

Illinois Department of Natural Resources
Division of Fisheries

Nearshore Fish Community of Lake Michigan: 2012 Summer 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 2012. North Point Marina had the highest number of species ($N = 19$), followed by Jackson Harbor ($N = 17$). Twelve species were found in both Waukegan South Harbor and Calumet Harbor. Rock bass, largemouth bass, smallmouth bass, bluegill, pumpkinseed, and black bullhead were the most abundant target species that we encountered. Several of these species have expanded their ranges and are more actively pursued by anglers compared to a decade ago. For example, young-of-the-year smallmouth and largemouth bass have been collected recently by seining in areas at which no black bass have been stocked or juvenile bass have been collected in the past. In 2012, 157 smallmouth bass were of Stock size (≥ 180 mm), 108 of Quality size (≥ 280 mm), 69 of Preferred size (≥ 350 mm), 25 of Memorable size (≥ 430 mm), and two of Trophy-size (≥ 510 mm). Largemouth bass were similarly abundant but generally smaller than smallmouth bass, with 147 largemouth bass of Stock size (≥ 200 mm), 121 of Quality size (≥ 300 mm), 52 of Preferred size (≥ 380 mm), and no Memorable (≥ 510 mm) or 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, has not resulted in large increases in catch-per-unit-effort or mean lengths of largemouth bass or smallmouth bass. PIT tagged black bass were not collected in 2012, but a compilation of PIT tag recapture data from 2009 through 2011 revealed that all but two black bass were recaptured at the harbor where they were originally tagged; all were at liberty for at least one year with one fish at liberty for almost seven years.

Introduction

Several sport and non-sport fish species inhabit Illinois harbors and nearshore areas of Lake Michigan in summer. 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 Smith-Root Model 5.0 GPP Pulsed-DC electrofishing unit, operated at 8-10 amps and 60 pulses per second. 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 2012 (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. The south face of the Calumet breakwall and the harbor at Calumet Harbor's Yacht Club were sampled on a few occasions.

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 1983 as reported in Anderson and Gutreuter 1996). Standard non-linear fit von Bertalanffy growth models were developed for smallmouth and largemouth bass using methods of Cope and Punt (2007).

Results and Discussion

North Point Marina had the highest number of species ($N = 19$), followed by Jackson Harbor ($N = 17$). Twelve species were found in both Waukegan South Harbor and Calumet Harbor. Rock bass, largemouth bass, smallmouth bass, bluegill, pumpkinseed, and black bullhead were the most abundant target species that we encountered. Overall, we sampled 12 sport (target) fish species by electrofishing in 2012, in addition to a number of 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, very few centrarchid species (the exception being rock bass) were present. 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 for 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 crappies were collected only in Jackson Inner Harbor and northern pike only were collected in North Point Marina and Waukegan South Harbor.

Smallmouth bass

Sporadic and limited stockings of juvenile smallmouth bass occurred in 1969 through 1984 at Diversey, Belmont, and 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 Great Lakes Naval Training Center 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 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 in 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, pumpkinseeds) are known nest predators, but the presence of round gobies (*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 gobies could deplete energy reserves quickly, potentially forcing smallmouth bass to abandon their broods (Steinhart et al. 2004).

We sampled 157 Stock size smallmouth bass in 2012 and 38 individuals less than Stock size (< 180 mm). A disproportionate number of smallmouth bass were collected at Calumet Harbor (N = 110). More than twice the number of smallmouth bass were caught at North Point Marina (N=55) than at Waukegan South Harbor (N=22), and only eight were caught at Jackson Inner Harbor. Although not as high in 2012 as in 2011, which was an anomalous year, catch-per-unit-effort (CPE) at Waukegan South Harbor was higher than in years past. CPE at Calumet Harbor steadily declined between 2008 through 2011, but CPE increased in 2012 (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, therefore potentially inflating CPEs for sampling efforts; a decline in CPEs from 2007 onward may be attributed to the subsequent reduction of these tournament releases. CPEs at Jackson Harbor and North Point Marina have remained relatively stable (Table 5).

