Illinois Department of Natural Resources

Division of Fisheries

Nearshore Fish Community of Lake Michigan:

2019 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 during summer 2019. Species richness was highest in North Point Marina and Jackson Harbor with a total of 25 fish species detected in each harbor. We sampled 17 species in Waukegan South Harbor and only eight species were collected along the shoreline in Calumet Harbor. Rock Bass, Largemouth Bass, Pumpkinseed, Yellow Perch, Black Bullhead, Bluegill, and Smallmouth Bass were the most abundant targeted, sportfish encountered. In 2019, a total of 146 Smallmouth Bass were collected; of these 118 were Stock size (≥ 180 mm), 91 were Quality size (≥ 280 mm), 56 were Preferred size (≥ 350 mm), and 21 were Memorable size (≥ 430 mm). No Trophy-size (≥ 510 mm) Smallmouth Bass were sampled. A total of 261 Largemouth Bass were sampled in 2019; 63 fish were Stock size (≥ 200 mm) and the remaining 76% were less than 200 mm TL. A total 50 Largemouth Bass were Quality size (≥ 300 mm) and 38 were Preferred size (≥ 380 mm). No Memorable (≥ 510 mm) or Trophy-size (≥ 630 mm) Largemouth Bass were sampled. Overall, the relative weight of Smallmouth and Largemouth Bass we measured was equivalent to standard weights (*Ws*).

Introduction

Several sport and non-sport fish species inhabit Illinois harbors and nearshore areas of Lake Michigan during summer. Common sport fish found in these areas include: Smallmouth Bass (*Micropterus dolomieu*), Largemouth Bass (*Micropterus salmoides*), Yellow Perch (*Perca flavescens*), Northern Pike (*Esox lucius*), Black Bullhead (*Ameiurus* melas), 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. Prior to 1996 no estimate of Smallmouth Bass harvest could be calculated from creel data because few were found in the possession of anglers. However, by 2000 anglers reported catching an estimated 4,892 Smallmouth Bass (pers. comm. W. Brofka, INHS) and within the last five years annual catch ranged from approximately 2,314 to a peak of 12,951 Smallmouth Bass in 2018 (pers. comm. C. Roswell, INHS).

Historical stocking of juvenile Smallmouth Bass in Illinois harbors may or may not have contributed to the establishment of sustainable populations or supplemented existing populations. For example, no stocking records exist for Largemouth Bass and yet they are also observed in the nearshore fish community. Regardless, stocking events for Smallmouth Bass were small scale, sporadic and last occurred in 1985. Since that time, Young-of-the-year (YOY) Smallmouth Bass have been captured at multiple sites that were never stocked and have been collected in areas where no Smallmouth Bass were collected in the past (e.g., Farwell Avenue Pier since 2000). Both these observations suggest that natural reproduction and immigration have allowed Smallmouth Bass to expand its range along the Illinois shoreline. In regards to Largemouth Bass, 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. Over the past 10 years, monitoring data suggest stable abundance of Smallmouth Bass, a downward trend in the abundance of Largemouth Bass, but quality sizes of both species within Illinois waters of Lake Michigan. In fact, during 2019 a pedestrian angler landed the new Illinois state record Smallmouth Bass (22.5 inch, 7lb 3oz) along the shoreline at Monroe Harbor.

Although management of fish species inhabiting 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 were previously obtained through incidental catches of non-salmonid fish species during fall electrofishing for returning salmonids and through a sport angler creel survey. During creel surveys sport anglers were interviewed, fish in their possession were measured and weighed, and estimated sport harvest was used as an index 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 like 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 size structure and growth indices for sport fish inhabiting these harbors; and 5) collect age-composition data during select years 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 2019 (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 except for black bass fry whose presence was only noted. Other targeted species (e.g., Rock Bass, Crappie, Yellow Perch) were subsampled to obtain a representative distribution of sizes. The presence of non-target, incidental species (e.g., Alewife, Gizzard Shad, White Sucker, and Common Carp) was usually only noted, but when possible established aquatic nuisance species (e.g., Goldfish, Koi) were captured and removed from the water. All other sampled fish were dip-netted and held onboard in a 100-gallon 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 while biological data were obtained. Fish were measured to the nearest 5 mm (maximum total length) and weighed to the nearest 10 grams. No pit-tagged Smallmouth or Largemouth Bass were collected during 2019. Otoliths were collected from a subsample of Smallmouth and Largemouth Bass ≥ 125 mm during 2019 and were processed following methods of Robillard and Marsden (1996). Stomachs from a sub-set of these fish also were examined.

Catch-per-unit-effort (CPUE) for targeted species was calculated as the number of fish per hour of electrofishing effort.   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 Neumann 1996). Relative Weight (*Wr*) of Smallmouth and Largemouth Bass was compared to species-specific Standard Weight (*Ws*) equations taken from Anderson and Neumann (1996). Only fish collected after 24 June were included in this analysis because pre-spawn fish tend to have inflated *Wr* values. Age-length keys and non-linear von Bertalanffy growth models also were developed for Smallmouth and Largemouth Bass following the methods of Isely and Grabowski (2007). The von Bertalanffy growth curve was then used to predict L∞ which is not the maximum length of an individual, but rather the theoretical average length at which growth approaches zero (Frances 1988). As with any average, individuals vary about that average and thus, some fish may be larger than L∞. Diet composition was expressed as percentage occurrence of prey items from all stomachs examined.

