Inland Seas Angler

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Highlights of the Annual Lake Committee Meetings

Great Lakes Fishery Commission proceedings, Sault Ste. Marie, Ontario

This is the second of a series of annual special reports is an extensive summary of Great Lakes Region-wide activities. These lake committee reports are from the annual Lake Committee meetings hosted by the Great Lakes Fishery Commission in March/April 2018. We encourage reproduction with the appropriate credit to the GLSFC and the agencies involved. Our thanks to the the USFWS for their contributions to these science documents. Thanks also to the Great Lakes Fishery Commission, its staff, Bob Lamb & Marc Gaden, in again convening and hosting the Lower Lake Committee meetings in Sault Ste. Marie**,** Ontario.

Great Lakes Regional News

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Abbreviation	**Expansion**
ADCWT	Adipose fin clip/coded wire tag
CLC	Council of Lake Committees
CPH	Catch per hectare
CPUE	Catch per unit effort
CWT	Coded Wire Tag
DEC	NY Dept. of Environment Conservation
DFO	Dept. of Fisheries and Oceans
MDNR	MI Dept. of Natural Resources
IL DNR	IL Dept. of Natural Resources
ODNR	Ohio Dept. of Natural Resources
OMNRF	ON Ministry of Natural Resources
USFWS	U.S. Fish and Wildlife Service
YAO	Age 1 and older
YOY	Young of the year (age 0)

Highlights

- 3.8 million **lake trout,** 2.8 million steelhead, & 2.1 million Chinook salmon were fin clipped in 2017
- > 98.3% of **Chinook salmon, lake trout, and steelhead** were successfully clipped or tagged in the hatcheries
- In 2017, 57% of **lake trout** recovered in Lake Huron had no fin clip and were presumed wild
- 26% of **lake trout** recovered in Lake Michigan had no fin clip
- 71% recovered in Lake Huron outside of district MH1 were without a fin clip and presumed to be wild
- During April – August 2016, 95% of **Chinook** stocked in Lake Huron were recovered in Lake Michigan
- Using the automated trailers, the USFWS tagged and/or clipped a total of 2,130,882 **Chinook salmon**
- For 2018, the Service is preparing to stock approximately 3,510,000 **yearling lake trout** into the Great Lakes,
- **For the first time ruffe were captured in the St. Marys River offshore of Brimley State Park in Michigan**.

Great Lakes Mass Marking Program 2018 Updates, (USFWS)

The Great Lakes Mass Marking Program is a collaboration between federal, state and tribal fisheries agencies, coordinated by the U.S. Fish and Wildlife Service, to answer questions critical for Great Lakes fisheries management.

2017 Tagging and marking activities

- 3.8 million lake trout, 2.8 million steelhead, & 2.1 million Chinook salmon were fin clipped in 2017; most of the lake trout and steelhead, and 0.5 million of the Chinook salmon, were also coded-wire tagged.
- < 0.5 million each of Atlantic salmon, coho salmon, brown trout, and brook trout were also marked in 2017
- > 98.3% of Chinook salmon, lake trout, and steelhead were successfully clipped or tagged in the hatcheries
- Ave. throughputs were 8,361, 7,627, and 7,030 fish/hr for Chinook salmon, lake trout and steelhead respectively.

2017 Data and tag recovery activities

- In 2017, Fish and Wildlife Service bio-technicians stationed on Lakes Michigan and Huron, working with the states, sampled 40 ports and examined 10,474 salmonines, including 3,657 Chinook salmon and 2,819 lake trout.
- Over 90,000 coded-wire tags have been recovered since the inception of the project.

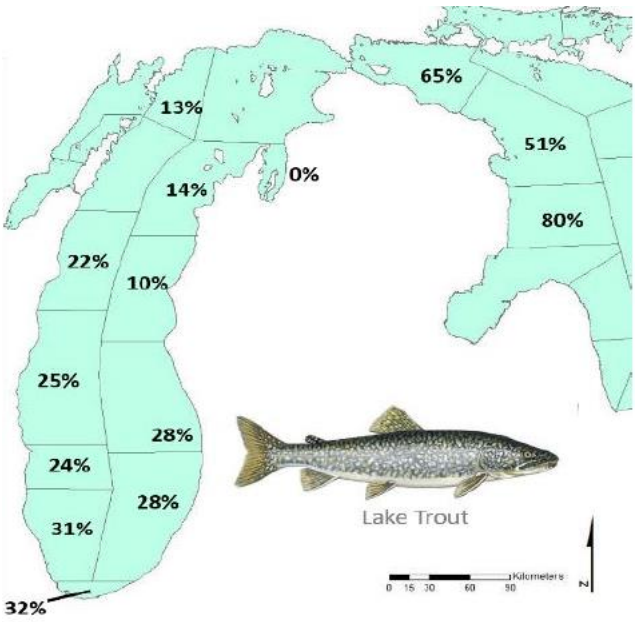

Fig. 1: Percent of lake trout recovered without a fin clip and presumed wild in each district in 2017.

2017 Estimated contributions of wild lake trout to fisheries in Lakes Michigan and Huron

- In 2017, 57% of lake trout recovered in Lake Huron had no fin clip and were presumed wild (Fig. 1).
- 26% of lake trout recovered in Lake Michigan had no fin clip; wild fish comprised a greater percentage of the catch in southern and western areas **(Fig. 1).**

2017 Estimated contributions of wild Chinook salmon to fisheries in Lakes Michigan and Huron

- 67% of Chinook salmon (all ages) recovered in Lake Michigan and 71% recovered in Lake Huron outside of district MH1 were without a fin clip and presumed to be wild **(Fig. 2),** consistent with values from the past several years.

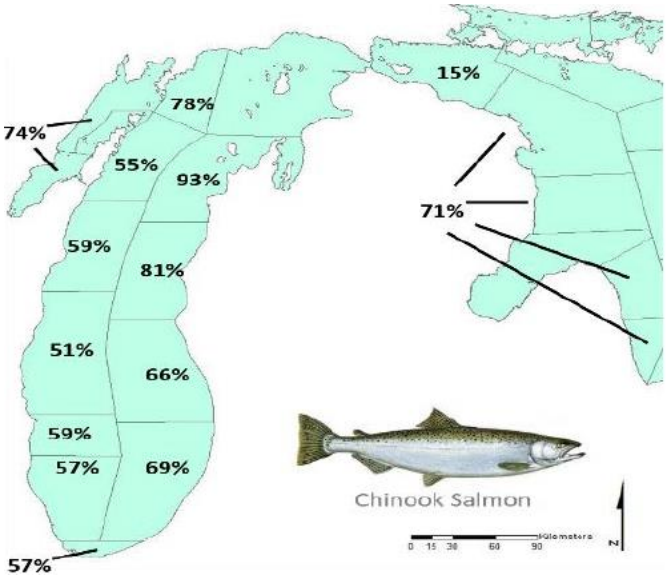

Fig. 2: Percent of Chinook salmon recovered without a fin clip and presumed wild.

- Estimated production of wild Chinook salmon from the 2016 year class was much greater than the weak 2013 and 2015 year classes and on par with most year classes from the mid- to late- 2000s (**Fig. 3;** blue bars are wild fish).

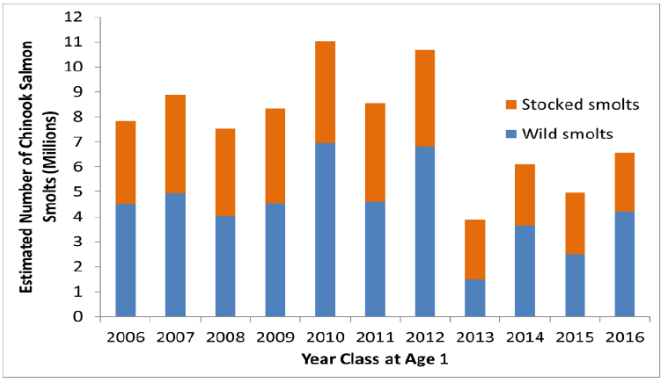

Fig. 3: Estimated number of wild and stocked Chinook salmon in the 2006 – 2016 year classes in Lake Michigan.

Estimated contribution of stocked Chinook salmon to the fishery by stocking district

▪ Chinook salmon stocked on the western shore of Lake Michigan have greater survival post-stocking than those stocked on the eastern shore and in Green Bay **(Fig. 4).** Even at eastern ports, fish stocked on the west shore tended to be caught the most (e.g., Frankfort, MI in **Fig. 8**). Analysis was based on Age 2-3 Chinook salmon, separately analyzed for the 2011-2014 year classes and corrected for sampling and stocking effort. Total of 10,399 fish.

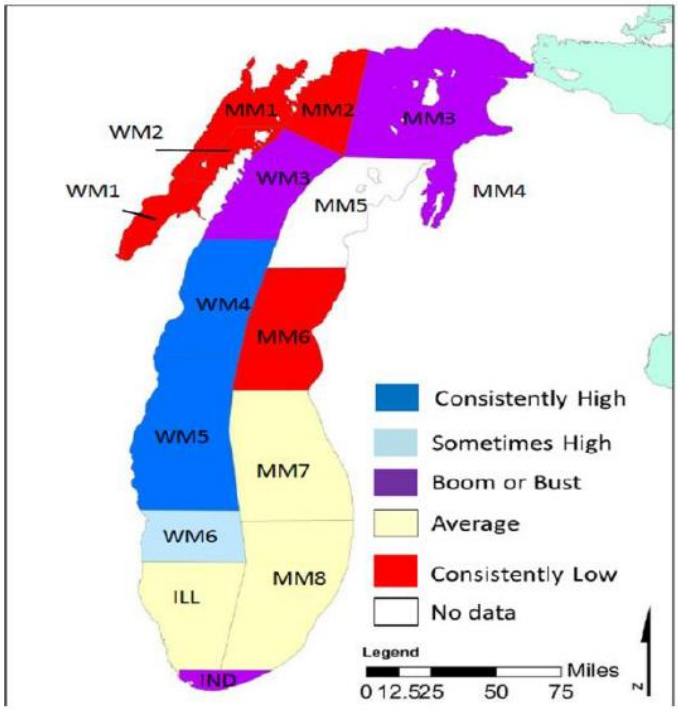

Fig. 4: Districts in which year classes consistently had high survival (dark blue); high survival of some year classes (light blue); average survival (yellow); highly variable survival depending on year class (purple); consistently low survival (red).

