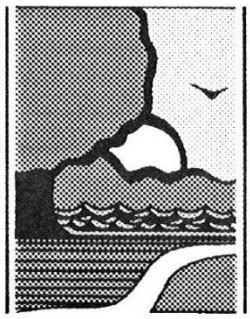

Illinois Department of Natural Resources
Division of Fisheries

Salmonid Community of Lake Michigan: 2013 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 lakewide 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.*, 2012; Warner *et al.*, 2012) prompted further Chinook stocking reductions to approximately 230,000 in 2013. In fall 2013, we sampled mature salmonids in four Illinois harbors to assess their relative abundance, age and growth, and the homing tendency of marked fish.

Coho Salmon and Chinook Salmon comprised 81.3% of the salmonids sampled. Compared to 2012, catch-per-unit-effort (CPUE) of all salmonids in 2013 increased at each harbor, with the exception of Waukegan Harbor where CPUE continued to decline. In 2013, total numbers of Coho and Chinook salmon as well as Rainbow Trout caught increased at all harbors compared to 2012, while Brown Trout numbers dropped from last year's survey.

Similar to years past, most (58.4%) of the Chinook Salmon (N = 293) in 2013 were age-2. The second most abundant age class was age-1 (22.5%); age-3 was the second most abundant age class in 2012. Information from coded-wire tags indicated that most of the Chinook Salmon sampled in Waukegan Harbor were stocked at that harbor (74%; 128 of 173). Although numbers of sampled Chinook Salmon were lower in the other two stocked harbors, most marked fish were stocked at those harbors (14/16 Diversey Harbor; 4/4 Jackson Harbor).

INTRODUCTION

The origin of the salmon fishery of 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). Since 1976, approximately 14.7 million salmonids have been 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 salmonid stocking in Illinois currently accounts for approximately 6% of the lakewide stockings. Illinois currently stocks approximately 250,000 Chinook Salmon, 300,000 Coho Salmon, 100,000 Rainbow Trout, and 100,000 Brown Trout annually (Table 1). However, in 2013 Chinook Salmon stocking in Illinois was reduced to approximately 230,000 as lakewide-prey fish biomass estimates have continued to decline (Madenjian *et al.* 2012; Warner *et al.* 2012).

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 the fall salmonid harbor sampling were to: 1) collect fish flesh samples to update the Illinois Fish Consumption Advisory; 2) collect data on returning fin-clipped and coded wire tagged fish and assess movements and fidelity to stocking sites; and 3) 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.

METHODS

Fish were sampled using a Smith-Root Model 5.0 GPP Pulsed-DC electrofishing unit, operated at 12-14 amps and 120 pulses per second. 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 (i.e., < 3 m in depth) and harbors in which salmonids were stocked. In 2013, 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).

Salmonid species were the target of sampling efforts. Abundance of non-target species (e.g., alewife, gizzard shad, and 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. 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 a coded wire tagged fish, also had the head removed for tag extraction. Fall harbor assessment catch-per-unit-effort (CPUE) was calculated as the number of fish sampled per 1 hour electrofishing effort.

RESULTS AND DISCUSSION

A total of 497 salmonids were sampled in four Illinois harbors during fall of 2013. Chinook Salmon (N=293) and Coho Salmon (N=111) comprised a majority of fish sampled, 81.3%; with Brown and Rainbow trout contributing 11.6 and 7.1%, respectively (Table 3).

Fall assessment CPUE for all salmonids combined was highest in Waukegan Harbor (31.5 fish/hour). CPUE at North Point Marina was 11.4 fish/hour and 10.2 fish/hour at Diversey Harbor. Jackson Harbor CPUE more than doubled the 2012 results in 2013 with 4.8 fish/hour, but still remains the lowest out of all harbors sampled. The 2011 sampling season in Jackson Harbor appears to have been a highly anomalous year; CPUE patterns of the four harbors in the last two years reflect patterns observed in most previous years (Figure 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).

