NEUSE RIVER BLACK CRAPPIE ELECTROFISHING SURVEY: 2009 and 2011

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Abstract.—Sampling Black Crappie *Pomoxis nigromaculatus* in coastal North Carolina rivers can be a challenge because shore slopes are steep for trap nets and previous intensive efforts yielded few fish and variable catch rates. To explore an alternate method for sampling Black Crappie in coastal rivers, we sampled the Neuse River with boat-mounted electrofishing during 2009 and 2011. Two settings were used to collect Black Crappie: a 120 pulse-per-second (PPS) setting intended specifically to capture Black Crappie (120 PPS, 8 A, 1000 V) and a 60 PPS setting typically used to collect Largemouth Bass *Micropterus salmoides* and sunfish (60 PPS, 4-5 A, 1000V). Total catch was 90 fish in 2009 and 87 fish in 2011. Mean CPUE ranged between 7 fish/h in 2009 and 14 fish/h in 2011, but was highly variable both years. Size structure, condition, age composition, von Bertalanffy growth curves, and mortality rates were similar to previous Neuse River estimates derived from trap net sampling. Boat electrofishing for Black Crappie in the Neuse River provides a viable alternative to trap net sampling and can be performed in conjunction with other fisheries sampling objectives. Fisheries managers should consider operator experience with the 120 PPS electrofishing and incorporate a measure of effort that includes area sampled, electrofishing time and search time when sampling for Black Crappie in coastal rivers. Investigations into the relationship between Black Crappie electrofishing catch rates and environmental variables such as time of year, water temperature, and conductivity may also help reduce variability of CPUE estimates.

Background

In North Carolina coastal rivers, Black Crappie *Pomoxis nigromaculatus* receive considerable angling effort and can be subject to high harvest rates in North Carolina coastal rivers, including the Chowan (Dockendorf et al. 2004), Neuse (Rundle et al. 2005) and Tar Rivers (Homan et al.

2006). While biologists have typically encouraged the harvest of Black Crappie because of their tendency to overpopulate, fishery managers recognize that overexploitation can occur (Colvin 1991). Recent creel surveys revealed that Black Crappie < 203 mm were frequently harvested and this finding along with requests from anglers to protect smaller fish prompted a regulation change in 2002 (Dockendorf et al. 2004). Effective 1 July 2002, Black Crappie in most public waters in the Chowan and Roanoke river basins were regulated via a 203-mm minimum length limit and a 20 fish daily creel limit. This regulation was also applied to all public waters east of Interstate 95 (with the exception of Tar River Reservoir and Sutton Lake) effective 1 July 2007.

Fishery managers need to sample fish populations in an efficient and effective manner to evaluate regulation applicability. However, sampling Black Crappie with conventional sampling gear (i.e. trap nets) has met limited success in North Carolina coastal rivers. Several studies (Clemmons and Kornegay 1987, Van Horn and Jones 1990, Clemmons et al. 1991, Hand 2000, Barwick and Rundle 2005) reported low and variable catch rates of Black Crappie using trap nets in coastal rivers and some indicate that trap nets may not effectively sample Black Crappie < age 2 (Clemmons and Kornegay 1987). However, based on angler catch rates in excess of 2 crappie/h (Dockendorf et al. 2004, Rundle et al. 2005, Homan et al. 2006), low trap net catch rates may not accurately indicate low fish abundance. The North Carolina Wildlife Resources Commission's (NCWRC) crappie management plan (NCWRC 2001) also indicates a need to develop and evaluate stock assessment techniques for crappie populations in coastal rivers.

Recent NCWRC boat electrofishing in coastal rivers suggests that a specific electrofishing setting and approach may provide an alternative gear to sample crappie. This electrofishing setting is a higher direct current (DC) pulse rate (120 pulses-per-second, PPS) than the typical electrofishing setting (60 PPS) used for other fish species of the family Centrachidae in coastal North Carolina. This electrofishing approach needs to be evaluated as a crappie stock assessment technique in NC coastal rivers. Also, because of time constraints and heavy workloads, fisheries biologists support collecting crappie encountered during routine sportfish sampling and the potential for incorporating this information to manage crappie populations. The objectives of this study were to calculate abundance, relative weight, size structure, age composition, growth rates, and mortality of Neuse River Black Crappie collected using boat-mounted electrofishing, compare these data to past trap netting data, and to evaluate the potential for a standardized electrofishing method to collect crappie in coastal rivers.

