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Division of Fisheries

Salmonid Community of Lake Michigan: 2018 Fall Harbor Assessment

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EXECUTIVE SUMMARY

Four salmonid species have 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 (Bunnell *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 2017-2018. In fall 2018, 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 84% of the salmonids sampled. Compared to 2017, catch-per-unit-effort (CPUE) of all salmonids increased at Waukegan Harbor and was 3-fold higher at Diversey Harbor while total CPUE declined at North Point Marina (-42%) and at Jackson Harbor (-77%). In 2018, the number of Chinook Salmon that we sampled was similar to 2017, Rainbow Trout was 150% higher, Coho Salmon doubled, but Brown Trout decreased by 56%.

The highest proportion of Chinook Salmon in 2018 were age-2 (57%). The second most abundant age class was age-1 (24%), followed by age-3 (17%), and age-0 (2%). Similar to past years, most of the coded-wire tagged Chinook Salmon captured in Waukegan Harbor were stocked at that harbor (60%; 89 of 149). Numbers of sampled Chinook Salmon were lower in the other two stocked harbors. A majority (46 of 58) of the CWT fish captured at Diversey Harbor were originally stocked there but none of the 4 CWT fish captured at Jackson Harbor were stocked there.

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 150,000 Chinook Salmon, 300,000 Coho Salmon, 110,000 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 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 5.0kw 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 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 2018, 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 mid-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 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 10 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 with an adipose fin clip, indicating the presence of a coded-wire tag, also had the head removed for tag extraction. Coded-wire tags 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 electrofishing effort.

RESULTS AND DISCUSSION

A total of 584 salmonids were sampled in four Illinois harbors during fall of 2018. Chinook Salmon (N=304) represented the highest proportion of fish sampled, 52%, followed by Coho Salmon (N=186,

32%), then Rainbow (N=68) and Brown Trout (N=26) contributing 12% and 4% of the total catch in 2018 (Table 3).

Fall assessment CPUE for all salmonids combined was highest in Waukegan Harbor (38.7 fish/hour). CPUE increased to 24.4 fish/hour at Diversey Harbor and declined to 4.2 fish/hour at Jackson Harbor. North Point Marina CPUE remained the low at 4.1 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 2018, CPUE for all salmonids combined declined at Jackson Harbor (-77%) and North Point Marina (-42%) compared to 2017, and increased at Waukegan Harbor (+14%) and Diversey Harbor (+300%).

CPUEs vary from year to year at each of the sampling sites depending on the success of capturing particular species during their peak spawning run, water temperatures, growth, survival, and variability in sport angler harvest. It is generally assumed that CPUEs represent actual returns regardless of variability in electrofishing effort and environmental conditions among harbors.

Chinook Salmon

Chinook Salmon CPUE in 2018 was highest in Waukegan Harbor (24.6 fish/hour), followed by Diversey Harbor (9.0 fish/hour), Jackson Harbor (2.7 fish/hour), and North Point Marina (1.3 fish/hour). Chinook Salmon CPUEs at two sampling locations were below the fifteen-year (2003-2017) averages of 23.9, 6.4, 8.5, and 4.8 fish/hour at Waukegan Harbor, Diversey Harbor, Jackson Harbor, and North Point Marina, respectively.

Sampled Chinook Salmon averaged 798 mm in length and ranged from 270 to 1060 mm (Figure 3), 28 mm longer than the average length of Chinook Salmon sampled in 2017 and 78 mm longer than the 15-

year average. The most commonly sampled age group in 2018 was age-2. Age-1 fish averaged 626 mm in length in 2018, 58 mm longer than the 15-year average (2003-2017). The observed bi-modal length distribution of Chinook Salmon in 2018 is typical for the species, and the proportion of age-1 fish (24%) is similar to past years (15 year average proportion of age-1 fish = 23%). In fall 2018, we sampled 5 age-0 (stocked in 2018), 72 age-1, 172 age-2, and 52 age-3 Chinook Salmon (Figure 3).

During 2011-2016, all hatchery-reared Chinook Salmon stocked in Lake Michigan were implanted with coded-wire tags as part of a lake-wide mass-marking program coordinated through the U.S. Fish and Wildlife Service (USFWS)¹. In 2017-2018, hatchery stocked Chinook Salmon were marked with only an adipose fin clip. An adipose fin clip was present on 303 of 304 Chinook Salmon sampled in 2018; one Chinook Salmon did not have any fin clips. CWTs were recovered from 220 individuals; no tags were lost during extraction.