Results and Discussion

Species Composition

Overall, we sampled 13 targeted, sportfish species, 4 hybridized forms of Centrarchids, and 22 non-targeted (incidental) species by electrofishing in 2019. The highest number of species were detected in North Point Marina and Jackson Harbor (N=25), followed by Waukegan South Harbor (N=17), and then Calumet Harbor (N=8). Rock Bass, Largemouth Bass, Pumpkinseed, Yellow Perch, Black Bullhead, Bluegill, and Smallmouth Bass were the most abundant targeted, sportfish encountered. The presence and abundance of sportfish differed among harbors. For example, abundance of Rock Bass, Pumpkinseed, Yellow Perch, and Bluegill was far higher in North Point Marina than at any other sampling location (Table 3). The highest CPUE (No. fish/hr) for

Largemouth Bass and Black Bullhead occurred at Jackson Harbor and a large diversity of Centrarchids were also collected at this site. CPUE of Smallmouth Bass was highest at Calumet, while few other Centrarchid species were present at this location. This is likely a result of the Calumet site being an open-lake area more exposed to wave action, slower warm up during the spring, and rapid changes in water temperatures during the summer, all of which are conditions not conducive to establishing aquatic vegetation and supporting Centrarchids.

The types of sport fish species we encountered in the three protected harbors (North Point Marina, Waukegan Harbor and Jackson Harbor) were similar to those typically found in warm-water inland lakes with similar habitats. 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). 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 can intermittently decrease temperatures during summer upwellings. A second difference is the relatively restricted fishing access; much of the area within these harbors is dedicated to moored vessels and closed to fishing. Thus, Illinois harbors likely act as refuges on Lake Michigan where populations of warm-water fish may grow in a near natural state with limited fishing mortality.

Smallmouth Bass

A total of 146 Smallmouth Bass were measured and weighed in 2019; 118 fish were Stock size ($\geq$ 180 mm) and 28 individuals were less than 180 mm long. Most Stock size Smallmouth Bass were collected at Calumet Harbor (N = 80), followed by Jackson Inner Harbor (N=21), North Point Marina (N=12), and then Waukegan South Harbor (N=5). Catch-per-unit-effort (CPUE) of Stock size Smallmouth Bass was similar to that reported in 2018 at Calumet Harbor and Jackson Harbor, but decreased at North Point Marina and Waukegan South (Table 4). A general decline in CPUE at Calumet Harbor since 2007 may be attributed to the concurrent reduction in the number of bass tournaments that held weigh-ins and released fish at this harbor. These location specific tournament releases prior to 2007 were likely inflating our sampling CPUEs at Calumet Harbor during 2000-2006.

Most Smallmouth Bass sampled in 2019 were of Quality size (N=91), fewer of Preferred (N=56; RSD_{350} =47) size, and still fewer of Memorable (N=21; RSD_{430}=18) size. No trophy-size Smallmouth Bass ($\geq$ 510 mm) were collected in 2019. Overall, the size structure of the population was similar to that in 2018. Stock size Smallmouth Bass collected at Calumet Harbor ranged in length from 180-500 mm and multiple size classes were well represented in 2019 (Figure 2).   The average relative weight (*Wr*) of Smallmouth Bass in 2019 was 100 and measured weights of these fish were similar to standard weights (*Ws*; Figure 3). Based on age sub-sampling and

the development of an age-length key, Smallmouth Bass collected in 2019 ranged from 1 to 13 years old. Age-3 fish (2016 year-class) dominated the sample (32%), followed by age 2 (15%). Age 4 through age 8 fish were also well represented and collectively these age classes made up 30% of the sample (Figure 4). Length of Smallmouth Bass was directly related to age and the von Bertalanffy growth plot predicted L∞ (average length maximum) at 498 mm (Figure 5).   Diet information was evaluated for 26 Smallmouth Bass which were divided into two size groups (125-300 mm and 305-480 mm). The smaller size group primarily consumed Round Goby, crayfish and smaller invertebrates such as Chironomids and Amphipods (Figure 6). The diet of Smallmouth Bass ≥ 305 mm was dominated by prey fish and crayfish. Most of the fish consumed were Alewife and Round Goby and an additional 20% of fish were too digested to identify (Other fish category).

Largemouth Bass

We sampled 261 Largemouth Bass in 2019 of which 63 fish were Stock size (≥ 200 mm) and the remaining 76% of fish were less than 200 mm long. Most Largemouth Bass were collected at Jackson Harbor (N=191). More Largemouth Bass were caught at North Point Marina (N=57) than Waukegan Harbor (N=5) and none were collected along the shoreline in Calumet Harbor. CPUE of Stock size Largemouth Bass declined by approximately 48% at both North Point Marina and Jackson Inner Harbor compared to 2018. CPUE of Stock size fish at Waukegan Harbor was similar to 2018 (Table 5). A higher number of small (<200 mm) Largemouth Bass were collected in 2019 (N=191) compared to the previous year (N=53) and most of these fish were collected in Jackson Inner Harbor.

Most Largemouth Bass sampled in 2019 were of Quality size (N = 50), fewer were of Preferred size (N = 38; RSD_{380}= 60), and no Memorable (≥ 510 mm) or Trophy (≥ 630 mm) size Largemouth Bass were sampled. Overall, the size structure of the population was similar to that measured in 2018 (Figure 7). The average relative weight (*Wr*) of Largemouth Bass in 2019 was 100 and the measured weights of these fish were similar to standard weights (Ws; Figure 8). Largemouth Bass collected in 2019 ranged from 1 to 9 years old. Age-2 fish (2017 year-class) dominated the sample (32%), followed by age 1 (26%). Age 3 through age 5 fish were also well represented and collectively these age classes made up 28% of the sample (Figure 9). Length was directly related to age and the von Bertalanffy growth plot predicted L∞ (average length maximum) at 478 mm (Figure 10). Diet information was evaluated for 19 Largemouth Bass which were divided into two size groups (125-300 mm and 305-480 mm). The smaller size group primarily consumed Round Goby, Alewife, other fish, and a smaller proportion of Isopods (Figure 11). The diet of Largemouth Bass ≥ 305 mm was dominated by prey fish. A large proportion of these prey fish were too digested to identify and a few of these were likely newly stocked salmonids (Other fish). Smaller proportions of Alewife and Round Goby also were consumed.