Methods

Black Crappie were collected from the Neuse River using boat-mounted electrofishing (Smith-Root 7.5 GPP; crew of one netter and one boat operator) during fall 2009 (September–October) and late winter/early spring 2011 (February–March). During 2009, Black Crappie were directly targeted at eight sites using 120 PPS electrofishing settings (120 PPS, 8 A, 1000 V) and at seven sites using 60 PPS electrofishing settings (60 PPS, 4–5 A, 1000V; Figure 1) during sampling for juvenile Blueback Herring *Alosa aestivalis* and Largemouth Bass *Micropterus salmoides*. At 120 PPS sites where Black Crappie were specifically targeted, we sampled between the shoreline and a depth of about 6 m and near structure indicative of crappie habitat (logs, downed trees, stumps, docks, etc.). The boat would remain stationary over structure between 30 and 60 seconds until crappie were observed. If no Black Crappie were

observed, the boat operator would navigate to the next piece of structure. When observed, all Black Crappie were collected until no more were observed. During 60 PPS sampling, the electrofishing boat was navigated to sample all available habitats within a 1–km shoreline site. During 2011, most Black Crappie were collected at five sites using 60 PPS electrofishing settings during weekly sampling for adult Blueback Herring. Black Crappie were also collected at two sites using 120 PPS electrofishing settings (Figure 1). At each site, water conductivity (µS/cm) and temperature (°C) was measured using a YSI 85 dissolved oxygen meter in 2009 and a YSI Pro 2030 dissolved oxygen meter in 2011.

All Black Crappie were measured for total length (TL, mm), weighed (g), and sacrificed for otolith removal. All otoliths were immersed in water and examined in whole view as suggested by Maceina and Betsill (1987) under 10–40X magnification. Black Crappie collected during 2009 were aged by one reader and the otolith edge was not counted as an annulus since the fish were collected during fall. For otoliths which could not be aged by direct observation, estimates of ages were determined using an age-length key (ALK; Bettoli and Miranda 2001). All Black Crappie otoliths collected during 2011 were aged by two independent readers and initial reader agreement was 98%. The two discrepancies were later resolved in a concert read of the two independent readers. Since these fish were collected in early spring (February and March) the otolith edge was counted as an annulus.

Black Crappie abundance was indexed as catch-per-unit-effort (CPUE) and expressed as number of fish collected per hour of electrofishing. Population size structure was analyzed using length-frequency distributions (10-mm length groups), proportional size distribution (PSD) and proportional size distribution-preferred (PSD-P; Gabelhouse 1984a, Guy et al. 2007). Trends in body condition were assessed using relative weights (Wr) of all fish ≥ 100-mm according to Neumann and Murphy (1991; $\log_{10} = -5.618 + 3.345(\log_{10}(TL))$). Relative weight was also calculated separately for stock (130–199 mm), quality (200–249 mm), preferred (250–299 mm), and memorable (300–379 mm) total length groups (Gabelhouse 1984a). For fish collected in 2009, mean total length at age was calculated according to Bettoli and Miranda (2001). Because all Black Crappie collected in 2011 were aged, mean total length at age was calculated for each age class based on observed total length at capture. Growth was modeled using the von Bertalanffy growth equation (FAST 2001):

$$L_t = L_{inf}\,(1 - e^{-K(t - t_0)})$$

where t = time in years, L_t = length at time t, L_{inf} = maximum theoretical length, K = growth coefficient, and t_0 = time at which Lt = 0. Total annual mortality (AM) rates were estimated using Robson-Chapman maximum likelihood estimator (Robson and Chapman 1961).

Results and Discussion

During 2009, a total of 90 Black Crappie was collected from the Neuse River. Fifty were collected with the 120 PPS electrofishing settings while 40 were collected with the 60 PPS electrofishing settings. Mean CPUE using the 120 PPS setting was 6.9 fish/h (95% C.I., 7.4) while mean CPUE using the 60 PPS setting was 6.8 fish/h (95% C.I., 6.0). When analyzed by length group, CPUE was similar between sampling methods (Figure 2). During 2011, a total of 87 Black

Crappie was collected with a mean CPUE of 14.1 fish/h (95% C.I., 10.2; Table 1). Because only two sites were sampled using the 120 PPS setting during 2011, analyses of population characteristics were combined for the two methods. Trends in CPUE of Black Crappie were not apparent as some of the highest CPUE values recorded varied with date and water temperature (Table 2).