▪ Underlying mechanisms are unknown, but could include differences in habitat (e.g., water temperature, food availability) that make western shore locations favorable for young Chinook salmon; differences in rearing or release practices; or greater competition with wild Chinook salmon on the eastern shore.

Chinook salmon growth patterns

▪ Chinook salmon stocked on the western shore grew slightly faster than those stocked elsewhere, mirroring survival patterns, but overall growth differences were minor, consistent with lakewide mixing due to salmon movement post-stocking.

▪ Annual variability in Chinook salmon growth mirrored year-and-older alewife density**,** indicative of a limited food supply.

Chinook salmon movement patterns - between basins

▪ During April – August 2016, 95% of Chinook stocked in Lake Huron were recovered in Lake Michigan, consistent with values from prior years. 0% of Chinook stocked in Lake Michigan were recovered in Lake Huron over the same time period. Most mature Huron-stocked fish returned to Lake Huron in autumn to spawn.

▪ Chinook salmon move from Huron to Michigan with little reciprocal movement. Thus, most Chinook salmon stocked in Lake Huron are considered as part of the Lake Michigan population for the purposes of the predator-prey ratio model, which is used to help maintain balance between predator and prey biomass in Lake Michigan.

Chinook salmon movement patterns – within Lake Michigan

▪ In the open-water fishery, over 90% of Chinook salmon were harvested in a different statistical district then where they were stocked during April – July. During Sept.-Oct., most (50-95% depending on age) were harvested in their stocking district. August was a transitional month.

▪ Mean distance between the centers of stocking and recovery districts during the open-water fishery was 117-151 km (73-94 mi), dependent on age. The distribution of distances travelled was a long right tail for all ages**,** with recoveries up to 520 km (323 mi) away from stocking location.

Post-release survival of lake trout stocked at historical spawning reefs

▪ Analysis of coded-wire tagged lake trout recovered by spring gill net assessment surveys showed that lake trout catch-per-unit-effort (CPUE, corrected for number of fish stocked and a proxy for survival) was primarily affected by stocking location and genetic strain.

▪ Lake trout CPUE was lowest from fish stocked in the Northern Refuge, due in part to mortality from sea lamprey and commercial fishing, and highest from fish stocked at Julian's Reef .

In stocking locations with low lake trout mortality, Lake Michigan remnant genetic strains (Lewis Lake and Green Lake) had higher CPUE than Seneca Lake strain.

▪ High CPUE of lake trout stocked in southern Lake Michigan may have contributed to increased recoveries of wild lake trout recently reported from that area by building spawning stock biomass.

Post-release movement of lake trout stocked at offshore reefs

▪ Over 50% of lake trout stocked offshore in southern Lake Michigan were recovered in nearshore waters accessible to the recreational fishery (**Fig. 5).** Spread of lake trout from northern Lake Michigan was more limited.

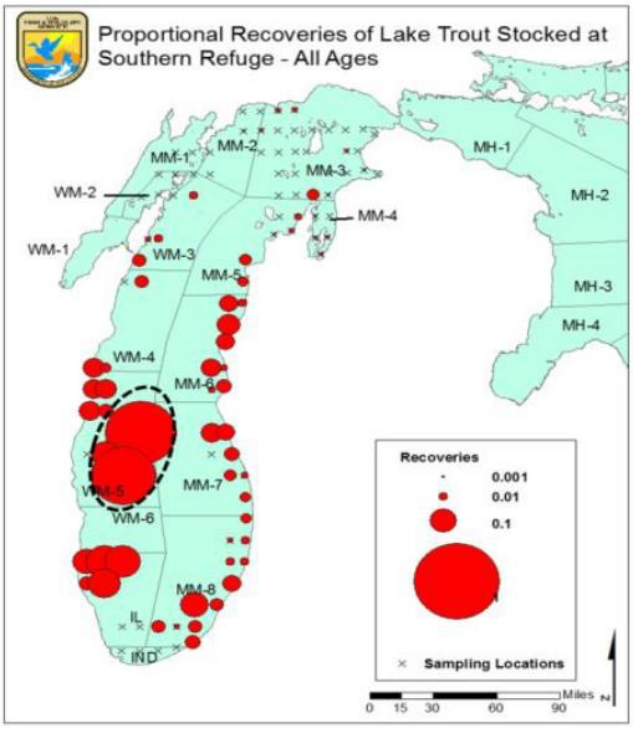

Fig. 5: CPUE of lake trout stocked offshore at the Southern Refuge (dashed black oval). Dot size is proportional to CPUE. X's are sampling sites.

- Analysis of angler-caught lake trout from 2012-2016 suggested lake trout stocked offshore contributed more to angler catches and had greater returns per number stocked than those stocked nearshore.

- This may be due to better survival of lake trout stocked at offshore locations, and counters the perception that lake trout must be stocked nearshore to benefit anglers.

Stable isotopes of Lake Michigan salmon and trout

- Stable isotopes of carbon (δ13C, indicates offshore vs. nearshore foraging) and nitrogen (δ15N, indicates food web position) were analyzed to assess potential for competition.

- Lake trout were unique, with <25% overlap with Chinook salmon, coho salmon and steelhead and had a greater reliance on bottom-oriented and offshore prey (e.g., goby, bloater, sculpin; **Table 1).**

- Pacific salmon species (Chinook salmon, coho salmon, and steelhead) were very similar isotopically.

- Niche overlap and diet mixing models **(Table 1**) suggest competition for declining alewives and rainbow smelt will be highest among Chinook salmon, coho salmon, and steelhead.

Predator	Alewife & Rainbow Smelt	Bloater	Sculpin spp.	Round Goby	Stickleback spp.
Lake Trout	54	15	15	10	6
Chinook Salmon	85	1	0	6	8
Coho Salmon	80	1	1	12	6
Rainbow Trout	78	1	1	15	6
Brown Trout	72	2	2	13	10

Table 1: Percentage of fish prey in Lake Michigan salmon and trout diets, as estimated by stable C and N isotope mixing models. Values are lake-wide averages; variability is likely among regions, seasons, and individual fish. Numbers may not add to 100% due to rounding.✧

Great Lakes Fish Mass Marking Program Activities, 2017 (USFWS)

Including Steelhead, Brown, Brook, Lake Trout; Coho and Chinook Salmon

Introduction

Fisheries managers in the Great Lakes, along with the USFWS, annually stock over 20 million salmonines to diversify sport fisheries, restore native fish populations, and control invasive fishes. However, information is required to determine how well these fish survive and contribute to commercial and recreational fisheries and the levels of natural reproduction by native and non-native salmonines. To this end, the Council of Lake Committees (CLC), a basin-wide group of fishery managers that operates under the auspices of the Great Lakes Fishery Commission, agreed in 2005 to promote the development of a basin-wide program to tag and/or mark (fin- clip) all stocked salmonines. This effort would provide greater insight into survival and movement of stocked salmonines, the contribution of stocking to the restoration of native lake trout, the ability to manage harvest away from wild fish, and the opportunity to evaluate and improve hatchery operations.

The CLC requested that the USFWS deliver a basin-wide mass marking program based on its successful delivery of the basin-wide sea lamprey control (U.S. agent) and lake trout restoration programs. To address this request, the Great Lakes Fish Tag and Recovery Laboratory was established at

the Green Bay Fish and Wildlife Conservation Office in New Franken, WI. Pilot tagging and marking operations began in 2010 and recovery of tagged fish began in 2012.

In 2017, the Lab staff consisted of three AutoFish trailer operators, one data analyst/statistician, and one supervisory biologist. In addition, 11 seasonal biological technicians were hired to assist state agencies with recovery of coded wire tags and biological data from sport fisheries on lakes Michigan and Huron. The program's tagging trailer fleet consists of four automated tagging and marking trailers and one manual trailer. In 2017, the Lab staff used these trailers to coded wire tag and/or adipose fin clip 9,566,973 trout and salmon at fifteen state and federal hatcheries. The Great Lakes Restoration Initiative, managed by the USEPA, provided annual operational funding of $1.3 million through requests made by the USFWS, Region 3.

Summary of Chinook Salmon Tagging Operations

For the previous six years, (2011-2016), all Chinook salmon stocked into Lake Michigan and the U.S. waters of Lake Huron received a coded wire tag and an adipose fin clip (ADCWT). In 2017, due to a shift in funding priorities, 77% of the hatchery reared Chinook salmon were only adipose fin clipped (AD only) with the balance being coded wire tagged and clipped to support ongoing state sponsored research projects. Using the automated trailers, the Lab tagged and/or clipped a total of 2,130,882 Chinook salmon (Table 1). These efforts required coordination and cooperation with six state-administered hatcheries in Michigan, Wisconsin, Indiana, and Illinois.

Hatchery	Agency	# clip ADCWT	Number AD only	Date Completed
Jake Wolf	Illi DNR	0	161,033	3/18/17
Mixsawbah	Ind DNR	0	63,731	4/12/17
Wild Rose	Wis DNR	124,183	712,949	4/23/17
Wolf Lake	MI DNR	0	335,373	4/10/17
Platte River	MI DNR	374,862	61,258	4/25/17
Thompson	MI DNR	0	297,493	5/6/17
Totals		499,045	1,631,837	

Table 1. Total # of Chinook salmon processed and project completion dates by hatchery in 2017.

Chinook salmon tagging and/or clipping performance comparison 2010 - 2017

This year had continued high performance in efficiency and throughput that is attributable to consistent operator experience, and to hardware and software improvements. The average throughput has remained consistent at more than 8,300 fish/hour for the past six years. **(Table 2).** (During processing with the automated system, the coded wire tagging operation occurs simultaneously with the clipping operation, therefore, realized throughput is not significantly different for AD only and ADCWT groups.)

