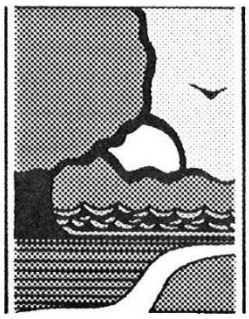

Illinois Department of Natural Resources
Division of Fisheries

Salmonid Community of Lake Michigan: 2019 Fall Harbor Assessment

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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. In fall 2019, 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 74% of the salmonids sampled. Compared to 2018, catch-per-unit-effort (CPUE) of all salmonids declined at Waukegan Harbor (-60%), Diversey Harbor (-47%), North Point Marina (-13%), but increased 3-fold at Jackson Harbor (+296%). In 2019, the number of all salmonid species that we sampled declined: Chinook Salmon (-67%), Rainbow Trout (-49%), Coho Salmon (-62%), and Brown Trout (-12%).

Similar proportions of age-1 (33%) and age-2 (31%) Chinook Salmon were sampled in 2019. Age-0 (16%) and age-3 (18%) constituted the remainder of the fish, although one age-4 Chinook Salmon was sampled. Unlike previous years, less than half of the coded-wire tagged Chinook Salmon captured in Illinois harbors were stocked at that harbor (7 of 16).

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 μm/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, 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 2019, 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 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 and Rainbows Trout 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 227 salmonids were sampled in four Illinois harbors during fall of 2019. Chinook Salmon (N=99) represented the highest proportion of fish sampled, 44%, followed by Coho Salmon (N=70, 31%), then Rainbow (N=35) and Brown Trout (N=23) contributing 15% and 10% of the total catch in 2019 (Table 3).

Fall assessment CPUE for all salmonids combined was highest in Jackson Harbor (16.6 fish/hour). CPUE declined to 13.0 fish/hour at Diversey Harbor and declined to 15.5 fish/hour at Waukegan Harbor. North Point Marina CPUE remained the low at 3.6 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 2019, CPUE for all salmonids combined increased 3-fold at Jackson Harbor (+296%) compared to 2018, and declined at Waukegan Harbor (-60%), Diversey Harbor (-47%), and North Point Marina (-13%)

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. We were only able to sample Lincoln Park Lagoon as part of Diversey Harbor on two of seven sampling events in 2019 however due to high water levels and not being able to navigate the boat under the Fullerton Avenue bridge which may have resulted in lower catches at that site.

Chinook Salmon

Chinook Salmon CPUE in 2018 was highest in Waukegan Harbor (10.4 fish/hour), followed by Diversey Harbor (4.7 fish/hour), Jackson Harbor (2.9 fish/hour), and North Point Marina (0.2 fish/hour). Chinook

Salmon CPUEs at all four sampling locations were below the fifteen-year (2004-2018) averages of 23.2, 6.5, 8.7, and 4.2 fish/hour for Waukegan Harbor, Diversey Harbor, Jackson Harbor, and North Point Marina, respectively.

Sampled Chinook Salmon averaged 673 mm in length and ranged from 255 to 1040 mm (Figure 3), 124 mm shorter than the average length of Chinook Salmon sampled in 2018 and 52 mm shorter than the 15-year average (2004-2018). Similar numbers of age-1 and age-2 Chinook Salmon were sampled in 2019. Age-1 fish averaged 566 mm in length in 2019, 8 mm shorter than the 15-year average (2004-2018). The observed tri-modal length distribution of Chinook Salmon in 2019 is atypical for the species. We sampled more age-0 and age-1 fish and less older fish than usual. Age-0 fish comprised 16% of the sample (4%, 2004-2018 average) in fall 2019. Overall, we sampled 16 age-0 (stocked in 2019), 33 age-1, 31 age-2, 18 age-3, and one age-4 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). In 2017-2019, hatchery stocked Chinook Salmon were marked with only an adipose fin clip. An adipose fin clip was present on 98 of 99 Chinook Salmon we sampled in 2019; one Chinook Salmon did not have any fin clips. CWTs were recovered from 16 individuals; tag presence was not confirmed for one Chinook Salmon in the lab.

