AMERICAN SHAD MONITORING IN THE CAPE FEAR RIVER–2015

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Abstract.—American Shad *Alosa sapidissima* were sampled weekly with boat electrofishing in the Cape Fear River during spring 2015 at four sample sites including Lock and Dams 1, 2, 3, and Buckhorn Dam. A total of 1,306 American Shad were collected; 21 were collected at Buckhorn Dam, 360 at Lock and Dam 3, 566 at Lock and Dam 2, and 341 at Lock and Dam 1. Overall American Shad catch per unit effort (CPUE) averaged 69.2 fish/h. Overall relative abundance of American Shad in 2015 was comparable to previous sample years with site specific increases documented among years. Male American Shad were more abundant than females. Male American Shad ranged 339–504 mm in total length, while female American Shad ranged 441–580 mm. American Shad ages ranged 2–8 with 76% of males 3–4 years old and 74% of females 5–6 years old. In addition to these monitoring efforts in 2015, recreational angling effort as well as catch and harvest of American Shad was estimated through a creel survey administered by the North Carolina Division of Marine Fisheries. Comparisons between pre- and post-rock arch ramp relative abundance estimates indicated that American Shad may be passing Lock and Dam 1 at higher rates than those observed utilizing only the locking schedule.

The North Carolina Wildlife Resources Commission (NCWRC) is responsible for the spawning stock assessment of American Shad *Alosa sapidissima* in designated Inland waters of the Cape Fear River. Population characteristics from coastal rivers are summarized each spring, and then submitted to the North Carolina Division of Marine Fisheries (NCDMF) for updating stock assessment models and inclusion in North Carolina's annual American Shad compliance report to the Atlantic States Marine Fisheries Commission (ASMFC). This information is required of the state of North Carolina as mandated under conditions set forth within the fishery management

plan for alosine species established for the eastern United States (ASMFC 1985) and associated addendum (ASMFC 2002; ASMFC 2010). Compliance with this plan is necessary to support the enhancement of American Shad populations within coastal North Carolina for the benefit of recreational and commercial fishermen.

American Shad are an important species for both recreational and commercial fishermen in the Cape Fear River. They are targeted by commercial fishermen in joint waters downstream of Lock and Dam 1 during the Cape Fear River shad season which has occurred from 20 February to 11 April since 2013. Recreational anglers target this species primarily in inland waters from Lock and Dams 1 (rkm 97), 2 (rkm 149), and 3 (rkm 187) in Bladen County. While creating fishing opportunities for anglers by concentrating migrating fish, these lock and dams have also limited migration upstream to historic spawning grounds (Nichols and Louder 1970; Moser et al. 2000; Dycus and Fisk 2014). Declines in commercial catch rates in the 1950's when compared to pre-lock and dam catch rates led to investigations in the 1960's and eventual implementation of a locking schedule to facilitate upstream migration of anadromous species (Nichols and Louder 1970) which continues through an agreement with the United States Army Corps of Engineers (USACOE) today. The locking schedule has been modified several times with the most recent modification in 2014 (Appendix 1). Subsequent to the construction of a rock arch ramp built at Lock and Dam 1 in 2012 to aid in anadromous fish passage, there has been no locking for fish passage purposes from 2013–2015 at Lock and Dam 1 in order to formally evaluate fish passage exclusively through the rock arch ramp.

The objectives of this survey were to examine trends in relative abundance and to document the current age and size structure of the Cape Fear River American Shad population. This report summarizes Cape Fear River American Shad spawning stock characteristics and presents creel survey results collected by NCDMF during spring 2015.