Studies in large lake systems indicate that smallmouth bass are typically resident fishes and do not frequently move beyond their established home ranges (Fraser 1954; Hair 1979; Pflug and Pauley 1983). In a previous tagging study conducted in southern Lake Michigan by Loyola University, the farthest a tagged smallmouth traveled was approximately 6 km between Calumet Harbor (8 May 1996) and Jackson Park Harbor, where it was harvested by an angler on 16 July 1996 (J. Savitz, pers. comm.). In 2009 one individual implanted with a PIT tag in 2006 was

recaptured in Calumet Harbor; two smallmouth bass that were tagged in 2004 and 2006 were recaptured in Calumet Harbor in 2010 (Table 6). One smallmouth bass tagged in 2006 was recaptured in North Point Marina in 2011. All four smallmouth bass were recaptured at the same harbor in which they were tagged. These findings support conclusions of Savitz and Treat (2007) who implanted acoustic transmitters into Lake Michigan smallmouth bass from three Illinois harbors – Calumet Harbor, Jackson Harbor, and North Point Marina – and found no inter-harbor movement of tagged bass, though movements in and out of the harbors were noted.

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 change to “one fish \geq 21 inches” in 2004. Mean length of smallmouth bass that were Stock-size (180 mm) or longer has been variable; mean length increased between 2008 and 2009, decreased in 2010 and 2011, and rebounded in 2012 (Figure 2). Many smallmouth bass sampled in 2012 were of Quality size (N = 108; PSD = 69), fewer of Preferred (N = 69; RSD₃₅₀ = 44) size, and still fewer of Memorable (N = 25; RSD₄₃₀ = 16) size. Two trophy-size smallmouth bass (\geq 510 mm) were sampled in 2012. Most young (< 250 mm) smallmouth bass were sampled at North Point Marina and larger fish (>330 mm) were sampled at Calumet Harbor (Figure 3). Otoliths were collected from one smallmouth bass in 2012; this XX mm smallmouth bass was age-7. The Von Bertalanffy growth plot predicted L_{∞} (mean maximum length) at 489 mm (Figure 4).

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 (N = 147) were captured in similar numbers (N = 157) as smallmouth bass. CPEs in 2012 however declined relative to 2011 at all sites, including a more than 50% decrease in CPE at Jackson Harbor (Table 7); no largemouth bass have been sampled at Calumet Harbor since 2009.

No PIT tagged largemouth bass were recaptured in 2012. However, we have provided data for recaptured largemouth bass from 2009-2011 (Table 8). One largemouth bass that was tagged at North Point Marina in 2005 was recaptured in Waukegan South Harbor in 2009; all other largemouth bass were recaptured at the tagging site. Results of our monitoring efforts over the past 10 years indicate that there is high site fidelity to harbors. Like smallmouth bass, largemouth bass have been shown to move in and out of Illinois harbors, but typically not between them (Savitz and Treat 2007).

Many largemouth bass sampled in 2012 were of Quality size (N = 121; PSD = 82) and over one-third were of Preferred size (N = 52; RSD₃₈₀ = 35); no Memorable (510–625 mm) or Trophy (≥ 630 mm) largemouth bass were sampled (Figure 6). We sampled 161 individuals less than the Stock size (< 200 mm) in 2012. The Von Bertalanffy growth plot predicted L_{∞} at 418 mm (Figure 7).

Between 2000 and 2012, mean lengths of largemouth bass significantly increased (ANOVA; $F_{12,3071} = 36.6$; $P < 0.0001$). The most obvious distinction from visual inspection of the data showed a sustained increase in mean length after 2006 (Figure 5). Post-hoc analysis confirmed this, showing similar mean lengths from 2007 through 2012 following a steady increase from 2004 to 2007 (Tukey HSD; $P < 0.05$). 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 regulations however, we would expect to sample larger 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 2012. Poor weather conditions prevented sampling on two days in late July.

	Location			
	North Point Marina	Waukegan South Harbor	Jackson Inner Harbor	Calumet Harbor
8, 10 May 2012	0:52 / 57F	0:25 / 55F	0:30 / 62F	0:59 / 56F
4, 6, 7 June 2012	0:57 / 64F	0:32 / 62F	0:37 / 70F	1:00 / 64F
19, 20 June 2012	1:05 / 69F	0:45 / 70.5F	0:45 / 81F	1:03 / 70
2, 3 July 2012	0:53 / 75.5F	0:35 / 74F	0:32 / 80F	1:05 / 72F
24, 25 July 2012	0:51 / 79F	na	0:35 / 81F	na
15, 17 August 2012	0:55 / 75F	0:40 / 75F	0:26 / 77F	0:46 / 72F

Table 2. Proposed minimum lengths (mm) for smallmouth and largemouth bass of various size categories (from Gabelhouse 1983).

