NEW RIVER SMALLMOUTH BASS SURVEY SUMMARY 2003

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SPORT FISH RESTORATION

Abstract.—Boat mounted electrofishing gear was used to sample smallmouth bass *Micropterus dolomieu* in the South Fork New River, North Fork New River, and mainstem New River from June-September 2003. Densities, size structure, age structure, and growth rates were evaluated separately for smallmouth bass collected from each river segment (South Fork, North Fork, mainstem) sampled. Catch rates of smallmouth bass ranged from a high of 90 fish/hour in the North Fork New River, to a low of 51 fish/hour in the South Fork New River. Few quality sized smallmouth bass were collected, with most fish being ≤ 300 mm in length. Most smallmouth bass were between ages 1-6 at all river segments, with no young-of-year fish and very few fish older than age 6 being collected. Growth rates were similar between the South Fork New River and the North Fork New River, with fish reaching 300 mm sometime between ages five and six. Smallmouth bass in the mainstem New River grew slightly faster, reaching 300 mm by age five.

The New River, which originates in Watauga County and flows northward through Ashe and Alleghany Counties, is believed by many to be the oldest river in North America. It is designated as a State Scenic River and is a part of the National Wild and Scenic River System. The New River supports sportfisheries for smallmouth bass *Micropterus dolomieu*, rock bass *Ambloplites rupestris*, redbreast sunfish *Lepomis auritus*, muskellunge *Esox masquinongy*, brown trout *Salmo trutta*, and flathead catfish *Pylodictis olivaris*. The scenic beauty of the river, coupled with the diverse angling opportunities it offers, make it a popular destination for recreational paddlers and anglers alike.

The morphology of the upper New River has historically limited the amount of stock assessment work that the North Carolina Wildlife Resources Commission (NCWRC) 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 possible to collect samples using traditional boat mounted electrofishing gear. Due to the considerable width of the river, backpack mounted electrofishing gear is also ineffective. As a result, the only stock assessments that were performed on the river before the late 1990's consisted of a series of rotenone and electric seine samples that were performed on the North Fork New River and South Fork New River between 1958 and 1962. However, the low numbers of fish collected in these surveys limited the utility of the data they produced (Richardson 1963).

In 1997, an electrofishing boat with a jet drive outboard designed specifically for sampling shallow rivers was acquired by the NCWRC. Between 1997 and 1999, smallmouth bass stock assessments on the South Fork and mainstem New River were performed annually. In summer 1997, pilot data was collected on the mainstem New River in Alleghany County. In spring 1998, five sites on the South Fork New River were sampled, and these same sites were sampled again in summer 1999. Based on these samples, it was determined that smallmouth bass catch-per-unit-effort (CPUE) was highest during the summer, and that although smallmouth bass size distribution varied considerably between surveys, most fish in the system appeared to be less than 300 mm in length (Hodges 2000). Because the goal of these initial surveys was to identify the optimal time of year for sampling and to refine sampling protocol, no age data was collected. Additionally, no sites on the North Fork New River were sampled.

The objectives of this survey were to 1) collect additional data on size distribution, abundance, and body condition from the South Fork and mainstem New River, 2) collect baseline data on size distribution, abundance, and body condition from the North Fork New River, 3) to obtain initial estimates of age structure and growth rates from all locations, and 4) to attempt to explain the variability in smallmouth bass year class production by comparing estimates of smallmouth bass recruitment with streamflows.

Methods

Fish were collected from eight sites along the New River in Ashe and Alleghany Counties between June 26-September 26, 2003 (Figure 1). The duration of the sampling period was protracted due to the persistent high flows and poor water clarities that typified river conditions in summer 2003. A boat mounted pulsed direct current electrofishing unit equipped with a jet drive outboard was used to collect fish from four sites on the South Fork New River, three sites on the North Fork New River, and one site on the mainstem New River. Sample sites were restricted to areas of the river having sufficient depths for boat navigation and areas along the shore from which we could launch the boat.

All smallmouth bass were collected at each site and measured for total length (mm) and weight (g). For each river segment (South Fork New River, North Fork New River, mainstem New River), catch-per-unit effort (CPUE) was determined, length distribution histograms were constructed, and stock indices (PSD, RSD-P, RSD-M, RSD-T) and relative weights were calculated. The lengths for stock, quality, preferred, memorable, and trophy sized smallmouth bass used in determining stock index values were those proposed by Gabelhouse (1984). Relative weights were computed using the equations of Kolander et al. (1993).

Sagittal otoliths were removed from all smallmouth bass collected in the South Fork and North Fork New River. In the site on the mainstem, otoliths were only removed from a randomly selected subsample of smallmouth bass. Otoliths were prepared for reading by breaking them in half perpendicular to their longest axis and polishing the broken end using 220 grit sandpaper. 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 by two readers. Discrepancies in annuli counts between readers were rectified at a joint reading.

Age distribution histograms were constructed and mean length-at-age at time of capture was determined for all year classes represented by more than one fish. Additionally, annual survival (S) estimates were made with the Jackson estimate, using age classes represented in the descending portion of the catch curve (Everhart and Youngs 1981). Annual mortality (A) was then calculated using the equation:

$$A = 1 - S$$

All age and growth parameters were figured independently for fish collected from the North Fork, South Fork, and mainstem New River.