Information from the CWTs confirms “homing” to harbors for Illinois fish. Fish with CWTs were recaptured at the location where they were originally stocked 74% of the time (135 of 183; Table 4); similar return rates were measured in 2015-2017 (71% to 74%). This information suggests however that homing to harbors is not absolute. In 2018, CWTs indicated that 34 (15%) of the Chinook Salmon sampled in Illinois harbors were stocked in Wisconsin, and 3 were stocked in Indiana. In addition, 48 (26%) Illinois-stocked Chinook Salmon were sampled in harbors different from their stocking location.

Coho Salmon

Coho Salmon CPUE was similar at Diversey Harbor (10.8 fish/hour) and Waukegan Harbor (10.3 fish/hour). CPUEs at all harbors were below the 15-year average for their respective harbors and catch rate for Coho Salmon has remained low since 2011 (i.e., < 2 fish/hour) at North Point Marina, where no salmon are stocked. Coho Salmon CPUE increased at all harbors, except Jackson Harbor, in 2018.

¹ Indiana released 52,969 unclipped Chinook salmon into Salt Creek, a tributary to Lake Michigan, in 2011.

Sampled Coho Salmon ranged in length from 300 to 775 mm (Figure 4). The mean length of Coho Salmon in 2018 was 526 mm, and was below the 15-year sampling average (2003-2017, 542 mm). In past years, length distributions tended to be skewed toward smaller sizes as was seen in 2015, but lengths were more normally distributed in 2018 (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 and 2017; a right pectoral clip (RP) applied to Coho Salmon stocked into Waukegan Harbor in 2016 and 2018. 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 2018, 41 Coho Salmon with LP fin-clips (i.e., stocked into Diversey Harbor in 2017) were sampled, of which 39 were collected from Diversey Harbor. One RP-marked and three AD-marked Coho Salmon were sampled in Waukegan Harbor; AD-marked Coho Salmon were of Indiana origin.

Rainbow Trout

Approximately 60,000 Arlee-strain and 50,000 Skamania-strain Rainbow Trout have been stocked each year since 2014. In general, relatively few Rainbow Trout are sampled during the fall in comparison to Coho and Chinook Salmon. Sixty-eight Rainbow Trout were collected in 2018, averaging 726 mm and ranging from 585 to 895 mm (Figure 5). The time-series of relatively low Rainbow Trout CPUEs (15 year average = 0.73 fish/hour) provides little meaningful information on whether a trend in the data exists or not. Almost all (64 of 68) Rainbow Trout sampled were marked with an adipose right-pectoral (AdRP) fin clip indicating Illinois origin (Skamania-strain). One sampled Rainbow Trout had an adipose-only clip (origin unknown) and one Rainbow Trout had a right-maxillary clip (Wisconsin origin). Two Rainbow Trout sampled had no fin-clip, thus their origin (i.e., stocked or of wild recruitment) could not be determined.

An attempt to mark all Rainbow Trout stocked in Lake Michigan with fin clips has been less than successful, meaning site fidelity and growth rates have not been determined. A USFWS coordinated lake-wide mass-marking program to clip and implant Rainbow Trout with CWTs was initiated in 2017.

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, although the overall trend has been declining CPUEs. Only 26 Brown Trout were sampled in 2018, and the 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 stocked in Wisconsin waters in the past) and weather patterns.

Fins typically are not clipped on Brown Trout stocked into Illinois waters because significant regeneration of the fins and the naturally-occurring curving of the fins by this species make identification difficult. One Brown Trout sampled in 2018 had a left-pectoral fin clip; no Brown Trout with that fin clip were recorded in the lakewide stocking database. Sampled Brown Trout averaged 612 mm in length and ranged from 415 to 725 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 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., 2016). 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.

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 coded-wire tags. Beginning in 2017, the USFWS-coordinated lake-wide mass-marking program will mark Chinook Salmon with an adipose-only clip (i.e., no CWT), and CWT tagging efforts will instead be focused 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 2018 suggest high site fidelity (95%) by LP-clipped Coho Salmon stocked into Diversey Harbor in 2017.

Recommendation: Participation in lake-wide marking (i.e., CWT) of Rainbow Trout in 2017-2021 to evaluate site fidelity to stocking locations. Continue fin clipping Coho Salmon and examination of site fidelity to stocking locations.