Species	Size designation				
	Stock	Quality	Preferred	Memorable	Trophy
smallmouth bass	180	280	350	430	510
largemouth bass	200	300	380	510	630

Table 3. A complete list of target fish species and a partial list of non-target species sampled during summer 2012 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	Waukegan South Harbor	Jackson Inner Harbor	Calumet Harbor
<i>target species</i>				
black bullhead	P	P	A	P
brown bullhead	P		P	
bluegill	A	P	A	P
green sunfish	P			
largemouth bass	A	A	A	
northern pike	P	P	P	
pumpkinseed	A	A	A	P
rock bass	A	A	P	P
smallmouth bass	A	A	P	A
yellow bullhead		P	P	
yellow perch	P			P
warmouth	P			
<i>non-target species</i>				
alewife	P		P	
white bass				P
freshwater drum			P	P
golden shiner			P	
rainbow trout	P	P		
round goby	P			
spottail shiner		P		
channel catfish				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 Harbor	4,000
1977	Belmont Harbor	1,000
1977	Great Lakes Harbor	5,000
1980	Diversey Harbor	20,000
1983	Lincoln Park Lagoon	25,000
1984	Great Lakes Harbor	18,000
1985	Jackson Harbor	18,400

Table 5. Catch-per-unit-effort (No. fish / 1 hr electrofishing) of Stock-size (180 mm) or longer smallmouth bass in four Illinois harbors, 1999-2012.

Year	Location			
	North Point Marina	Waukegan South Harbor	Jackson Inner Harbor	Calumet Harbor
1999	24.00	0.00	13.68	56.57
2000	27.60	0.80	6.00	26.50
2001	19.64	6.22	9.33	20.93
2002	16.81	6.91	10.67	42.67
2003	10.19	3.38	5.09	12.91
2004	13.67	1.64	7.57	57.04
2005	17.50	3.50	3.00	33.53
2006	10.89	9.66	1.33	34.83
2007	4.00	2.53	0.00	33.45
2008	8.83	8.67	2.78	30.29
2009	7.68	2.14	2.11	20.25
2010	5.92	0.45	2.40	25.00
2011	6.49	30.09	2.70	14.50
2012	5.77	7.12	1.46	20.27

Table 6. Smallmouth bass with PIT tags that were recaptured in 2009-2011. Note: no PIT tagged smallmouth bass were recaptured in 2012.

ID	Tagging			Recapture			
	Date	Length (mm) / Weight (g)	Location	Date	Length (mm) / Weight (g)	Location	Days at liberty
467A3E210C	7/17/2006	375 / 710	Calumet Harbor	5/8/2009	440 / 1270	Calumet Harbor	1026
45491D1E71	5/26/2004	375 / 750	Calumet Harbor	6/29/2010	475 / 1450	Calumet Harbor	2225
467A214C4D	7/17/2006	320 / 460	Calumet Harbor	5/4/2010	390 / 860	Calumet Harbor	1387
4701513C26	5/8/2006	255 / 250	North Point Marina	6/2/2011	365 / 800	Waukegan Harbor	1851

Table 7. Catch-per-unit-effort (No. fish / 1 hr electrofishing) of Stock-size (200 mm) or longer largemouth bass in four Illinois harbors, 1999-2012.

Year	Location			
	North Point Marina	Waukegan South Harbor	Jackson Inner Harbor	Calumet Harbor
1999	21.00	1.00	9.40	1.14
2000	32.00	17.20	30.67	0.00
2001	22.70	31.56	38.67	0.39
2002	22.16	23.63	42.67	0.67
2003	22.04	11.81	27.64	0.60
2004	47.33	37.16	68.11	0.74
2005	72.00	41.96	99.00	0.60
2006	35.78	29.41	53.33	1.12
2007	32.24	26.27	22.57	0.00
2008	50.53	14.67	49.07	0.96
2009	33.99	16.43	24.51	0.42
2010	24.87	8.51	26.40	0.00
2011	19.46	9.73	44.49	0.00
2012	10.99	7.12	19.02	0.00

Table 8. Largemouth bass with PIT tags that were recaptured in 2009, 2010, and 2011. Note: no PIT tagged largemouth bass were recaptured in 2012. * Original tagging data not available. ^a Recaptured during fall harbor assessment.

