

Illinois Department of Natural Resources
Division of Fisheries

Salmonid Community of Lake Michigan: 2020 Fall Harbor Assessment

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TABLE OF CONTENTS

EXECUTIVE SUMMARY 3
INTRODUCTION 4
METHODS 4
RESULTS AND DISCUSSION..... 6
 Chinook Salmon..... 6
 Coho Salmon 7
 Rainbow Trout..... 9
 Brown Trout 9
CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS 10
LITERATURE CITED 11

TABLES AND FIGURES

Table 1. The 2020 salmonid stocking numbers for the Illinois waters of Lake Michigan and the sites where fall harbor assessments were conducted. 13
Table 2. Amount of electrofishing effort (min) and water temperature in four Illinois harbors sampled in 2020. Dates are separated over eight 1-week periods..... 13
Table 3. Total electrofishing effort and numbers of salmonids sampled in four Illinois harbors in 2020.. 14
Table 4. Origin and count of Rainbow Trout with coded-wire tags sampled in four Illinois harbors in 2020. 14
Figure 1. Sites of fall harbor salmonid assessments in 2020. 15
Figure 2. Catch-per-unit-effort (CPUE) of all salmonid species captured at four sampling sites from 2012 to 2020..... 16
Figure 3. Length distribution of Chinook Salmon sampled in four Illinois harbors in 2020..... 16
Figure 4. Length distributions of Coho Salmon sampled in four Illinois harbors in 2020..... 17
Figure 5. Length distribution of Rainbow Trout sampled in four Illinois harbors in 2020..... 17
Figure 6. Length distribution of Brown Trout sampled in four Illinois harbors in 2020. 18

EXECUTIVE SUMMARY

Four salmonid species had been stocked in the Illinois waters of Lake Michigan at rates of approximately 304,000 Chinook Salmon, 300,000 Coho Salmon, 100,000 Rainbow Trout, and 100,000 Brown Trout annually. In 2006, the number of Chinook Salmon stocked in Illinois waters was reduced to approximately 250,500 in a lake-wide effort to reduce the prey demand placed on the forage base by the number of Chinook Salmon in the lake. Continued declines in prey-fish biomass (Madenjian *et al.*, 2017; Warner *et al.*, 2017) prompted further Chinook Salmon stocking reductions to approximately 230,000 in Illinois waters during 2013-2016 and 150,000 in 2017-2019. Chinook stocking levels were increased to 180,000 for 2020. In fall 2020, we sampled mature salmonids in four Illinois harbors to assess their relative abundance, age and growth, and the tendency of marked fish to return to the location at which they were stocked.

Chinook Salmon and Coho Salmon comprised 67% of the salmonids sampled. Compared to 2019, catch-per-unit-effort (CPUE) of all salmonids declined at Waukegan Harbor (-44%), Diversey Harbor (-16%), North Point Marina (-35%), and Jackson Harbor (-50%). In 2020, the number of all salmonid species that we sampled declined: Chinook Salmon (-70%), Rainbow Trout (-9%), Coho Salmon (-10%), and Brown Trout (-43%).

Similar proportions of age-1 (33%) and age-2 (40%) Chinook Salmon were sampled in 2020. Age-3 (27%) constituted the remainder of the Chinook salmon sampled and no fish age-0 or age-4 were collected.

Unlike previous years, no coded-wire tagged Chinook Salmon were captured in Illinois harbors in 2020.

INTRODUCTION

The origin of the salmon fishery in Lake Michigan dates back to 1966 when Coho Salmon were first stocked as a means to utilize and ultimately control the over-abundant Alewife population (Keller *et al.*, 1990). Over 10 million salmonids are stocked annually into Lake Michigan in an attempt to control Alewife population growth and also support the world class fishery that has developed. Salmonids were first stocked in Illinois waters in 1969 and Illinois currently stocks approximately 180,000 Chinook Salmon, 300,000 Coho Salmon, 135,000 Rainbow Trout, and 110,000 Brown Trout annually comprising approximately 8.4% of the lake-wide stockings (Table 1).

Since the Illinois shoreline of Lake Michigan lacks permanent flowing tributaries, salmon and trout are stocked in harbors. Adult fish that return to these harbors in the fall are sampled by Lake Michigan Program staff using a DC electrofishing boat. This technique has proven both convenient and effective for collecting information on mature salmon and trout in harbors with relatively low water conductivity (approx. 150 $\mu\text{m}/\text{cm}$).

The objectives of annual fall salmonid harbor sampling are to: 1) collect data on returning fin-clipped and coded-wire tagged fish and assess movements and fidelity to stocking sites; 2) collect information on the condition and abundance of returning fish to address questions regarding health of the fish and the effects on the forage base; and 3) collect fish flesh samples for contaminant analysis to update the Illinois Fish Consumption Advisory.

