

Illinois Department of Natural Resources  
Division of Fisheries

# Salmonid Community of Lake Michigan: 2017 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 2013-2016 and 150,000 in 2017. In fall 2017, 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 82% of the salmonids sampled. Compared to 2016, catch-per-unit-effort (CPUE) of all salmonids increased at Jackson Harbor and North Point Marina while total CPUE decreased slightly at Waukegan Harbor and declined by 76% at Diversey Harbor. In 2017, the number of Brown Trout sampled increased by 74%, Rainbow Trout and Chinook Salmon numbers were similar to 2016, and Coho Salmon decreased by 70%.

The highest proportion (53%) of Chinook Salmon (N = 303) in 2017 were age-2. The second most abundant age class was age-1 (32%), followed by age-3 (13%), age-4 (1.2%), age-0 (<1%), and age-5 (<1%). Similar to past years, most of the coded-wire tagged Chinook Salmon captured in Waukegan Harbor were stocked at that harbor (80%; 146 of 182). Although numbers of sampled Chinook Salmon were lower in the other two stocked harbors, a majority of CWT fish captured at those locations were originally stocked there also (22/27 Diversey Harbor; 37/60 Jackson Harbor).

## 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 1976 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 60 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 2017, 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. Fish 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 482 salmonids were sampled in four Illinois harbors during fall of 2017. Chinook Salmon (N=305) represented the highest proportion of fish sampled, 63%, followed by Coho Salmon (N=92,

19%), then Brown (N=59) and Rainbow Trout (N=26) contributing 12% and 5% of the total catch in 2017 (Table 3).

Fall assessment CPUE for all salmonids combined was highest in Waukegan Harbor (33.7 fish/hour). CPUE declined to 6.1 fish/hour at Diversey Harbor and was 18.5 fish/hour at Jackson Harbor. North Point Marina CPUE remained the low at 7.1 fish/hour, although it exceeded Diversey Harbor CPUE (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 2017, CPUE for all salmonids combined increased at Jackson Harbor (+21%) and North Point Marina (+39%) compared to 2016, and declined at Waukegan Harbor (-13%) and Diversey Harbor (-76%).

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. We noted that water temperatures were nearly 5F above those in 2016 during the first two weeks of sampling and 10F below those of 2016 during the last three weeks of sampling. For purposes of this assessment, 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 2017 was highest in Waukegan Harbor (22.5 fish/hour), followed by Jackson Harbor (17.1 fish/hour), Diversey Harbor (3.3 fish/hour), and North Point Marina (1.4 fish/hour).

Chinook Salmon CPUEs at three sampling locations were below the fifteen-year (2002-2016) averages of 26.9, 6.9, 7.9, and 5.5 fish/hour at Waukegan Harbor, Diversey Harbor, Jackson Harbor, and North Point Marina, respectively.

Sampled Chinook Salmon averaged 770 mm in length and ranged from 330 to 1050 mm (Figure 3), 84 mm longer than the average length of Chinook Salmon sampled in 2016 and 50 mm longer than the 15-year average. The most commonly sampled age group in 2017 was age-2. Age-1 fish averaged 642 mm in length in 2017. The observed bi-modal length distribution of Chinook Salmon in 2017 is typical for the species, however the proportion of age-1 fish (32%) is higher than in past years (15 year average proportion of age-1 fish = 24%). In fall 2017, we sampled 2 age-0 (stocked in 2017), 96 age-1, 160 age-2, 40 age-3, 5 age-4, and 1 age-5 Chinook Salmon (Figure 3).

Since 2011, all hatchery-reared Chinook Salmon stocked in Lake Michigan have been implanted with coded-wire tags as part of a lake-wide mass-marking program coordinated through the U.S. Fish and Wildlife Service (USFWS)<sup>1</sup>. An adipose fin clip, indicating the presence of a coded-wire tag (CWT), was present on 305 Chinook Salmon sampled in 2017; although CWTs from 26 individuals were either not recovered, lost, or damaged so that stocking information for these fish could not be determined.

