SUTTON LAKE LARGEMOUTH BASS SURVEY 2010-2013

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Abstract.—Sutton Lake was sampled using shoreline electrofishing during the spring from 2010 to 2013 to evaluate the Largemouth Bass *Micropterus salmoides* population. Population characteristics were described including relative abundance, size structure, growth, and body condition. Results suggested that although yearly variation in metrics was apparent, the Largemouth Bass population can best be described as being in good condition. The largest concern with these findings was the lack of older individuals that may indicate that older fish have higher mortality rates than the rest of the population. Factors that may affect mortality include environmental conditions like above normal water temperatures and angler impacts (i.e. post tournament mortality), although these factors were not specifically evaluated during Commission sampling. We recommend continuing to manage fisheries populations in Sutton Lake under the current regulation framework. Sport fish monitoring should continue annually with emphasis on determining the effects of summertime water temperatures on Largemouth Bass catch and release mortality during the transition of the L.V. Sutton Electric plant conversion from coal to natural gas power. Continued partnerships with Duke Energy and angling groups will be beneficial to the successful long-term fisheries management of Sutton Lake.

Sutton Lake is a 445-ha cooling lake that was constructed in 1972 for the coal-fired L. V. Sutton Electric Plant in New Hanover County (Figure 1). The North Carolina Wildlife Resources Commission (Commission) has sampled the lake each spring since 1990 to obtain population characteristics data needed to evaluate and manage the Largemouth Bass *Micropterus salmoides* fishery in Sutton Lake. Due to the thermal effluent and shallow nature of the lake, water temperatures in the vicinity of the discharge canal can remain mild when compared to other waterbodies nearby (e.g. Cape Fear River). These conditions can attract and concentrate fish around the discharge canal which may lead to over harvest by anglers. Surveys and routine monitoring conducted in the 1990's documented high levels of angler harvest and the absence of larger bass. In July 1996, a 457 mm minimum size limit and a harvest moratorium from December 1 to March 31 were enacted for Largemouth Bass. After a 5-year evaluation period, the minimum size limit did not have any effect on the size distribution of Largemouth Bass and was changed to a 356 mm minimum limit in July 2005; however, the seasonal harvest moratorium was not changed as Largemouth Bass continued to congregate around the thermal effluent in winter (Rundle et al. 2005). The warmer water temperature also lead to longer growing seasons and this is reflected by growth rates of Largemouth Bass. These milder conditions in winter turn into above normal water temperatures during summer months and may lead to higher mortality rates for older fish. Water temperatures can exceed 32°C during summer months (J. Homan, NCWRC, unpublished data, 2012). Current regulations are intended to promote the presence of larger, older (age-5+) Largemouth Bass while reducing angler harvest in the winter when fish concentrate near the discharge canal. Sutton Lake is currently managed with a minimum size limit of 356 mm and five fish per day creel limit. Harvest of Largemouth Bass remains closed from December 1 to March 31 during the winter when fish congregate in the vicinity of the hot water discharge canal from the power plant.

The long growing season provides suitable conditions for a variety of aquatic plants including filamentous algae, slender pondweed *Potamogeton pusillus*, *Lyngbya wollei* and southern naiad *Najas guadalupensis*. These plant species are controlled by Duke Energy with a combination of Grass Carp *Ctenopharyngodon idella* stockings and herbicide applications. The lake is not directly connected to the Cape Fear River although a pump is used to resupply water lost due to evaporation.

Sutton Lake contains many fish species of interest to anglers including Largemouth Bass, sunfish *Lepomis* spp., Flathead Catfish *Pylodictis olivaris*, and Black Crappie *Pomoxis nigromaculatus*. Sutton Lake is regionally known for its Largemouth Bass fishery. Although the fishery can be highly variable, during periods of "good fishing" the lake can host multiple fishing tournaments a week. There is some question as to what effect this angling pressure has on the Largemouth Bass fishery, especially when water temperatures are high. Anecdotal evidence points to high fishing pressure during the summer time and subsequent high rates of catch and release mortality of larger bass. Other potential factors that may be influencing Largemouth Bass population structure include water quality fluctuations and interactions with introduced species.

Flathead Catfish are an invasive apex predator that was first documented in the lake in 1993 and have become the dominant catfish species within the lake (Duke Energy 2003; Ashley at al. 2009). A diet study found that sunfish and Largemouth Bass are the primary prey for Flathead Catfish in this lake (Herndon and Waters 2000). The last assessment of Sutton Lake reported reductions in Largemouth Bass catch rates and body condition, and a decrease in individuals ≥ 405 mm (NCWRC 2010). An updated survey was needed to determine if current metrics have improved and if existing size and creel regulations are adequately enhancing these fisheries for recreational anglers. The objective of this survey was to describe the population characteristics of Largemouth Bass in Sutton Lake. Specifically, to evaluate several parameters: relative abundance, size structure, age structure, growth, and body condition. Information from these categories was used to evaluate the effectiveness of current regulations and develop management recommendations to maintain and improve the Largemouth Bass fishery.