The reported age of the fish in this survey is not always equal to the number of annuli that were present on otoliths. Previous work in Illinois has shown that annulus formation in smallmouth bass occurs between April and May (Heidinger and Clodfelter

1987). In this survey, annuli were still in the process of forming during the survey period of June-September. For most fish collected in June and July, the 2003 annulus had not yet begun to form and there was significant growth between the last annulus and the otolith radius. In these cases, fish were assigned an age equal to the number of annuli plus one since annulus formation was imminent. For fish collected in August and September, annulus formation had usually either begun or been completed, so fish age was considered to be equal to the number of annuli present on the otolith. This approach was chosen so that all fish from a given year class would be given the same age. Otherwise, fish from the same year class would be considered one year younger in the June-July samples than they would be in the August-September samples. An additional difficulty associated with the varying state of annulus formation observed on the otoliths is that it was not possible to back calculate length-at-age to standardize length-at-age estimates. This would have been beneficial in this study given that fish from the September samples had three additional months of growth relative to the fish collected from the late June samples. For all fish aged in this survey, it was assumed that length-at-age at time of capture was approximately equal to true length-at-age since the survey coincided with the period of annulus formation.

To assess the relationship between streamflow and smallmouth bass recruitment, the strength of recent year classes from the South Fork New River was compared qualitatively against streamflows. Coarse estimates of the strength of the 1996-2003 year classes were made using age structure data collected in 2003 and estimates of the strength of earlier year classes obtained by analyzing length-frequency histograms from the 1997-99 samples conducted on the South Fork New River. Flow information was obtained from a gauging station on the South Fork New River that has been operated by the U.S. Geological Survey since 1924. No gauging stations are in operation on the North Fork New River or on the North Carolina portion of the mainstem New River.

Results and Discussion

Abundance

We collected 149 smallmouth bass from the South Fork, 129 smallmouth bass from the North Fork, and 61 smallmouth bass from the mainstem New River. Catch per unit effort was 51, 90, and 71 fish per hour in the South Fork, North Fork, and mainstem New River, respectively. Smallmouth bass abundance in the South Fork, although considerably lower than that in the North Fork and mainstem, was similar to that observed in our 1999 survey of the South Fork (Hodges 2000). Overall, densities of smallmouth bass appear to be comparable to those found in the New River in Virginia. In 2000, CPUE averaged 58 fish per hour across seven sites located between the North Carolina/Virginia border and Claytor Lake (VDGIF 2000).

Size Structure

Smallmouth bass ranged in length from 77 to 476 mm, with most fish being less than 300 mm in total length (Figures 2-4). Stock indices reflected the lack of quality fish in the river, with PSD values being 14, 10, and 25 for the South Fork, North Fork, and mainstem New River, respectively (Table 1). Stock indices from the South Fork were generally similar to those obtained in the 1999 survey, when the river was also sampled during the summer (PSD = 17; Hodges 2000).

However, stock indices for all sites within the New River appear to be somewhat low in comparison with other smallmouth bass populations in the region. Average PSD values from a recent statewide survey of smallmouth bass streams in Tennessee were 34 (Fiss et al. 2001), with indices for preferred, memorable, and trophy sized fish also being higher than values observed in the New River (Table 1). Similarly, PSD values averaged 33 (VDGIF 2003) across all smallmouth bass rivers sampled in Virginia (Table 1).

In addition to there being low numbers of fish greater than 300 mm, few fish < 140 mm were collected, especially in the South Fork and mainstem New River. Conversely, more than half of the fish collected from the South Fork New River in 1999 were ≤ 140 mm, suggesting that recruitment was higher for the period preceding the 1999 survey than it was prior to this survey (Hodges 2000). More smallmouth bass ≤ 140 mm were collected from the North Fork than from the South Fork or mainstem New River. It is not clear if fish of this size were actually more abundant in the North Fork New River, or if they were simply more susceptible to the gear because of the timing of our samples. Most sites in the South Fork and mainstem New River were sampled in June and July, while the North Fork New River was sampled in September. It is possible that during this period fish in the North Fork New River added enough additional size to become better recruited to the gear.

Smallmouth bass in the New River are managed with a 305-mm minimum size limit, with two fish being allowed of any size. The lack of fish greater than 300 mm in length suggests that fish may be getting harvested as soon as they reach harvestable size. Previous work on the New River in Virginia and West Virginia suggested that a 305-mm length limit was ineffective at increasing the number of larger smallmouth bass, presumably due to slow growth rates, illegal harvest of sub-legal fish, and high harvest of fish as soon as they reached 305 mm (Austen and Orth 1988). In the Virginia portion of the Shenandoah River, a 305-mm minimum size limit failed to increase the harvest of smallmouth bass greater than 305 mm and also resulted in a decline in the number of fish > 382-mm (Kauffman 1983). Conversely, implementation of a 305-mm minimum length limit on the Maquoketa River in Iowa resulted in improvements to the fishery (Paragamian 1984).

It is not clear what impact the 305-mm minimum length limit is having on the New River smallmouth bass population. We conducted a creel survey of the South Fork New River, along with a one-mile stretch of the mainstem New River, in 1998 and 1999. Although final analyses has yet to be completed, preliminary results documented low levels of usage by anglers, with harvest of smallmouth bass appearing to be insignificant (NCWRC unpublished data). Further analyses of the results of this creel, particularly the harvest directed at larger size classes of larger fish, should help determine the effectiveness of the current size limit.