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 during select years to determine ages.

Literature Cited

Anderson, R. O., and R. M. Neumann. 1996. Length, weight, and associated structural indices. Pages 447–482 *in* Murphy, B. R., and D. W. Willis (eds.) *Fisheries Techniques* (2nd ed.). American Fisheries Society, Bethesda, Maryland.

Danehy, R. J. 1984. Comparative ecology of fishes associated with natural cobble shoals and sand substrates in Mexico Bay, Lake Ontario. MS Thesis. State University of New York, Syracuse. 84 pp.

Frances, R. 1998. Are growth parameters estimated from tagging and age-length data comparable? Canadian Journal of Fisheries and Aquatic Sciences 45:936-942.

Gabelhouse, D.W. 1984. A length categorization system to assess fish stocks. North American Journal of Fisheries Management 4:273-285.

Isely, J. J., and Grabowski, T.B. 2007. Age and growth. In C. S. Guy and M. L. Brown (Ed.), *Analysis and Interpretation of Freshwater Fisheries Data* (pp. 187-228). Bethesda, Maryland: American Fisheries Society.

Jude, D., Stoermer, E., Johengen, T., and A. N. Perakis. 2002. Non-indigenous species in the Great Lakes: ecology, interactions, impacts, and future research directions. White paper prepared for the University of Michigan's Great Lakes Initiative. 39 pp.

Robillard, S. R., and J. E. Marsden. 1996. Comparison of otolith and scale ages for yellow perch from Lake Michigan. Journal of Great Lakes Research 22(2):429-435.

Table 1. Amount of electrofishing effort (hrs:min) and water temperatures at three Illinois harbors and along the shoreline in Calumet Harbor during 2019.

Sampling Date	Location			
	North Point Marina	Waukegan South Harbor	Jackson Inner Harbor	Calumet Harbor
6, 10 May	0:55 / 49F	0:23 / 49F	0:35 / 55F	0:41 / 50F
17, 20, 23 May	1:00 / 51F	0:22 / 53F	0:22 / 57F	0:51 / 52F
3, 4 June	1:06 / 58F	0:30 / 55F	0:50 / 62F	0:35 / 60F
18, 21 June	0:55 /na	0:28 / 56F	0:41 / 66F	0:50 / 62F
2, 3 July	1:12 / 69F	0:30 / 71F	0:42 / 76F	0:43 / 72F
22, 23, 25 July	0:52 / 66F	0:38 / 70F	0:43 / 77F	0:46 / 69F
5, 7 August	1:10 / 77F	0:46 / 77F	0:44 / 81F	0:41 / 73F

Table 2. Proposed minimum lengths (mm) for Smallmouth and Largemouth Bass of various length categories (taken 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 2019 by electrofishing in three Illinois harbors and along the shoreline in Calumet Harbor. Catch-per-unit-effort (No. fish / 1 hr electrofishing) is shown for targeted species and the presence of incidental species is denoted with the letter P.

	Location			
Target Species	North Point Marina	Waukegan South Harbor	Jackson Inner Harbor	Calumet Harbor
Black Bullhead	0.14	0.28	38.83	
Black Crappie	0.14			
Bluegill	16.16	2.76	6.51	
Green Sunfish	3.48	2.21		
Largemouth Bass	7.94	3.59	41.43	
Northern Pike	0.70		0.43	
Pumpkinseed	27.86	6.63	6.07	
Sunfish (hybrid)	0.84		0.22	
Rock Bass	36.63	25.14	3.90	1.96
Smallmouth Bass	3.06	2.21	5.21	18.00
Walleye	0.14			
Warmouth	0.84			
Yellow Bullhead	0.42	0.28	0.22	
Yellow Perch	28.13	1.66	0.43	
Incidental Species				
Alewife	P	P	P	P
Banded Killifish			P	
Bluntnose Minnow			P	
Bowfin		P		
Brook Stickleback		P		
Brown Trout	P	P		
Buffalo spp.			P	P
Chinook Salmon	P			P
Coho Salmon		P	P	P
Common Carp	P	P	P	P
Freshwater Drum			P	
Gizzard Shad	P		P	
Golden Shiner	P		P	
Goldfish	P		P	
Grass Pickerel	P			
Koi		P		
Rainbow Trout	P		P	P
Round Goby	P	P	P	P
Redhorse spp.	P		P	
Sand Shiner			P	
Spottail Shiner	P			
White Sucker	P	P	P	P

Table 4. Catch-per-unit-effort (No. fish / 1 hr electrofishing) of Stock size (≥180 mm) Smallmouth Bass in three Illinois harbors and along the shoreline in Calumet Harbor, 2000-2019.

	Location			
Year	North Point Marina	Waukegan South Harbor	Jackson Inner Harbor	Calumet Harbor
2000	22.67	0.80	6.00	69.62
2001	20.66	8.00	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	2.00	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	20.70
2010	4.49	0.56	2.80	21.51
2011	12.57	5.79	2.41	14.52
2012	5.59	7.12	1.47	20.16
2013	5.43	3.60	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	3.90	0	16.03
2017	5.17	3.86	1.89	16.24
2018	3.78	2.14	4.12	16.30
2019	1.67	1.38	4.56	15.66

Table 5. Catch-per-unit-effort (No. fish / 1 hr electrofishing) of Stock size (≥200 mm) Largemouth Bass in three Illinois harbors and along the shoreline in Calumet Harbor, 2000-2019.