While electrofishing catch rates appear to be low and variable for Black Crappie, overall catch was higher than that reported for trap nets by Barwick and Rundle (2005). While sampling the Neuse River during fall 2004, Barwick and Rundle (2005) reported catching only 41 Black Crappie in 52 net-nights (mean CPUE = 0.8 crappie/net-night). During this study, we caught over twice that many fish in both sample years; however differences in sampling gears preclude any comparison between catch rates. Because estimates of electrofishing CPUE are highly variable, abundance estimates using electrofishing may not be more precise than abundance estimates derived from trap net sampling. However, electrofishing collections could be used to collect information regarding size-structure, condition, age composition, growth rates, and mortality. Given the heavy work load of fishery biologists in coastal North Carolina and variability in CPUE estimates, collecting Black Crappie during sampling for other species and calculating these estimates may be a desirable alternative to directed sampling for crappie.

Further refinement of electrofishing sample design and consideration of Black Crappie habits and movements may eliminate some variability in catch rates. With the 60 PPS setting, the boat operator navigated between two points sampling all available habitats and recorded continuous electrofishing effort in seconds. With the 120 PPS setting only ideal habitat between two points was sampled and effort was only recorded when the boat was actively electrofishing the habitat (i.e. when there was an electrical output from the boat). Therefore, CPUE using the 120 PPS setting can vary widely depending on amount of time spent searching for proper habitat and the boat operator's knowledge of available habitat. Investigation of standard sampling techniques for the 120 PPS setting is needed. Possible metrics to evaluate are a "search time" to quantify time spent searching for Black Crappie in likely habitat, CPUE based on linear distance or surface area sampled rather than time, and the ambient conditions at which sampling would be most effective.

Mean Wr during 2009 was 91 (95% C.I., 1.9) and declined with size while mean Wr in 2011 was 92 (95% C.I., 2.1), and increased with size (Figure 3). These estimates are slightly higher than the mean Wr of 88 reported on the Neuse River by Barwick and Rundle (2005). Estimates of mean Wr by length group were similar between sample years for all fish combined and stock-size fish but higher for quality and preferred-size fish in 2011 (Figure 3). In general, these values of Wr indicate that Neuse River Black Crappie were healthy and in good condition during the 2009 and 2011 sample years.

Total length of fish collected during 2009 ranged 61–317 mm and the length frequency distribution displayed several modes (Figure 4). The 2011 length frequency distribution also displayed several modes and total length of fish collected ranged 83–375 mm (Figure 4). In both years, we collected Black Crappie as small as 61 mm via boat electrofishing during this study in contrast to previous trap net studies where fish less than 100mm were not represented. During 2009, PSD was 54 and PSD-P was 20, and during 2011 PSD was 52 and PSD-P was 24. Barwick and Rundle (2005) reported similar values for PSD (58) and PSD-P (22) during 2004 (Table 3). All

of these values were within acceptable ranges of PSD and PSD-P for Black Crappie reported by Gabelhouse (1984b; Table 3).

Six year-classes collected in 2009 ranged in age from 0–5 (2004–2009 cohorts). Most of the fish collected were in the 2006–2009 cohorts with only four fish older than age 3 (Figure 5). Incremental growth rates ranged 23–77 mm per year and minimum quality size (200 mm) was usually reached by the third growing season (age 2; Figure 5). During the 2011 collections, seven year-classes ranged in age from 1–8 (2003–2010 cohorts) and most fish collected were 2–5 years old (2006–2009 cohorts; Figure 5). Incremental growth rates ranged 31–59 mm per year (Figure 5). These values are within the range of growth rates (39–71 mm per year) reported by Barwick and Rundle (2005). Total annual mortality for the 2009 sample year was 52% (95% C.I., 9%) based on the 2004–2008 year-classes while annual mortality for the 2011 sample year was 55% (95% C.I., 8%) based on the 2006–2009 year-classes.

Management Recommendations

1. Implement electrofishing techniques for crappie as a viable sampling alternative to trap nets.
2. Continue refinement of 120 PPS electrofishing settings by evaluating the inclusion of search time as well as distance and area sampled within the methodology.
3. Investigate further the attainment of more precise estimates of abundance to quantify CPUE; this could include analysis of seasonality, water temperature, and other environmental variables. Black Crappie appear most vulnerable to electrofishing during spring and fall when water temperatures are between 10–20 °C. Future sampling should be focused during these time periods.
4. Use sampling via electrofishing to evaluate the effect of current harvest regulations on Neuse River crappie population size and age structure.

Literature Cited

Barwick, R. D., and K. R. Rundle. 2005. A survey of Black Crappie populations in the Tar River, Neuse River, and Sutton Lake, North Carolina. North Carolina Wildlife Resources Commission, Federal Aid in Sport Fish Restoration, Project F-22, Final Report, Raleigh.

Bettoli, P. W., and L. E. Miranda. 2001. Cautionary note about estimating mean length at age with subsampled data. North American Journal of Fisheries Management 21:425–428.