ID	Tagging			Recapture			Days at Liberty
	Date	Length (mm) / Weight (g)	Location	Date	Length (mm) / Weight (g)	Location	
46146F3E2B	6/15/2005	360 / 680	North Point Marina	6/1/2009	450 / 1540	Waukegan South Harbor	1077
45587D2347	5/23/2005	255 / 200	North Point Marina	6/23/2009	360 / 555	North Point Marina	1492
460E190A66	8/30/2005	290 / 320	North Point Marina	6/23/2009	390 / 825	North Point Marina	1393
467A511B5D	7/16/2006	400 / 1100	North Point Marina	6/23/2009	405 / 1170	North Point Marina	1070
454945203E	4/14/2004	295 / 350	North Point Marina	7/8/2009	405 / 1080	North Point Marina	1911
467A6F480A *	na	na	na	8/11/2009	385 / 810	North Point Marina	na
4641453D18	5/23/2006	355 / 670	Jackson Inner Harbor	5/4/2010	450 / 1370	Jackson Inner Harbor	1442
47010A1264 ^a	7/19/2006	310 / 430	North Point Marina	9/22/2010	360 / 750	North Point Marina	1526
43105A087C	9/3/2004	250 / 220	North Point Marina	6/21/2011	380 / 870	North Point Marina	2482
461458295C	6/15/2005	270 / 300	North Point Marina	6/21/2011	360 / 640	North Point Marina	2197
467A1F1172	5/8/2006	285 / 320	North Point Marina	6/21/2011	375 / 750	North Point Marina	1870