Information from the CWTs confirms “homing” to harbors for Illinois fish. Fish with CWTs were recaptured at the location where they were originally stocked 73% of the time (205 of 279; Table 4); similar return rates were measured in 2015 (76%) and 2016 (71%). This information suggests however that homing to harbors is not absolute. In 2017, CWTs indicated that 17 (6%) of the Chinook Salmon sampled in Illinois harbors were stocked in Wisconsin, 2 were stocked in Indiana and one was stocked in Michigan. In addition, 54 (19%) Illinois-stocked Chinook Salmon were sampled in harbors different from their stocking location.

### ***Coho Salmon***

Coho Salmon CPUE was highest at Waukegan Harbor (9.1 fish/hour) and no Coho Salmon were sampled at North Point Marina. CPUEs at all harbors were below the 15-year average for their respective harbors

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

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 declined at all harbors (38% to 100%) in 2017.

Sampled Coho Salmon ranged in length from 250 to 830 mm (Figure 4). The mean length of Coho Salmon in 2017 was 582 mm, and was above the 15-year sampling average (2002-2016, 537 mm). In past years, length distributions tended to be skewed toward smaller sizes as was seen in 2015, yet favored median size classes in 2017 (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 a right pectoral clip (RP) applied to Coho Salmon stocked into Waukegan Harbor in 2016. Coho Salmon with a LP clip were stocked in Diversey Harbor again in 2017. 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 2017, 35 Coho Salmon with RP fin-clips (i.e., stocked into Waukegan Harbor in 2016) were sampled, of which 100% were collected from Waukegan Harbor. No LP-marked Coho Salmon were sampled.

### ***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. Twenty-six Rainbow Trout were collected in 2017, averaging 721 mm and ranging from 430 to 825 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 (21 of 26) Rainbow Trout sampled were marked with an adipose right-pectoral (AdRP) fin clip indicating Illinois origin (Skamania-strain). Five 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. The total number of Brown Trout captured in 2017 (N=59) was higher than in 2016 (N = 34) and 2015 (N = 25), and the total CPUE (2.0 fish/hour) in 2017 was similar to the 15-year average (2.1 fish/hour). 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 annually) 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, and no Brown Trout were sampled in 2017 with fin clips so stocking source could not be determined. Brown Trout averaged 595 mm in length and ranged from 350 to 795 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 has been developed by the Salmonid Work Group of the Lake Michigan Technical

Committee to provide guidance to fishery management agencies, and current indications suggest that a continued decline in Alewife abundance in Lake Michigan requires further reduction 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 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 2017 suggest high site fidelity (100%) by RP-clipped Coho Salmon stocked into Waukegan Harbor in 2016.

*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.*

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Table 1. The 2017 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					10,584
Waukegan Harbor	X	91,485	53,305		26,893	10,584
Highland Park				10,043		10,047
Dawes Park				10,043		10,048
Montrose Harbor				10,034		10,020
Belmont Harbor						10,021
Diversey Harbor	X	107,799	53,699		27,509	10,038
Burnham Harbor				14,989		10,039
31st Street Harbor				6,995		10,038
Jackson Harbor	X	100,844	56,918	6,996		
Calumet Harbor						20,175
<b>TOTALS</b>		<b>300,128</b>	<b>163,992</b>	<b>59,370</b>	<b>54,402</b>	<b>111,594</b>

Table 2. Amount of electrofishing effort (min) and water temperature in four Illinois harbors sampled in 2017. Dates are separated over nine 1-week periods.

Dates	Location			
	North Point Marina	Waukegan Harbor	Diversey Harbor	Jackson Harbor
20, 21 September	49 / 71F	64 / 70F	61 / 74F	30 / 76F
26, 27 September	53 / 73F	56 / 74F	60 / 71F	34 / 72F
3, 5 October	56 / 59F	63 / 59F	60 / 66F	25 / 70F
9, 13 October	55 / 57F	67 / 56F	60 / 65F	25 / 68F
16, 17 October	57 / 58F	64 / 57F	56 / 60F	28 / 62F
23, 24 October	50 / 57F	60 / 57F	60 / 60F	27 / 59F
31 October; 2, 3 November	55 / 46F	55 / 49F	62 / 51F	N/A
7, 8 November	50 / 47F	49 / 46F	62 / 49F	31 / 48F
13, 14 November	62 / 40F	55 / 40F	57 / 43F	24 / 42F

Table 3. Total electrofishing effort and numbers of salmonids sampled in four Illinois harbors in 2017.