	2010	2011	2012	2013	2014	2015	2016	2017
Number of fish processed	1,104,166	4,689,947	4,320,884	2,856,038	2,953,814	2,968,797	2,769,628	2,130,882
# of machine run hours	162.0	667.4	518.9	319.0	321.6	323.2	322.1	235.6
Ave fish/hour	6,816	7,027	8,327	8,953	9,185	9,186	8,599	9,044

Table 2. Total numbers of Chinook salmon processed and average throughput for 2010 - 2017 tagging projects for all hatcheries combined.

Summary of Lake Trout Tagging Operations

This was the eighth year that all lake trout (2010-2017) were coded wire tagged and adipose fin clipped at USFWS hatcheries in Region 3 (Lakes Michigan and Huron), and the sixth year (2012-2017) at USFWS hatcheries in Region 5 (Lakes Erie and Ontario).

In 2017, 2,967,291 fish were tagged and clipped at three Region 3 hatcheries, and 602,091 fish at one Region 5 hatchery (**Table 3).** An additional 142,205 lake trout were tagged and clipped at the Michigan Department of Natural Resources Marquette State Fish Hatchery.

Hatchery	Agency	Number tagged	Date completed
Marquette	MI DNR	142,205	7/14/2017
Jordan R.	FWS, R 3	1,012,605	9/12/2017
Pendill's Crk	FWS, R 3	860,549	9/12/2017
Iron River	FWS, R 3	1,094,137	10/4/2017
Allegheny	FWS, R 5	602,091	8/28/2017
Total		3,711,587	

Table 3. Total number of lake trout processed and completion dates by hatchery in 2017.

Lake trout tagging performance comparison 2010 - 2017

A continued high level of efficiency and throughput was maintained in 2017 that was attributable to consistent operator experience, and hardware and software improvements. Average throughput across all hatcheries has remained stable at about 8,000 fish/hour for the past five years, and has increased from under 6,000 fish/hour in 2010 (**Table 4).** Throughput has varied among hatcheries in the last several years, possibly due to differences in the variations in fish length at time of tagging as well as fish health and water quality issues at the time of tagging.

	2010	2011	2012	2013	2014	2015	2016	2017
Number of fish processed	4,584,509	5,077,425	6,094,302	5,660,034	6,412,006	6,389,825	4,916,035	3,711,587
Number of machine run hours	837.5	796.6	856.7	697.3	791.1	839.9	691.3	463.7
Average throughput (fish/hour)	5,474	6,374	7,114	8,117	8,105	7,608	7,111	8,004

Table 4. Total numbers of lake trout processed and throughput during 2010 - 2017 for all federal hatcheries combined.

Summary of Steelhead Tagging Operations

In 2017, coded wire tagging was shifted from Chinook salmon to hatchery-reared steelhead stocked into lakes Michigan and Huron. As with the Chinook salmon, steelhead are reared and stocked by state agencies. The Lab coded wire tagged and adipose fin clipped 2,204,643 steelhead and marked 593,138 steelhead with only an adipose fin clip at seven state hatcheries (**Table 5).**

The steelhead released into lakes Michigan and Huron are comprised of five different strains, each with unique behavioral and biological characteristics. Some characteristics (e.g., high size variability within cohorts and varying life cycles) complicate the mass marking logistics compared to lake trout or Chinook salmon. Given that 2017 was the first season we mass marked this species, and that there has been limited use elsewhere of the automated tagging system with this species, many of these variables could not be foreseen until implementation of the large scale program.

Based on experience gained during the inaugural 2017 steelhead season, it was determined that the optimum size for processing steelhead is at an average of 80 mm total length. Because of the differences in life cycles among strains, steelhead in Great Lakes hatcheries attain this optimum size between March and November. Some hatcheries rear multiple strains that vary in size and require multiple visits to process all the steelhead at that site, which increases the complexity of the tagging schedule as well as transportation and travel costs.

In addition, steelhead exhibit considerable size variation within rearing cohorts. In some strains this variability may be attributed to extended spawning seasons that are comprised of multiple egg takes over many weeks or may represent differing feeding behaviors among individuals. The automated tagging system must be configured to process a group of fish of a given size to optimize accuracy and efficiency; large size ranges within groups greatly lowers throughput and accuracy. Throughput varied among projects and averaged 6,982 fish per hour – well below that for lake trout and Chinook salmon **(Table 6).**

Hatchery	Agency	# Tagged/ Clipped	# AD clipped	Date Completed
Jake Wolf	IL DNR	119,284	0	6/1/17
Mixsawbah	IN DNR	296,935	0	11/2/17
Bodine	IN DNR	185,982	0	11/7/17
Lake Mills	WI DNR	123,736	0	6/5/17
Wolf Lake	MI DNR	716,805	247,493	10/21/17
Kettle Moraine	WI DNR	338,597	0	10/25/17
Thompson	MI DNR	423,304	345,645	10/8/17
Totals		2,204,643	593,138	

Table 5. Total numbers of Steelhead processed and project completion dates by hatchery in 2017 (See Appendix I for project summary data).

Hatchery	Agency	Dates	Strain	Number	Run Hrs	Fish/ hour	Ave T.L. (mm)
Jake Wolf	IL DNR	3/19 - 21	Arlee Rainbow trout	64,900	12.1	5,364	94
Jake Wolf	IL DNR	6/1	Skamania Steelhead	54,384	7.6	7,156	92
Mixsawbah	IN DNR	7/13 - 15	Skamania Steelhead	173,738	24.3	7,150	84
Mixsawbah	IN DNR	10/31 – 11/2	Lake Michigan Steelhead	123,197	16.9	7,290	87
Bodine	IN DNR	7/26 - 29	Skamania Steelhead	145,068	25.8	5,623	85

Bodine	**IN DNR**	**11/7**	**Lake Michigan Steelhead**	**40,914**	**7.0**	**5,845**	**92**
Wolf Lake (ADCWT)	**MI DNR**	**9/20 – 10/21**	**Lake Michigan Steelhead**	**716,805**	**106.3**	**6,743**	**89**
Wolf Lake (AD only)	**MI DNR**	**9/23 - 10/ 21**	**Lake Michigan Steelhead**	**247,493**	**35.8**	**6,913**	**89**
Kettle Moraine	**WI DNR**	**10/12 - 14**	**Skamania Steelhead**	**73,235**	**9.0**	**8,137**	**108**
Kettle Moraine	**WI DNR**	**10/14 - 18**	**Chambers Creek Steelhead**	**133,423**	**16.1**	**8,287**	**84**
Kettle Moraine	**WI DNR**	**10/19 - 25**	**Ganaraska Steelhead**	**131,939**	**15.8**	**8,351**	**80**
Lake Mills	**WI DNR**	**6/3 - 5**	**Arlee Rainbow trout**	**123,736**	**18.4**	**6,725**	**83**
Thompson (ADCWT)	**MI DNR**	**9/20 – 10/8**	**Lake Michigan Steelhead**	**423,304**	**61.9**	**6,839**	**89**
Thompson (AD only)	**MI DNR**	**9/25 – 10/ 7**	**Lake Michigan Steelhead**	**345,645**	**43.7**	**7,909**	**86**
Totals				**2,797,781**	**400.7**	**6,982**	

Table 6. Total numbers of Steelhead processed and average throughput by strain and hatchery in 2017.

Summary of Marking Operations with Species other than Chinook Salmon, Lake Trout, and Steelhead

When logistically feasible, the Great Lakes Fish Tag and Recovery Laboratory has continued to support Great Lakes fisheries management by providing fish tagging and marking support on projects outside of the primary focus areas. In 2017, 848,740 fish from five additional species were tagged and/or marked using the automated system; the application of this technology is unique to the Great Lakes program for four of these species.

Species	Hatchery	Agency	Operation	# Fish	Date Completed
Brown Trout	**Les Voight**	**WI DNR**	**AD only**	**176,713**	**7/29/2017**
Brown Trout	**Wild Rose**	**WI DNR**	**AD only**	**295,726**	**7/11/2017**
Atlantic Salmon	**Platte River**	**MI DNR**	**ADCWT**	**169,829**	**8/13/2017**
Brook Trout	**Iron River**	**FWS, R. 3**	**ADCWT**	**75,158**	**9/8/2017**
Coho Salmon	**Bodine**	**IN DNR**	**AD only**	**61,117**	**7/31/2017**
Splake	**Les Voight**	**WI DNR**	**AD only**	**70,197**	**8/2/2017**

Table 7. Total numbers of fish other than Chinook salmon, lake trout, or steelhead processed by the Great Lakes Fish Tag and Recovery Laboratory in 2017 (AD only = adipose fin clip only, ADCWT = adipose fin clip and coded wire tag).

Atlantic salmon tagging and marking was conducted August 9 -13 at the Michigan DNR Platte River State Hatchery. Over five days and 33.1 machine-processing hours, 169,829 Atlantic salmon were coded wire tagged and adipose fin clipped for release into Lake Huron. The average throughput was 5,161 fish/hour, which is lower than that for lake trout and Chinook salmon due to tagging trailer mechanical limitations along with logistical and behavioral complications that Atlantic salmon present while processing with the automated system. This was the fifth year of Atlantic salmon tagging; prior to the 2012 pilot project, Atlantic salmon had never been processed using the automated tagging system.

During September 7 - 8, a brook trout tagging and clipping project took place at the USFWS Iron River Fish Hatchery for release into Lake Superior. It took 8.0 machine run hours to coded wire tag and adipose fin clip 75,158 brook trout, with an average throughput of 9,395 fish/hour. This was the third year that these fish were tagged and clipped to provide a valuable tool to aid in assessing the restoration of this native species.

Brown trout projects were carried out at two Wisconsin DNR hatcheries: at Wild Rose hatchery during July 14-18 and at Les Voight hatchery during July 26 - 29. At both projects the fish were marked only with an adipose fin clip and not tagged; a total of 472,439 were adipose fin clipped in 63.2 machine processing hours at an average throughput of 7,475 fish/hour. These fish were Seeforellen strain brown trout and the adipose fin clip will be used for genetic strain identification during future gamete collections.

Also marked with an adipose clip at the Wisconsin DNR Les Voight hatchery during the July project were 70,197 splake (brook trout x lake trout hybrid) and 77,983 lake trout. All the fish processed at Les Voight hatchery are to be stocked into Lake Superior, marking them with an adipose fin clip allows biologists and managers to differentiate the hatchery origin fish from those resulting from natural reproduction.

