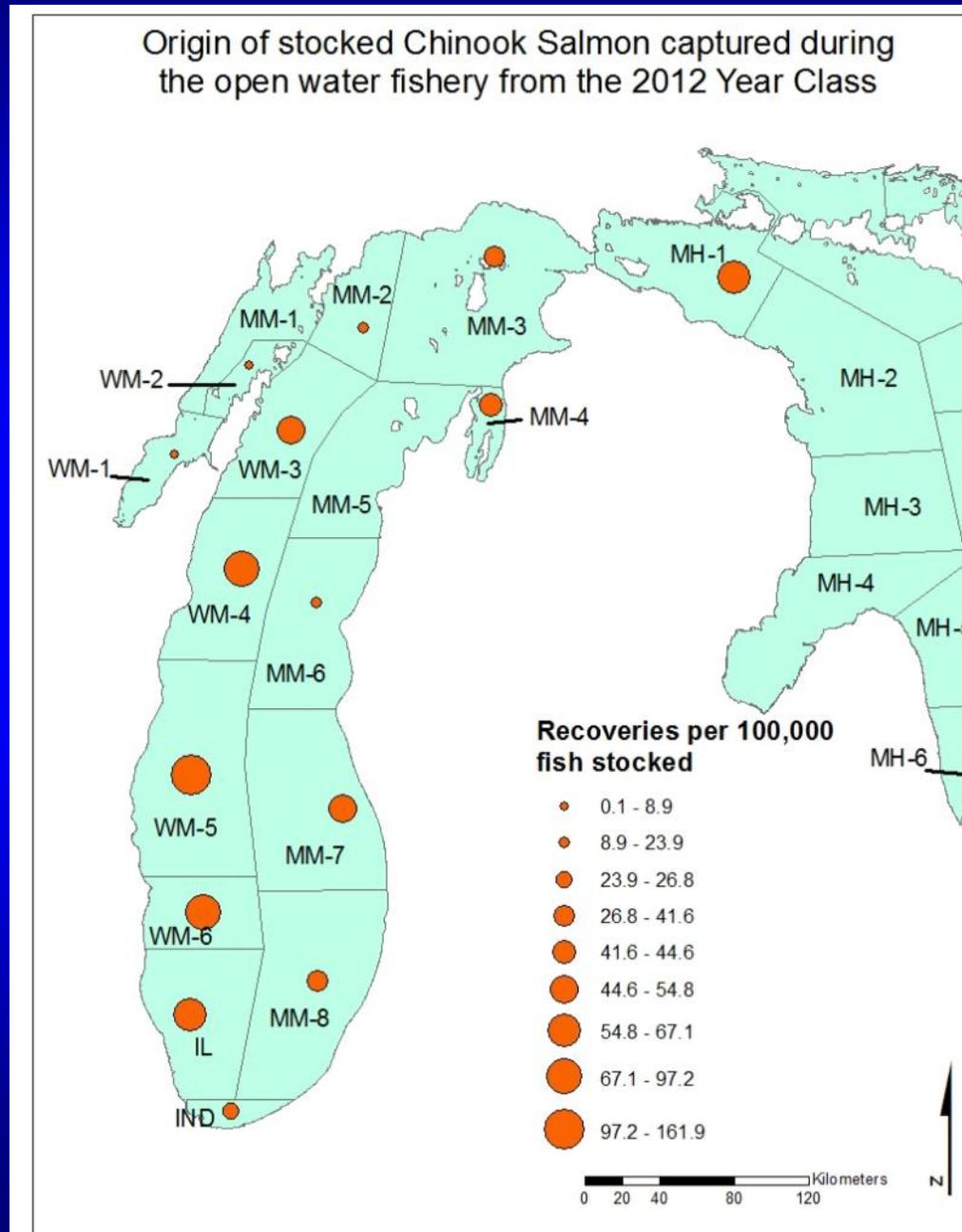
# Recoveries per 100,000 Fish Stocked – Stocking District



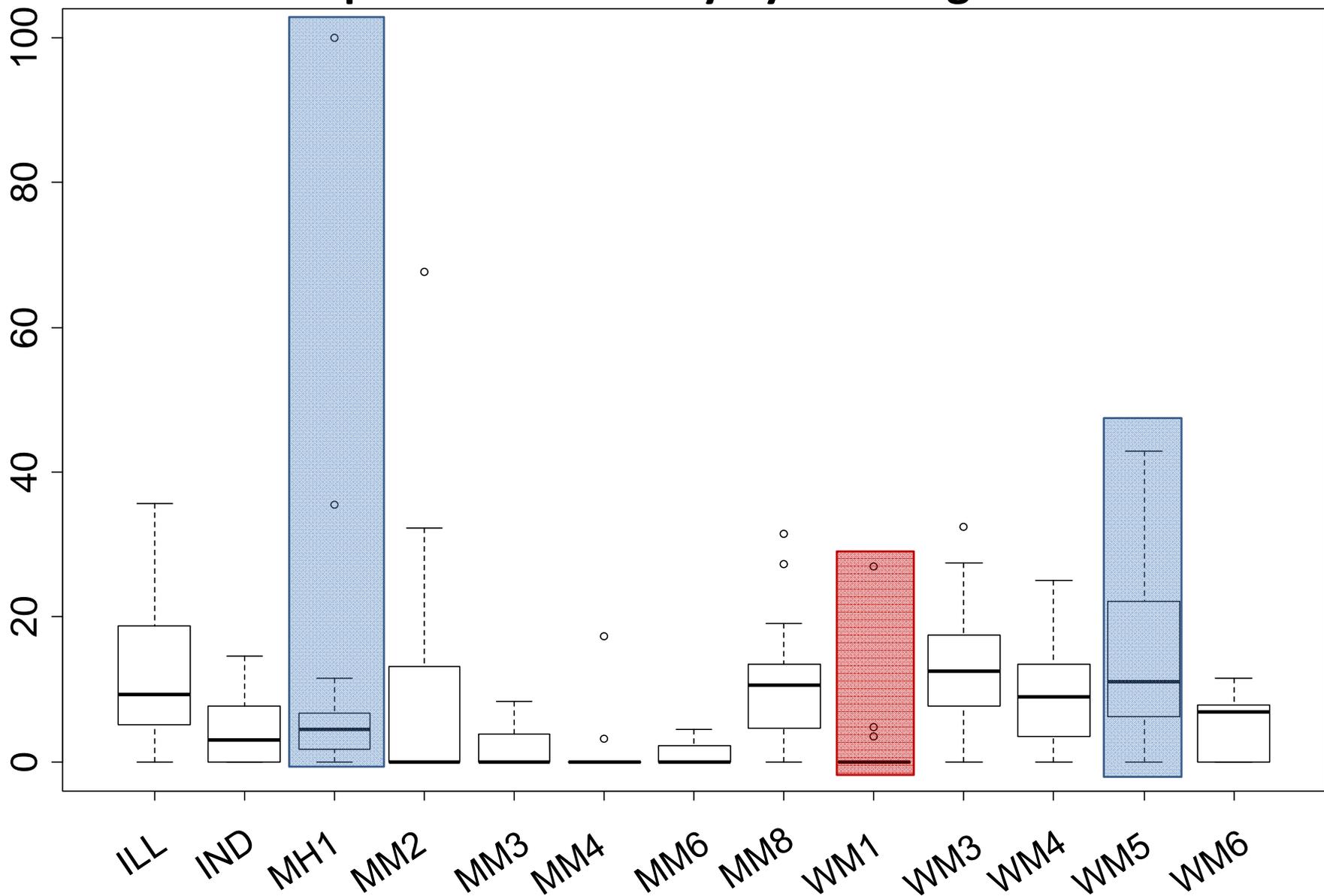
# 2012 Year Class: Estimated Contribution the Lake Michigan Open-Water Fishery by Stocking District



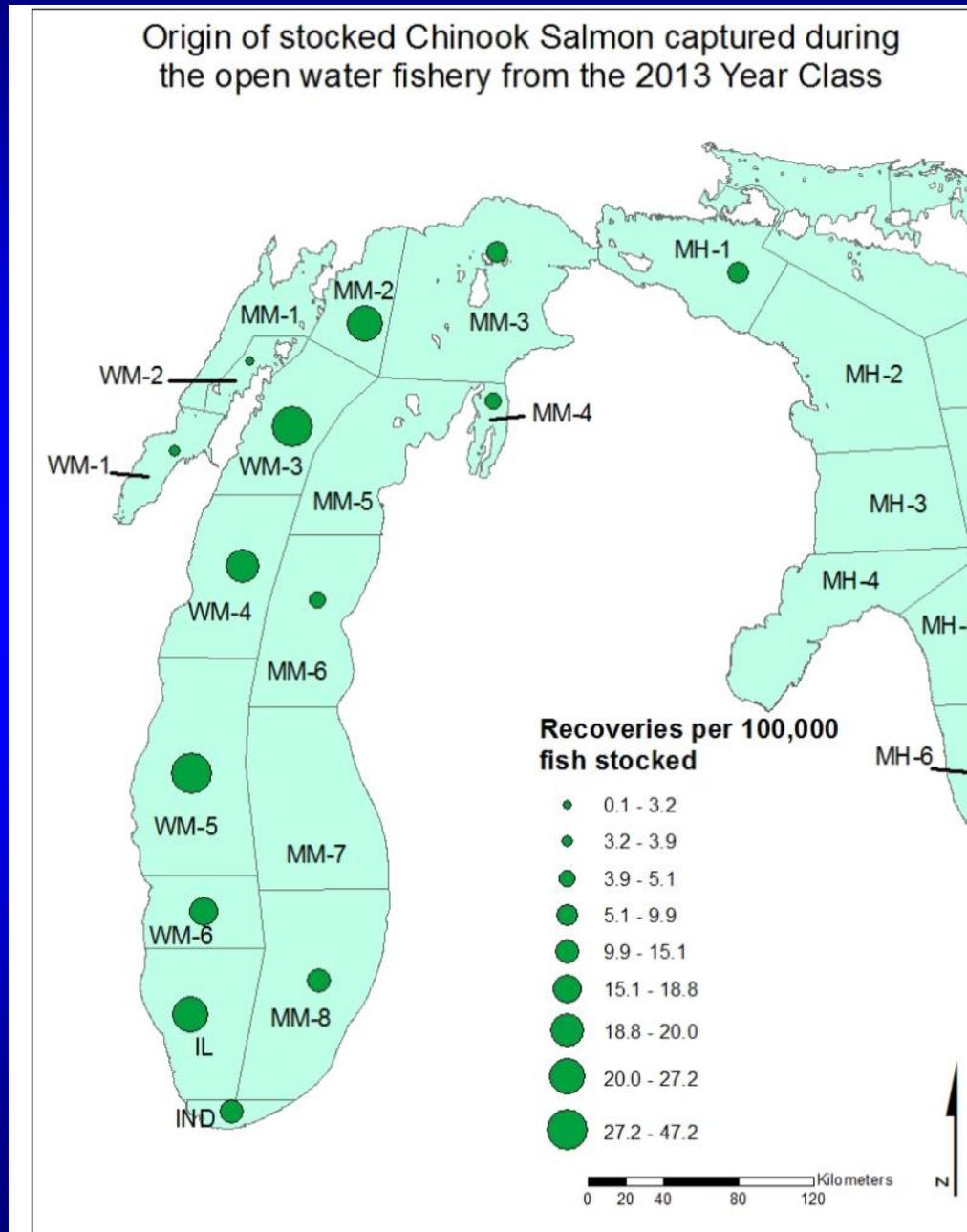
# Recoveries per 100,000 Fish Stocked – Stocking District