METHODS

Fish were sampled using a GPP 5.0 (Smith-Root, Inc.) boat electrofishing pulsed-DC control box capable of delivering 5.0 kw from the generator to the electrodes. Prior to beginning an electrofishing run, the control box was used to adjust amperage to 10-12 amps and pulse frequency was set to 120 Hz. Total sampling time was based on harbor size, weather conditions, and the amount and type of fish collected.

Most sites were sampled for approximately one hour. In some cases, however, the entire site was sampled in less than 60 minutes due to weather conditions, limited access to the entire sampling site (i.e., Diversey Harbor), or an abundance of shoreline anglers preventing sampling in much of the harbor. Selection of sampling sites (Figure 1) was based on harbor configurations that were conducive to electrofishing (e.g., areas < 3 m in depth) and harbors in which salmonids were stocked. In 2020, both basins of North Point Marina, the south harbor at Waukegan (referred to as Waukegan Harbor throughout), Diversey Harbor and adjacent Lincoln Park Lagoon (jointly referred to as Diversey Harbor throughout), and the inner harbor at Jackson Park (referred to as Jackson Harbor throughout) were sampled weekly between mid-September and early November (Table 2).

Three of the four sampling sites are stocked with a full complement of the four species; however, North Point Marina is only stocked with Brown and Rainbow Trout (Table 1). Salmonid species were the target of sampling efforts. Abundance of non-target species (e.g., Alewife, Gizzard Shad, and Common Carp) was usually only noted. Sampled fish were dip-netted and held onboard until biological data were obtained. Fish were measured to the nearest 5 mm (maximum total length) and weighed to the nearest 20 grams. In addition, clipped fins, lamprey wounds, sex and maturity, and snag hook wounds were recorded. Otoliths were collected from Chinook Salmon and processed as per Robillard and Marsden (1996). Chinook Salmon and Rainbows Trout with an adipose fin clip, indicating the presence of a coded-wire tag, were checked with handheld CWT detector. Heads that had a positive detection were removed for tag extraction. Coded-wire tags (CWTs) were removed in the lab and tag numbers were used to pair stocking site and location information with specific fish. Fall harbor assessment catch-per-unit-effort (CPUE) was calculated as the number of fish sampled per one hour of electrofishing effort.

RESULTS AND DISCUSSION

A total of 139 salmonids were sampled in four Illinois harbors during fall of 2020. Coho Salmon (N=63) represented the highest proportion of fish sampled, (45%), followed by Rainbow Trout (N=33, 24%), and Chinook Salmon (N=30, 22%). Brown Trout (N=13) contributed 9% of the total catch in 2020 (Table 3).

Fall assessment CPUE for all salmonids combined was highest in Diversey Harbor (10.8 fish/hour). CPUE was 8.8 fish/hour at Waukegan Harbor and 8.3 fish/hour at Jackson Harbor. North Point Marina CPUE was the lowest of the four harbors at 2.3 fish/hour (Figure 2). With the exception of anomalously high CPUEs at Jackson Harbor in 2011 and Diversey Harbor in 2009, CPUEs have exhibited a general decline since 2006, reaching decadal lows at Jackson Harbor in 2012, Waukegan Harbor in 2014, and Diversey Harbor and North Point Marina in 2015. In 2020, CPUE for all salmonids combined decreased at Jackson Harbor (-50%) compared to 2019. Year-over-year catches also declined at Waukegan Harbor (-44%), Diversey Harbor (-16%), and North Point Marina (-35%)

CPUEs vary from year to year at each of the sampling sites depending on the success of capturing species during their peak spawning runs. Variation in water temperatures, growth and survival of each year class, and sport angler harvest may influence capture success among years. It is generally assumed that CPUE represents actual returns regardless of variability in electrofishing effort and environmental conditions among harbors. We were unable to sample Lincoln Park Lagoon as part of Diversey Harbor in 2020 due to high water levels that prevented navigation of the boat under the Fullerton Avenue Bridge. The exclusion of sampling in the lagoon may have resulted in lower catches at this site compared to previous years.

Chinook Salmon

Chinook Salmon CPUE in 2020 was highest in Waukegan Harbor (2.8 fish/hour), followed by Diversey Harbor (1.7 fish/hour), North Point Marina (0.6 fish/hour), and Jackson Harbor (0.3 fish/hour). Chinook

Salmon CPUEs at all four sampling locations were below the 15-year (2006-2020) averages of 20.8, 5.2, 8.6, and 2.9 fish/hour for Waukegan Harbor, Diversey Harbor, Jackson Harbor, and North Point Marina, respectively.

Sampled Chinook Salmon averaged 749 mm in length and ranged from 465 to 1030 mm (Figure 3). The average was 76 mm longer than the average length of Chinook Salmon sampled in 2019 and 19 mm longer than the 15-year average (2006-2020). Similar numbers of age-1 and age-2 Chinook Salmon were sampled in 2020. Age-1 fish averaged 573 mm in length in 2020, 1 mm shorter than the 15-year average (2006-2020).

