NEW RIVER SMALLMOUTH BASS SURVEY — 2013

Federal Aid in Sport Fish Restoration
Project F-108
Final Report

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Division of Inland Fisheries
Raleigh

2017

Keywords: New River, Smallmouth Bass, electrofishing

This project was funded under the Federal Aid in Sport Fish Restoration Program utilizing state fishing license money and federal grant funds derived from federal excise taxes on fishing tackle and other fishing related expenditures. Funds from the Sport Fish Restoration Program are used for fisheries management and research, aquatic education, and boating access facilities. The program is administered cooperatively by the N.C. Wildlife Resources Commission and the U.S. Fish and Wildlife Service.

Abstract.—Boat-mounted electrofishing gear was used to collect Smallmouth Bass (SMB) *Micropterus dolomieu* in the mainstem New River, North Fork New River, and South Fork New River from May–September 2013. Relative abundance, body condition, size structure, age structure, and growth rates were evaluated separately for each river segment. Catch rates of SMB ranged from a low of 82 fish/hr (SE = 4.7) in the South Fork New River to a high of 139 fish/hr in the North Fork New River. Catch rates in all river segments were the highest on record since stock assessment work began in 1997, although new sampling protocols implemented during the 2013 survey may have contributed to the higher catch rates. Quality-sized SMB were most abundant in the mainstem New River, and although most SMB in all three river segments were < 300 mm in total length, larger fish were more abundant than during the previous survey conducted in 2005. Relative weights ranged from a low of 90 in the South Fork New River to a high of 95 in the North Fork New River, with a negative relationship between relative weight and fish length being observed in all three river segments. The ages of SMB collected ranged from 1 to 14, although 94% of fish were between ages 1 and 6. Relationships between South Fork New River SMB year-class formation and river hydrology were examined and strong year-classes may be more likely to be formed when mean flows during the month of July are < 300 ft^3/sec. Growth rates of SMB were highest in the mainstem New River, with fish reaching 300 mm at age 5, and growth rates in all river segments were generally faster than growth rates reported in the 2005 survey.

The New River, which originates in Watauga County and flows northward through Ashe and Alleghany counties, is designated as a State Scenic River and is part of the National Wild and Scenic River System. Throughout the warmwater portion of the river, it supports sportfisheries for Smallmouth Bass (SMB) *Micropterus dolomieu*, Rock Bass *Ambloplites rupestris*, Redbreast Sunfish *Lepomis auritus*, and Flathead Catfish *Pylodictis olivaris*.

The geomorphology of the upper New River has historically limited the amount of stock assessment work that the North Carolina Wildlife Resources Commission (Commission) has performed on the river's sportfish community. Given that the river is rocky and shallow (mean depth < 1 m) with frequent shoals and riffles, it is not feasible to collect samples using traditional boat-mounted electrofishing gear. Due to the considerable width of the river, backpack electrofishing gear is also ineffective. As a result, the only stock assessments performed on the New River by the Commission before the late 1990s consisted of a series of rotenone and electric seine samples conducted between 1958 and 1962 and surveys using backpack electrofishing and angling that were performed in the late 1970s, although the low numbers of fish collected during these surveys limited the utility of the data obtained (Richardson 1963; Mickey 1980).

In 1997, an electrofishing boat with a jet-drive outboard designed specifically for sampling shallow rivers was acquired by the Commission. SMB were collected from the mainstem New River (MNR) in summer 1997 and the South Fork New River (SFNR) in spring 1998 and summer 1999. Based on these samples, it was determined that SMB catch per unit effort was highest during the summer, and that although SMB size distribution varied considerably between surveys, most fish in the system were < 300 mm in length (Hodges 1999). Because the goal of these initial surveys was to identify the optimal time of year for sampling and to refine sampling protocols, no age data were collected. In 2003, a survey was conducted that included sites on the North Fork New River (NFNR), SFNR, and MNR (Hodges 2004), and age data were collected from SMB at all locations. Attempts were made to estimate total mortality (A) using catch curve analysis. However, given the erratic recruitment exhibited by riverine SMB populations (Lukas and Orth 1995; Slipke et al. 1998; Buynak and Mitchell 2002), these mortality estimates were somewhat speculative. Subsequent surveys were carried out in 2005 to obtain both updated biological data and additional estimates of mortality using cohort analysis (Hodges 2006).

Previous work has shown that year-class production is strongly linked to hydrologic conditions during the spawning season and early life stages of river-dwelling SMB. Some studies have shown that poor year-classes tend to be formed when rainfall (Buynak and Mitchell 2002) or stream discharge (Lukas and Orth 1995; Slipke et al. 1998) is above average between April and July, while other studies have demonstrated that SMB recruitment is strongly tied to mean streamflow during the month of June, with declines in recruitment when flows were either substantially higher or lower than historical means (Smith et al. 2005). A coarse-scale analysis of flow-recruitment relationships for SFNR SMB was conducted for fish collected during the 2005 survey. The strength of each year-class was qualitatively assessed by examining the age-frequency distribution of fish collected during the sample and compared against flow data from the SFNR, the only segment of the New River for which flow data are available. This analysis suggested that the aforementioned predictors of year-class strength did not appear to accurately describe SMB recruitment patterns within the upper New River and suggested that SMB recruitment might be more closely linked with mean flows during July (Hodges 2006).

