BLACK CRAPPIE POPULATION CHARACTERISTICS WITHIN MAIN AND ROSE BAY CANALS, LAKE MATTAMUSKEET, 2014

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Abstract.—The canal system associated with Lake Mattamuskeet supports a popular Black Crappie *Pomoxis nigromaculatus* fishery. The survey objective was to collect Black Crappie for management purposes at Lake Mattamuskeet. Black Crappie were sampled using 25.4 mm mesh trap nets in Main Canal in November and Rose Bay Canal in December 2014. A total of 363 and 147 Black Crappie were collected in Main Canal and Rose Bay Canal, respectively. Main canal relative abundance was exceedingly high (72.6 fish/net-night; SE = 22.3) compared with Rose Bay Canal (29.4 fish/net-night; SE = 4.4). While abundance in Main Canal was higher, Rose Bay canal supported a wider range of sizes classes, including larger fish (> 320 mm). Proportional size distribution analysis indicated that the preferred-length category comprised the majority of fish collected in Main Canal and Rose Bay Canal. The majority of Black Crappie were fast-growing age-2 fish from the 2012 cohort, with fish up to age 6 collected; however, mortality of fish >age 3 was apparently high. No age-0 Black Crappie were collected indicating potential poor recruitment or gear selectivity bias. The absence of age-0 Black Crappie warrants the need to evaluate if gear is inefficient in collecting these fish or if it is representative of weak year class. Black Crappie recruitment can be highly variable; however, caution needs to be taken when one age class is supporting harvest. If harvest continues to be supported by only one fast growing year class, length limit increases may need to be initiated to protect fish through reproductive maturity. Future efforts should focus on assessing the extent of year class strength for Black Crappie and the relationship with water quality in the canals. Additional age structure information will help determine estimates of mortality and will help evaluate the efficacy of increasing length limits.

Lake Mattamuskeet is a 16,194 ha natural lake located in Hyde County, North Carolina. The lake is encompassed by the Mattamuskeet National Wildlife Refuge managed by the U.S. Fish and Wildlife Service (USFWS) primarily for waterfowl and migratory bird habitat; however, the lake's fisheries resources have been recognized for their ecological, recreational, economic, and cultural importance. Lake Mattamuskeet is connected to the Pamlico Sound by four large drainage canals (Main, Lake Landing, Waupoppin, and Rose Bay), and each canal is equipped with water control structures designed to let excess water flow out of the lake, keeping average water depths generally less than 1 meter. These water control structures have the benefit of providing passage of Alewife *Alosa pseudoharengus* and Blueback Herring *A. aestivalis* into the lake during the spring; however, episodic saltwater intrusion into the lake can occur if gates malfunction or become lodged open by debris. Lake Mattamuskeet is divided by a causeway formed by N.C. Highway 94. Five concrete culverts enable the exchange of water between the east and west sections of the lake, but transfer is dependent on water level, wind speed, and direction. Water inputs to the lake come from direct precipitation as well as small canals that drain forested and agricultural areas. Additionally, landowners within the Mattamuskeet Drainage District are allowed to pump water from agricultural lands into canals feeding the lake, and landowners may pump water from adjoining canals for private waterfowl impoundments. United States Geological Survey (USGS) gaging stations were recently installed on the east side and west side of the lake; these stations allow for daily monitoring of lake levels and a suite of water quality parameters.

Lake Mattamuskeet and its associated canals boast a variety of fishing opportunities; anglers can catch Largemouth Bass *Micropterus salmoides*, Black Crappie *Pomoxis nigromaculatus,* Bluegill *Lepomis macrochirus*, and various estuarine species including Blue Crab *Callinectes sapidus,* Southern Flounder *Paralichthys lethostigma*, and Striped Mullet *Mugil cephalus*. Current fishing regulations established by the North Carolina Wildlife Resources Commission (NCWRC) include a 20 fish daily creel limit and minimum size limit of 8 inches (203 mm) for Black Crappie. Federal regulations prohibit boating, sport fishing, bow fishing, and crabbing 1 November–28 February, except in designated areas (USFWS 2010). The survey objective was to collect fisheries data needed to manage Black Crappie in Lake Mattamuskeet and its associated canals based on collections in Main and Rose Bay canals.

Methods

Black Crappie were sampled using standard 25.4 mm mesh trap nets in Main Canal from 17 to 18 November and Rose Bay Canal from 3 to 4 December 2014. Nets were deployed at five sites in Main Canal and five sites in Rose Bay Canal and checked the following day (Figure 1). Soak time, set type (perpendicular or angled), and depth for each net sample were recorded. Total length (mm) and weight (g) were recorded for all Black Crappie collected. Sagittal otoliths were extracted from five Black Crappie per 10-mm length group from Main and Rose Bay canals for ageing purposes. To determine age, otoliths were read in whole view independently by two readers, using a dissecting microscope. Annuli (opaque bands) were counted; if otoliths were not readable in whole view, or age discrepancies occurred between readers, the otoliths were sectioned to obtain age.

All data analyses were conducted separately for Main Canal and Rose Bay Canal. Black Crappie relative abundance was indexed with catch-per-unit-effort (CPUE), expressed as the number of fish caught per net-night. Size structure of Black Crappie was evaluated with length-frequency distributions and calculations of proportional size distribution (PSD) and incremental PSD metrics (Guy et al. 2007). Stock, quality, preferred, and memorable minimum lengths were 130, 200, 250, and 300 mm, respectively (Gabelhouse 1984).