# 2013 Year Class: Estimated Contribution the Lake Michigan Open-Water Fishery by Stocking District



# Recoveries per 100,000 Fish Stocked – Stocking District

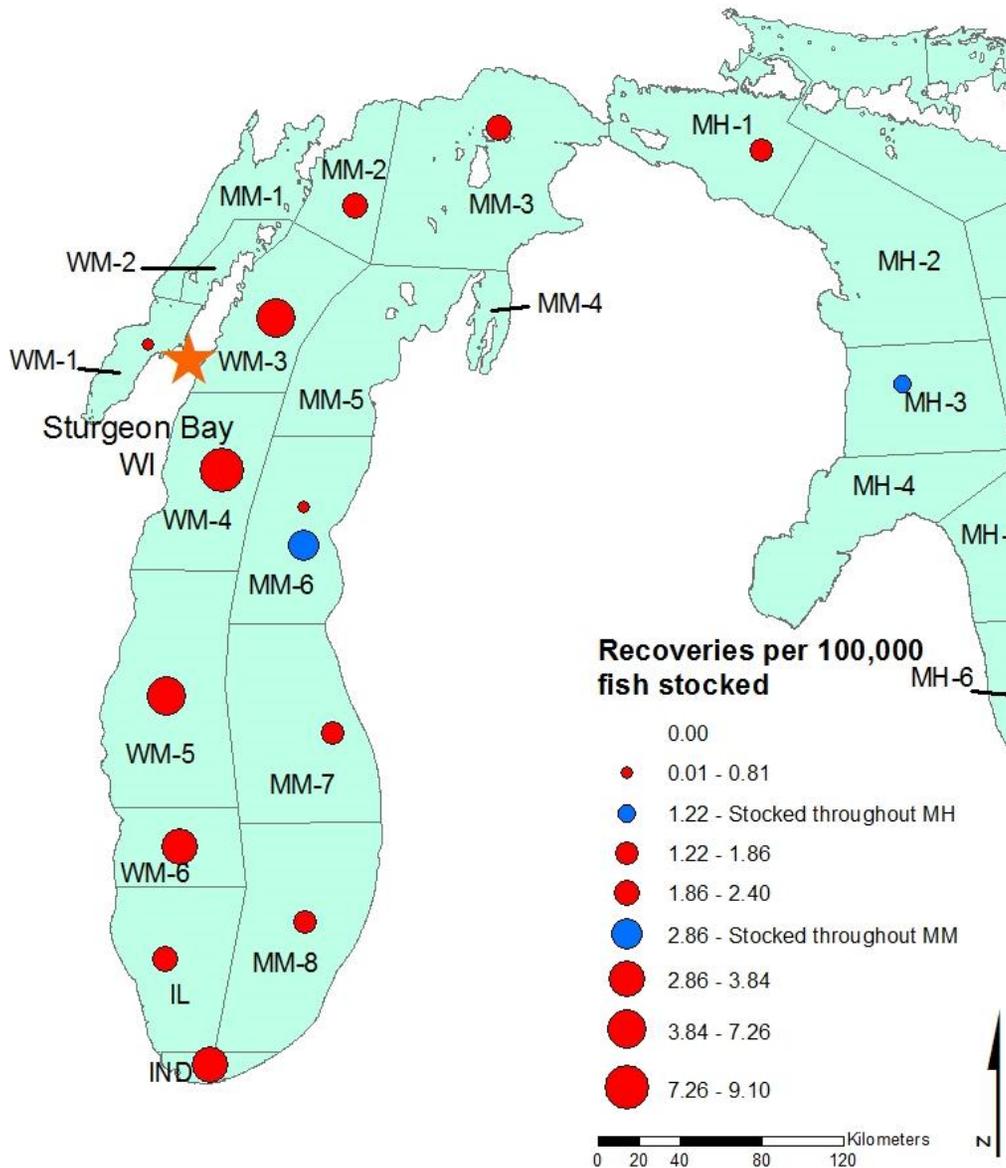


# Overall Chinook Salmon Movement Patterns From Select Ports

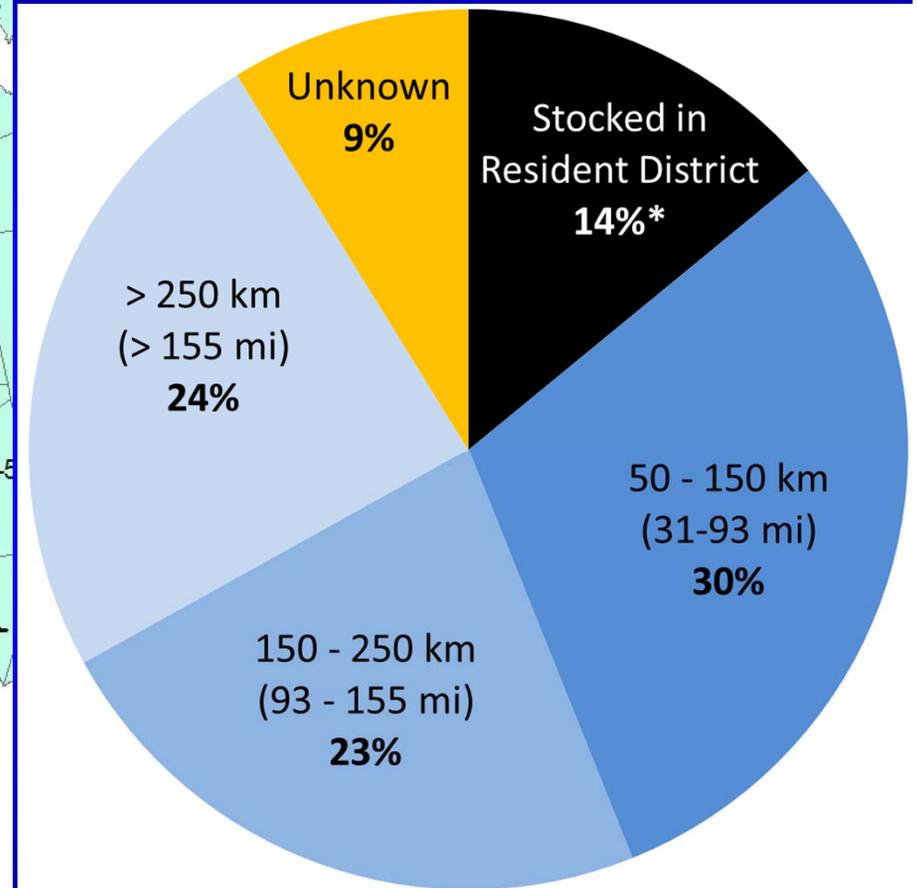


# Chinook Salmon Captured at Sturgeon Bay, WI

Origin of stocked Chinook Salmon captured during the open water fishery at Sturgeon Bay, WI (2012-2014)



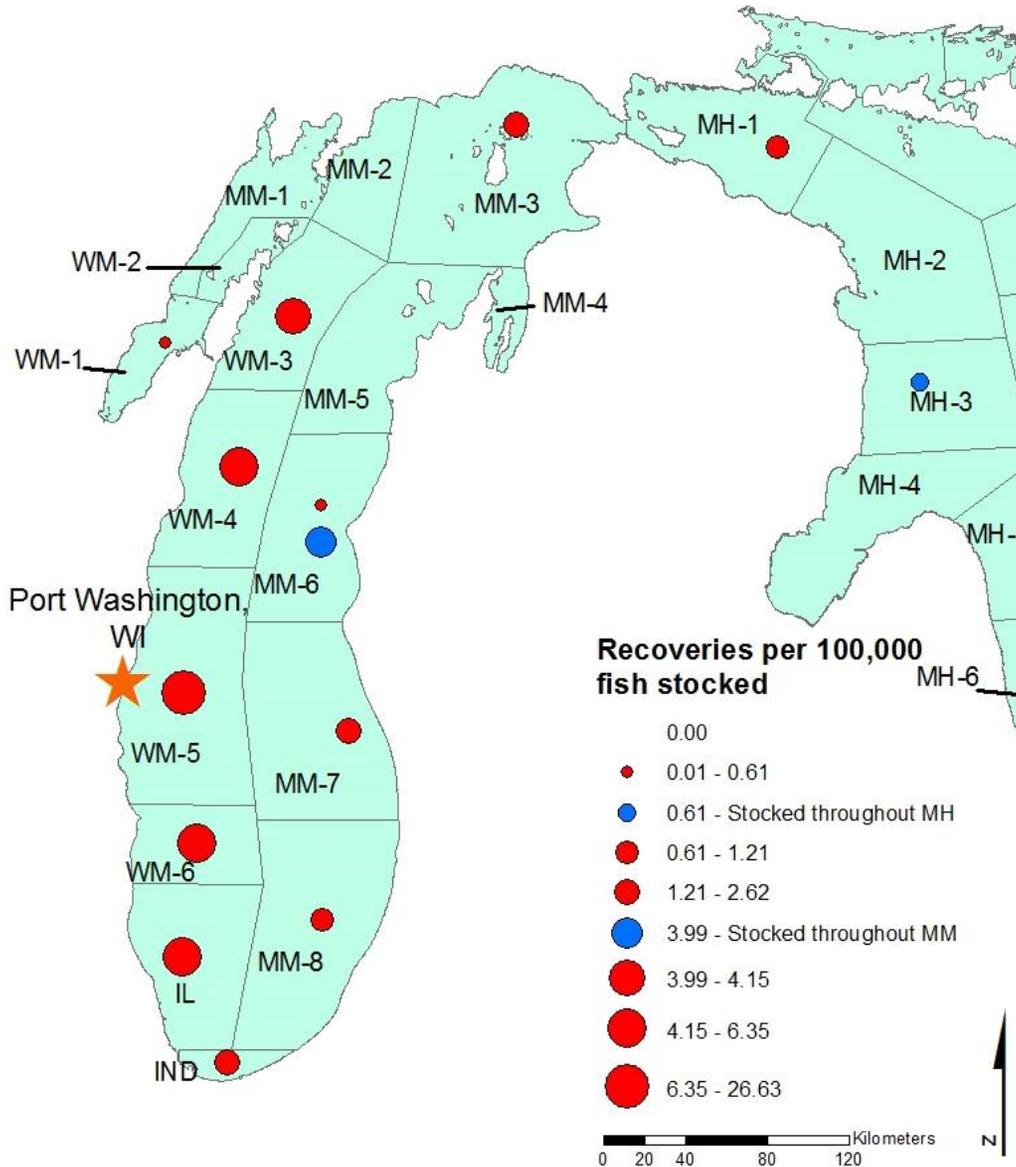
Distance from stocking district for open-water recovered Chinook salmon



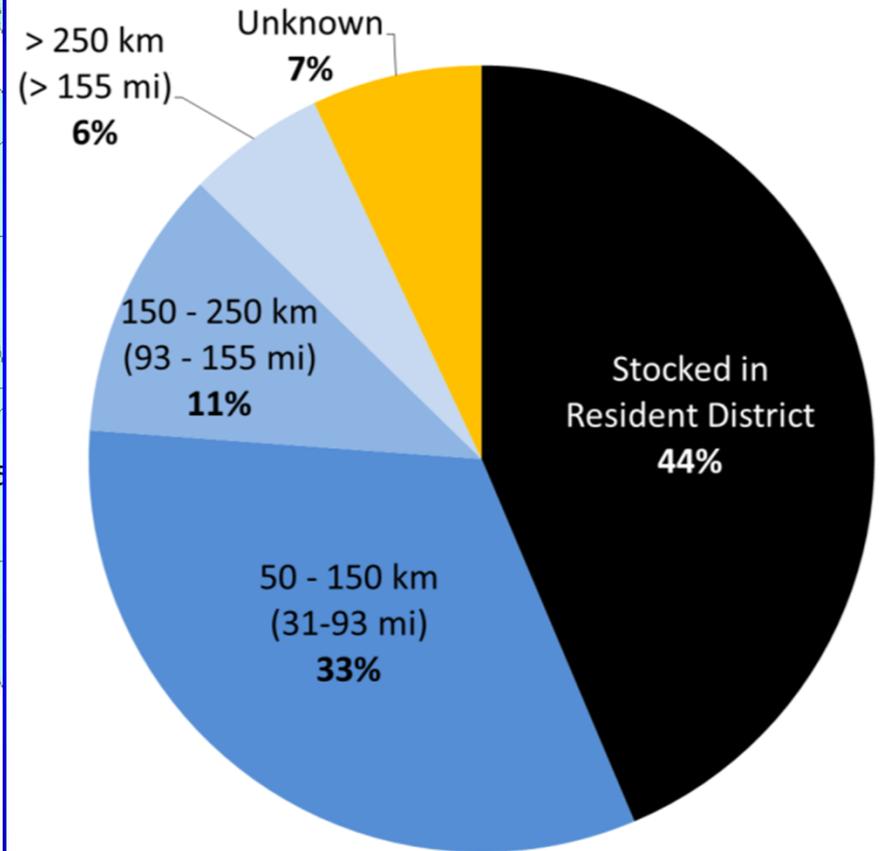
\* Both WM1 and WM3 are considered 'resident districts'. All other distances measured to WM3.

# Chinook Salmon Captured at Port Washington, WI

Origin of stocked Chinook Salmon captured during the open water fishery at Port Washington, WI (2012-2014)

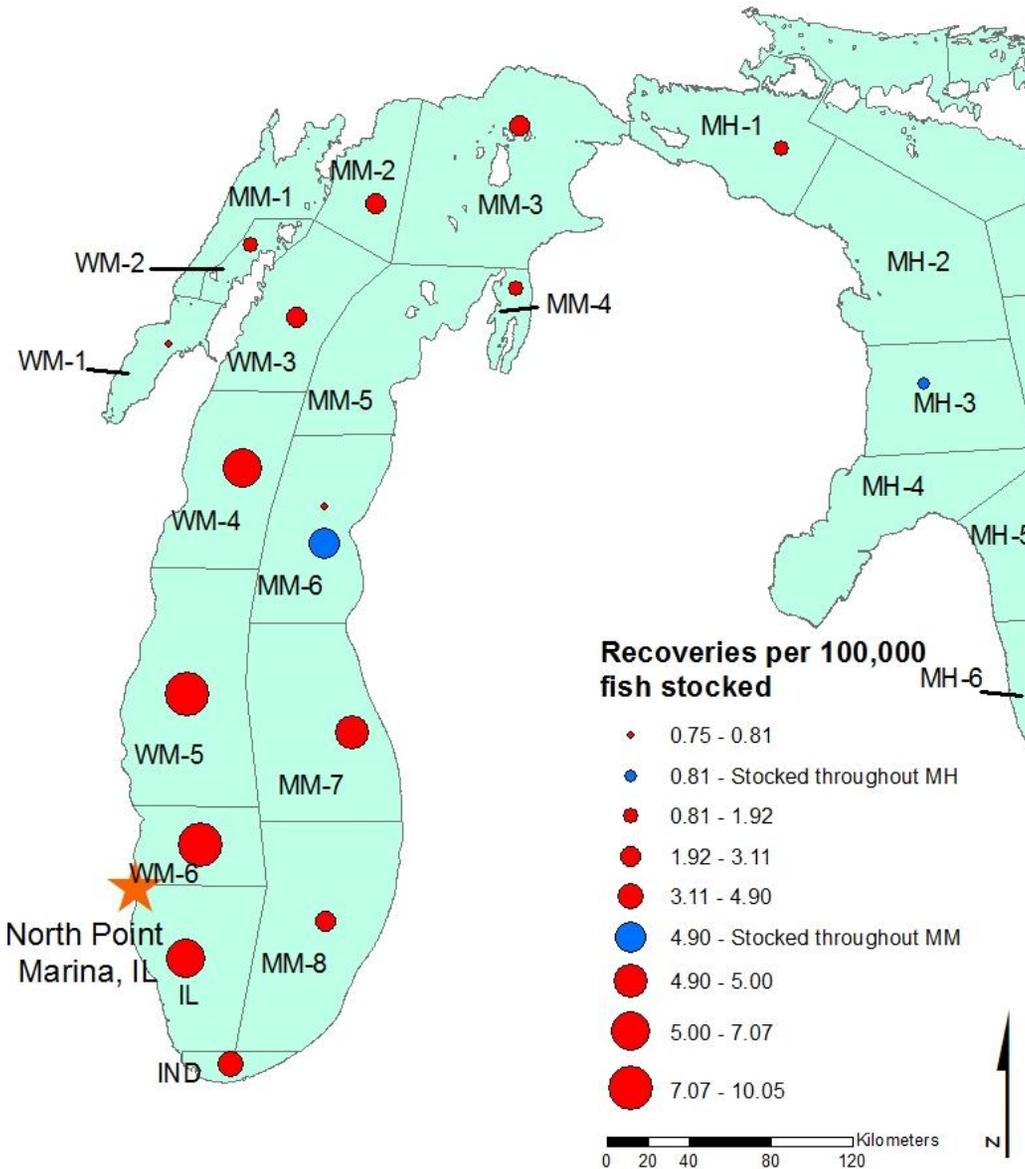


Distance from stocking district for open-water recovered Chinook salmon

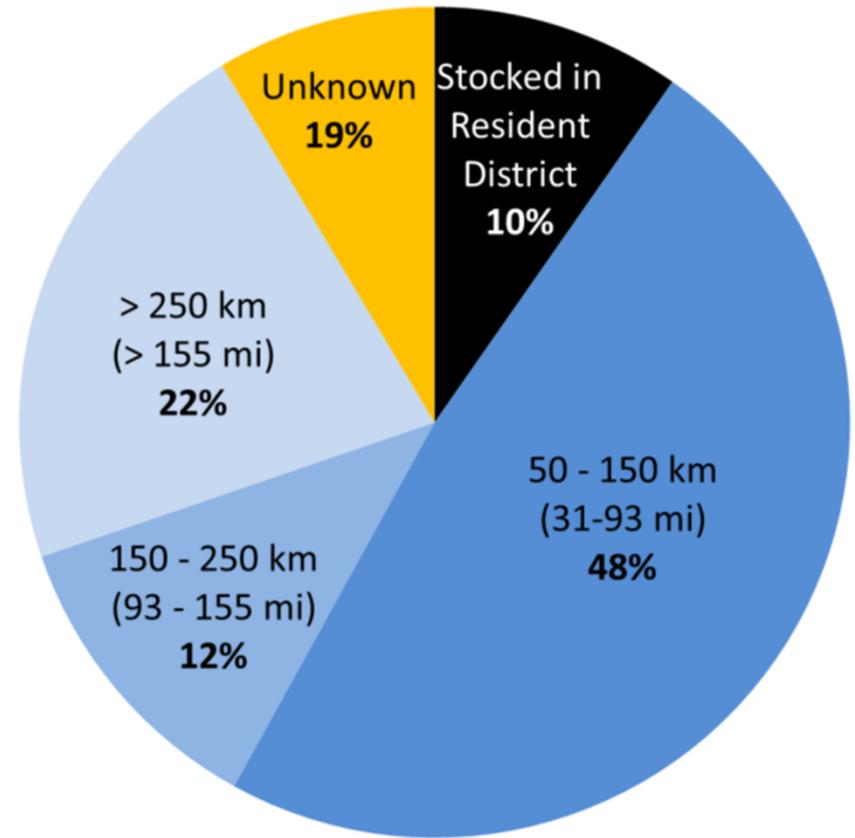


# Chinook Salmon Captured at North Point Marina, IL

Origin of stocked Chinook Salmon captured during the open water fishery at North Point Marina, IL (2012-2014)