The goals of the 2013 survey were to monitor the abundance, size structure, body condition, age structure, and growth rates of New River SMB, and to further assess the relationship between river flows and SMB year-class formation. This report summarizes the results of the 2013 surveys.

Methods

Electrofishing.—Commission staff conducted electrofishing surveys using boat-mounted electrofishing gear on the MNR, NFNR, and SFNR in Ashe and Alleghany counties between May 28 and September 10, 2013. A Smith-Root GPP 5.0 electrofishing unit was used and settings of 500–1000 V, 4 A, and 120 pulses per second were employed throughout the study. The 2013 sampling season in northwest North Carolina was one of the rainiest on record, with mean daily flows for the entire calendar year being the highest since record keeping began in 1925 (USGS 2016). As a result, the river was characterized by high flows and poor water clarities that were unsuitable for conducting electrofishing surveys throughout most of the study period. Although our goal was to complete all surveys by early summer, the study period became protracted since the moderate flows and good water clarities needed to conduct effective electrofishing surveys only occurred sporadically throughout the sampling season.

During previous surveys, the electrofishing boat was launched and retrieved at the same location within each site. This approach limited the amount of habitat that could be surveyed since the prevalence of rocky shoals in the upper New River restricted navigability, especially when moving in an upstream direction. During this survey, upstream launch points were paired with downstream takeout points on the NFNR and SFNR. By launching upstream and floating downstream while sampling, the electrofishing boat was better able to pass over shoals than during previous surveys when upstream navigation was required. As a result, the length of river reaches that we were able to sample increased relative to previous surveys. This same approach was used during our initial survey of the upstream site on the MNR, although equipment problems limited the amount of electrofishing we were able to perform. However, during a return visit to complete our sampling at the upstream site, as well as during our survey of the downstream MNR site, we launched and took out at the same location because the river was large enough to allow for unrestricted navigation throughout the target sample reach.

Two sites were surveyed on each segment of the river (Figure 1), with totals of 8.9, 9.6, and 8.8 km of river being sampled on the MNR, NFNR, and SFNR, respectively. The entire length of each sample site was electrofished, aside from the aforementioned sample of the upper MNR site when we were only able to electrofish sporadically throughout the survey reach. During the NFNR and SFNR surveys and the initial survey of the upper MNR site, a single pass was made through the survey reach, and we alternated between sampling left bank, right bank, and mid-channel habitats. During the follow-up survey of the upper MNR site and the survey of the lower MNR site, where the river was much wider and deeper than either the NFNR or SFNR, multiple, non-overlapping passes were made through the sample reach since the increased size of the river allowed for unrestricted upstream navigation. All SMB were collected at each site and measured for total length (TL; mm). While weight (g) was measured for all SMB collected from MNR sites, it was only collected from a subsample of fish from the NFNR and SFNR since some of these fish were frozen and processed at a later date. Sagittal otoliths were removed from all SMB collected from the MNR and NFNR and from a randomly-selected subsample of SMB collected from the SFNR.

Data analysis.—For each river segment, catch per unit effort (CPUE; fish/hour) was determined, length-frequency distribution histograms were constructed, size-structure indices (Proportional Size Distribution; PSD) were calculated for quality (PSD)-, preferred (PSD-P)-, and memorable (PSD-M)-sized SMB, and relative weights were calculated. The lengths for stock-, quality-, preferred-, and memorable-sized SMB used in determining stock index values were those proposed by Gabelhouse (1984) and refined by Guy et al. (2007). Relative weights were computed using the equations of Kolander et al. (1993).

Otoliths were prepared for reading by breaking them in half perpendicular to their longest axis and polishing the broken end using 320–400 grit sandpaper (Besler 1999). The otolith section was then submerged in a shallow dish of water, with the unbroken end embedded in a layer of clay lining the bottom of the dish. The otolith section was illuminated from the side with a fiber optic light and read under a dissecting microscope. Otoliths were read independently by two readers, and discrepancies in annuli counts between readers were rectified at a joint reading.

Age-frequency distribution histograms were constructed, and the relationship between SMB recruitment and mean river discharge (ft^3/sec) in April–July, June, and July (USGS 2016) was examined for SFNR SMB. The relative strength of each year-class present in appreciable numbers was qualitatively assessed and assigned a rating of strong or weak. Year-class ratings were then compared against flow data from the SFNR. Data describing year-class strength gathered from earlier surveys conducted in 2003 and 2005 were also included to maximize the number of year-classes available for analysis.

Mean length at age at time of capture was determined for all year-classes represented by at least two fish and Fishery Analysis and Modeling Software (FAMS) v. 1.64 (Slipke and

Maceina 2014) was used to determine asymptotic length (L_∞) for each river segment using the von Bertalanffy growth equation (von Bertalanffy 1938).

The reported age of fish in this survey was not always equal to the number of complete annuli that were present on otoliths. In this survey, the annuli had not yet begun to form in May and June, partially-formed annuli began appearing on some fish in August, and all fish had complete annuli by September. In cases where the new annulus had either not yet begun to form or was only partially complete, fish were assigned an age equal to the number of complete annuli plus one to maintain consistency in age assignment throughout the study period.