During 2011-2016, all hatchery-reared Chinook Salmon stocked in Lake Michigan were implanted with CWTs as part of a lake-wide mass-marking program coordinated through the U.S. Fish and Wildlife Service (USFWS). In 2017-2020, hatchery stocked Chinook Salmon were marked with only an adipose fin clip. An adipose fin clip was evident on 29 of 30 Chinook Salmon sampled in 2020; one Chinook Salmon did not have any fin clips. No CWTs were recovered. The lack of CWT recovery was not unexpected given that 2016 was the last year Chinook Salmon stocked in Illinois waters were implanted with CWTs and only small numbers of CWTs are being implanted into Chinook Salmon in other states.

Coho Salmon

Coho Salmon CPUE was highest at Jackson Harbor (5.7 fish/hour) and lower at Diversey Harbor (4.2 fish/hour) and Waukegan Harbor (4.3 fish/hour). Coho Salmon CPUE was below the 15-year average at each respective harbor and catch rate has remained low since 2011 at North Point Marina (< 2 fish/hour; zero Coho sampled in 2020), where no Coho Salmon are stocked.

Sampled Coho Salmon ranged in length from 390 to 800 mm (Figure 4). The mean length in 2020 was 489 mm, which was below the 15-year average of 539 mm. Coho Salmon lengths were normally distributed in 2020 (Figure 4).

In 2015, Illinois initiated the first alternating fin-clip schedule for Coho Salmon since 1998. The left pectoral clip (LP) was used for Coho Salmon stocked into Diversey Harbor in 2015, 2017, and 2019; a right pectoral clip (RP) was applied to Coho Salmon stocked into Waukegan Harbor in 2016 and 2018. No Coho Salmon were fin-clipped in 2020. Information on returns of fin-clipped Coho Salmon has indicated that Coho Salmon generally return to Illinois harbors to spawn following two summers in the lake. In 2020, 11 sampled Coho Salmon had fin-clips and all were LP clips. Nine of these fish were sampled in Diversey Harbor and one each was sampled in Waukegan Harbor and Jackson Harbor. All fin-clipped Coho Salmon were stocked in 2019.

Rainbow Trout

Approximately 60,000 Arlee-strain and 50,000 Skamania-strain Rainbow Trout have been stocked each year since 2014. The number of Skamania-strain Rainbow trout increased to 75,000 in 2020. In general, relatively few Rainbow Trout are sampled during the fall in comparison to Coho and Chinook Salmon, although more Rainbow Trout than Chinook Salmon were sampled in 2020. The 33 Rainbow Trout collected in 2020 averaged 746 mm in length and ranged from 510 to 850 mm (Figure 5). The long-term time-series of Rainbow Trout CPUE has generally been low (15 year average = 1.02 fish/hour) providing little information on indexed trends in the abundance for this species.

Almost all (31 of 33) sampled Rainbow Trout in 2020 were marked with an adipose-only clip, indicating the presence of a CWT. These fish were given adipose clips and implanted with CWTs as part of a USFWS coordinated lake-wide mass marking program that began in 2017. The two additional sampled

trout had an adipose right-pectoral clip, indicating Illinois origin (Skamania-strain) Rainbow Trout from stockings before 2017.

Tags were recovered from 27 of the 31 adipose-only clipped fish (Table 4). We found that three fish did not have tags and one tag was lost during the recovery process. Information from the tags indicated that 25 of the 27 tagged trout were stocked in Illinois. Twenty-four were Skamania strain stocked in 2017 (Age-3) and one was an Arlee strain stocked in 2019 (Age-1). Two of the tagged fish were stocked in other states; one was a Skamania strain stocked in Indiana in 2018 (Age-2) and the other was an Arlee strain stocked in Wisconsin in 2018 (Age-2).

Arlee-strain Rainbow Trout are stocked at six locations in Illinois annually; however, those stocking sites are not sampled as part of the Fall Harbor assessment. Consequently, the one Illinois stocked, Arlee-strain Rainbow Trout sampled in 2020 was not sampled at the designated Arlee strain stocking site but instead was caught at North Point Marina. Skamania-strain Rainbow Trout are stocked at Northpoint Marina (beginning in 2020), Waukegan Harbor, and Diversey Harbors. Skamania-strain Rainbow Trout were caught at Waukegan, Diversey, and Jackson Park Harbors. The eight Skamania-strain Rainbow Trout collected at Jackson Park were stocked in either Waukegan or Diversey harbors (Table 4), indicating stocking site fidelity for returning Rainbow Trout to Illinois harbors is not absolute and some straying to other locations does occur.