Clemmons, M. M., and J. W. Kornegay. 1987. Effectiveness of trap nets for sampling crappie in coastal waters. North Carolina Wildlife Resources Commission, Federal Aid in Sport Fish Restoration, Project F-22-11, Final Report, Raleigh.

Clemmons, M. M., J. W. Kornegay, and S. L. Van Horn. 1991. Evaluation of trap netting as a technique for sampling Black Crappies in a coastal river. North Carolina Wildlife Resources Commission, Federal Aid in Sport Fish Restoration, Project F-22-14, Final Report, Raleigh.

Colvin, M. A. 1991. Population characteristics and angler harvest of White Crappies in four large Missouri reservoirs. North American Journal of Fisheries Management 11:572-584.

Dockendorf, K. J., C. D. Thomas, and J. W. Kornegay. 2004. Chowan River recreational angling survey, 2001-2002. North Carolina Wildlife Resources Commission, Federal Aid in Sport Fish Restoration, Project F-22, Final Report, Raleigh.

FAST (Fishery Analyses and Simulation Tools). 2001. FAST user's manual. Department of Fisheries and Allied Aquacultures, Auburn University, Alabama.

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

Gabelhouse, D. W., Jr. 1984b. An assessment of crappie stocks in small Midwestern private impoundments. North American Journal of Fisheries Management 4:371–384.

Guy, C. S., R. M. Neumann, D. W. Willis, and R. O. Anderson. 2007. Proportional Size Distribution (PSD): A further refinement of population size structure index terminology. Fisheries 32(7):348.

Hand, G. R. 2000. Assessment of Black Crappie populations in the Chowan and Cashie Rivers, North Carolina. North Carolina Wildlife Resources Commission, Federal Aid in Sport Fish Restoration, Project F-22, Final Report, Raleigh.

Homan, J. M., R. D. Barwick, and K. R. Rundle. 2006. Tar-Pamlico River basin sport fishery creel survey, 2004-2005. North Carolina Wildlife Resources Commission. Federal Aid in Sport Fish Restoration, Project F-22, Final Report, Raleigh.

Maceina, M. J., and R. K. Betsill. 1987. Verification and use of whole otoliths to age White Crappie. Pages 267-278 *in* R. C. Summerfelt and G. E. Hall, editors. The age and growth of fish. The Iowa State University Press, Ames, Iowa.

NCWRC. 2001. A management plan for Black and White Crappie in North Carolina. North Carolina Wildlife Resources Commission. Raleigh.

Neumann, R. M., and B. R. Murphy. 1991. Evaluation of the relative weight (Wr) index for assessment of White crappie and Black crappie populations. North American Journal of Fisheries Management 11:543-555.

Robson, D. S. and D. G. Chapman. 1961. Catch curves and mortality rates. Transactions of the American Fisheries Society 90:181.

Rundle, K. R., C. T. Waters, and R. D. Barwick. 2004. Neuse River basin sport fishery creel survey, 2002-2003. North Carolina Wildlife Resources Commission, Federal Aid in Sport Fish Restoration, Project F-22, Final Report, Raleigh.

Van Horn, S. L. and R. I. Jones. 1990. Characteristics of North Carolina crappie populations and a proposed stock assessment model. North Carolina Wildlife Resources Commission, Federal Aid in Sportfish Restoration, Project F-23-S, Final Report, Raleigh.

TABLE 1.—Mean CPUE of Black Crappie by length group collected by electrofishing on the Neuse River 2011. Because there were only two 120 PPS sample sites in 2011, mean CPUE was calculated for all sample sites combined. Values in parentheses are 95% confidence intervals.

Length Group	Black Crappie (N)	CPUE (fish/h)
All sizes	4.6 (2.7)	14.1 (10.2)
Stock	2.0 (1.9)	6.5 (7.0)
Quality	1.2 (0.6)	3.1 (1.9)
Preferred	0.7 (0.4)	2.5 (2.1)
Memorable	0.3 (0.3)	0.7 (0.7)

TABLE 2.—CPUE and water quality measurements by sample date and electrofishing setting during 2009 and 2011. Range of measured values are in parentheses where applicable.