Unlike previous years, information from the CWTs provides a mixed message regarding “homing” to harbors for Illinois and other state’s fish. Fish with CWTs were recaptured at the location where they were originally stocked only 44% of the time (7 of 16; Table 4); much higher return rates were measured in 2015-2018 (71% to 74%). This information suggests that homing to harbors is not absolute and can vary through time. In 2019, CWTs indicated that 5 (31%) of the Chinook Salmon sampled in Illinois

harbors were stocked in Wisconsin. In addition, 4 (25%) Illinois-stocked Chinook Salmon were sampled in harbors different from their stocking location.

Coho Salmon

Coho Salmon CPUE was highest at Jackson Harbor (13.0 fish/hour) and low but similar at Diversey Harbor (3.0 fish/hour) and Waukegan Harbor (2.6 fish/hour). CPUEs were below the 15-year average for their respective harbors, except for Jackson Harbor, and catch rate for Coho Salmon has remained low since 2011 (i.e., < 2 fish/hour) at North Point Marina, where no Coho Salmon are stocked.

Sampled Coho Salmon ranged in length from 270 to 750 mm (Figure 4). The mean length of Coho Salmon in 2019 was 528 mm, and was below the 15-year sampling average (2004-2018, 540 mm). In past years, length distributions tended to be skewed toward smaller sizes, but lengths were more normally distributed in 2019 (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) 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 2019, 11 Coho Salmon with fin-clips were sampled. Nine Coho Salmon with a RP fin-clip were sampled in Waukegan Harbor; based on lengths, all were stocked in 2018. One 275 mm Coho Salmon with a LP fin-clip was sampled in Diversey Harbor (likely stocked in 2019). One additional RP-marked Coho Salmon was sampled in North Point Marina.

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. Thirty-five Rainbow Trout were collected in 2019, averaging 746 mm and ranging from 555 to 845 mm (Figure 5). The time-series of relatively low Rainbow Trout CPUEs (15 year average = 1.02 fish/hour) provides little meaningful information on whether a trend in the data exists or not.

Almost all (27 of 35) Rainbow Trout sampled were marked with an adipose right-pectoral (AdRP) fin clip indicating Illinois origin (Skamania-strain). Eight sampled Rainbow Trout had an adipose-only clip, indicating presence of a coded-wire tag. A USFWS coordinated lake-wide mass-marking program to clip and implant Rainbow Trout with CWTs was initiated in 2017. Information from the CWTs indicated that all eight tagged Rainbow Trout were stocked in Illinois. Two of the tagged Rainbow Trout were Arlee strain, ages 1 and 2. The remaining six were age 2 Skamania strain Rainbow Trout. Arlee-strain Rainbow Trout are stocked at 5 or 6 locations annually however those stocking sites are not sampled as part of the Fall Harbor assessment. Therefore, these two Rainbow Trout were caught at sites not stocked with Arlee-strain fish (one sampled at Jackson Harbor and one at Diversey Harbor). Skamania-strain Rainbow Trout are stocked at Waukegan and Diversey harbors. All six of the Skamania-strain Rainbow trout were sampled at either Waukegan or Diversey harbor.

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 23 Brown Trout were sampled in 2019, 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 2019 had adipose fin clip, although no coded-wire tag was detected. Sampled Brown Trout averaged 641 mm in length and ranged from 435 to 870 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., 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.

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 2019 suggest high site fidelity (90%) by RP-clipped Coho Salmon stocked into Waukegan Harbor in 2018.

Recommendation: Participate 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 2019 salmonid stocking numbers for the Illinois waters of Lake Michigan and the sites where fall harbor assessments were conducted.

