RIVERINE SMALLMOUTH BASS SURVEYS

Interim Report

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Abstract.—Rivers and streams containing viable smallmouth bass *Micropterus dolomieu* populations provide important fishery resources. However, little is known regarding riverine smallmouth bass population dynamics in North Carolina. Consequently, during 2007 North Carolina Wildlife Resources Commission (NCWRC) began a three-year study to obtain riverine smallmouth bass data in western North Carolina. Study objectives were to identify smallmouth bass populations, collect life history information, and evaluate management opportunities. When feasible, backpack or boat mounted electrofishing gear was used to obtain samples. Where access or physical habitat impaired electrofishing sampling efficiency, fish were collected by angling. During summer 2007 and 2008, NCWRC personnel collected 1058 and 1066 smallmouth bass, respectively. Thirty-one different populations were sampled, of which 16 were sampled both years. Total length and weight were recorded, and otoliths were removed from all captured smallmouth bass. Smallmouth bass overall two-year mean PSD, PSD-P, and PSD-M values were 27, 8, and 1 respectively. Mean relative weight (+SE) of each population ranged from 79±2 to 105±2. Generally, relative weight declined as total length increased. Currently, age and growth information is being analyzed; however, preliminary data suggested growth rates varied considerably among populations. Additional surveys are planned for summer 2009, with final report completion by April 2011.

Western North Carolina smallmouth bass *Micropterus dolomieu* streams provide an important recreational fishery resource (Finke and Van Horn 1993); however, little is known regarding the extent of fishable smallmouth bass populations, the variability in growth and mortality characteristics of these populations, or their resilience to increasing fishing pressure. It is often difficult for fisheries managers to collect adequate information for every managed fish population (Beamesderfer and North 1995), especially when trying to evaluate riverine fish populations that are often difficult to sample with traditional sampling techniques.

Historical information on riverine smallmouth bass populations in western North Carolina is limited. Initial efforts to assess smallmouth bass populations in northwestern North Carolina were conducted in the late 1970s (Mickey 1980) and led to subsequent stocking of smallmouth bass fingerlings to establish and augment smallmouth bass populations throughout the district. However, evaluation of stocked streams found little evidence of success (Mickey 1985). Most recent information on smallmouth bass in North Carolina results from collections in the New River, where sampling efforts have occurred since 1997 (Hodges 1999, 2004, 2006), and an assessment of smallmouth bass stocking efforts in the Bridgewater tailrace of Catawba River. In the Catawba River, fingerling stockings ceased after subsequent monitoring revealed poor growth and low abundance of the stocked smallmouth bass (Goudreau 1998; Besler 2003).

Recently, the Tennessee Wildlife Resources Agency sought to compile information on Tennessee's riverine smallmouth bass to guide future management actions (Fiss et al. 2001). Information collected during their study led to the formation of a comprehensive smallmouth bass management plan that outlines the agency's goal of maintaining and improving smallmouth bass fisheries (Fiss and Churchill 2003). The current North Carolina Wildlife Resources Commission (NCWRC) black bass management plan (NCWRC 1993) lacks a substantial smallmouth bass component due to the lack of available smallmouth bass information, and comprehensive smallmouth bass population data are needed to develop specific management goals.

Smallmouth bass anglers will benefit directly from a regional survey of riverine populations. Information on length and age distributions and growth and mortality rates from a range of smallmouth bass populations will allow evaluation of the potential of coolwater stream systems to support recreational smallmouth bass fisheries, and help to predict the resilience of riverine smallmouth fisheries to increasing fishing pressure. Fishing access improvements and improved communication among smallmouth bass anglers continue to introduce more people to western North Carolina smallmouth bass streams. Recent angler requests for more restrictive harvest regulations indicate interest in more diverse smallmouth bass fishing opportunities. Smallmouth bass population information collected during this study will also help evaluate harvest regulations and direct fishery development activities.

The objectives of this three-year study are (1) to develop descriptive characteristics of smallmouth bass populations in selected streams in western North Carolina, and (2) to determine if riverine smallmouth bass populations can be grouped into different classes for purposes of harvest regulation or other management activities. This interim report summarizes the first two years of smallmouth bass collections, evaluates the success of collection techniques, and establishes specific needs for the third year of data collection and subsequent data analyses.

Methods

Study Areas and Smallmouth Bass Collections

During May–October 2007 and 2008, smallmouth bass were collected from 31 stream reaches in seven river basins representing a variety of stream orders in NCWRC Districts 7, 8, and 9 (Figure 1). Stream elevation varied between 180 m to 790 m above mean sea level, and widths ranged from 10 m to 200 m. Each river or stream was sampled at multiple representative habitat sites. Sample sites were distributed as evenly as possible throughout the entire stream reach where smallmouth bass occurred, but depended heavily on available access points. Three water bodies, the Yadkin River, Broad River, and French Broad River, were split into upper and lower reaches because of a dam or habitat differences among sections.

Fish were collected qualitatively using multiple sampling gears, including boat, cataraft, and backpack electrofishing equipment, angling, and seines, with an objective of collecting 50 to 100 fish per water body; due to the variety of sampling gears used, catch per unit effort was not quantified. District 9 water bodies were predominately mainstem rivers in the greater Tennessee Valley, characterized by shallow riffles and deep pools that were not conducive to backpack or boat electrofishing. Therefore, the majority of samples were taken by angling, and where possible, samples were supplemented with backpack electrofishing and seining. Water bodies in the Atlantic Slope region of Districts 7 and 8 were more accessible to backpack and boat electrofishing although angling was still predominant, especially in 2008. Total length (TL, mm) and weight (g) were recorded for each fish, and sagittal otoliths were removed and stored in plastic vials for age determination.

Data Analysis

Length distribution histograms were constructed and stock indices were calculated for streams where sufficient numbers ($\geq$5) of smallmouth bass were collected. Proportional size distribution (PSD) and relative stock density values were calculated for each population as described by described by Gabelhouse (1984), as modified by Guy et al. (2007). Relative stock density indexed the proportion of preferred (PSD-P) and memorable (PSD-M) sized fish in the sample (Guy 2007). Standard errors for the PSD estimates were calculated as

$$\sigma_\pi = \sqrt{\frac{\pi\,(1-\pi)}{n}}$$

where π is the proportion of fish in the size category and n is the sample size (Ott 1993).

Relative weight (W_r) was used to index fish condition. Relative weight was calculated for smallmouth bass ≥ 150 mm TL using the standard weight (W_s) equation describe by Kolander et al. (1993). The precision of the estimate of mean W_r was reported as the standard error of the mean. Statistical difficulties with W_r calculations preclude our ability to test for differences among populations (Brenden et al. 2003).

Results and Discussion

Total Catch and Gear Type

In total, 2,124 smallmouth bass were collected from rivers and streams in western North Carolina during the summer of 2007 (N = 1,058) and 2008 (N = 1,066). Of 31 populations sampled, 16 were sampled during both years. The majority of smallmouth bass were captured using angling (N = 1,294) and electrofishing gear (N = 782), with a small number of fish (2%) collected with seines (N = 48).

Length Structure and Gear Selectivity

Length-frequency distributions (Figure 2) were reported for 44 of the 47 smallmouth bass samples, with 3 not reported due to small sample size (N < 5). Smallmouth bass ranged in length from 30 to 495 mm TL, and only 5% of the fish collected were greater than 350 mm TL. Proportional stock density values ranged from 0 to 63 (mean = 27), PSD-P from 0 to 28 (mean = 8), PSD-M from 0 to 8 (mean = 1), and no trophy length bass (≥510 mm TL) were observed in any sample (Table 1). Mean stock indices were higher than reported for smallmouth bass from the New River in North Carolina (Hodges 2006), but lower than reported for rivers and streams in Tennessee (Fiss et al. 2001) and Virginia (VDGIF 2003). Although length frequencies and stock indices revealed a low proportion of quality length fish (16%), 70% of the populations surveyed contained fish in excess of 350 mm TL and 12% contained fish greater than 430 mm TL, indicating the ability for some of these resources to produce preferred and memorable length smallmouth bass.

At several sites the number of smallmouth bass collected was insufficient for meaningful application of stock indices; however, these data are included in Table 1 for simple comparison with other sample sites and to indicate additional data needs. In some streams the low number of fish collected was due to poor habitat conditions, whereas other populations were likely sampled inadequately due to gear or effort limitations. Additional effort will be allocated in 2009 to streams where sample sizes are likely to allow application of stock indices; streams with poor smallmouth habitat will not receive further sampling or data analyses.

Electrofishing was not feasible at many of the sites sampled. Deep pools and runs (>1.5 m in depth) often prevented the use of backpack electrofishing gear, just as shallow riffles and access limitations often prevented sampling with boat mounted electrofishing gear. The use of an electrofishing barge was often not possible due to access limitations at many sites and the staff commitment needed for the large number of streams and rivers sampled. As a result of these issues, angling gear was used in 28 of the 47 samples.

Electrofishing and angling gear are often biased towards larger fish (Willis et al. 1993; Reynolds 1996;), and several studies have found strong correlations between the size structure of fish collected with these two gear types (Ebbers 1987; Santucci and Wahl 1991; Isaak et al. 1992). A comparison of smallmouth bass captured with these two gears during this study (Figure 3) showed that angling sampling collected primarily fish 180 mm TL or larger (77% of total angling catch), whereas electrofishing gear was more efficient at collecting smallmouth bass less than 180 mm TL (62% of total electrofishing catch). However, PSD, PSD-P, and PSD-M values for smallmouth bass collected by angling (26, 8, and 1, respectively) and electrofishing gear (32, 7, and 0, respectively) were comparable. Although angling gear provided limited numbers of smaller and presumably younger individuals, this gear type served as a viable method for obtaining stock length fish when the use of electrofishing gear was not feasible.