LITERATURE CITED

- Madenjian, C. P., D. B. Bunnell, T. J. Desorcie, M. J. Kostich, M. A. Chriscinske, and J. V. Adams. 2017. Status and trends of prey fish populations in Lake Michigan, 2016. Lake Michigan Committee Meeting, March 22, 2017.
- Keller, M., K. D. Smith, and R. W. Rybicki. 1990. Review of Salmon and Trout Management in Lake Michigan. Report to the Michigan Department of Natural Resources. 254 pp.
- Robillard, S. R., and J. E. Marsden. 1996. Comparison of otolith and scale ages for yellow perch from Lake Michigan. *Journal of Great Lakes Research* 22(2):429-435.
- Warner, D. M., R. M. Claramunt, D. Hanson, T. Desorcie, T.P. O'Brien, P. Armenio, L. Ogilvie, and K. Donner. 2017. Status of pelagic prey fishes in Lake Michigan, 2016. Lake Michigan Committee Meeting, March 20, 2017.

Table 1. The 2018 salmonid stocking numbers for the Illinois waters of Lake Michigan and the sites where fall harbor assessments were conducted. ^a Jackson Harbor was not stocked with 10,000 brown trout in 2018 due to a shortfall at the hatchery.

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					9,453
Waukegan Harbor	X	90,188	56,810		26,630	9,425
Highland Park				20,152		9,548
Dawes Park						9,382
Montrose Harbor				10,010		9,053
Belmont Harbor						9,027
Diversey Harbor	X	82,907	58,514		25,792	10,041
Burnham Harbor				10,025		10,041
31st Street Harbor				9,781		10,034
Jackson Harbor ^a	X	85,410	57,318	7,316		
Calumet Harbor						10,034
TOTALS		258,505	172,642	57,284	52,422	96,038

Table 2. Amount of electrofishing effort (min) and water temperature in four Illinois harbors sampled in 2018. Dates are separated over nine 1-week periods.

Dates	Location			
	North Point Marina	Waukegan Harbor	Diversey Harbor	Jackson Harbor
20, 21 September	54 / 71F	60 / 73F	54 / 74F	25 / 80F
25, 26 September	60 / 63F	65 / 67F	68 / 71F	35 / 70F
2, 4 October	60 / 60F	82 / 63F	50 / 66F	NA
9, 12 October	56 / 56F	65 / 60F	63 / 65F	30 / 62F
18, 19 October	60 / 53F	60 / 51F	63 / 56F	28 / 56F
22, 23 October	55 / 50F	60 / 50F	66 / 53F	26 / 52F
29, 31 October	50 / 49F	58 / 49F	60 / 52F	27 / 52F
5, 7 November	55 / 47F	50 / 48F	55 / 50F	30 / 50F
15 November	NA	NA	55 / 42F	NA

Table 3. Total electrofishing effort and numbers of salmonids sampled in four Illinois harbors in 2018.

Harbor	Effort (hrs)	Coho Salmon	Chinook Salmon	Rainbow Trout	Brown Trout	All salmonids
North Point Marina	7.50	2	10	1	18	31
Waukegan Harbor	8.33	86	205	23	8	322
Diversey Harbor	8.90	96	80	41	0	217
Jackson Harbor	3.35	2	9	3	0	14
All Harbors	28.08	186	304	68	26	584

Table 4. Origin and count of Chinook Salmon with coded-wire tags sampled in four Illinois harbors in 2018.

Stocking year	Stocking location	Sampling Location			
		North Point Marina	Waukegan Harbor	Diversey Harbor	Jackson Harbor
2015	IL-Diversey Harbor		5	10	
	IL-Waukegan Harbor		22	1	
	WI-Pike/Root	3	5	1	
2016	IL-Diversey Harbor		11	36	2
	IL-Jackson Harbor		16	5	
	IL-Waukegan Harbor	4	67	4	
	IN, Jeros Park		2		1
	WI- Pike/Root	1	16	1	
	WI - Kewaunee/Pugh		2		1
	WI - McKinley/Port Washington	1			