Methods

Field Collections.—Largemouth Bass were sampled using shoreline electrofishing at 8 fixed monitoring sites first established in 1990 (Figure 1). Annual sampling (2010–2013) was initiated in March and completed by March or April depending on water temperature. Fish were collected using a Smith-Root 7.5 GPP boat electrofisher. Sampling was conducted using 500-1000 V and 4-10 amps of pulsed DC electrical current. All fish collected were measured (total length, mm) and weighed (g). A subsample (up to 5 fish per 25 mm length class) of fish was sacrificed for age determination using sagittal otoliths and the remaining fish were returned to the lake. A suite of water quality parameters were recorded at each sampling site including: dissolved oxygen (mg/L), conductivity (ÂµS/cm), salinity (ppt), and water temperature (°C) (Table 1).

Relative Abundance.—Relative abundance was quantified by calculating catch-per-unit-effort (CPUE). CPUE was measured as the number of Largemouth Bass collected per hour of pedal time at an electrofishing site. Relative abundance was reported for the following multiple length categories: stock (200−299 mm), quality (300−379 mm), preferred (380−509 mm), and memorable (510−629 mm).

Size Structure.—Size structure was evaluated using length-frequency histograms and stock density indices. Stock density indices are numerical descriptors of length-frequency data (Anderson and Neumann 1996). Two commonly used stock density indices are Proportional Size Distribution (PSD) and Proportional Size Distribution-Preferred (PSD-P) (Guy et al. 2007). For Largemouth Bass, PSD is the percentage of fish ≥ 200 mm that are also ≥ 300 mm. PSD-P is the percentage of Largemouth Bass ≥ 200 mm that are also ≥ 380 mm (Gabelhouse 1984).

Age Structure.—Age structure was based on the percentage of fish in the sample that were within each age group. An age-length key was used to expand age information from the subsample of sacrificed fish for all fish ≥ 150 mm.

Growth.—Growth of Largemouth Bass was modeled using the von Bertalanffy growth curve:

$$L_t = L_\infty \left(1 - e^{-k\,(t - t_0)}\right)$$

where L_t = length at time t, L_∞ = maximum length, k = growth coefficient, and t_0 = the theoretical age at which the fish would have zero length (Ricker 1975).

Body Condition.—Relative weight was calculated for all Largemouth Bass ≥ 150 mm according to Anderson and Neumann (1996) to provide an indication of body condition compared to a national average, with a value of 100 considered ideal.

Results

Relative Abundance.—Number of Largemouth Bass collected and associated catch rates varied among years from 2010–2013. In 2010, 322 Largemouth Bass were collected; in 2011, n = 559; in 2012, n = 347; and in 2013, n = 258. Mean CPUE ranged from 64.7 in 2013 to 96.1 fish per hour in 2011 (Figure 2). In 2010 and 2012, CPUE decreased as fish length increased. In 2011, CPUE was highest in the stock and quality length categories. In 2013, CPUE was highest for quality and preferred length categories. Overall, CPUE was lowest for preferred and memorable length categories. Long-term CPUE data showed that annual catch rates were highly variable; however, total mean CPUE has been trending upwards since the early 2000's (Figure 3).

Size Structure.—Harvestable (≥ 356 mm) percentages of Largemouth Bass were 14% in 2010, 23% in 2011, 17% in 2012, and 35% in 2013 (Figure 4). The PSD values each year ranged from 50 in 2010 up to 88 in 2013, while the PSD-P values ranged from 19 in 2010 up to 40 in 2013 (Table 2).

Age Structure and Growth.—Percentage of age-1 and age-2 Largemouth Bass ranged from 68% in 2013 to 87% in 2010 (Table 3). Largemouth Bass aged ranged from 1–6 years old in 2010, 1–7 years old in 2011, 1–8 years old in 2012, and 1–7 years old in 2013. Largemouth Bass collected that were ≥ age-5 ranged from 0.7% in 2012 up to 2.7% in 2011. Largemouth Bass reached harvestable size (≥ 356 mm) between age 2 and age 3 (Table 4; Figure 5). Von Bertalanffy growth models for each year estimated growth to asymptote around 501 mm up to 541 mm while growth rate (K) ranged from 0.44 up to 0.54 (Table 4).The percentage of age-2 Largemouth Bass that obtained harvestable size (≥ 356 mm) ranged from 10% in 2010 up to 36% in 2013 (Table 5). The percentage of age-3 Largemouth Bass that obtained harvestable size ranged from 81% in 2010 up to 100% in 2013. All (100%) age-4 bass were harvestable size.