Methods

NCWRC staff collected American Shad from the Cape Fear River March through May 2015 at four sampling sites (Figure 1). A boat-mounted electrofishing unit (Smith-Root 7.5 GPP) with one or two dip netters was used to capture fish during daylight hours, and electrofishing effort was recorded (s). Two dip netters were utilized at Lock and Dams 1, 2, and 3 from 13 April–11 May 2015 for a total of five weeks (14 sampling events). All other sampling events utilized one dip netter (n = 23). Ideal flow ranges were targeted to ensure safe, effective sampling (Table 1). To minimize size selection during sampling, American Shad were netted as they were encountered. Relative abundance was indexed by overall catch-per unit-effort (CPUE) and expressed as number of fish captured per hour of electrofishing. Since 2010, sampling efforts were standardized by electrofishing for 30 minutes downstream of each lock and dam. NCWRC staff sampled for 15 minutes on one side of the river from the middle of each dam down the adjacent shoreline and duplicated the same effort starting again at the middle of the dam on the opposite shoreline. Lock and Dams 1, 2, and 3 were sampled weekly. In 2014, an additional weekly site was added downstream of Buckhorn Dam near Corinth (rkm 316). Two additional reaches upstream of Lock and Dam 3 were sampled once each in 2015, referred to as Riverside (rkm 236) and Lillington (rkm 290).

To determine passage efficiency following completion of the rock arch ramp on catch rates of American Shad, a 3-year mean was calculated as pre-rock arch ramp (2009–2011) and post-rock arch ramp (2013–2015) for relative abundance estimates. A Mann-Whitney-Wilcoxon test was used to determine statistical significance at $\alpha = 0.05$ level.

Sex was determined for each captured American Shad by applying directional pressure to the abdomen toward the vent and observing the presence of milt or eggs. Each fish was weighed (g) and measured for total length (mm). American Shad were marked with fin clips to determine within-season recaptures and movement between sample sites. American Shad were fin clipped according to sample site and fin type as follows: Lock and Dam 1, upper caudal; Lock and Dam 2, lower caudal; Lock and Dam 3, left pectoral fin clip. American Shad captured at Buckhorn Dam were not fin clipped. American Shad were assigned ages based on an age-length key created from aged American Shad of previous collections (2010–2014) from the Cape Fear River. Proportions of each age class within each 10-mm length group of known ages were used to expand and populate all American Shad collected within each length group by sex. Age distributions and CPUE by age-class were then calculated. Mean lengths at age were calculated for the entire sample following methods described by Bettoli and Miranda (2001).

Recreational Harvest Regulations and Monitoring

Effective 1 August 2013, anglers in the Cape Fear River could harvest no more than 10 Hickory Shad *A. mediocris* or American Shad per day in aggregate with no more than 5 being American Shad. The daily creel limit was adjusted based on target thresholds established within the North Carolina American Shad Sustainability Plan (NCDMF and NCWRC 2012) that addresses appropriate fishing mortality rates for American Shad populations. A creel survey led by NCDMF was conducted at Lock and Dams 1, 2, and 3 as well as four other access areas on the Cape Fear River during the 2015 anadromous sampling season. The estimate of American Shad caught was calculated by summing the total number of reported discards with the total number harvested. Percent of American Shad released was estimated by calculating the total number of discards divided by American Shad caught. In addition, angler catch rates were calculated by dividing the estimated number of American Shad caught by total shad angler effort (trips and hours fished for shad). The mean weight (kg) of each shad harvested was also estimated.

Results

A total of 1,306 American Shad were collected during springtime surveys from 18 March–18 May 2015, with 1,288 collected at Lock and Dams 1, 2, 3, and Buckhorn Dam. Of the total, 21 were collected at Buckhorn Dam, 360 at Lock and Dam 3, 566 at Lock and Dam 2, and 341 at Lock and Dam 1 (Table 2). Eighteen additional shad were collected from sites at Lillington (N = 9) and Riverside (N = 9). These two sites were only sampled once and were not included in analyses. Only three Hickory Shad were collected, all collected near Lock and Dam 1 in March. Mean relative abundance of American Shad was 5.4 fish/h at Buckhorn Dam, 79.4 fish/h at Lock and Dam 3, 113.1 fish/h at Lock and Dam 2, and 67.6 fish/h at Lock and Dam 1 (Table 2). Pooled mean CPUE for all sites in 2015 was 69.2 fish/h. Pooled mean CPUE for Lock and Dams 1, 2, and 3 was 84.2 fish/h. Weekly catch rates were highest during periods of reduced flow (Figure 2).