Results and Discussion

Abundance.—We collected 261 SMB from the MNR (CPUE = 105 fish/hour; SE = 4.5), 185 SMB from the NFNR (CPUE = 139 fish/hour), and 174 SMB from the SFNR (CPUE = 82 fish/hour; SE = 4.7). Catch rates were not determined for our initial survey at the upstream site on the MNR since mechanical problems affected catch rates, or for the upstream site on the NFNR because the timer on the electrofishing unit malfunctioned. Catch rates obtained during the 2013 surveys were the highest recorded since electrofishing surveys began on the New River in 1997. In comparison to the average of catch rates compiled from all previous surveys (Hodges 1999, 2004, 2006), 2013 catch rates were 48, 54, and 58% higher on the MNR, NFNR, and SFNR, respectively. Although these increased catch rates could reflect increases in the abundance of SMB, they may also have been affected by our new sampling protocol which allowed us to survey longer stretches of river and reduced the amount of river that was sampled by making multiple passes within survey reaches. However, the sampling protocol used during the MNR surveys in 2013 was largely similar to the protocol used during previous surveys, yet catch rates were still substantially higher in 2013. As such, the effects of sampling methods on catch rates cannot be conclusively determined.

Size structure.—SMB ranged in length from 73 to 482 mm TL, with most fish being < 300 mm TL (Figure 2). The proportion of fish > 300 mm TL was higher in the MNR (11%) than in the NFNR (7%) or SFNR (7%). Among all three river segments, nine percent of SMB were > 300 mm TL, which is a substantial improvement over the 2005 survey when only two percent of SMB were > 300 mm TL (Hodges 2006).

While PSD values reflected the higher proportion of quality-sized SMB in the MNR (PSD = 23) versus the NFNR (PSD = 14) and SFNR (PSD = 13), PSD-P and PSD-M values were more comparable between river segments (Table 1). Although PSD values in 2013 were similar to those obtained during the 2005 survey when larger fish were less abundant, PSD-P and PSD-M values during this survey were substantially higher than in 2005 when PSD-P values ranged from 0 to 1.5 and all PSD-M values were 0 (Hodges 2006).

Average values for PSD, PSD-P, and PSD-M were 24, 5, and 0, respectively, during surveys of most known North Carolina riverine SMB populations conducted by the Commission between 2007–2009 (Goodfred et al. 2012). While these regional stock index values closely resemble those from the MNR, PSD values from the regional survey were considerably higher than values from the NFNR and SFNR. However, sample sizes for most streams in the regional survey were insufficient to allow for accurate assessment of size structures. Furthermore, due to angling being used to collect many of the fish from the regional survey, stock-sized (180 mm) SMB were likely not fully recruited to the sampling gear, which would underrepresent their true abundance and cause stock indices to be artificially elevated. As such, any inferences that can be gained by comparing New River stock index values against average values obtained during the regional survey are limited.

Condition.—Relative weights for SMB in the MNR, NFNR, and SFNR averaged 92, 95, and 90, respectively, with body condition declining with increasing fish length in all three river segments (Figure 3). This same negative relationship between SMB body condition and fish length has been observed during all previous New River surveys (Hodges 1999, 2004, 2006) and it generally characterizes length-condition relationships for riverine SMB populations in western North Carolina (Goodfred et al. 2012).

Many SMB collected during this survey exhibited severe infestations of tapeworms and leeches. While the proportion of infected fish was not quantified, the presence of these parasites had not been noted during previous stock assessments. Tapeworms and leeches were particularly noticeable during the May and June surveys, while very few were noticed in August and September. Although we were concerned about the possible effects of these parasites on the health of the SMB population, relative weight values were within the ranges reported during previous New River SMB stock assessments (Hodges 1999, 2004, 2006), suggesting that parasite loads were not high enough to affect the overall health of the fish.

Age structure and growth.—Ages of SMB ranged from 1 to 14, although 94% of fish were ≤ 6 years old (Figure 4). Although only three fish were > 9 years old, they all came from the NFNR, which is similar to the results of the 2005 survey when all SMB > 7 years old came from the NFNR (Hodges 2006). Year-class strength varied considerably among cohorts, with the age structures of all three river segments consisting primarily of 2-, 3-, and 6-year-old fish, with no age-0 and very few 1- and 4-year-old fish being collected (Figure 4). SMB age structures from all three branches of the river were highly similar during this survey, unlike previous surveys in 2003 and 2005 when age structures of SMB in the MNR and SFNR closely resembled each other but were largely dissimilar to the age structure of SMB in the NFNR (Hodges 2004, 2006).

On average, older fish were more prevalent in the New River than in the streams surveyed during the 2007–2009 regional SMB assessment. Within streams surveyed during the regional assessment, 71% of SMB were < 3 years old (Goodfred et al. 2012), while in the New River 73% of SMB were ≥ 3 years old. However, differences in sample sizes and collection methods limit inferences that can be made by comparing SMB age structures from the New River and regional surveys.