These projects represent the only applications of the automated tagging system for these species. This experience provides valuable insight on how differences in morphology and behavior among species affect the system performance and throughput compared to lake trout and Pacific salmon. These results suggest that future tagging projects for other salmon and trout species are possible.

Recoveries of fish from Lakes Michigan and Huron

During May 27 – October 8, 11 Service biological technicians worked with Wisconsin, Michigan, Illinois and Indiana DNRs to sample sport-caught salmon and trout on Lakes Michigan and Huron. Technicians engaged anglers at various ports and boat landings, with collection efforts concentrated at fish cleaning stations and fishing tournaments. Technicians collected biological data (**Table 5)** including length, weight, fin clip, sex, maturity stage, lamprey wounding and aging structures from 10,474 salmonines. Scales, otoliths, or maxillae were also collected from over 2,028 wild fish to estimate age and year class membership. Over 2,700 snouts were collected from fish that had an adipose fin-clip only, producing over 2,450 tag recoveries.

The Lab continued to collaborate on multiple cooperative studies in 2017. Viscera, belly flaps, and dorsal muscle tissue were collected from 400 lake trout and Chinook salmon to help understand the physiological response to sea lamprey attacks by specifically analyzing total lipid and protein content. Steelhead otoliths were collected from 563 fish for an otolith microchemistry analysis to help estimate the proportion of the wild Lake Michigan steelhead population that originate from different natal streams. Tissue specimens consisting of muscle tissues, belly flaps and stomachs were collected from 926 salmonids for analyzing the gut content and stable isotope concentration on the rapidly changing Lakes Michigan and Huron food web.

All hatchery reared lake trout, and all 2011 – 2017 year class hatchery-reared Chinook salmon – which seldom reach Age 4 or greater – have been fin clipped. Therefore, all lake trout and Chinook salmon recovered in 2017 that lack a fin clip are presumed to be naturally reproduced (wild). Pre-release QA/QC checks, and inspection of unclipped Chinook salmon for CWTs, show that fin clip error or regeneration is extremely low at about 0.5%. The percent of wild Chinook salmon and Lake Trout (without a fin clip) was determined for each jurisdiction (**Table 6).** A summary of all 2012-2016 sampling activities on Lakes Michigan and Huron is in Appendix VI.

State of landing	Chinook salmon	Lake trout	Steelhead	Coho salmon	Brown trout	Atlantic salmon	Pink salmon	Total
Wisconsin	**2,303**	**861**	**1,632**	**1,219**	**282**	**0**	**9**	**6,306**
Michigan-L. Huron	**188**	**336**	**46**	**13**	**6**	**11**	**11**	**611**
Michigan-L. Mich.	**857**	**673**	**123**	**320**	**5**	**0**	**0**	**1,978**
Illinois	**256**	**529**	**160**	**93**	**15**	**0**	**0**	**1,053**
Indiana	**53**	**420**	**18**	**33**	**2**	**0**	**0**	**526**
Totals	**3,657**	**2,819**	**1,979**	**1,678**	**310**	**11**	**20**	**10,474**
Number and % wild	**2,194 (60.0%)**	**808 (28.7%)**						

Table 5. Number of fish by species examined by USFWS for CWTs from Lake Michigan and Lake Huron in 2017.

Sampling Jurisdiction	Wild Chinook salmon	Wild lake trout
WI- Lake Michigan	56.8%	23.7%
MI-Lake Huron	23.9%	53.0%
MI-Lake Michigan	77.6%	18.4%
Illinois	57.0%	31.0%
Indiana	56.6%	32.9%

Table 6. Percent of examined Chinook salmon and lake trout in each sampling jurisdiction that did not have any fin clips and presumed to be wild. ✧

Great Lakes Highlights 2017
USFWS: Fish and Aquatic Conservation Program

Lake Trout Broodstock Management

To meet the stocking requests for the restoration of lake trout in the five Great Lakes, the USFWS (Service) manages multiple broodstock hatcheries across the country; Iron River National Fish Hatchery (NFH), WI, Sullivan Creek NFH, MI, Saratoga NFH, WY, Berkshire NFH, MA, and Allegheny NFH. Lake trout eggs for the spring of 2017 yearling stocking came from several distinct broodstock strains: Superior Klondike (SKW), Lewis Lake (LLW), Seneca Lake (SLW), Huron Parry Sound (HPW), and Lake Champlain Domestic (CLD). The state of Vermont also provided eggs for the program.

Egg Incubation Facilities at Sullivan Creek NFH

Lake Trout Production and Stocking

In 2017, the Service's Iron River, Jordan River, Pendills Creek, Allegheny, and Dwight D. Eisenhower NFHs raised and released 4,337,205 yearling lake trout into the Great Lakes in support of lake trout rehabilitation and in accordance with Lake Committee rehabilitation plans and the 2000 Consent Decree. The M.V. Spencer F. Baird delivered fish to seven priority reefs in Lake Huron and 19 priority reefs in Lake Michigan. The vessel was underway for 68 days throughout the entire distribution season and traveled over 2,800 miles in the upper Great Lakes. In total, distribution included 1,329,729 yearlings into Lake Huron, 2,730,170 into Lake Michigan, 76,456 into Lake Erie, and 200,850 into Lake Ontario. All lake trout yearlings were adipose fin clipped and coded-wire tagged prior to stocking.

For 2018, the Service is preparing to stock approximately 3,510,000 yearling lake trout into the Great Lakes, all of which were adipose fin clipped and coded-wire tagged by the Great Lakes Mass Marking Program in 2017. The M/V Spencer F. Baird will continue to deliver lake trout yearlings offshore to prescribed rehabilitation sites in Lake Huron and Lake Michigan in 2018.

Lake Trout Post-stocking Assessment

Surveys conducted in 2017 by the FWS Offices (FWCO) in Green Bay and Alpena have documented continued progress toward lake trout restoration in lakes Michigan and Huron.

In Lake Huron, approximately 50% of the lake trout captured during monitoring surveys conducted by Alpena FWCO in northern Lake Huron were of wild origin. Catch rates of wild lake trout have increased markedly since 2008 and continued recruitment of wild fish is evident in summer graded-mesh surveys conducted by the Alpena FWCO since 2003. Long-term monitoring of spawning Lake Trout at offshore reefs (Yankee Reef and Six Fathom Bank) in Lake Huron began in 1994 and recent surveys suggest that more than ten year classes of wild fish are now contributing to the spawning stock at these historically important sites. Wild fish now compose a significant portion (>50%) of the offshore spawning population.

In Lake Michigan, increased stocking in the Northern Refuge Reef complex since 2009 and a concomitant reduction in sea lamprey mortality has rapidly increased lake trout abundance in the Northern Refuge reef complex. Spring gill net assessments caught < 1 lake trout per 1000' of net in 2009 but this increased to 16 lake trout in 2017. This increasing trend has also been observed at other sites in the northern half of Lake Michigan. In southern Lake Michigan, spring catch rates of roughly 15 lake trout per 1000' were reported at the Southern Refuge but lower catch rates were found at the other proximate nearshore southern sites.

Lakewide, all sites remain below the spring evaluation objective of 25 lake trout per 1000'; however fall gill net assessments indicate adult spawner abundance exceeds 50 lake trout per 1000' at most of the reefs throughout Lake Michigan and suggests spawner abundance is sufficient to support natural reproduction. Detection of wild lake trout continues to increase throughout management units in the southern half of Lake Michigan. The highest proportion of wild fish, 58%, were documented from gill net assessments in Illinois while wild fish from other southern and mid-latitude waters comprised 5 — 25% of lake trout catches. These southern waters have a diverse age structure among spawning populations; natural recruitment remains undetectable in the northern waters of Lake Michigan where current spawning populations are solely comprised of young fish.

Lake Trout Research

In 2017, the Green Bay FWCO completed collaborations with USGS, MIDNR, and Michigan State U. scientists on examining fine and large-scale movements of lake trout in Lake Huron with acoustic telemetry, and large scale interchange of Chinook salmon from Lake Huron to Lake Michigan by examining the recovery of coded-wire tagged hatchery fish responding to declining forage base in Lake Huron..

In 2017, the Ashland FWCO continued to work cooperatively with the National Park Serviceto sample historic lake trout spawning sites around Isle Royale National Park. Isle Royale has been less impacted by the dramatic changes to the Lake Superior ecosystem and the NPS is interested in measuring the extent of remnant of lake trout diversity and habitat (bathymetry and substrate composition), at many historic lake trout spawning sites. Ultimately the data collected should aid the management and conservation of lake trout stocks near Isle Royale.

In 2017, the Lower Great Lakes FWCO continued a study using acoustic telemetry to track lake trout movements in the lower Niagara River during spawning season. This study is in cooperation with NYS DEC and leveraged GLRI funding to pull in NRDA funds. This study looks to understand the timing and cues associated with river spawning lake trout that use the Niagara Gorge habitats for spawning. Ten fish were tagged in both 2015 and 2016. Although no new tags were implanted in 2017, data collection in the river continues and will continue for through 2019. Near fine-scale tracking showed many movements that are believed to be associated with spawning and staging. Large-scale movements have also being to be observed as tagged fish have moved around the lake showing up on GLATOS participating researchers receivers. The Lower Great Lakes FWCO also deployed and recovered 8 of the 18 pop-off satellite archive tags used to document habitat use in Lake Ontario. Preliminary results show some interesting behaviors in depth selection and excursions into shallow waters during summer months.

Genetic assessment of naturally-reproduced lake trout in Lake Ontario by the Northeast Fishery Center in partnership with the Lower Great Lakes FWCO and USGS continued in 2017. This work helps to evaluate which stocked lake trout strains are successfully reproducing and therefore have an opportunity to contribute to restoring self-sustaining lake trout in Lake Ontario.

Upgraded Assessment Capability

A new 57' multipurpose vessel, the R/V *Stanford H. Smith*, will be a big boost to the scientific research capabilities for the Service's Upper Great Lakes FWCO offices starting in 2018. The vessel, built by Moran Iron Works in Onaway, Michigan, was sea-tested in October 2017 and will be delivered to its home port of Kewaunee, Wisconsin this spring. This vessel's mission is to continue and expand assessments of fish communities in the Upper Great Lakes.