Body Condition.—Mean relative weights varied across size classes (Figure 6). From 2010–2013, mean relative weight for stock size fish remained above 85. For quality size Largemouth Bass, mean relative weights were above 85 except for 2012. For preferred size fish, 2010 was the only year the mean relative weight was below 85. Memorable sized fish were all below 85 except for 2013 where the mean relative weight was highest among size classes and years.

Discussion

From 2010–2013, the relative abundance of Largemouth Bass in Sutton Lake would be considered above average when compared to nearby coastal rivers. Catch rates have varied considerably since annual spring time sampling was initiated in 1990. Total catch rates for Largemouth Bass were well above the 25 fish per hour average usually considered an adequate measurement of abundance for rivers in the region; comparison with other impounded coastal waterbodies is limited. Sub-stock and stock size fish catch rates decreased in 2013 compared to previous years. It is uncertain whether this trend will continue or if it is just part of the annual variation observed over the time series beginning in 1990. In 2013, catch rates in quality and preferred-size Largemouth Bass length categories were the highest observed. This may indicate a strong year class of larger fish or that sampling occurred during peak spawning when the largest fish were staged in shallow water and more vulnerable to sampling gear. It may also indicate that the forage base for Largemouth Bass may have increased and prey may have been more available.

From 2010–2013, length frequency distributions and length-at-age matrices indicated that multiple size and age classes were present for each year. The presence of smaller fish coupled with high percentages of age-1 and age-2 fish indicate good recruitment each year. The percentage of harvestable fish each year was low in 2010 but did increase to 35% in 2013 and may have provided anglers better opportunities to catch harvestable-size fish. PSD and PSD-P values increased from 2010 to 2013 indicating an increase in larger fish collected throughout the timeframe. PSD values were within the range considered ideal for Largemouth Bass (50–70) for 2010–2012; however, PSD-P values were below ideal ranges (30–40) from 2010–2012. PSD and PSD-P values in 2013 were above the normal range mentioned above. If these values continue to trend upwards, concern will be that the lake may become unbalanced with an absence of smaller fish recruiting into the system but at this time the population appears balanced.

The relative absence of older Largemouth Bass indicated that a small percentage of Largemouth Bass survive past age-5. This issue has been addressed throughout the management history of Sutton Lake (Rundle et al. 2005; NCWRC 2010). Environmental factors including water temperature may affect survival to older ages. Hot water effluent from the L. V. Sutton Electric Plant can increase lake temperatures that can exceed 32°C (90°F) throughout the summer months (J. Homan, NCWRC unpublished data 2012). These conditions are stressful, especially to larger fish. In addition, high fishing pressure during these stressful conditions can lead to high mortality in larger fish. The lake is a popular Largemouth Bass fishery and receives a considerable amount of angler pressure throughout the year. There has been some anecdotal evidence of above-average catch and release mortality with larger fish, especially following summer fishing tournaments at the lake. The power plant has recently converted its power supply from coal to natural gas. This change will decrease the thermal load on the power plant and may result in a reduction in thermal effluent from the discharge canal. This situation will potentially decrease water temperatures in the lake throughout the year, especially during the hotter months of summer. Evaluation of summer temperature reductions and associated impacts on larger, older fish will need to continue as plant operations change; if thermal reductions are significant, habitat conditions may improve enough to effect long-term survival.

Although high summer water temperatures are problematic, the increase in water temperature at other times of the year likely has a positive effect on annual growth rates. Growth rates for 2010–2013 were high with fish reaching harvestable size within 2 or 3 years. Ten to 36% of age-2 fish and 80-100% of age-3 bass were ≥ 356 mm. The warmer water temperatures throughout the year resulting from thermal effluent from the power plant likely lead to a longer growing season for Largemouth Bass. The current minimum size limit of 356 mm is protecting a substantial proportion of the population as demonstrated by the number of sub-stock and stock sized fish in the lake each year. However, these fish grow out of this protected size limit fast and a proportion of fish become vulnerable to harvest as early as age 2 while 100% of the population is vulnerable by age 4. An Increase in the minimum size limit to promote larger fish in the lake has been attempted but was not successful and is not recommended at this time (Rundle et al. 2005). Other presently unknown factors besides angler harvest are impacting long-term survival of Largemouth Bass in Sutton Lake. In addition to their impact on survival, factors including water temperature and forage availability can impact the condition of Largemouth Bass. Body conditions of Largemouth Bass were not at the ideal value of Wr = 100 but in general, did fall within acceptable ranges found in the coastal region. The mean Wr for the memorable size class demonstrated the most variation between years. This size class was not encountered as often which could explain some of the variation. The large increase in Wr for the memorable size class in 2013 indicates these fish were in very good condition. This may be due to an increase in forage fish availability including Gizzard Shad *Dorosoma cepedianum*, Threadfin Shad *D. petenense*, and Atlantic Menhaden *Brevoortia tyrannus*. Although not quantified in Commission electrofishing surveys, these species were observed and qualified as highly abundant in 2012 and 2013. These findings also correspond to electrofishing surveys conducted by Duke Energy during the same timeframe (Duke Energy 2013).

