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Nearshore Fish Community of Lake Michigan: 2017 Summer Harbor Assessment

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Executive Summary

Electrofishing methods were used to assess the nearshore fish community in three Illinois harbors and the shoreline inside Calumet Harbor in summer 2017. North Point Marina had the highest number of species (N = 27). We sampled 14 species in both Jackson Harbor and 11 in Waukegan South Harbor; only six species were sampled in Calumet Harbor. Rock Bass, Largemouth Bass, Bluegill, Pumpkinseed, and Smallmouth Bass were the most abundant target species that we encountered. In 2017, 123 Smallmouth Bass we sampled were of Stock size (≥ 180 mm), 90 of Quality size (≥ 280 mm), 56 of Preferred size (≥ 350 mm), 14 of Memorable size (≥ 430 mm), and 2 Trophy-size (≥ 510 mm) were sampled. Largemouth Bass were similarly abundant but generally smaller than Smallmouth Bass. We sampled 140 Largemouth Bass of Stock size (≥ 200 mm), 77 of Quality size (≥ 300 mm), 36 of Preferred size (≥ 380 mm), and 1 Memorable size (≥ 510 mm); no Trophy (≥ 630 mm) sized Largemouth Bass were sampled. A black Bass catch-and-release regulation for Lake Michigan, adopted in 1998, and subsequently changed to one black bass over 21 inches in 2004, has not resulted in large increases in abundance or length of Largemouth Bass or Smallmouth Bass.

Introduction

Several sport and non-sport fish species inhabit Illinois harbors and nearshore areas of Lake Michigan in summer. Common sport fish species found in these areas include: Smallmouth Bass (*Micropterus dolomieu*), Largemouth Bass (*Micropterus salmoides*), Yellow Perch (*Perca flavescens*), Northern Pike (*Esox lucius*), Rock Bass (*Ambloplites rupestris*), and several other Centrarchids (sunfish family). There has been an increasing demand for sport fishing opportunities in nearshore areas and an increased interest in the nearshore sport fishery since 1998, especially for black bass. Increases in the abundances of these warm- and cool-water fish species and angler effort for non-perch and non-salmonid fish species in the Illinois waters of Lake Michigan are evident from sport angler creel data. So few Smallmouth Bass were found in the possession of anglers that no estimate of harvest could be calculated from creel data prior to 1996; in 2000 however, anglers reported catching an estimated 4,892 Smallmouth Bass (pers. comm. W. Brofka, INHS).

Although management of fish species inhabiting these nearshore areas has been incorporated into the Illinois Strategic Plan for Lake Michigan fisheries since the early 1980s, personnel and funding deficiencies did not allow their investigation until 1995. This assessment program was developed to monitor the relative abundance and distribution of nearshore sport fish species and to determine whether those species were susceptible to overexploitation by tracking changes in relative abundances over time. Species composition, abundance, and length distribution data previously was obtained through incidental catches of non-salmonid fish species when sampling returning salmonids by electrofishing in the fall and through a sport angler creel survey. Sport anglers were interviewed, fish in their possession were measured for length and weight, and estimates of the sport harvest were considered to be estimates of the relative abundance of these fish species. Abundance and species composition data obtained through a creel survey, however, may be biased because anglers target specific species, effort is not equivalent at all locations, and harvest (rather than total catch) is usually reported. In addition to biological information (e.g., length and weight), an understanding of seasonal dispersal patterns of the sport fish associated with the nearshore fish community is required to effectively manage these species. If sport fish dispersal patterns for Lake Michigan are similar to the patterns observed in Lake Ontario, then some of these fish species will inhabit protected areas early in the year and later move into open lake areas once water temperatures reach 15° C (Danehy 1984).

The objectives of this ongoing study are to: 1) determine the fish species composition of select Illinois harbors and nearshore areas of Lake Michigan; 2) monitor changes in the relative abundances of

Smallmouth and Largemouth Bass and other sport fish through time; 3) evaluate intra- and inter-annual fidelity of Smallmouth and Largemouth Bass to harbors; 4) monitor growth indices for sport fish inhabiting these harbors; and 5) collect age-composition data which may eventually be used to determine recruitment rates of the most abundant fish species.