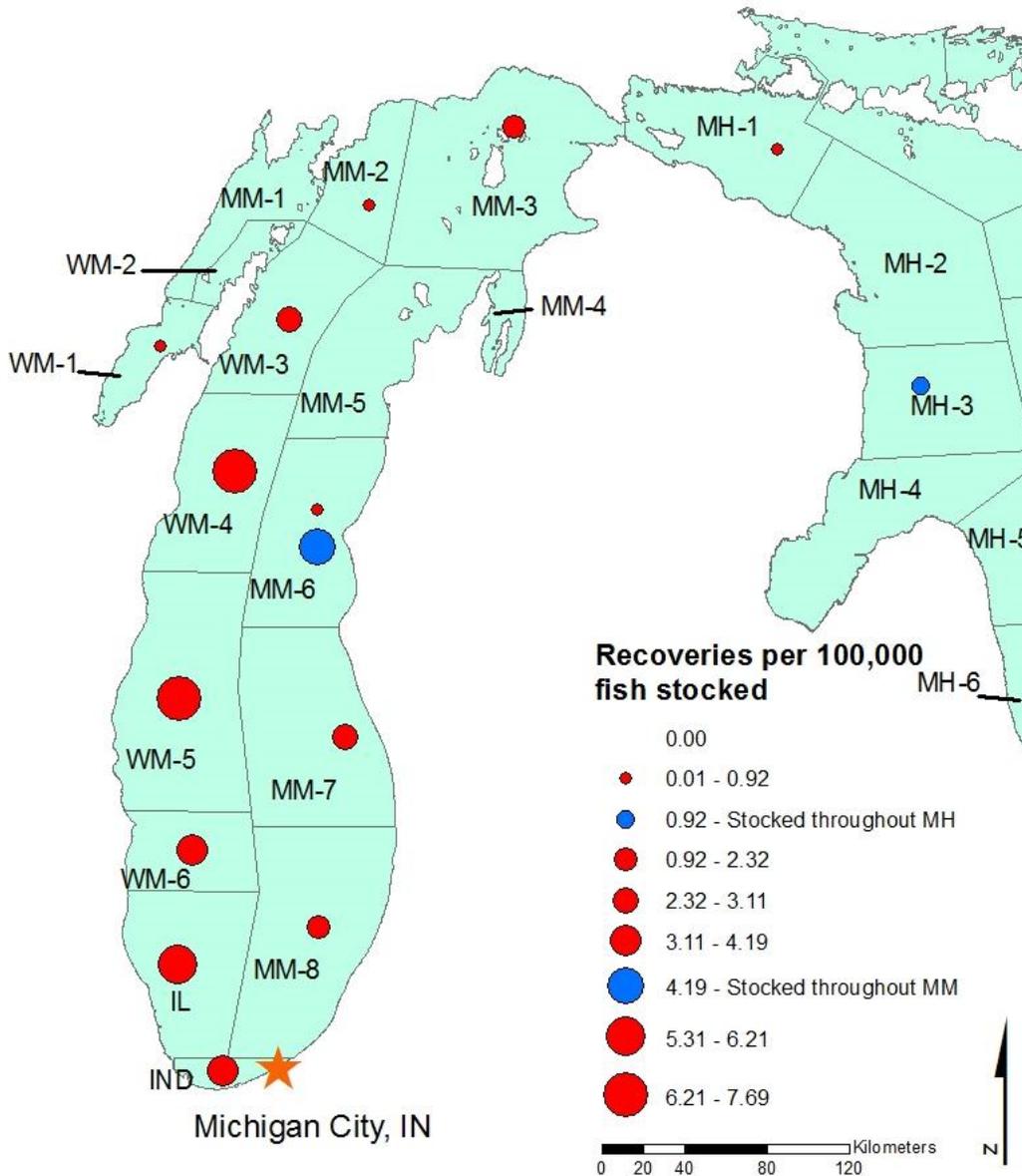


Distance from stocking district for open-water recovered Chinook salmon

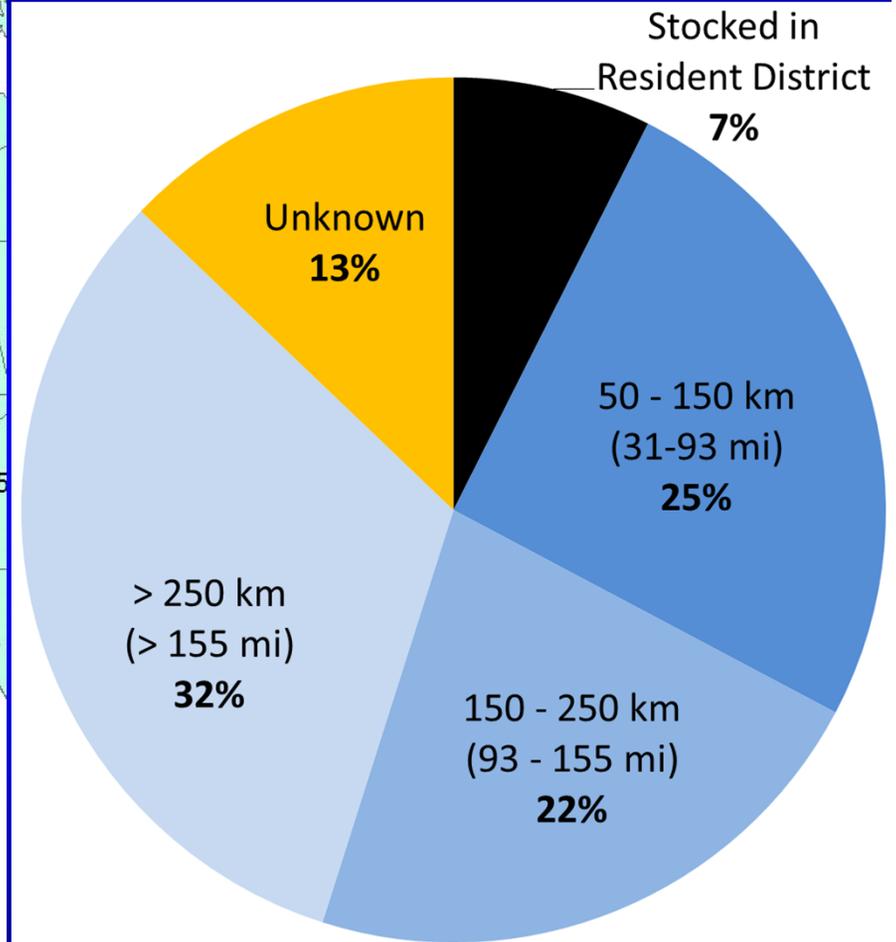


# Chinook Salmon Captured at Michigan City, IN

Origin of stocked Chinook Salmon captured during the open water fishery at Michigan City, IN (2012-2014)

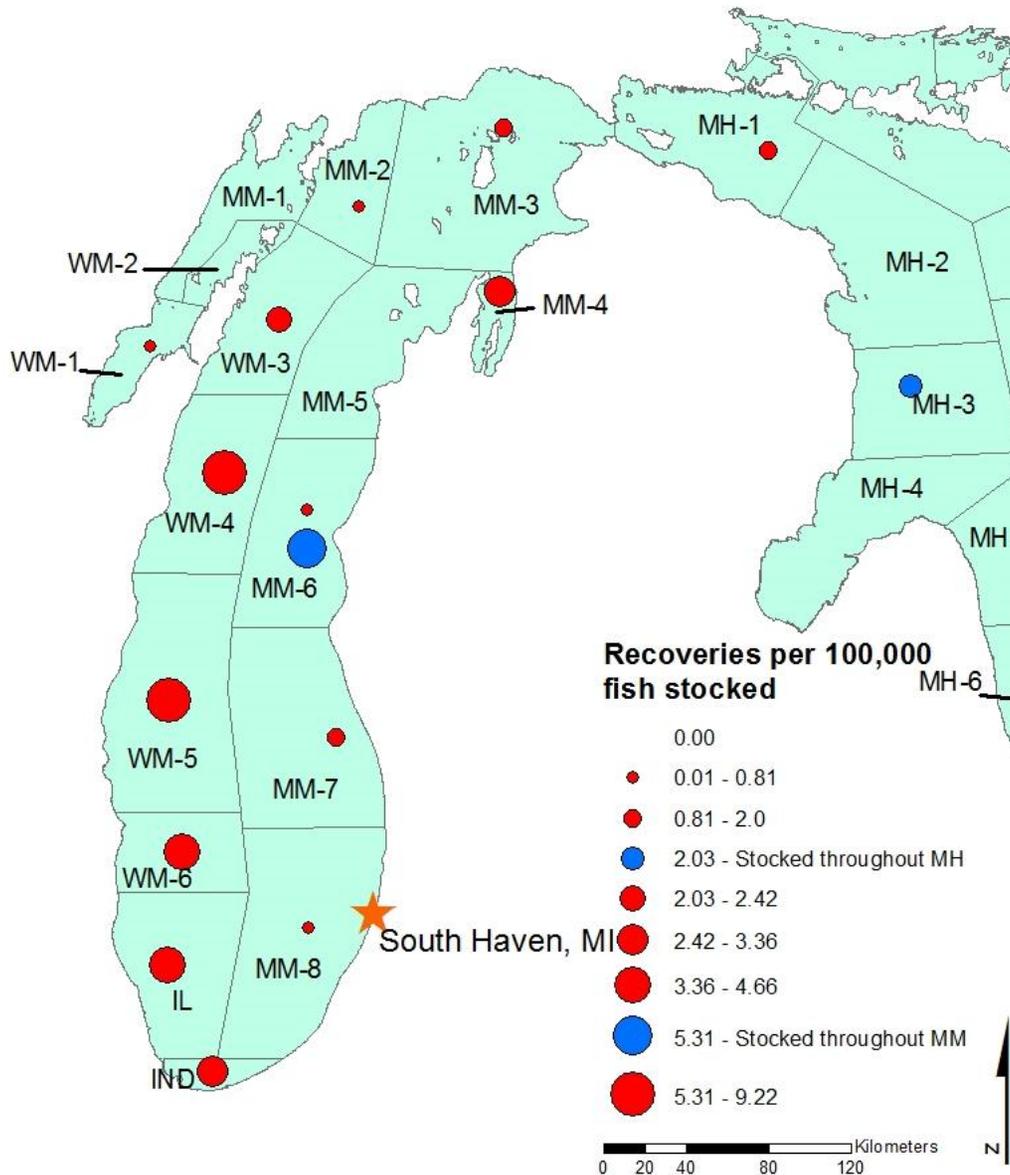


Distance from stocking district for open-water recovered Chinook salmon

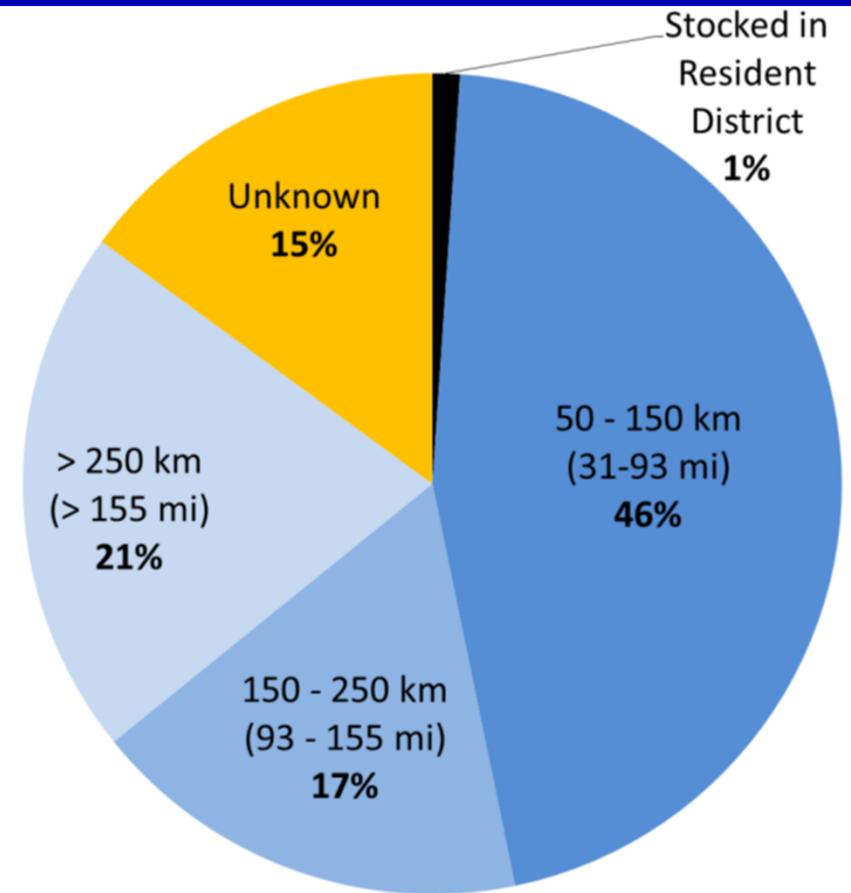


# Chinook Salmon Captured at South Haven, MI

Origin of stocked Chinook Salmon captured during the open water fishery at South Haven, MI (2012-2014)