For the analysis of the relationship between SFNR flow data and SMB year-class formation, data from the 1999–2013 year-classes were used, with the exception of those year-classes (2006, 2008) whose strength could not be reliably assessed. Although similar trends between SMB year-class strength and river discharge were observed for flows during April–July, June, and July, the relationship between flow and year-class strength was most pronounced using flow data from July. All strong year-classes were formed during years when mean monthly discharge in July was < 300 ft^3/sec, while mean monthly discharge was > 300 ft^3/sec during all but one year (2012) in which weak year-classes were formed (Figure 5).

Based on the record-high flows of 2013 and the lack of age-0 SMB observed during this survey, it is unlikely that the 2013 year-class was very strong. In addition, the 2012 year-class appeared to be weak based on the results of this survey, creating the potential to have poor year-classes formed in consecutive years. On the other hand, if the apparent relationship between year-class formation and July river discharge holds true, good year-classes may have subsequently been formed in 2014 and 2015 since mean flows during July of both years were < 250 ft^3/sec. If strong year-classes were actually formed during 2014 and 2015, they, along with the exceptionally strong 2010 year-class, should help offset the poor year-classes that were likely produced in 2012 and 2013.

On average, SMB in the MNR grew more rapidly than in the SFNR, and SMB in the SFNR grew slightly faster than in the NFNR. The mean length of age-5 SMB was 300 mm in the MNR, 256 mm in the SFNR, and 236 mm in the NFNR (Table 2). L_∞ for MNR SMB was 449 mm, but the L_∞ values for NFNR and SFNR SMB were highly inflated and not representative of the true growth potential of the populations. The hierarchy observed between growth rates of MNR, NFNR, and SFNR SMB parallels the relationships between water temperature data collected from each river segment between June 1 – September 30, 2008, which showed that average temperatures were highest in the MNR (23.0° C), lowest in the NFNR (21.4° C), and intermediate in the SFNR (22.2° C; Commission unpublished data). Given that SMB grow best at temperatures between 20–29° C (Coutant 1975; Coutant and DeAngelis 1983), differences in growth rates between the segments of the New River would appear to be related at least in part to water temperature differences between the segments.

For the most part, growth rates from this survey were more similar to those obtained during the first stock assessment conducted on all three branches of the New River in 2003 than in 2005 when growth rates on all three branches were reduced relative to both the 2003 and 2013 surveys (Hodges 2004, 2006). To compare growth rates of New River SMB against those from the 2007–2009 Commission survey of western North Carolina SMB streams, mean length at age 5 was determined for all streams in the regional study having ≥ two 5-year-old SMB. Mean length of age-5 SMB collected during the regional study was 303 mm (Goodfred et al. 2012), which is nearly identical to mean lengths of 5-year-old SMB in the MNR but considerably greater than those of SMB from the NFNR and SFNR. Streams surveyed during the regional SMB assessment ranged in elevation from 180 to 790 m, with streams at lower elevations generally having faster growth rates than higher elevation streams (Goodfred et al. 2012). Given that most streams surveyed during the regional assessment were lower in elevation than the New River, where the average elevation of sample sites was 760 m, it is not surprising that SMB growth rates in the New River were generally slower than the regional average.

Management Recommendations

1. Conduct additional New River SMB surveys in 2018 to determine the accuracy of year-class strength assessments made in this report and to evaluate any impacts the minimum-size limit increasing from 305 mm to 356 mm in 2012 might have had on population size and age structure.
2. Continue to investigate the relationship between recruitment and river hydrology to gain a better understanding of the factors affecting the population dynamics of the New River SMB population.
3. Monitor the prevalence of tapeworms and leeches in future surveys and research possible causes if their presence persists.
4. The sampling protocol developed during this survey that increased the amount of river that could be electrofished by utilizing upstream launch points and downstream takeout points worked well and should be continued in the future.

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TABLE 1.— Proportional Size Distribution values for quality (PSD)-, preferred (PSD-P)-, and memorable (PSD-M)-sized Smallmouth Bass collected from the mainstem New River, North Fork New River, and South Fork New River by electrofishing, 2013.

Location	PSD	PSD-P	PSD-M
Mainstem New River	23	5	1
North Fork New River	14	3	1
South Fork New River	13	5	2

TABLE 2.— Mean length at age with range, standard error (SE), and sample size (n) for Smallmouth Bass collected from the mainstem New River, North Fork New River, and South Fork New River by electrofishing, 2013. Data are only shown for age-classes represented by > 1 fish.