		Number of fish stocked				
Location	Fall harbor assessment site	Coho Salmon	Chinook Salmon	Rainbow Trout (Arlee)	Rainbow Trout (Skamania)	Brown Trout
North Point Marina	X					12,525
Waukegan Harbor	X	105,219	50,048		27,934	12,525
Highland Park				21,340		13,425
Dawes Park						10,048
Montrose Harbor						10,047
Belmont Harbor						23,475
Diversey Harbor	X	65,298	57,537		31,192	10,050
Burnham Harbor				10,690		10,025
31st Street Harbor				6,383		10,025
Jackson Harbor	X	99,540	51,611	6,247		10,037
Calumet Harbor						10,038
TOTALS		**270,057**	**159,196**	**55,330**	**59,126**	**132,220**

Table 2. Amount of electrofishing effort (min) and water temperature in four Illinois harbors sampled in 2019. Dates are separated over seven 1-week periods.

	Location			
Dates	North Point Marina	Waukegan Harbor	Diversey Harbor	Jackson Harbor
17, 18 September	56 / 67F	54 / 66F	20 / 69F	37 / 72F
24, 26 September	55 / 59F	60 / 56F	60 / 61F	30 / 63F
1, 4 October	53 / 57F	64 / 58F	15 / 58F	25 / 61F
7, 8 October	53 / 58F	60 / 57F	15 / 58F	20 / 60F
17, 18 October	52 / 50F	60 / 51F	27 / 55F	26 / 57F
21, 22, 23 October	50 / 54F	56 / 51F	54 / 54F	22 / 55F
28 October, 1 November	50 / 50F	60 / 50F	27 / 47F	25 / 46F

Table 3. Total electrofishing effort and numbers of salmonids sampled in four Illinois harbors in 2019.

Harbor	Effort (hrs)	Coho Salmon	Chinook Salmon	Rainbow Trout	Brown Trout	All salmonids
North Point Marina	6.15	1	1	0	20	22
Waukegan Harbor	6.90	18	72	15	2	107
Diversey Harbor	3.63	11	17	18	1	47
Jackson Harbor	3.08	40	9	2	0	51
All Harbors	**19.77**	**70**	**99**	**23**	**26**	**227**

Table 4. Origin and count of Chinook Salmon with coded-wire tags sampled in four Illinois harbors in 2019.

		Sampling Location			
Stocking year	Stocking location	North Point Marina	Waukegan Harbor	Diversey Harbor	Jackson Harbor
2015	IL-Diversey Harbor			1	
2016	IL-Diversey Harbor			1	1
	IL-Jackson Harbor		2	1	
	IL-Waukegan Harbor		5		
	WI - Pike/Root		4		
2018	WI - Root River		1		

Table 5. Origin and count of Rainbow Trout with coded-wire tags sampled in four Illinois harbors in 2019.

		Sampling Location			
Stocking year	Stocking location	North Point Marina	Waukegan Harbor	Diversey Harbor	Jackson Harbor
2017	IL-Diversey / Waukegan		1	5	
	IL, multiple harbors			1	
2018	IL-Diversey / Waukegan				
	IL, multiple harbors				1