Black Crappie body condition was assessed with a relative weight index (*Wr*) described by Wege and Anderson (1978). Relative weight was calculated as,

$$Wr = \left(\frac{W}{Ws}\right) * 100$$

where *W* is the measured weight (g) of each fish, and *Ws* is a length-specific standard weight. The *Ws* equation for Black Crappie was $\log_{10}(Ws) = -5.618 + 3.345*\log_{10}(TL)$ as described by Murphy et al. (1991). Fish less than stock-length were excluded from the relative weight analysis. Mean relative weight of Black Crappie was calculated for PSD length groups. Length and weight data were $\log_{10}$-transformed for linear regression analysis.

Age structure of Black Crappie was assessed with age frequency and mean length at age analyses. An age-length key was generated from subsampled Black Crappie and was used to assign ages for un-aged fish. Age and growth parameters of Black Crappie were evaluated by calculating mean length at age and von Bertalanffy growth models using FAST 3.0 software (Slipke and Maceina 2013).

Results

In November 2014, 363 Black Crappie were collected during five net-nights in Main Canal resulting in a mean CPUE of 72.6 fish/net-night (SE=32.3; Figure 2). Relative abundance varied widely in Main Canal (range 21–200 fish/net-night). In Rose Bay Canal, 147 Black Crappie were collected in five net-nights, and mean CPUE was 29.4 fish/net-night (SE=4.4; Figure 2). Relative abundance for Black Crappie collected in Main Canal during 2014 was higher than surveys using 25.4-mm trap nets in 2013, when CPUE was 22.5 fish/net-night in Main Canal (Table 1 and Figure 2). In Rose Bay Canal, however, relative abundance in 2014 was similar to 25.4-mm trap net survey results in 2013 (26.1 fish/net-night; Potoka et al. 2014; Table 1 and Figure 2).

Length frequency distributions of Black Crappie in Main Canal and Rose Bay Canal were similar and both contained unimodal peaks at 280–290 mm (Figure 3). A wide range of sizes was present; fish lengths ranged from 169 to 318 mm in Main Canal and from 128 to 345 mm in Rose Bay Canal (Figure 3). The proportion of collected Black Crappie available for angler harvest was 98% in Main Canal and 92% in Rose Bay Canal. Similar to 2013 surveys, few Black Crappie less than stock length (130 mm) were collected in Rose Bay, and none were collected in Main Canal. Additionally, no fish <100 mm were collected.

Analysis of Black Crappie PSD indicated a population comprised of large individuals (Figure 4). The calculated PSD values for Main Canal (98%) and Rose Bay Canal (94%) were higher than values that reflect balanced populations (30–60) in Piedmont reservoirs (Oakley and Dorsey 2013; Figure 4). $PSD_{P\text{-}M}$ and $PSD_{M\text{-}T}$ values in Main and Rose Bay canals revealed Black Crappie >250 mm comprised a relatively high percentage of the population (80%). Preferred length (250 mm) fish made up the largest proportion of available fish in Main Canal (75%) and Rose Bay Canal (55%); Figure 4). Black Crappie greater than quality length comprised 96% of total catch and were available for capture in high proportions in Main (98%) and Rose Bay (93%) canals.

Otolith age was assessed for 138 Black Crappie by two independent readers. Initial agreement between both readers was 93%, and discrepancies of the remaining ages were resolved in concert. Ages for all un-aged fish (n=372) in the sample were assigned using an age-length key generated from the 138 aged Black Crappie. Five age groups (age 1–4 and 6) were represented (Figure 5). In Main Canal, fish ages ranged from 1 to 3, and in Rose Bay Canal, ages ranged from 1 to 6 (Figure 5). Age-2 (2012 cohort) individuals dominated Black Crappie catch in both canals; of 510 Black Crappie collected in net surveys, 4% were age 1, 80% were age 2, 14% were age 3, and 2% were ≥ age 4.

Mean length at age of Black Crappie was estimated for each canal sample. Similar to 2013 survey results, the 2012 cohort exhibited extremely high growth rates and reached preferred length in their third growing season (Figures 6 and 7). The 2012 year class (age-2) exhibited extremely fast growth (276 mm by the end of the second growing season) that may be a result of reduced competition with the less abundant 2011 year-class and older fish. Future survey efforts should determine if Black Crappie growth rates and year class formation are influenced by variable environmental conditions.

Body condition of Black Crappie collected in Main and Rose Bay canals was good, suggesting growth is not limited by prey availability. Mean *Wr* was >90 for stock, quality, preferred, and memorable length fish (Figure 8). Mean *Wr* of Black Crappie in Main Canal increased from stock to memorable length. In Rose Bay Canal mean *Wr* of Black Crappie increased from stock to preferred length and declined for memorable length fish; however, *Wr* remained above 90 for all length groups and did not indicate poor condition. Log_{10} transformed weight and length regression equations calculated for each canal indicate good growth of Black Crappie. The slope associated with the standard weight equation for Black Crappie from various

Black Crappie populations in North America is 3.345 (Murphy et al. 1991). Slopes calculated for Black Crappie were 3.66 for Main Canal and 3.48 Rose Bay Canal, indicating that Black Crappie weight increased proportional to length at a faster rate than the standard weight estimations (Figures 9 and 10).