Smallmouth Bass Condition

In general, indices reflected poor condition. Relative weight (W_r) values calculated for 46 smallmouth bass samples representing 31 populations ranged from 59 to 140 (mean = 92; Table 2). Twenty-nine of 49 total samples (59%) reflected moderate mean condition values ($W_r \geq 90$); however, 25 of these samples were located in District 7 (Table 2). Mean stock size W_r values ranged from 82 to 110 (mean = 91), and quality size values ranged from 76 to 98 (mean = 87; Table 3; Figure 4). Preferred size mean W_r values ranged from 59 to 98 (mean = 85), and memorable size W_r values ranged from 75 to103 (mean = 87; Table 3; Figure 4). Highest overall mean W_r values were found in larger streams on the northern part of the Atlantic Slope in District 7 populations, followed by in the large Tennessee Valley streams in District 9 (Figure 5). Condition of smallmouth bass below memorable class decreased with increased fish length (Table 3; Figure 4; Figure 6). Observed differences in population characteristics among such groups of streams may indicate a relation to river basin, elevation, geology, gradient, latitude, river order, or other physiographic properties of the associated watersheds. Further analysis of 2007–2009 smallmouth bass collections will examine the effect of physiographic differences within and among river basins.

As with stock indices, sample sizes at several sites limited applicability of condition values beyond simple comparison to other streams sampled. Sites receiving additional effort in 2009 will be included in comparisons of condition, whereas those streams that have yielded fewer than 10 smallmouth bass in the first two years of survey will be eliminated from further analyses.

Smallmouth bass feeding habits and growth may be influenced by available forage (Probst et al. 1984), habitat and stream flow variations (Gwinner 1973; Smith et al. 2005), or temperature and latitude (Armour 1993; Beamesderfer and North 1995). During 2007 and 2008 NCWRC surveys, smallmouth bass typically were collected from clear mountain streams with complex riffle, run, and pool habitats. Western North Carolina stream productivity is limited by granite-dominated geology, which may contribute to poor smallmouth bass condition by negatively influencing trophic state; however, some watersheds drain nutrient rich areas. For example, the North Fork Catawba River population showed relatively high W_r values, (Table 2); this stream's geology is limestone based, which may provide additional nutrients ($CaCO3$), buffer water pH, and increase fish yield (Arce and Boyd 1975). Similarly, the Cane River population may reflect increased nutrient loads (phosphorous) via waste-water treatment plant effluent located within its watershed (deBruyn et al. 2003).

Condition of North Carolina's riverine smallmouth bass populations also may be influenced by elevation. Characteristics of sampling locations varied across the region, but many samples were collected from high-elevation streams (≥762 m). Streams and rivers at such elevations may exhibit cooler temperature patterns, thereby influencing smallmouth bass condition and growth (Patton and Hubert 1996). Conversely, lower elevation water bodies may prolong growing seasons and provide more suitable foraging conditions (Stroud 1948; Slipke et al. 1998).

In addition to temperature effects, abiotic factors such as stream flow and weather patterns may influence riverine smallmouth bass growth (Graham and Orth 1986). North Carolina's below-average stream flows due to drought conditions during 2007 and 2008 must be considered when evaluating condition data collected during this study. Suitable habitat elements (rocky substrate, cobble, and boulders) are critical for smallmouth bass development and survival (Todd and Rabeni 1989), and these habitat criteria were often limited during drought conditions in North Carolina. Consequently, increased density-dependent competition may occur in habitat-limited areas, reducing population condition values. Relative weights reflected declining condition with increased fish length, which has been observed in previous North Carolina smallmouth bass population surveys (Hodges 2000, 2004, 2006).

More detailed information on smallmouth bass growth and survival is needed during a year of higher stream flow to evaluate performance of existing stocks and potential for site-specific management activities, particularly harvest regulations. Relative weight calculations indicate fish condition only at the time of capture, but these values should be viewed with caution when evaluating food availability throughout the year. Accurate age data are needed to determine growth rates within riverine populations over time, and to estimate mortality rates that will further allow assessment of riverine smallmouth bass population responses to alternative harvest regulations.

Conclusions

Electrofishing was effective at capturing smallmouth bass at some sites; however, angling proved a more versatile and economical capture method that yielded comparable size ranges of fish from more diverse habitats. Condition of western North Carolina's riverine smallmouth bass tended to be poor, with the exception of several larger, higher-order stream sites, certain nutrient-rich systems, and streams along the northern Atlantic Slope portion of the region. The potential of these streams for more restrictive regulations should be further evaluated at the river basin level in the final year of the study. To the extent possible, effects of abiotic factors on smallmouth bass populations should be investigated at selected sites where multiple years of data are available. Otoliths collected from 2007–2009 samples will be used to further assess growth and mortality of smallmouth bass populations, and the results will help determine the potential of site-specific regulations. Public involvement and education should be emphasized throughout the remaining phase of this project to assess and cultivate support for angling methods and potential regulation changes.

Recommendations

1. Continue to use electrofishing and angling sampling to collect smallmouth bass in the 2009 survey season; as needed, incorporate volunteers and educate public on need for angling sampling.
2. Focus 2009 surveys on streams with high potential for special regulations, and streams where multiple years of data will allow detailed examination of population responses to abiotic habitat influences. Where possible, fill geographic or sample-size data gaps from first two survey years.
3. Complete age determinations on smallmouth bass collected in 2007–2009 field seasons.
4. Where sufficient sample sizes exist, model growth and mortality rates of individual smallmouth populations to determine potential utility of special regulations or other management enhancements.
5. Examine effects of river basin, stream order, and other physiographic characteristics of streams for relation to quality of smallmouth bass fisheries.
6. Examine the relationship between water quality data from the North Carolina Division of Water Quality and smallmouth bass population characteristics.
7. Develop outreach resources to communicate purpose and findings of smallmouth bass surveys, including rationale of sampling methods, and explore opportunities for interactive web-based public access to site-specific data.

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TABLE 1.—Stock indices for smallmouth bass collected during NCWRC district surveys, May 2007–October 2008. Given are proportional stock density (PSD); relative stock density of preferred length fish (PSD-P); and relative stock density of memorable length fish (PSD-M). The 95% confidence interval for each value is included.

Water Body	NCWRC District	Year	# of Stock Length Fish	PSD (±95% CI)	PSD-P (±95% CI)	PSD-M (±95% CI)
Dan River	7	2007	67	36 (11)	12 (8)	0
Dan River	7	2008	110	16 (6)	12 (6)	0
Hunting Creek	7	2008	19	0	0	0
Mitchell River	7	2008	65	26 (10)	2 (3)	0
Mulberry Creek	7	2008	24	42 (20)	21 (16)	0
Reddies River	7	2007	17	35 (23)	0	0
Reddies River	7	2008	6	0	0	0
Roaring River	7	2008	25	16 (14)	4 (8)	0
Stony Fork	7	2007	15	13 (17)	7 (12)	0
Watauga River	7	2008	15	13 (17)	7 (13)	0
Yadkin River (Lower)	7	2007	40	30 (14)	28 (14)	8 (8)
Yadkin River (Lower)	7	2008	53	19 (11)	9 (8)	2 (4)
Yadkin River (Upper)	7	2008	23	4 (8)	0	0
Broad River (Lower)	8	2008	80	26 (10)	3 (4)	1 (2)
Broad River (Lower)	8	2007	7	17 (30)	17 (30)	0
Broad River (Upper)	8	2008	41	5 (6)	0	0
Cane River	8	2007	34	32 (16)	21 (13)	0
Cane River	8	2008	61	44 (12)	15 (9)	2 (3)
Catawba River	8	2007	8	63 (33)	25 (30)	0
Catawba River	8	2008	18	6 (11)	0	0
Cove Creek	8	2007	5	60 (43)	0	0
Henry Fork River	8	2007	10	30 (28)	0	0
Jacob Fork River	8	2007	9	11 (20)	0	0
Johns River	8	2007	19	42 (22)	5 (10)	0
Linville River	8	2007	16	44 (35)	13 (16)	0
Mulberry Creek	8	2007	8	25 (30)	13 (23)	0
North Fork Catawba River	8	2007	8	50 (35)	0	0
North Fork Catawba River	8	2008	31	32 (16)	3 (6)	0
North Toe River	8	2007	22	50 (21)	9 (12)	5 (9)
North Toe River	8	2008	113	42 (9)	9 (5)	0
South Toe River	8	2008	12	42 (28)	8 (15)	0
Upper Creek/Warrior Fork	8	2007	10	30 (28)	0	0
Wilson Creek	8	2007	23	48 (20)	9 (11)	0
French Broad River (Lower)	9	2007	13	46 (27)	0	0
French Broad River (Lower)	9	2008	50	20 (11)	8 (15)	0
French Broad River (Upper)	9	2007	30	53 (18)	3 (6)	0
French Broad River (Upper)	9	2008	10	10 (19)	0	0
Little Tennessee River	9	2007	3	33 (53)	0	0
Little Tennessee River	9	2008	22	14 (14)	5 (8)	0
Pigeon River	9	2007	26	19 (15)	8 (10)	0
Pigeon River	9	2008	3	0	0	0
Pigeon River (By-Pass)	9	2007	56	14 (9)	0	0
Pigeon River (By-Pass)	9	2008	16	0	0	0
Tuckaseegee River	9	2008	36	28 (14)	8 (9)	0
Angling			983	26 (3)	8 (2)	1 (1)
Electrofishing			299	32 (5)	7 (3)	0
Total			1,282	27 (2)	8 (1)	1 (1)

TABLE 2.—Mean relative weight (W_r) values, with associated condition statistics for smallmouth bass collected during NCWRC surveys, May 2007–October 2008. Standard error values are listed in parentheses.