Based on Commission sport fish monitoring since 1990, Sutton Lake has been characterized as a dynamic system where sport fish populations can fluctuate considerably (Rundle et al. 2005; NCWRC 2010). The lake has been managed since the early 1990's to improve Largemouth Bass fishing for the benefit of recreational anglers, and issues including adult Largemouth Bass mortality, water quality conditions, overharvest, aquatic vegetation, and invasive species have all been recognized as contributors to the changes in population structure. The conversion from coal to natural gas as the power source at L.V. Sutton Electric Plant is anticipated to decrease the water temperature of the effluent discharged in Sutton Lake. Moreover, by-products of coal fired power production will no longer be contained with the effluent discharge. Understanding how changes in plant operations will affect Largemouth Bass and other sport fish populations is important for future management efforts for Sutton Lake.

Management Recommendations

1. Maintain the current minimum size limit of 356 mm and a creel limit of 5 Largemouth Bass per day.

2. Maintain the current no harvest season from December 1 to March 31 to protect Largemouth Bass from over harvest while these fish are congregated in the vicinity of the power plant water effluent during cooler months.

3. Continue annual springtime surveys at the eight long-term sampling stations to monitor Largemouth Bass population trends.

4. Incorporate surveys during springtime electrofishing that would monitor abundance and composition of forage species to better understand influences on Largemouth Bass condition.

5. Monitor summer water temperatures for reductions in maximum values during the peak of summer to determine potential impacts on Largemouth Bass mortality as cooling plant operational changes are implemented.

6. Conduct a creel survey to estimate angler effort, catch, and harvest for available fish species at Sutton Lake from July 1, 2015 to June 30, 2016.

7. Enhance habitat with fish attractors for angler's benefit. Maintain up-to-date information on the Commission website and enhance user availability.

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TABLE 1.—Mean water quality measurements (± 1 SE) for Sutton Lake collected at each site (n = 8) during sampling events from 2010-2013.

Date	2010	2011	2012	2013
Dissolved Oxygen (mg/L)	9.1 (0.3)	9.6 (0.6)	7.0 (0.2)	8.3 (0.6)
Conductivity (ÂµS/cm)	245 (3.4)	245 (7.4)	387 (4.8)	239 (4.2)
Salinity (ppt)	0.1 (0.0)	0.1 (0.0)	0.2 (0.0)	0.1 (0.0)
Water Temperature (°C)	18.3 (0.4)	17.2 (0.7)	23.8 (0.4)	15.3 (0.4)

TABLE 2.—Proportional Size Distribution and Proportional Size Distribution-Preferred values for Largemouth Bass collected during springtime sampling events in Sutton Lake (2010-2013).

	PSD	PSD-P
2010	50	19
2011	57	19
2012	59	26
2013	88	40

TABLE 3.—Percentages of age-1, age-2, and ≥ age-5 Largemouth Bass from 2010-2013 in Sutton Lake.

	Percent				
	Age 1	Age 2	Age 3	Age 4	Age ≥ 5
2010	65	22	6	2	5
2011	36	48	10	3	3
2012	60	19	16	3	2
2013	26	42	27	3	2

TABLE 4.—Estimated parameters for von Bertalanffy growth model by year (2010-2013) for Sutton Lake.

Estimated Parameters	Year			
	2010	2011	2012	2013
L_∞	501.55	518.61	541.06	515.41
K	0.44	0.51	0.44	0.56
t_0	-0.20	0.11	-0.16	0.07

TABLE 5.—Percent of age classes that were harvestable size (≥ 356 mm) from 2010-2013 in Sutton Lake.