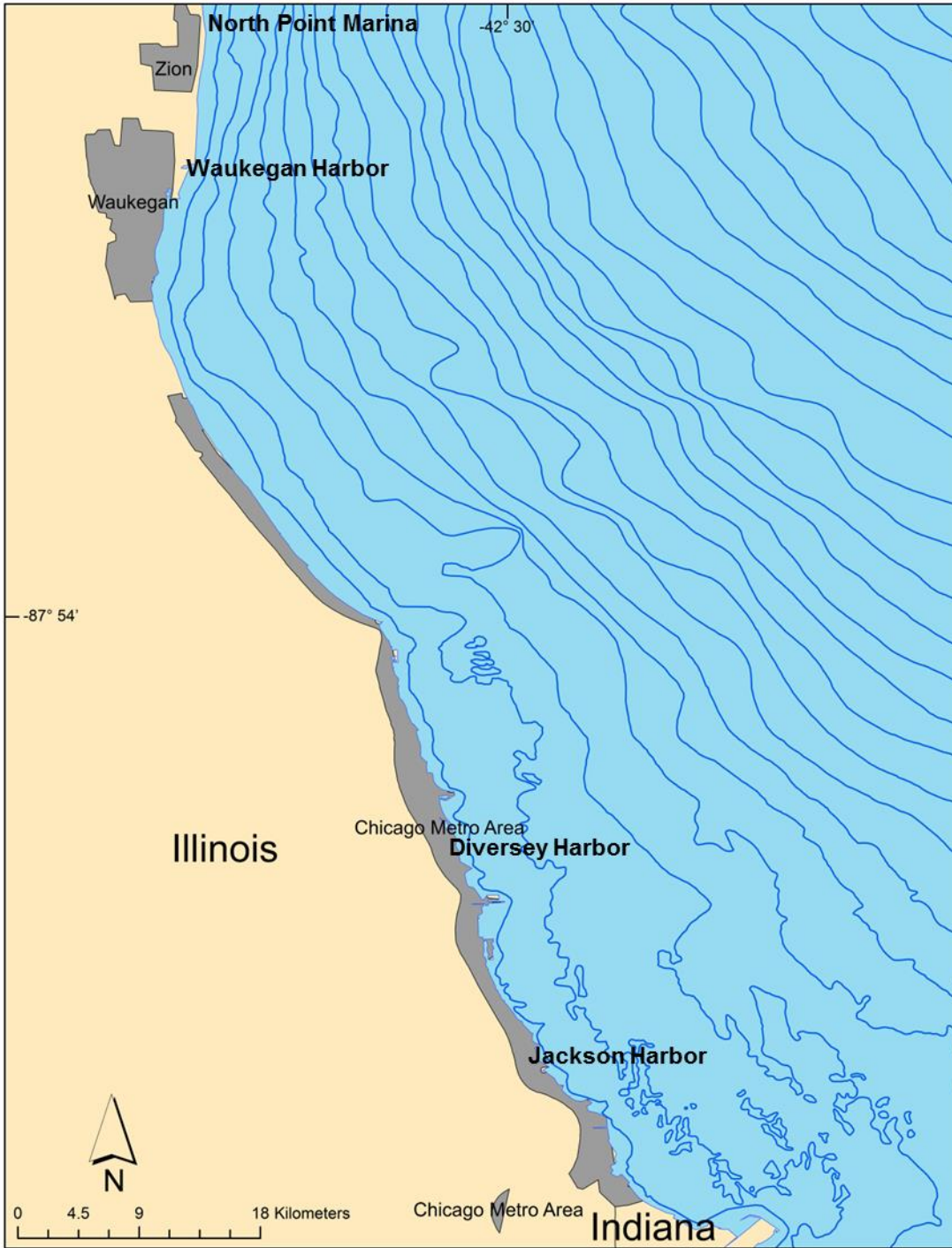


Figure 1. Sites of fall harbor salmonid assessments in 2018.