With a cruising speed of 17 knots, the R/V *Smith* provides the FWCOs with a technologically advanced research platform that can travel quickly and safely throughout Lakes Michigan, Huron, and Superior. The vessel is equipped with a gill net lifter, hydraulic winches, net reels, and net configuration sensors to deploy and retrieve gillnets, mid-water and bottom trawls, and 120 kHz split-beam transducers to measure fish biomass with hydroacoustics. The R/V Stanford Smith emphasizes Region 3's commitment to science for the conservation of native species within the Upper Great Lakes.

The new R/V Standford H. Smith during sea trials in October 2017

Mass Marking

At the request of the Council of Lake Committees, the Service continued to deliver a Mass Marking Program in the Great Lakes in 2017, with the goal of marking/tagging all stocked salmonines. Utilizing $1.4 million in Great Lakes Restoration Initiative funding, and carryover funds, the Mass Marking Program coded-wire tagged and/or fin-clipped 3.8 million Service-reared lake trout for lakes Michigan, Huron, Erie, and Ontario, as well as 2.1 million State-reared Chinook salmon and 2.8 million State-reared steelhead, for lakes Michigan and Huron. A detailed report of Fish and Wildlife Service tagging activities in 2017 is available upon request. 4

Eleven seasonal technicians assisted Wisconsin, Illinois, Indiana, and Michigan with tag recoveries on lakes Michigan and Huron in 2017. The lab collected data on over 10,400 sport-caught salmon and trout and recovered 14,390 tags from these and other fish from weir and assessment activities. Wild lake trout recoveries from the sport fishery were higher in southern and western Lake Michigan (21 – 33 %) than elsewhere (0 – 14%), and lakewide percent wild increased from 17% in 2016 to 26% in 2017. In Lake Huron, 57% of sport-caught lake trout were wild. Results also indicated sustained natural reproduction of Chinook salmon, as 67% of fish recovered from Lake Michigan and 71% from

Lake Huron (excluding MH1) were of wild origin in 2017, consistent with values from the past several years. Technicians also collected tissue and stomach specimens from five salmon and trout predators to understand the changing Lake Michigan food web, tissues from lake trout and Chinook salmon to estimate non-lethal, physiological effects of sea lamprey attacks, and otoliths (ear bones) to determine the natal origin of wild steelhead in Lake Michigan using microchemistry signatures.

Operating parameters of the trailer

Staff scientists continued to provide analytical support to states. Origin of Chinook salmon harvested by anglers in each jurisdiction, and recovery locations of Chinook salmon stocked in each jurisdiction, were determined and shared with state partners. Chinook salmon survival and growth rate tended to be highest for fish stocked on the western shore of Lake Michigan, and annual differences in Chinook salmon growth mirrored variability in year-and-older alewife density.

Recoveries of lake trout with legacy coded-wire tags (1985-2003) showed that post-release survival was lower for fish stocked in northern Lake Michigan than southern Lake Michigan and that survival was higher from Lake Michigan remnant genetic strains. Early returns of mass-marked lake trout suggested offshore-stocked fish contributed more to recreational angler harvest than nearshore-stocked fish. Sea lamprey wounding rates from 2012 - 2016 were also evaluated from salmon and trout species on lakes Michigan and Huron. Finally, lab scientists assisted with developing diet and ration estimates for the five primary salmonine species in Lake Michigan. All species fed on alewife, but results highlighted spatial and seasonal variability in diets of lake trout, brown trout, and steelhead, which were more reliant on other prey such as round gobies and terrestrial invertebrates than Chinook salmon and coho salmon, which fed more exclusively on alewife. The findings are consistent with earlier and ongoing work with stable isotope signatures, which reflect long term diet and foraging location.

Fish are sorted by size and moved through an automated system within each trailer where they receive an adipose fin clip and a coded wire tag.

In 2018, the Service anticipates receiving $1.4 million in operational funds for the Mass Marking Program through the GLRI. If received, these funds will be used to: tag and fin clip 3.8 million lake trout at Federal hatcheries; adipose fin clip the Chinook salmon stocked into lakes Michigan and Huron to maintain hatchery versus wild origin identification capabilities; tag and fin clip 2.8 million steelhead stocked into lakes Michigan and Huron; assist the States with smaller tagging/clipping projects on other species; and provide similar technical support related to all aspect of the tagging and marking program including cooperative analysis of the tag recovery data. A permanent addition to the Service base budget will be required to obtain remaining capital equipment and to provide operational funding needed to fully implement and sustain the Mass Marking Program across all the Great Lakes into the future.

Lake Sturgeon Streamside rearing

In 2017, the Ashland and Green Bay FWCOs and the Genoa NFH, continued to operate streamside rearing facilities on the Ontonagon River in Lake Superior, and the Kalamazoo River in Lake Michigan. The intent of streamside rearing is to rear and stock juvenile lake sturgeon in a manner that promotes imprinting and site fidelity so that stocking can help build populations to self-sustaining levels while minimizing genetic risks to wild populations from potential straying.

The Ontonagon River facility is the only one operating on Lake Superior and is a partnership between the Service, Michigan DNR, Ottawa National Forest, Upper Peninsula Power Company, Fond du Lac Band, and Keweenaw Bay Indian Community. Using the Sturgeon River, MI as a source, eggs were collected from 10 females which were paired with 40 males (1:4 ratio). A total of 1,264 young-of-year (168 mm TL) lake sturgeon were released into the Ontonagon River, with surplus fish of varying sizes being

released into the upper St. Louis River, MN in support of the Fond du Lac Band's rehabilitation efforts.

Kalamazoo River Streamside Rearing Unit.

The Kalamazoo River facility is one of 6 streamside facilities being operated across the Lake Michigan basin by a multi-agency partnership (Michigan DNR, Wisconsin DNR, Little River Band of Ottawa Indians, Match-e-be-nash-she-wish band of Pottawatomi Indians, River Edge Nature Center, and Sturgeon for Tomorrow) to build and restore populations. Since 2004, over 40,000 fall fingerling lake sturgeon have been stocked from these facilities following approved and published guidelines designed to establish founding populations of 750 adults in each river over a 25 year period.

Completion of the newest rearing facility in the Great Lakes and the only one on Lake Erie is scheduled. In 2016, the Toledo Zoo and project partners received funding through the Great Lakes Fish and Wildlife

Restoration Act to construct and maintain a rearing facility along the Maumee River with technical assistance from the Alpena FWCO and Genoa NFH. A lake sturgeon restoration plan has been developed for the Maumee River and the first year of stocking is scheduled to begin in the fall of 2018.

Sturgeon passage was conducted for a 3rd year on the Menominee River, Lake Michigan where up and downstream passage facilities now allow movement of sturgeon around the first 2 dams on this river system. The Service works closely with partners (MIDNR, WIDNR, River Alliance of Wisconsin, Eagle Creek Renewable Energy, and UW Stevens Point) to operate and evaluate this facility. The passage facilities include an upstream elevator, a sorting and truck and transfer facility, and two downstream bypass flumes. At present, up to 90 adult sturgeon per year are allowed to pass up river during this initial evaluation period. To date, 85% of the adults passed upstream have quickly migrated 20 miles upstream and have occupied high quality spawning habitat during the spawning season before moving back down river to Green Bay during the following year.

To assess rehabilitation stocking progress in the Ontonagon River, MI the Ashland FWCO their annual standardized juvenile/sub-adult gill net survey in 2017. Catch per unit effort was the same in 2017 as in 2016 at 0.9 sturgeon/305 m net night.

Population assessments continued in the lower Niagara River in 2017, collecting samples from 67 new fish for a total of 924 unique fish sampled since 2011. During this period, there have been only 54 recaptures for a 6% re-capture rate. In 2017, the Lower Great Lakes FWCO finalized and published the results from our analysis of lake sturgeon diet in the lower Niagara River. Our findings showed that diets consisted primarily of invasive species. These included round goby and an invasive amphipod. Gobies were the most consumed diet item across the sampled fish occurring in 85% of stomachs.

Juvenile lake sturgeon

Recent surveys have shown that in Michigan's highly alkaline Manistee and Muskegon rivers, young lake sturgeon exposed to TFM during sea lamprey treatments can experience high mortality. In 2016 and 2017, the Service's Green Bay FWCO and Sea Lamprey Control Programs worked with the Little River Band of Ottawa Indians and Michigan DNR to collect and temporarily remove wild age-0 sturgeon from these rivers during the scheduled TFM treatment, and then return them to the river immediately after treatment. Post treatment surveys have verified the importance of this rescue effort in preserving sturgeon year classes in lamprey treatment years. Current plans are to continue this work in these two river systems while research of other treatment alternatives continues.

Lake Sturgeon Habitat Restoration

The Service and partners have constructed eight spawning reefs in the St. Clair-Detroit River System since 2004 adding 16.64 acres of hard substrate to the system to remove the loss of fish and wildlife habitat and degradation of fish and wildlife populations beneficial use impairments in these

rivers. In the spring of 2018 another 4 acre reef, the Fort Wayne reef, is scheduled to be constructed. The reefs consist of loose rock strategically placed on the river bottom and replace natural spawning areas that were present in the St. Clair and Detroit rivers before construction of commercial shipping channels removed much of the rocky habitat. The rock provides a safe place for eggs to incubate until the fish larvae hatch out and drift down the river. Assessments are conducted to monitor the biological and physical response to each reef and results are used in an adaptive management process to guide future reef restoration projects. For more information on these projects visit http://scdrs.org/.

Brook Trout Status, Distribution, and Habitat

Results from a pilot study completed by the Service's Ashland FWCO and Northeast Fishery Center, to explore the use of environmental DNA (eDNA - qPCR) and next-generation sequencing (NGS) technology relative to electrofishing to assess the presence/absence and relative abundance of trout and salmon at five sites in Wisconsin tributaries to Lake Superior were completed. For five small (<25 cfs) coldwater streams, no differences were found in the relative abundance measures obtained using qPCR, metabarcoding, and electrofishing. In all locations, species data recovered using the various techniques were highly correlated

(Pearson $r > 0.88$). These data suggest that similar measures of presence/absence and relative abundance can be obtained using eDNA detection techniques in small, coldwater stream habitats as compared to that of electrofishing. Additional studies are necessary to evaluate the repeatability of this work, longitudinal persistence (or transport) of eDNA in streams, and whether similar results can be obtained from a wider diversity of habitat types with increasing species complexity.