Percent Harvestable Size	2010	2011	2012	2013
Age-2	10	17	27	36
Age-3	81	96	88	100
Age-4	100	100	100	100

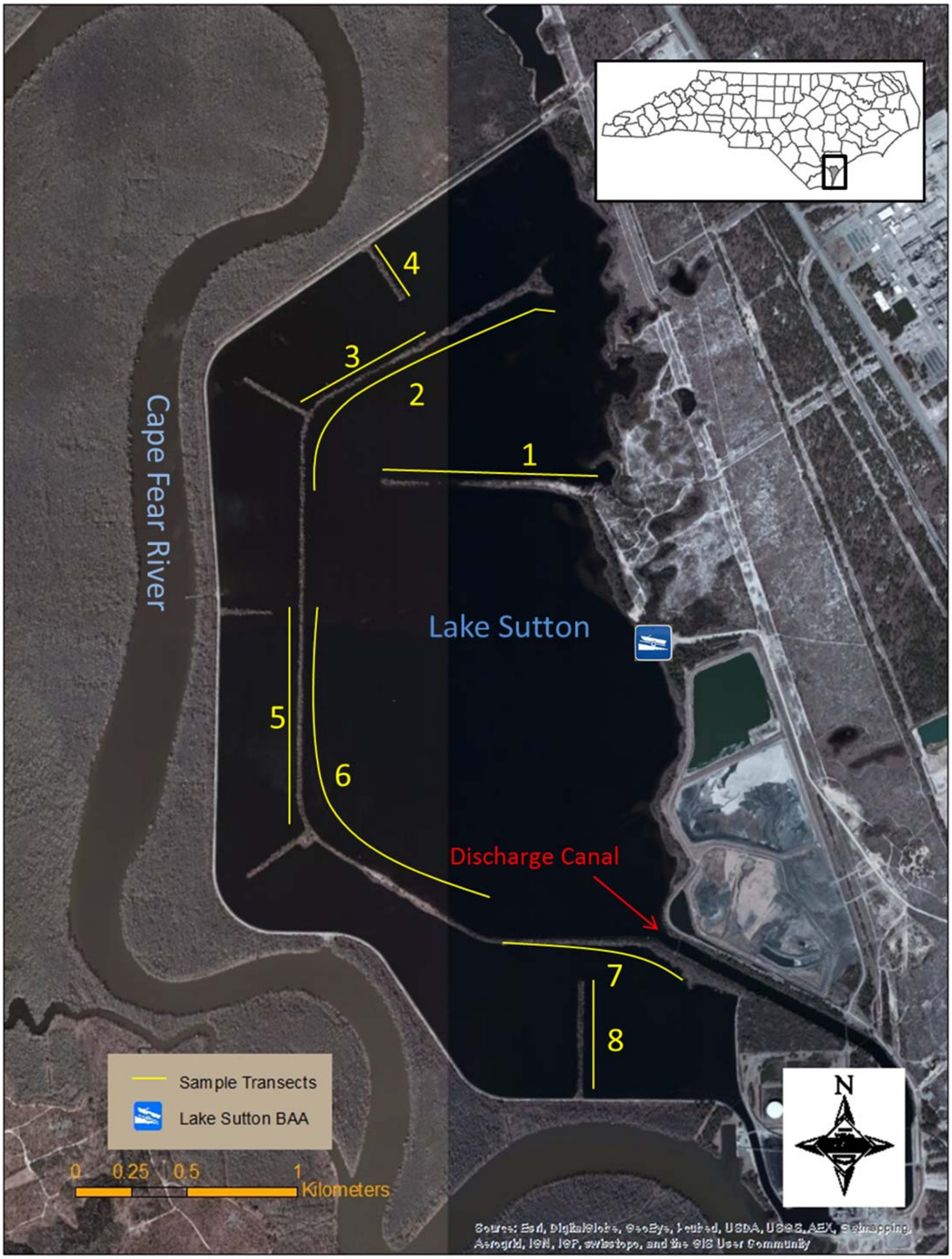

FIGURE 1.—Map of sampling transects in Sutton Lake in New Hanover County.