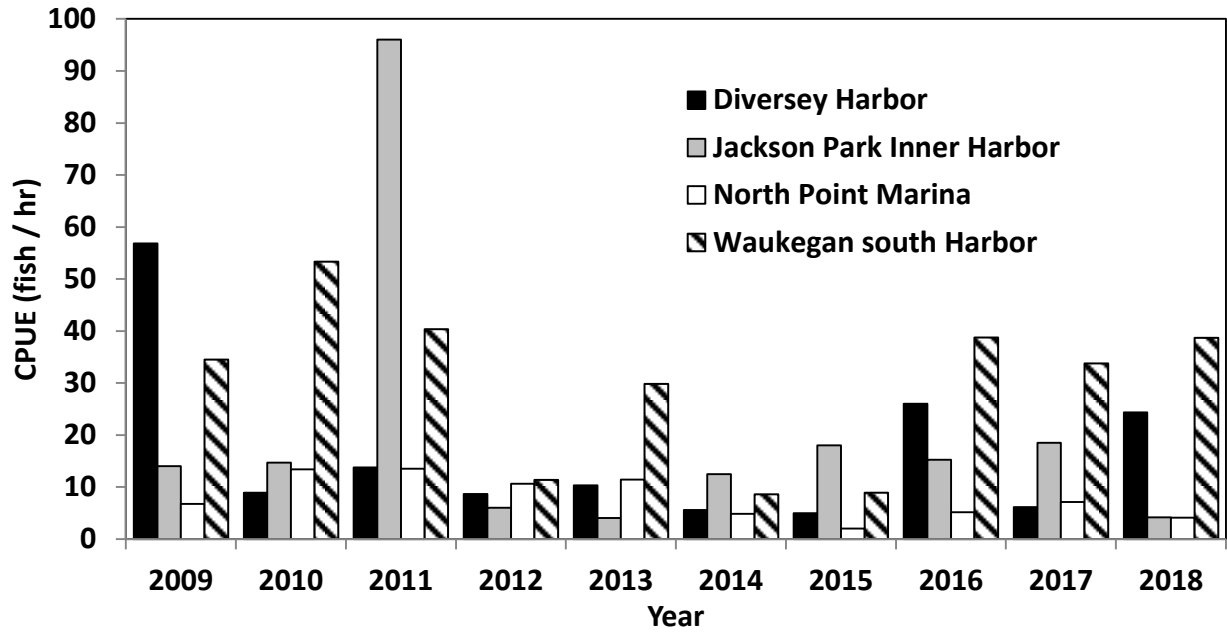


Figure 2. Catch-per-unit-effort (CPUE) of all salmonid species captured at four sampling sites from 2009 to 2018.

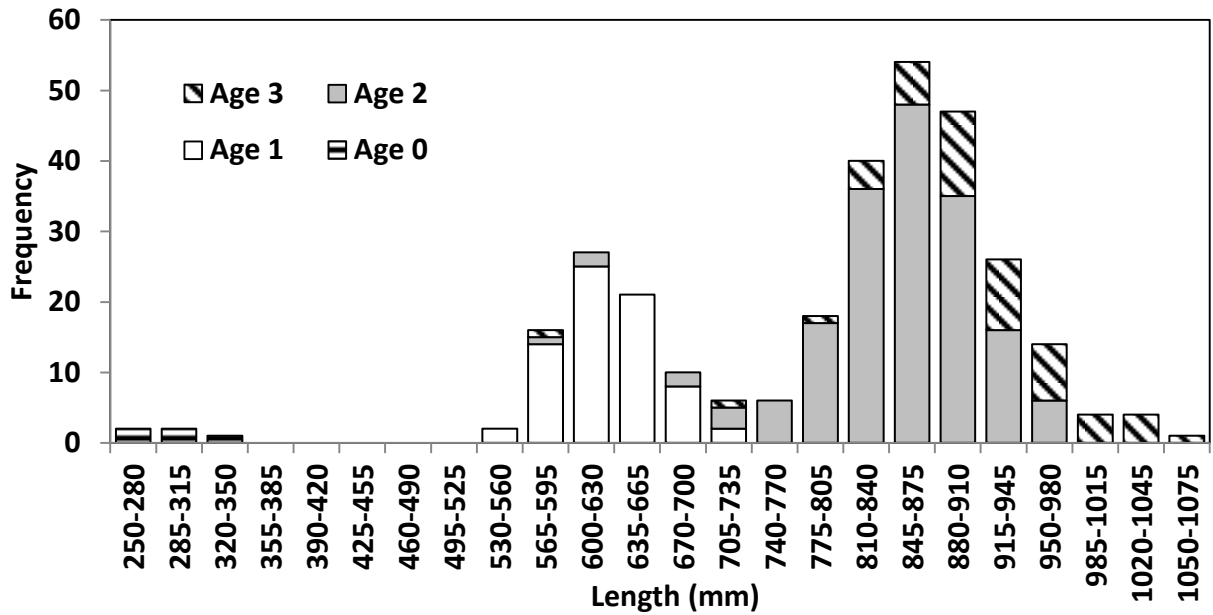


Figure 3. Length distribution of Chinook Salmon sampled in four Illinois harbors in 2018.