In support of goals and objectives outlined in the Lake Superior Brook Trout Rehabilitation Plan, the Ashland FWCO implemented the Lake Superior Technical Committee standardized shoreline electrofishing index survey protocol at Tobin Harbor, Isle Royale and Big Bay, Michigan, and Chequamegon Bay, WI. The cooperative effort among fishery agencies examines coaster abundance and distribution in shoreline waters on a location specific basis and may help agencies detect establishment of new populations in Lake Superior. In 2017, coaster CPUE (#/shoreline km) in Tobin Harbor was 6.5, up from 3.5 in 2016.

The Ashland FWCO and partner State, Tribal, and Federal fishery agencies, university researchers and NGOs continued to utilize brook trout population status and distribution data in Wisconsin and Michigan to prioritize fish passage and culvert removal projects and to identify priority watersheds for riparian and instream habitat restoration.

From 2015 through 2017, the Lower Great Lakes FWCO partnered with the Northeast Fishery Center in Lamar, PA and the NYS Department of Environmental Conservation to use genetic analysis to assess differences in brook trout populations in western New York. A total of 3416 fin clips were sampled from 73 brook trout populations in four western New York watersheds including the Erie/Niagara, Genesee River, Allegheny River, and upper Susquehanna River. Initial findings indicate that all populations show high levels of genetic differentiation likely due to isolation and/or small population sizes. Genetic diversity varied widely. The genetic influence of stocked brook trout was low across all populations, but showed potential evidence of hatchery introgression at sites near long-term brook trout stocking locations. A final report is expected in 2018.

Forage Fish Surveys

The Alpena and Green Bay FWCOs continue to make substantial contributions to multi-agency prey fish assessments in Lakes Huron and Michigan. In 2017, the FWCOs utilized the M/V Spencer F. Baird to perform a total of 24 hydroacoustic transects (6 on Lake Huron, 5 on Lake Michigan proper and 13 in Green Bay waters of Lake Michigan) to estimate fish densities and 31 midwater trawls (15 on Lake Huron and 10 each on Lake Michigan proper and Green Bay) to determine species and size compositions. This marks the seventh consecutive year of the Service's involvement in these surveys that provide critical information to the management and research communities regarding the status of important Great Lake's prey fish stocks. Overall these surveys show total prey fish biomass remains at low levels, but the Lake Huron prey community is dominated by a native deepwater cisco (Bloater) while the exotic alewife are still the primary prey species in Lake Michigan.

Cisco Assessment

The Lake Superior Technical Committee has highlighted the need for a comprehensive cisco stock assessment that is capable of handling both fishery dependent and fishery independent information. Both Ashland FWCO and USGS biologists have collaborated with the Quantitative Fisheries Center (QFC) at Michigan State U. to develop an age-based

stock assessment model for the Thunder Bay cisco population. Results of this effort were shared with management agency personnel during a 2-day workshop held at the USFWS Regional Office in Bloomington, MN. During the meeting, staff from the QFC described the mechanics of the model and also charted a path for how similar models could potentially be built for other jurisdictions in 2018.

The statistical catch-at-age assessment model developed for Lake Superior Cisco has highlighted the need for accurate hydroacoustic estimates. Members of the Lake Superior Technical Committee recognize that ship-based, down-looking acoustics could be a potential source of bias due to the limited sampling volume near the surface of the lake. Staff from the Ashland FWCO, USGS, Red Cliff Band of Lake Superior Chippewa, and the University of Minnesota-Duluth have initiated a study to better appreciate the vertical distribution of spawning cisco. A recently acquired acoustic sled will allow scientists to deploy transducers at greater depths so they can aim sound waves upwards and increase the volume of water sampled near the surface. This sled-based, up-looking approach was used successfully during the fall of 2017 and will provide valuable insights about the density of cisco throughout the entirety of the water column. This equipment will be used again in subsequent years and help to refine the methods by which Lake Superior cisco populations are assessed.

Cisco Restoration

Lake Ontario's reintroduction program for Bloater, a native species of deepwater cisco, was initially supported through fertilized eggs collected from Lake Michigan's bloater populations between 2012 and 2017. Extensive efforts were put forth to annually collect up to one million eggs that were sent directly to Lake Ontario where, most importantly, hatcheries developed methods to successfully rear the eggs to juvenile life-stages. To date these efforts have resulted in the total stocking of nearly 600,000 juvenile bloaters in Lake Ontario. This year the bloater reintroduction efforts entered "production-phase" when a brood-stock line was created at Jordan River NFH from a wild Lake Michigan donor source. Staff from the Green Bay FWCO and Jordan River NFH made weekly trips on Lake Michigan this winter aboard the *Susie Q* bottom trawler vessel to access spawning bloater in offshore waters. Eggs were obtained from wild spawn pairings using 25 females per week, in total 134 females were spawned with 268 males, to ensure a genetically diverse source of eggs for brood-stock creation. These eggs will be reared to maturity at Jordan River NFH and within four years it is expected that Region 3 hatcheries will supply Lake Ontario hatcheries with millions of bloater eggs. Brood-stock creation in Region 3 is a significant achievement that is expected to ramp up stocking rates in excess of 500,000 juvenile bloater per year in Lake Ontario!

Cisco collected from Lake Huron.

In Lake Huron, management agencies are preparing for a restorative stocking study for Cisco in Saginaw Bay under the guidance of the Lake Huron Technical Committee. The Alpena FWCO is leading efforts to obtain necessary fertilized gametes to support the Study's production target of 750,000 fingerling Cisco. Following up on pilot work conducted in 2015-2016 at the Les Cheneaux Islands and Potagannissing Bay, this year's objective was to collect sufficient spawning to pairs to develop second brood cohort, while concurrently providing eggs to meet production targets for stocking in 2018. Alpena FWCO staff teamed with staff from the Jordan River, Iron River, Pendills Creek and Genoa National Fish Hatcheries to collect gametes from 142 spawning Cisco pairs during the fall of 2017. Field work for the project occurred over a period of two weeks, though the bulk of spawning pairs were collected during Nov 16-20. Fertilized gametes spawned for the second brood cohort were shipped to an isolation facility at the Genoa National Fish Hatchery for initial rearing, while the rest of the eggs intended for production were transported to the Jordan River National Fish Hatchery. In addition to obtaining standard biological information, each spawning animal was assessed for fish health and morphometry (ie characteristics of its body proportions).

Tissue samples were collected from all spawning animals for future genetic analyses. Furthermore, the field team provided gamete samples to the USGS Great Lake Science Center and University of Wisconsin-Stevens Point for development of genetic linkage map for Cisco as well as further genetics work. A field team also provided live adult Cisco to researchers at the Hammond Bay Biological Station to test their surgical methods of Telemetry tag insertion on Cisco. This work showed promise as all six of the surgically implanted fish were successfully revived after surgery. Additionally the Alpena FWCO staff have been conducting early life history work for recruitment and distribution of Coregonids in Saginaw and Thunder Bays during the presumed peak emergence in the spring. Sampling has been done to determine if larval density differences can be detected, as well as an indicator of presence/ absence of Cisco in Saginaw Bay prior to them being stocked in 2018.

In Lake Ontario, cisco populations have been greatly reduced with small remnant populations existing in Chaumont Bay and the Bay of Quinte. The Chaumont Bay population was identified as a possible source for restoration stocking. In partnership with NYDEC and USGS, the Lower Great Lakes FWCO has initiated population surveys to better understand the abundance and population data of this spawning group. Additionally, 50 cisco have now been tagged with acoustic telemetry tags to assess habitat selection and characteristics for spawning. Movement data will be combined with sonar technologies to help understand spawning site characteristics and selection.

Working with partners at the Lower Great Lakes FWCO, USGS Tunison, and NYDEC, the Service's Northeast Fishery Center in Lamar, PA reared 164,000 cisco in 2017 for stocking into Lake Ontario. Also at the Northeast Fishery Center, genetic assessment of adults spawned was conducted to monitor genetic diversity, and genetic studies were completed to evaluate reproductive success of individual broodstock. Other studies at the Northeast Fishery Center included evaluation of the impacts of handling stress on cisco during transport to stocking location, and comparison of marking methods to be able to identify hatchery produced cisco following release.

Region 3 and Region 5 biologists also participated with USGS scientists in reporting out the results of a workshop conducted in October 2016 to identify and discuss key uncertainties associated with coregonine restoration, and develop a coordinated approach as the principal Department of the Interior bureaus to address Great Lakes fishery issues. Workshop objectives were to identify (1) perceived key uncertainties associated with coregonine restoration in the Great Lakes and (2) DOI capacities for addressing these key uncertainties.

Aquatic Invasive Species

Ruffe

In addition to AIS efforts targeting new non-native species, the Alpena and Lower Great Lakes FWCO's conducted targeted efforts to detect new populations of ruffe in Lakes Huron, Erie, and Ontario. Alpena FWCO has been conducting annual ruffe surveillance since 1996. In 2017, efforts were conducted to detect ruffe in and around locations where they have been captured in the past and also to survey other Lake Huron ports in an effort to detect new populations. The Lower Great Lakes FWCO has surveyed select port locations in both Lake Erie and Lake Ontario since 1994. In 2017, surveys were completed at all planned locations. **For the first time ruffe were captured in the St. Marys River offshore of Brimley State Park in Michigan**. In addition to completing planned surveys, biologists evaluated survey protocols to ensure effectiveness and consistency.

Asian Carp

The Service, in cooperation with its partners, currently implements two different strategies to address the threat of Asian carps: the Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States (Plan), which is national in scope, and the Asian Carp Regional Coordinating Committee's (ACRCC) Asian Carp Control Strategy Framework (Framework), which is focused on preventing the introduction and establishment of Asian carp in the Great Lakes.