Methods

Fish were sampled using a boat electrofishing pulsed-DC control box (Smith-Root Inc.) capable of delivering 5kw from the GPP 5.0 generator to the electrodes. Pulse frequency was set to 60 Hz and duty-cycle was internally controlled. Total sampling time was based on harbor size, weather conditions, and the amount and type of fish collected. Selection of sampling sites (Figure 1) was based on harbor configurations that were conducive to electrofishing (i.e., availability of shallow water areas <3 m in depth), availability of a launch ramp, and sport-angler creel survey data. Three Illinois harbors and the shoreline inside Calumet Harbor were selected for sampling in 2017 (Table 1). Sampling at North Point Marina was limited to the inner entrance of the north harbor, the channel connecting the north and south harbors, and the south harbor. At Waukegan, the south harbor was sampled, and the inner harbor was sampled at Jackson Harbor. The Calumet Harbor site consisted of the rip-rap shoreline between the Calumet River and the north slip within Calumet Harbor. In addition, the north face of the confined disposal facility and the south face of the Calumet breakwall were sampled when weather and waves permitted.

Sport fish species were the target of electrofishing sampling effort. We attempted to capture all Largemouth and Smallmouth Bass that were encountered; other target species were subsampled to obtain a representative distribution of sizes. Abundance of non-target species (e.g., Alewife, Gizzard Shad, White Sucker, and Carp) was usually only noted. Sampled fish were dip-netted and held onboard in a 100 ga tank filled with a 0.5% solution of NaCl and lake water. An oxygen cylinder with an air stone was used to increase retention time and keep the fish alive until biological data were obtained. Fish were measured to the nearest 5 mm (maximum total length) and weighed to the nearest 10 grams.

Relative Stock Density (RSD) for Quality, Preferred, and Memorable length fish were calculated for Smallmouth and Largemouth Bass (Table 2; Gabelhouse 1984 as reported in Anderson and Gutreuter 1996). Temporal trends in length for Smallmouth and Largemouth Bass were assessed by linear regression.

Results and Discussion

North Point Marina had the highest number of species (N = 27), followed by Jackson Harbor (N = 14) and Waukegan South Harbor (N=11). Six species were sampled in Calumet Harbor. Rock Bass, Largemouth Bass, Bluegill, Pumpkinseed, and Smallmouth Bass were the most abundant target species that we encountered. Overall, we sampled 15 sport (target) fish species, including 3 hybridized forms of Centrarchids, by electrofishing in 2017 and 16 non-target species (Table 3). It is likely that increased water clarity and aquatic vegetation in the protected areas of these harbors have produced favorable conditions for a number of these cool- and warm-water fish species (Jude et al. 2002). While Calumet still had a number of target species, relatively few Centrarchid species were present compared to the other sampling sites. This is likely a result of the Calumet site being an open-lake area and more exposed to wave action and rapid changes in water temperatures, which are not conducive to establishing aquatic vegetation.

The types of sport fish species we encountered in the three protected harbors were similar to those that are typically found in warm-water inland lakes with similar habitats. One major difference between these harbors and inland lakes is the abbreviated growing season in the harbors caused by influxes of cool water from the main lake, which suppresses water temperatures in the spring and may intermittently decrease temperatures during the summer due to upwellings. A second difference is the relatively large areas of restricted fishing access; much of the harbors' areas contain moored vessels and are closed to fishing. Thus, Illinois harbors may act as refuges on Lake Michigan where populations of warm-water fish may grow in a near natural state with limited fishing mortality.

Largemouth Bass, Smallmouth Bass, Bluegill, Pumpkinseed, and Rock Bass were generally the most abundant target species that we encountered. Furthermore, some fish species were found only in particular harbors. For example, Black Crappie were collected only in Waukegan Harbor, and we collected Yellow Bass, Warmouth, Green Sunfish, and Northern Pike at only North Point Marina.

Smallmouth Bass

Sporadic and limited stockings of juvenile Smallmouth Bass occurred in 1969 through 1984 at Diversey, Belmont, and Naval Station Great Lakes harbors (Table 4). Jackson Harbor was stocked in 1985, although young-of-the-year (YOY) Smallmouth Bass had been collected during annual beach seine sampling at that site since 1982. The harbor at Naval Station Great Lakes Harbor in North Chicago was