Year	Location			
	North Point Marina	Waukegan South Harbor	Jackson Inner Harbor	Calumet Harbor
2000	26.33	17.20	30.00	0.63
2001	22.70	35.50	38.19	0.36
2002	26.98	24.73	42.67	0.67
2003	22.27	14.29	31.85	0.58
2004	54.40	35.00	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	15.50	4.96	39.76	0
2012	10.66	7.12	19.06	0
2013	15.13	15.2	18.80	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
2018	5.26	4.50	16.25	0
2019	2.65	1.38	8.46	0
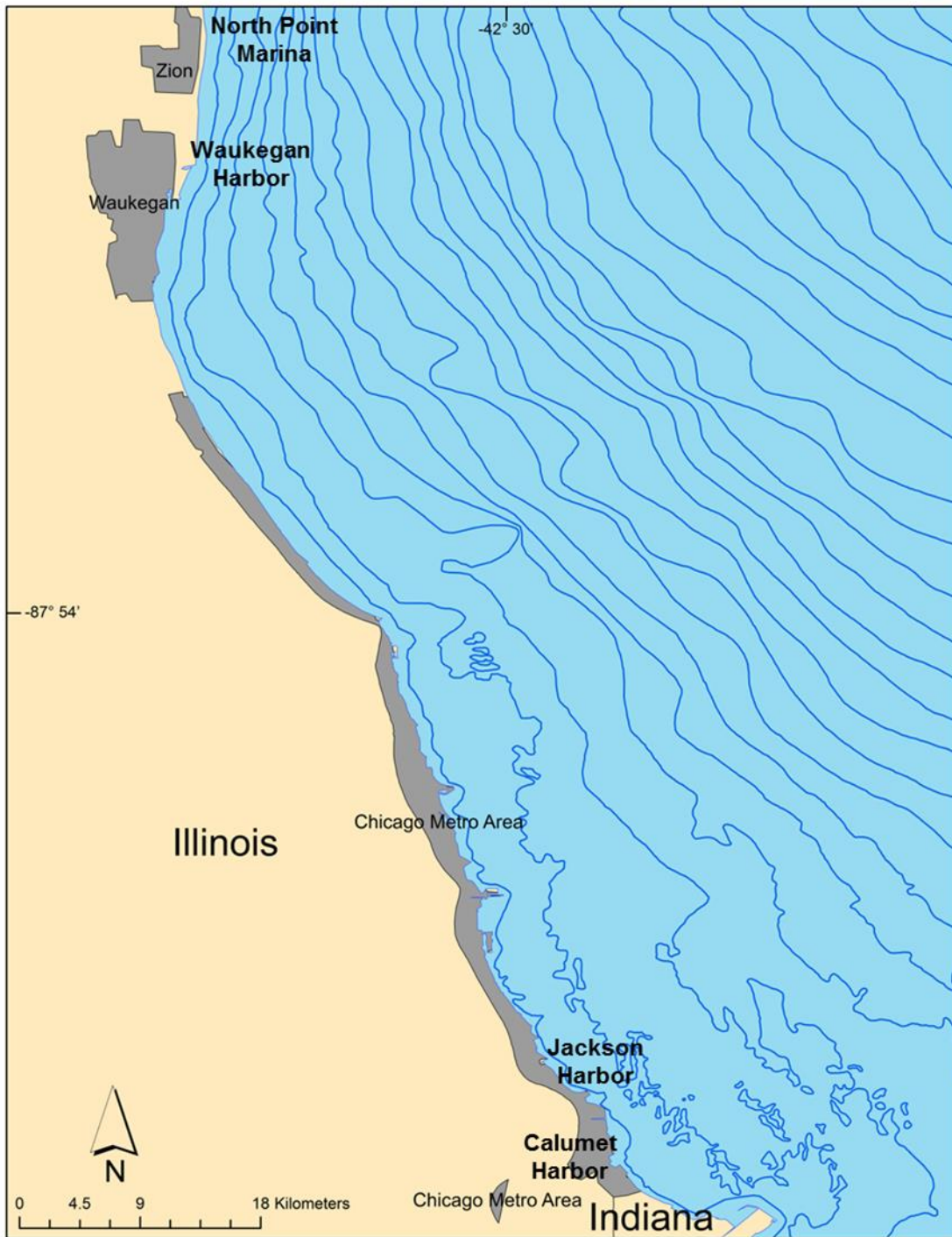
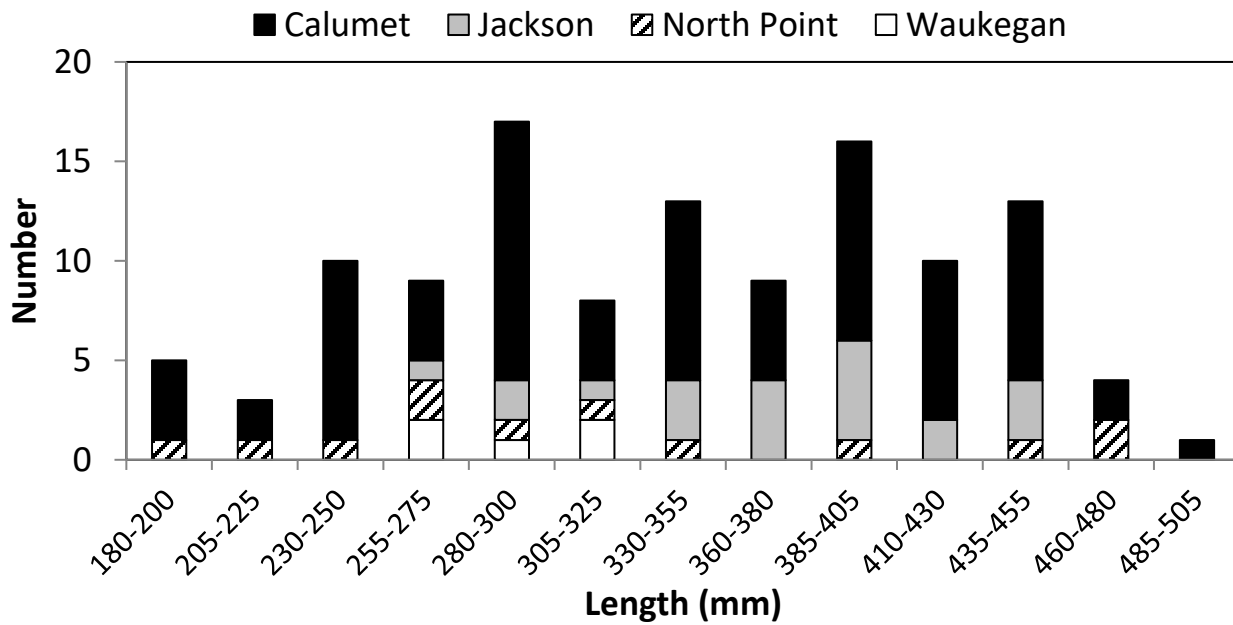Figure 1. Locations of Lake Michigan harbors sampled in 2019.