	Setting	Sample Sites	Crappie	Effort (h)	CPUE (fish/h)	Conductivity (uS)	Temperature (°C)
				2009			
09/15/2009	120 PPS	3	0	1.0	0.0	554 (366-914)	24.0 (22.3-25.4)
09/16/2009	120 PPS	4	38	2.6	14.4	185 (172-213)	26.1 (25.5-26.5)
10/19/2009	120 PPS	3	10	1.0	9.7	162 (152-175)	14.5 (13.5-15.6)
10/28/2009	120 PPS	2	2	1.4	1.5	173 (168-177)	18.4 (18.1-18.6)
09/10/2009	60 PPS	1	2	0.7	2.8	206 (n/a)	23.4 (n/a)
09/15/2009	60 PPS	1	2	0.6	3.6	678 (n/a)	24.0 (n/a)
10/19/2009	60 PPS	1	6	0.8	7.4	152 (n/a)	14.5 (n/a)
10/20/2009	60 PPS	2	7	2.1	3.4	169 (165-172)	14.0 (12.8-15.1)
10/22/2009	60 PPS	2	23	1.5	15.0	132 (132-133)	15.5 (n/a)
				2011			
03/11/2011	120 PPS	2	35	0.5	67.3	118 (112-123)	13.4 (13.3-13.5)
02/08/2011	60 PPS	3	11	1.4	7.9	92 (74-115)	8.8 (8.6-9.2)
02/24/2011	60 PPS	2	3	0.8	3.8	124 (120-128)	10.9 (10.5-11.2)
03/02/2011	60 PPS	2	2	0.6	3.4	134 (133-135)	14.7 (14.3-15.1)
03/04/2011	60 PPS	1	3	0.4	7.1	142 (n/a)	12.1 (n/a)
03/11/2011	60 PPS	1	3	0.5	5.6	121 (n/a)	13.1 (n/a)
03/15/2011	60 PPS	2	3	0.6	5.1	116 (111-121)	14.0 (13.7-14.2)
03/23/2011	60 PPS	6	27	2.5	10.6	145 (112-160)	18.4 (17.4-19.7)

TABLE 3.—Proportional size distribution and PSD-P of Neuse River Black Crappie in 2004, 2009, and 2011 compared to generally accepted values of stock density index ranges.

	PSD	PSD-P	Source
2004	58	22	Barwick and Rundle (2005)
2009	54	20	This study
2011	52	24	This study
Accepted range	30-60	>10	Gabelhouse (1984b)

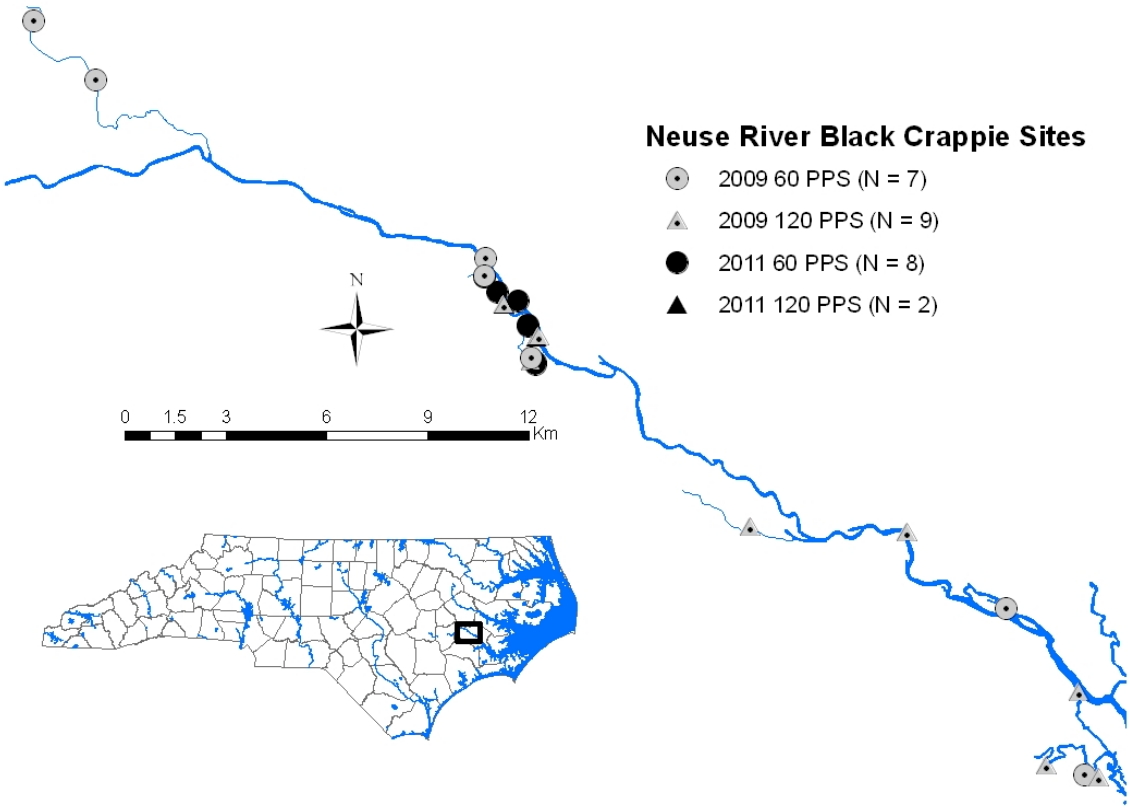

FIGURE 1.—Neuse River Black Crappie electrofishing sites in 2009 (N = 16) and 2011 (N = 10).