Discussion

Relative abundance of Black Crappie in Main Canal was exceedingly high compared with past years but was largely driven by one net set that collected 200 Black Crappie in one night. Despite this occurrence, relative abundance in Main Canal was still high and would have been similar to Rose Bay Canal if the net with the high catch had been excluded from analysis. While Main Canal had a higher abundance of Black Crappie, Rose Bay Canal supported a wider range of size classes and larger fish. Good numbers of preferred length Black Crappie should be available for anglers fishing in both canals in 2015; however, harvest will likely be supported almost entirely by the 2012 year class.

Recruitment in Black Crappie populations is known to fluctuate due to density-dependent competition and variable environmental conditions (Allen and Miranda 2001). In 2014, Black Crappie age distributions for both canals were dominated by age-2 fish from the 2012 cohort. The 2012 cohort was also strongly represented in the 2013 survey as age-1 fish indicating a strong year class (Potoka et al. 2014). Despite high overall catch rates, abundance of age-1 Black Crappie was low in 2014, which suggests poor recruitment for the 2013 cohort. Poor recruitment may have resulted from the lack of older, spawning fish in the population during 2013 (Potoka et al. 2014), or environmental conditions may have restricted reproduction or recruitment in 2013. Fish >age 3 were also lacking in the 2014 sample suggesting low recruitment or high mortality rates for older cohorts. The angler creel surveys conducted concurrently at Lake Mattamuskeet will provide valuable information regarding harvest and fishing mortality.

The lack of age-0 Black Crappie in 2014 was likely a result of gear selectivity bias and was not necessarily an indication of year class failure. Standard trap-nets with 25.4 mm mesh do not typically catch age-0 crappies in Piedmont reservoirs of North Carolina (Oakley and Dorsey 2013). Because Black Crappie typically reach reproductive maturity after their second growing season, the highly abundant 2012 cohort could have produced a strong cohort in 2014 if environmental conditions were suitable for spawning and recruitment. Continued trap net sampling in fall 2015 should confirm the presence of a 2014 cohort. Survey efforts in 2015 should also implement use of an experimental set of 12.7 mm mesh trap nets to determine presence of age-0 fish and attempt to predict year class strength at an earlier time frame.

Mortality estimates are necessary for fisheries managers to understand population dynamics and evaluate regulations of harvested fish stocks (Miranda and Bettoli 2007).

Traditional catch curve analysis could not be used to estimate mortality rates because of the variable recruitment apparent in the Lake Mattamuskeet Black Crappie population. It may become necessary to protect fast-growing year classes by increasing the length limit if variable recruitment continues to limit the number of abundant year classes in the population. Additional years of catch at age data are necessary to conduct a cohort analysis to estimate mortality of the strong 2012 year class, which can be used to evaluate the efficacy of increasing the minimum length limit. If survival is increased by altering the length limit, greater numbers of memorable-sized Black Crappie and a more stable population may result. Continued sampling is necessary to document future recruitment failures, changes in abundance, and age distributions.

Management Recommendations

1. Increase the minimum length limit for Black Crappie from 8 inches to 10 inches and maintain the daily bag limit at 20 fish.
2. Collect Black Crappie annually each fall in Main and Rose Bay canals with standard, 25.4-mm mesh trap nets to evaluate regulation and monitor population characteristics. Although Black Crappie concentrate in these canals during the fall which improves their catchability, consideration should be given to establishing sampling sites in main lake locations when possible.
3. Utilize 12.7-mm mesh trap nets to determine if gear efficiency is better for small (age-0) Black Crappie.
4. Collect Black Crappie otoliths in 2015 for age structure analysis to estimate mortality rates using Chapman Robson method.
5. Install data loggers at selected locations throughout canals to capture water quality data, especially salinity and temperature.
6. Conduct maturation and fecundity analysis for Black Crappie to provide insight to the age-at-maturation at Lake Mattamuskeet.

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TABLE 1.—Collection date, canal, net identifier, soak time, set type (perpendicular or angled), and number of Black Crappie collected in 25.4 mm mesh trap nets in 2013 and 2014.

Date	Canal	Net	Net Nights	Set Type	n
11/5/2013	Main	MC4	1	PERPENDICULAR	52
11/5/2013	Main	MC6	1	PERPENDICULAR	24
11/7/2013	Main	MC4	2	PERPENDICULAR	14
11/7/2013	Main	MC6	2	PERPENDICULAR	14
11/17/2014	Main	MC1	1	PERPENDICULAR	41
11/17/2014	Main	MC2	1	PERPENDICULAR	200
11/17/2014	Main	MC3	1	PERPENDICULAR	21
11/17/2014	Main	MC4	1	PERPENDICULAR	56
11/17/2014	Main	MC5	1	PERPENDICULAR	45
11/6/2013	Rose Bay	RB4	2	PERPENDICULAR	68
11/6/2013	Rose Bay	RB5	2	ANGLED	109
11/5/2013	Rose Bay	RB9	1	ANGLED	7
11/6/2013	Rose Bay	RB9	1	ANGLED	9
12/3/2014	Rose Bay	RB1	1	ANGLED	31
12/3/2014	Rose Bay	RB2	1	PERPENDICULAR	35
12/3/2014	Rose Bay	RB3	1	ANGLED	15
12/3/2014	Rose Bay	RB4	1	ANGLED	25
12/3/2014	Rose Bay	RB5	1	PERPENDICULAR	41