Brown Trout

The number of Brown Trout sampled in any particular year has been highly variable and most strongly influenced by the number sampled at North Point Marina. Overall, we have observed declining trend in annual Brown Trout CPUE. Only 13 Brown Trout were sampled in 2020 and site-specific CPUE was below the 15-year average at all sites. Given that the number of Brown Trout stocked into Illinois waters has been consistent, it is likely that the variability in sport angler harvest and fall returns of

Brown Trout is driven by stocking in other states (e.g., 700,000-900,000 Brown Trout have been stocked in Wisconsin waters in the past). Changing weather patterns could affect timing of fall returns.

Fins typically are not clipped on Brown Trout stocked in Illinois waters because significant regeneration of the clipped fins has been documented and the natural curving of the fins in this species makes fin clip identification difficult. Sampled Brown Trout averaged 582 mm in length and ranged in size from 340 to 790 mm (Figure 6).

CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS

The number of Chinook Salmon stocked in Lake Michigan was reduced in 1999 in an effort to minimize stress on the limited forage base and lessen the possibility of another epizootic outbreak of Bacterial Kidney Disease which resulted in mass die-offs of Chinook Salmon in the late-1980s. Chinook Salmon numbers were reduced again in 2006 (25% lake-wide) and then again in 2013 (50% lake-wide) due to the continued decline of forage fish (primarily Alewife) and measured increases in Chinook Salmon natural recruitment. A new index of predator-prey balance was developed by the Salmonid Work Group of the Lake Michigan Technical Committee to provide guidance to fishery management agencies, and the model suggested that a continued decline in Alewife abundance in Lake Michigan would require further reductions in Salmonine predator stocking (Madenjian et al., 2017). In 2017, Illinois reduced the number of stocked Chinook Salmon to 150,000 (35% reduction from 2016) to contribute to a coordinated lake-wide reduction in predators. Slight improvement in predator-prey balance resulted in an increased stocking of Chinook Salmon to 180,000 in 2020.

Recommendation: Work with Salmonid Work Group of the Lake Michigan Technical Committee to continue adapting Chinook Salmon stocking strategies and monitoring the effects of reduced Chinook Salmon stocking on a lake-wide basis; provide data to assess predator-prey dynamics.

A very high return rate of stocked salmon to Illinois harbors is not likely to be realized since Illinois lacks tributary streams where fish may imprint and return to at maturity, and because relatively few fish are stocked compared to other jurisdictions. In an attempt to identify stocking site fidelity and track mortality rates, all Chinook Salmon stocked in Illinois waters during 2011-2016 were implanted with CWTs. In 2017, the USFWS-coordinated lake-wide mass-marking program began marking Chinook Salmon with an adipose-only clip (i.e., no tags), instead focusing coded-wire tagging efforts on identifying growth, movements, and site fidelity of Rainbow Trout stocked in Lake Michigan. A Coho Salmon marking program was initiated in Illinois in 2015, with stocked Coho Salmon receiving an RP or LP fin clip, alternating by year and stocking location. Clip returns during 2020 suggest high site fidelity (81%) by LP-clipped Coho Salmon stocked into Diversey Harbor in 2019.

Recommendation: Participate in lake-wide marking of Rainbow Trout in 2017-2021 to evaluate site fidelity to stocking locations. Continue fin clipping Coho Salmon and examining of site fidelity to specific Illinois stocking locations.

Acknowledgements

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Table 1. The 2020 salmonid stocking numbers for the Illinois waters of Lake Michigan and the sites where fall harbor assessments were conducted.

Location	Fall harbor assessment site	Number of fish stocked				
		Coho Salmon	Chinook Salmon	Rainbow Trout (Arlee)	Rainbow Trout (Skamania)	Brown Trout
North Point Marina	X				27,476	12,320
Waukegan Harbor	X	103,801	61,854		25,155	12,782
Highland Park				10,027		10,026
Dawes Park				10,027		12,166
Montrose Harbor				8,779		12,342
Belmont Harbor						10,166
Diversey Harbor	X	105,576	62,268		35,666	10,171
Burnham Harbor				8,779		10,008
31st Street Harbor				11,204		10,062
Jackson Harbor	X	108,200	61,612	11,276		10,044
Calumet Harbor						10,008
TOTALS		317,577	185,734	60,092	88,297	120,095

Table 2. Amount of DC electrofishing effort (min) and water temperature in four Illinois harbors sampled in 2020. Dates are separated over eight 1-week periods.