Harbor	Effort (hrs)	Coho Salmon	Chinook Salmon	Rainbow Trout	Brown Trout	All salmonids
North Point Marina	8.12	0	11	2	45	58
Waukegan Harbor	8.88	81	200	11	8	300
Diversey Harbor	8.97	7	30	12	6	55
Jackson Harbor	3.73	4	64	1	0	69
<b>All Harbors</b>	<b>29.70</b>	<b>92</b>	<b>305</b>	<b>26</b>	<b>59</b>	<b>482</b>

Table 4. Origin and count of Chinook Salmon with coded-wire tags sampled in four Illinois harbors in 2017.

Stocking year	Stocking location	Sampling Location			
		North Point Marina	Waukegan Harbor	Diversey Harbor	Jackson Harbor
2013	MI - Little Manistee	0	1	0	0
	WI - Kenosha/Racine	1	0	0	0
2014	IL-Diversey Harbor	0	5	1	2
	IL-Jackson Harbor	0	0	0	4
	IL-Waukegan Harbor	0	13	0	0
	WI-Pike/Root	1	0	0	0
2015	IL-Diversey Harbor	1	9	14	7
	IL-Jackson Harbor	1	6	0	14
	IL-Waukegan Harbor	0	91	1	2
	IN, Little Calumet	0	0	0	1
	IN, Buffington	0	0	0	1
	WI, Strawberry Crk	0	1	0	0
	WI-Kenosha/Racine	3	4	0	0
WI - Kewaunee/Pugh	0	1	0	0	
2016	IL-Diversey Harbor	0	3	7	8
	IL-Jackson Harbor	0	3	2	19
	IL-Waukegan Harbor	2	42	0	2
	WI - Kenosha/Pugh	0	3	1	0
	WI - Port Washington	1	0	0	0
	WI, Strawberry Crk	0	0	1	0