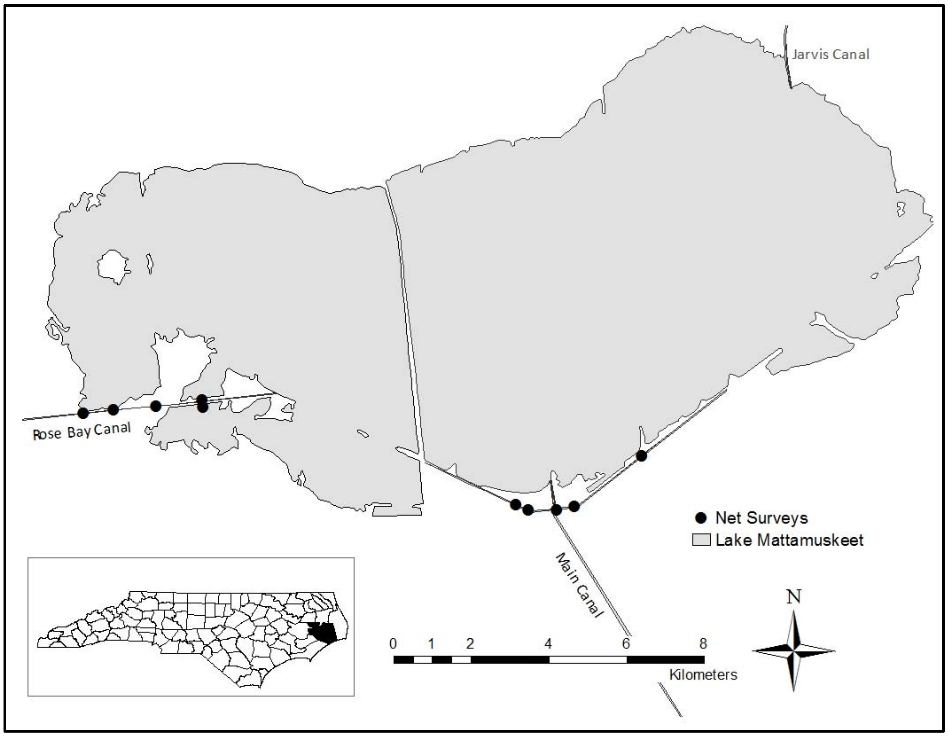

FIGURE 1.—Trap net survey site locations in Main Canal and Rose Bay Canal, November and December 2014.

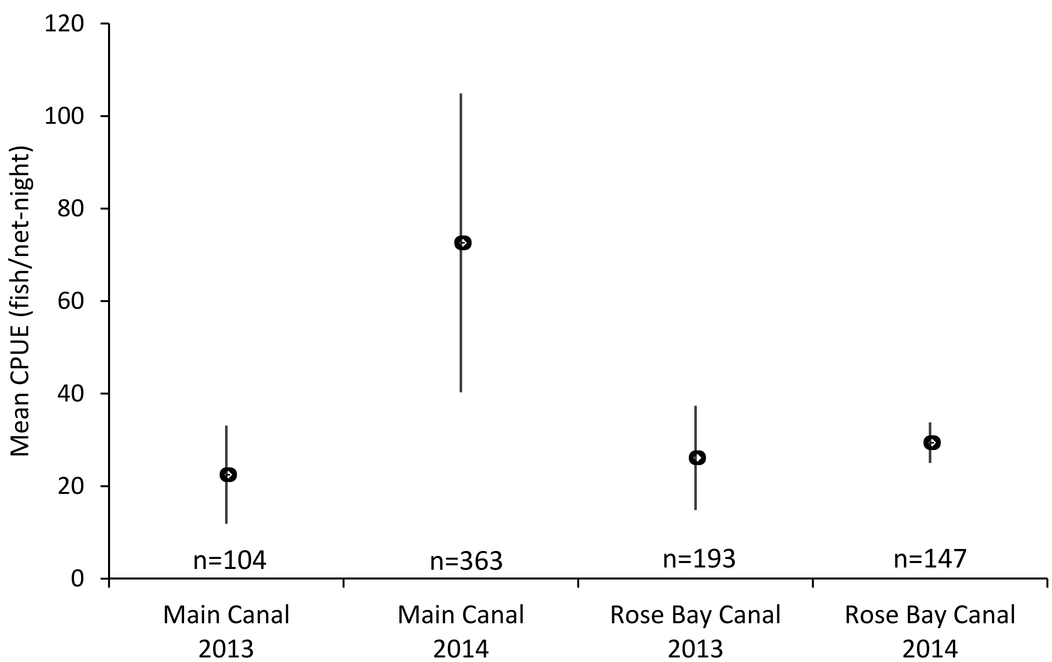

FIGURE 2.—Catch per unit effort (fish caught per net night) for Black Crappie collected by trap nets in Main Canal and Rose Bay Canal, 2013 and 2014. Error bars represent one standard error.