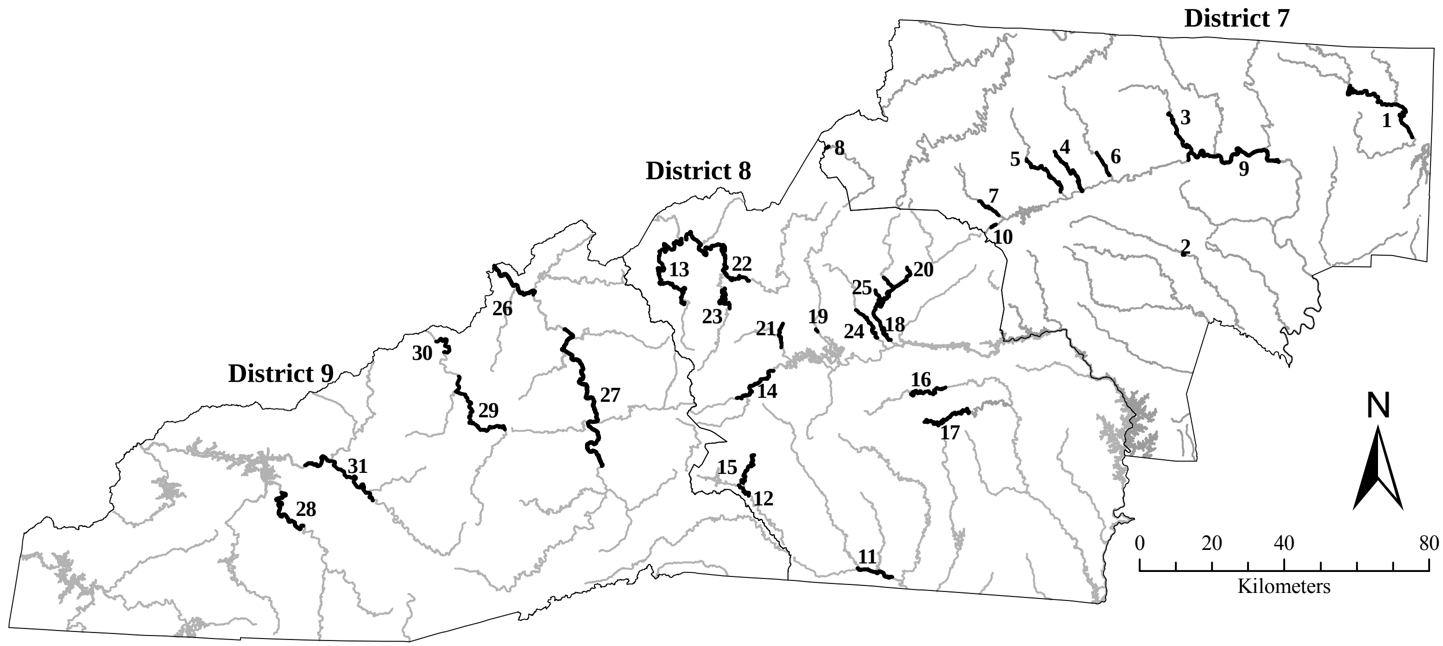
Water Body	NCWRC District	Year	N*	Mean W_r	95% $\pm$ C.I.	Range	Median
Dan River	7	2007	77	92 (0.74)	91–93	78–108	92
Dan River	7	2008	118	93 (0.72)	92–94	76–140	93
Hunting Creek	7	2008	21	91 (1.30)	88–94	81–102	91
Mitchell River	7	2008	69	96 (1.03)	94–98	76–119	95
Mulberry Creek	7	2008	25	91 (1.53)	88–94	77–108	90
Reddies River	7	2007	40	99 (1.37)	96–102	80–125	99
Reddies River	7	2008	7	88 (2.34)	82–94	77–98	88
Roaring River	7	2008	26	92 (1.38)	89–95	75–108	92
Stony Fork	7	2007	20	97 (1.60)	94–100	86–110	95
Watauga River	7	2008	15	84 (1.00)	82–86	74–90	84
Yadkin River (Lower)	7	2007	41	92 (1.11)	90–94	78–109	92
Yadkin River (Lower)	7	2008	72	95 (1.13)	93–97	72–119	92
Yadkin River (Upper)	7	2008	25	94 (1.08)	92–96	83–103	95
Broad River (Lower)	8	2008	80	85 (0.66)	84–86	73–103	85
Broad River (Upper)	8	2007	10	92 (2.78)	86–98	76–102	95
Broad River (Upper)	8	2008	44	86 (0.94)	84–88	74–99	86
Cane River	8	2007	50	95 (1.55)	92–98	70–138	93
Cane River	8	2008	62	84 (0.82)	82–86	68–104	83
Catawba River	8	2007	11	96 (2.62)	90–101	84–115	95
Catawba River	8	2008	22	104 (2.19)	99–109	84–130	102
Cove Creek	8	2007	6	93 (3.45)	84–102	82–103	93
Henry Fork River	8	2007	12	85 (1.88)	81–89	72–95	88
Jacob Fork River	8	2007	13	92 (1.54)	89–95	84–100	93
Johns River	8	2007	22	87 (1.23)	86–98	78–100	86
Linville River	8	2007	25	87 (1.64)	84–90	76–113	85
Linville River	8	2008	4	80 (2.13)	73–87	74–84	82
Mulberry Creek	8	2007	9	92 (2.55)	86–98	83–106	92
North Fork Catawba River	8	2007	14	94 (2.53)	89–99	77–109	93
North Fork Catawba River	8	2008	36	92 (1.03)	90–94	76–106	92
North Toe River	8	2007	30	86 (1.43)	83–89	72–102	86
North Toe River	8	2008	47	87 (0.84)	85–89	74–100	87
South Toe River	8	2007	4	91 (2.82)	82–100	83–95	93
South Toe River	8	2008	12	79 (2.22)	74–84	59–91	81
Upper Creek	8	2007	11	87 (1.72)	83–91	76–98	86
Wilson Creek	8	2007	26	87 (1.27)	84–90	80–104	85
French Broad River (Lower)	9	2007	14	105 (2.40)	100–110	94–130	103
French Broad River (Lower)	9	2008	62	85 (0.74)	84–86	73–100	84
French Broad River (Upper)	9	2007	68	99 (0.94)	97–101	81–118	98
French Broad River (Upper)	9	2008	15	90 (2.25)	85–95	72–102	92
Little Tennessee River	9	2007	12	90 (2.36)	85–95	76–100	92
Little Tennessee River	9	2008	27	89 (1.36)	86–92	76–103	89
Pigeon River	9	2007	58	91 (1.34)	88–94	73–135	90
Pigeon River	9	2008	12	99 (2.64)	93–104	79–112	98
Pigeon River (By-Pass)	9	2007	81	90 (0.77)	88–92	74–108	89
Pigeon River (By-Pass)	9	2008	25	88 (1.30)	85–91	75–102	88
Tuckaseegee River	9	2008	43	93 (1.35)	90–96	77–115	93

*sample size based on recommended total length (i.e., ≥ 150 mm) as described by Kolander et al. (1993)

TABLE 3.—Mean relative weight (W_r) values for stock (S), quality (Q), preferred (P), and memorable (M) size smallmouth bass collected during NCWRC surveys, May 2007–October 2008. Standard error values are listed in parentheses.

Water Body	NCWRC District	Year	S*	Q*	P*	M*
Dan River	7	2007	93 (0.81)	89 (1.53)	85 (1.90)	
Dan River	7	2008	94 (0.62)	84 (2.36)	86 (1.32)	
Hunting Creek	7	2008	92 (1.32)			
Mitchell River	7	2008	98 (1.13)	91 (2.37)	95	
Mulberry Creek	7	2008	93 (1.57)	85 (2.48)	86 (3.03)	
Reddies River	7	2007	96 (3.59)	92 (3.12)		
Reddies River	7	2008	88 (2.77)			
Roaring River	7	2008	92 (1.62)	92 (2.82)	83	
Stony Fork	7	2007	96 (2.06)	94	89	
Watauga River	7	2008	84 (1.15)	82	86	
Yadkin River (Lower)	7	2007	94 (1.33)	84	88 (1.85)	85 (1.13)
Yadkin River (Lower)	7	2008	92 (1.01)	84 (3.51)	89 (2.90)	103
Yadkin River (Upper)	7	2008	95 (1.11)	85		
Broad River (Lower)	8	2008	86 (0.72)	82 (1.43)	91	83
Broad River (Upper)	8	2007	92 (4.40)	84		
Broad River (Upper)	8	2008	85 (0.99)	84 (3.45)		
Cane River	8	2007	90 (1.45)	94 (3.73)	90 (3.57)	
Cane River	8	2008	85 (1.06)	85 (1.78)	82 (1.69)	75
Catawba River	8	2007	100 (2.24)	90 (0.86)	86 (2.37)	
Catawba River	8	2008	104 (2.38)	84		
Cove Creek	8	2007	98 (4.24)	87 (2.95)		
Henry Fork River	8	2007	84 (2.68)	84 (2.37)		
Jacob Fork River	8	2007	92 (1.74)	84		
Johns River	8	2007	86 (1.61)	86 (1.36)	81	
Linville River	8	2007	88 (2.84)	88 (2.45)	88 (2.95)	
Linville River	8	2008	82 (0.84)			
Mulberry Creek	8	2007	91 (3.77)	94	98	
North Fork Catawba River	8	2007	91 (2.28)	93 (6.46)		
North Fork Catawba River	8	2008	92 (1.47)	92 (1.82)	87	
North Toe River	8	2007	85 (2.43)	83 (2.56)	82	91
North Toe River	8	2008	85 (0.71)	81 (1.04)	82 (1.39)	
South Toe River	8	2007	91 (2.82)			
South Toe River	8	2008	82 (1.85)	80 (2.17)	59	
Upper Creek	8	2007	89 (1.95)	82 (3.15)		
Wilson Creek	8	2007	87 (1.49)	86 (2.30)	82 (2.06)	
French Broad River (Lower)	9	2007	110 (3.67)	98 (1.25)		
French Broad River (Lower)	9	2008	84 (0.84)	84 (2.41)	84 (3.95)	
French Broad River (Upper)	9	2007	96 (1.69)	94 (1.84)	88	
French Broad River (Upper)	9	2008	90 (3.49)	92		
Little Tennessee River	9	2007	86 (3.19)	76		
Little Tennessee River	9	2008	90 (1.69)	87 (4.10)	76	
Pigeon River	9	2007	86 (1.98)	87 (6.68)	86 (0.83)	
Pigeon River	9	2008	89 (4.95)			
Pigeon River (By-Pass)	9	2007	90 (1.06)	92 (2.78)		
Pigeon River (By-Pass)	9	2008	86 (1.38)			
Tuckaseegee River	9	2008	92 (1.67)	88 (1.88)		