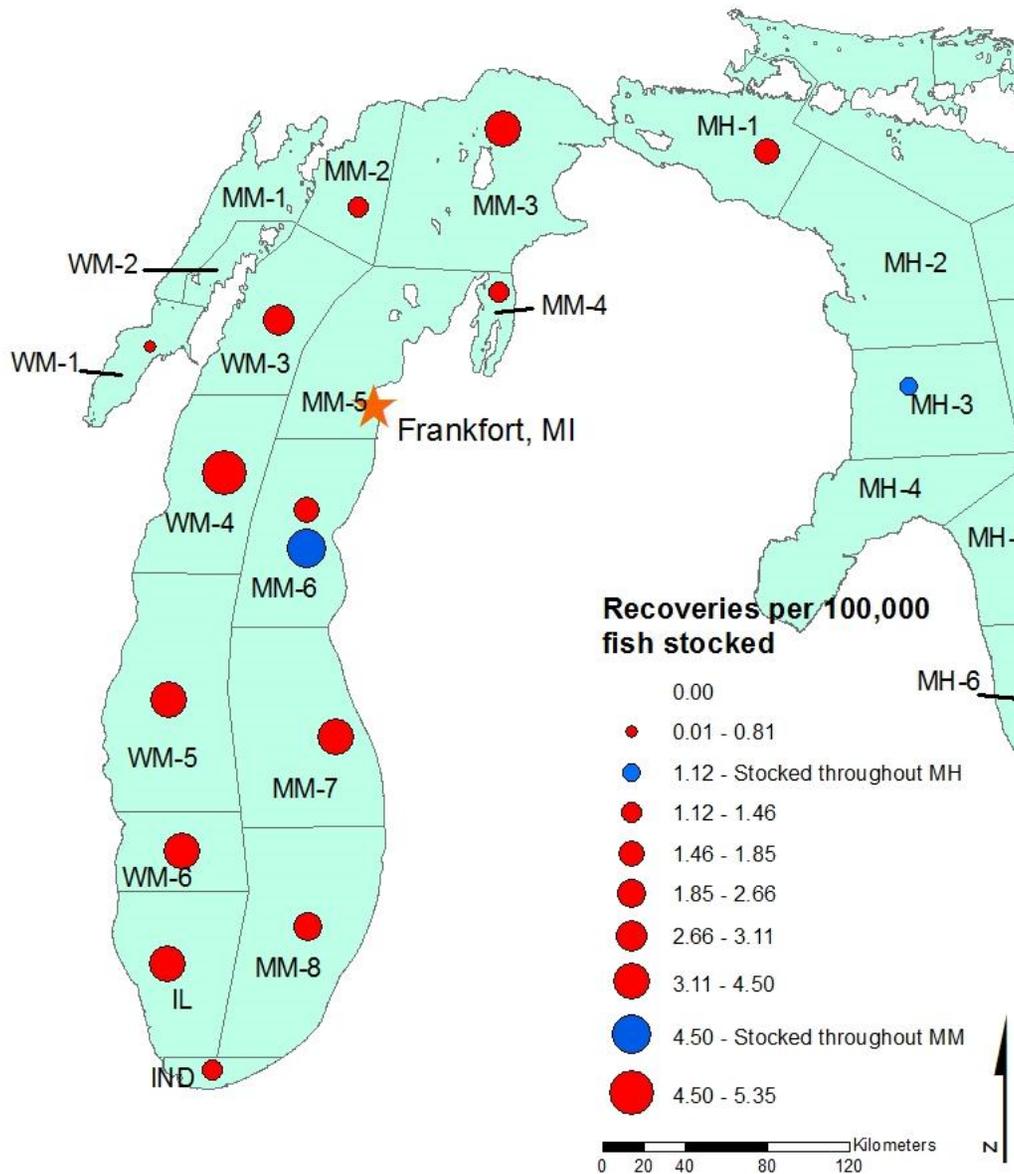


Distance from stocking district for open-water recovered Chinook salmon

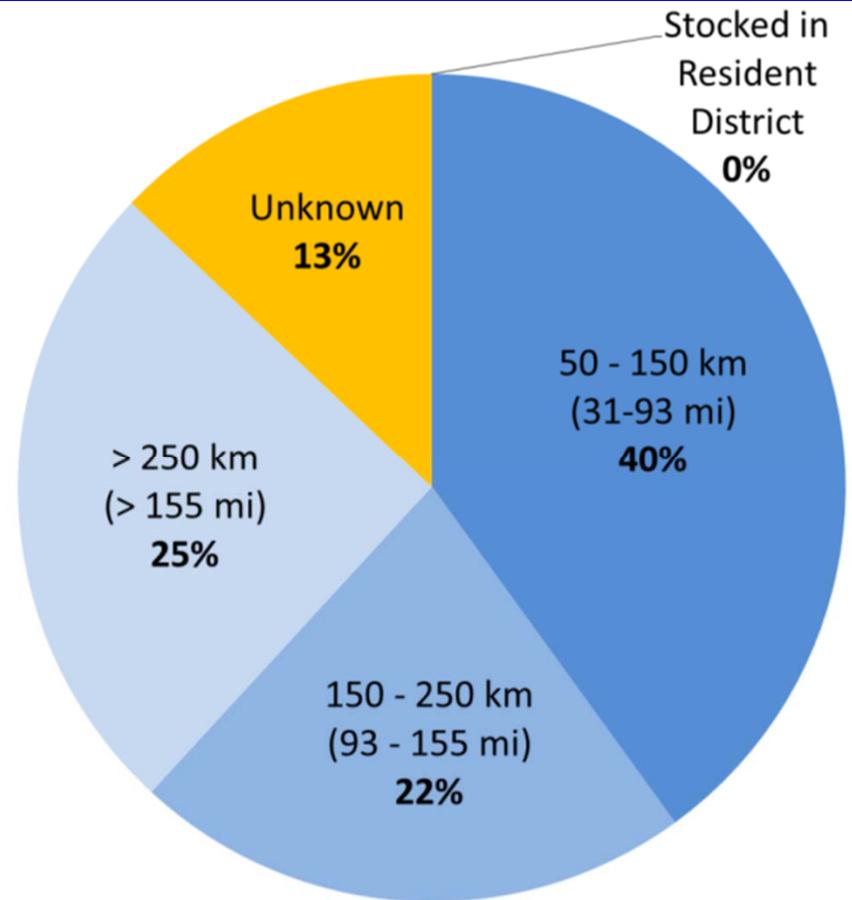


# Chinook Salmon Captured at Frankfort, MI

Origin of stocked Chinook Salmon captured during the open water fishery at Frankfort, MI (2012-2014)

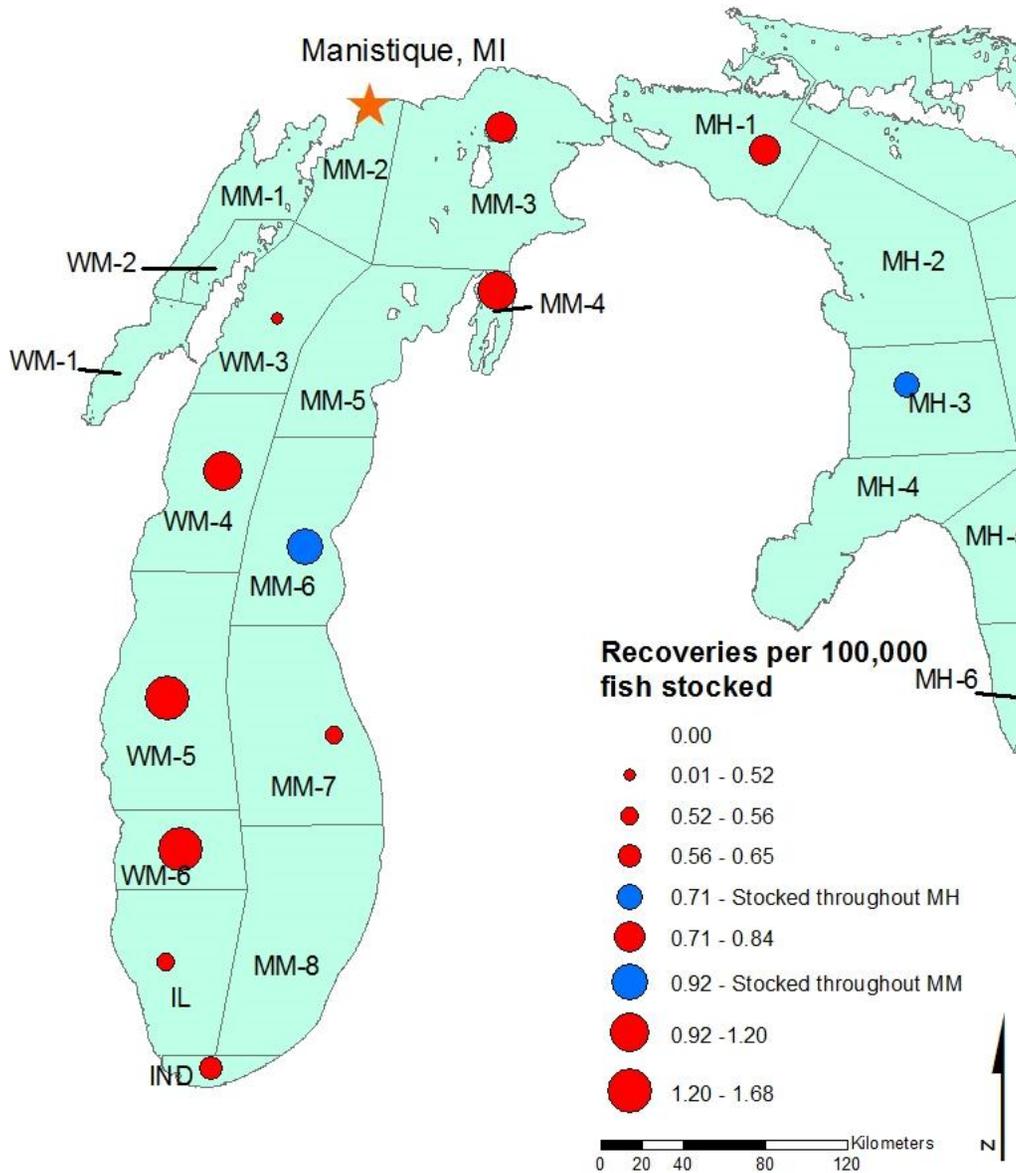


Distance from stocking district for open-water recovered Chinook salmon

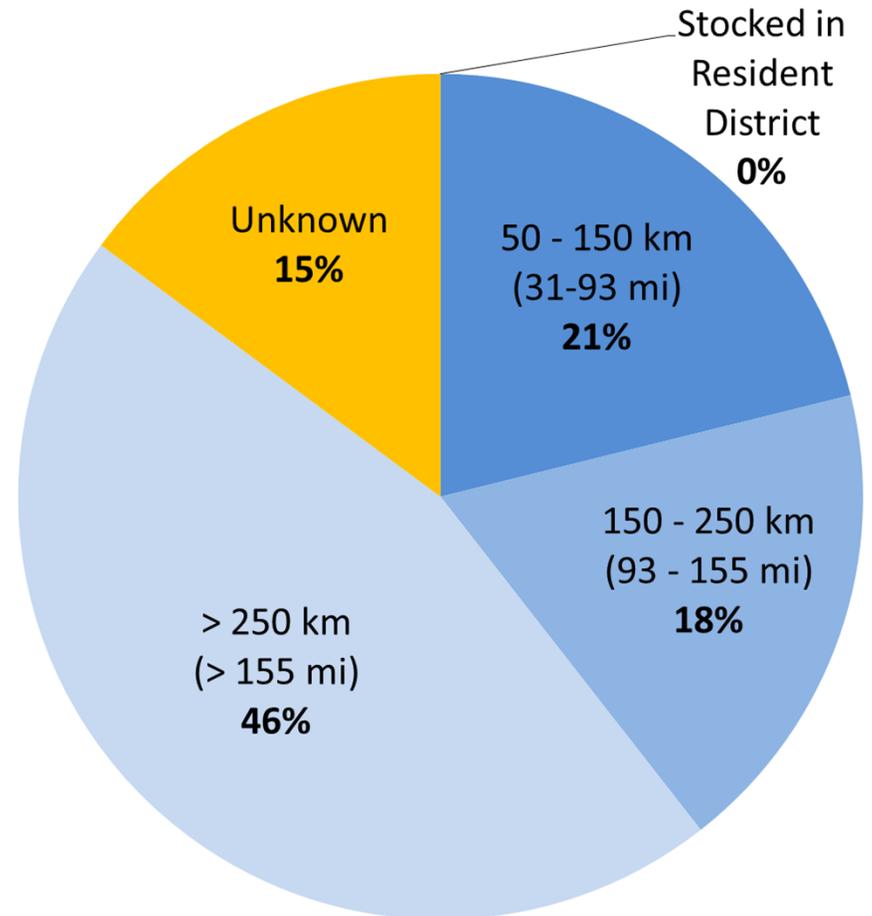


# Chinook Salmon Captured at Manistique, MI

Origin of stocked Chinook Salmon captured during the open water fishery at Manistique, MI (2012-2014)

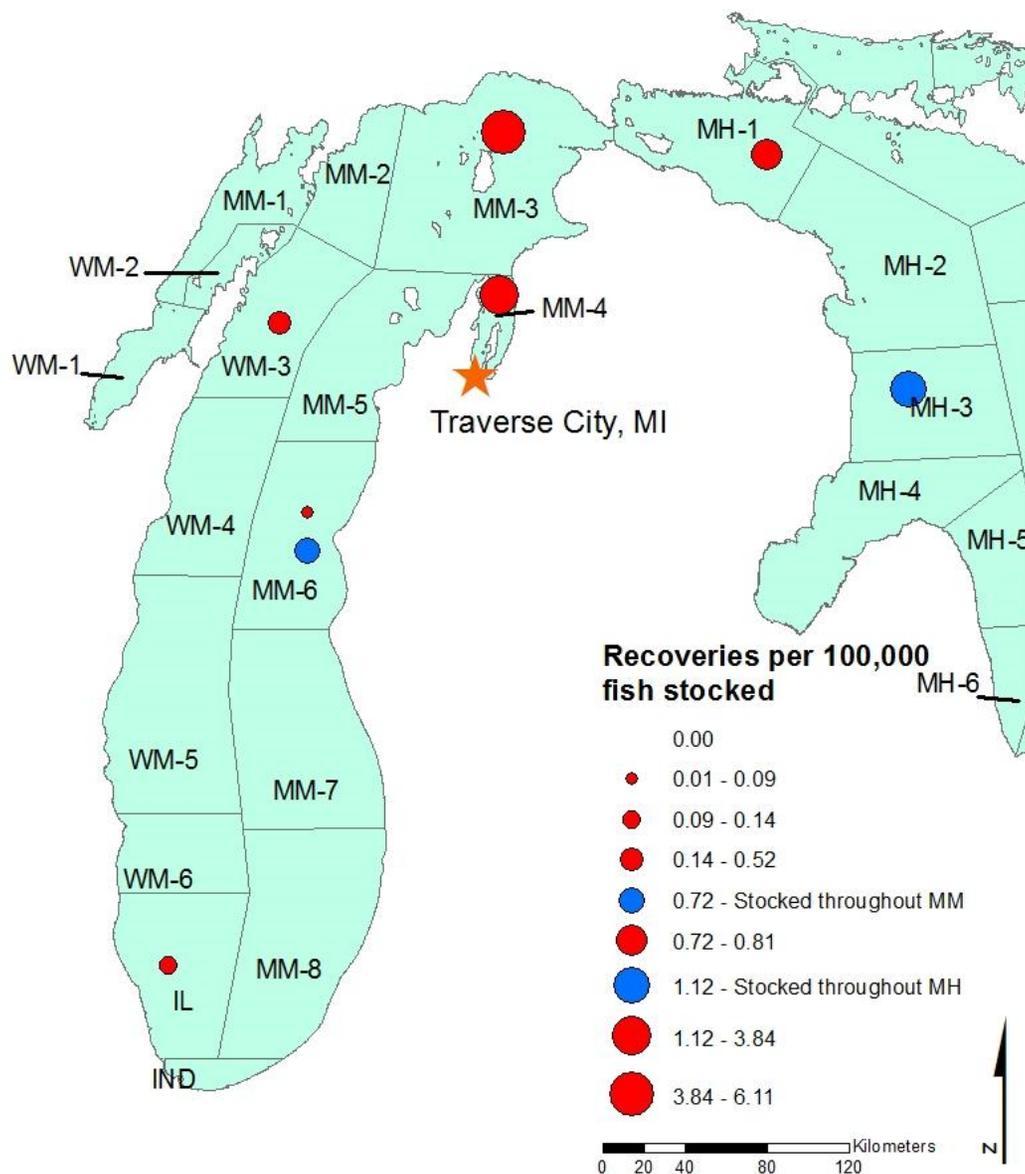


Distance from stocking district for open-water recovered Chinook salmon

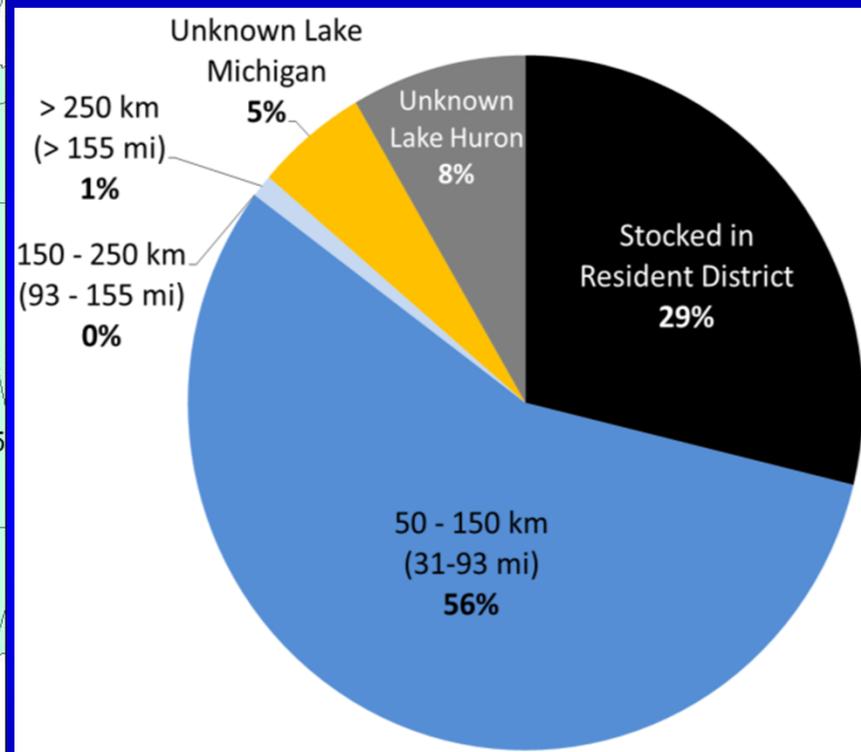


# Chinook Salmon Captured at Traverse City, MI

Origin of stocked Chinook Salmon captured during the open water fishery at Traverse City, MI (2012-2014)