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 and survival, and variability in sport angler harvest. 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 2013 was highest in Waukegan Harbor (23.1 fish/hour), followed by North Point Marina (5.1 fish/hour), Diversey Harbor (2.8 fish/hour), and Jackson Harbor (2.2 fish/hour). Chinook Salmon CPUEs at all sampling locations fell below the fifteen year average CPUE from 1998-2012; 9.8, 31.0, 11.7, and 9.1 fish/hour at North Point Marina, Waukegan Harbor, Diversey Harbor, and Jackson Harbor, respectively.

Sampled Chinook Salmon averaged 787 mm in length and ranged from 300 to 1025 mm (Figure 3), a 43 mm increase from the 2012 sampling period. The increase in average size was due largely to an increase in size at age for all ages rather than an increase in age (size) of fish between years. The most commonly sampled age group in 2012 and 2013 was age-2 and fish of this age averaged 833 mm in length in 2013 compared to 751 mm in 2012 (approximately 3-inch increase), and was the greatest average length at age-2 recorded since length at age analysis began in 1997. The length distribution of Chinook Salmon is typically bi-modal, with modes for age-1 and overlapping ages-2 and 3; in 1999 and 2004 however age-0 Chinook Salmon were well represented in the samples and the distribution was tri-modal. In fall 2013, three age-0 (stocked in 2013), 66 age-1, 171 age-2, 49 age-3, and four age-4 were sampled (Figure 3).

In 1999-2010, various combinations of pectoral and ventral fins were clipped on all Chinook Salmon stocked in Waukegan Harbor; Chinook Salmon stocked in Diversey and Jackson Harbors were not clipped aside from a single event in 2006 when a 10,007 surplus of Chinook Salmon with a Waukegan clip were stocked into Jackson Harbor. Non-adipose fin clips were evident on 22 Chinook Salmon we sampled in 2013. In the original stocking location of these fish was Waukegan Harbor in 2009 (RPLV fin clip) or 2010 (LPRV fin clip). Nearly all (21 of 22) of these Chinook Salmon were sampled at Waukegan Harbor (Table 4). One Chinook Salmon was recovered at a different site (Jackson Harbor). Thirty-two Chinook Salmon did not have any fin clips and origin could not be determined with certainty for these fish. Potentially, many of these unclipped fish could be of Illinois origin since age determination indicated that 28 were stocked in 2009 and 2010 when fish stocked in Diversey and Jackson harbors were not marked.

An adipose fin clip, indicating presence of a coded-wire tag (CTW), was present on 239 of the Chinook salmon sampled in 2013. Since 2011, all hatchery-reared Chinook Salmon stocked in Lake Michigan have received CWTs as part of a lake-wide mass-marking program coordinated through the U.S. Fish and

Wildlife Service[1]. Of the 239 adipose-clipped Chinook Salmon, four CWTs were lost during processing and origin could not be determined; seven Chinook Salmon had adipose fin clips but no CWT was detected. Information from the CWTs confirms "homing" to harbors for Illinois fish. Fish with CWTs were recaptured at the location where they were originally stocked 64.0% (146 of 228) of the time (Table 5), down from 80% found in 2012. The information indicates that homing to harbors is not absolute. For example ten fish tagged and released in Wisconsin were collected in Illinois harbors during the fall. In addition, no Chinook Salmon have been stocked in North Point Marina, so all of the 35 CWT and 17 unclipped Chinook Salmon that were sampled and strayed to that harbor from other sources.

Coho Salmon

Coho Salmon CPUE was highest at Waukegan Harbor (6.2 fish/hour) and lowest at Jackson Harbor (1.5 fish/hour). Catch rate for Coho Salmon has been variable among harbors, with the exception of Waukegan Harbor in 1998-2002 when Coho Salmon CPUE was consistently near 25 fish/hour. Coho Salmon CPUE increased at each harbor relative to CPUEs in 2012.

Sampled Coho Salmon ranged in length from 440 to 815 mm (Figure 4). The mean length of Coho Salmon in 2013 was 600 mm, an increase from 490 mm in 2012, and was above the 25 year sampling average (1988-2012, 545 mm). In past years, length distributions tended to be skewed toward smaller sizes, but in 2013 length distributions favored the middle length bins, tapering off into the longer length bins.