Dates	Location			
	North Point Marina	Waukegan Harbor	Diversey Harbor	Jackson Harbor
22, 23 September	52 / 64F	50 / 64F	31 / 66F	22 / 66F
29, 30 September	54 / 55F	59 / 55F	8 / 63F	30 / 65F
5, 6 October	58 / 52F	54 / 52F	15 / 59F	34 / 60F
13, 15 October	50 / 53F	60 / 53F	30 / 59F	35 / 60F
21 October	58 / 49F	52 / 50F		
27, 28 October	50 / 46F	55 / 47F	31 / 49F	32 / 49F
4, 5 November	45 / 45F	54 / 45F	30 / 48F	23 / 50F
12, 13 November	44 / 50F	48 / 49F	26 / 50F	34 / 52F

Table 3. Total DC electrofishing effort and numbers of salmonids sampled in four Illinois harbors in 2020.

Harbor	Effort (hrs)	Coho Salmon	Chinook Salmon	Rainbow Trout	Brown Trout	All salmonids
North Point Marina	6.85	0	4	1	11	16
Waukegan Harbor	7.2	31	20	10	2	63
Diversey Harbor	2.85	12	5	14	0	31
Jackson Harbor	3.5	20	1	8	0	29
All Harbors	20.4	63	30	33	13	139

Table 4. Origin and count of Rainbow Trout with coded-wire tags sampled in four Illinois harbors in 2020.

Stocking year	Stocking location	Sampling Location			
		North Point Marina	Waukegan Harbor	Diversey Harbor	Jackson Harbor
2017	IL-Diversey / Waukegan		6	10	8
2018	WI, multiple sites		1		
2018	IN, Salt Creek			1	
2019	IL, multiple harbors	1			

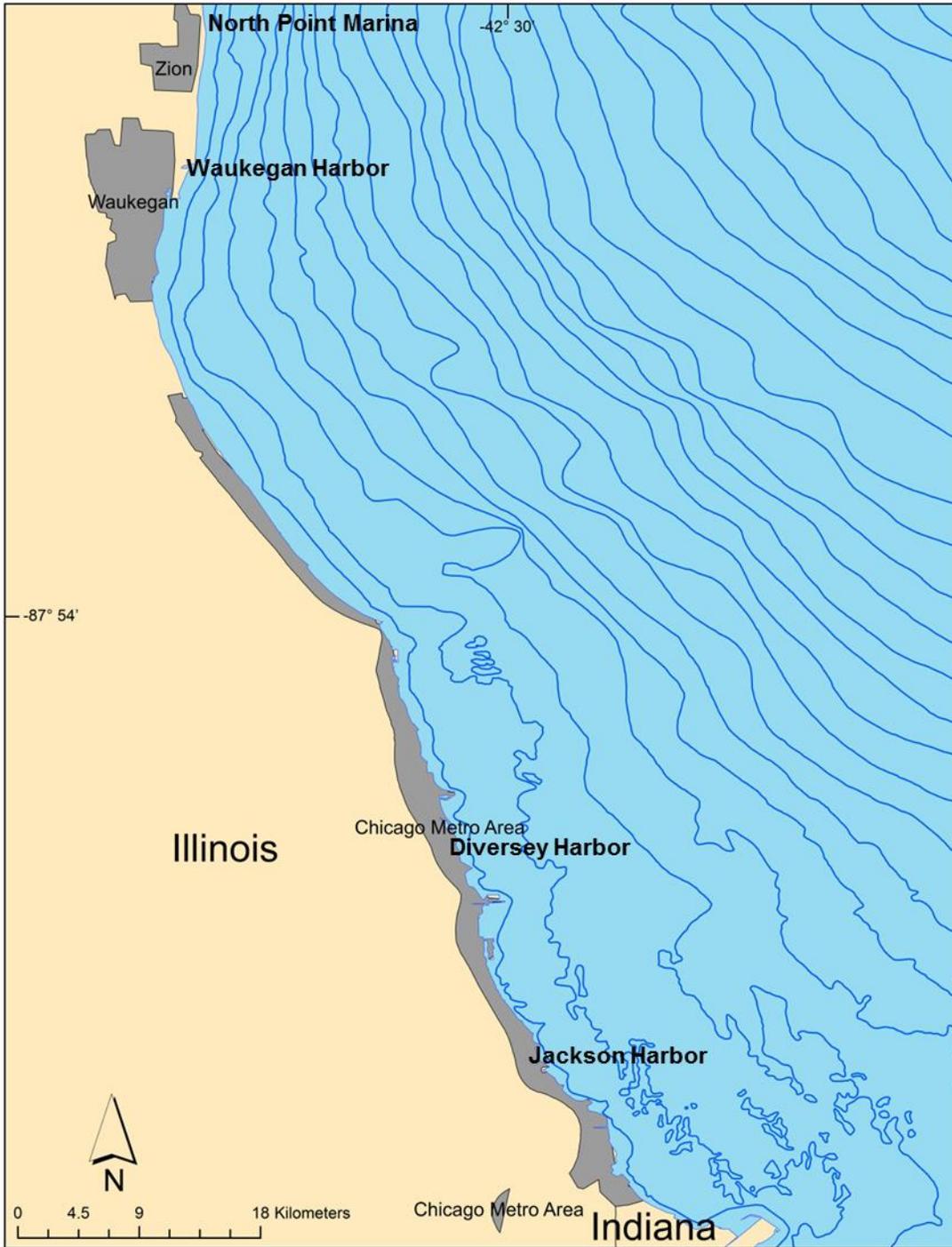


Figure 1. Sites of fall harbor salmonid assessments in 2020.