*length-class qualifications presented as described by Gabelhouse (1984) as modified by Guy et al. 2007



ID	District	Water Body	ID	District	Water Body	ID	District	Water Body
1	7	Dan River	12	8	Broad River (Upper)	23	8	South Toe River
2	7	Hunting Creek	13	8	Cane River	24	8	Upper Creek/Warrior Fork
3	7	Mitchell River	14	8	Catawba River	25	8	Wilson Creek
4	7	Mulberry Creek	15	8	Cove Creek	26	9	French Broad River (Lower)
5	7	Reddies River	16	8	Henry Fork River	27	9	French Broad River (Upper)
6	7	Roaring River	17	8	Jacob Fork River	28	9	Little Tennessee River
7	7	Stony Fork	18	8	Johns River	29	9	Pigeon River
8	7	Watauga River	19	8	Linville River	30	9	Pigeon River By-pass
9	7	Yadkin River (Lower)	20	8	Mulberry Creek	31	9	Tuckaseegee River
10	7	Yadkin River (Upper)	21	8	North Fork Catawba River			
11	8	Broad River (Lower)	22	8	North Toe River			

FIGURE 1.—Map of study area in NCWRC districts 7, 8, and 9. Highlighted reaches represent sites where smallmouth bass were collected in 2007–2008.

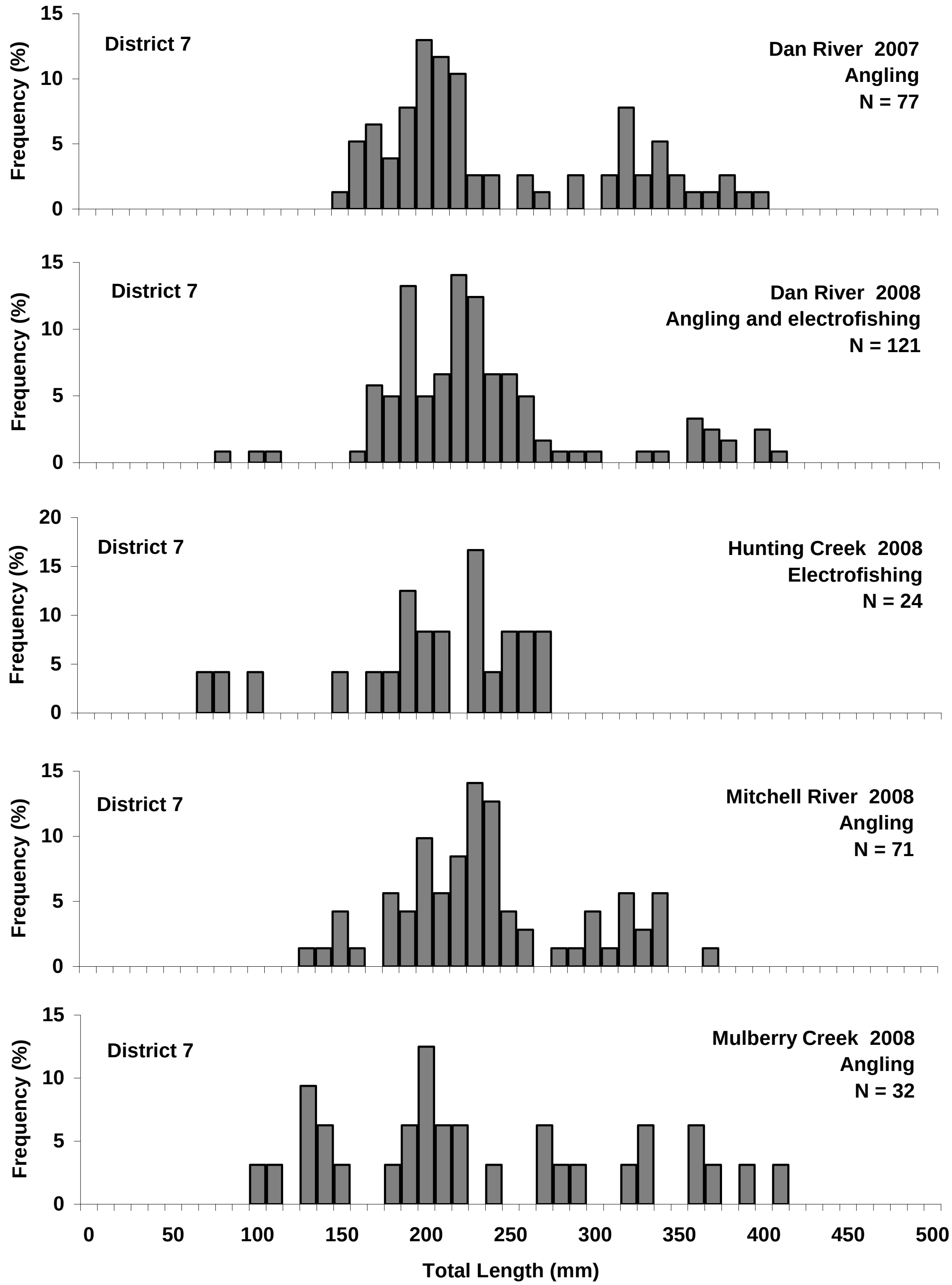


FIGURE 2.—Length-frequency distributions of smallmouth bass collected from western North Carolina streams, with stream name, NCWRC district, sample year, gear used, and sample size.