No fin-clipped Coho Salmon have been stocked in Illinois harbors since 1998 and all fish sampled this year had no fin clip present. Previous 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.

[1] Indiana released 52,969 unclipped Chinook salmon into Salt Creek, a tributary to Lake Michigan, in 2012

Rainbow Trout

Approximately 50,000 Arlee-strain and 50,000 Skamania-strain Rainbow Trout have been stocked each year since 2002. 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 2013, averaging 710 mm and ranging from 460 to 835 mm (Figure 5). The time-series of relatively low CPUEs provides little meaningful information on whether a trend in the data exists or not. The majority (25 of 35) of Rainbow Trout sampled had an adipose right-pectoral (AdRP) fin clip indicating Illinois origin (Skamania strain); nine fish had no clipped fins and one fish had an adipose fin clip. An attempt to mark all Rainbow Trout stocked in Lake Michigan has been less than successful and plans to mass mark all Rainbow Trout with CWTs will be delayed pending additional funding for the US Fish and Wildlife Service. As such, determination of the origin of unmarked Rainbow Trout will be unlikely.

Brown Trout

The number of Brown Trout that we have sampled in any particular year has been highly variable and most strongly influenced by the number sampled at North Point Marina. Brown Trout CPUEs have been variable among harbors and years, although the recent trend has been declining CPUEs. The total number of Brown Trout captured in 2013 dipped from 2012 efforts and remained below the 25 year sampling CPUE average at all locations, with the exception of Diversey Harbor. Given that the number of Brown Trout stocked in 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 in Illinois waters because significant regeneration of the fins and the naturally-occurring curving of the fins by this species make identification difficult. Five

fish collected in 2013 were recorded with fin clips indicating they were not stocked in Illinois waters. Brown Trout averaged 565 mm in length and ranged from 335 to 810 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% lakewide) and an additional reduction of 50% (lakewide) took effect in 2013 due to the continued decline of forage fish (primarily alewife) and increases of Chinook Salmon natural recruitment. The Red Flags analysis has been used by the Salmonid Work Group of the Lake Michigan Technical Committee to monitor a suite of indicators related to salmon condition and prey abundance. *Recommendation: Work with Salmonid Work Group of the Lake Michigan Technical Committee to continue monitoring the effects of reduced Chinook Salmon stocking on a lakewide basis and provide data for the Red Flags evaluation 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 relatively few fish are stocked compared to other jurisdictions. In an attempt to identify stocking site fidelity and track mortality rates, Chinook Salmon stocked in Illinois waters were fin-clipped between 1999-2010. Similar percentages of fin-clipped Chinook Salmon were found each year in both Waukegan Harbor (53 and 52%) and North Point Marina (25 and 24%) in 2003 and 2004. Percentages of fin-clipped fish sampled in Waukegan Harbor have increased since 2004, with the exception of 2008 (39%), to a high of 75% in 2006. High return rates indicate greater site fidelity and provide key information on the movements of Chinook Salmon.

The inclusion of coded wire tag data this year has confirmed this pattern where a majority of fish were captured at stocking locations (Waukegan, Diversey, and Jackson harbors). Fish captured at North Point Marina where no fish are stocked maintained a high catch per unit effort for Chinook Salmon, second only to Waukegan Harbor.

Recommendation: Continue participation in lakewide marking (i.e., CWT) of Chinook Salmon during 2011-2015 and evaluate site fidelity at other Illinois harbors.

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Table 1. The 2013 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					10,508
Waukegan Harbor	X	99,891	74,888		21,407	10,516
Dawes Park				9,461		10,053
Montrose Harbor				13,451		10,053
Belmont Harbor						10,274
Diversey Harbor	X	104,879	73,662		21,526	10,053
Burnham Harbor				11,577		10,053
31st Street Harbor				9,442		10,257
Jackson Harbor	X	105,518	78,786	12,404		10,257
Calumet Harbor						10,257
TOTALS		**310,288**	**227,336**	**56,335**	**42,933**	**102,281**

Table 2. Amount of electrofishing effort (min) and water temperature in four Illinois harbors sampled in 2013. Dates are separated over ten 1-week periods.