Overall catch rates have generally increased since 2012 (Figure 3). Pooled mean CPUE for 2013–2015, as well as Lock and Dams 2 and 3 was significantly higher when compared to the 2009–2011 values (Table 3). Catch rates increased at Lock and Dam 1 during the same timeframe but not significantly.

Out of 1,288 American Shad collected, 609 were marked with fin clips to evaluate recapture rates and movement between sites; 142 at Lock and Dam 1, 298 at Lock and Dam 2, and 169 at Lock and Dam 3. Fifteen individuals were recaptured from Lock and Dam 1 (N = 12), Lock and Dam 2 (N = 3), and Lock and Dam 3 (N = 1). Fish marked at Lock and Dam 1 were recaptured at Lock and Dams 2 and 3, while fish marked at Lock and Dams 2 and 3 were only recaptured at the same locations (Table 4). Overall recapture percentage was 2%.

Males comprised 57% of the catch compared to females at 43%. The male to female ratio ranged 0.6–2.1:1 with the overall mean = 1.4:1 (Table 2). Male and female American Shad collected in 2015 exhibited unimodal length distributions. Males ranged from 339 to 551 mm and peaked in the length frequency histogram from 390 and 410 mm. Females ranged from 441 to 580 mm and the length distribution peaked from 510 and 530 mm (Table 5; Figure 4). Males ranged in age 2–7 years old while 76% were age 3–4 based on application of an age length key (Table 5). Females ranged from 3–8 years old and 74% were age 5–6. Mean weight of males was 810 g while females mean weight was 1,449 g.

Based on information reported by anglers interviewed by NCDMF creel clerks during the spring of 2015, an estimated 10,261 American Shad were caught on the Cape Fear River. Total angling effort for American Shad was 3,411 trips and 13,930 angler-hours from March through May in 2015 (Table 6). Angler effort and harvest was highest in March comprising 47% of trips, 48% of the hours, and 50% of harvest. Estimates for May were lowest with angler trips, hours fished, and harvest <10% of their respective totals. Estimated harvest for this time period was 4,136 individuals weighing 5,218 kg. On average, anglers caught 3.0 shad per trip, catch rates were 0.7 fish per hour, and the mean weight of shad caught was 1.3 kg (Figure 5). Anglers were estimated to have released 60% of fish caught and harvested 40%. Based on recreational and commercial harvest comparisons from 2013–2015, recreational harvest has decreased from 18,651 kg to 5,219 kg in 2015. During this same time frame, recreational catch rates (kg of American Shad harvested/trip) has ranged from 1.5 kg/trip in 2013 and 2015 to 3.6 kg/trip in 2014. Commercial harvest ranged from 24,699 kg in 2015 to 46,398 kg in 2014. Commercial American Shad catch rates were 73.2, 116.2, and 87.9 kg/trip in 2013, 2014, and 2015 (Table 7 and Figure 6; NCDMF unpublished data).

Discussion

The 2015 sampling season for anadromous species marks the highest number of American Shad caught to date with an overall CPUE of 69.2 fish/h. CPUE has increased from 54 fish/h observed in 2014, which was the previous highest recorded catch during American Shad electrofishing efforts. Catch rates at each Lock and Dam have trended upward since 2012 with Lock and Dam 2 experiencing the largest increase. The comparison of catch rates pre (2009–2011) and post (2013–2015) construction of the rock arch ramp revealed significant increases in overall as well as site specific catch rates. There may be several potential factors effecting the increase in catch rates in American Shad, with the most likely factor attributed to increased