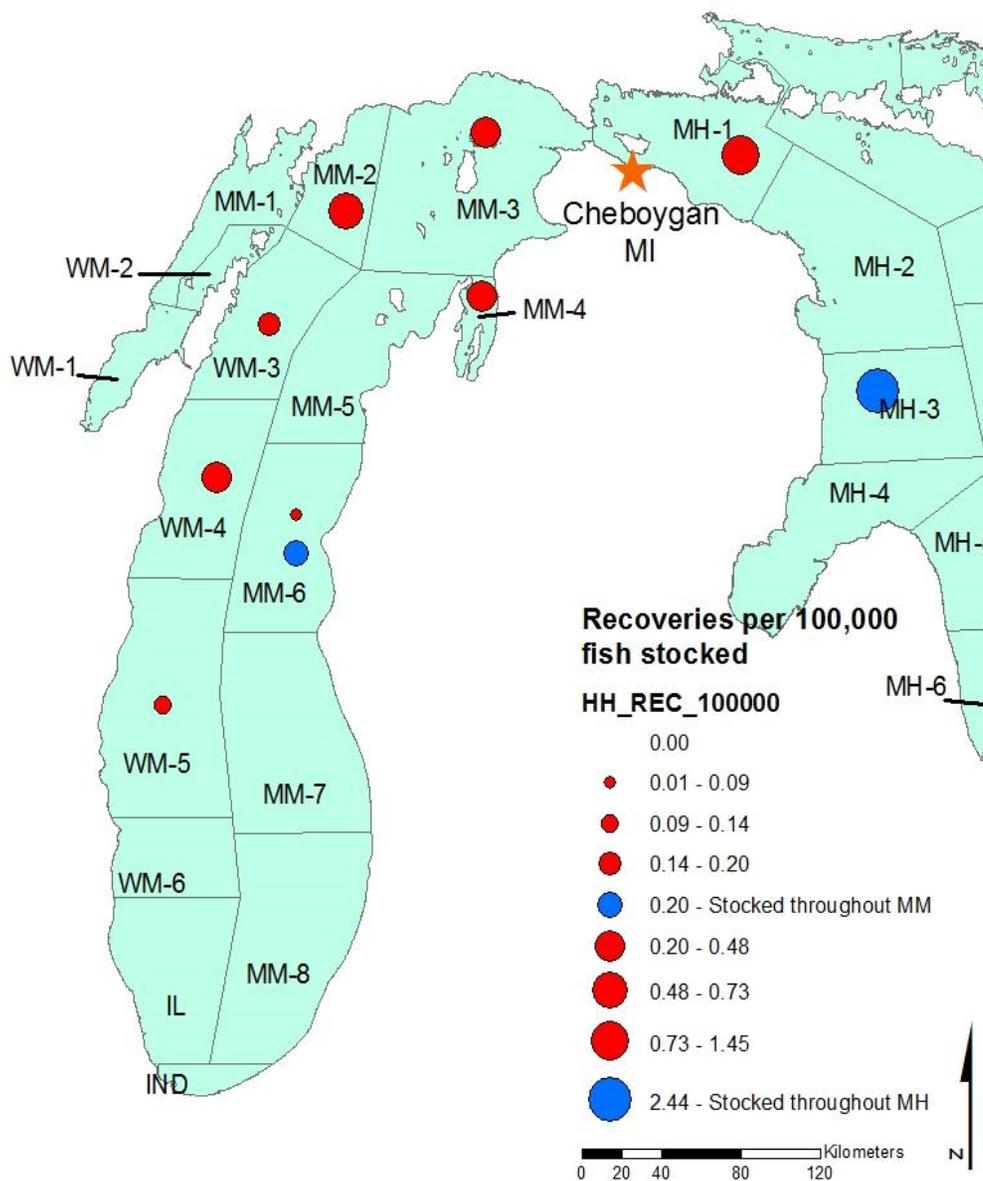


Distance from stocking district for open-water recovered Chinook salmon

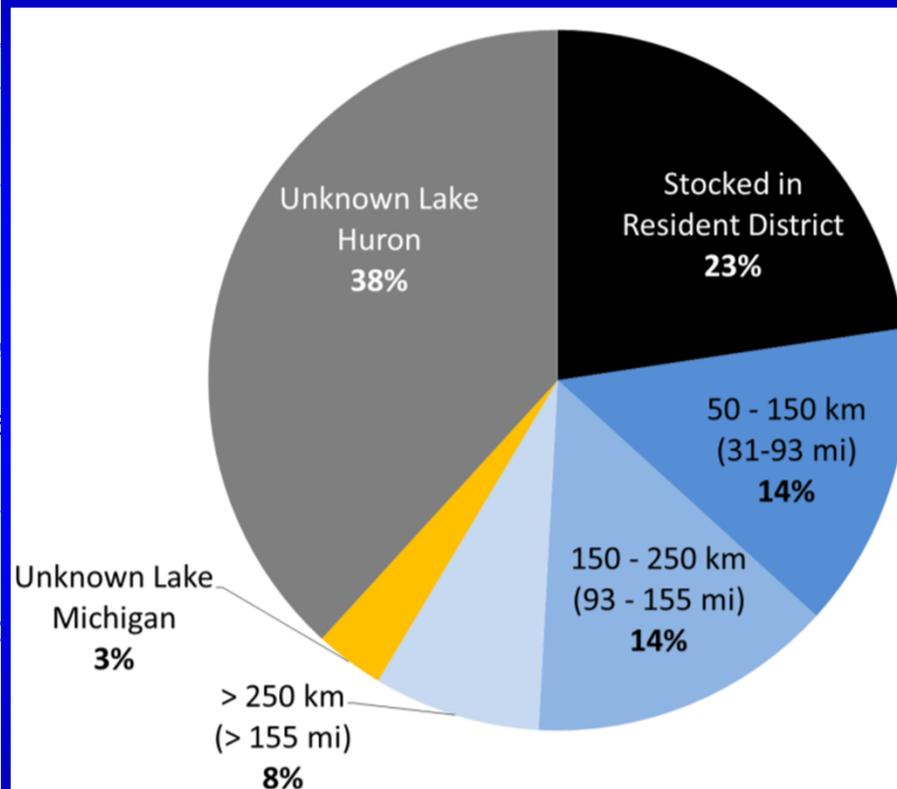


# Chinook Salmon Captured at Cheboygan, MI

Origin of stocked Chinook Salmon captured during the open water fishery at Cheboygan, MI (2012-2014)

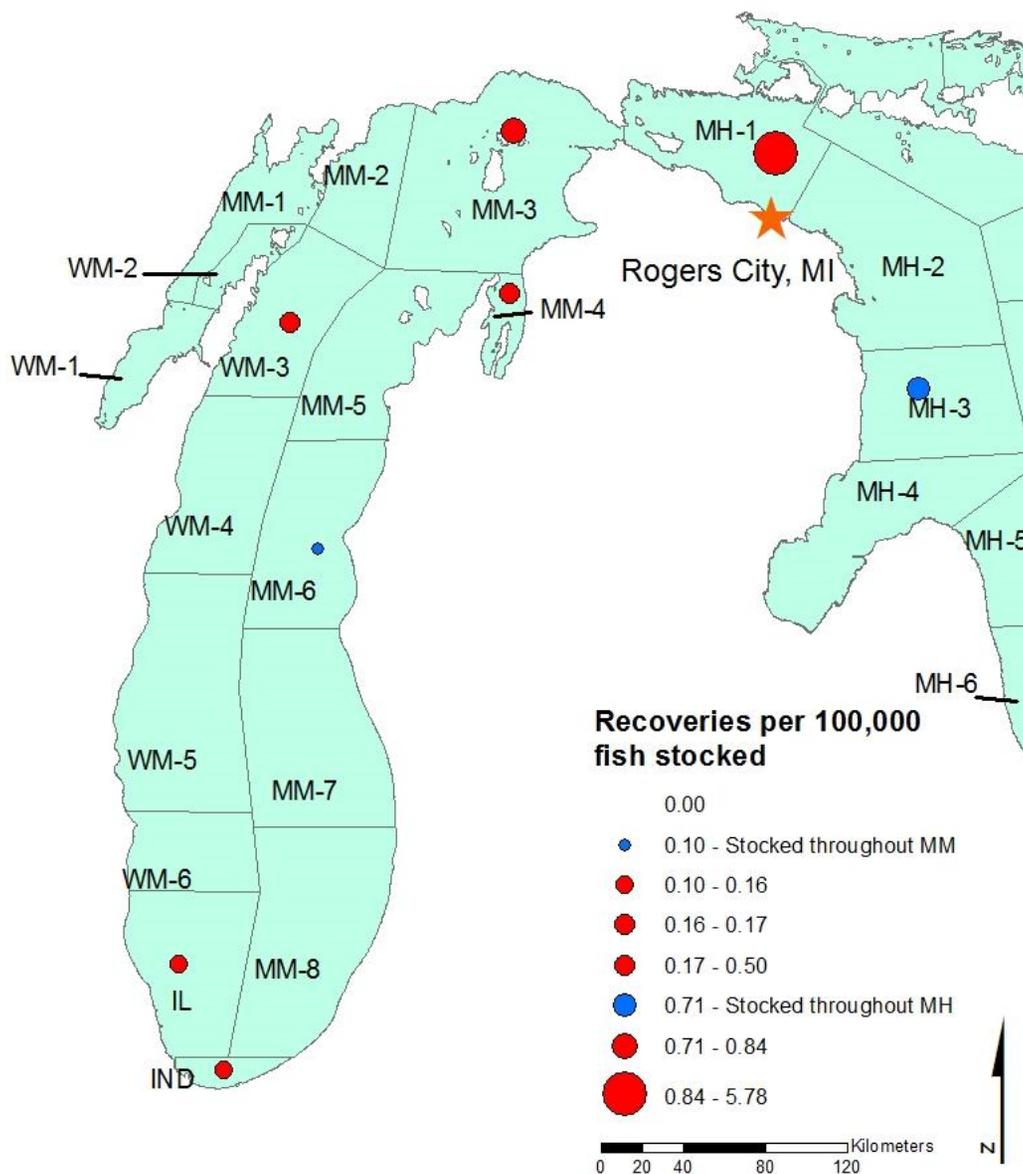


Distance from stocking district for open-water recovered Chinook salmon

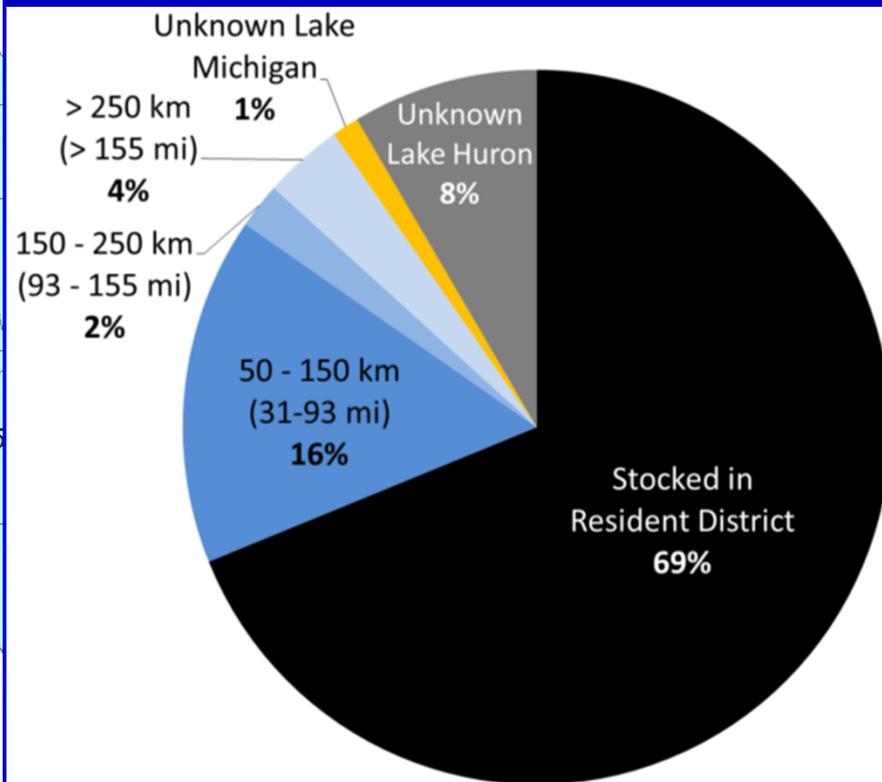


# Chinook Salmon Captured at Rogers City, MI

Origin of stocked Chinook Salmon captured during the open water fishery at Rogers City, MI (2012-2014)