	Location			
Dates	North Point Marina	Waukegan Harbor	Diversey Harbor	Jackson Harbor
17, 19 September	60 / 66F	60 / 69F	60 / 68F	27 / 68F
25, 26 September	59 / 64F	65 / 64F	60 / 67F	32 / 68F
30 September, 1 October	60 / 64F	57 / 63F	50 / 67F	30 / 70F
7, 11 October	60 / 59F	60 / na	50 / 62F	27 / 66F
16 October	65 / 57F	45 / 52F	na	na
23, 24 October	56 / 49F	60 / 49F	60 / 52F	26 / 51F
30 October, 1 November	60 / 48F	55 / 49F	60 / 50F	22 / 52F
4, 7 November	60 / 48F	55 / 46F	60 / 49F	na
13, 15 November	64 / 40F	53 / 40F	60 / 42F	na
19 November	54 / 44F	45 / 43F	na	na

Table 3. Total electrofishing effort (hrs) and numbers of salmonids sampled in four Illinois harbors in 2013.

Harbor	Effort (hrs)	Coho Salmon	Chinook Salmon	Rainbow Trout	Brown Trout	All salmonids
North Point Marina	9.97	19	51	7	37	114
Waukegan Harbor	9.25	57	214	16	4	291
Diversey Harbor	7.67	31	22	12	14	79
Jackson Harbor	2.73	4	6	0	3	13
All Harbors	**29.62**	**111**	**293**	**35**	**58**	**497**

Table 4. Number of Chinook Salmon with Illinois fin clips sampled in four Illinois harbors in 2013. Fin clip abbreviations are as follows: RPLV (right pectoral, left ventral); LPRV (left pectoral, right ventral).

			Sample Location (2013)			
Fin Clip	Year	Location Stocked	North Point Marina	Waukegan Harbor	Diversey Harbor	Jackson Harbor
RPLV	2009	Waukegan Harbor	0	3	0	0
LPRV	2010	Waukegan Harbor	0	17	0	1

Table 5. Origin and count of Chinook Salmon with coded-wire tags sampled in four Illinois harbors in 2013.

		Sampling Location			
Year	Stocking location	North Point Marina	Waukegan Harbor	Diversey Harbor	Jackson Harbor
2010	WI-Milwaukee Harbor	0	1	0	0
2011	IN-Buffington Harbor	1	0	0	0
	IL-Diversey Harbor	9	24	9	0
	IL-Jackson Harbor	0	8	1	2
	IL-Waukegan Harbor	14	87	1	0
	WI-Pike River	2	2	0	0
	WI-Sheboygan R.	1	1	0	0
2012	IL-Diversey Harbor	1	2	5	0
	IL-Jackson Harbor	1	3	0	2
	IL-Waukegan Harbor	4	41	0	0
	WI-McKinley Marina	1	0	0	0
	WI-Pugh Marina	1	1	0	0
2013	IL-Diversey Harbor	0	1	0	0
	IL-Jackson Harbor	0	2	0	0