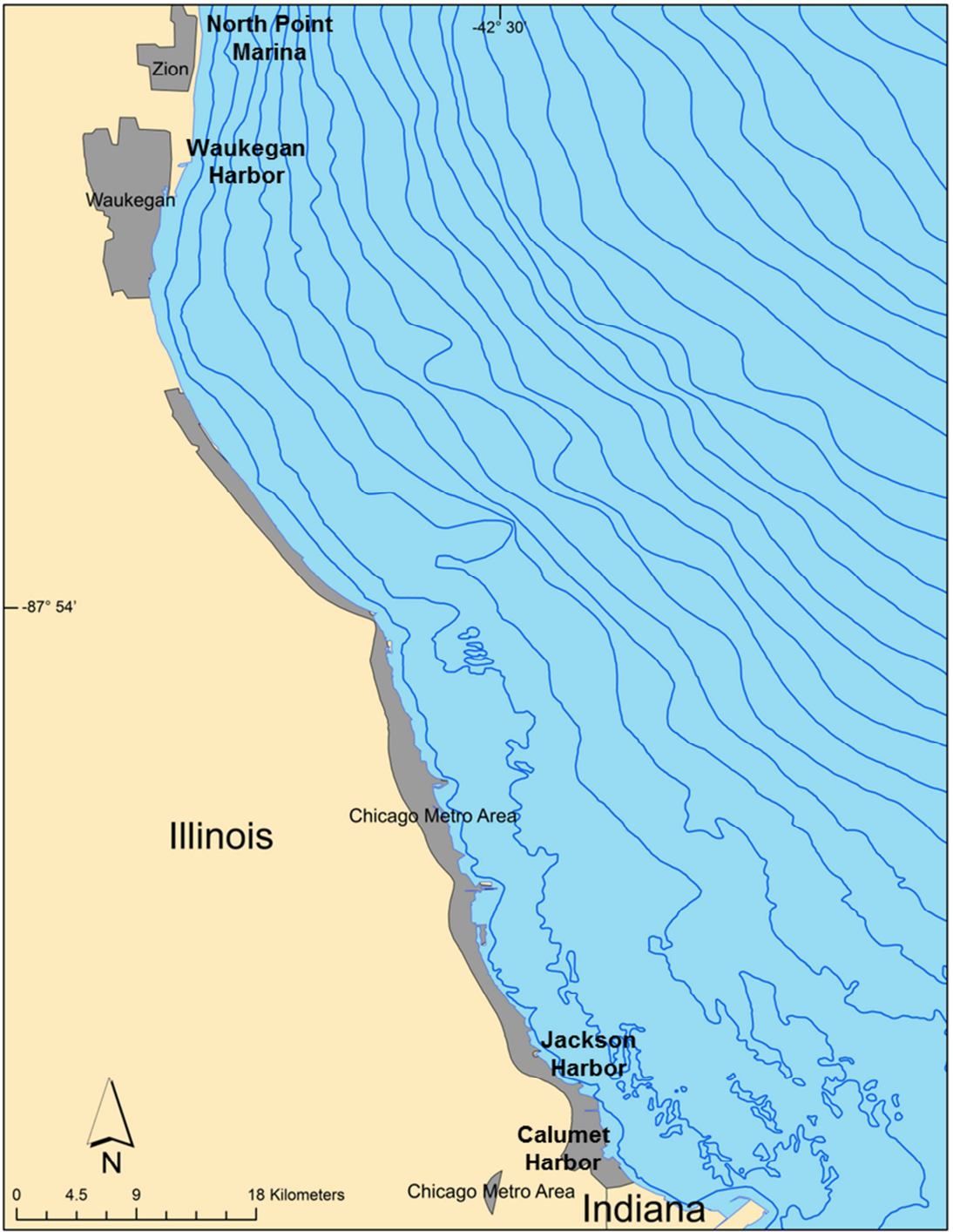


Figure 1. Locations of Lake Michigan harbors sampled in 2012.

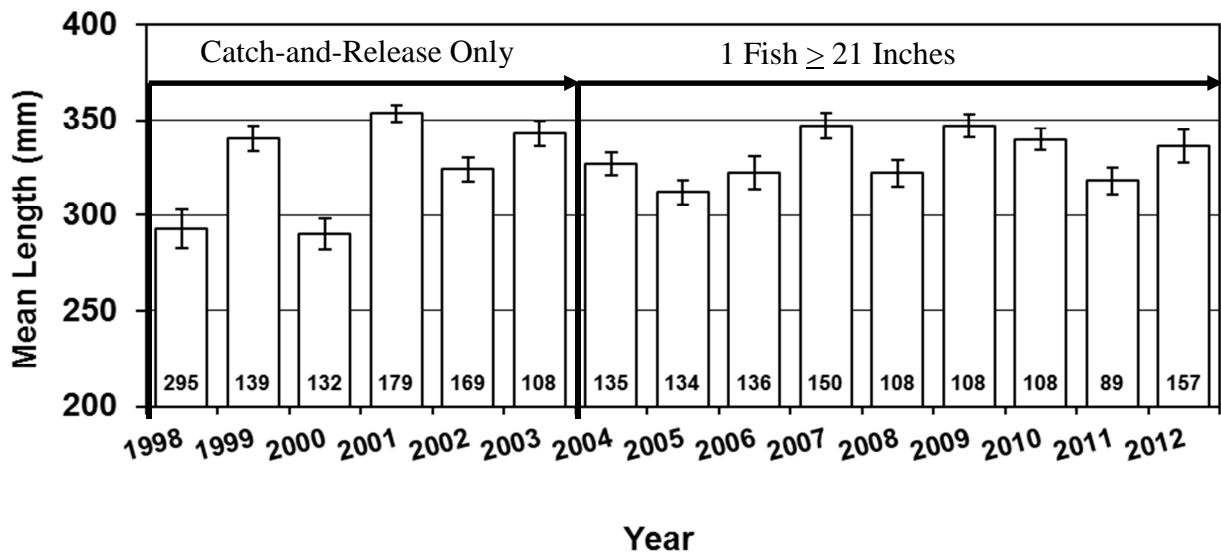


Figure 2. Mean lengths (± 1 S.E.) of Stock size (≥ 180 mm) smallmouth bass sampled from 1998 to 2012. Arrows indicate time periods of two different angling regulations: catch and release only (1998–2004) and a minimum size limit of 21 inches (2004–present).