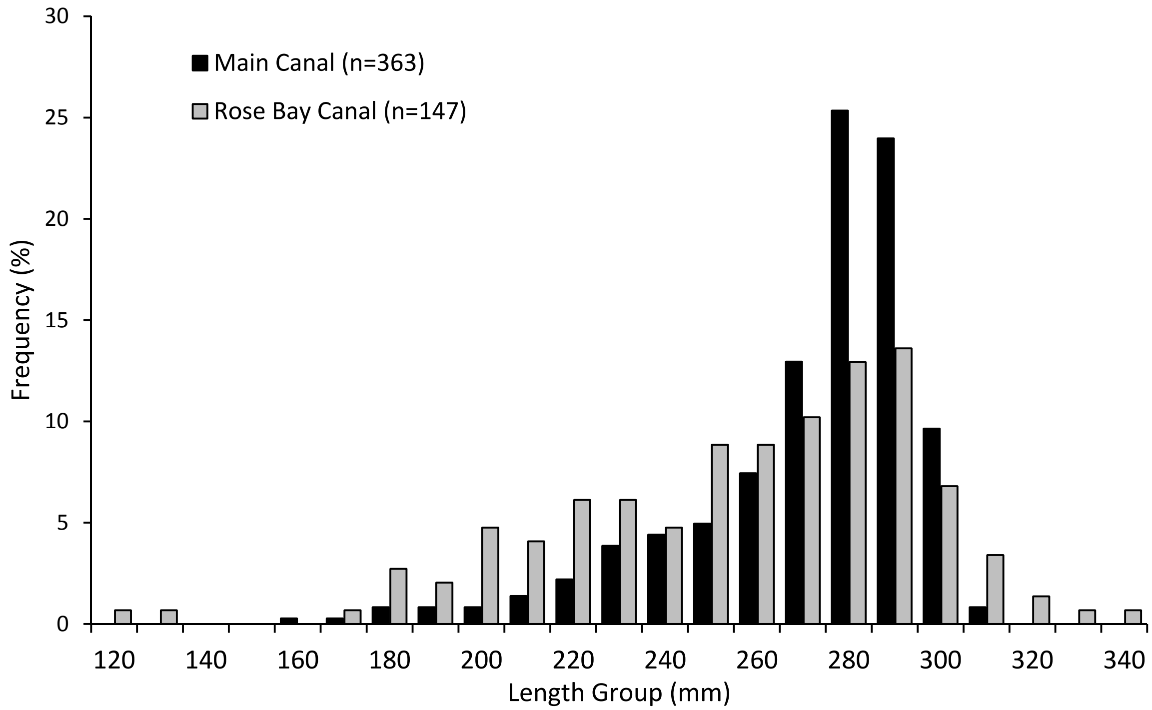

FIGURE 3.—Length frequency histograms for Black Crappie collected by trap nets in Main Canal and Rose Bay Canal, November and December 2014.

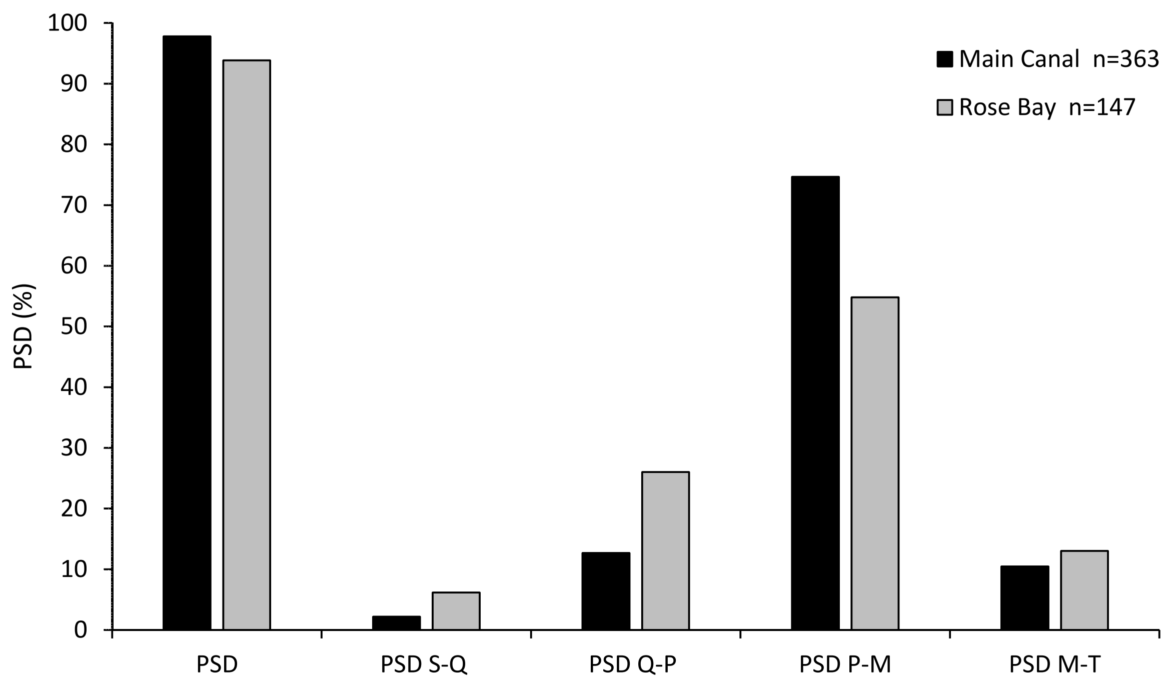

FIGURE 4.—Proportional size distribution for quality, preferred, and memorable Black Crappie collected by trap nets in Main Canal and Rose Bay Canal, November and December 2014.