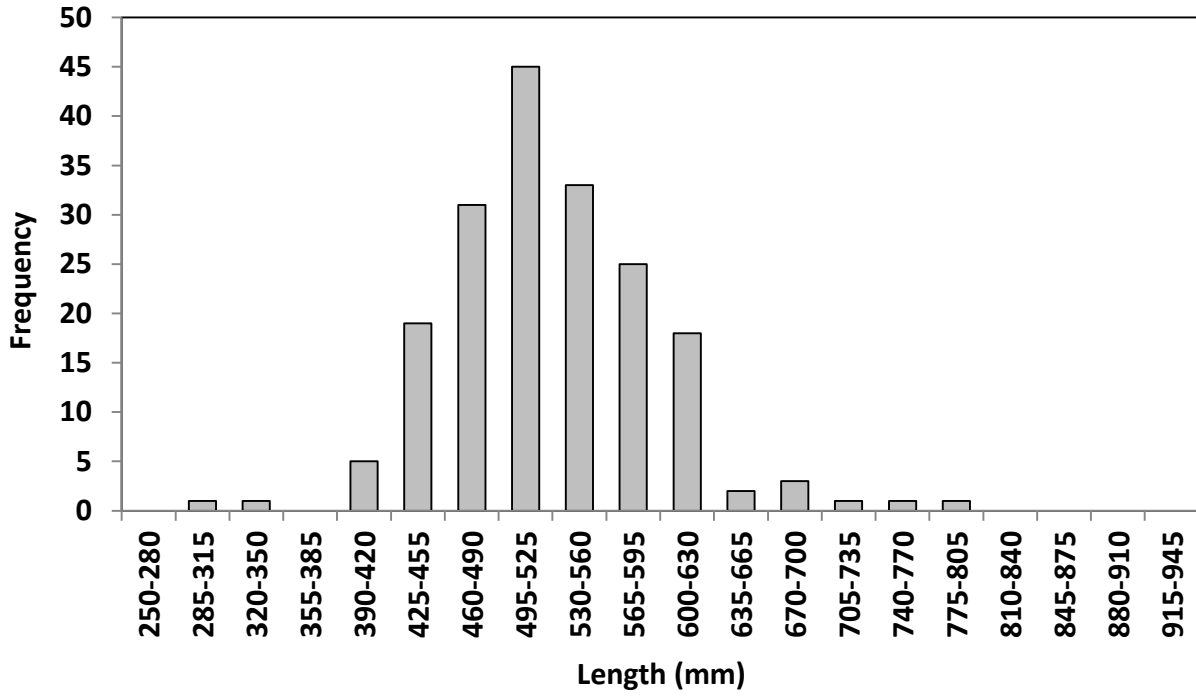


Figure 4. Length distributions of Coho Salmon sampled from four Illinois harbors in 2018.