stocked with YOY Smallmouth Bass in 1973, 1977, and 1984, but no YOY Smallmouth Bass were captured in that harbor from 1982-1986. YOY Smallmouth Bass however were collected at Naval Station Great Lakes Harbor from 1987 until 1994, when the site was no longer sampled. Additionally, YOY Smallmouth Bass have been collected at Calumet (since 1991) and Waukegan (1997) where no stocking occurred. Thus, it is likely that Smallmouth Bass stocking either contributed to the establishment of sustainable populations or only marginally supplemented an existing population in the case of Jackson Harbor. Since YOY Smallmouth Bass have been collected recently in areas at which no Smallmouth Bass have been collected in the past (e.g., Farwell Avenue Pier since 2000), it appears that the population also has expanded its range along the Illinois shoreline. A potential limiting factor to the further expansion of the Smallmouth Bass population may be insufficient spawning habitat (protected areas with stable, warm water), though relatively few successful nests can sustain a population (Coble 1975). Small Centrarchids (e.g., Bluegill, Pumpkinseed) are known nest predators, but the presence of Round Goby (*Neogobius melanostomus*) poses an additional threat to successful recruitment of Smallmouth Bass in Lake Michigan. The increased energy needed to successfully defend nests from predatory attacks by Round Goby could deplete energy reserves quickly, potentially forcing Smallmouth Bass to abandon their broods (Steinhart et al. 2004).

We sampled 123 Stock size (≥ 180 mm) Smallmouth Bass in 2017 and 28 individuals less than Stock size. Most Smallmouth Bass were collected at Calumet Harbor (N = 75). More Smallmouth Bass were caught at North Point Marina (N=50) than Waukegan South Harbor (N=16), and eight were sampled at Jackson Inner Harbor. Catch-per-unit-effort (CPE) increased at North Point Marina but was similar at other sites compared to 2016 (Table 5). Until 2007, a large number of bass tournaments held weigh-ins at Calumet Harbor where Smallmouth Bass were released after the weigh-in. A decline in CPEs from 2007 onward may be attributed to the reduction of these tournament releases which were potentially inflating CPEs for sampling efforts.

Mean length of Smallmouth Bass that were Stock-size (≥ 180 mm) has been variable (Figure 2). Many Smallmouth Bass sampled in 2017 were of Quality size (N = 90; PSD = 73), fewer of Preferred (N = 56; RSD₃₅₀ = 46) size, and still fewer of Memorable (N = 14; RSD₄₃₀ = 11) size. We also did sample two trophy-size Smallmouth Bass (≥ 510 mm) in 2017. The size structure of the population was similar to 2016. Most young (<250 mm) Smallmouth Bass were sampled at North Point Marina and Jackson Inner Harbor; larger fish (>330 mm) were sampled primarily at Calumet Harbor (Figure 3). There has been no distinguishable increase in mean length following the 1998 enactment of a “catch-and-release only”

regulation for black Bass in Lake Michigan and the subsequent change to “one fish \geq 21 inches” in 2004 (Linear Regression; $F_{1,16} = 0.67$; $P = 0.42$).

Largemouth Bass

No stocking records exist for Largemouth Bass, but nonetheless they are observed in the nearshore fish community. Populations may have occurred naturally in protected areas along the shoreline and dispersed from these remnant stocks. There are several potential sources for brood fish to have entered Lake Michigan in the past, such as the Lake Calumet complex, Wolf Lake, the Japanese Gardens ponds at 59th Street Harbor, Lincoln Park Zoo ponds, the diversion structure at the North Branch of the Chicago River (Wilmette), and Prairie Cove Harbor on the Illinois/Wisconsin state line. Remnant populations of brood fish may have existed in these locations until recent changes in the lake favored their dispersal.

Largemouth Bass have been less actively pursued by anglers than Smallmouth Bass, yet Stock size Largemouth Bass are typically captured in greater numbers than Smallmouth Bass. Similar to Smallmouth Bass, CPEs for Largemouth Bass in 2017 increased relative to 2016 at three of the sampling sites (Table 6); no Largemouth Bass were sampled at Calumet Harbor.

At least half of the Largemouth Bass sampled in 2017 were of Quality size ($N = 77$; $PSD = 55$), one-quarter were of Preferred size ($N = 36$; $RSD_{380} = 26$), and one Memorable size (≥ 510 mm) was sampled. No Trophy (≥ 630 mm) Largemouth Bass were sampled (Figure 6). We also sampled 110 individuals less than the Stock size (< 200 mm) in 2017. Between 2000 and 2017, mean lengths of Largemouth Bass significantly increased (Linear Regression; $F_{1,16} = 7.2$; $P = 0.01$). The most obvious distinction from visual inspection of the data was a sustained increase in mean length that occurred during 2004-2007 (Figure 5); the mean length of Largemouth Bass however has not changed appreciably since 2007 (Linear Regression; $F_{1,9} = 4.3$; $P > 0.05$). The data do not support definitive conclusions as to the specific reasons for this increase, but we speculate that a shift in prey consumption (e.g., addition of Round Goby as a large contributor to diets) or decreased competition for food may be responsible for the increase in sizes rather than the harvest regulation. Given low densities and a highly restrictive harvest regulation however we would expect to see continued increases in size of fish in our surveys.