	Mainstem New River				North Fork New River				South Fork New River			
Age	Mean	Range	SE	n	Mean	Range	SE	n	Mean	Range	SE	n
1	109	86-139	3.3	17	—	—	—	—	87	73-105	6.9	4
2	183	150-272	2.0	80	144	126-168	2.0	24	161	135-196	2.4	31
3	237	196-306	1.8	111	201	165-241	1.6	104	205	172-253	1.9	55
4	281	255-311	7.6	6	—	—	—	—	—	—	—	—
5	300	260-359	11.9	8	236	222-253	2.7	13	256	226-300	6.5	10
6	307	267-345	4.0	24	277	238-377	4.9	32	263	215-305	5.4	22
7	370	282-482	28.7	7	278	255-307	15.3	3	333	300-355	12.9	4
8	379	346-431	12.7	6	328	287-420	19.9	6	351	306-419	34.6	3

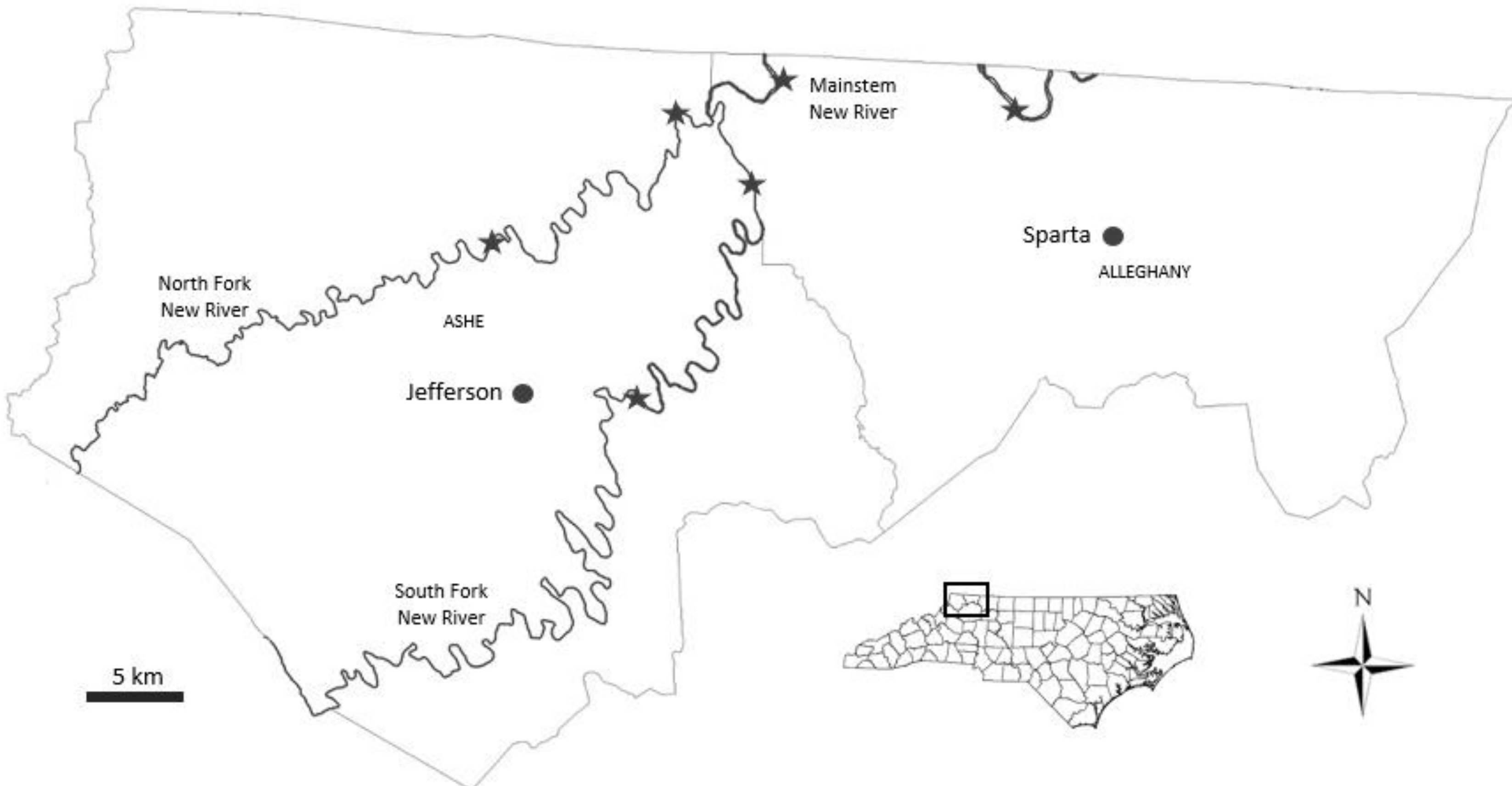

FIGURE 1.— Map of the mainstem New River, North Fork New River, and South Fork New River in Ashe and Alleghany counties showing Smallmouth Bass electrofishing sites (★), 2013.