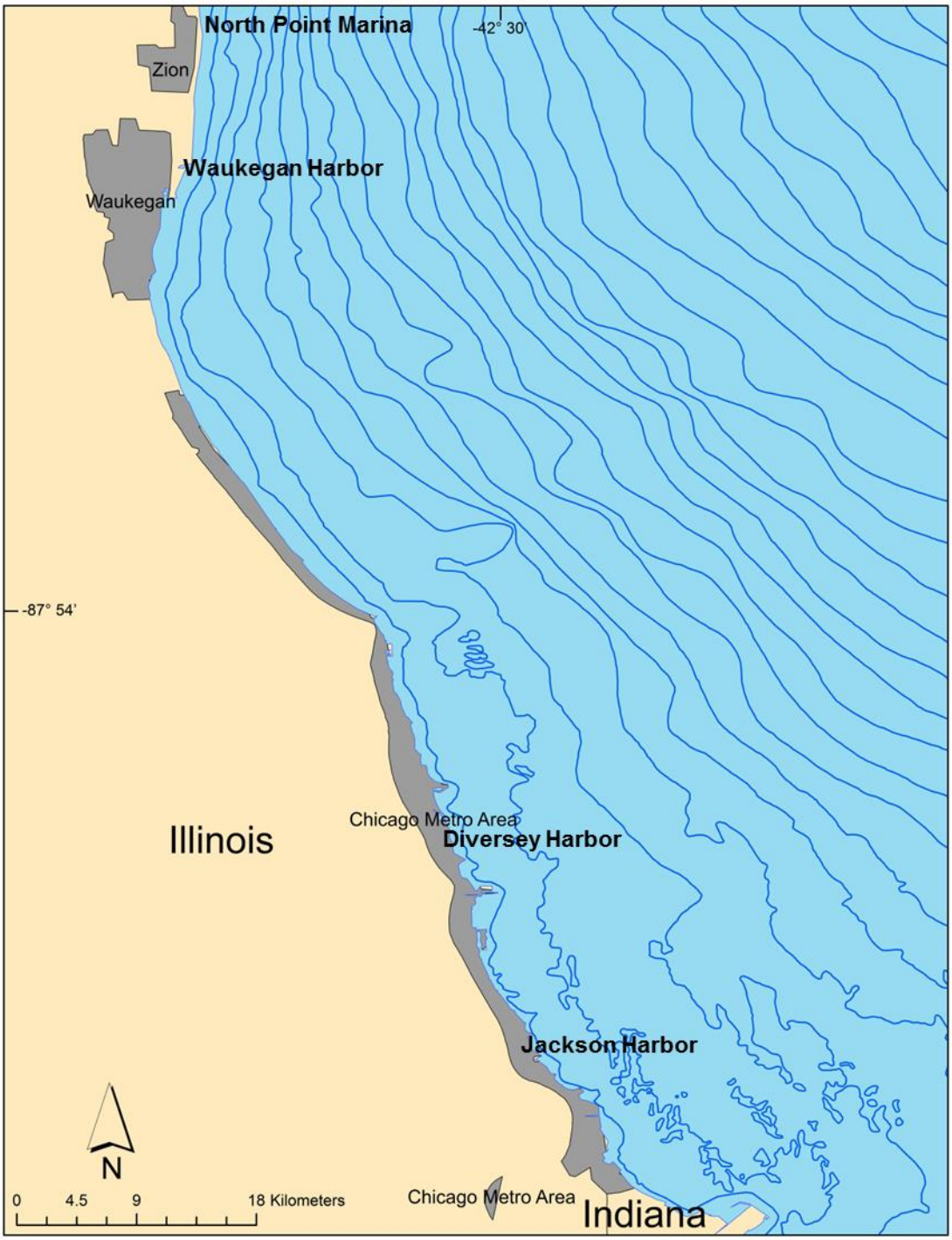

Figure 1. Sites of fall harbor salmonid assessments in 2019.