Recommendations

1. Monitor angler effort directed at Smallmouth and Largemouth Bass and potential population expansions using shoreline creel surveys.
2. Collect a representative sample of abundant sport fish species biennially to determine ages using otoliths.

Acknowledgements

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Table 1. Amount of electrofishing effort (hrs:min) and water temperatures in four Illinois harbor areas sampled in 2017.

Sampling Date	Location			
	North Point Marina	Waukegan South Harbor	Jackson Inner Harbor	Calumet Harbor
8, 9 May	1:00 / 52F	0:25 / 51F	0:35 / 57F	0:41 / 50F
30 May, 1 June	1:05 / 61F	0:27 / 58F	0:42 / 66F	0:56 / 60F
15, 16 June	1:04 / 63F	0:27 / 63F	0:40 / na	0:48 / 63F
5, 6, July	1:15 / 70F	0:35 / 68F	0:45 / 77F	0:56 / 70F
17 July	1:05 / 66F	0:32 / 64F	na	na
26, 31 July	1:04 / 74F	0:34 / 72F	0:30 / 79F	0:27 / 74F
17, 18 August	1:00 / 77F	0:22 / 76F	0:30 / 78F	0:31 / 76F

Table 2. Proposed minimum lengths (mm) for Smallmouth and Largemouth Bass of various size categories (from Gabelhouse 1984).

Species	Size designation				
	Stock	Quality	Preferred	Memorable	Trophy
Smallmouth Bass	180	280	350	430	510
Largemouth Bass	200	300	380	510	630

Table 3. Fish species sampled during summer 2017 by electrofishing in three Illinois harbors and along the shoreline in Calumet Harbor. A = abundant or frequently sampled; P = few specimens observed or infrequently sampled.

	Location			
	North Point Marina	Waukegan South Harbor	Jackson Inner Harbor	Calumet Harbor
<i>target species</i>				
Black Bullhead		P	A	
Black Crappie		P		
Bluegill	A	P	A	P
Bluegill x Green Sunfish hybrid	P			
Green Sunfish	P			
Largemouth Bass	A	P	A	
Northern Pike	P			
Pumpkinseed	A	P	A	
Pumpkinseed x Bluegill hybrid	P		P	
Rock Bass	A	A	P	P
Smallmouth Bass	A	P	P	A
Unidentified Hybrid Sunfish	P		P	
Warmouth	P			
Yellow Bullhead	P			
Yellow Perch	A	P	P	
<i>non-target species</i>				
Alewife	P	P	P	P
Brook Silverside	P		P	
Brown Trout	P	P		
Burbot	P			
Common Carp	P	P	P	P
Fall Chinook Salmon	P			
Freshwater Drum	P	P	P	P
Golden Shiner	P		P	
Goldfish	P			
Koi	P			
Rainbow Trout	P	P		
Round Goby	P	P	P	P
Spottail Shiner	P	P		
Unidentified Buffalo spp.			P	P
Unidentified Redhorse sp.	P			P
White Sucker	A	A		P

Table 4. Smallmouth Bass stocking in Lake Michigan harbors, 1969–1985.

Year	Location	Number
1969	Diversey Harbor	4,000
1969	Belmont Harbor	1,000
1969	Belmont Harbor	306
1971	Belmont Harbor, Diversey Harbor	5,000
1973	Great Lakes NTC Harbor	4,000
1977	Belmont Harbor	1,000
1977	Great Lakes NTC Harbor	5,000
1980	Diversey Harbor	20,000
1983	Lincoln Park Lagoon	25,000
1984	Great Lakes NTC Harbor	18,000
1985	Jackson Harbor	18,400

Table 5. Catch-per-unit-effort (No. fish / 1 hr electrofishing) of Stock-size (≥ 180 mm) Smallmouth Bass in four Illinois harbors, 2000-2017.