Figure 2. Length distribution of Stock size (≥ 180 mm) Smallmouth Bass sampled at three Illinois harbors and along the shoreline in Calumet Harbor during 2019.
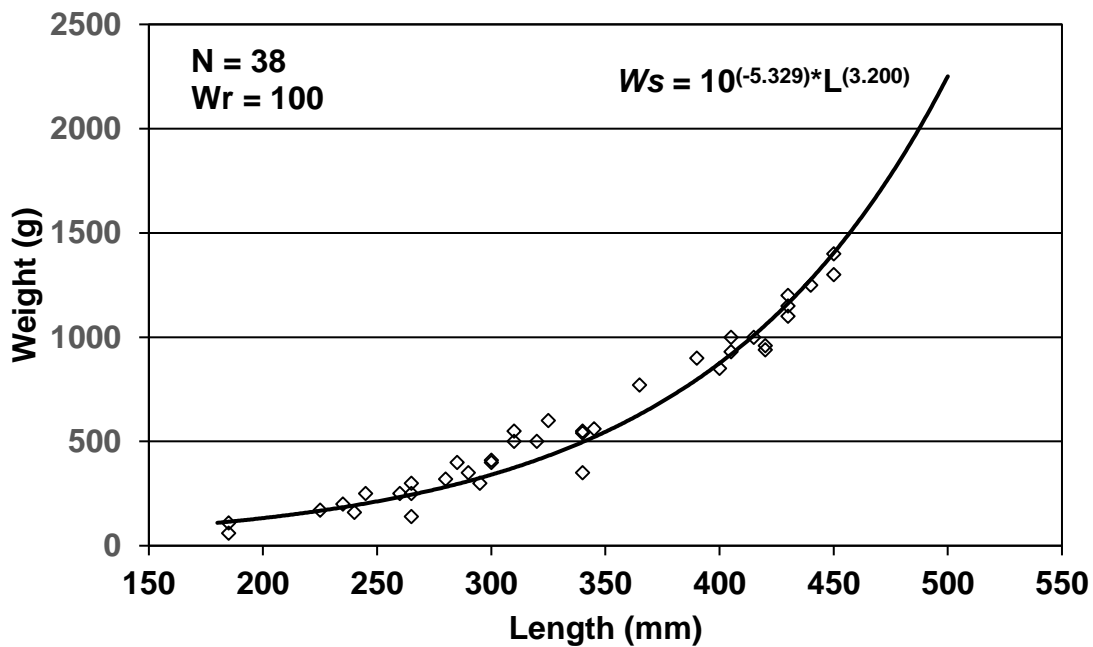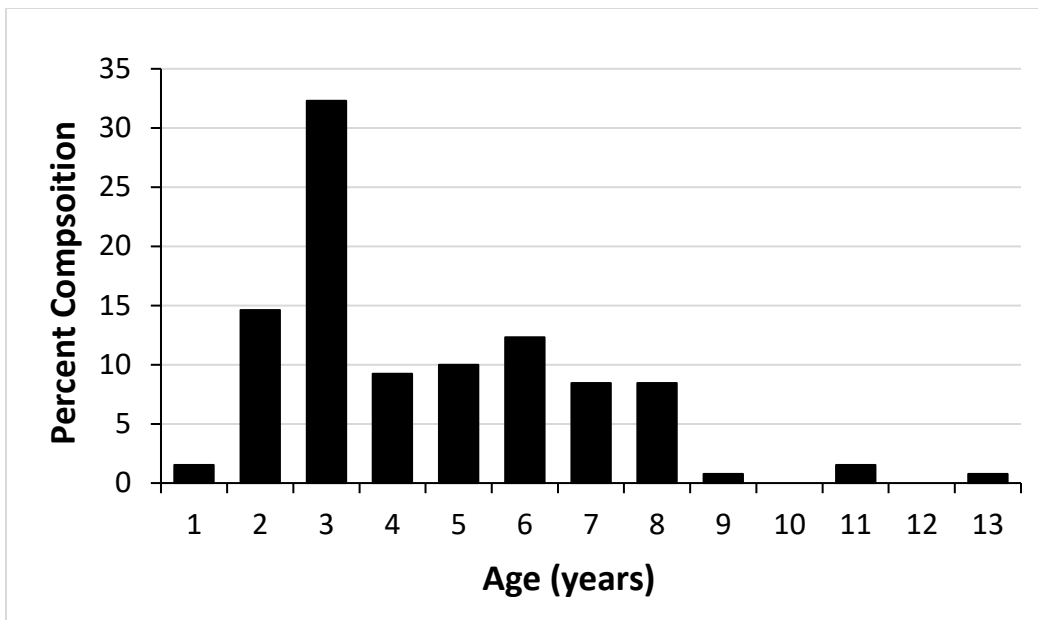

$$Ws = 10^{(-5.329)}*L^{(3.200)}$$

N = 38
Wr = 100

Figure 3. Observed weight-length relationship (white diamonds) and standard weight equation (*Ws*; black line) of Stock size (≥ 180 mm) Smallmouth Bass sampled at three Illinois harbors and along the shoreline in Calumet Harbor during 2019.