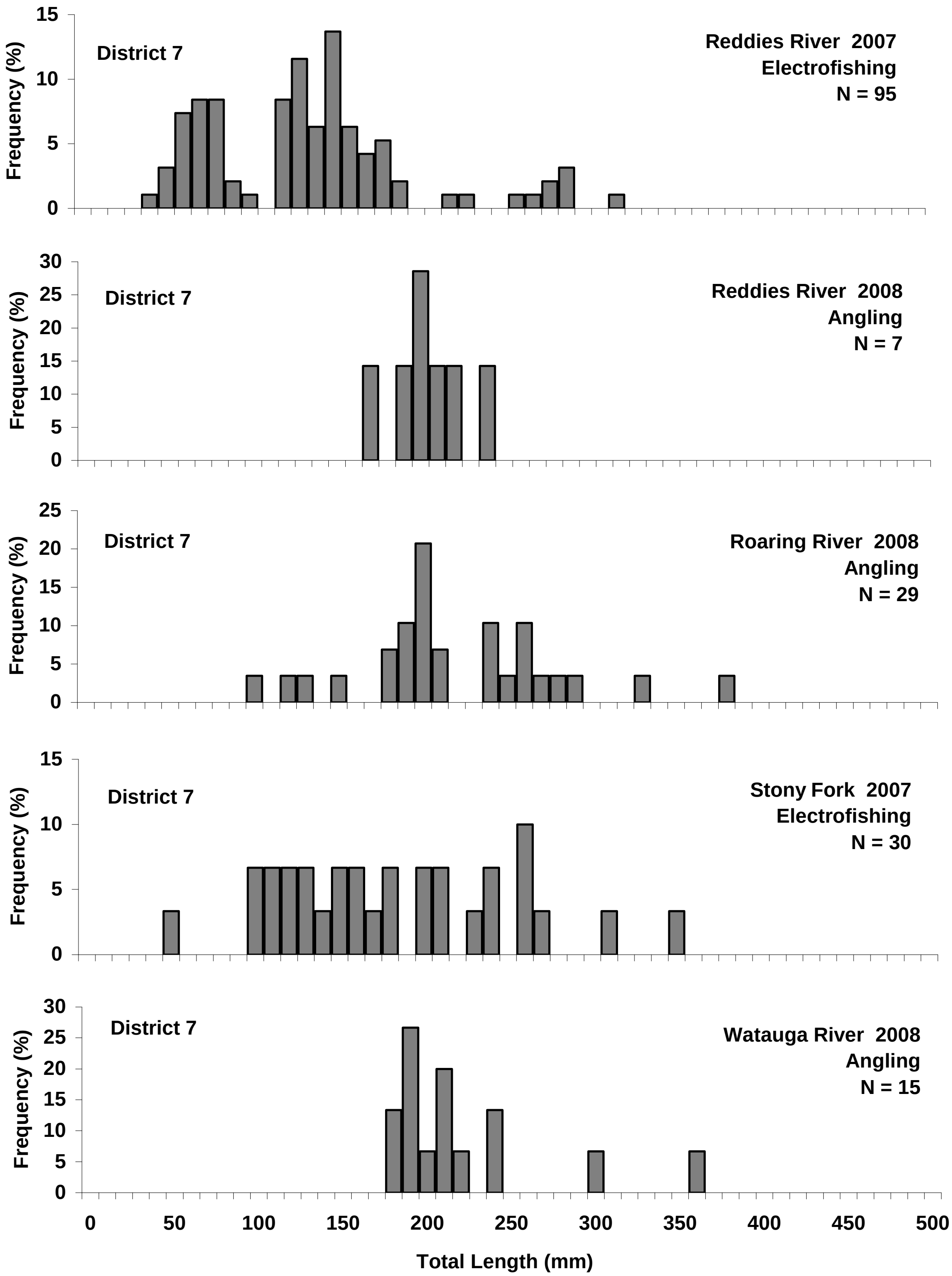
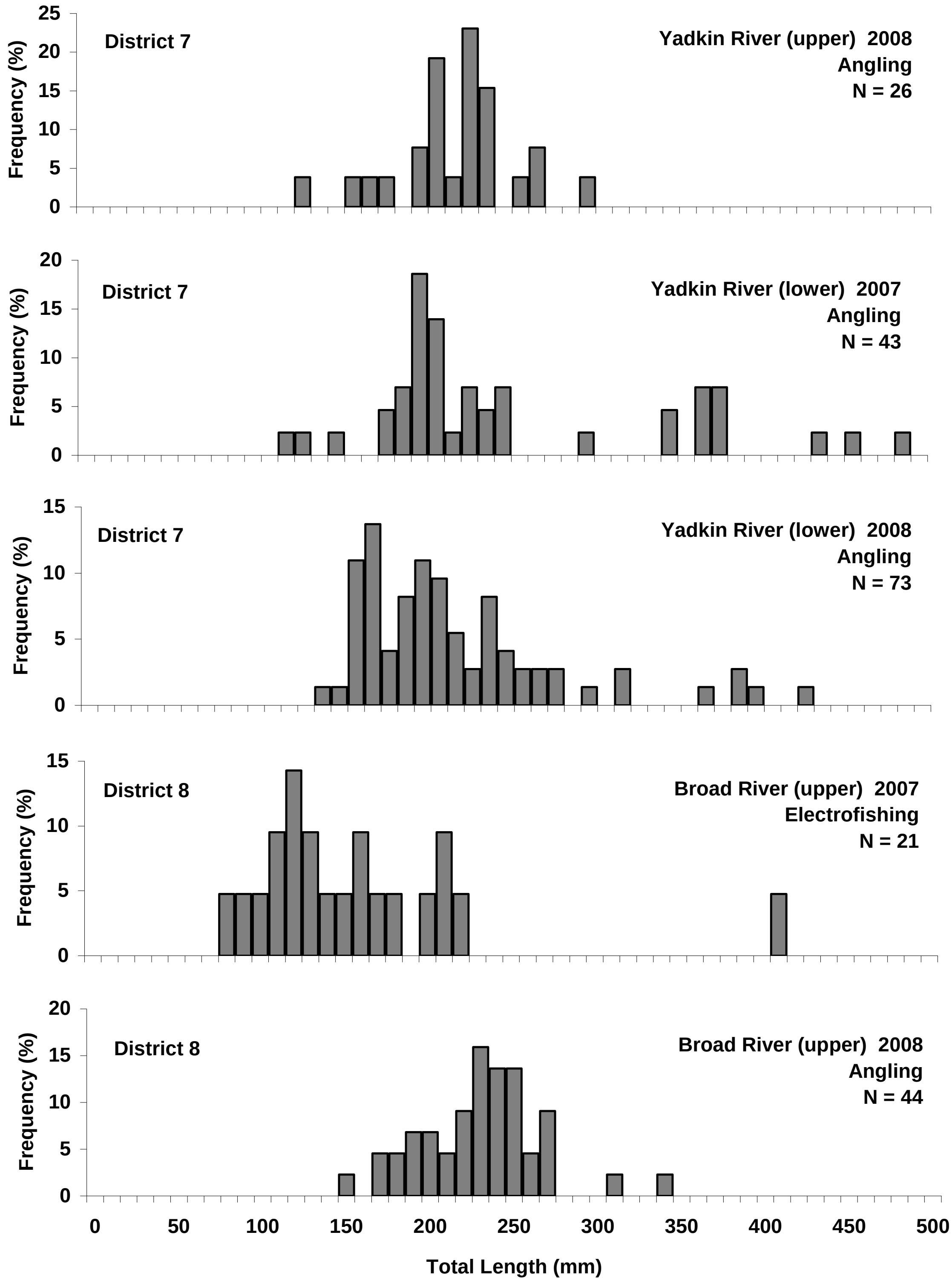


FIGURE 2.—Continued.



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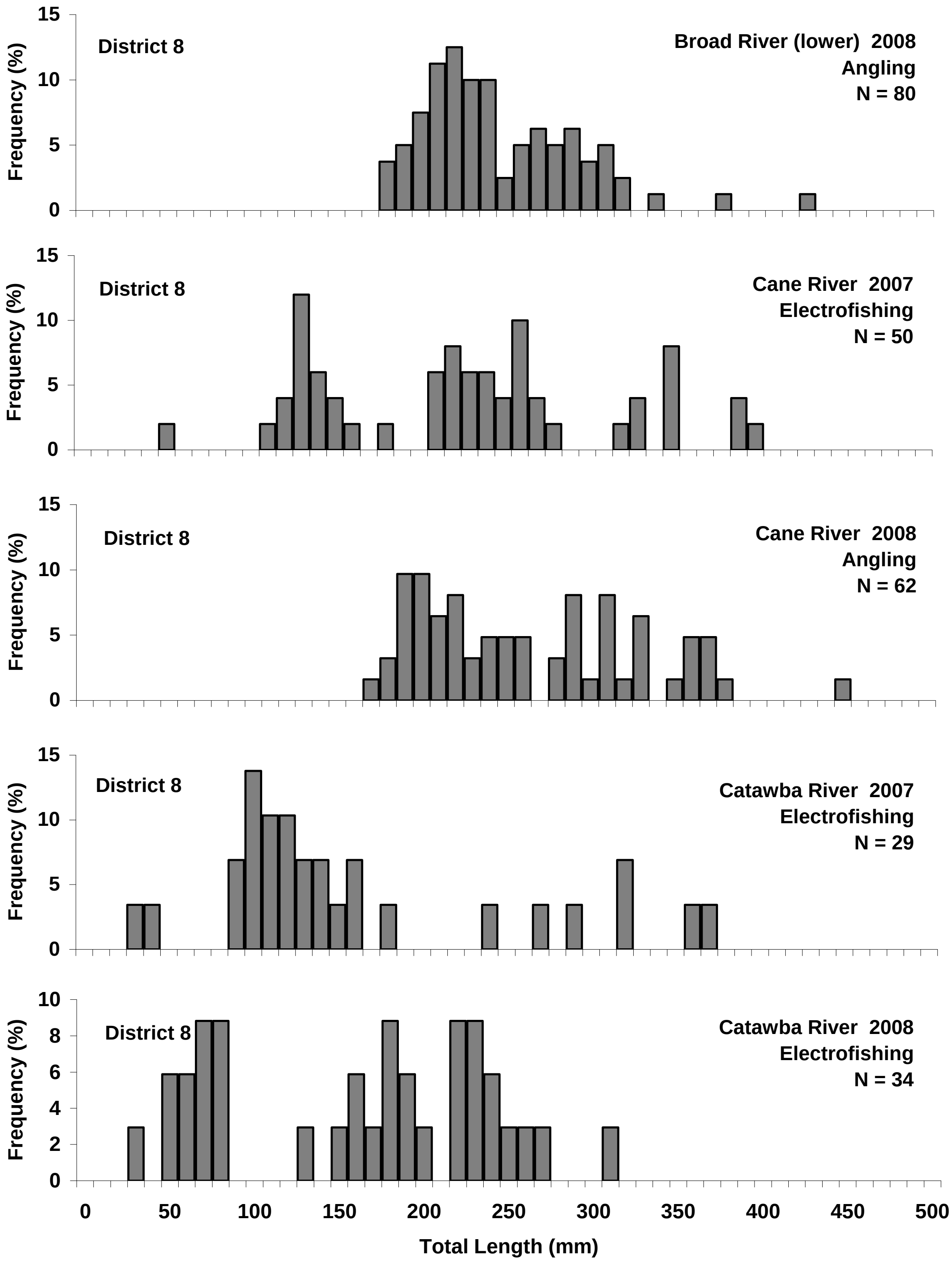
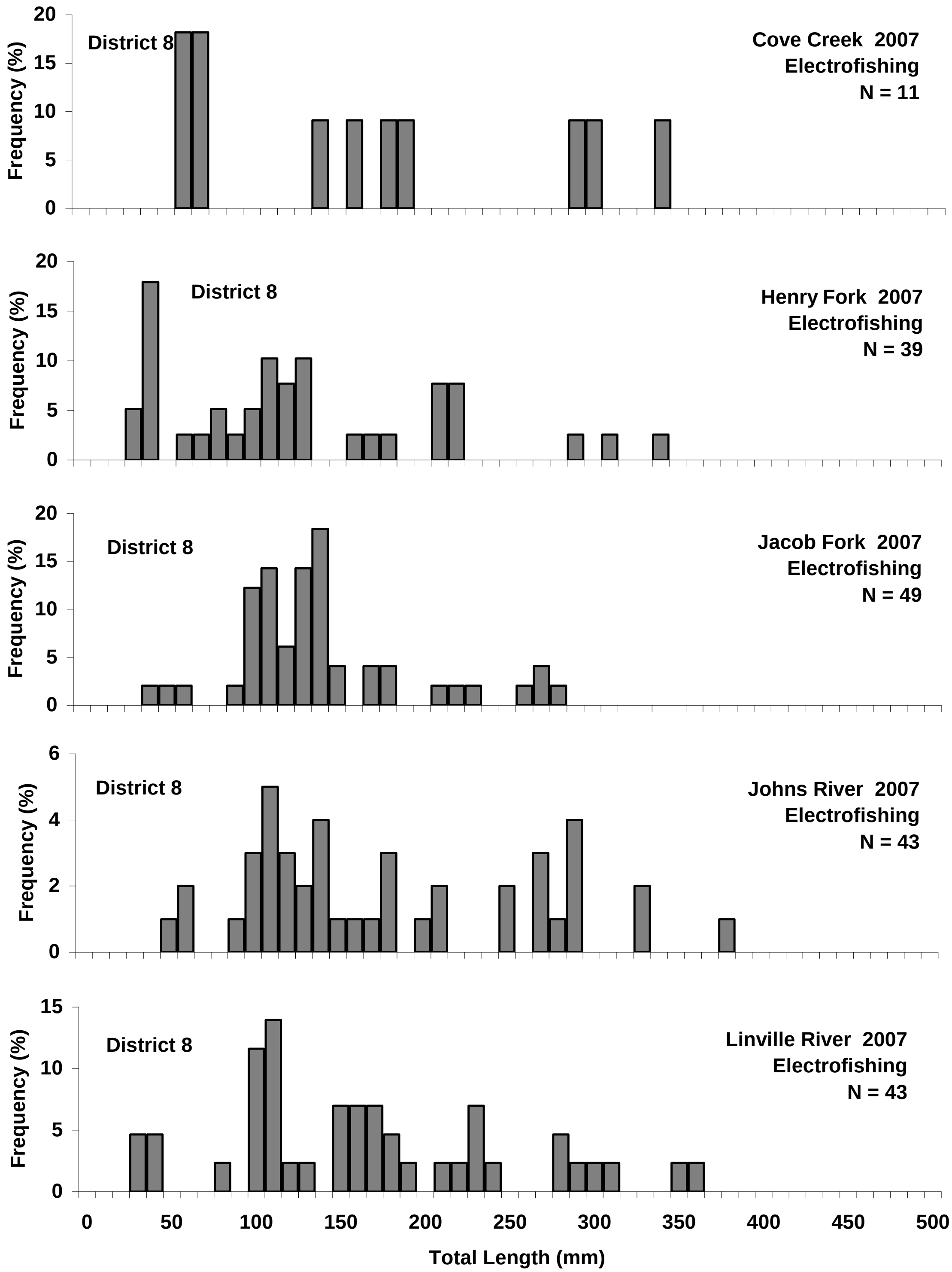