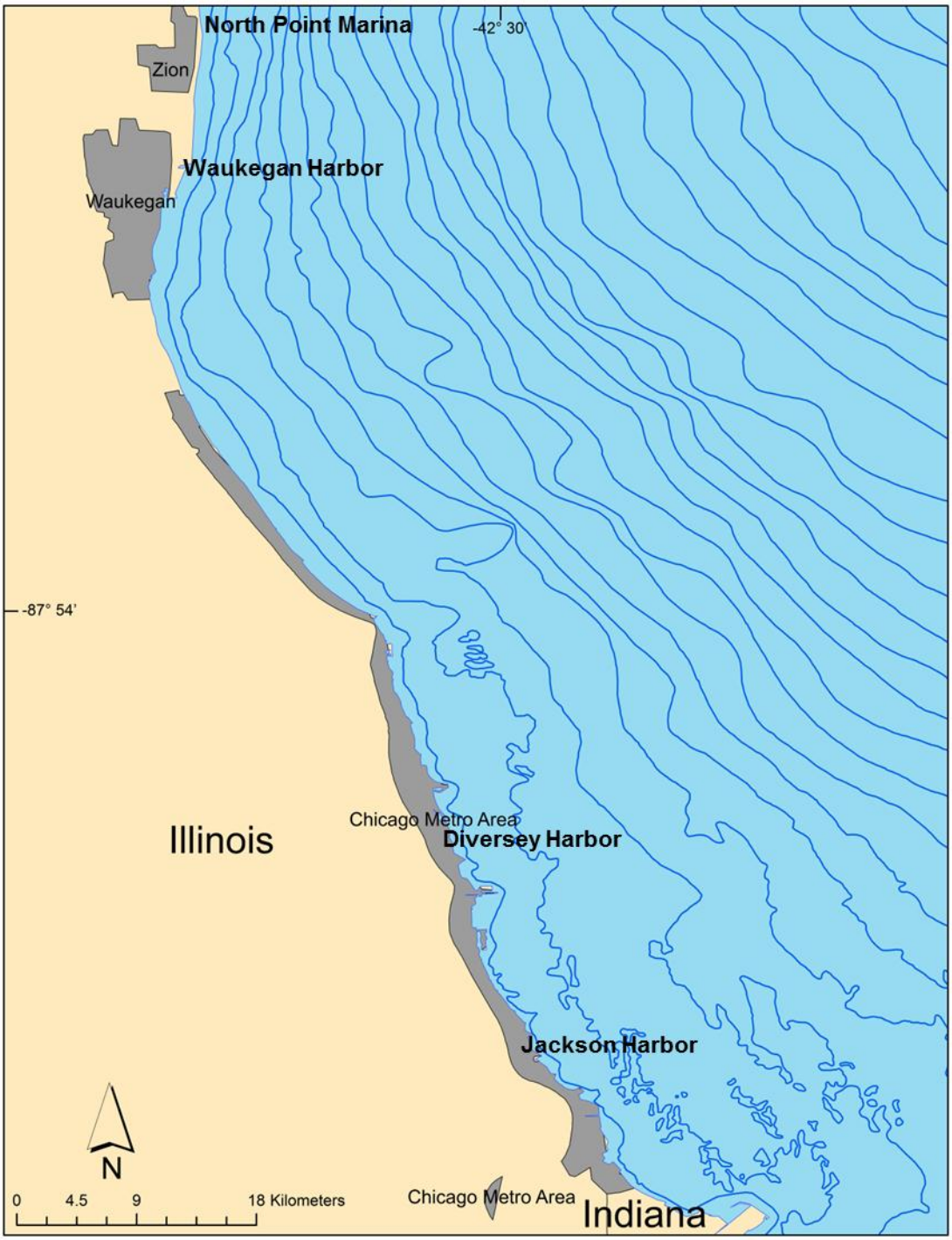

Figure 1. Sites of fall harbor salmonid assessments in 2013.