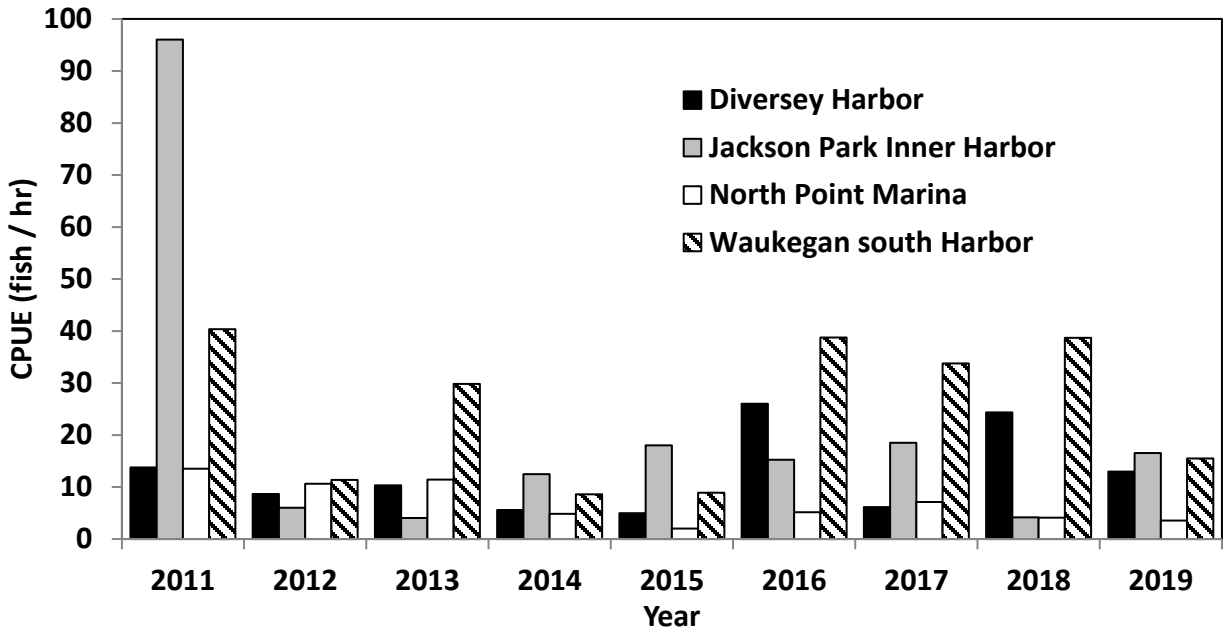

Figure 2. Catch-per-unit-effort (CPUE) of all salmonid species captured at four sampling sites from 2011 to 2019.

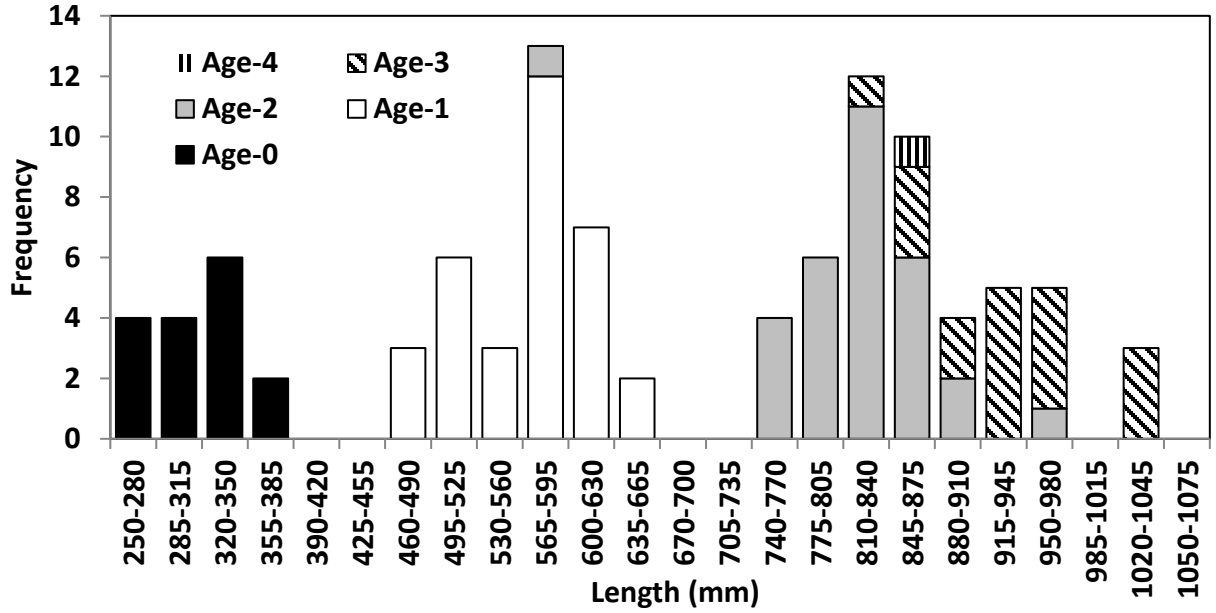

Figure 3. Length distribution of Chinook Salmon sampled in four Illinois harbors in 2019.