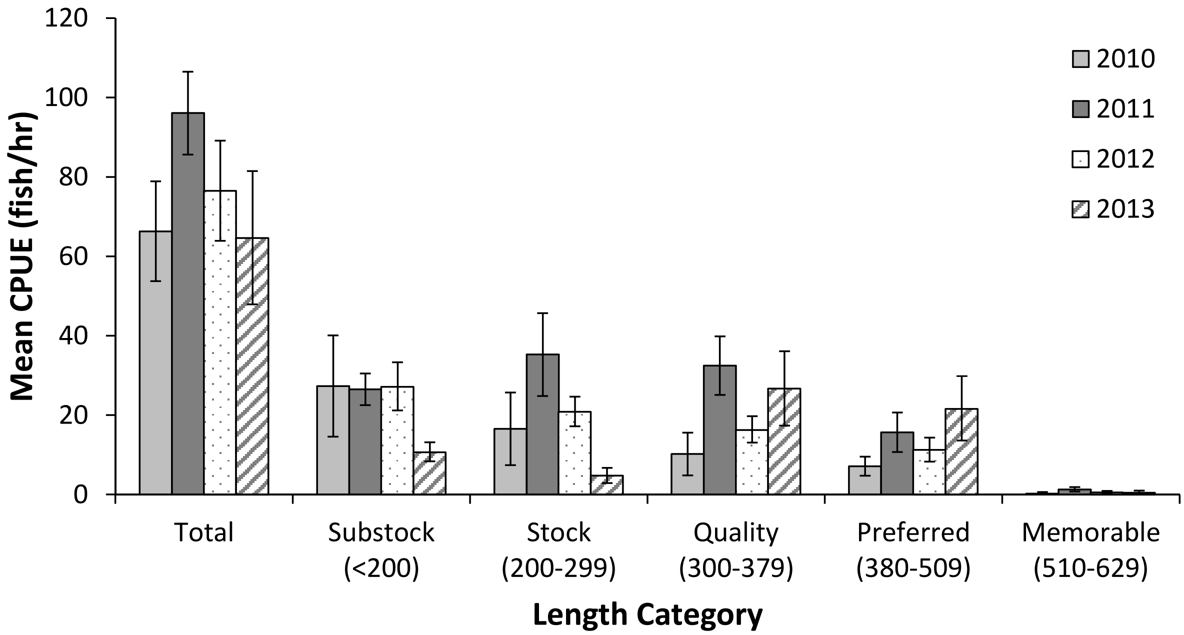

FIGURE 2.—Mean (CPUE) (± 1 SE) of Largemouth Bass categorized by proportional size distributions during spring electrofishing from Sutton Lake 2010 to 2013.

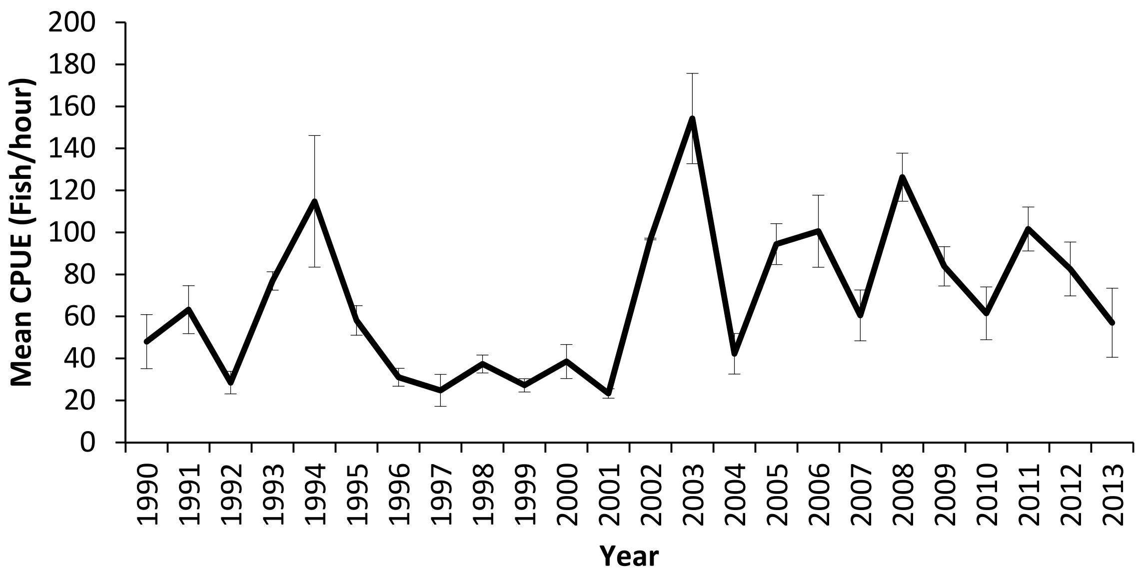

FIGURE 3.—Mean (CPUE) (± 1 SE) of Largemouth Bass collected during spring electrofishing from Sutton Lake 1990 to 2013.