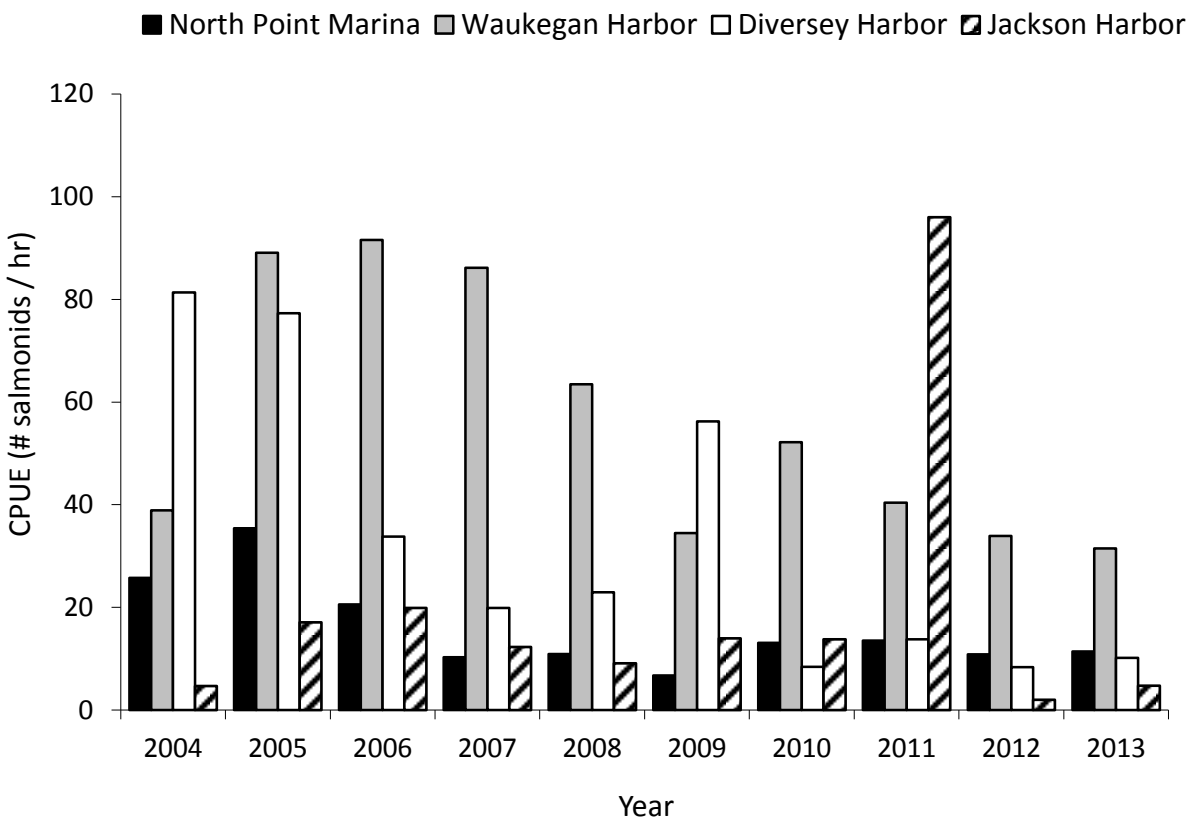

Figure 2. Catch-per-unit-effort of all salmonid species captured at four sampling sites from 2004 to 2013.