Year	Location			
	North Point Marina	Waukegan South Harbor	Jackson Inner Harbor	Calumet Harbor
2000	22.67	0.8	6	69.62
2001	20.66	8	9.06	19.64
2002	22.34	6.91	12.67	42.67
2003	10.19	3.69	5.65	12.57
2004	13.21	2	7.95	34.07
2005	15.35	3.98	1.09	15.71
2006	11.34	10.36	1.41	28.93
2007	4.17	2.62	0	30.79
2008	9.19	8.67	2.75	26.38
2009	7.67	2.14	2.11	20.7
2010	4.49	0.56	2.8	21.51
2011	12.57	5.79	2.41	14.52
2012	5.59	7.12	1.47	20.16
2013	5.43	3.6	0.54	17.42
2014	3.58	5.92	3.91	18.75
2015	2.49	3.82	1.23	22.67
2016	1.17	3.9	0	16.03
2017	5.17	3.86	1.89	16.24

Table 6. Catch-per-unit-effort (No. fish / 1 hr electrofishing) of Stock-size (≥ 200 mm) Largemouth Bass in four Illinois harbors, 2000-2017.

Year	Location			
	North Point Marina	Waukegan South Harbor	Jackson Inner Harbor	Calumet Harbor
2000	26.33	17.2	30	0.63
2001	22.7	35.5	38.19	0.36
2002	26.98	24.73	42.67	0.67
2003	22.27	14.29	31.85	0.58
2004	54.4	35	74.43	1.47
2005	64.82	42.61	115.22	1.19
2006	36.51	31.53	56.34	1.02
2007	33.82	31.46	20.97	0
2008	51.59	14.67	48.62	0.43
2009	33.92	16.43	24.47	0
2010	19.16	10.61	30.84	0
2011	15.5	4.96	39.76	0
2012	10.66	7.12	19.06	0
2013	15.13	15.2	18.8	0
2014	19.32	9.17	16.29	0
2015	8.19	3.82	16.31	0
2016	3.51	1.46	13.66	0.42
2017	7.68	2.97	19.73	0