Figure 4. Age composition of Smallmouth Bass (≥ 125 mm) sampled at three Illinois harbors and along the shoreline in Calumet Harbor during 2019.
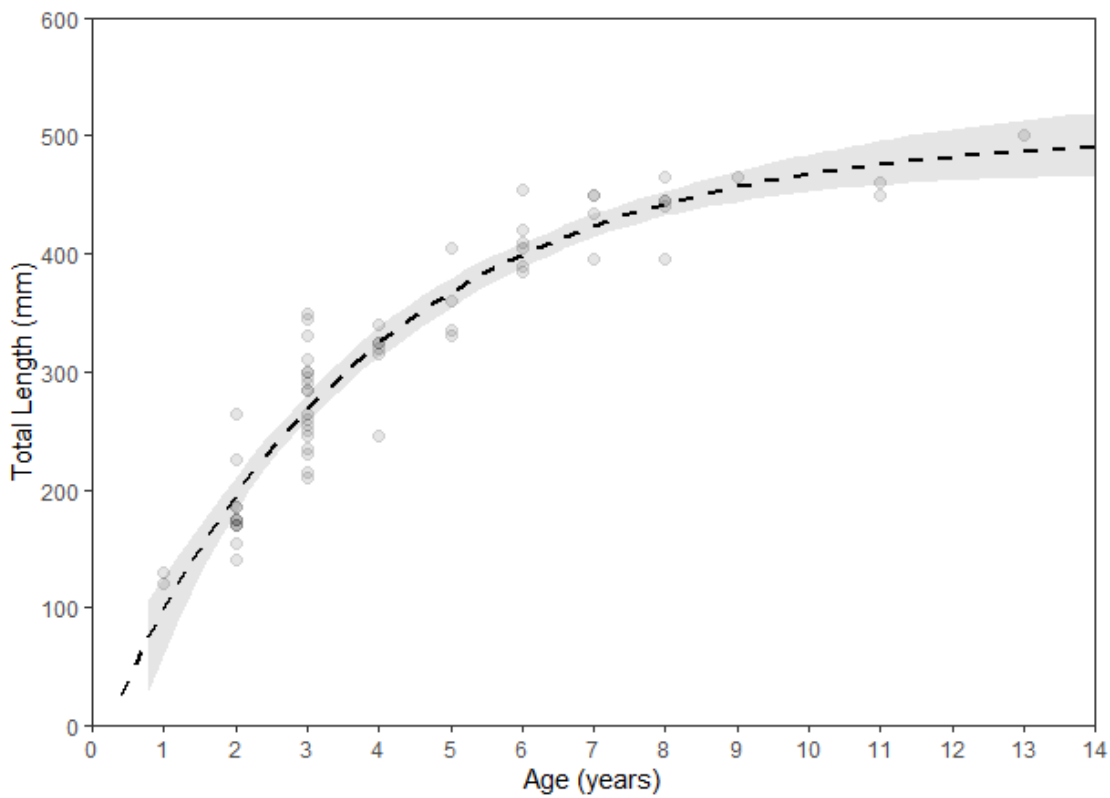
Figure 5. Von Bertalanffy growth plot of Smallmouth Bass sampled during 2019 (N = 62).
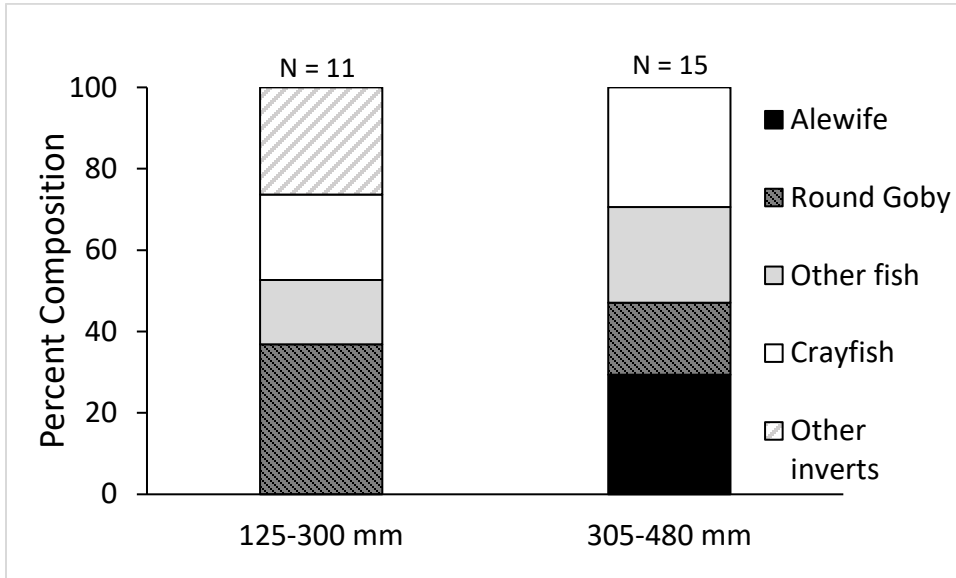
Figure 6. Diet composition of two size groups of Smallmouth Bass sampled during 2019 (N=26). The number above each bar is the sample size for each size group.
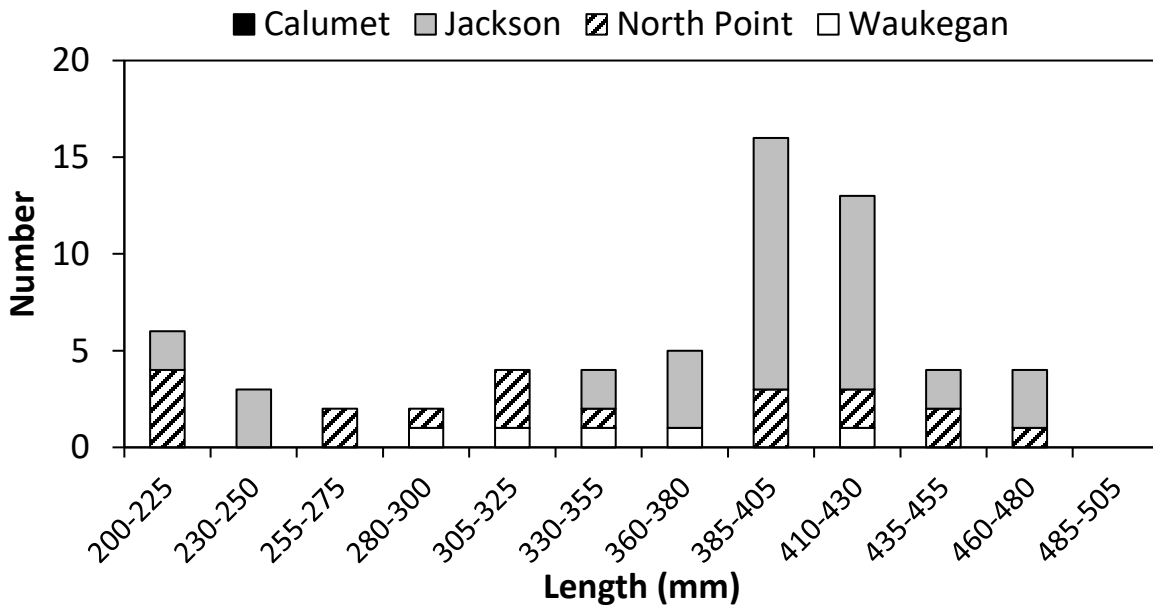