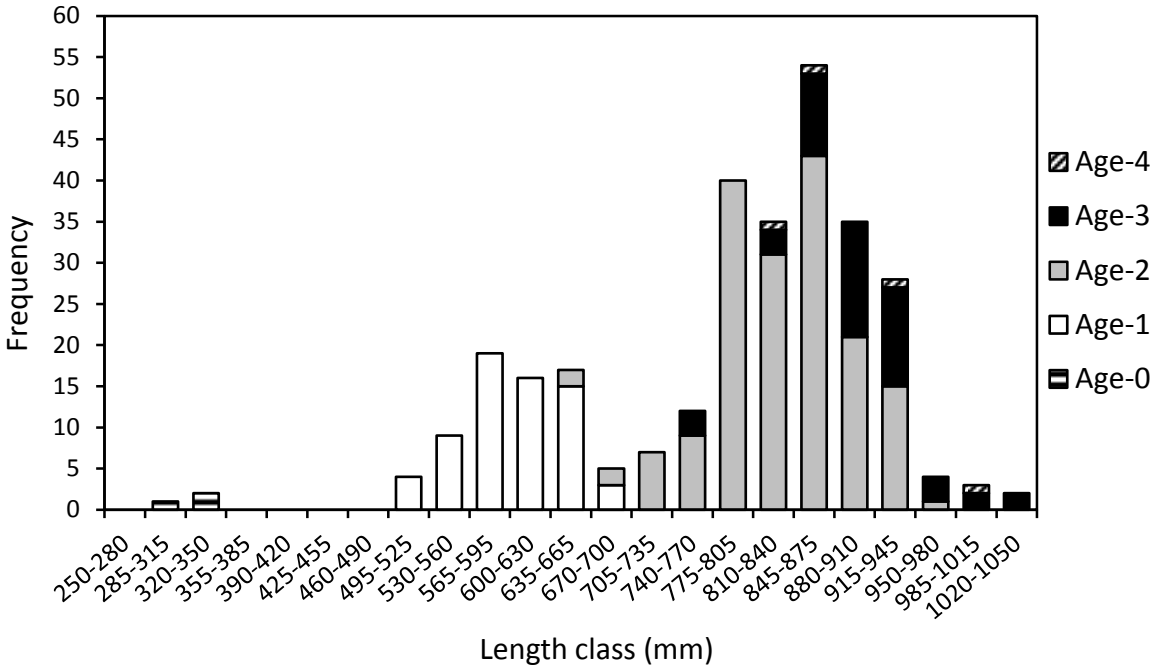

Figure 3. Length distribution of age-0 through age-4 Chinook Salmon sampled in four Illinois harbors in 2013.

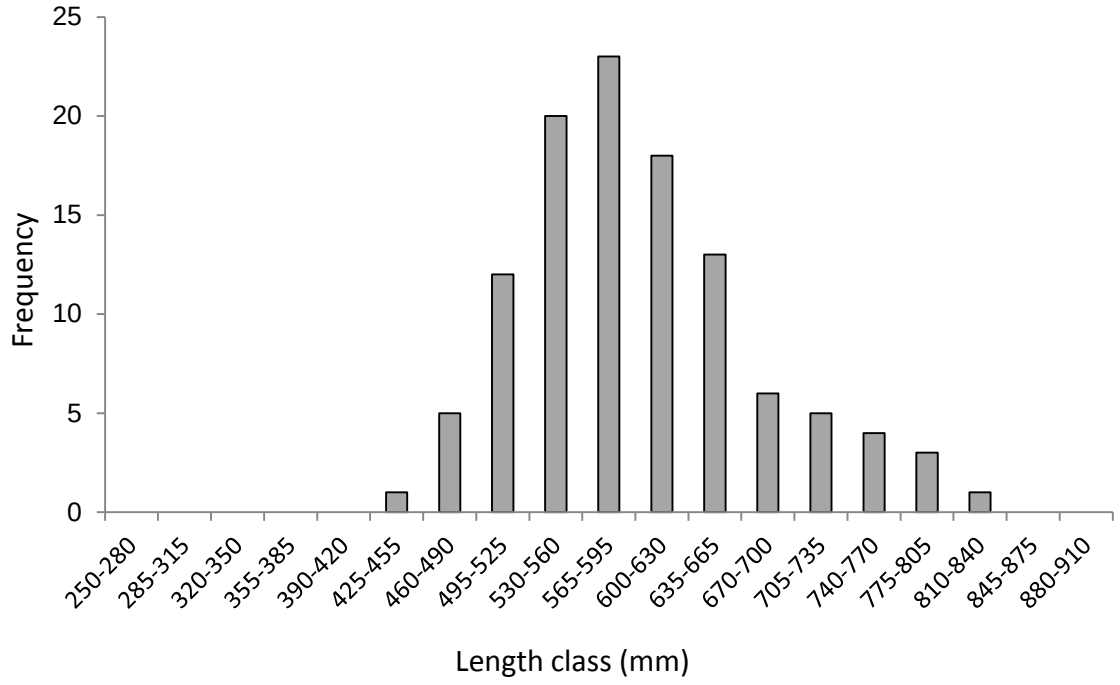

Figure 4. Length distributions of Coho Salmon sampled from four Illinois harbors in 2013.