passage efficiency following completion of the rock arch ramp in 2012. Our data compliments a fish passage study determining passage rates of several species including American Shad, where American Shad were found to be successful in passing the rock arch ramp at rates at or above utilizing the locking system alone (Moser et al. 2000; Raabe et al. 2014). Reductions in recreational harvest limits from 10 American Shad per day to 5 per day were implemented beginning with the 2014 season, and correspond with marked reductions in harvest of American Shad in subsequent creel surveys. According to the NCDMF creel survey, American Shad harvest and release has remained at 40% and 60% from 2013–2015. However, the over creel (> 5 fish) discard estimate has increased substantially in the same timeframe (2013 = 5.7%; 2014 = 39.4%, 2015 = 66.2%; NCDMF unpublished data). This regulation needs to be formally evaluated to determine if recreational harvest estimates are equitable with commercial harvest in the Cape Fear River, and are meeting the intended objectives specified within the NC American Shad Sustainability Plan. Increased electrofishing catch rates were also likely influenced by utilizing two dip netters instead of only one for a portion of the sampling events. Out of 37 sampling events in 2015, 14 utilized 2 dip netters. These 14 sampling events were all at Lock and Dams 1, 2, and 3. Future sampling will likely use 2 dip netters throughout the entire sampling season to help reduce gear saturation. Overall, recapture rates for individuals marked with caudal fin clips were low, yet comparable to Nichols and Louder (1970).

Along with modifications to regulations and sampling procedures, catch rates were likely influenced by river flows during sampling events. Pooled weekly catch rates peaked during periods of lower flows and were impacted by large numbers of shad collected at Lock and Dams 2 and 3. Hydrologic conditions at these sites were calmer and electrofishing may be more efficient during these lower flow events. Turbulence from the spillway over the dams becomes more powerful as flows increase and capture efficiency may be effected. These increases in catch rates may be an artifact of higher capture efficiency as opposed to changes in abundance, although during these periods of low flow, migrating fish become increasingly dependent on the locking schedule as flows are insufficient to pass over the dam. Further analysis investigating impacts of river flows and water temperature on catch rates is warranted to elucidate optimal sampling conditions. The effects of seasonal flows and spawning success as defined by returning cohorts also needs to be investigated to determine effects of spring and summer flows on year class survival and success. Sampling accessibility to areas upstream of Lock and Dam 3 are highly dependent on river flow and weekly sampling was not feasible in 2015 throughout the Smiley Falls reach. American Shad were present at the exploratory sites at Lillington and Riverside and additional sites will be explored throughout the Smiley Falls reach in 2016 to determine abundance and location of spawning activity.

The Cape Fear River mainstem has been the primary sampling focus for spawning American Shad as well as other anadromous species, although historic spawning aggregations were found in all the tributary rivers flowing into the Cape Fear River. Although historical catch rates indicate the Northeast Cape Fear and Black rivers had smaller spawning aggregations when compared to the Cape Fear proper comprising 9–15% of the Cape Fear commercial shad catch before the lock and dams were constructed (Cobb 1906), little contemporary data exists to evaluate these runs today. Spawning run assessments for the Northeast Cape Fear and Black rivers are warranted to determine current status of those stocks.

In an attempt to reduce duplicative effort for American Shad spawning mark assessments on the Cape Fear River, NCWRC has collaborated with NCDMF to determine annual rate of return of American Shad in the Cape Fear River since 2011. Based on frequency of American shad with repeat spawning marks, the Cape Fear River is the most semelparous stock in North Carolina. In 2014, the Cape Fear River had the highest proportion of virgin spawners and lowest proportion of repeat spawners when compared to the four major rivers in North Carolina (NCWRC and NCDMF 2015). Evidence of this was observed during sampling events for catfish and sport fish that occurred in June 2015 where on several occasions emaciated American Shad were found slowly swimming on the surface throughout the Cape Fear River. One American Shad was collected in the upper Black River in the same condition. Reports of "dying shad" were also confirmed in Lillington during the same time frame. During these same sampling events, several juvenile American Shad were collected while sampling from Lock and Dam 1 downstream to the mouth of the Black River. Past studies documenting American Shad spawning found juvenile fish from the mouth of the Black River to upstream of Lock and Dam 3 (Davis and Cheek 1966; Fischer 1980). Although there is no formal juvenile abundance survey conducted for American Shad in the Cape Fear River, sport fish surveys will continue in 2016 and further document juvenile American Shad distribution and abundance.