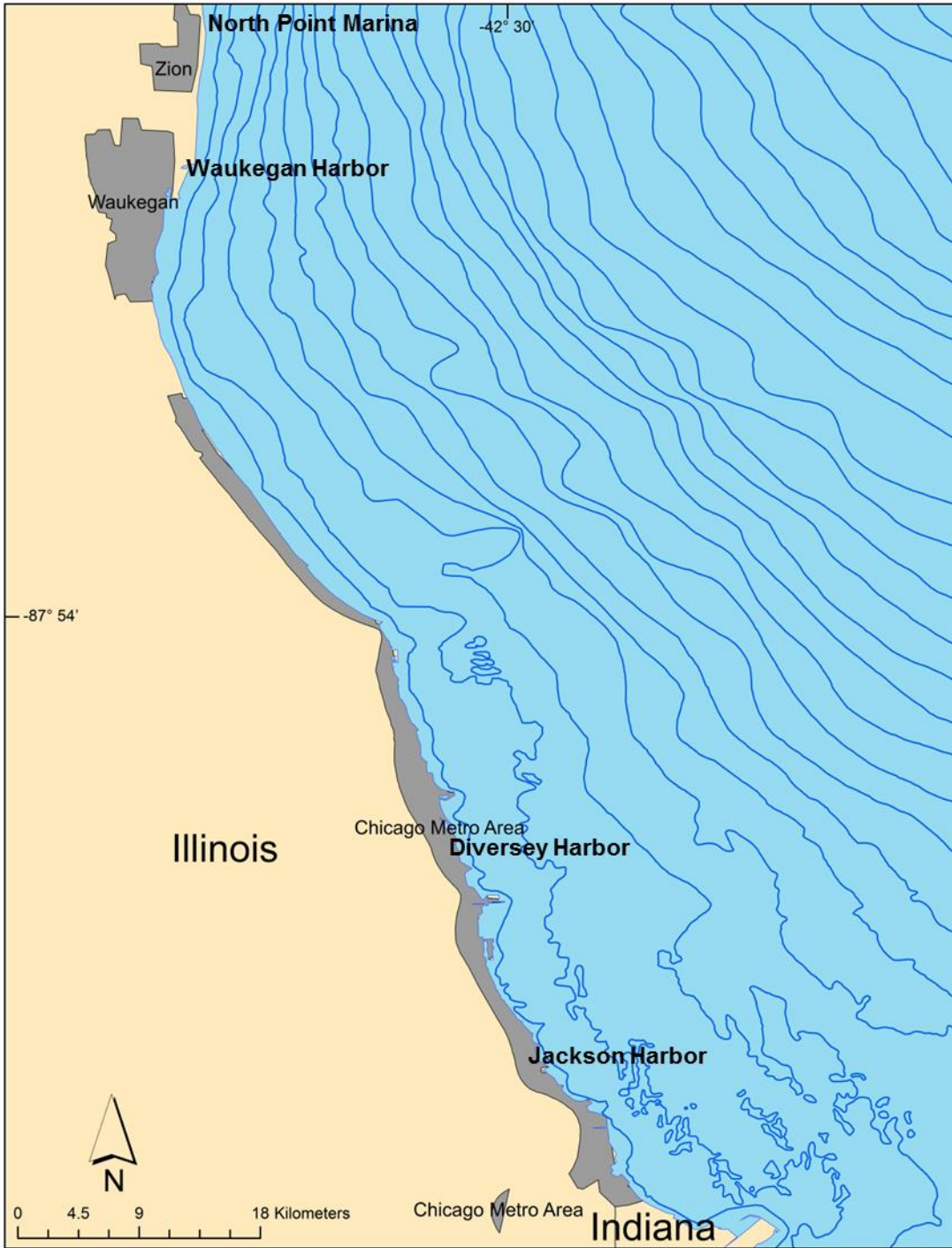


Figure 1. Sites of fall harbor salmonid assessments in 2017.