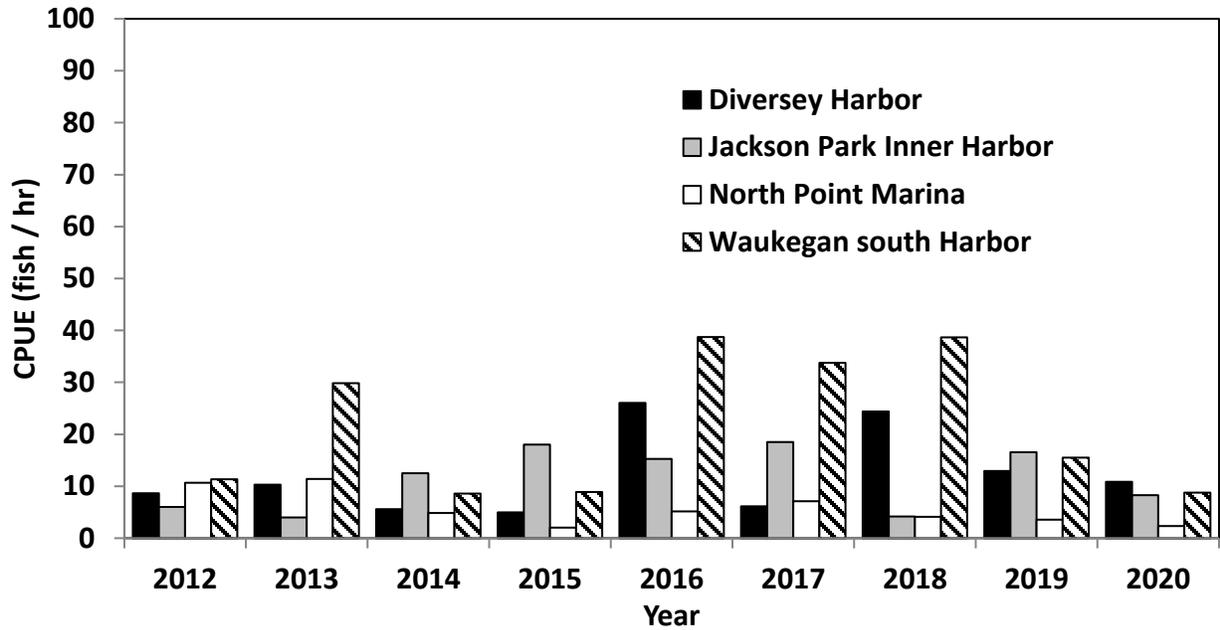


Figure 2. Catch-per-unit-effort (CPUE) of all salmonid species captured at four sampling sites from 2012 to 2020.