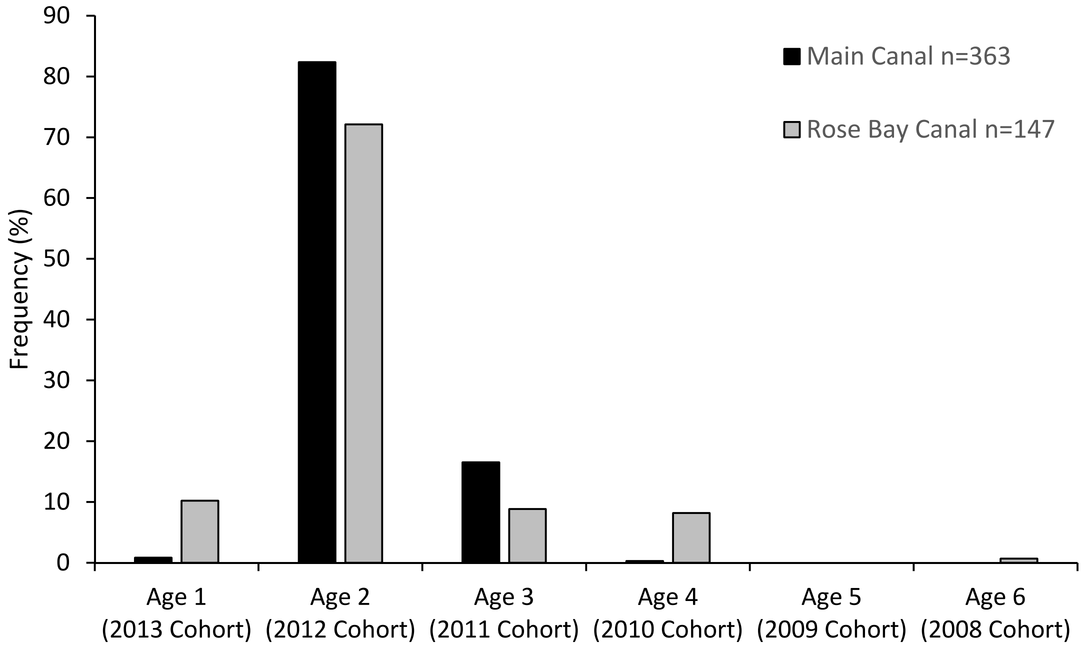

FIGURE 5.—Age frequency for 510 Black Crappie collected by trap nets in Main and Rose Bay canals, November and December 2014.

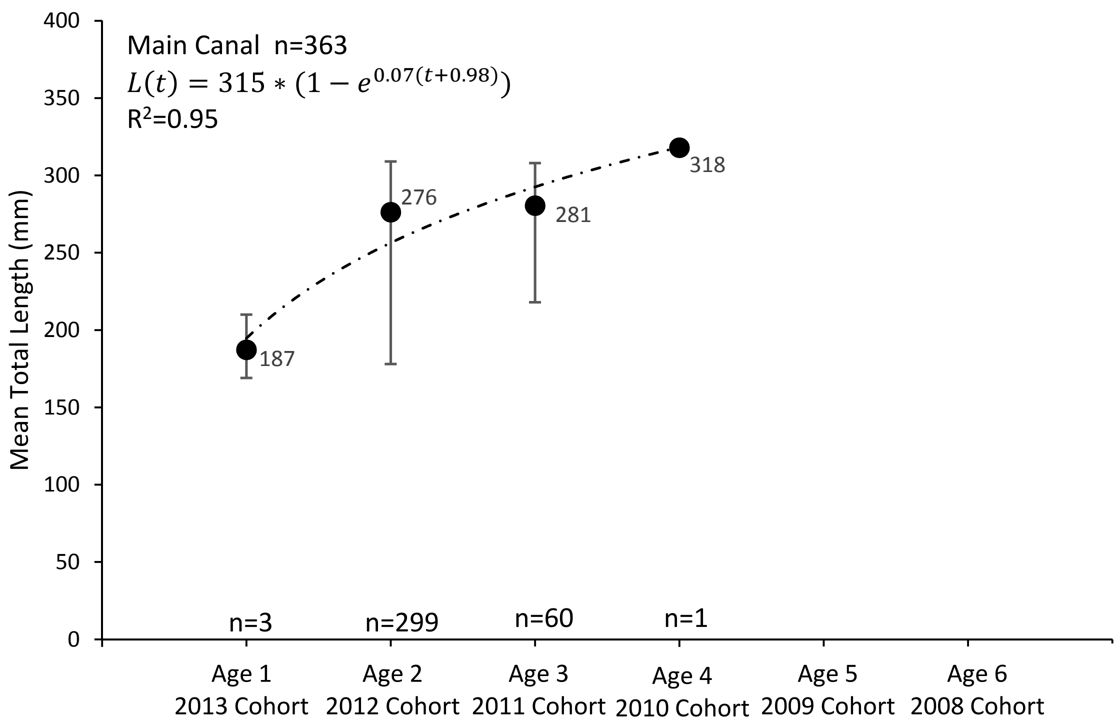

FIGURE 6.—Mean total length at age of Black Crappie collected by trap nets in Main Canal, November 2014. Dots represent mean total length; bars represent maximum and minimum length observed at each age.