Condition

Relative weights for smallmouth bass from the South Fork, North Fork, and mainstem New River averaged 86, 89, and 86, respectively (Figures 5-7). In all locations, body condition appeared to decline with increasing fish length. In the 1999 survey of the South Fork, smallmouth bass relative weight averaged 89, with the same relationship of decreasing condition in relation to increasing fish length being observed (Hodges 2000). Relative weights observed in this survey were similar to those observed in surveys of smallmouth bass streams in Virginia in 2003. Average relative weights of smallmouth bass collected from the James, Middle Fork Holston, New, Powell, and Staunton Rivers were 85-90, with smallmouth bass < 300 mm having higher relative weights than larger fish (VDGIF 2003).

Growth

Growth rates were similar between smallmouth bass in the South Fork and North Fork New River, with age-5 fish averaging 270 and 276 mm, respectively (Table 2). Growth rates of smallmouth bass from the site on the mainstem New River were slightly higher than in either the South Fork or North Fork New River, with age-5 fish averaging 300 mm (Table 2). However, only one site was sampled on the mainstem New River, with 33 fish being aged. New River smallmouth bass growth appears to be comparable to riverine smallmouth bass populations in adjacent states. In Tennessee, the statewide average for smallmouth bass length at age-5 was 300 mm (Fiss et al. 2001). In Virginia, the average 5 year old smallmouth bass in the New River upstream of Claytor Lake was 324 mm (VDGIF 2003). Growth rates of smallmouth bass from the New River appear to vary considerably among cohorts, as growth increments between older age classes were often larger than growth increments between younger age classes (Table 2).

Age Structure

Age structure in the South Fork (Figure 8) and mainstem New River (Figure 9) was very similar, with most fish being ages 1 through 6. In both locations, ages 3 and 4 were the most abundant age classes. In the North Fork New River, although most fish were still age 1 through 6, ages 1 and 4 were the most abundant age classes (Figure 10).

We failed to collect any age-0 fish at any of the sites sampled during this survey. Given that we collected high numbers of fish between 40-80 mm in the July/August 1999 survey using the same gear, age-0 fish should have been at least partially susceptible to the gear during this survey. Although age-0 fish may not have been fully recruited to the gear during this survey, the fact that we did not collect any indicates that spawning success was extremely poor in spring 2003.

Few fish from the 2002 year class were collected in either the South Fork New River or the mainstem New River sites, while they made up nearly 30% of the catch from the North Fork New River. Based on age structure data collected from the New River above Claytor Lake in Virginia, age-1 smallmouth bass do not appear to be fully recruited to electrofishing gear (VDGIF 2003). The North Fork was sampled in September, while all but one site of the South Fork and mainstem New River were sampled between late June and late July. As such, age-1 fish from the North Fork had several extra months to grow and could have been more susceptible to our gear than age-1 fish from the South Fork or mainstem New River. This could make it appear as if a stronger age class had been formed in the North Fork New River. Age data collected in future surveys will help determine what differences, if any, exist in the strength of this age class between the North Fork New River and the South Fork and mainstem New River.

Very few fish older than age 6 were collected during the survey. Smallmouth bass collected from the New River in Virginia between the North Carolina/Virginia border and Claytor Lake ranged in age from 1 to 13 years old, with approximately 9% of the fish being older than six (VDGIF 2003). In contrast, within the South Fork, North Fork, and mainstem New River in North Carolina, only 1.5, 1.6, and 0 % of the smallmouth bass collected were older than age 6. The low abundance of fish ages 6 and older in the North Carolina portion of the New River could be related to high annual mortality rates, periods of poor recruitment in the past, or to a lack of habitat suitable for supporting considerable numbers of older, larger fish. Age data was not collected during our 1997-1999 surveys. Age structure data from these earlier surveys would have provided valuable information on the relative strength of the year classes formed in 1995-1997, which comprise the 6, 7, and 8-year old fish collected during the 2003 survey.

However, it is still possible to make inferences about the strength of certain age classes present in these surveys. Given that there is little overlap between the size ranges of smallmouth bass less than age three (Table 2), it is possible to infer the relative strength of these year classes by analyzing the length-frequency histograms obtained between 1997-1999 (Hodges 2000). This analysis suggests that poor year classes were formed in 1995-1997, which explains in part the low abundance of older fish in this survey (Figure 11). Conversely, analysis of the 1999 length-frequency data suggests that strong year classes were formed in 1998 and 1999. This is confirmed by the age structure data obtained in the 2003 survey in which the 1998 (age five) and 1999 (age four) year classes make up 37% of the fish collected.

Comparing the growth rates with the current age structure of New River smallmouth bass largely explains the lack of fish > 300 mm collected in this sample. On average, smallmouth bass in the New River do not attain a length of 300 mm until age 6, and few fish older than age 6 were collected.

Mortality

No survival or mortality estimates could be generated for the North Fork due to the lack of fish in the descending portion of the catch curve. Within the South Fork and mainstem New River, abundance of age-3 fish was greater than all other age classes and abundance declined steadily through age 6. To maximize the number of age classes that could be used in determining survival, it was assumed that 3-year old fish were fully recruited to the gear. Annual survival was estimated at 56% in the South Fork and 61% in the mainstem New River. Accordingly, annual mortality estimates were 44% and 39% in the South Fork and mainstem New River, respectively. These values are within the ranges reported in Tennessee, where mortality rates averaged 38% in 12 riverine smallmouth bass populations sampled during a recent survey (Fiss et al. 2001). Similar mortality rates were reported in Virginia, where annual mortality rates averaged 42% across 12 smallmouth bass rivers sampled in 2003 (VDGIF 2003).