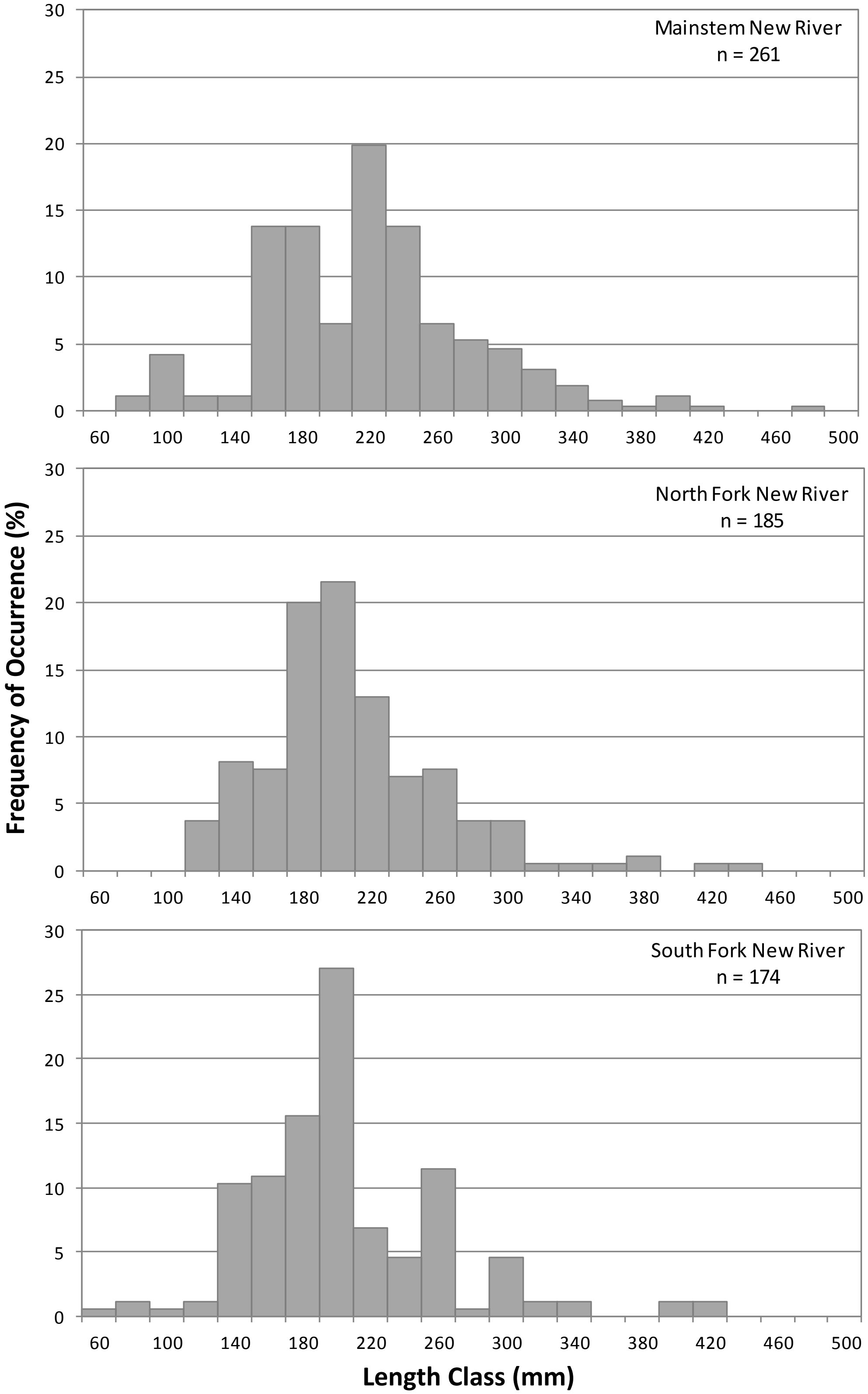

FIGURE 2.—Length-frequency distributions of mainstem New River, North Fork New River, and South Fork New River Smallmouth Bass collected by electrofishing, 2013.