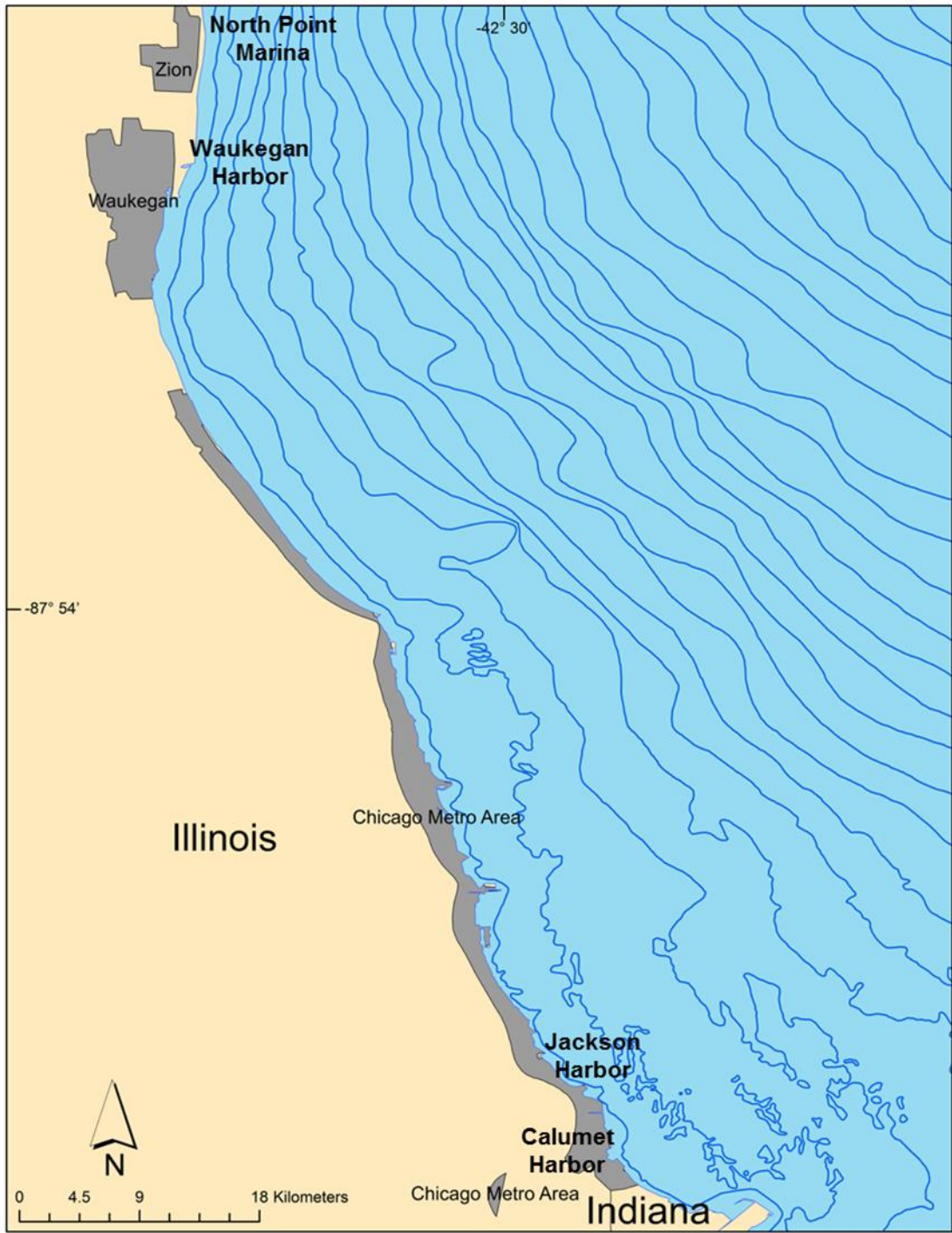


Figure 1. Locations of Lake Michigan harbors sampled in 2017.

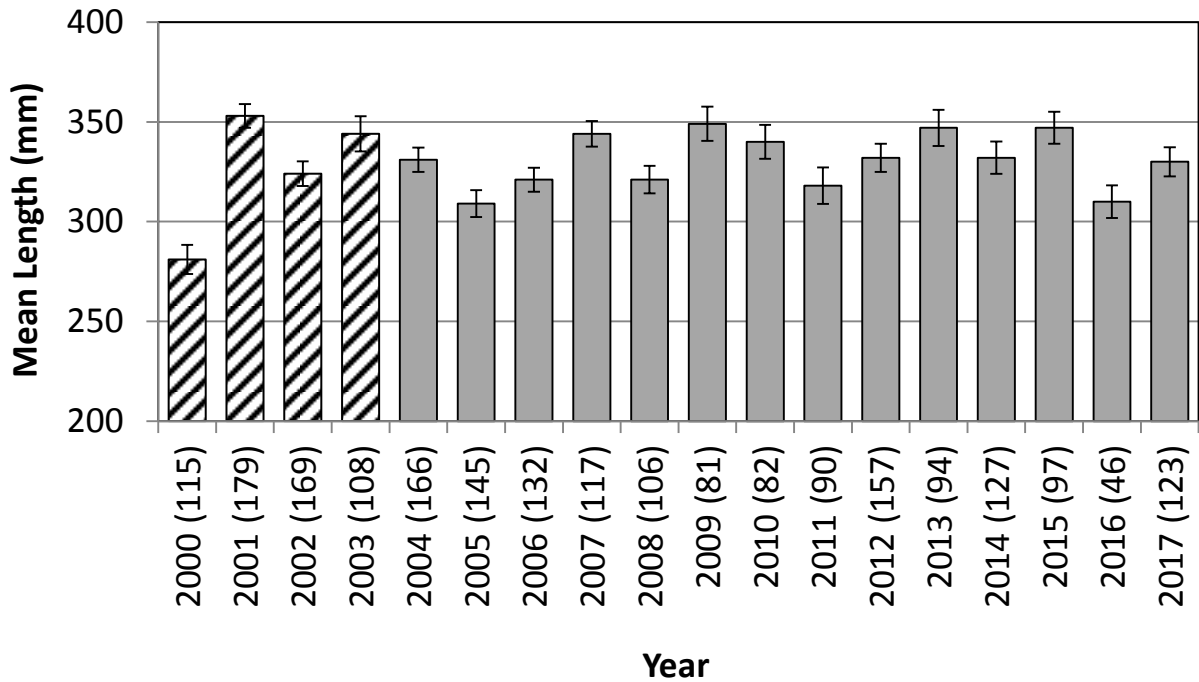


Figure 2. Mean lengths (± 1 S.E.) of Stock size (≥ 180 mm) Smallmouth Bass sampled under two different angling regulations: catch and release only (2000–2003, crosshatched) and a minimum size limit of 21 inches (2004–2017, solid color). Numbers in parentheses next to the year are sample sizes.