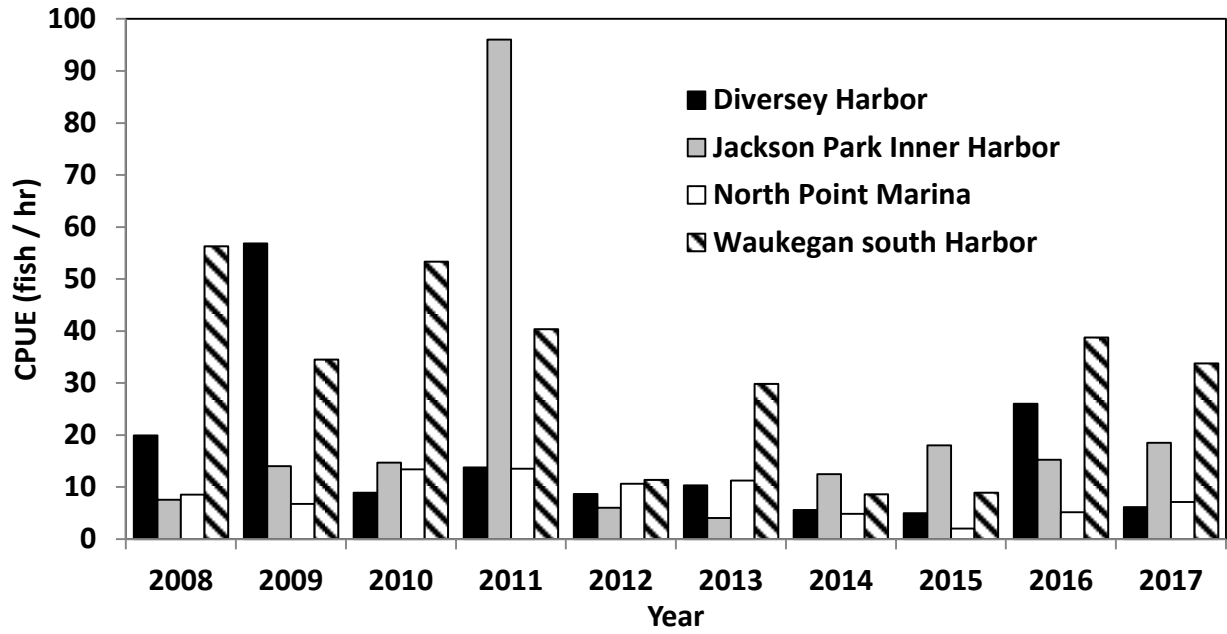


Figure 2. Catch-per-unit-effort (CPUE) of all salmonid species captured at four sampling sites from 2008 to 2017.

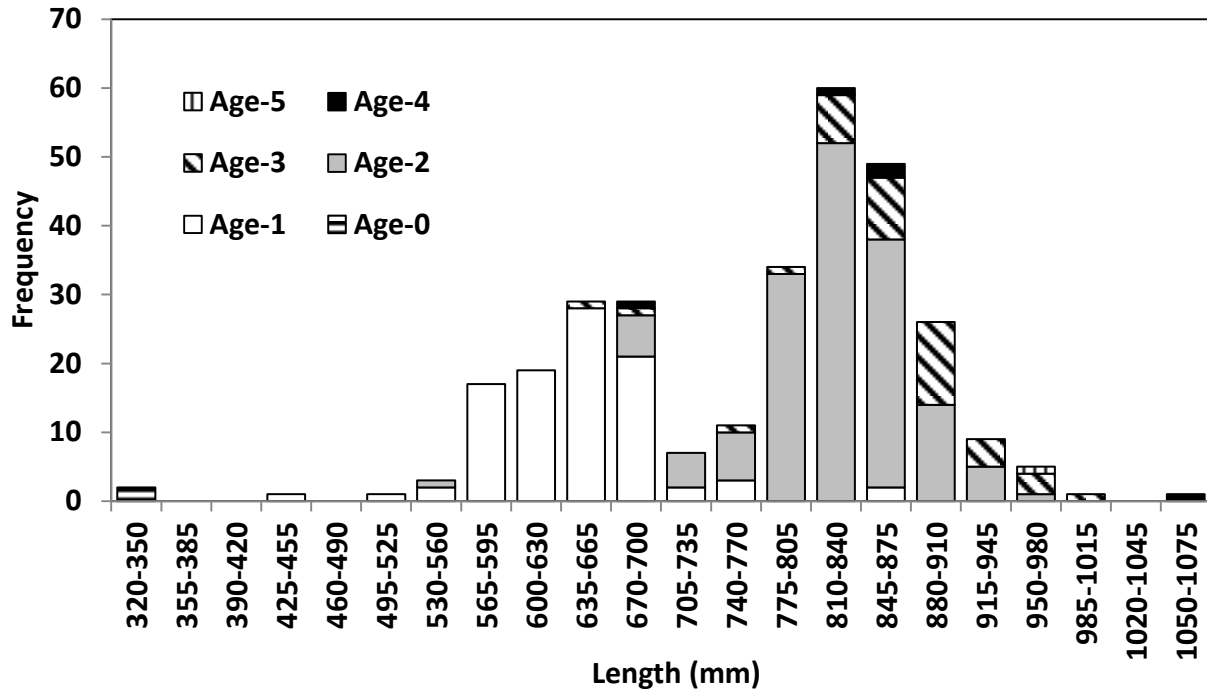


Figure 3. Length distribution of age-0 through age-5 Chinook Salmon sampled in four Illinois harbors in 2017.