Along with studies focusing on juvenile abundance and distribution throughout the Cape Fear River, other studies have investigated site-specific spawning grounds through the collection of American Shad eggs. Smith and Hightower (2012) found the majority of American Shad spawning was restricted downstream of Lock and Dam 1. In 2015, an informal egg survey was conducted through a collaborative effort by the NCWRC, NCDMF, and Cape Fear River Watch from 18 March–20 May 2015 sampling once a week at Lock and Dams 1 and 2. These results found that American Shad spawning activity may have increased at Lock and Dam 2 which differs from pre-rock arch ramp surveys (Smith and Hightower 2012). A more comprehensive study of egg and fry abundance will be conducted in 2016 to determine changes in spawning activity. The Cape Fear River American Shad stock will continue to be monitored and evaluated to determine impacts of changes in recreational harvest as well as habitat modifications through the continued cooperation with partner agencies and stakeholders.

Management Recommendations

1. Maintain current American Shad sampling efforts in the spring of 2016 and continue to add sample sites in the vicinity of Smiley Falls to increase efforts on upstream historical spawning grounds.
2. Conduct an egg and larval survey at each Lock and Dam in 2016 to determine spawning timing and activity and compare these to pre-rock arch ramp egg surveys.
3. Incorporate side-scan sonar technologies to map potential spawning habitats throughout the Cape Fear River.
4. Evaluate effects of spring and summer river flows on spawning success and cohort strength.
5. Include 2015 data in the American Shad Sustainability Plan for the next allocation assessment to evaluate the harvest regulations associated with American Shad.

Acknowledgments

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TABLE 1.—Minimum and maximum stream flow needed to access American Shad sample sites on the Cape Fear River. The flow range for Smiley Falls was used to sample sites at Lillington and Riverside.

Sample Site	Low Flow (cfs)	High Flow (cfs)
Buckhorn Tailrace	900	5,000
Smiley Falls	3,000	10,000
Lock and Dam 3	unobserved	20,000
Lock and Dam 2	unobserved	20,000
Lock and Dam 1	unobserved	unobserved

TABLE 2.— American Shad weekly electrofishing effort, total catch, male to female ratio, mean CPUE, standard error, number of fish collected at each sample site, mean weekly water temperature, and mean weekly discharge at USGS stream gage 2105769 near Kelly, NC. Total CPUE represents the total number of American Shad collected divided by the total number of sampling hours. Values missing were dates where river flows were not favorable to sample.

Sample Week (Date)	Effort (h)	Catch	Male:Female Ratio	Mean CPUE (SE)	Lock and Dam 1	Lock and Dam 2	Lock and Dam 3	Buckhorn Dam	Number of Sites	Mean Water temp (°C)	Mean Flow (cfs)
3/16/2015	2.03	105	1.3	51.9 (26.7)	64	25	16	0	4	13.7	5,555
3/23/2015	2.02	58	2.1:1	29.0 (14.7)	35	11	12	0	4	13.3	5,686
3/30/2015	2	71	2.1:1	35.4 (15.3)	37	14	20	0	4	13.2	5,915
4/6/2015	2.07	171	1.2:1	84.8 (39.1)	23	91	56	1	4	18.8	2,705
4/13/2015	2	129	1.4:1	64.3 (21.7)	38	45	46	0	4	19.1	5,320
4/20/2015	1	80	0.6:1	79.9 (12.2)	46	34			2	19	9,150
4/27/2015	2.02	144	2.1:1	70.6 (31.5)	66	7	61	10	4	17.5	6,600
5/4/2015	2.04	126	0.9:1	62.1 (20.5)	26	58	33	9	4	18.6	5,405
5/11/2015	1.79	222	1.3:1	111.1 (83.0)	4	178	39	1	4	21.8	2,640
5/18/2015	1.5	182	1.4:1	121.3 (60.6)	2	103	77		3	24.4	1,110
Totals	18.48	1,288	1.4:1		341	566	360	21			
Mean				69.2	67.6	113.1	79.4	5.4			
SE				11.9	13.6	33.9	14.5	2.9			