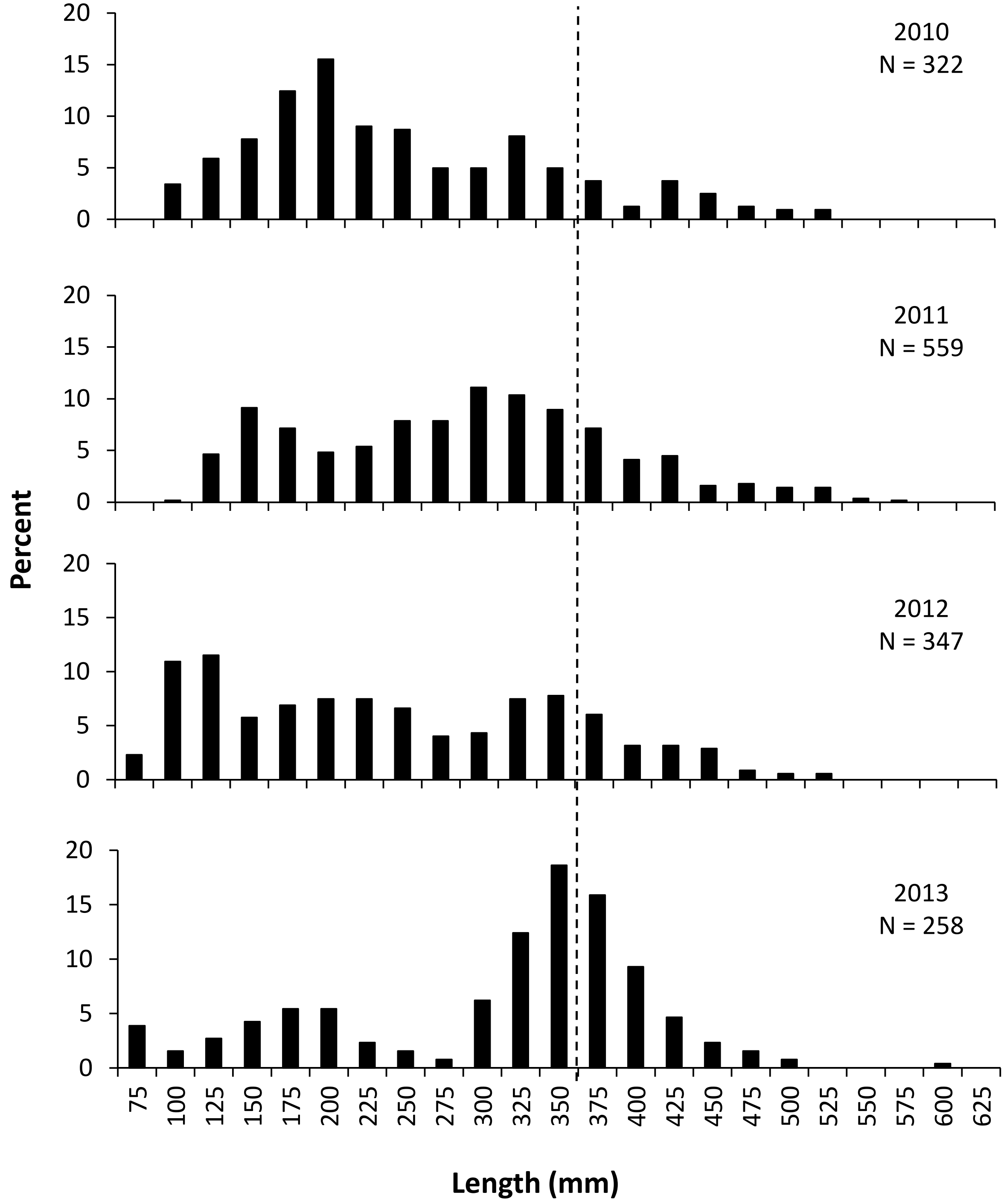

FIGURE 4.—Length frequency distributions of Largemouth Bass collected during spring electrofishing surveys from Sutton Lake, 2010 to 2013. Dashed line represents 356 mm minimum length limit.