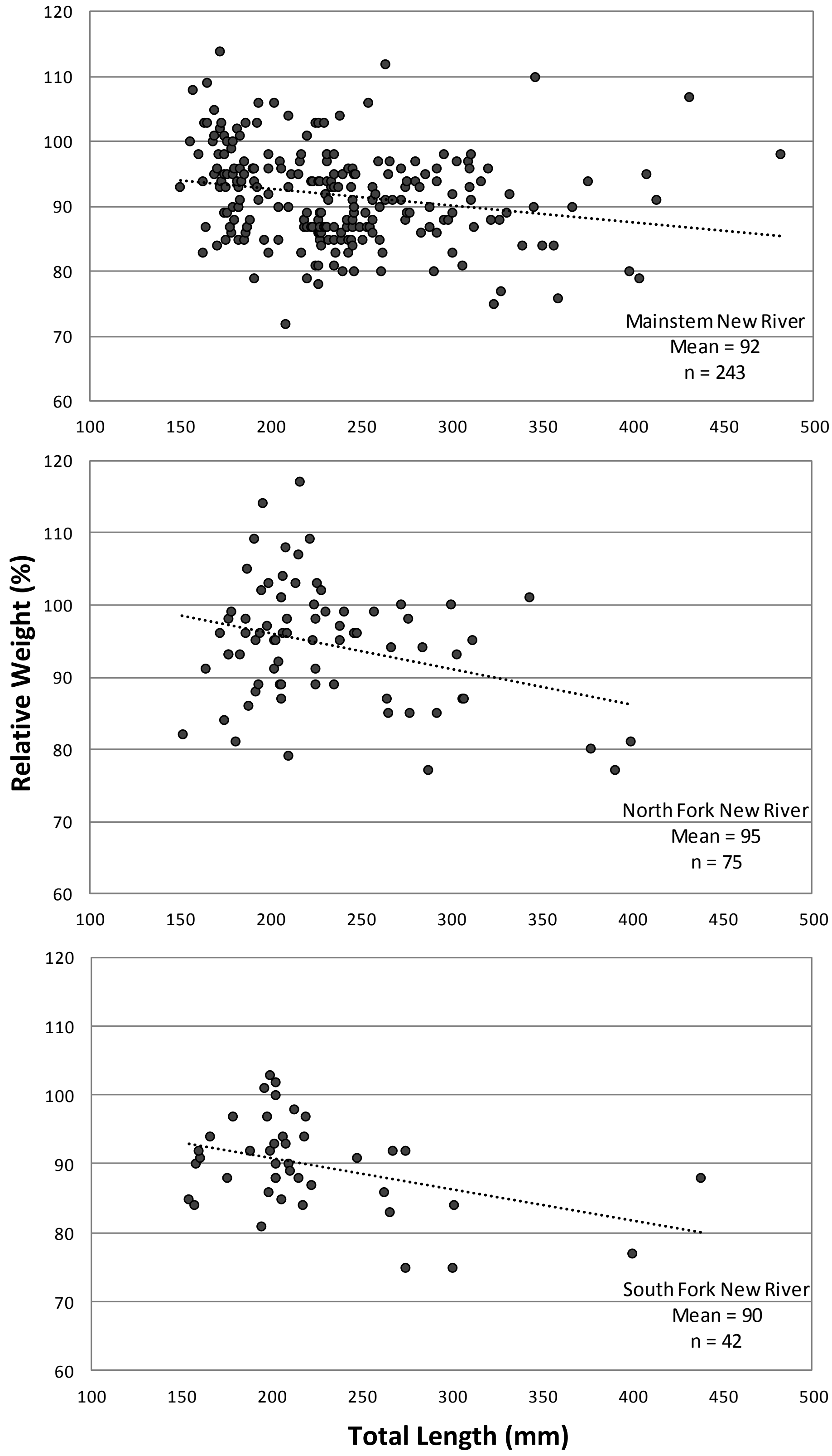

FIGURE 3.—Relative weights of mainstem New River, North Fork New River, and South Fork New River Smallmouth Bass collected by electrofishing, 2013.