TABLE 3.—American Shad relative abundance from 2009–2015 in the Cape Fear River. Column headings pre and post refer to the 3-year means (pre = 2009–2011; post = 2013–2015) before and after the rock arch ramp was completed in 2012. Data for Buckhorn Tailrace has only been sampled in 2014–2015 and in not available for all other years. P values < 0.05 were considered significant.

All months Mean CPUE	2009	2010	2011	2012	2013	2014	2015	Pre	Post	p-value
Lock and Dam 1	45.5	30.0	20.8	42.9	44.0	57.4	67.6	29.3	57.3	0.07
Lock and Dam 2	27.3	27.3	24.3	32.3	60.0	61.5	113.1	25.9	78.2	0.01
Lock and Dam 3	44.0	29.7	24.8	54.3	40.3	65.3	79.4	30.7	63.3	0.01
Buckhorn Tailrace						22.9	5.4			
Pooled CPUE	38.9	29.0	23.3	43.1	48.1	61.4	86.7	28.6	66.3	<0.01

TABLE 4.—American Shad fin clipped and recaptured in the Cape Fear River spring, 2015. Note all shad encountered were not fin clipped.

		Recaptures			Total	Percent
	Marked	LD1	LD2	LD3	Recaptured	Recaptured
LD1	142	2	6	3	11	8
LD2	298		3		3	1
LD3	169			1	1	1
Total	609				15	2

TABLE 5.—Mean total length (mm) at age for American Shad males and females collected from the Cape Fear River, spring 2015. American Shad ages were estimated from an age-length key created from previous known ages of American Shad from the Cape Fear River.

Sex	Age	Cohort	Mean	Min	Max	Total	Percent Composition by Sex
Male	2	2013	412	339	459	10	1
	3	2012	401	323	478	229	31
	4	2011	426	358	489	335	45
	5	2010	454	390	502	124	17
	6	2009	470	392	551	41	6
	7	2008	505	500	504	2	< 1
	Total					741	100
Female	3	2012	496	458	523	12	2
	4	2011	491	441	527	88	16
	5	2010	511	441	580	218	39
	6	2009	525	451	573	196	35
	7	2008	527	464	578	46	8
	8	2007	495	493	495	2	< 1
	Total					562	100

TABLE 6.—North Carolina Division of Marine Fisheries American Shad creel estimates collected at eight access areas adjacent to the Cape Fear River during spring 2015.

	All Effort		American shad Effort		American shad Harvest		American shad Discards (numbers)		
Month	Trips	Hours	Trips	Hours	Number	Kilograms	Over Creel	Legal Size	Total
Mar	1,843	7,636	1,616	6,635	2,061	2,412	941	191	1,132
Apr	2,453	13,620	1,488	6,405	1,860	2,540	3,113	1,880	4,993
May	4,760	34,207	307	890	215	267	0	0	0
Total	9,056	55,463	3,411	13,930	4,136	5,219	4,054	2,071	6,125

TABLE 7.— Estimated total trips, total harvest, and CPUE for the 2015 American Shad recreational creel and NCDMF commercial harvest in the Cape Fear River (NCDMF; unpublished data). Recreational and Commercial are abbreviated as “R” and “C.”