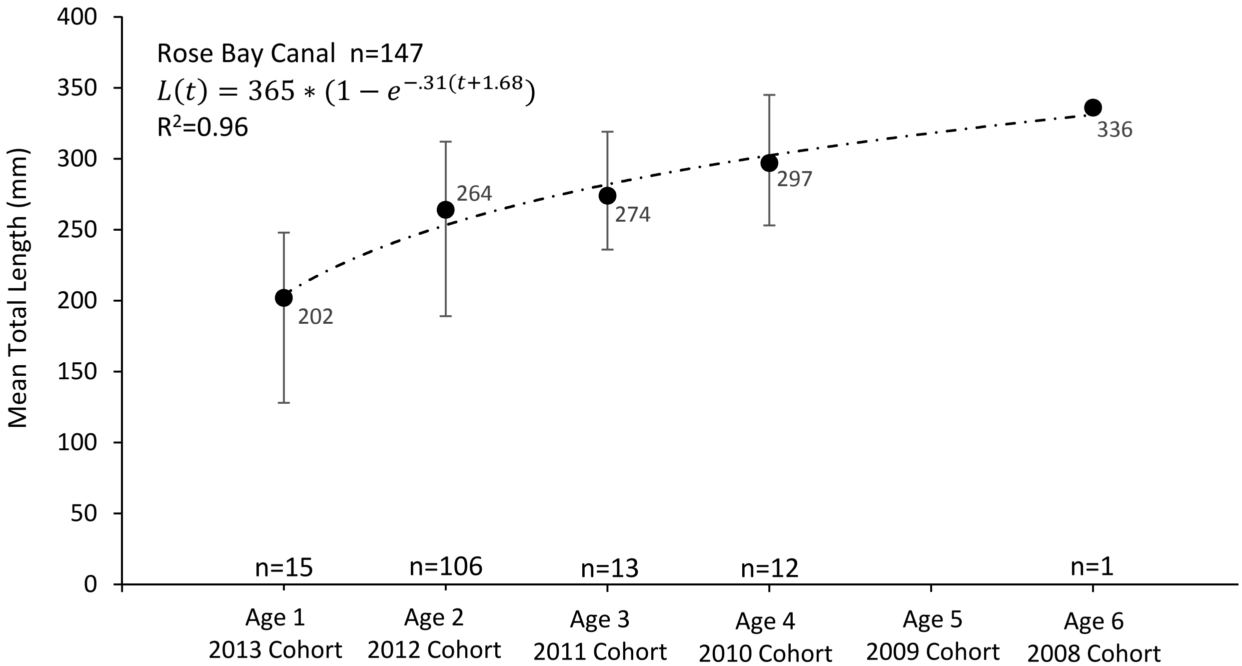

FIGURE 7.—Mean total length at age of Black Crappie collected by trap nets in Rose Bay Canal, December 2014. Dots represent mean total length; bars represent maximum and minimum length observed at each age.

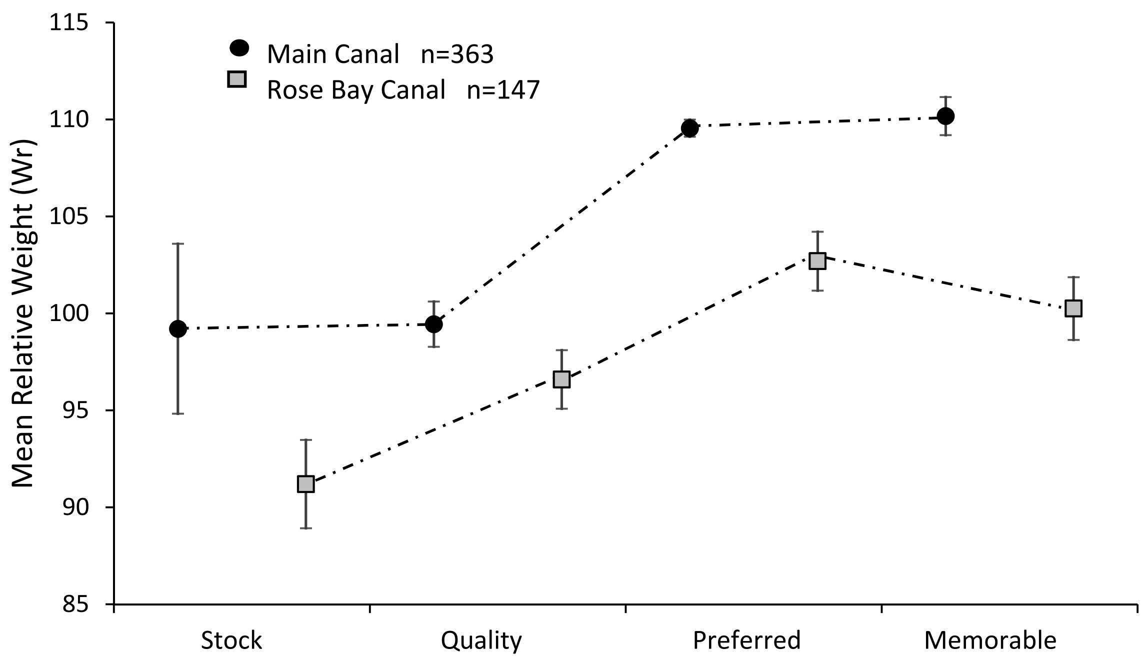

FIGURE 8.—Mean Relative weights of stock, quality, preferred, and memorable length Black Crappie collected by trap nets in Main Canal and Rose Bay Canal, November and December 2014. Error bars represent one standard error.