In 2017, the Service continued to lead implementation of actions identified in the National Plan; worked with partners to implement monitoring, control, rapid assessment, and electric barrier defense/clearing actions in the Chicago Area Waterway System (CAWS) as needed; assisted with updating and implementing a Monitoring and Response Plan for Asian Carp in the Upper Illinois River and CAWS under the Framework; served on and continued co-chairmanship of the ACRCC; served as webmaster of Asiancarp.us; performed risk analyses Asian carp species; administered ANS grant programs to States and Tribes in support of Asian carp actions; with our partners, coordinated and implemented a Great Lakes basin-wide eDNA surveillance program for Asian carps; with our partners completed an eDNA marker validation study resulting in more a more precise set of real-time PCR markers for use in monitoring; collected and examined over 7,400 water samples from all five Great Lakes, Ohio River, Upper Mississippi River, and CAWS for the presence Asian carp DNA at the Whitney Genetics Laboratory; continued to implement the Regional triploid grass carp inspection program; and implemented a comprehensive, Great Lakes basin- wide aquatic nuisance species monitoring program with our partners. For more info on Asian carp eDNA sampling efforts: http://www.fws.gov/midwest/fisheries/eDNA.html.

In 2017, the Service also worked with U.S. and Canadian resource management agency partners to develop strategies and recommendations to address invasive species issues of binational concern under the Great Lakes Water Quality Agreement. The Service and DFO Canada serve as co-chairs of the Annex 6 Invasive Species Subcommittee. The Water Resources Reform & Development Act of 2014 (WRRDA) was signed into law on June 10, 2014. As directed, the Service assumed a lead role in coordinating federal interagency efforts to address the threat of Asian carps in the Ohio River and Upper Mississippi River basins and their tributaries, including the CAWS. Per WRRDA, the Service led development of the second annual Report to Congress summarizing state and federal expenditures to manage the threat of Asian carps in these areas.

AIS Early Detection and Monitoring

In 2017, the Service continued implementation of a comprehensive, basinwide monitoring program aimed at early detection of non-native fishes, amphipods, gastropods, and bivalves in the Great Lakes. This program is carried out across the Great Lakes by the Ashland FWCO, the Green Bay FWCO, the Alpena FWCO, and the Lower Great Lakes FWCO in conjunction with input from our partners. Early detection is critical for management of non-native species, particularly when trying to keep them from becoming invasive. Service biologists target high-risk sites around the Great Lakes where species are likely to be first introduced to the system.

Detection techniques target all life stages for fishes (egg, larval, juvenile, adult), and also focus on adult bivalves, gastropods, and amphipods. Since 2013, thousands of samples were collected at high risk sites in the Great Lakes to search for a range of species that could be introduced to the Great Lakes from anywhere in the world. Genetic techniques are used in conjunction with standard identification methods to maximize species detection capabilities. The U.S. Environmental Protection Agency, USGS, and Ontario Ministry of Natural Resources and Forestry partnered with the Service on sample collection and processing. Funding continues to be provided by the Great Lakes Restoration Initiative.

No new invasive fish species were detected and most established AIS were consistently detected. Gears and methods for sampling fish were improved during 2017, allowing for geographic expansion of effort with similar, or better, efficiency compared to previous years. Benthic macroinvertebrate sampling took place where introduction and establishment would be most likely; including boat ramps, river mouths, and ship docking areas. Unfortunately, the first detection of bloody red shrimp in Lake Superior was made during a targeted sampling effort in the St. Louis River on June 02, 2017. Bloody red shrimp also appear to be expanding within Lake Michigan, as the species was found in locations where it had not been previously detected. ✧

2018 March Asian Carp Monitoring

Summary

Below is the 2018 March Asian Carp monthly summary from the crew working the Chicago Waterway System (CAWS). The goal of the summary is to provide up-to-date information on the monitoring and research projects outlined in the 2017 MRP and additional relevant Asian carp developments.

Bottom Line: Monitoring occurred in the CAWS and upper Illinois Waterway upstream and downstream of the Electric Dispersal Barrier in March. **NO LIVE BIGHEAD CARP OR SILVER CARP were found in any new locations immediately downstream of the Electric Dispersal Barrier.**

Fixed, Random and Targeted Site Sampling Downstream of the Electric Dispersal Barrier

Electrofishing:

• Crews from IDNR and USACE completed 52 electrofishing runs at fixed and random sites (13 hours total) in the Lockport, Brandon Rd, Dresden Island and Marseilles Pools in March.

• They collected 1,552 fish of 37 species.

• **No Asian carp were captured or observed in any of the pools.**

Commercial Netting:

• Contracted commercial fishers along with assisting IDNR biologists set 37.8 miles of gill net at fixed and targeted sites in the Lockport, Brandon Rd and Dresden Island Pools (including Rock Run Rookery) in March.

• They collected 2,098 fish of 13 species.

• One Bighead Carp and 16 Silver Carp were collected in Rock Run Rookery.

• Fifty-eight Bighead Carp and 79 Silver Carp were collected in the Dresden Island Pool, downstream of I-55.

• **No Bighead Carp or Silver Carp were captured or observed in the Lockport or Brandon Road Pools.**

Unified Fishing Method – Dresden Island Pool:

The Unified Fishing Method (UFM) in the Dresden Island Pool, which included Rock Run Rookery and the lower Kankakee River, took place the week of February 26th. One hundred forty-five Silver Carp and 77 Bighead Carp were removed totaling 4,342 pounds (2.2 tons), which equates to 26% of the total number of Asian carp collected in the Dresden Island Pool in 2017. Fifty-three of the 222 Asian carp collected during the UFM came from Rock Run Rookery. **No Asian carp were collected in any other locations upstream of I-55**. Bycatch totaled 3,565 individuals of 18 species with Smallmouth Buffalo comprising 71% of the bycatch followed by Common Carp

(13%). Four pound net nights and 11.8 miles of gill net were utilized during this effort.

Sampling results by pool below the electric dispersal barrier through March 2018, along with the same time period in 2016 and 2017 for comparison:

Lockport			
	2016	2017	2018
Yards of Net Fished	7,300	5,600	22,400
Miles of Net Fished	4.1	3.2	12.7
Hoop Net Nights	0	0	0
Mini Fyke Net Nights	0	0	0
Electrofishing Runs	4	0	0
Electrofishing Time (hrs)	1.0	0.0	0.0
Total Asian Carp (AC)	0	0	0
Tons of AC Harvested	0	0	0

Brandon Rd			
	2016	2017	2018
Yards of Net Fished	7,500	5,700	18,400
Miles of Net Fished	4.3	3.2	10.5
Hoop Net Nights	0	0	0
Mini Fyke Net Nights	0	0	0
Electrofishing Runs	4	0	0
Electrofishing Time (hrs)	1.0	0.0	0.0
Total Asian Carp (AC)	0	0	0
Tons of AC Harvested	0	0	0

Dresden Island			
	2016	2017	2018
Yards of Net Fished	5,350	4,900	32,900
Miles of Net Fished	3.0	2.8	18.7
Hoop Net Nights	0	0	0
Mini Fyke Net Nights	0	0	0
Electrofishing Runs	0	0	12
Electrofishing Time (hrs)	0.0	0.0	3.0
Asian Carp (AC) upstream I-55	0	0	0
AC downstream I-55	23	4	306
Total AC	23	4	306
Tons of AC Harvested	0.2	0.0	2.7
AC/1000 yds of gill net	4.3	0.8	9.3

Rock Run Rookery			
	2016	2017	2018
Yards of Net Fished	5,300	3,500	13,600
Miles of Net Fished	3.0	2.0	7.7
Pound Net nights	0	0	4
Bighead Carp	9	11	23
Silver Carp	12	5	47
Total Asian Carp (AC)	21	16	70
Tons of AC Harvested	0.3	0.2	0.9
AC/1000 yds of gill net	4.0	4.6	5.1

Barrier Defense Asian Carp Removal Project

Barrier Defense specifically takes place in the Marseilles and Starved Rock Pools. Below is a summary of all IDNR Barrier Defense activities through March 2018, which is solely comprised of the Unified Fishing Method in the West Pit the week of March 19th, along with the same time period in 2016 and 2017 for comparison:

	2016	2017	2018
Number of Days Fished	14	13	5
Number of Net Crew Days	92	98	35
Yards of Net Fished	78,300	56,130	24,100
Miles of Nets Fished	44.5	31.9	13.7
Number of Pound Net nights	20	35	15
Number of Hoop Net nights	0	0	0
Number of Bighead Carp	2,242	336	176
Number of Silver Carp	20,423	20,058	8,852
Number of Grass Carp	10	27	1
Number of Asian Carp (AC)	22,675	20,421	9,029
Tons of AC Harvested	96.1	74.1	40.9
AC/1000 yds of gill net	209.5	354.4	327.2

By comparison, the 2017 Unified Fishing Method in the West Pit resulted in 8,353 Asian carp (8,297 Silver Carp, 56 Bighead Carp) being removed over the course of two weeks totaling 75,161 pounds (37.6 tons). Total effort in 2017 was 20.1 miles of gill net, one 0.5 mile seine haul and 14 pound net nights.