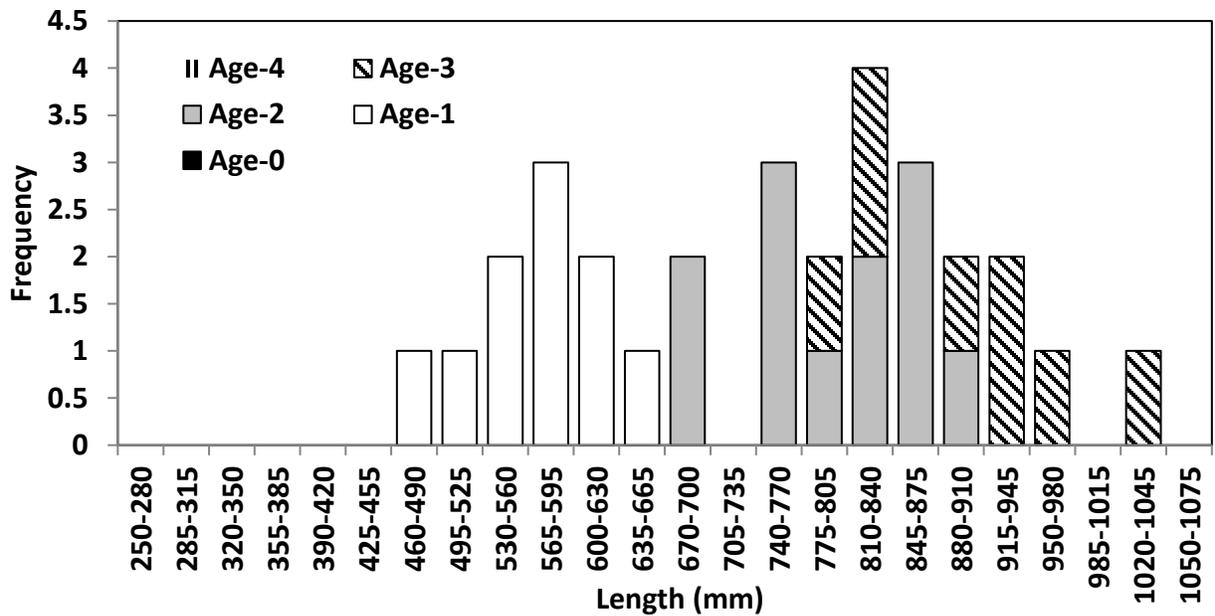


Figure 3. Length distribution of Chinook Salmon sampled in four Illinois harbors in 2020.

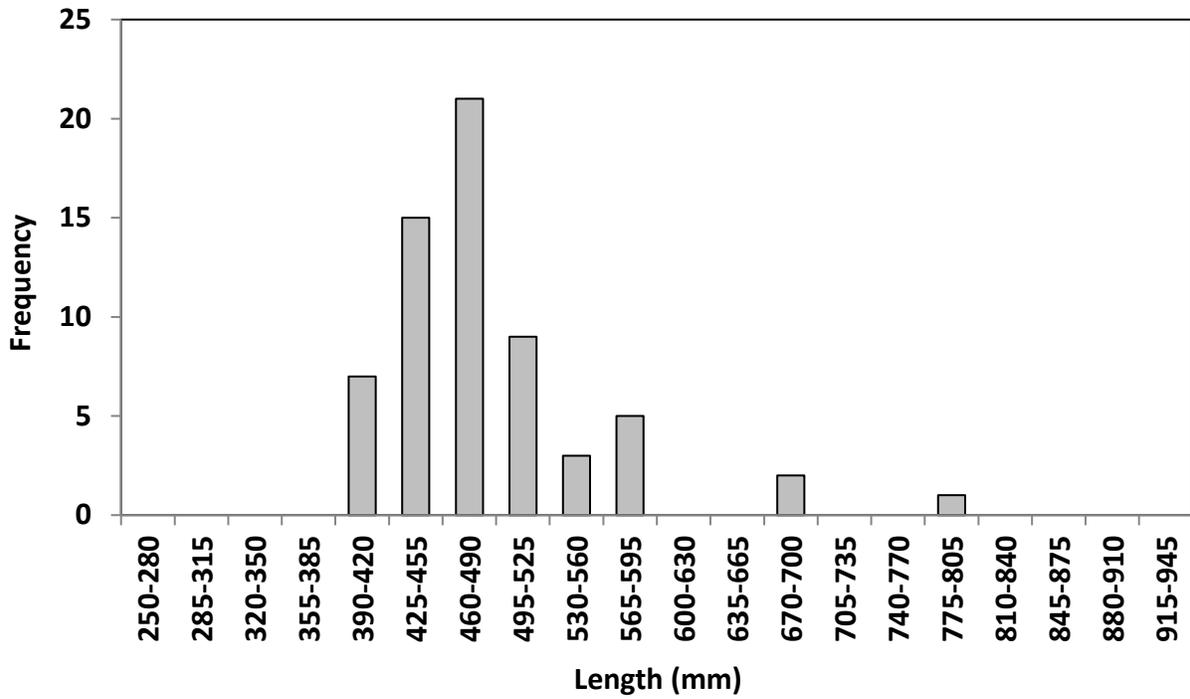


Figure 4. Length distribution of Coho Salmon sampled in four Illinois harbors in 2020.