Figure 7. Length distribution of Stock size (≥ 200 mm) Largemouth Bass sampled at three Illinois harbors and along the shoreline in Calumet Harbor during 2019. No Largemouth Bass were sampled at Calumet Harbor.
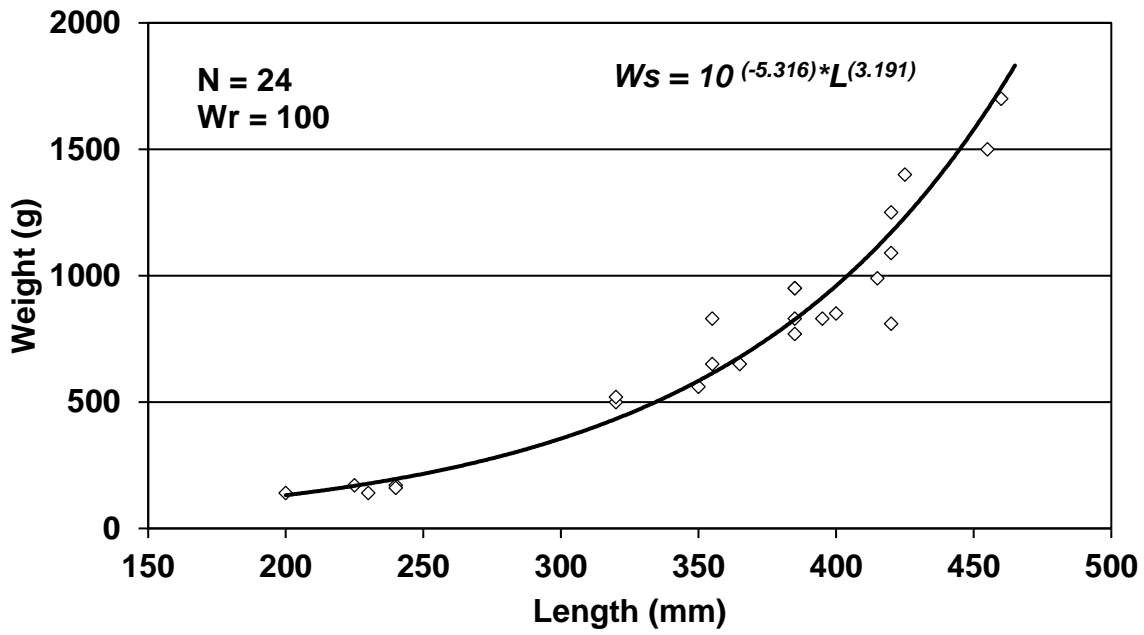
Figure 8. Observed weight-length relationship (white diamonds) and standard weight equation (*Ws*; black line) of Stock size (≥ 200 mm) Largemouth Bass sampled at three Illinois harbors and along the shoreline in Calumet Harbor during 2019.
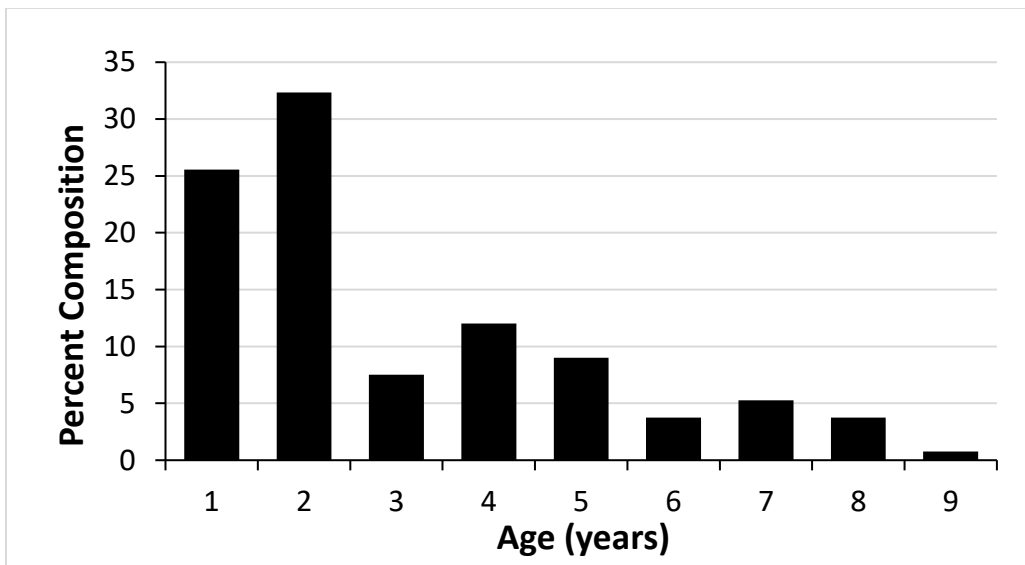