Marseilles			
	2016	2017	2018
Yards of Net Fished	72,650	41,330	23,900
Miles of Nets Fished	41.3	23.5	13.6
Pound Net nights	20	35	15
Hoop Net nights	0	0	0
Mini Fyke Net Nights	0	0	0
Electrofishing Runs	0	0	12
Electrofishing Time (hrs)	0.0	0.0	3.0
Bighead Carp	2,068	114	176
Silver Carp	18,075	10,109	8,777
Grass Carp	3	8	1
Total Asian Carp	20,146	10,231	8,954
Tons of AC Harvested	89.0	37.7	40.6
AC/1000 yds of gill net	191.0	234.8	326.8

Starved Rock			
	2016	2017	2018
Yards of Net Fished	5,650	14,800	200
Miles of Nets Fished	3.2	8.4	0.1
Hoop Net nights	0	0	0
Bighead Carp	174	222	0
Silver Carp	2,348	9,949	75
Grass Carp	7	19	0
Total Asian Carp	2,529	10,190	75
Tons of AC Harvested	7.0	36.4	0.3
AC/1000 yds of gill net	447.6	688.5	375.0

Using Long-term Asian Carp Abundance and Movement Data to Reduce Uncertainty of Management Decisions

Hydroacoustic data collected during the fall 2017 surveys were analyzed for Starved Rock, Marseilles, and Dresden Island pools. Mean pool-wide Asian carp (Bighead Carp and Silver Carp) densities remained similar from 2017 compared to 2016 in Starved Rock and Marseilles pools, but declined in Dresden Island Pool (**Fig 1**). The repeated surveys of Dresden Island Pool throughout 2017 were consistently low and similar to the fall 2017 density estimate **(Fig 2).**

Hydroacoustic surveys were completed in the HMS East and West pits of the Marseilles Pool in early 2018, as well as the Dresden Island Pool. Surveys at these locations were conducted before and after Unified Method harvest to provide information on fish spatial distributions to help guide removal efforts. Surveys after harvest will help determine effectiveness of the Unified Method at reducing Asian carp densities. Data from these surveys are currently being analyzed. Acoustic telemetry receivers in the Starved Rock Pool were also downloaded in March.

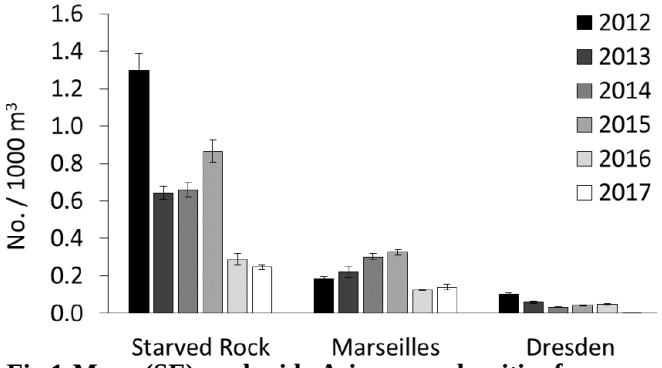

Fig 1-Mean (SE) pool-wide Asian carp densities from 2017 fall (October, after Unified Method harvest) hydroacoustic surveys in the upper Illinois River.

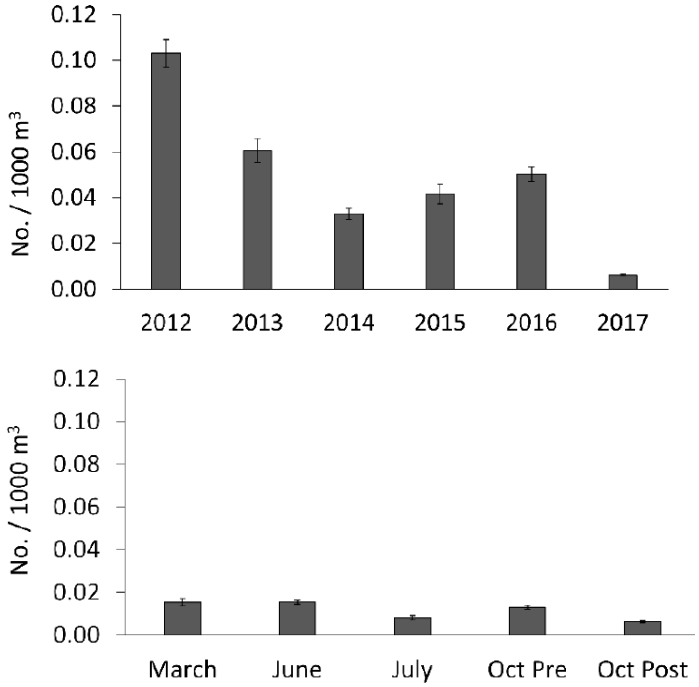

Fig 2-Mean (SE) pool-wide Asian carp densities in the Dresden Island pool from hydroacoustic surveys. Top: annual fall densities; bottom: bi-monthly densities throughout 2017 (Oct Pre and Oct Post: density estimates before and after the Unified Method in October, respectively).

Real-time USGS Acoustic Telemetry Receiver Summary

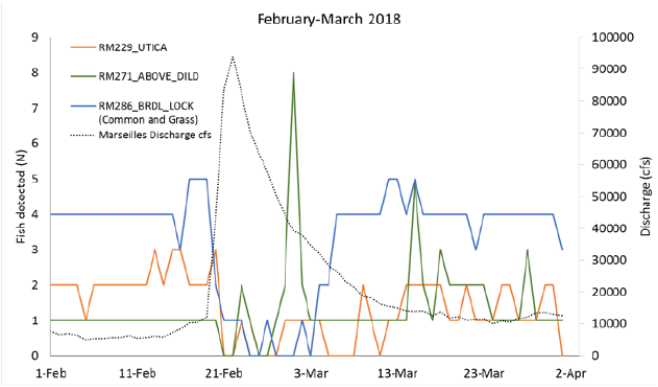

Fig 3-Graph showing fish detectgions for February and March at Utica, Minooka, and Rockdale receivers. All fish shown for Utica (RM 229; orange) and Minooka (RM 271; green) are Silver or Bighead carp. Discharge for the Marseilles gaging station (USGS 05543500) is shown as a black dotted line.

Twenty bighead or silver carp were detected on real-time receivers from 1 Mar – 1 Apr 2018. All bighead or silver carp were detected at Utica (N = 9 silver carp, 1 bighead carp) or at Minooka above Dresden Island Lock and Dam (N = 1 bighead carp, 1 big/silver hybrid, 1 silver carp). One fish was detected at two receivers, suggesting that this bighead carp passed downstream through three locks/dams (Dresden Island, Marseilles, and Starved Rock) over a two week time period (Mar 1 – Mar 15). The Bighead carp (A69-1601-23027) was detected above Dresden Island L&D (Minooka receiver) on March 1 and below Starved Rock Lock and Dam (Utica receiver) on March 15 and 16. Further downloads from stationary receivers will be necessary to confirm this movement. Additional common or grass carp were detected at the Rockdale receiver below Brandon Road Lock and Dam (N = 5 grass carp, 1 common carp), at Rockdale above Brandon Road Lock and Dam (N = 5 Common Carp), and at Minooka (N = 1 common carp). For additional details, please refer to the attached spreadsheet and graphs. For questions, please contact Marybeth Brey (mbrey@usgs.gov).

These data are preliminary or provisional and are subject to revision. They are being provided to meet the need for timely best science. The data have not received final approval by the U.S. Geological Survey (USGS) and are provided on the condition that neither the USGS nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the data.

Distribution and monitoring of juvenile Asian carp

Field crews sampled Starved Rock pool for small Silver and Bighead carps (TL <160mm) over one week during March 2018. Boat electrofishing was used from March 13 to March 15 at a total of 16 sites (4 hrs total fishing time) and resulted in a total of 1054 fish captured representing 28 species. A sum of 56 adult Silver carp and 3 adult Bighead carp were caught during sampling. No juvenile Silver or Bighead carp were captured during March 2018. High river stages as well as cold weather conditions negatively impacted the intensity of field work and fish catch rates.

Habitat usage and movement of juvenile Asian carp (telemetry)

Two weeks of effort were conducted as part of the telemetry project to determine habitat usage and movement of juvenile Silver and Bighead carps. One week was spent in the Peoria reach downloading radio telemetry data, checking batteries, and repairing radio equipment for the 2018 field season. During this time active tracking in the main channel also took place resulting in location of 3 of 12 silver carp tagged with VHF transmitters, however high water flow velocity and wind limited the signal range of tagged fish. A second week was spent in the Peoria reach deploying hydrophones in preparation for fish tagging during 2018.

Telemetry Monitoring

USACE biologists completed downloads at 13 receivers within the Lockport, Brandon Road, and Dresden Island Pools on 12-16 March. In addition, the receivers removed prior to winter were replaced throughout all three pools for the upcoming sampling season. Downloaded data was briefly analyzed to determine if any fish moved between pools or through the dispersal barrier. No Bighead or Silver Carp were detected upstream of the Brandon Road Lock and Dam. No fish passage through the electric dispersal barrier system was observed. One Common Carp appears to have moved upstream through Lockport Lock in early March. The data will continue to be processed for fish movement and habitat use patterns.

Barrier Maintenance & Fish Suppression

From March 7th through April 3rd, Barrier 2A was turned off to replace the electrodes. During the day time, when divers were in the water to remove and replace electrodes, Barrier 2B was also turned off. This occurred throughout the construction on weekdays starting around approximately 7 am to 3-5pm. Barrier 2B was operational during the weekends and turned back on once divers were out of the water. In addition, the demo barrier remained operational during the entire construction period, even when divers were in the water. Electrode replacement was complete on April 3rd and 2A was turned on. Water temperatures are being

closely monitored and barrier parameters will be adjusted to approximately 2.3 v/inch, as equipment allows, once the average water temperatures hit 50°F or greater for one consecutive week.

Ecosystem Response to Asian Carp Barrier Defense and Removal

INHS collected zooplankton and water chemistry samples at 15 main channel and backwater sites located in the Brandon Road, Dresden Island, Marseilles, Starved Rock, Peoria, LaGrange, and Alton Pools during March 26-27. The collected data will be compared to previous years' data from the same locations and will be used to assess changes in zooplankton densities and community composition in response to changing Asian carp densities.

Alternate Pathway Surveillance in Illinois - Law Enforcement

The Illinois Department of Natural Resources Invasive Species Unit (ISU) investigated a complaint from the Utah Division of Wildlife of an Illinois house boat owner transporting his boat from Lake Mead in Utah to Fox Lake in Northern Illinois that wasn't properly decontaminated for zebra and Quagga mussels.

ISU conducted several surveillance operations on a fish market that is receiving live shipments of fish from an unidentified fish hauler/dealer delivering without a license or required IDNR permits. The investigation is ongoing.

The ISU investigated a complaint of a bait shop in Northern Illinois that was selling minnows without the required license. The owner had a license purchased in his name instead of the business and was complying with all regulations.

The ISU provided training to District 4 Conservation Police Officers on fish truck inspections, commercial inspections, and invasive species enforcement techniques.

The ISU completed a training course and certification on Search Warrant and Major Case Management in Urbana, IL.

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