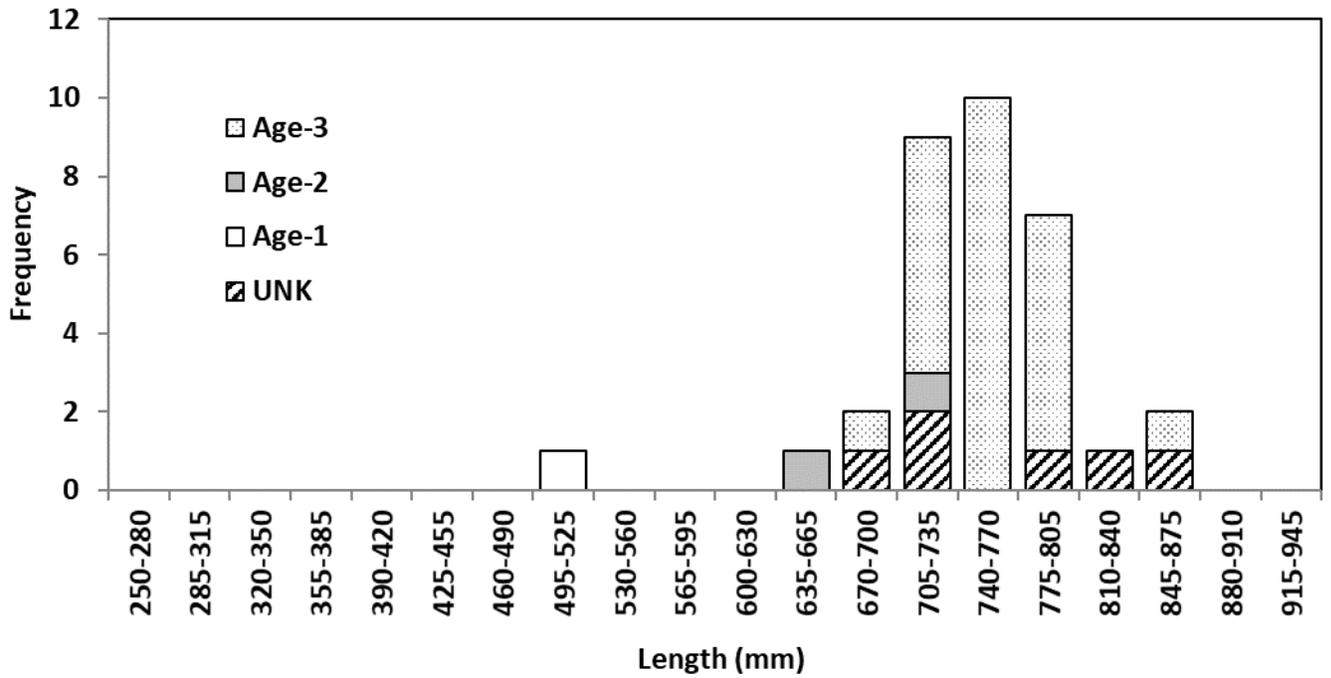


Figure 5. Length distribution of Rainbow Trout sampled in four Illinois harbors in 2020.

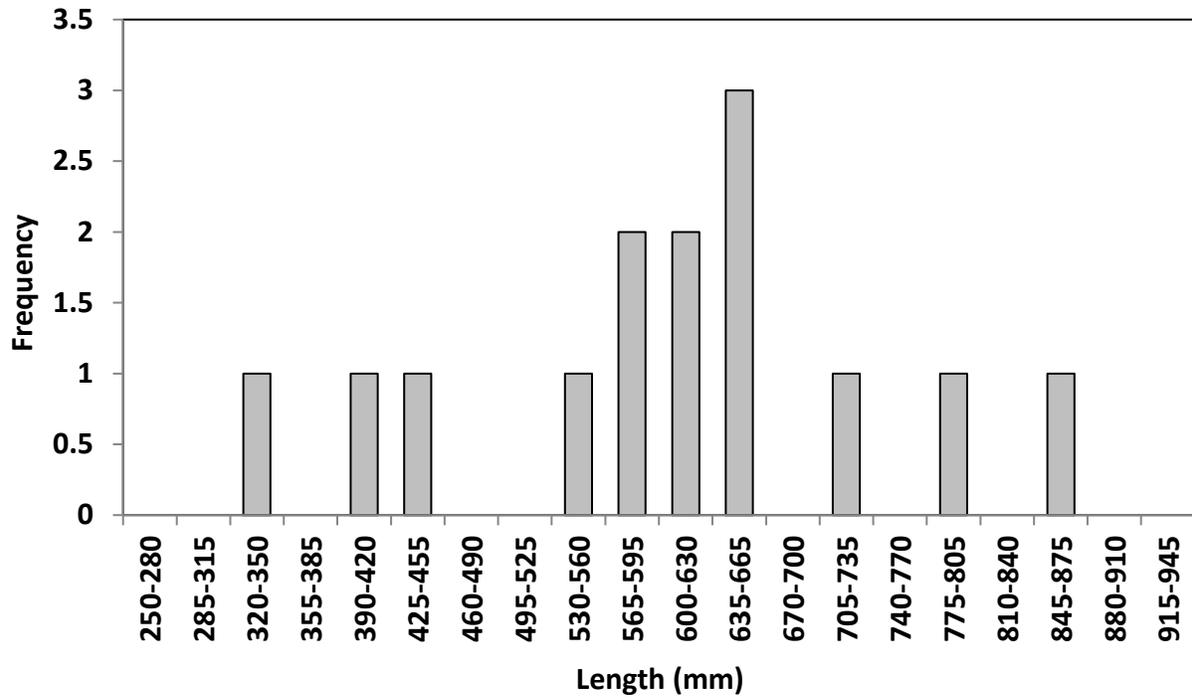


Figure 6. Length distribution of Brown Trout sampled from four Illinois harbors in 2020.