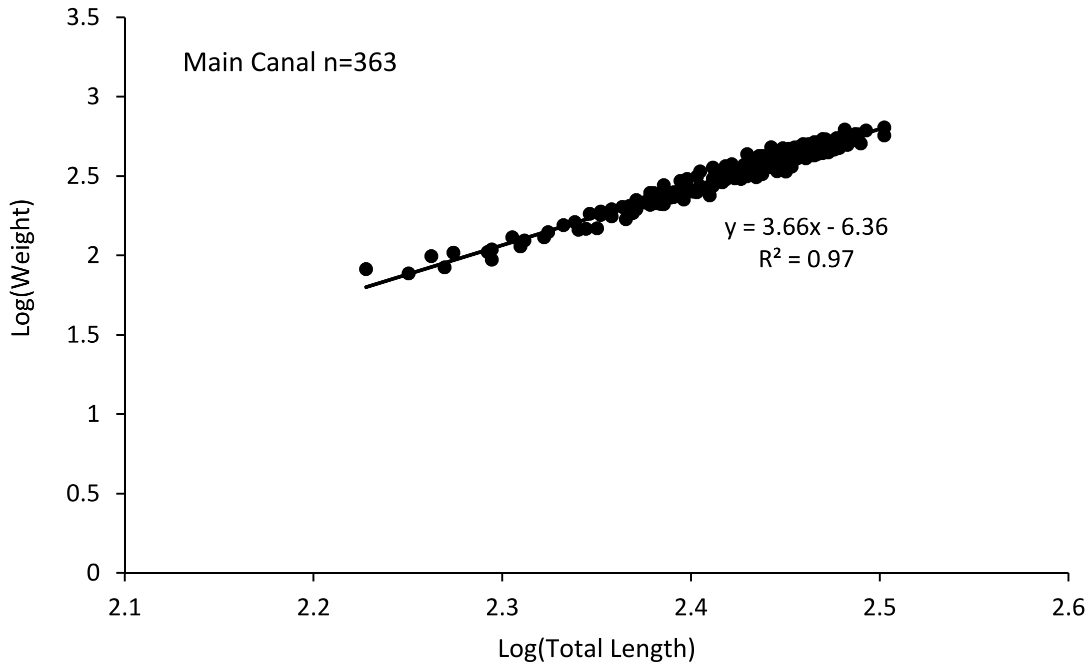

FIGURE 9.—Linear regression of the log transformed weight versus log transformed length of Black Crappie collected by trap nets in Main Canal, November 2014.

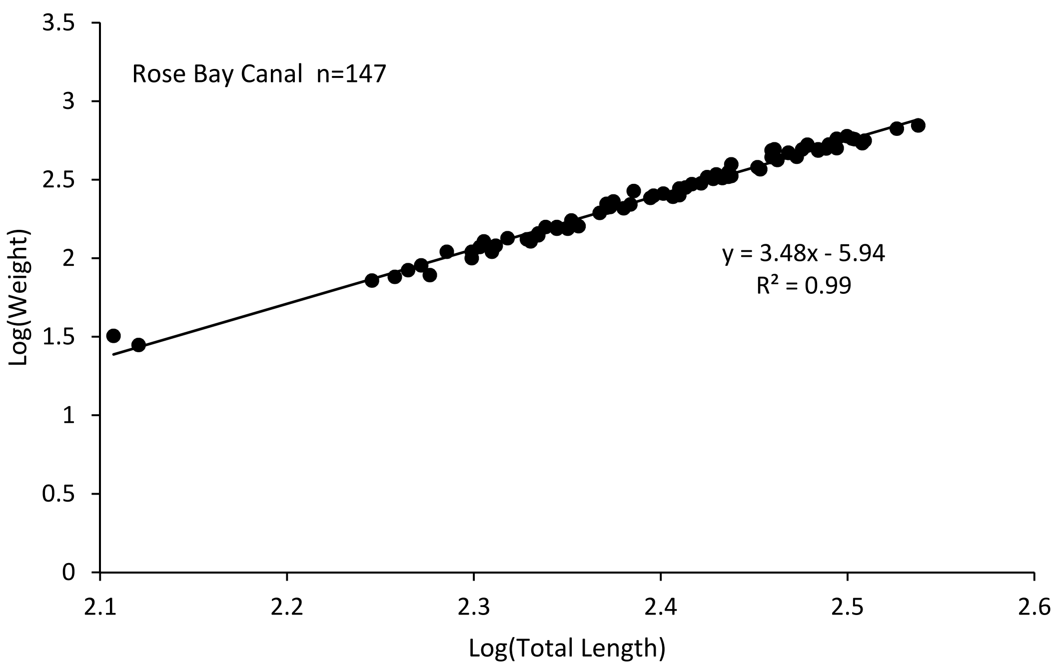

FIGURE 10.—Linear regression of the log transformed weight versus log transformed length of Black Crappie collected by trap nets in Rose Bay Canal, December 2014.