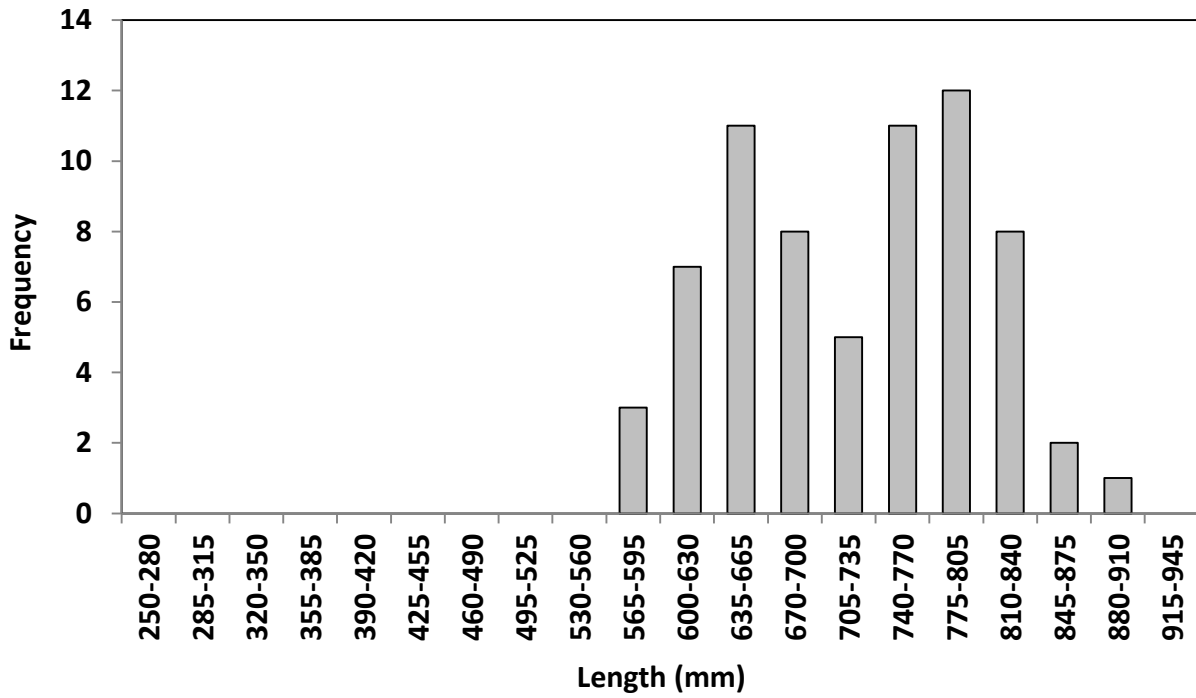


Figure 5. Length distribution of Rainbow Trout captured at four Illinois harbors in 2018.

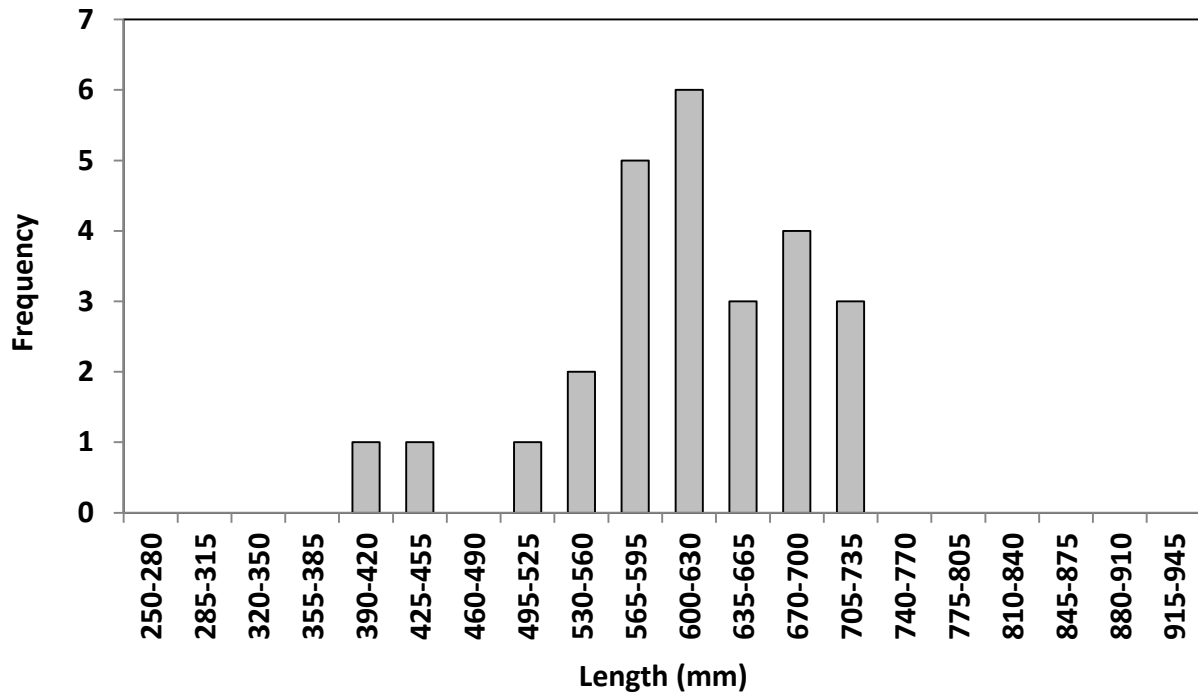


Figure 6. Length distribution of Brown Trout sampled from four Illinois harbors in 2018.