Distance from stocking district for open-water recovered Chinook salmon



# Chinook Salmon Movement Between Lakes Michigan and Huron



# Net Movement from Lake Huron to Lake Michigan

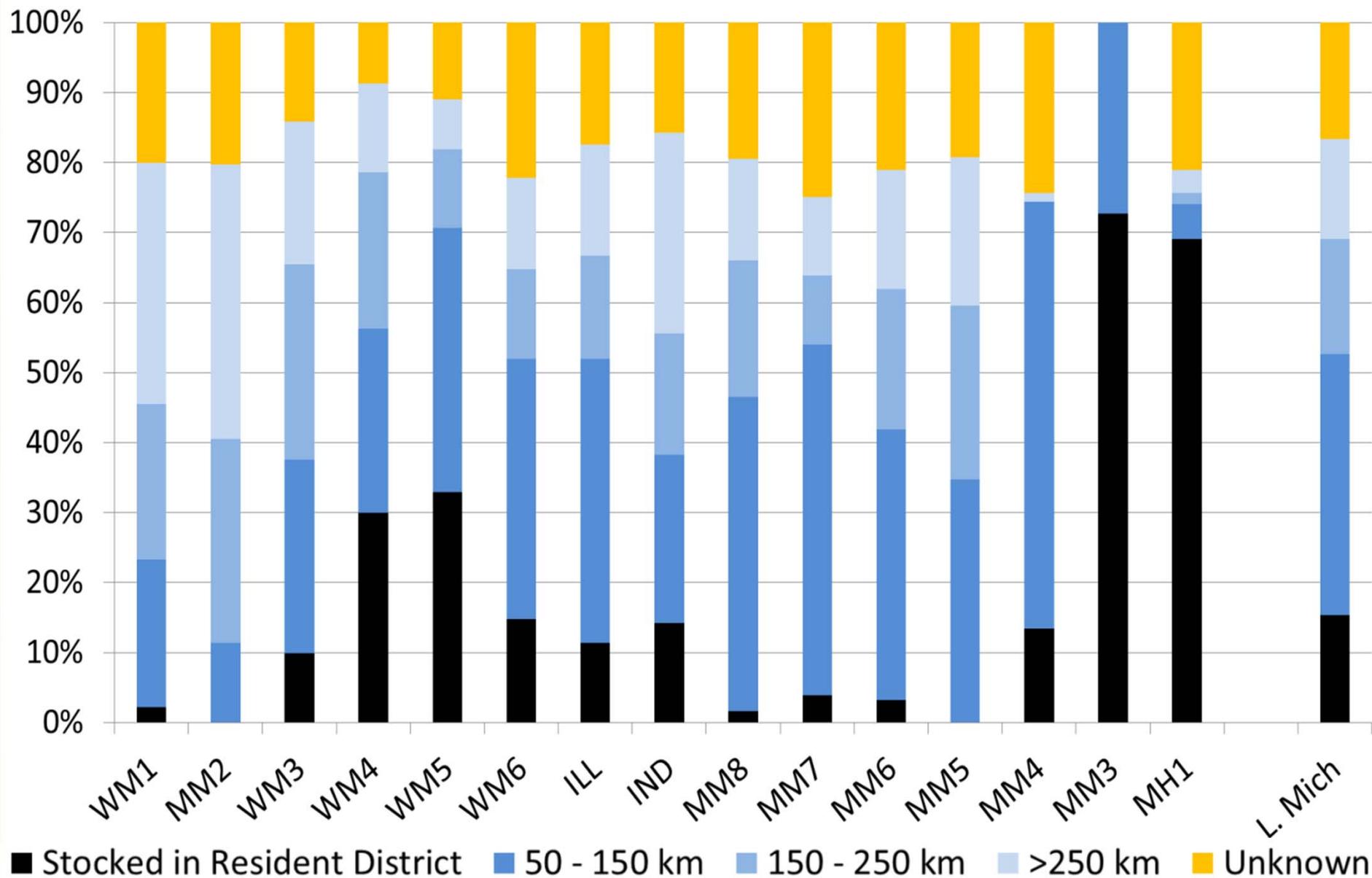
All values from April-August only

- 26.2 fish / 100,000 stocked in Lake Huron were recovered in Lake Michigan
- 0.3 fish / 100,000 stocked in Lake Michigan were recovered in Lake Huron
- 88.6% of fish that were stocked in Lake Huron were recovered in Lake Michigan
- 0.3% of fish that were stocked in Lake Michigan were recovered in Lake Huron
- 11.0% of fish recovered from Lake Michigan (679/6180 recoveries) were stocked in Lake Huron
- 15.5% of fish recovered from Lake Huron (16/103 recoveries) were stocked in Lake Michigan

# Overall Chinook Salmon Movement Patterns - Summary



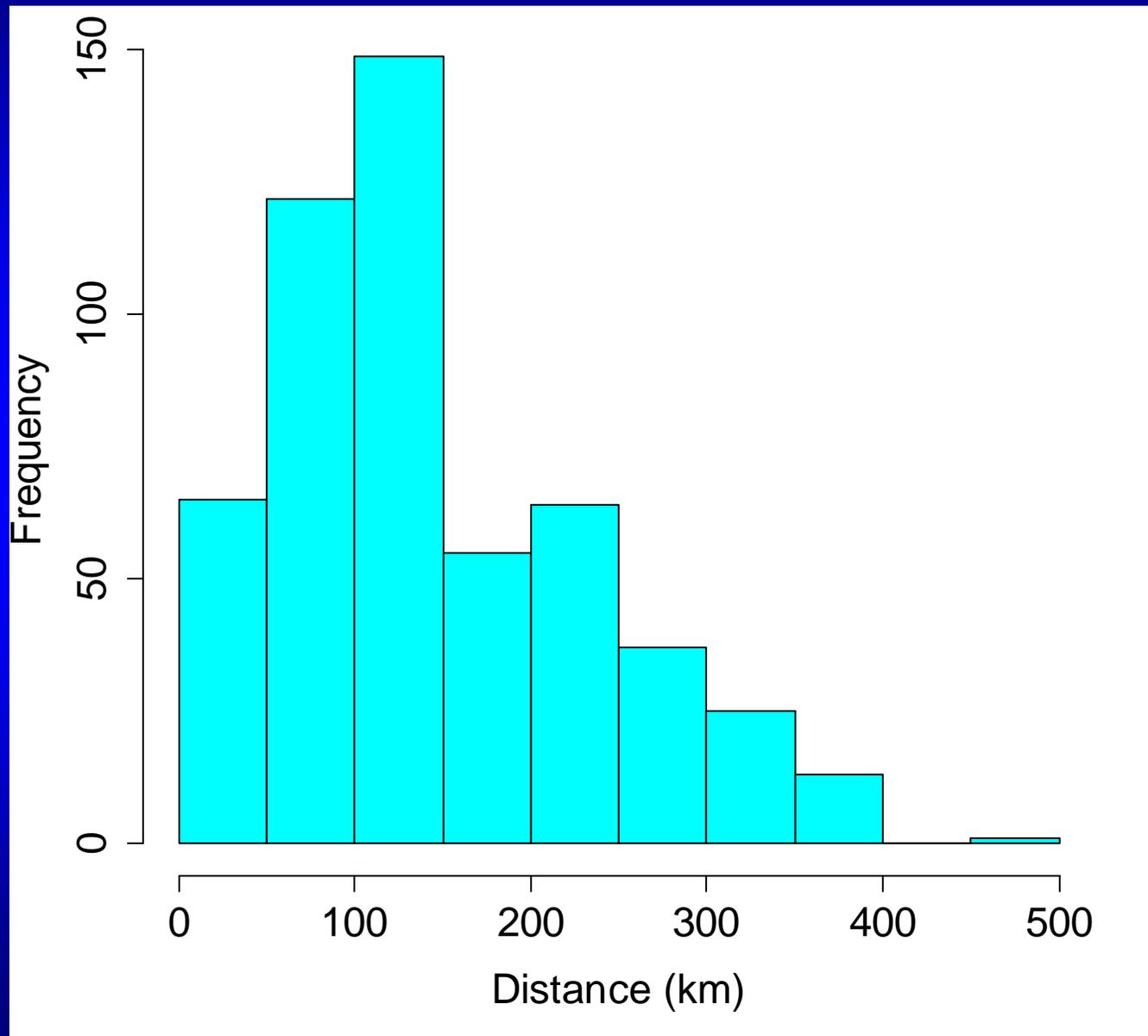
# Distance From Stocking District for Open-Water Recovered Chinook Salmon (2012-2014 Pooled), Ordered by Geography



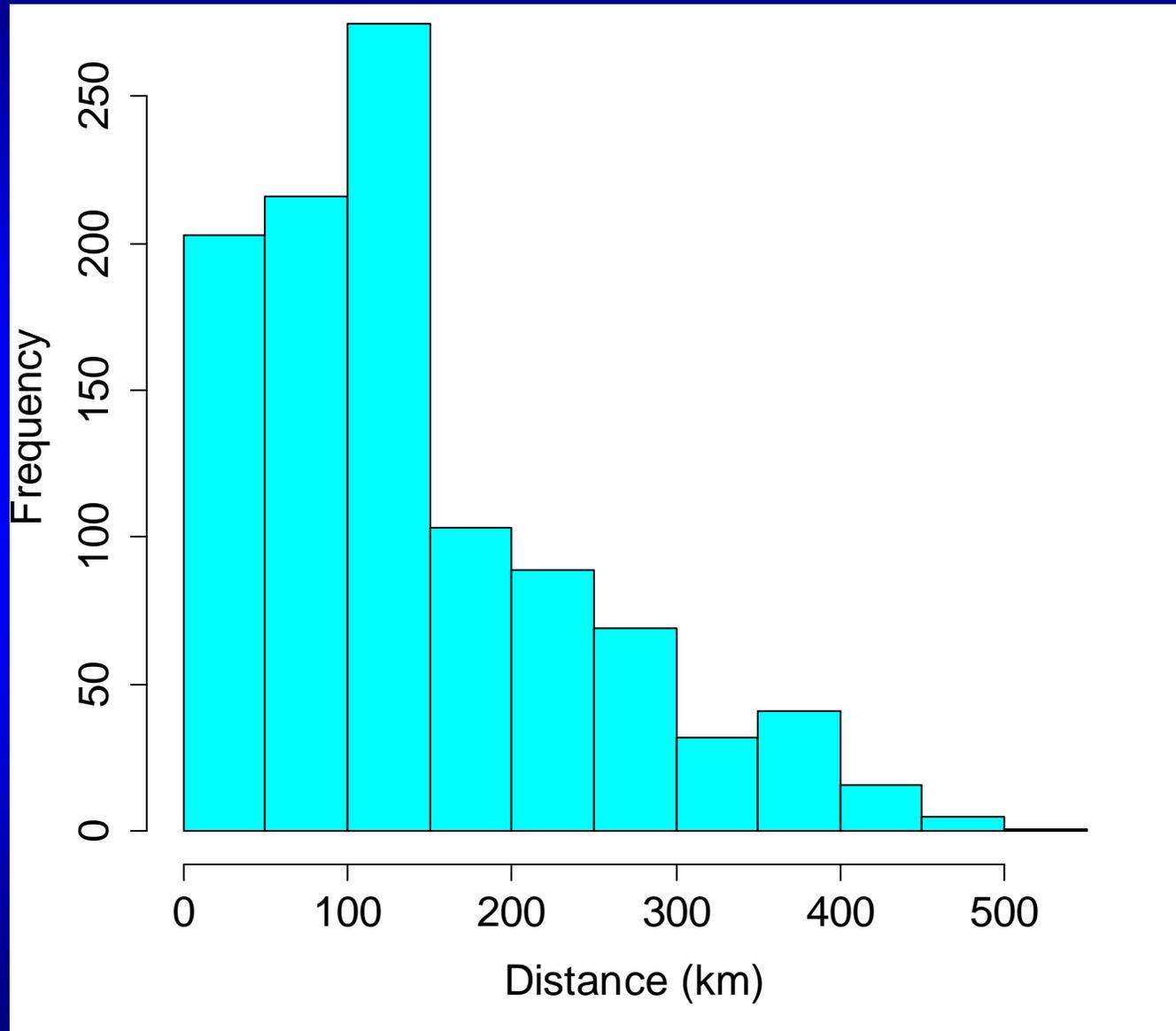
## Average Distance From Stocking District for Open-Water Recovered Chinook Salmon

Year Class and Age	Average Distance Between Stocking and Recovery Districts
2011 Age 1	141
2011 Age 2	134
2011 Age 3	117
2012 Age 1	146
2012 Age 2	151
2013 Age 1	142

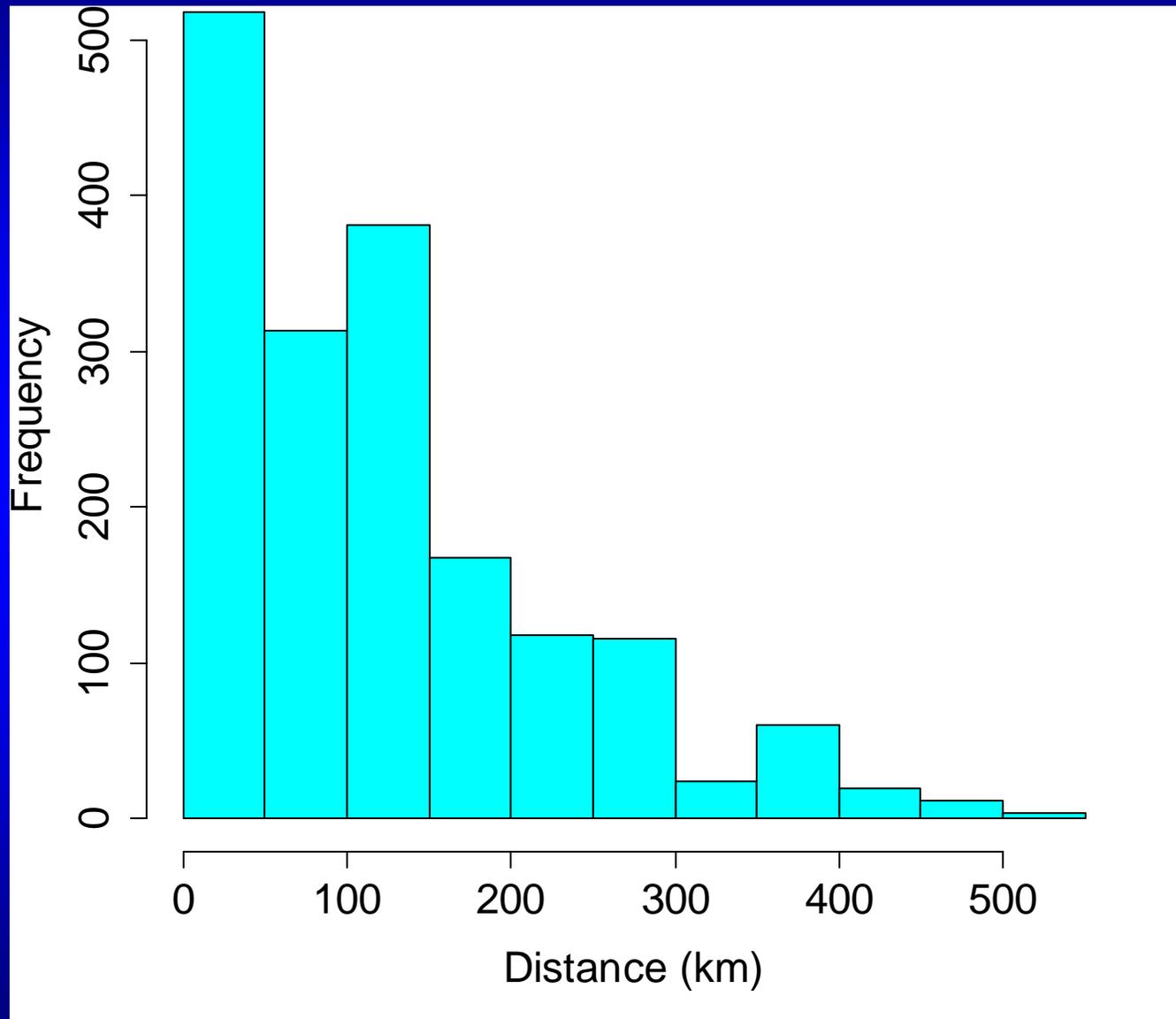
# Distance-Frequency Distribution of the 2011 Year Class at Age 1