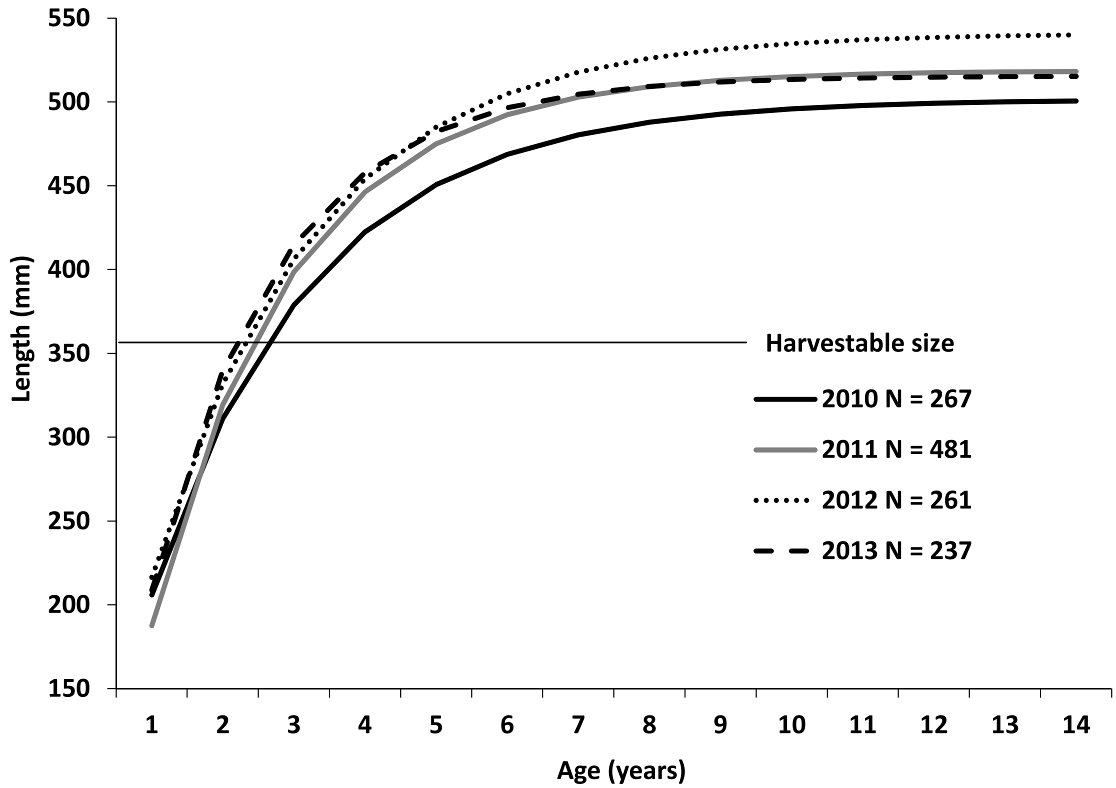

FIGURE 5.—Largemouth Bass von Bertalanffy growth models predicted from 2010–2013 in Sutton Lake. Estimated parameters can be found in Table 4 of this report.

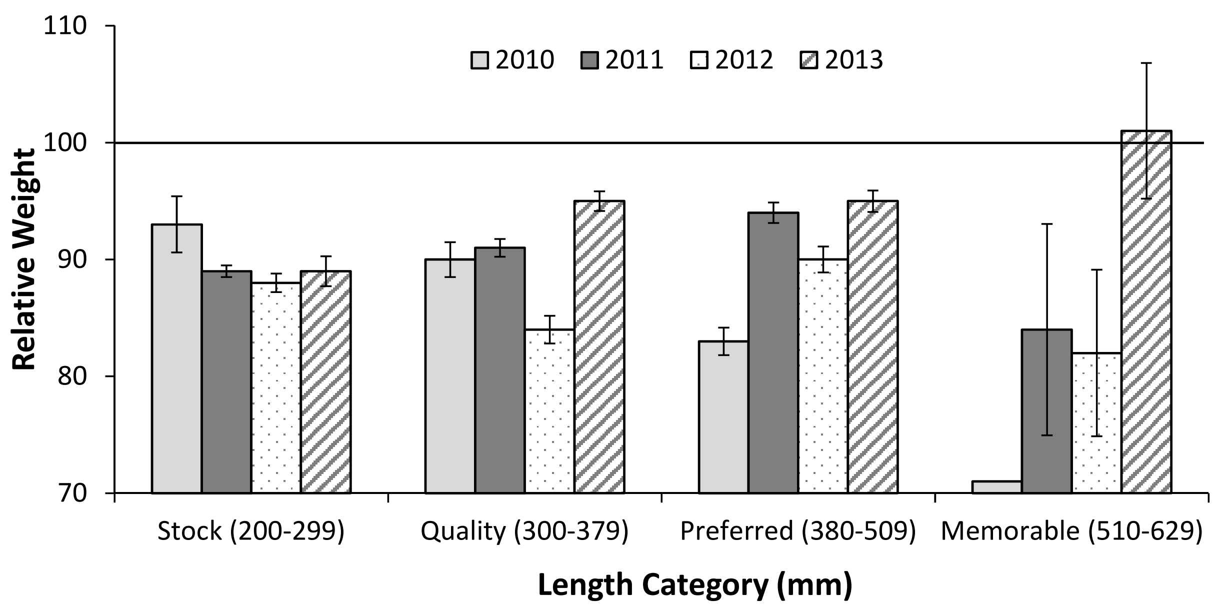

FIGURE 6.—Largemouth Bass mean relative weights (± 1 SE) by length class in Sutton Lake, 2010 to 2013. Horizontal line indicates hypothetical ideal mean relative weight of 100.