However, since the method used to determine mortality in this study assumes constant recruitment, it would have to be assumed that recruitment for the portion of the catch curve (ages 3-6) used in the calculations was constant. Given that it is unlikely that recruitment was constant for four consecutive years, this mortality estimate is speculative at best, and future surveys should attempt to produce more accurate mortality estimates. The New River will be sampled again in 2005 to gain a better understanding of survival and mortality rates by tracking the relative abundance of the cohorts that were well represented at the time of this survey.

Flow Relationships

Previous work has shown that smallmouth bass year class production is strongly linked to hydrologic conditions during the spawning season and early life stages of river dwelling smallmouth bass. Poor year classes of river dwelling smallmouth bass tend to be formed when rainfall (Buynak and Mitchell 2002) or stream discharge (Lukas and Orth 1995; Slipke et al. 1998) are above average between April and July.

Recent studies in Virginia have demonstrated that smallmouth bass recruitment is strongly tied to mean streamflow during the month of June when smallmouth fry are most vulnerable (Smith et al., in press). Year class strength, measured as CPUE of age-0 smallmouth bass collected in fall electrofishing samples, appears to be strongest in years when June streamflows are near their historical average. Weak year classes are formed when streamflows are either significantly higher or lower than their historical means.

Although there is insufficient data to make precise estimates of year class strength for recent year classes of New River smallmouth bass, it is still possible to make a cursory comparison of year class production in the South Fork New River with recent stream flows. Analysis of the length distributions from 1997-1999 suggests that recruitment was weaker in 1996 and 1997 than in 1998 or 1999 (Figure 11). Analysis of the age distribution derived from the current survey confirms that good year classes were produced in 1998 and 1999, and also indicates that recruitment was good in 2000. Weaker year classes appear to have been produced in 2001 and 2003. Because the 2002 year class was not fully recruited to the gear at the time of the 2003 survey, it is not possible to estimate its strength with the available data.

Comparisons of the strength of various year classes against stream discharge do not produce a conclusive link between streamflow and recruitment (Table 3). In the South Fork New River, the historical mean flow for the month of June between 1924 and 2003 was 389 ft^3/sec, and the average combined mean discharge for April-July over the same period was 1717 ft^3/sec (USGS 2004). In certain years where poor year classes appear to have been formed, streamflow parameters are nearly identical to years where strong year classes were formed. However, it should be noted that the accuracy of our year class strength estimates is unknown. The aforementioned studies that were able to demonstrate strong correlations between smallmouth bass recruitment and stream flows had access to more comprehensive age data than is available on the New River. Future surveys should continue to gather age data so that factors affecting recruitment in the North Carolina portion of the New River can be better understood.

Recommendations

1. Collect smallmouth bass from the same eight sites sampled in this survey during summer 2005 to monitor survival of the strong year classes documented in this survey.

2. Complete analysis of the 1998-99 creel survey to assess the impact of harvest on the New River smallmouth bass population. Particular emphasis should be given to the proportion of the total harvest that is focused on larger (> 300 mm) size classes of smallmouth bass.

3. Back-calculate lengths at previous ages for smallmouth bass collected in 2005 to better describe variability in growth rates between year classes.

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TABLE 1.— Stock index values for the New River (2003) and statewide averages from Virginia (2003) and Tennessee (2001).

	PSD	RSD-P	RSD-M	RSD-T
South Fork	14	2	2	0
North Fork	10	5	0	0
Mainstem	25	7	2	0
VA statewide average (2003)	33	16	5	*
TN statewide average (1995-2000)	34	13	3	<1

* RSD-T values not reported

TABLE 2.— Mean length-at-age, with range and standard error (SE), for smallmouth bass collected from the South Fork, North Fork, and mainstem New River, 2003.

	South Fork			North Fork			Mainstem		
Age	Mean	Range	SE	Mean	Range	SE	Mean	Range	SE
1	106	86-130	3.42	115	85-151	2.62			
2	149	133-176	3.04	161	138-177	7.78	180	176-184	1.65
3	202	177-246	2.07	207	182-270	4.55	216	180-237	5.47
4	236	194-291	4.11	228	197-286	2.12	256	235-289	5.94
5	270	222-300	6.26	276	236-363	12.27	300	282-322	6.52
6	324	295-345	11.5	323	308-350	13.38	353	332-375	21.5

TABLE 3.— Estimates of smallmouth bass year class strength, sum of mean flow for April-July, and mean flow in June for the South Fork New River, 1995-2003.

Year	Apparent Recruitment	April-July Flow (ft^3/sec)	June Flow (ft^3/sec)
1996	Weak	1683	487
1997	Weak	1785	506
1998	Strong	2479	505
1999	Strong	1097	216
2000	Strong	1187	211
2001	Weak	1061	230
2002	Not yet determined	848	172
2003	Weak	2760	743