Figure 9. Age composition of Largemouth Bass (≥ 125 mm) sampled at three Illinois harbors and along the shoreline in Calumet Harbor during 2019.
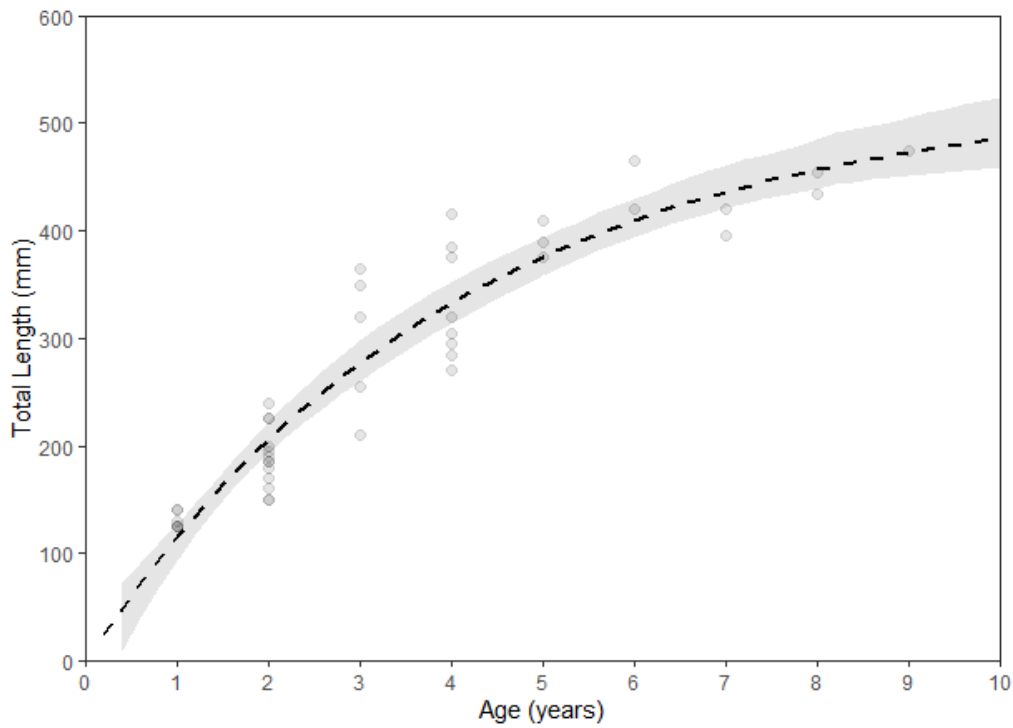
Figure 10. Von Bertalanffy growth plot of Largemouth Bass sampled during 2019 (N=42).
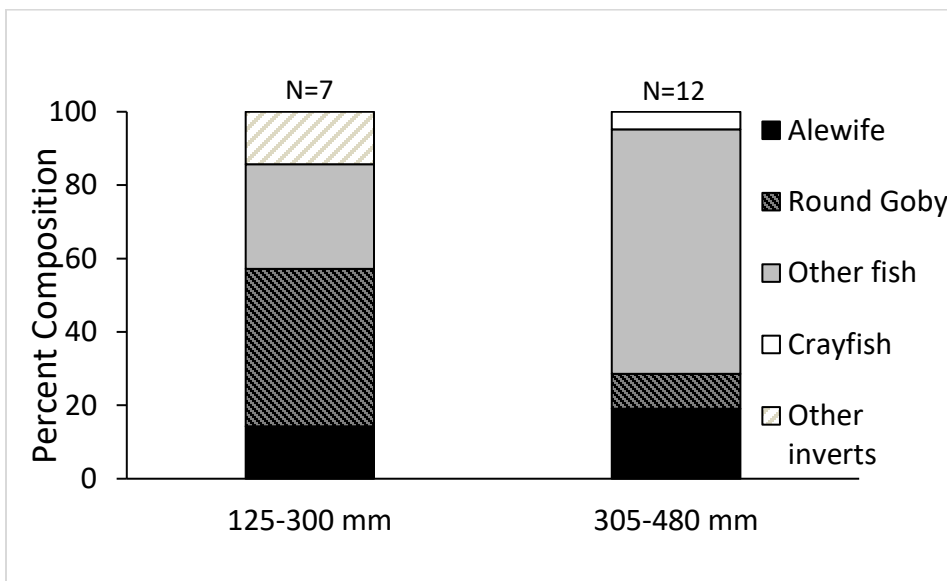

Figure 11. Diet composition of two size groups of Largemouth Bass collected during 2019 (N=19). The number above each bar is the sample size for that size group.