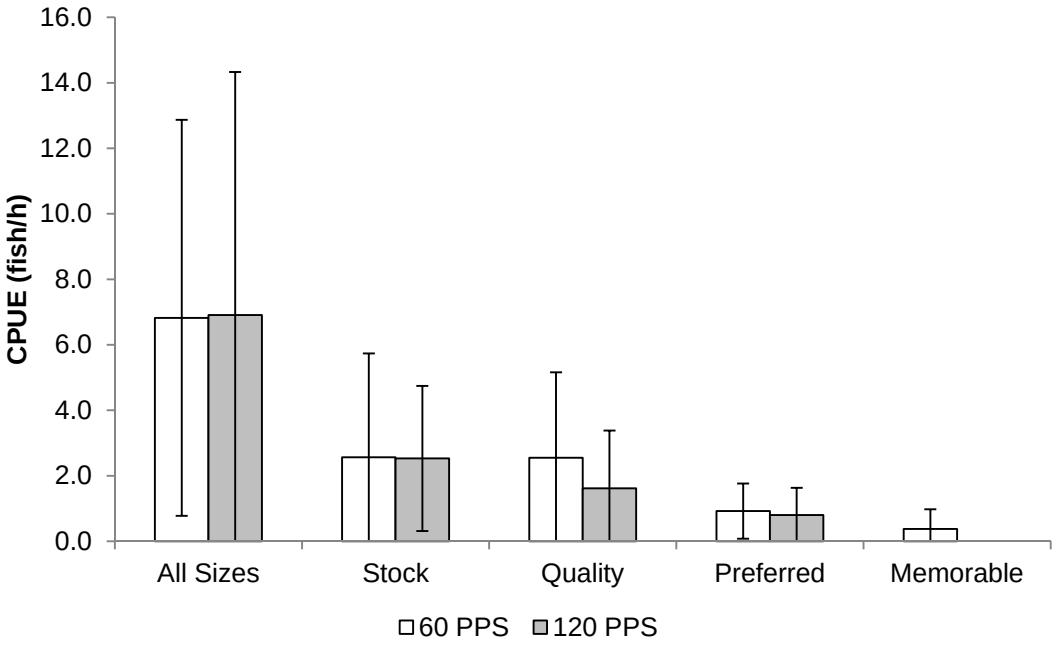

FIGURE 2.—Mean CPUE of Black Crappie collected by electrofishing on the Neuse River 2009. Error bars are 95% confidence intervals.