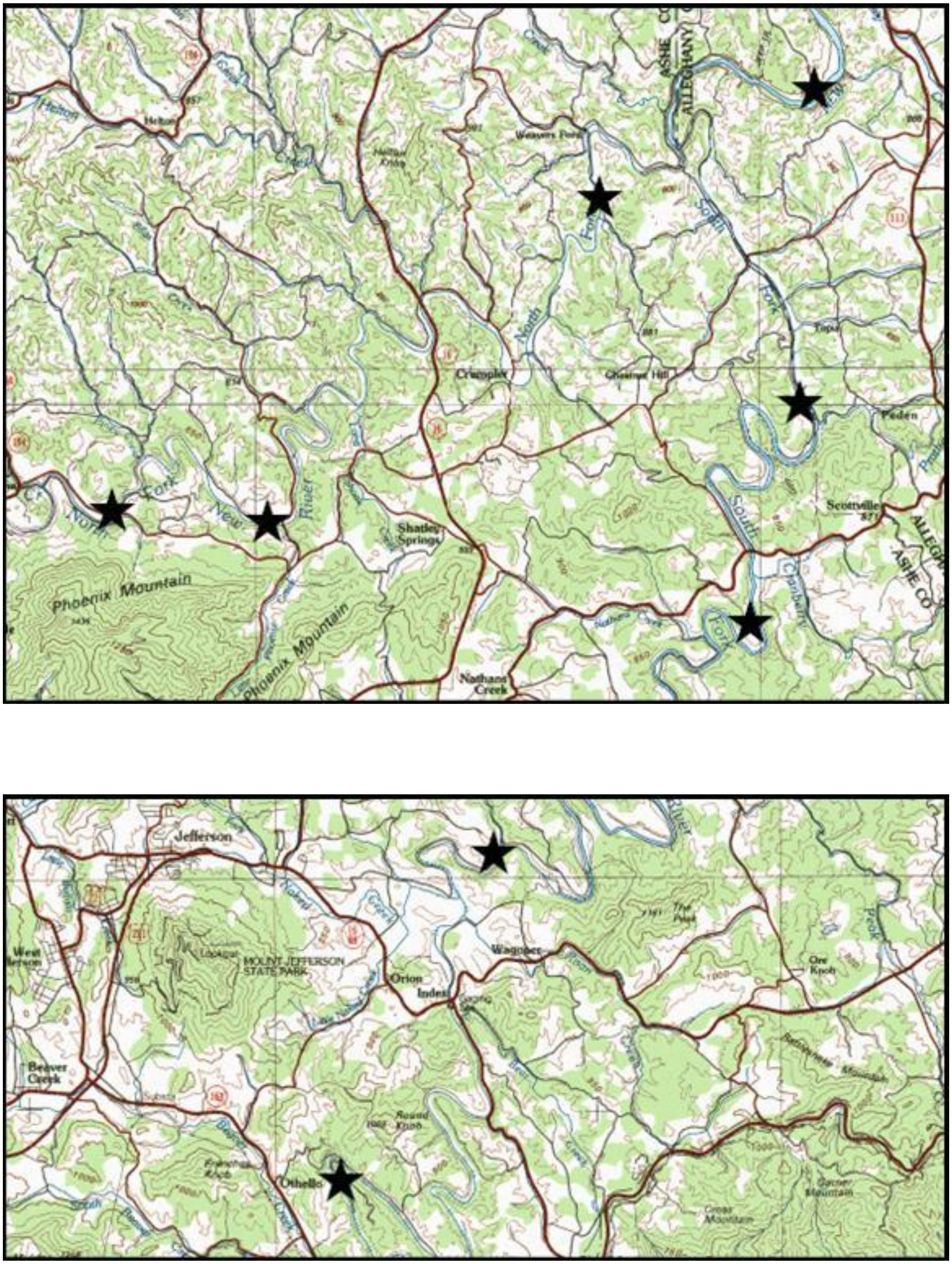

FIGURE 1.— Maps showing sample sites for the 2003 smallmouth bass survey on the South Fork New River, North Fork New River, and mainstem New River.

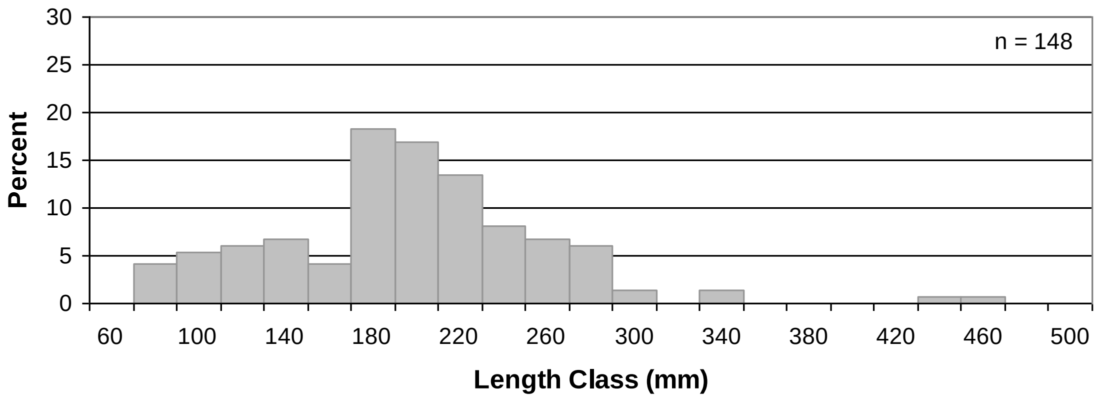

FIGURE 2.— Length distribution of South Fork New River smallmouth bass, 2003.