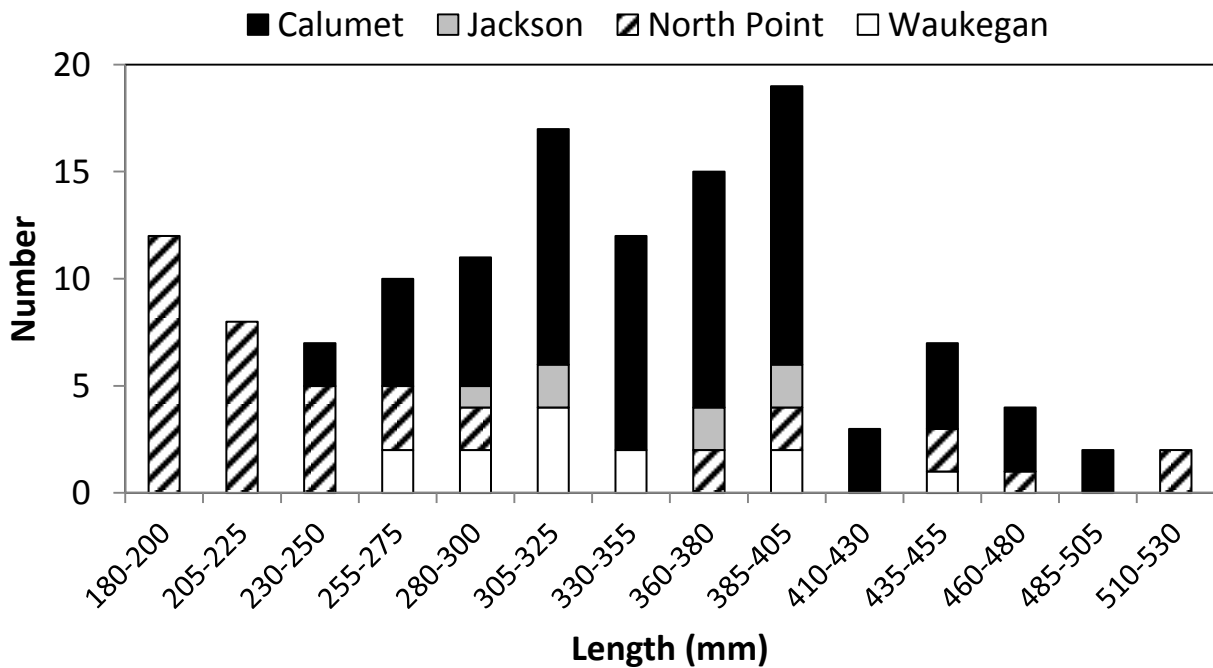


Figure 3. Length distribution of Stock size (≥ 180 mm) Smallmouth Bass sampled at four Illinois harbors in 2017.