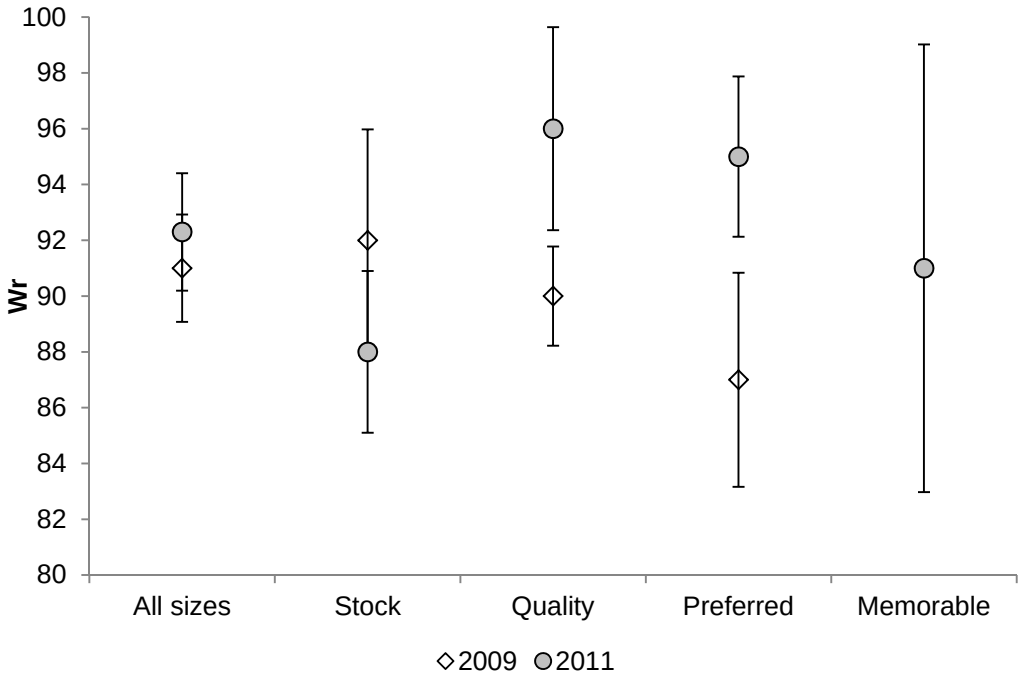

FIGURE 3.—Mean Wr of Black Crappie collected by electrofishing on the Neuse River in 2009 and 2011. Error bars are 95% confidence intervals.

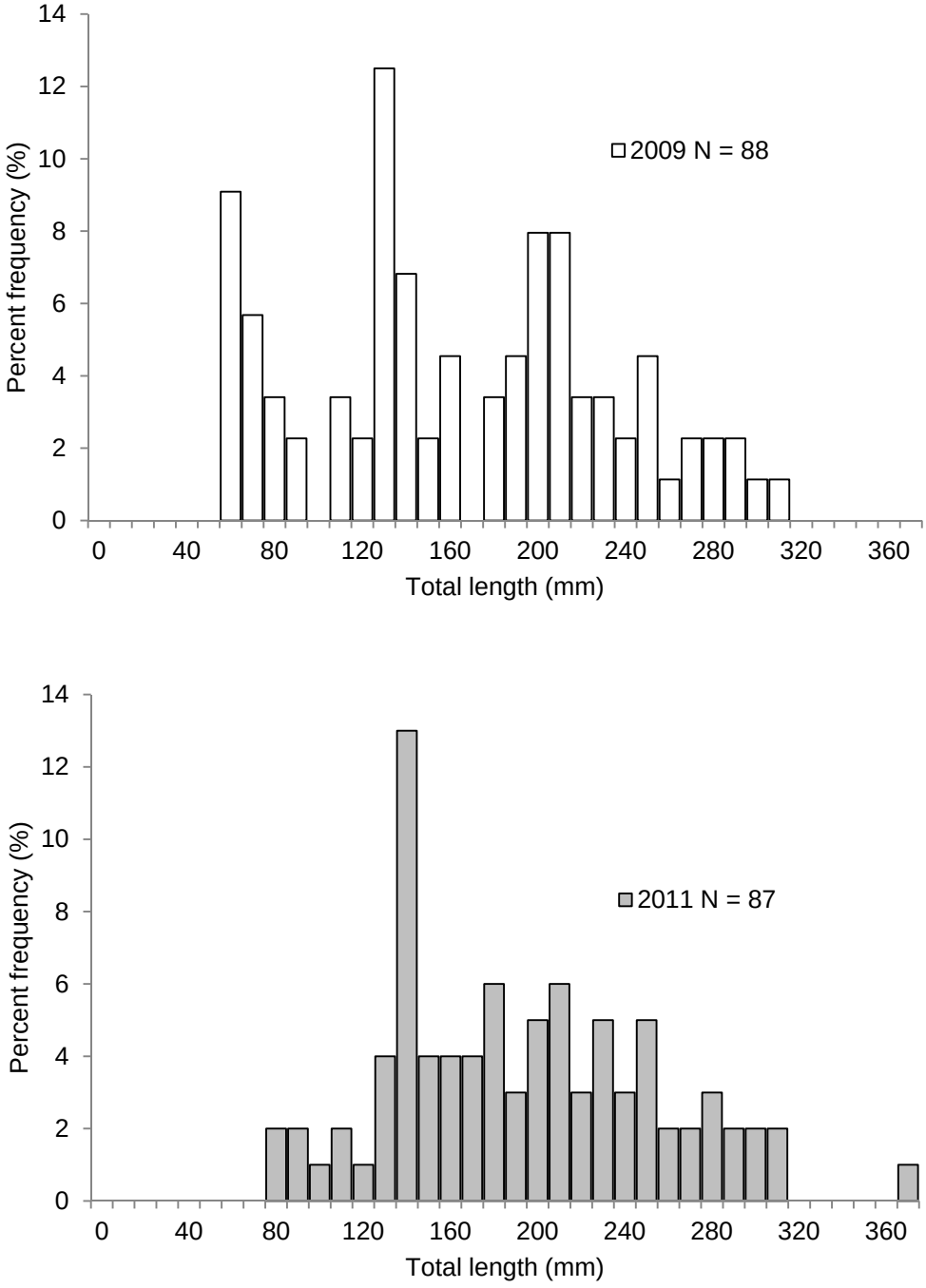

FIGURE 4.—Length-frequency distribution of Black Crappie collected by electrofishing on the Neuse River fall 2009 (top chart) and spring 2011 (bottom chart).