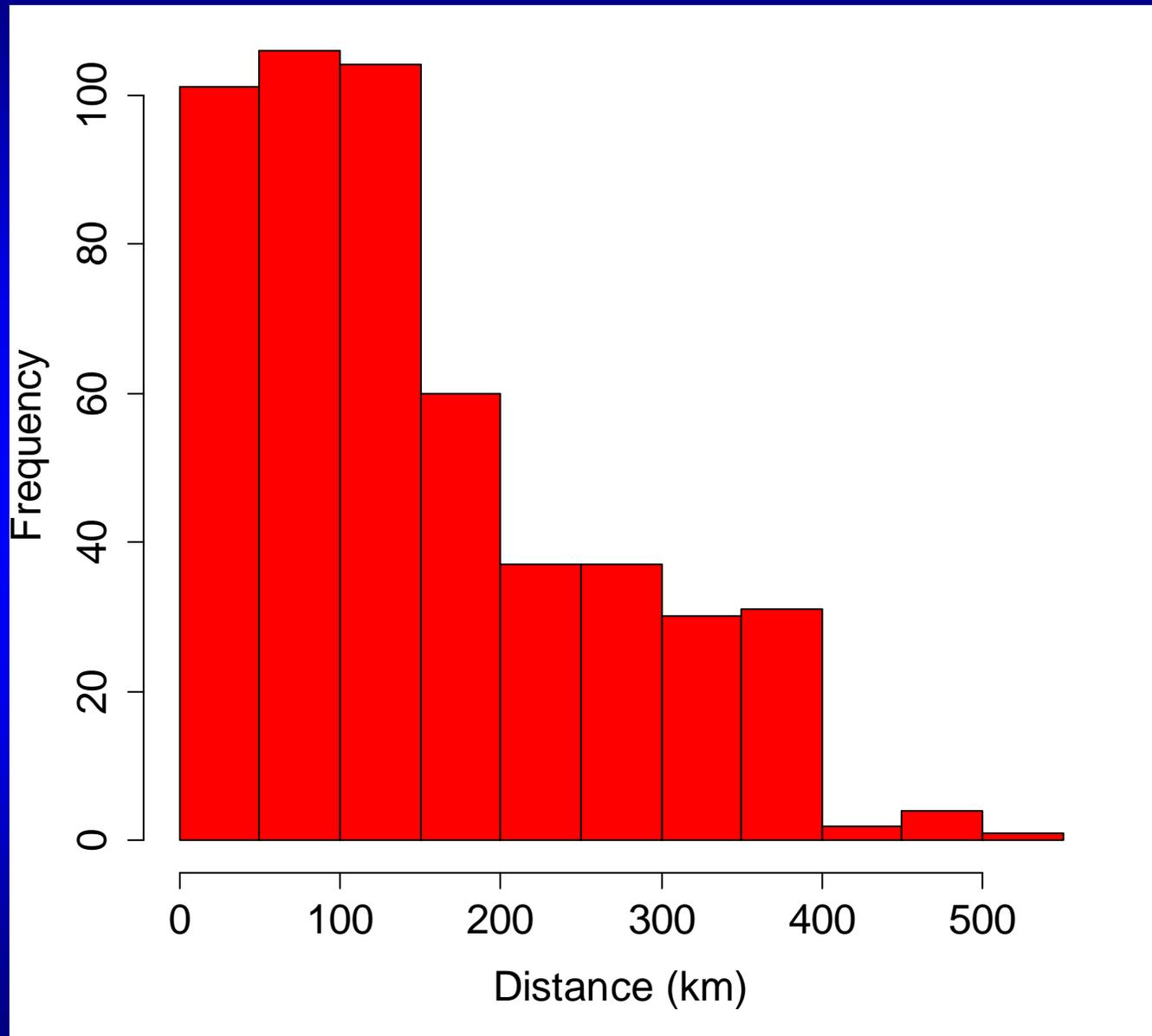
## Distance-Frequency Distribution of the 2011 Year Class at Age 2



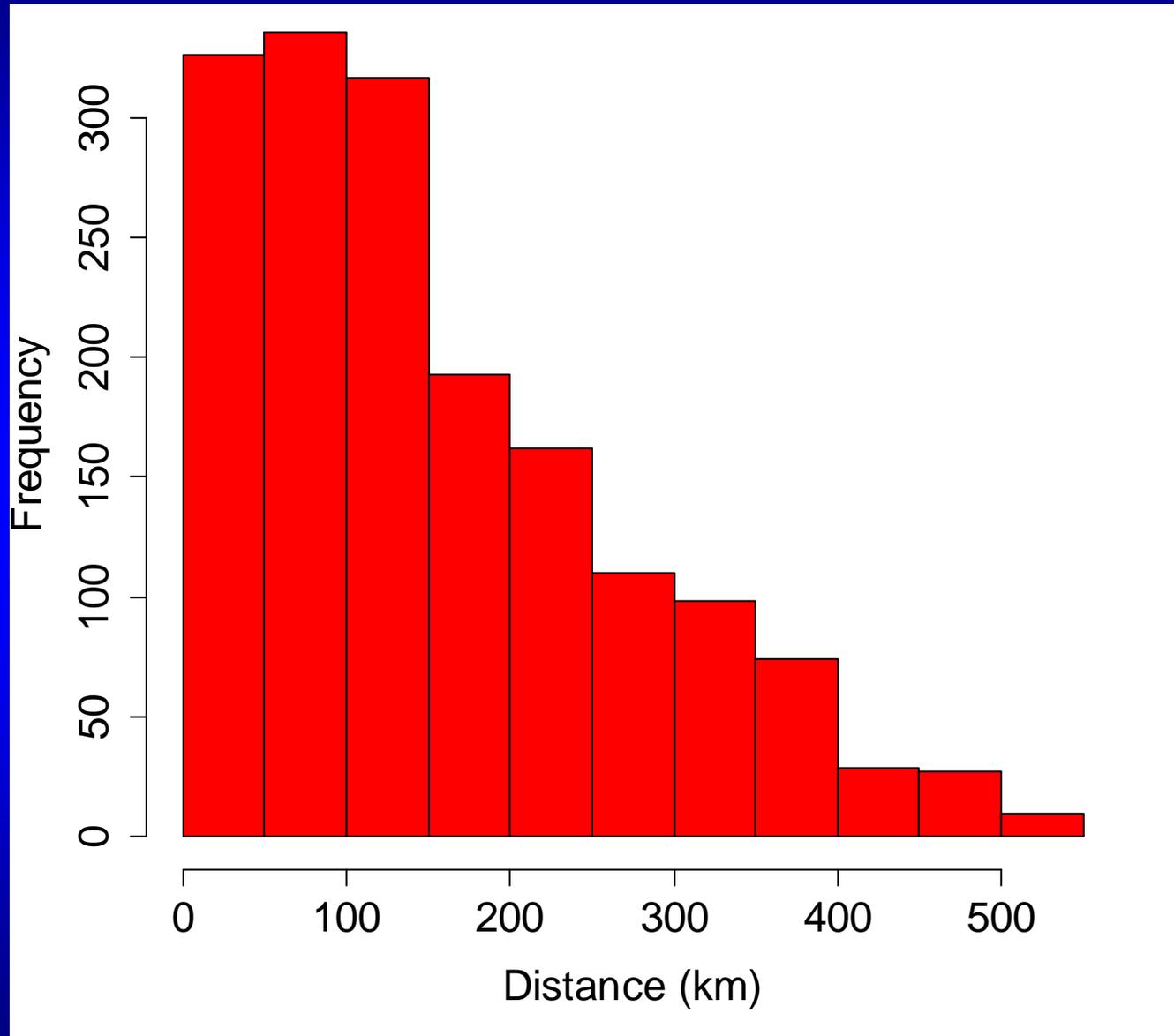
# Distance-Frequency Distribution of the 2011 Year Class at Age 3



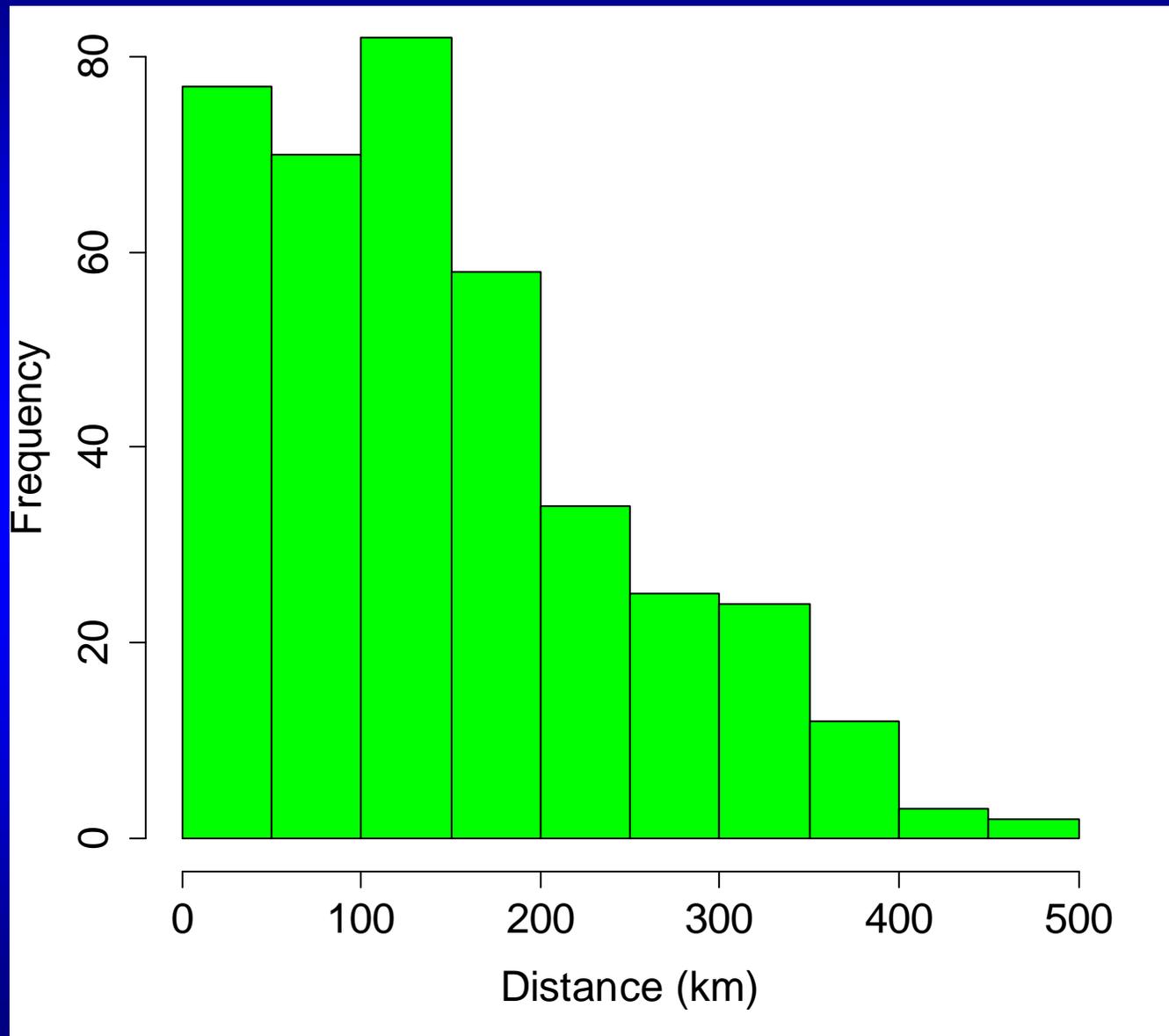
# Distance-Frequency Distribution of the 2012 Year Class at Age 1



## Distance-Frequency Distribution of the 2012 Year Class at Age 2



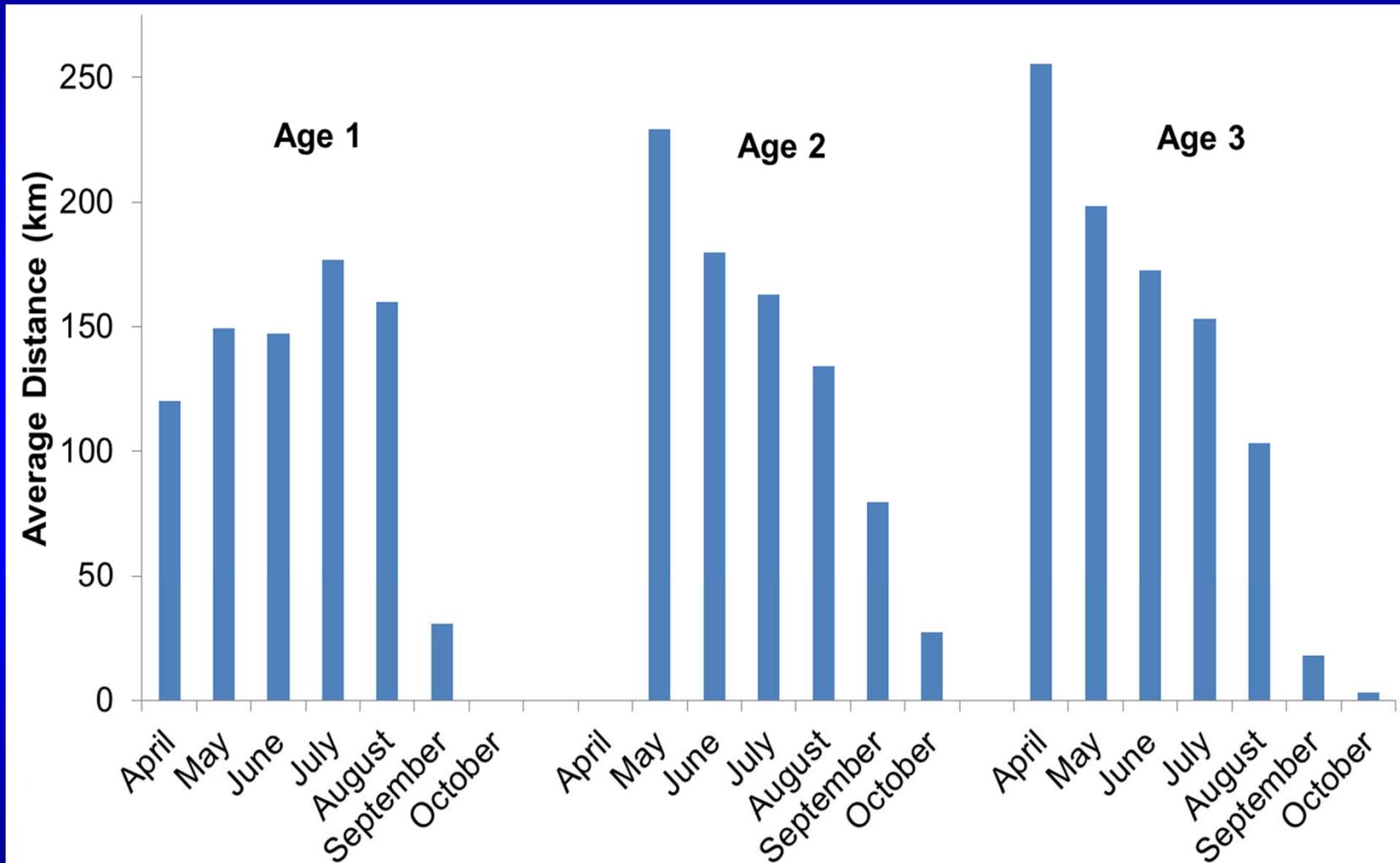
# Distance-Frequency Distribution of the 2013 Year Class at Age 1