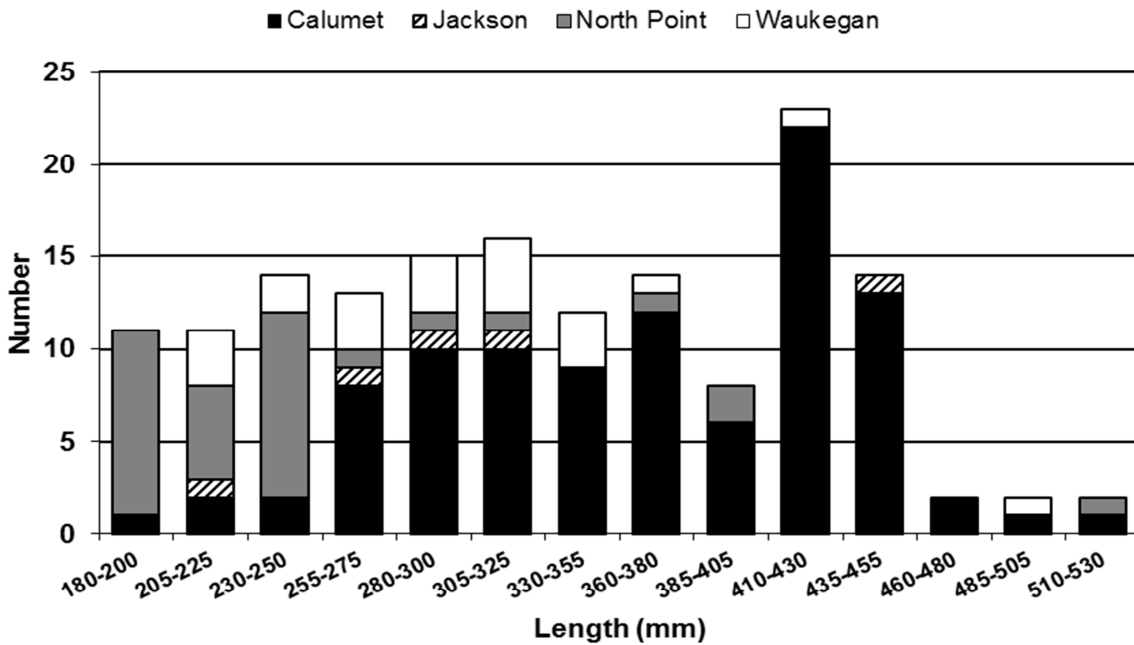


Figure 3. Length distribution of Stock size (≥ 180 mm) smallmouth bass sampled at four Illinois harbors in 2012.