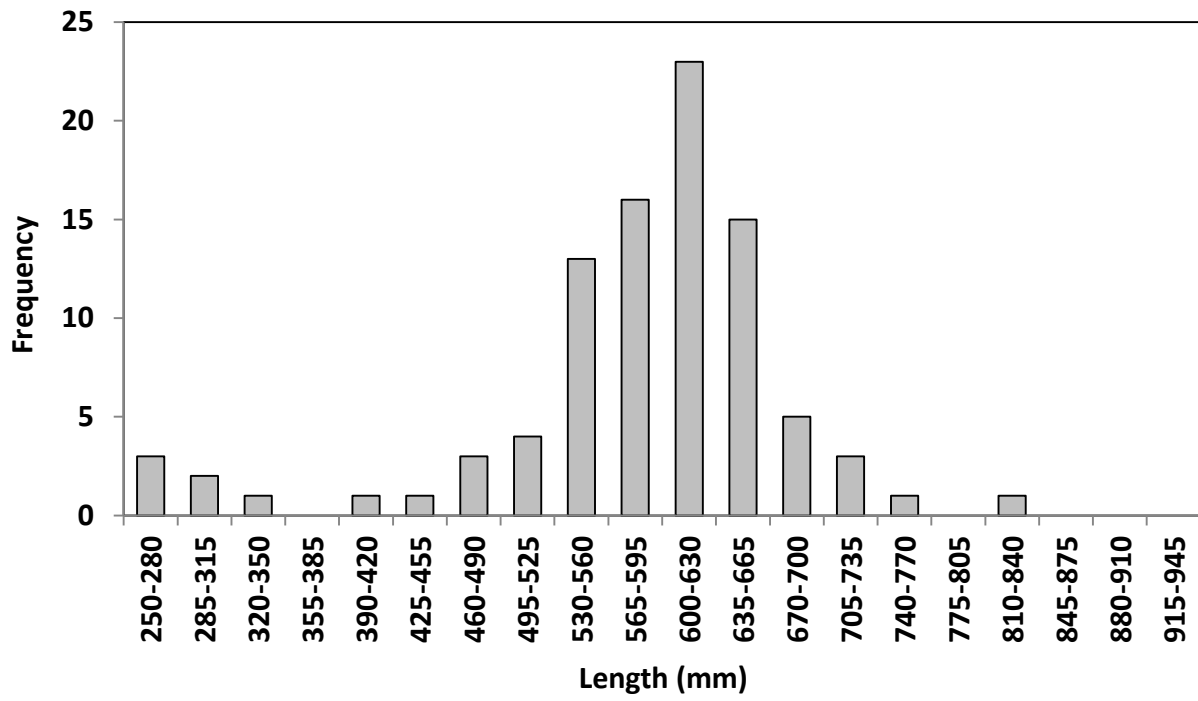


Figure 4. Length distributions of Coho Salmon sampled from four Illinois harbors in 2017.