FIGURE 2.—Continued.



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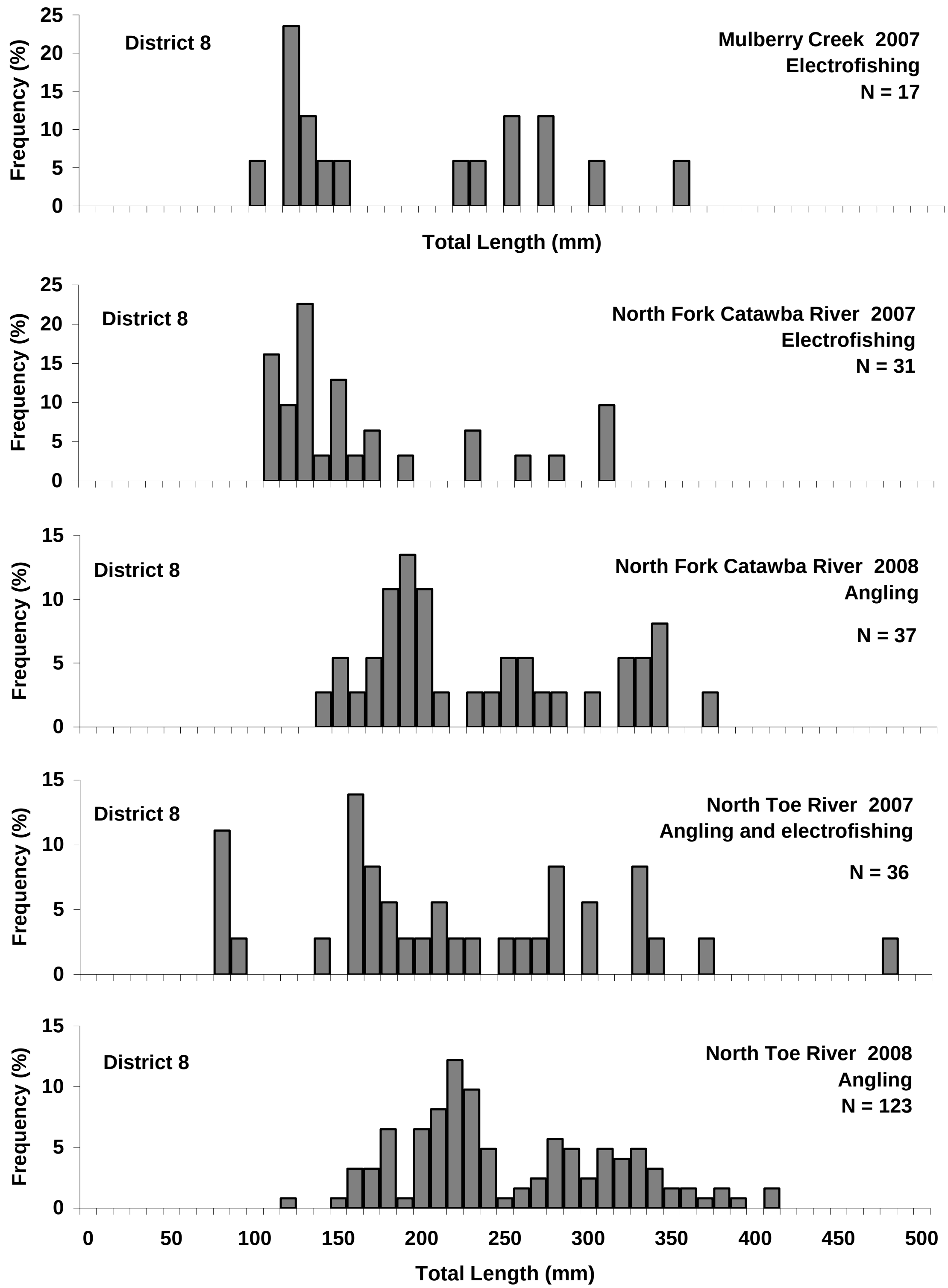

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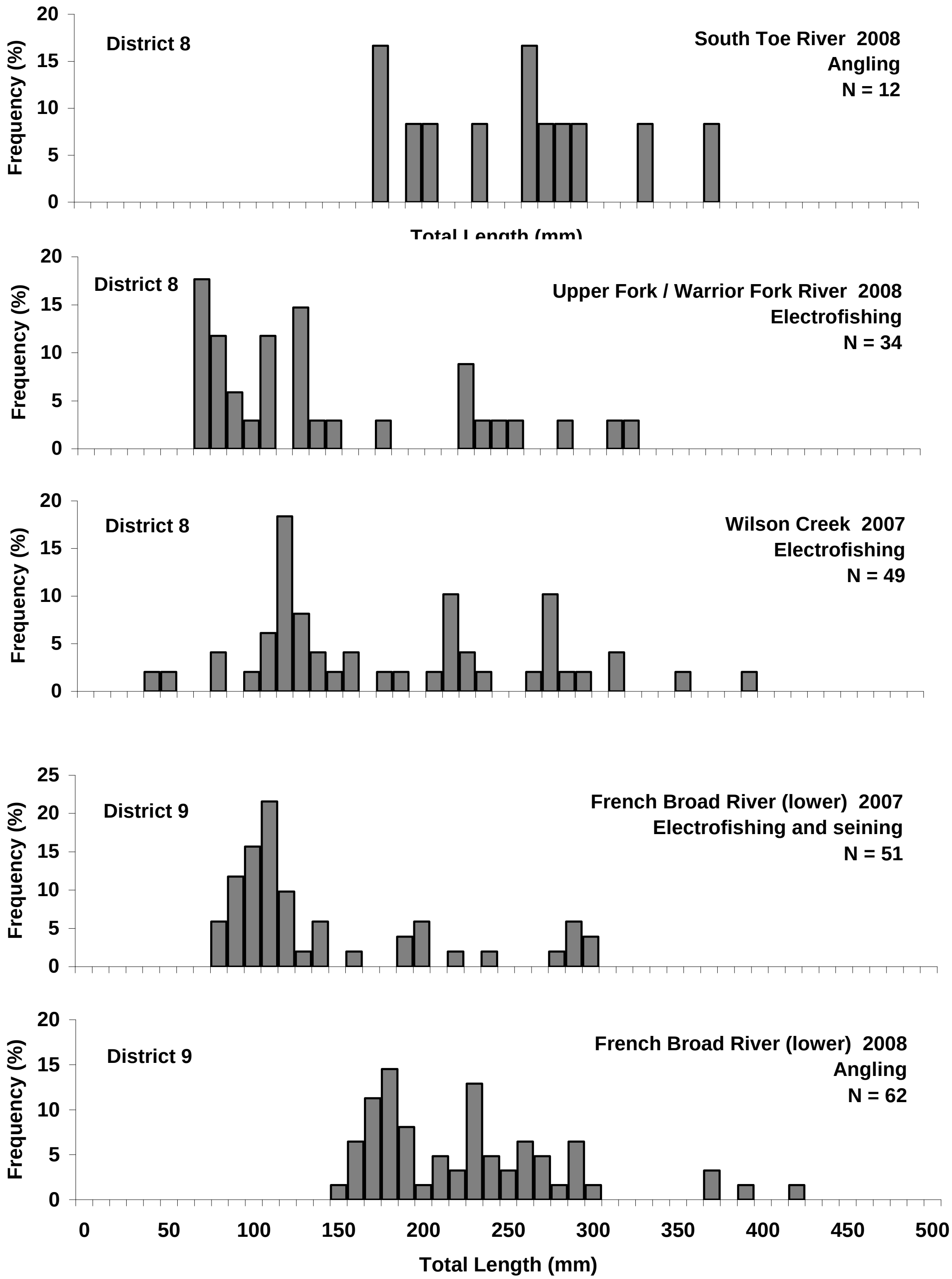