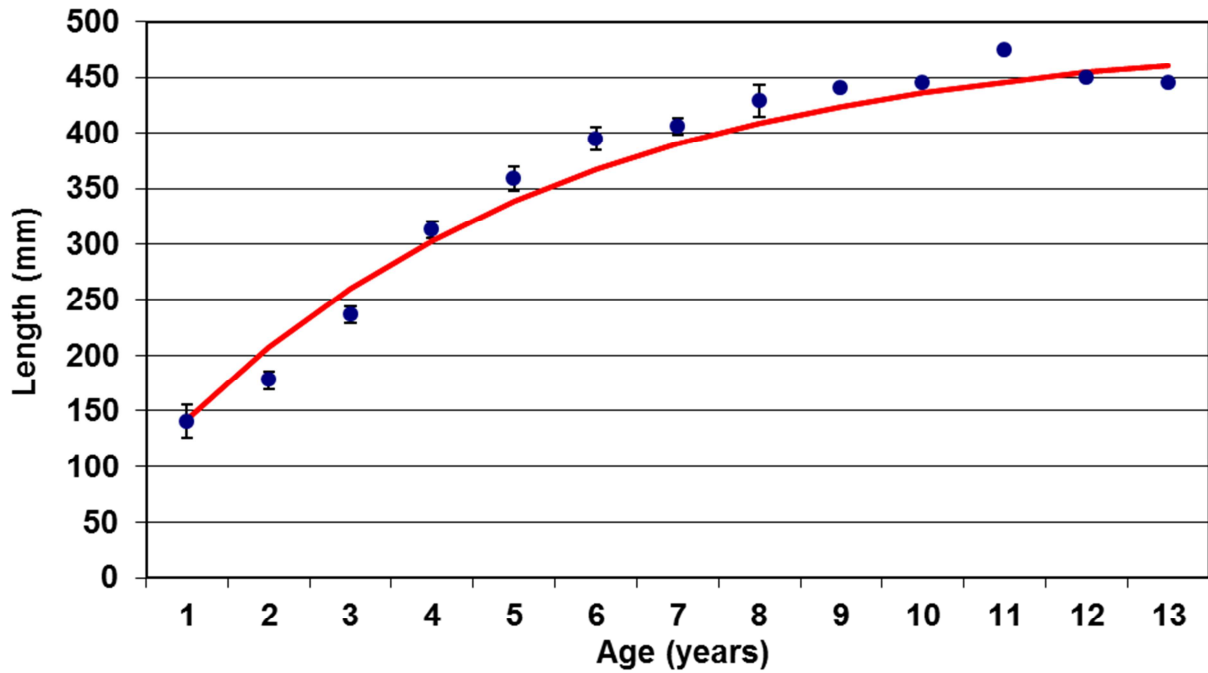


Figure 4. Von Bertalanffy growth plot of smallmouth bass sampled between 2002 and 2012 ($N_{\text{total}} = 129$).

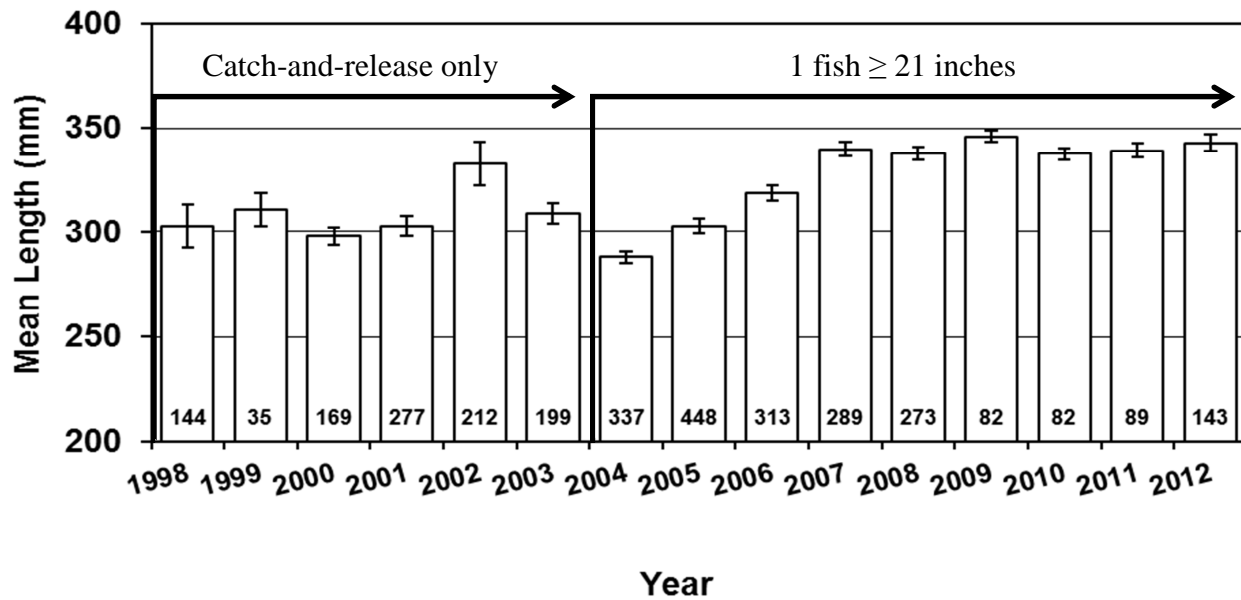


Figure 5. Mean lengths (± 1 S.E.) of Stock size (≥ 200 mm) largemouth bass sampled from 1998 to 2012. Arrows indicate time periods of two different angling regulations: catch and release only (1998–2004) and a minimum size limit of 21 inches (2004–present).