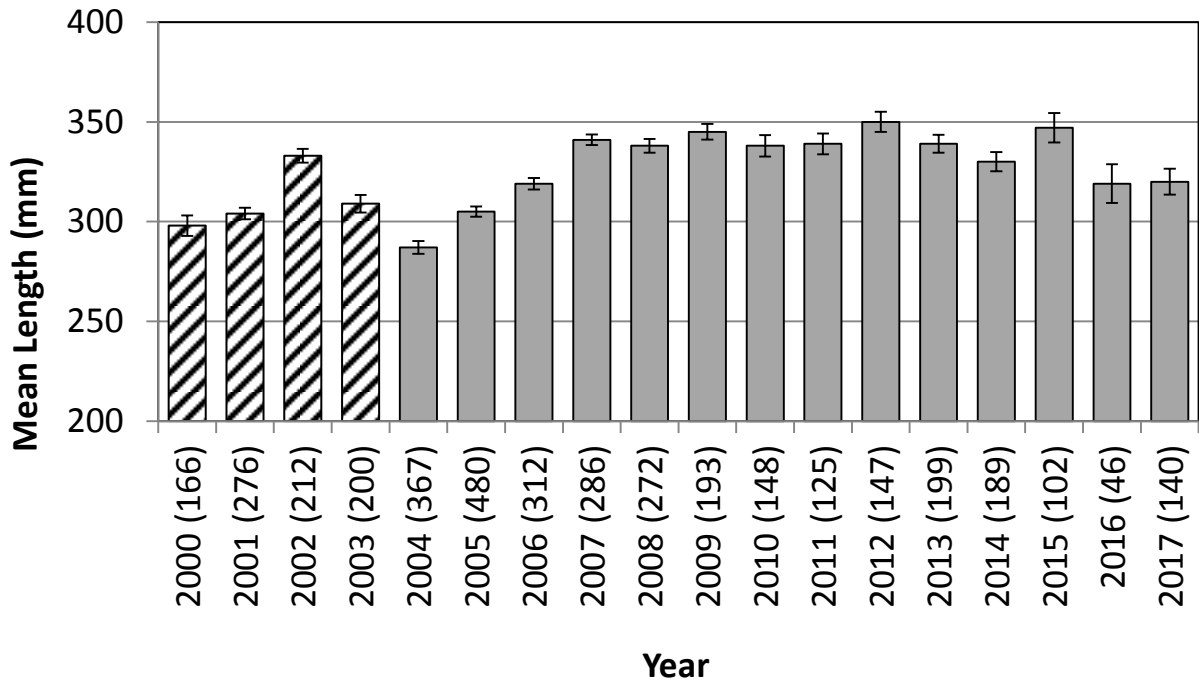


Figure 4. Mean lengths (± 1 S.E.) of Stock size (≥ 200 mm) Largemouth Bass sampled under two different angling regulations: catch and release only (2003–2003, crosshatched) and a minimum size limit of 21 inches (2004–2016, solid color). Numbers in parentheses next to the year are sample sizes.

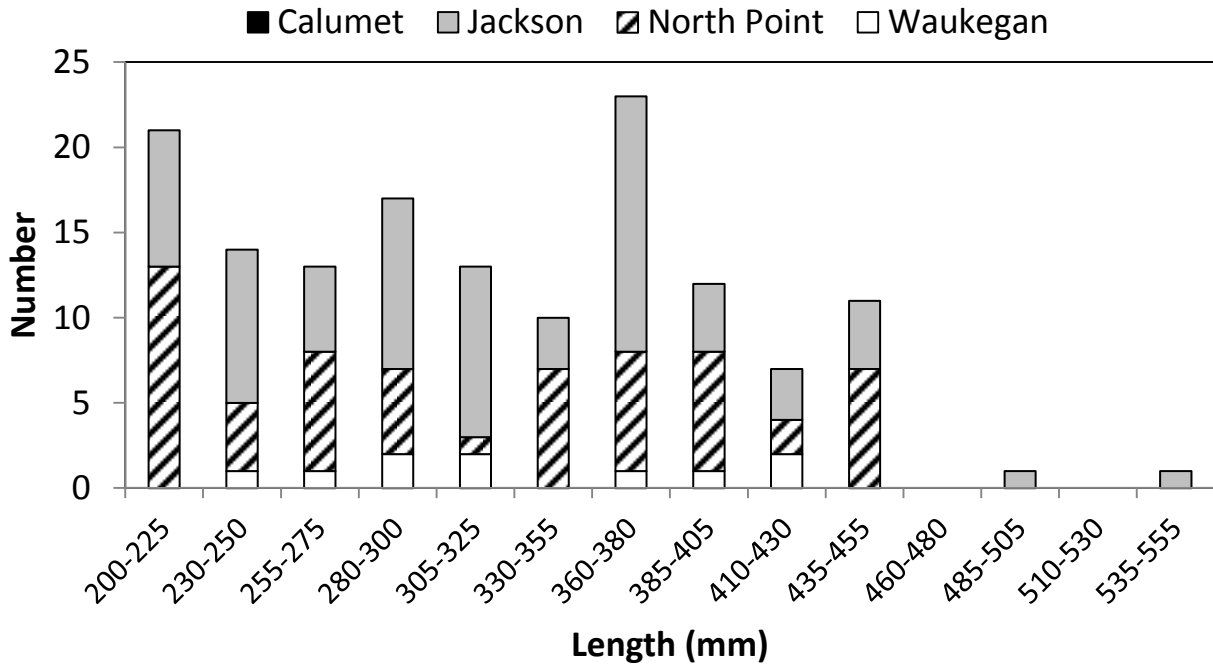


Figure 5. Length distribution of Stock size (≥ 200 mm) Largemouth Bass sampled at four Illinois harbors in 2017.