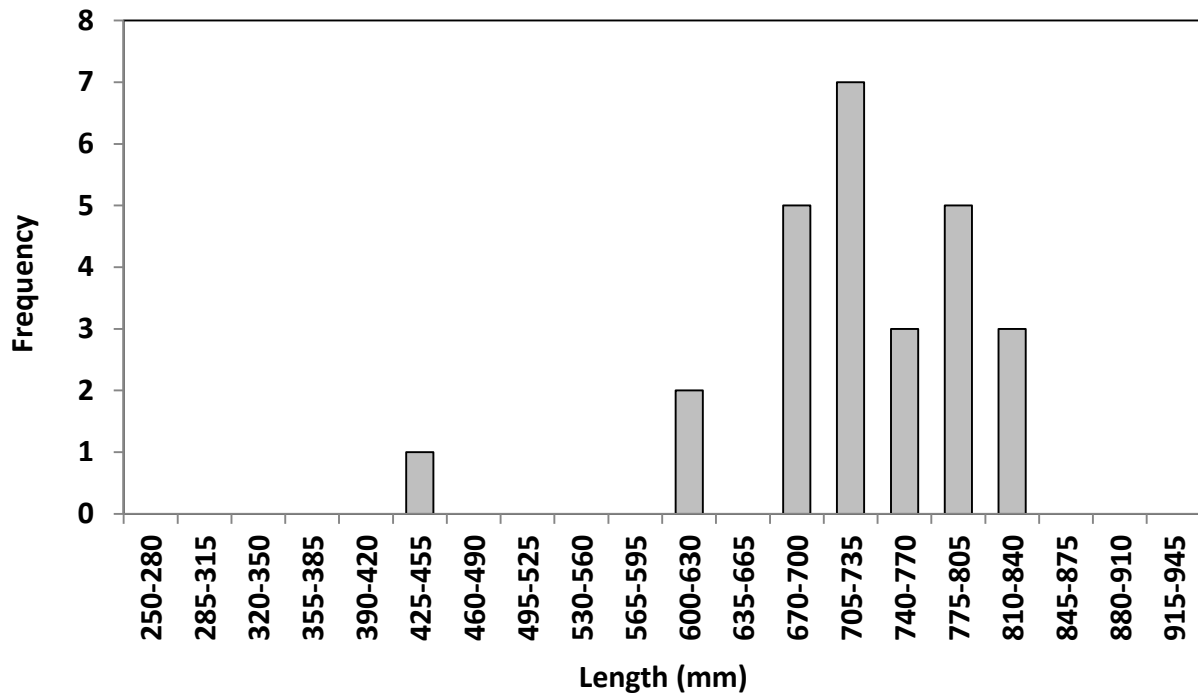


Figure 5. Length distribution of Rainbow Trout captured at four Illinois harbors in 2017.

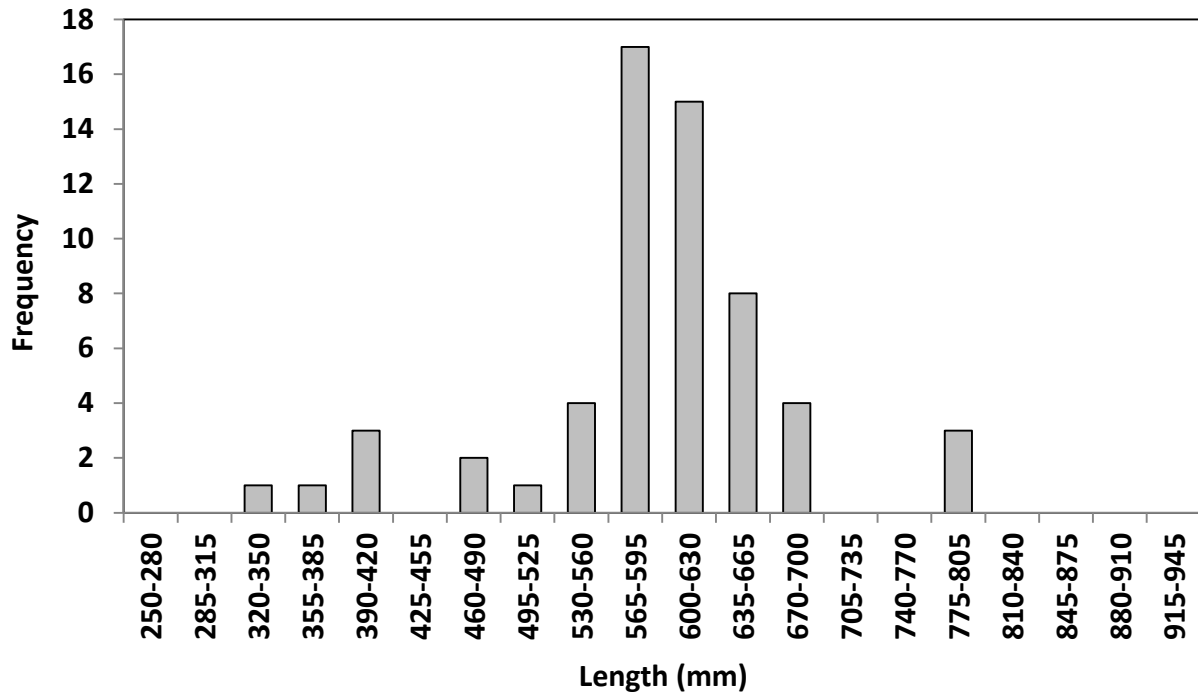


Figure 6. Length distribution of Brown Trout sampled from four Illinois harbors in 2017.