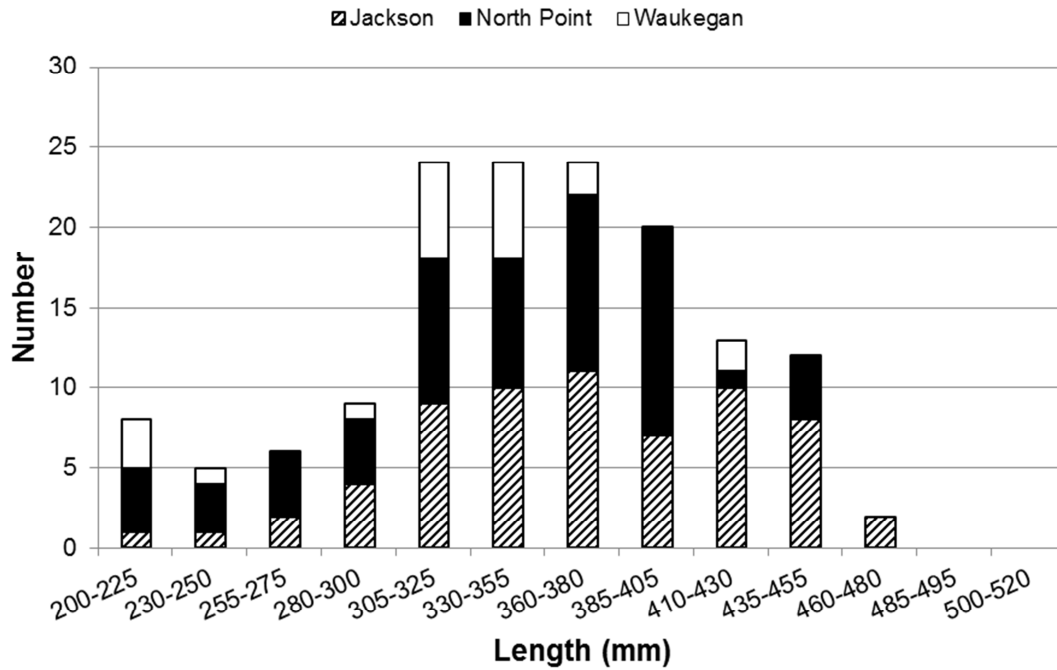


Figure 6. Length distribution of Stock size (≥ 200 mm) largemouth bass sampled at four Illinois harbors in 2012. No largemouth bass were sampled at Calumet Harbor.

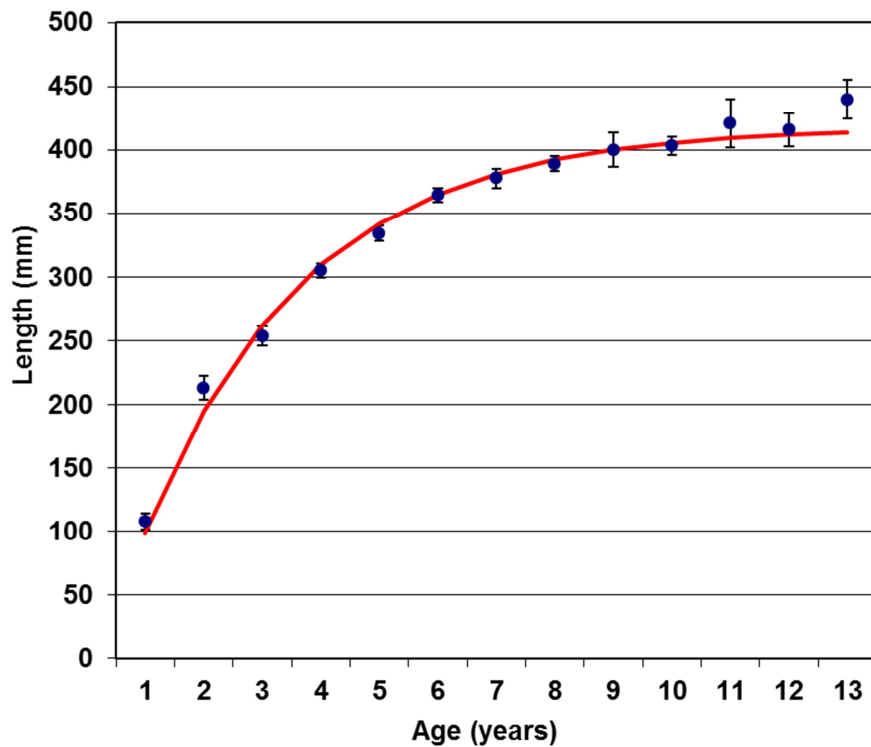


Figure 7. Von Bertalanffy growth plot of largemouth bass sampled between 2002 and 2011 ($N_{\text{total}} = 253$). Note: no largemouth bass ages were calculated for the 2012 field season.