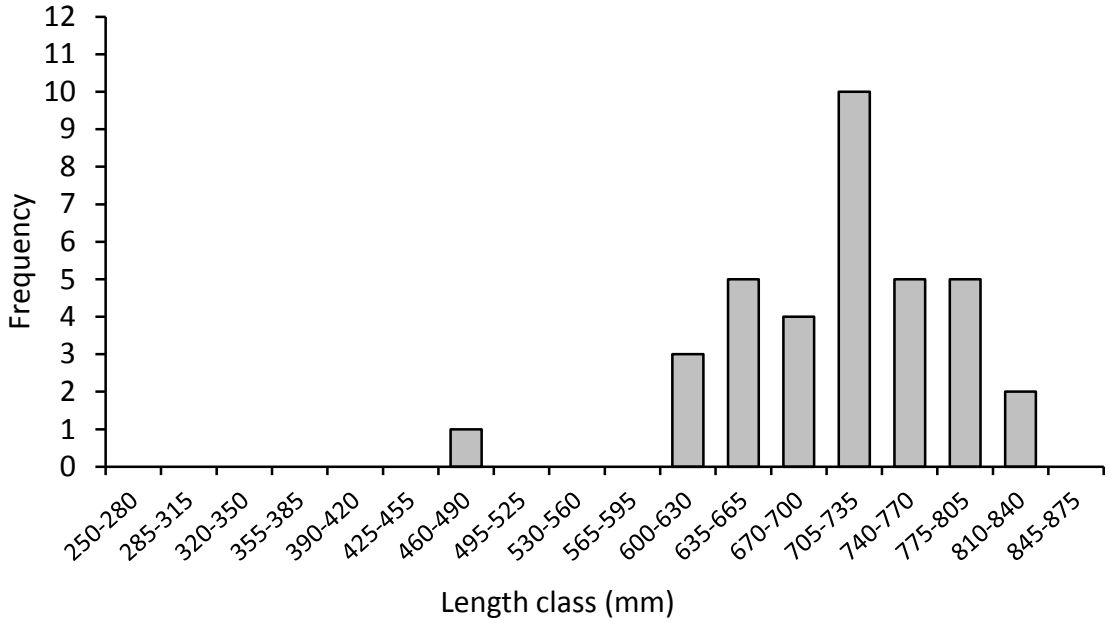

Figure 5. Length distribution of Rainbow Trout captured at four Illinois harbors in 2013.

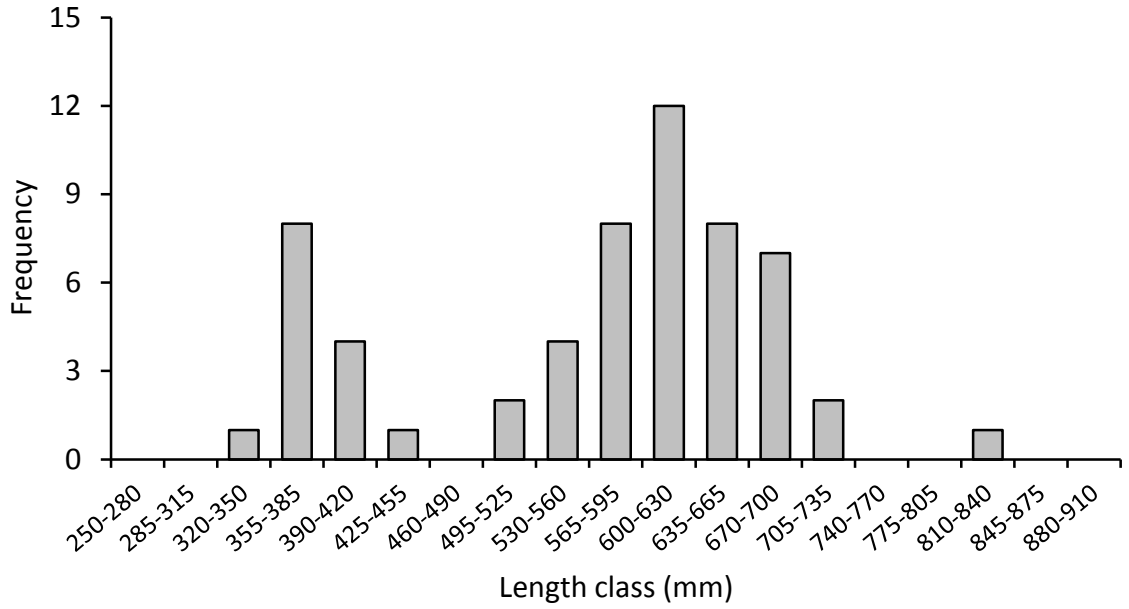

Figure 6. Length distribution of Brown Trout sampled from four Illinois harbors in 2013.