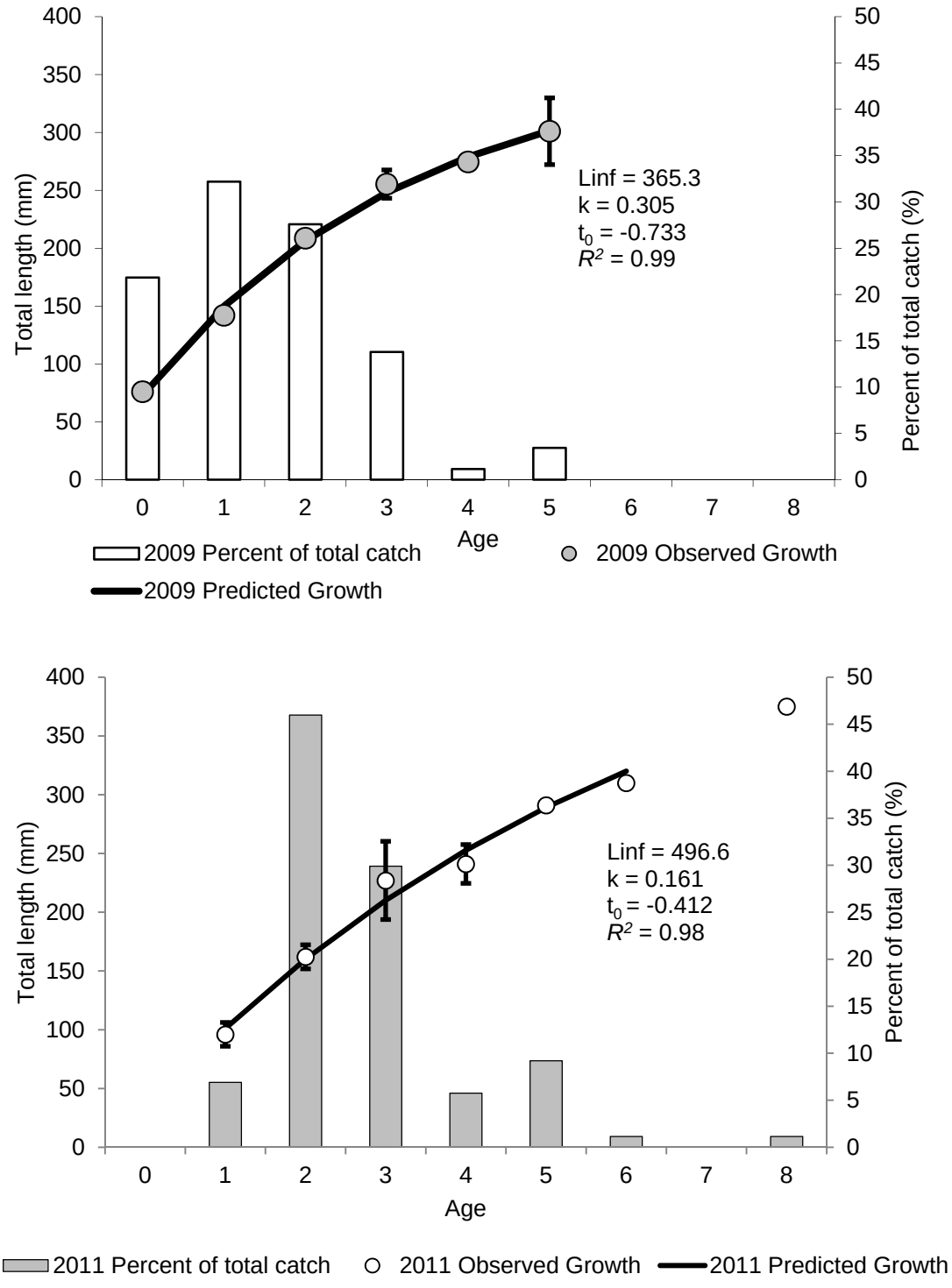

FIGURE 5.—Age composition, mean total length at time of capture, and von Bertalanffy growth curve for Black Crappie collected by electrofishing on the Neuse River in fall 2009 (top chart) and spring 2011 (bottom chart). Error bars are 95% confidence intervals.