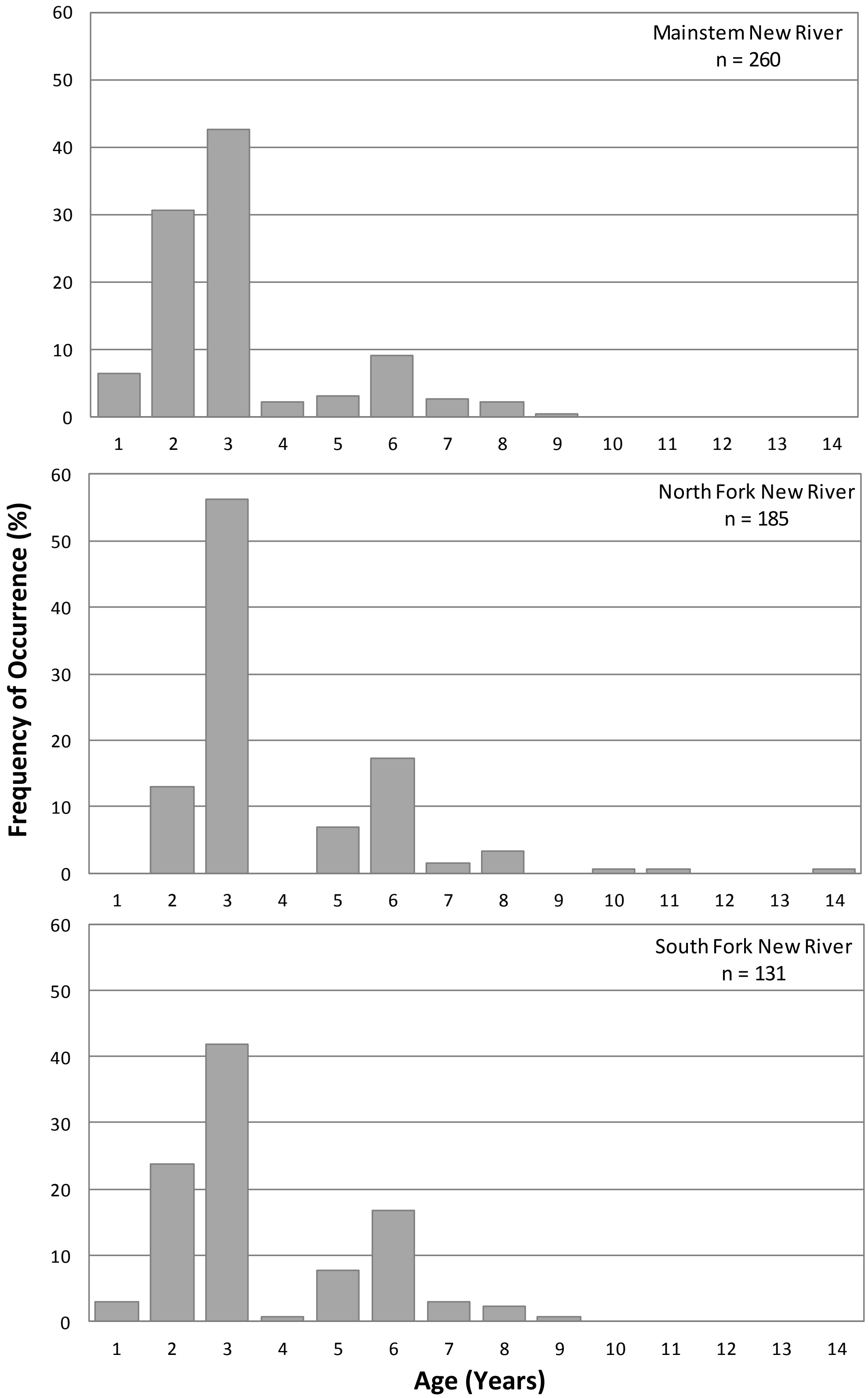

FIGURE 4.— Age-frequency distributions of mainstem New River, North Fork New River, and South Fork New River Smallmouth Bass collected by electrofishing, 2013.

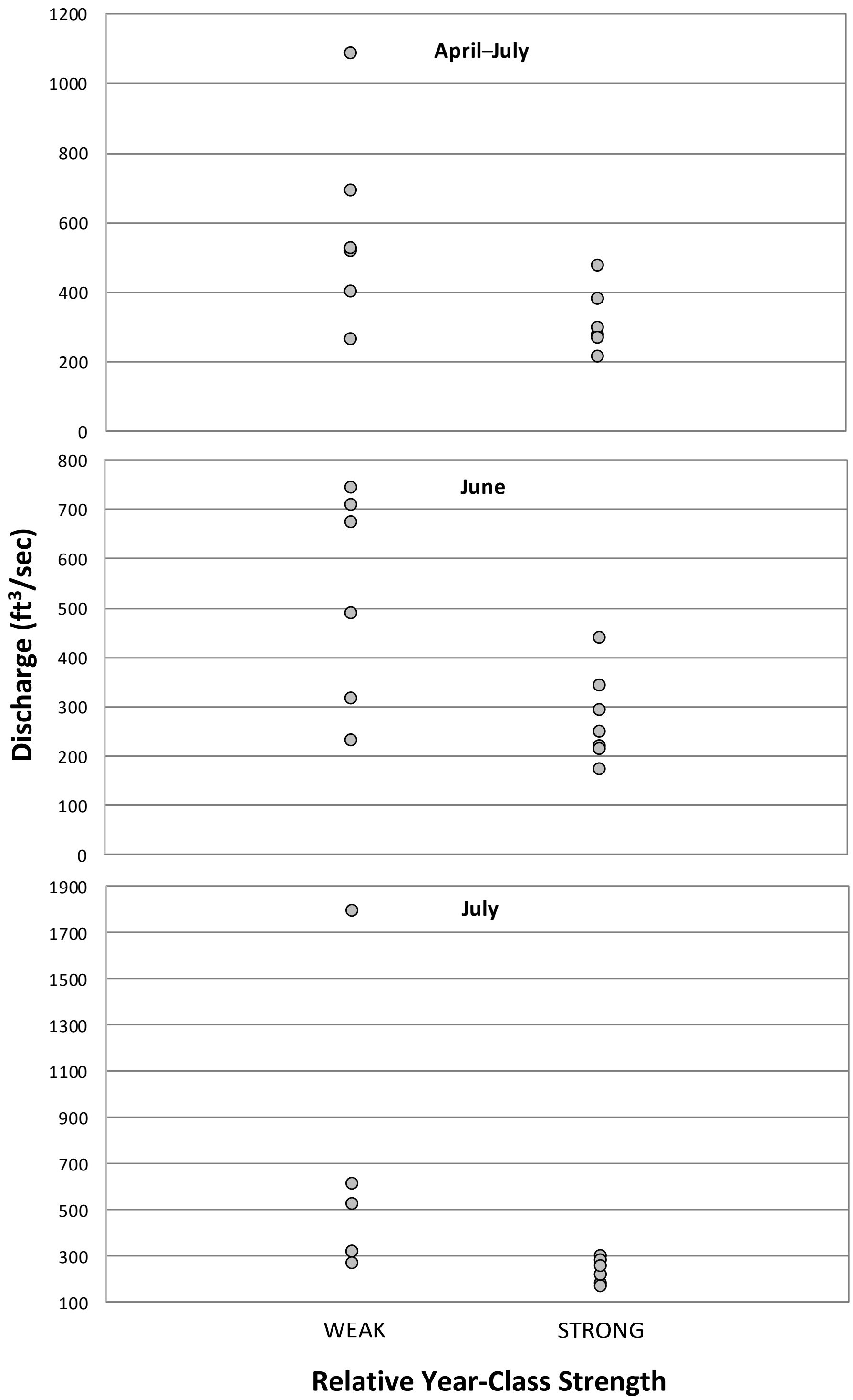

FIGURE 5.—Relationship between mean monthly discharge (April–July, June, July; ft^3/sec) and relative year-class strength of South Fork New River Smallmouth Bass. Study period includes data from 1999–2013, with the exception of 2006 and 2008 when year-class strength could not be determined.