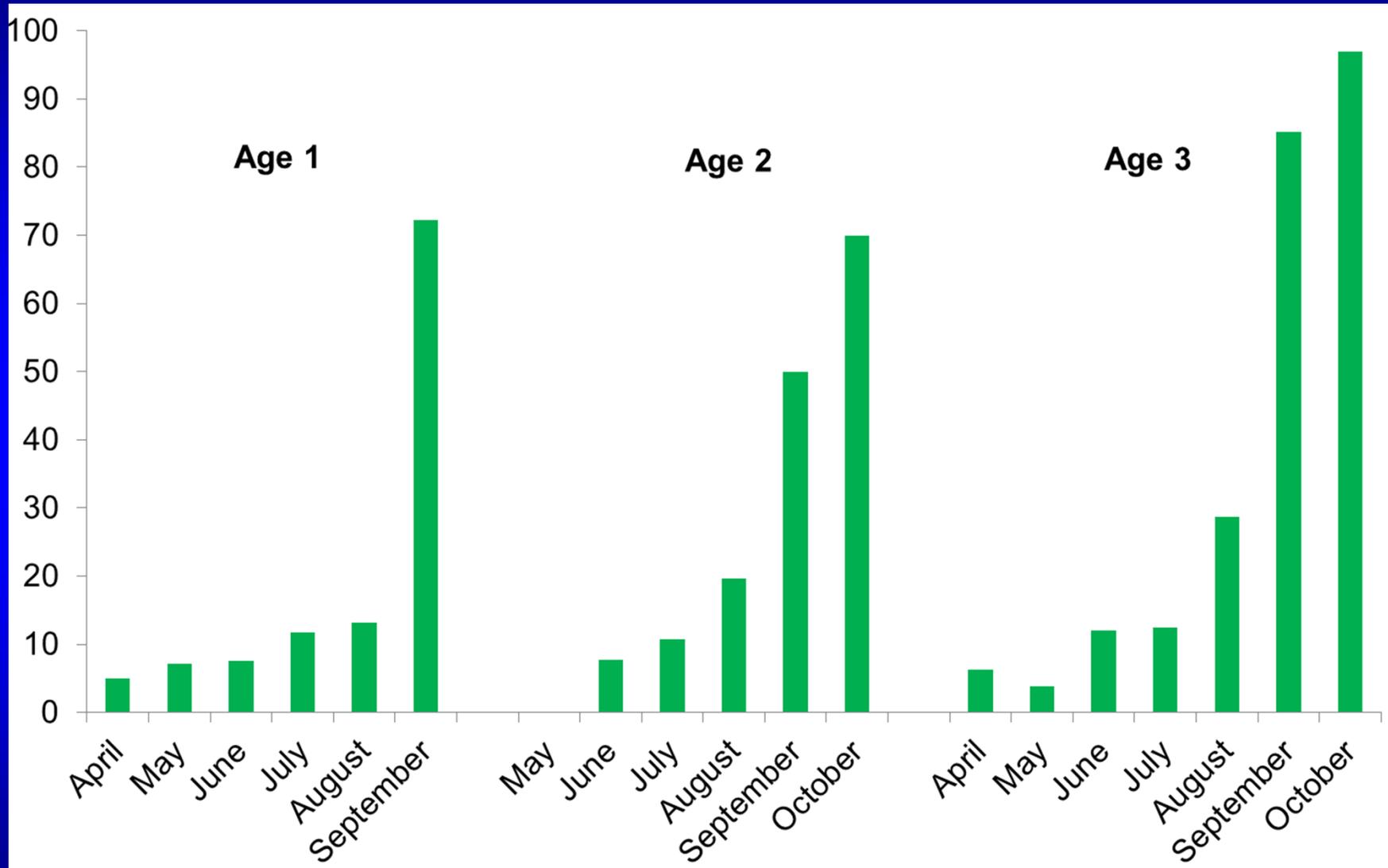
# Chinook Salmon Movement Patterns by Month (2011 Year Class Only)



# Average Distance Between Stocking and Recovery District for Chinook Salmon of the 2011 Year Class



# Percent of Chinook Salmon Recovered from Stocking District



## Other Mass Marking Related Studies (Added-Value Opportunities)

# Stable Isotopic Analysis of Lake Michigan Salmonines



- Stable isotope to determine salmonine trophic positions and primary energy sources.
- Addresses LM research priority regarding species-specific forage demands of the Lake Michigan salmonine community

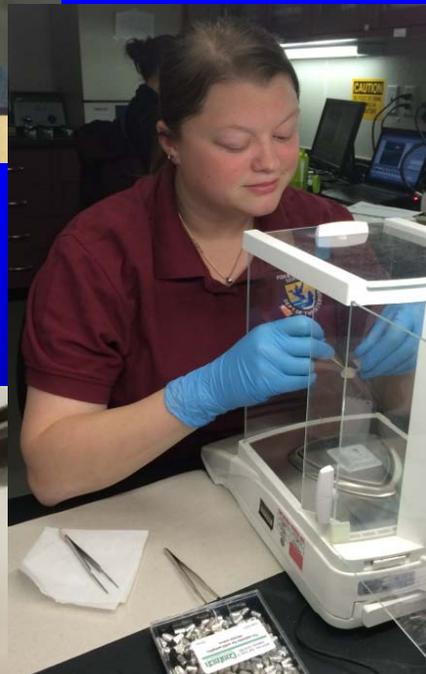
## Objectives

- Examining diet overlap among species
- Identify size- and region-specific patterns
- Identify potential differences between stocked and wild fish (lake trout and Chinooks only)
- Compare salmonine trophic position and niche overlap between altered (L. Michigan) and relatively intact (L. Superior) food webs

# Stable Isotopic Analysis of Lake Michigan Salmonines



- Muscle tissue collections took place in 2014
- Drying and encapsulation of samples nearly complete!
- Will be sent out for analysis of C and N this spring



# Lamprey Wounding in Lake Michigan

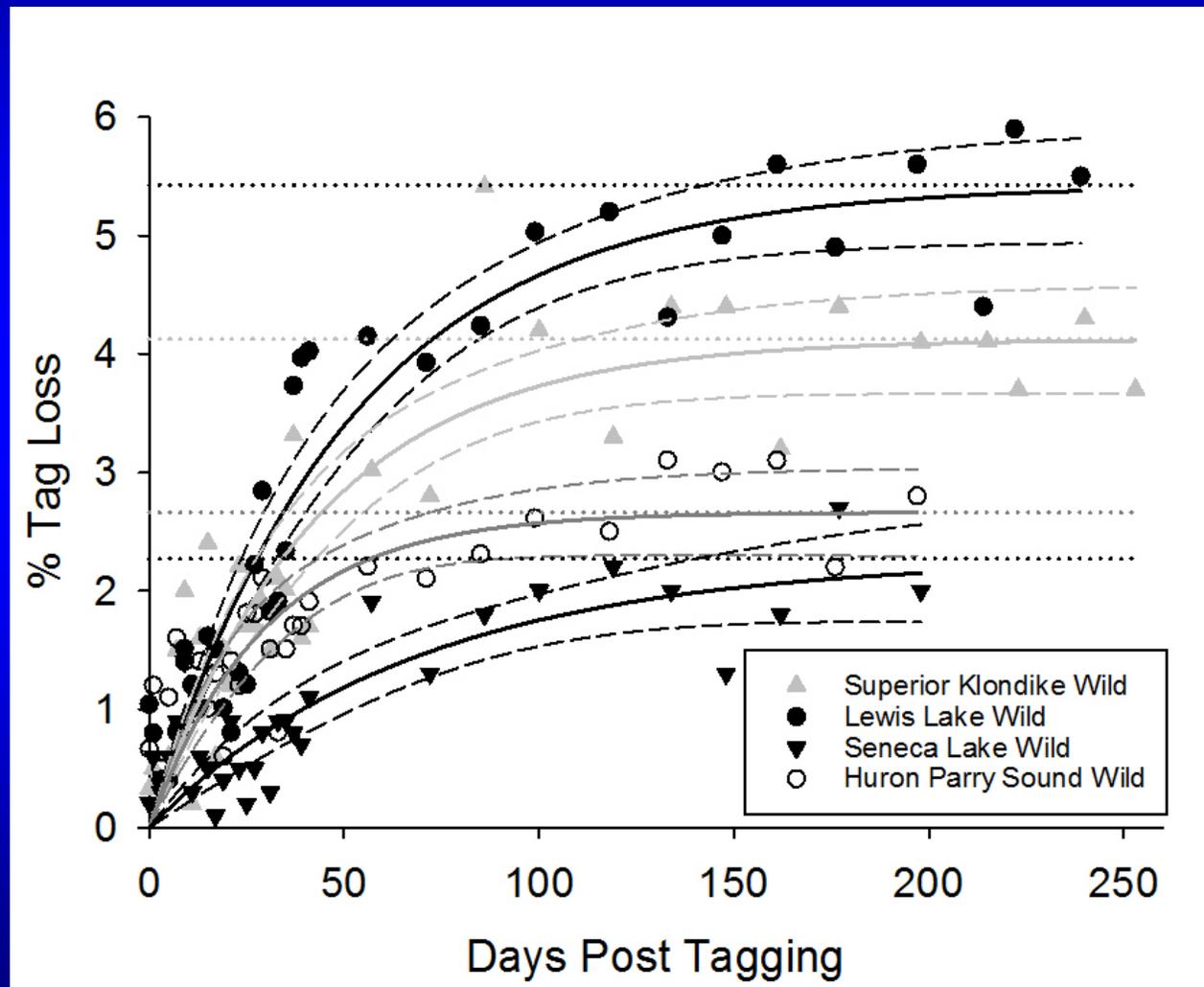
Species	No. Examined for Wounds	A1, A2, A3 wounds
Chinook Salmon	6,618	49 (0.7%)
Coho Salmon	2,616	12(0.5%)
Lake Trout	2,213	82(3.7%)
Rainbow Trout	1,571	4 (0.3%)
Brown Trout	284	1 (0.4%)

## Coded Wire Tag Retention in Automatically Tagged Lake Trout

- Affects estimates of number of fish stocked
- Stable after about 30 days in Chinook and Coho salmon as well as brown and rainbow trout
- Not previously studied for auto-tagged lake trout

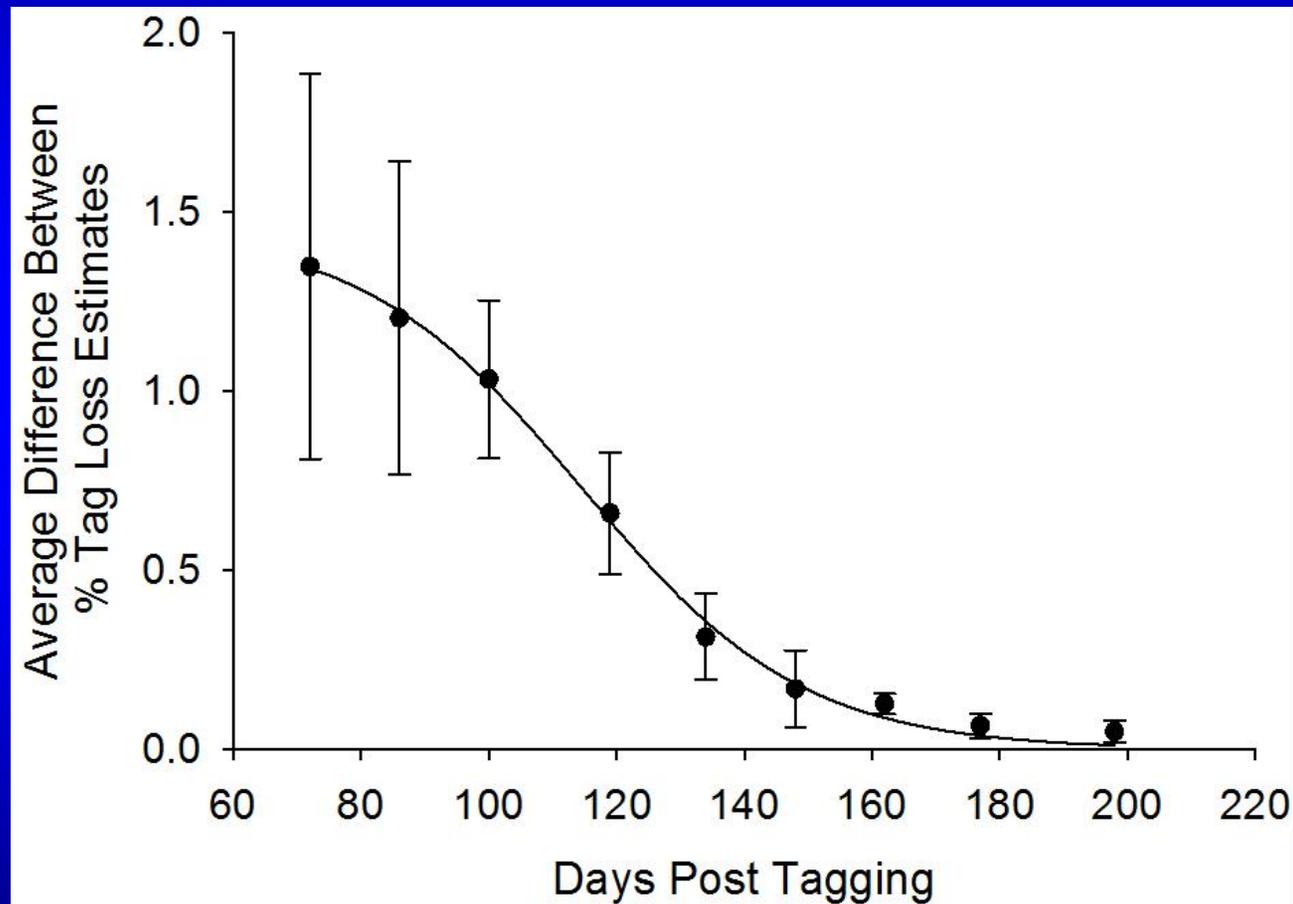
# Coded Wire Tag Retention in Automatically Tagged Lake Trout

- Stable after about 150 days in lake trout, with loss varying by tag lot (possible strain effect)



# Coded Wire Tag Retention in Automatically Tagged Lake Trout

- Can estimate time lag effect from a sigmoidal function
- Confidence greatest after 100 days post tagging



# Other Ongoing or Planned Collaborations

- Detailed assessment of Chinook salmon movement between Lakes Huron and Michigan (with Rick Clark, MSU)
- Evaluating how energy source and trophic position interact to influence contaminant bioaccumulation in Great Lakes salmonines (with Dominic Chaloner (Notre Dame), Gary Lamberti (ND), Brandon Gerig (ND), and Rick Rediske (Grand Valley State University))
- Factors affecting post-stocking survival of lake trout: an analysis LWAP surveys 1998-present (multi-agency collaboration under the LTWG)
- Examination of Chinook salmon homing: frequency of rogue fish returning to weirs (multi-agency collaboration)
- Invited to present preliminary Mass Marking results at the 2015 IAGLR meeting on use of tags for monitoring movement and habitat use of aquatic species (multi-agency collaboration)

Questions