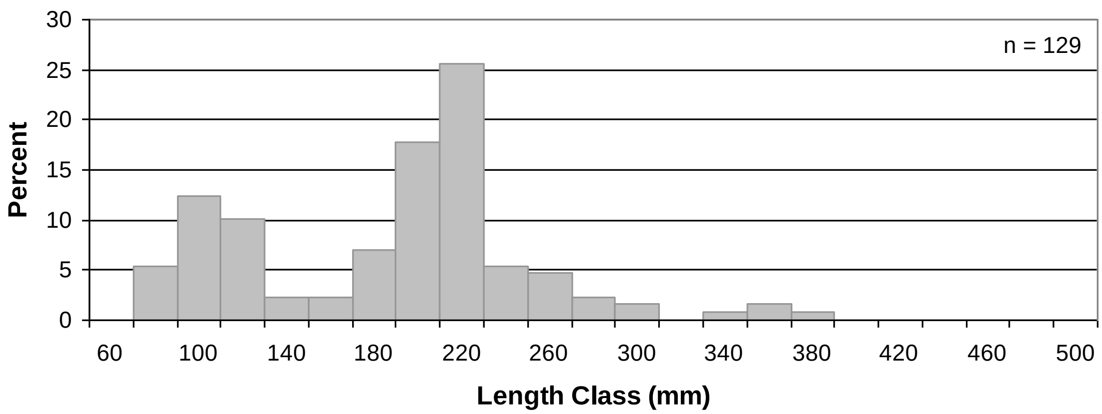

FIGURE 3.— Length distribution of North Fork New River smallmouth bass, 2003.

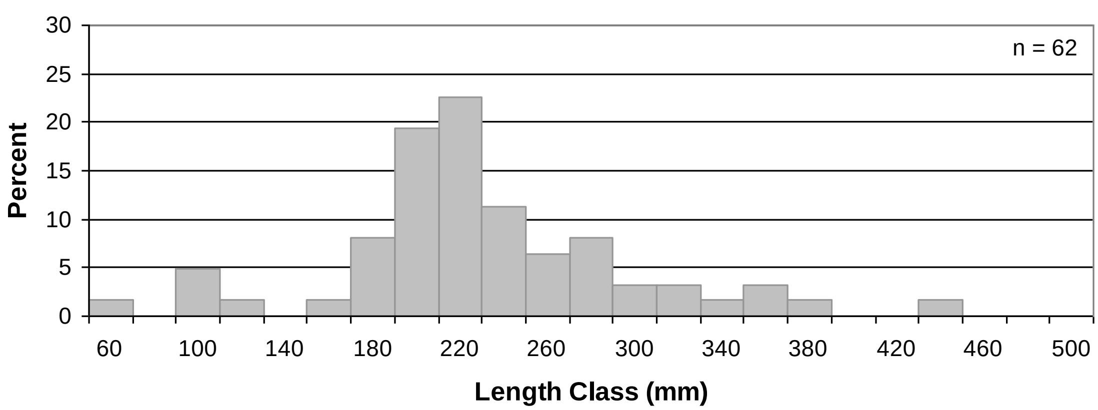

FIGURE 4.— Length distribution of mainstem New River smallmouth bass, 2003.

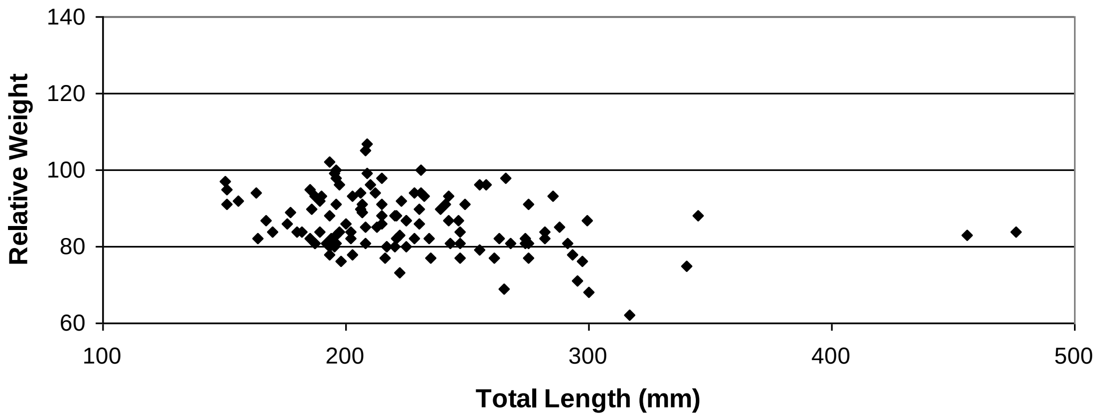

FIGURE 5.— Relative weights of South Fork New River smallmouth bass, 2003.

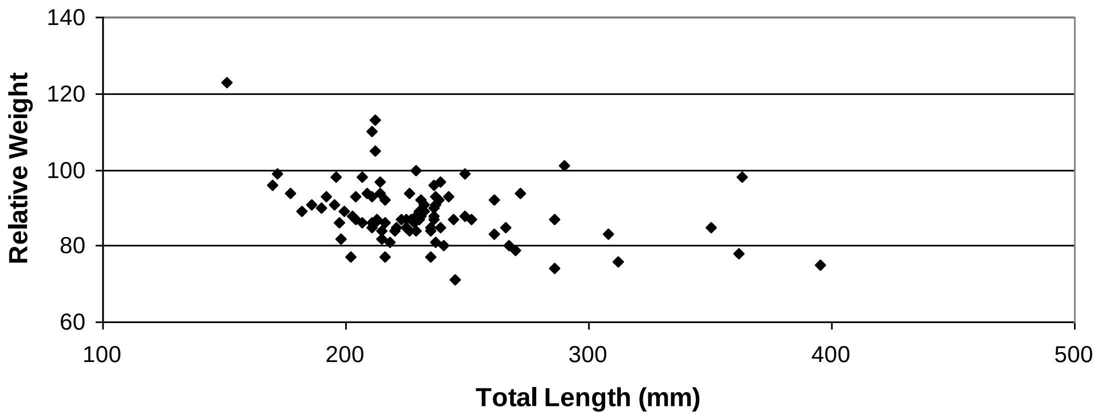

FIGURE 6.— Relative weights of North Fork New River smallmouth bass, 2003.