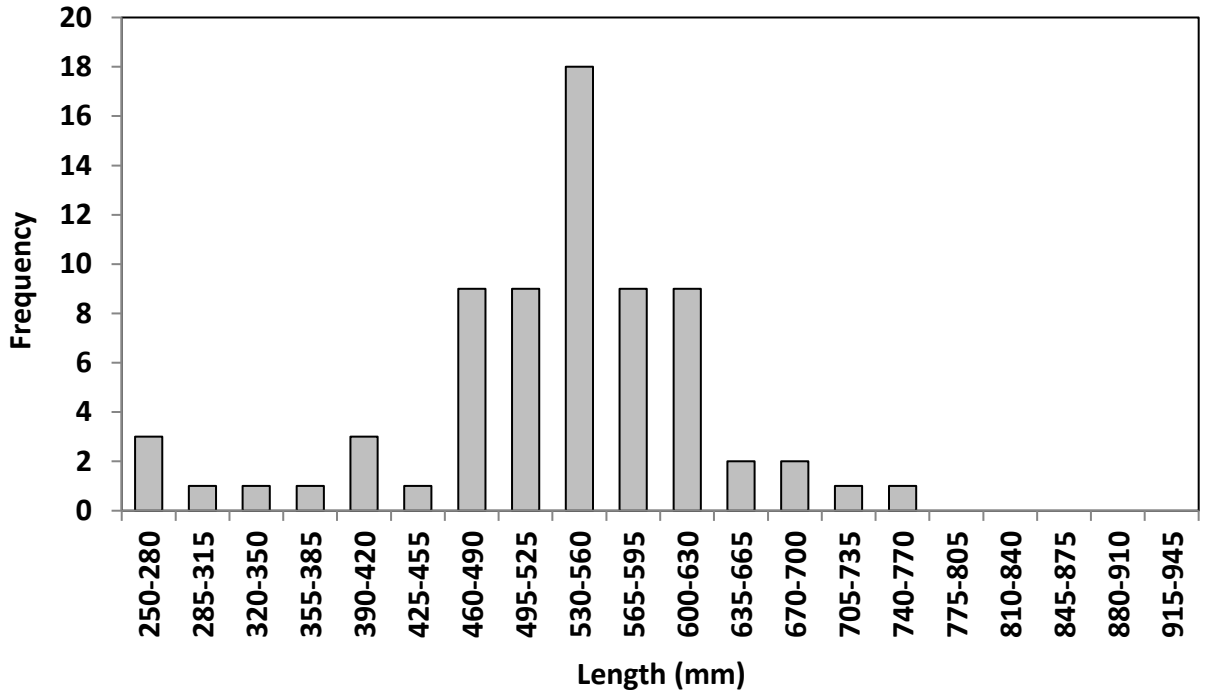

Figure 4. Length distribution of Coho Salmon sampled in four Illinois harbors in 2019.