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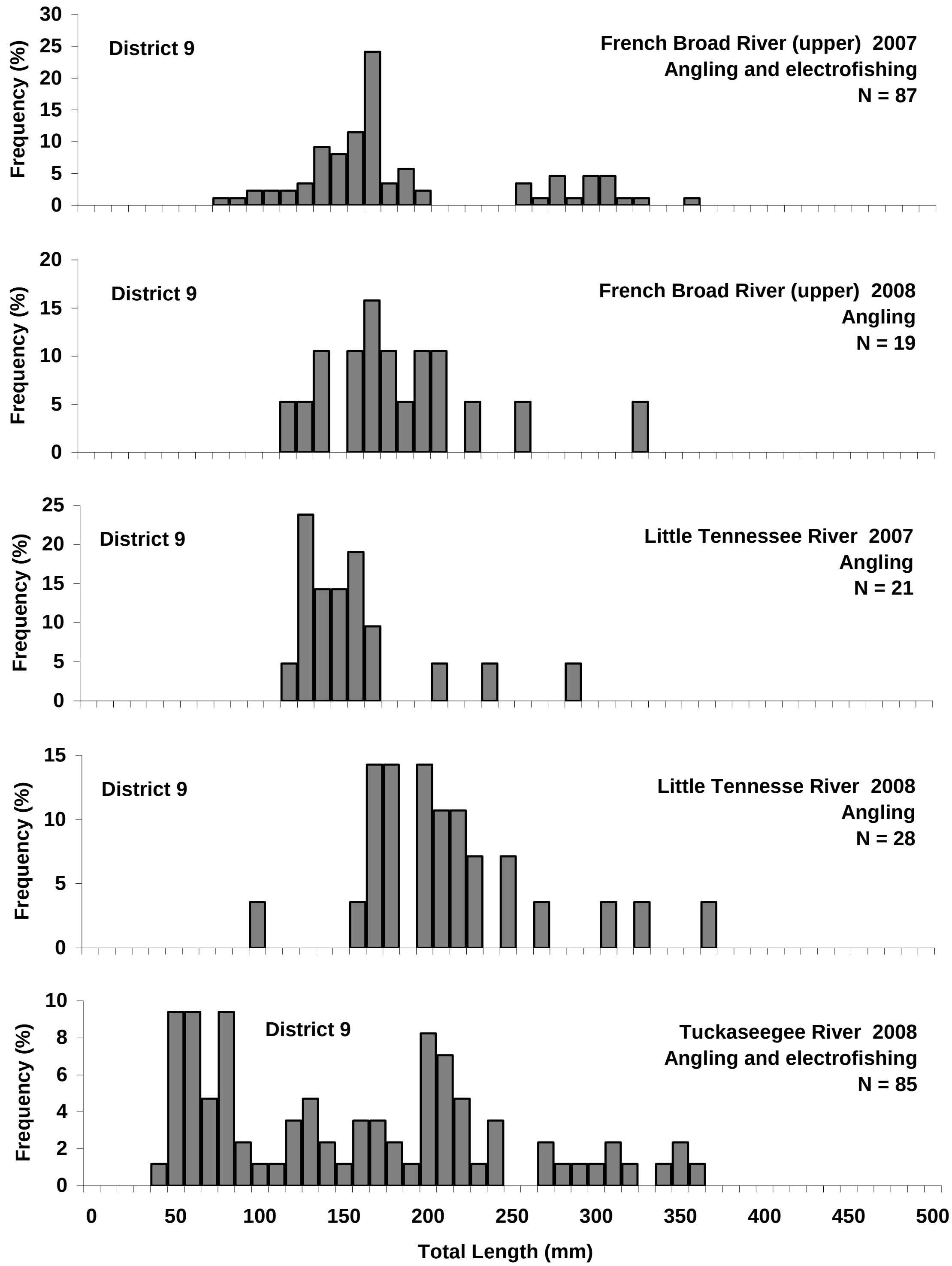

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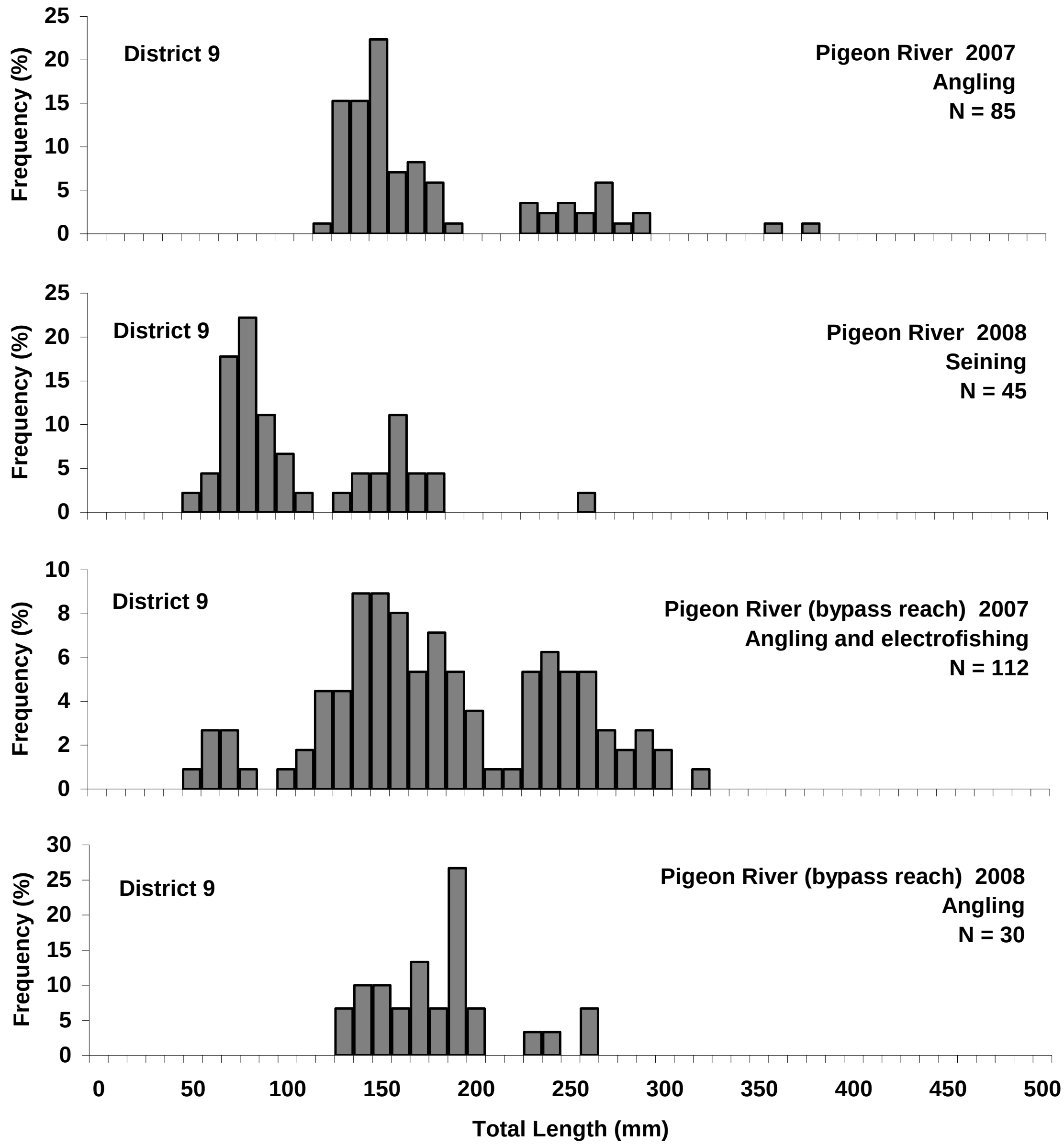

FIGURE 2.—Continued.

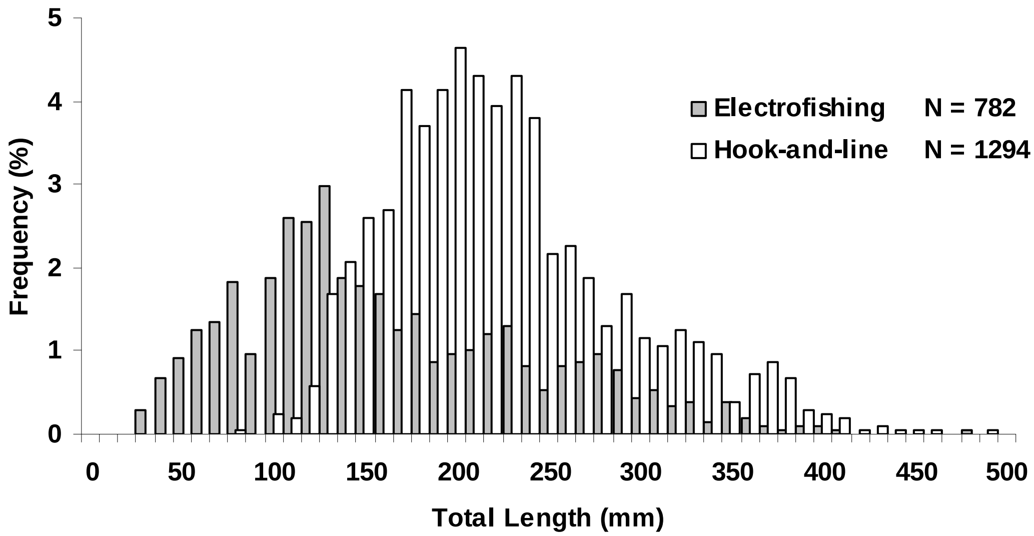

FIGURE 3.—Length-frequency distributions of smallmouth bass collected using electrofishing and angling gear from rivers and streams in western North Carolina, summer of 2007 and 2008.