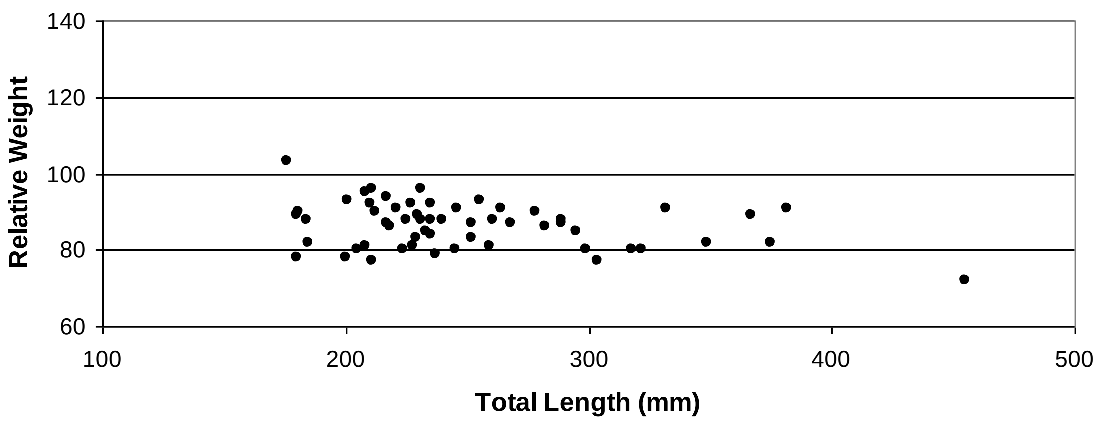

FIGURE 7.— Relative weights of mainstem New River smallmouth bass, 2003.

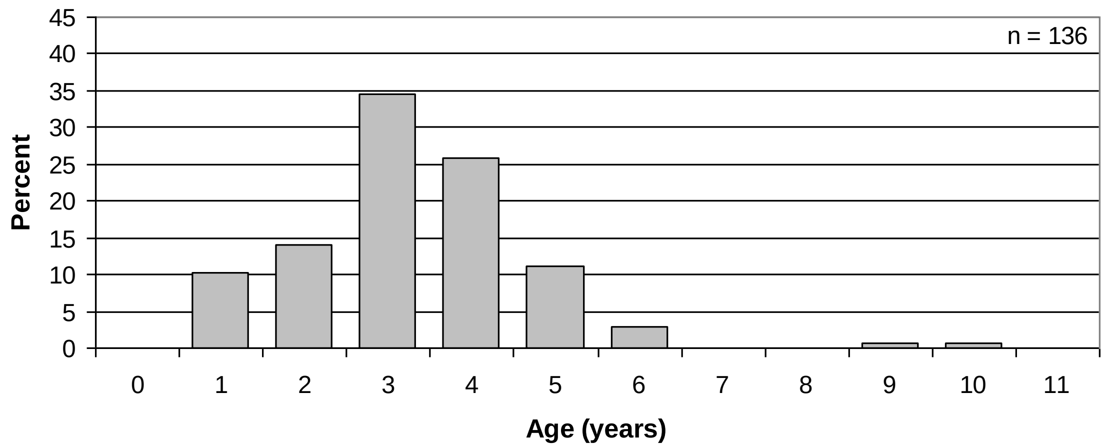

FIGURE 8.— Age distribution of South Fork New River smallmouth bass, 2003.

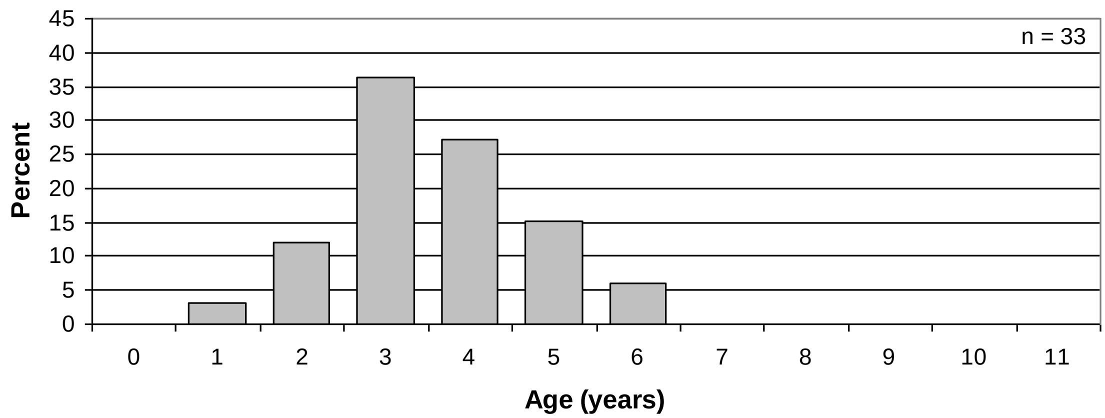

FIGURE 9.— Age distribution of mainstem New River smallmouth bass, 2003.