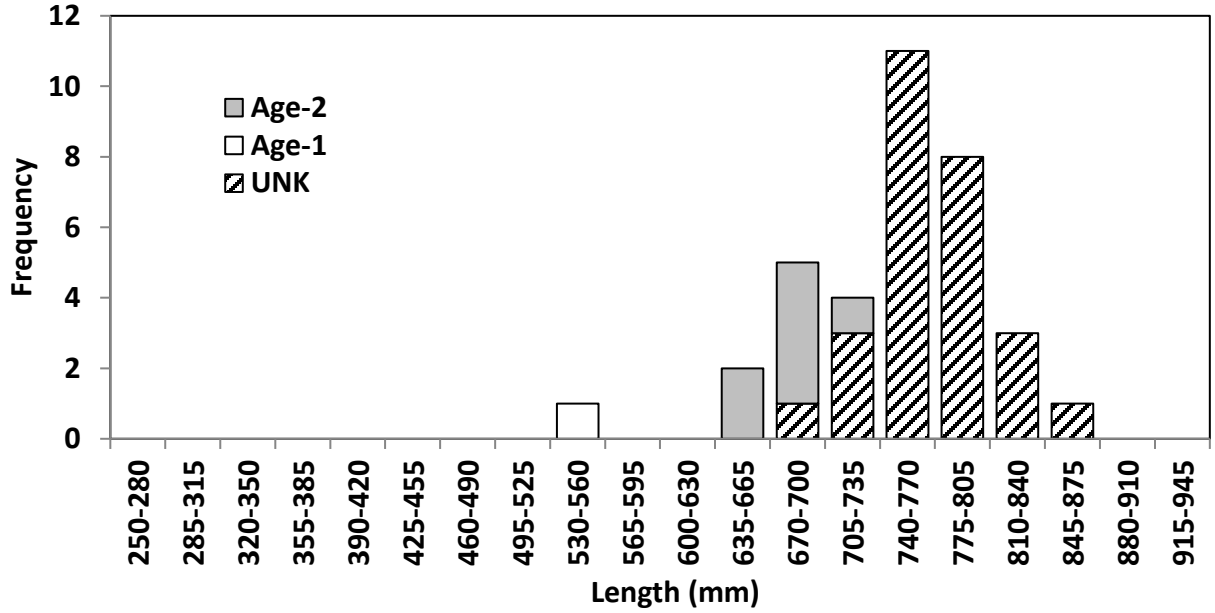

Figure 5. Length distribution of Rainbow Trout sampled in four Illinois harbors in 2019.

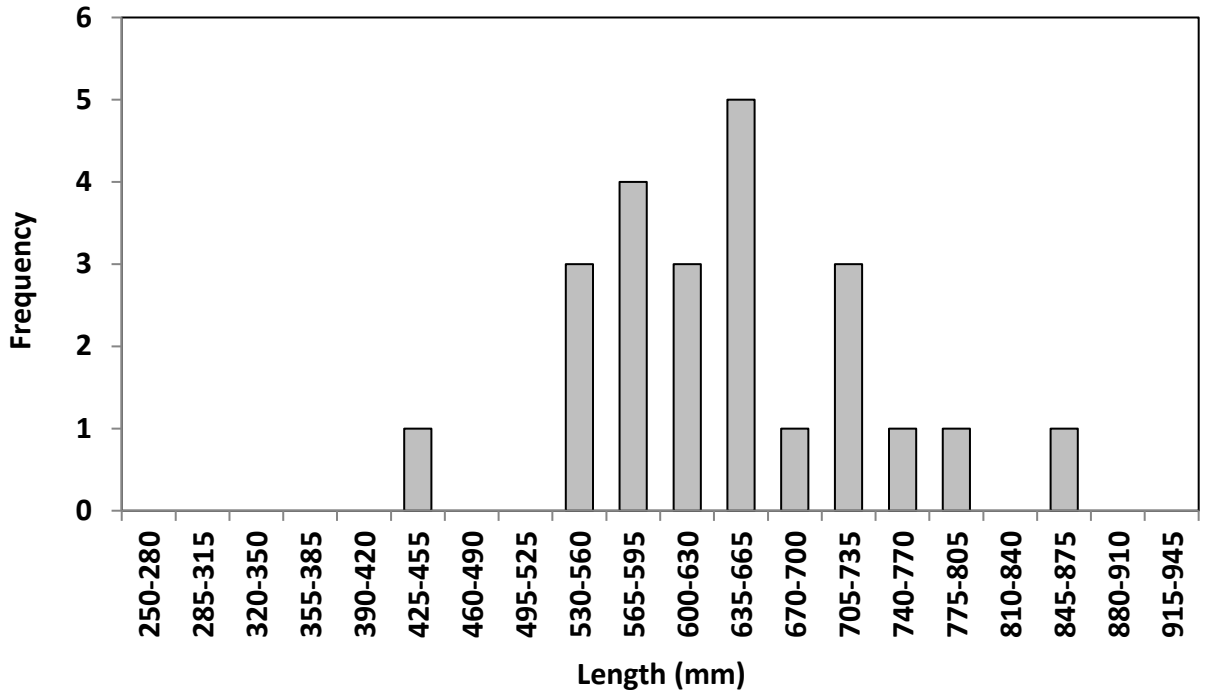

Figure 6. Length distribution of Brown Trout sampled from four Illinois harbors in 2019.