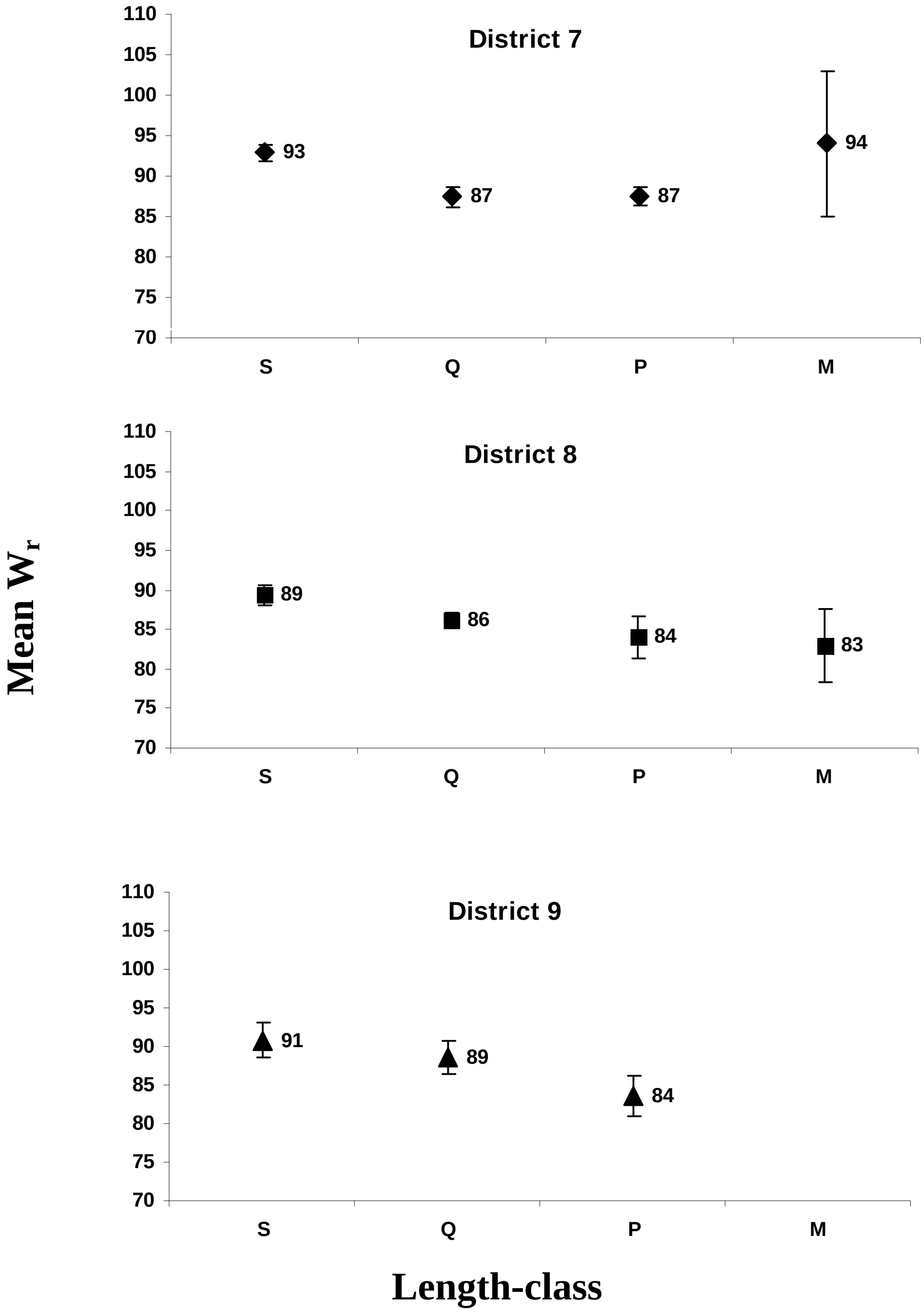

FIGURE 4.—Mean relative weight (W_r) values by District for stock (S), quality (Q), preferred (P), and memorable (M) size smallmouth bass collected during NCWRC surveys, May 2007–October 2008. Standard error bars associated with mean values are shown.

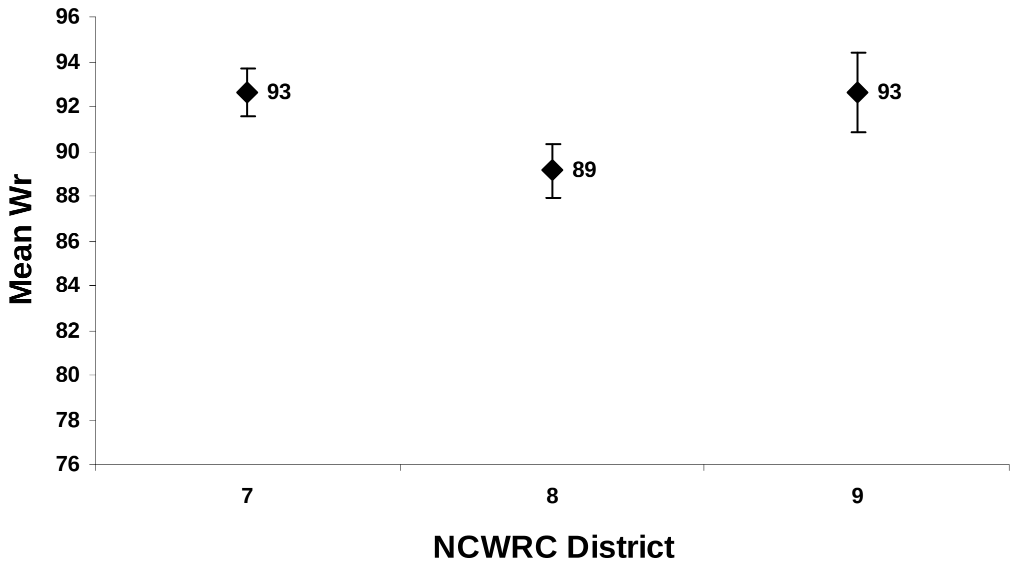

FIGURE 5.—Mean relative weight (W_r) values for smallmouth bass collected during NCWRC District surveys, May 2007–October 2008. Standard error bars associated with mean values are shown.

FIGURE 6.—Cumulative mean relative weight (W_r) values for stock (S), quality (Q), preferred (P), and memorable (M) size smallmouth bass collected during NCWRC surveys, May 2007–October 2008. Standard error bars associated with mean values are shown.

Appendix: Anticipated 2009 smallmouth bass sample sites

TABLE A.1.—Anticipated 2009 smallmouth bass collection sites with location, sampling priority, collection methods, target sample sizes, and primary purpose of collections.

District & Stream/River	Location	Priority	Gear	Total Fish Collected	Purpose
District 7:					
Yadkin River	Pilot Mt. State Park to Donnaha	High	Hook-and-Line (float) or Boat EF	50-100	Harvest regulation modeling and population analysis.
Dan River	Danbury area	High	Hook-and-Line (float)	50-100	Harvest regulation modeling and population analysis.
Fisher River	I-77 to Yadkin River	Medium	Hook-and-Line (wade)	50-100	Evaluate SMB population for potential management purposes.
Ararat River	Mt. Airy to Yadkin River	Medium	Hook-and-Line (float)	approx 30	Evaluate SMB population for potential management purposes.
Stewarts Creek	near Mt. Airy	Medium	Hook-and-Line (wade)	approx 30	Evaluate SMB population for potential management purposes.
Little River	Alexander County	Medium	Hook-and-Line (wade)	approx 30	Evaluate SMB population for potential management purposes.
Little River	Alleghany County	Low	Hook-and-Line (wade)	approx 30	Evaluate SMB population for potential management purposes.
Elk Creek	Ferguson	Low	Hook-and-Line (wade)	approx 30	Additional length, weight, and age data needed for population assessment.
Watauga River	NC/TN state line	Low	Hook-and-Line (wade)	approx 30	Additional length, weight, and age data needed for population assessment.
Reddies River	North Wilkesboro	Low	Hook-and-Line (wade)	approx 30	Additional length, weight, and age data needed for population assessment.
District 8:					
North Toe River	Kona Downstream	High	Hook-and-Line (wade)	$\geq$ 100	Harvest regulation modeling and population analysis.
Broad River (Lower)	Cliffside Steam Plant Downstream	High	Hook-and-Line (float)	$\geq$ 100	Harvest regulation modeling and population analysis.
Catawba River	Ford Place	Medium	Boat Electrofishing	50-100	Additional length, weight, and age data needed for population assessment.
Catawba River	Tom Johnson	Medium	Boat Electrofishing	50-100	Additional length, weight, and age data needed for population assessment.
Catawba River	Porche Justice	Medium	Boat Electrofishing	50-100	Additional length, weight, and age data needed for population assessment.
Catawba River	Parker Padget Road	Medium	Backpack Electrofishing	50-100	Additional length, weight, and age data needed for population assessment.
Catawba River	Parker Padget Road	Medium	Hook-and-Line (wade)	50-100	Evaluate electrofishing gear bias, as well as collect additional data for population assessment.
Green River	TBA	Low	Hook-and-Line (float)	$\geq$ 40	Evaluate SMB population for potential management purposes. Fill data gap within district.
District 9:					
French Broad River	Redmon Dam to TN state line	High	Hook-and-Line (float and wade)	$\geq$ 100	Harvest regulation modeling and population analysis.
Hiwassee River	Mission Dam to Murphy	Medium	Hook-and-Line (float)	50-100	Evaluate SMB population for potential management purposes. Fill data gap within district.