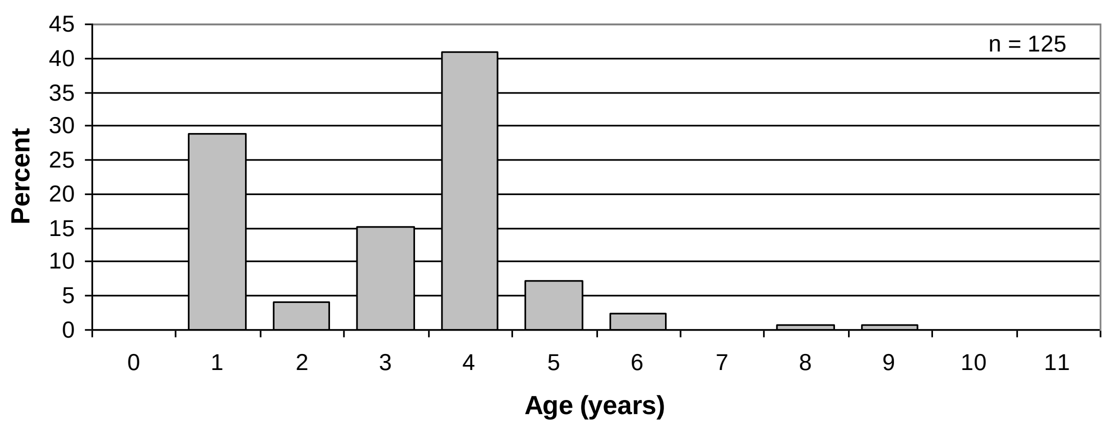

FIGURE 10.— Age distribution of North Fork New River smallmouth bass, 2003.

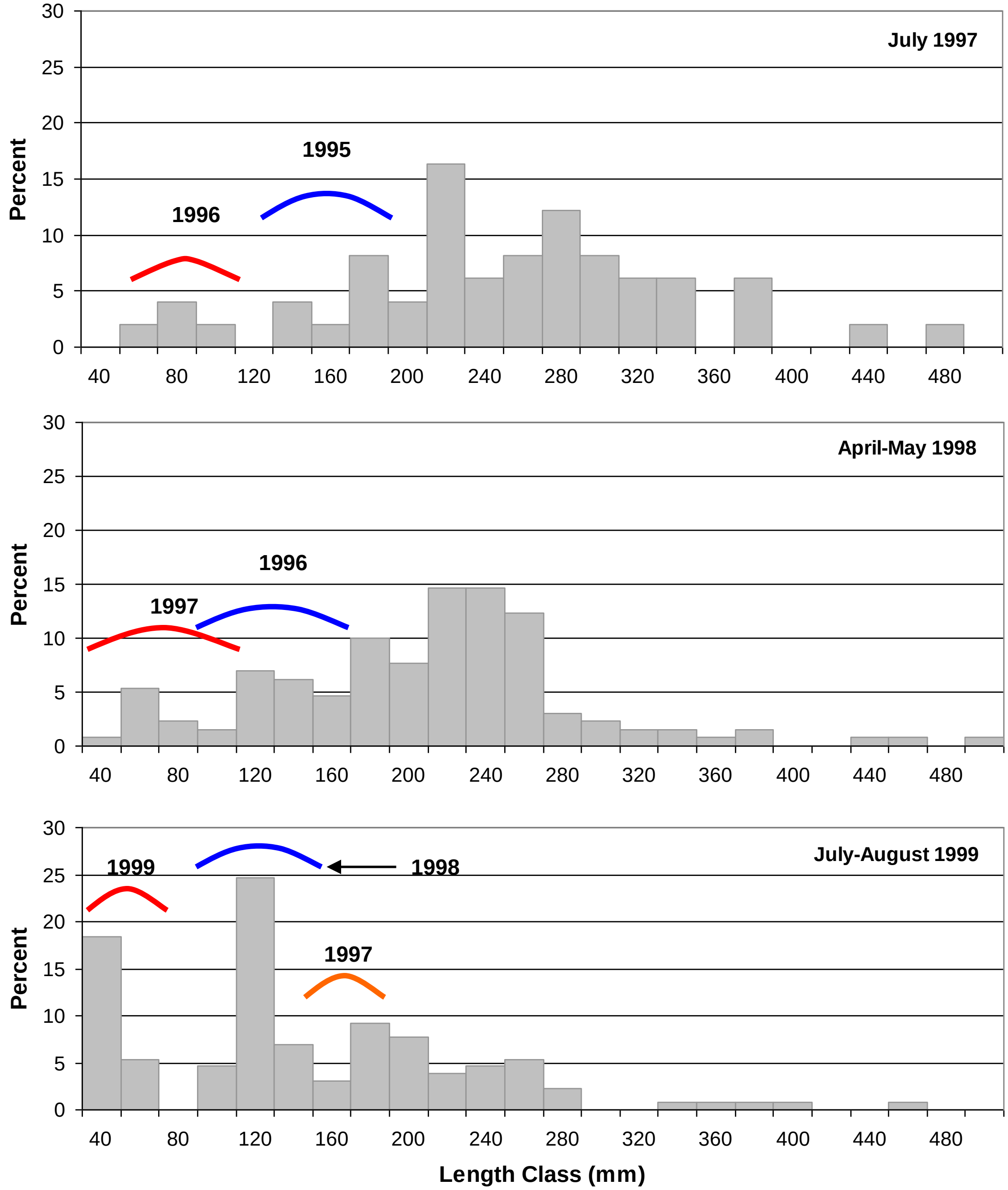

FIGURE 11.— Length-frequency estimates of year class strength for smallmouth bass collected from the South Fork and mainstem New River, 1997-1999.