	Total Harvest (kg)		Total Trips		CPUE (kg harvested/trip)	
	R	C	R	C	R	C
2013	18,651	24,888	12,081	340	1.5	73.2
2014	10,472	46,148	2,896	397	3.6	116.2
2015	5,219	24,699	3,411	281	1.5	87.9

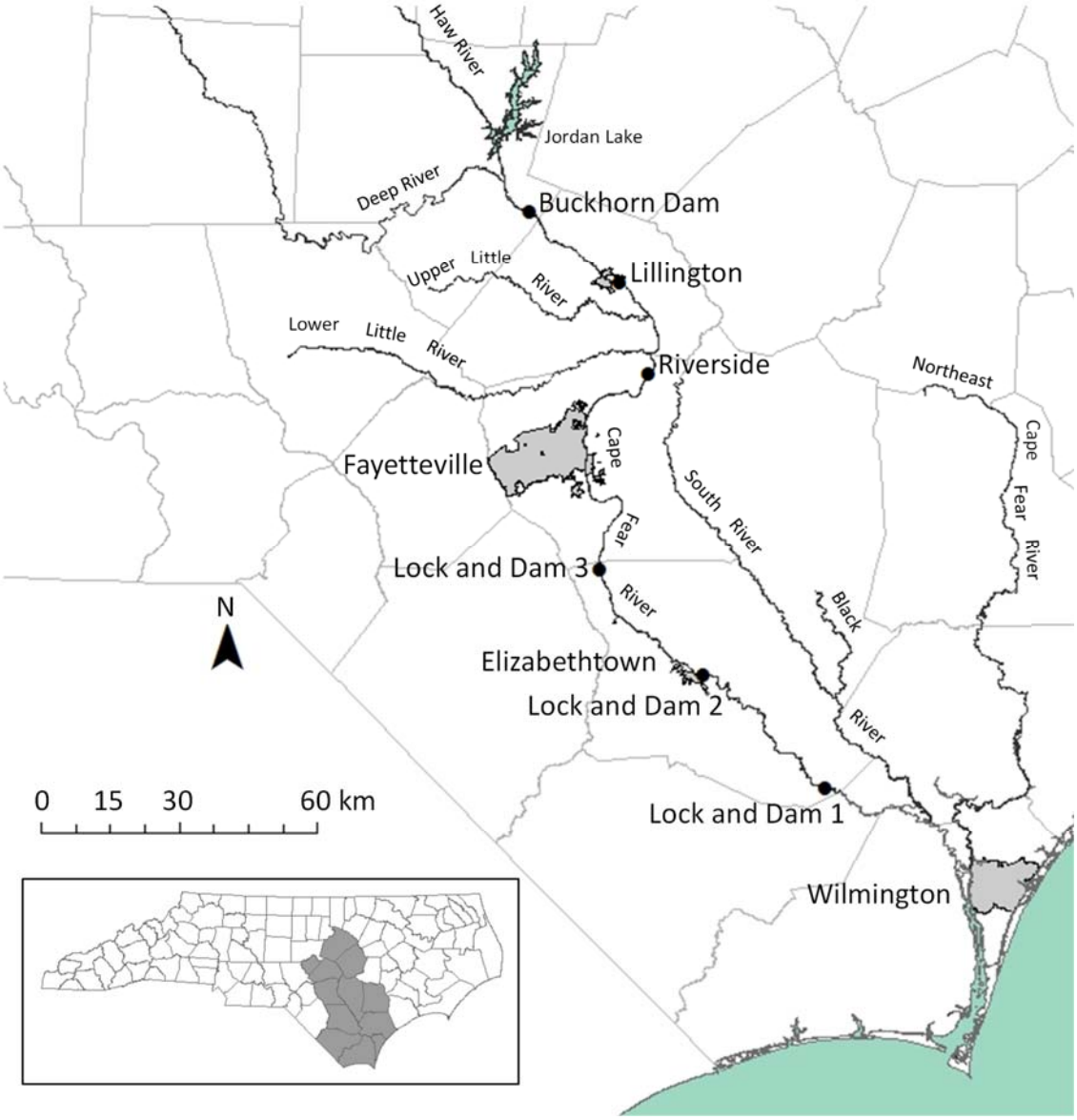

FIGURE 1.—Map of 2015 sample sites on the Cape Fear River. Note sites at Riverside and Lillington were only sampled one time each. Buckhorn Dam, Lock and Dams 1, 2, and 3 were sampled weekly from the week of 16 March 2015 through 18 May 2015.

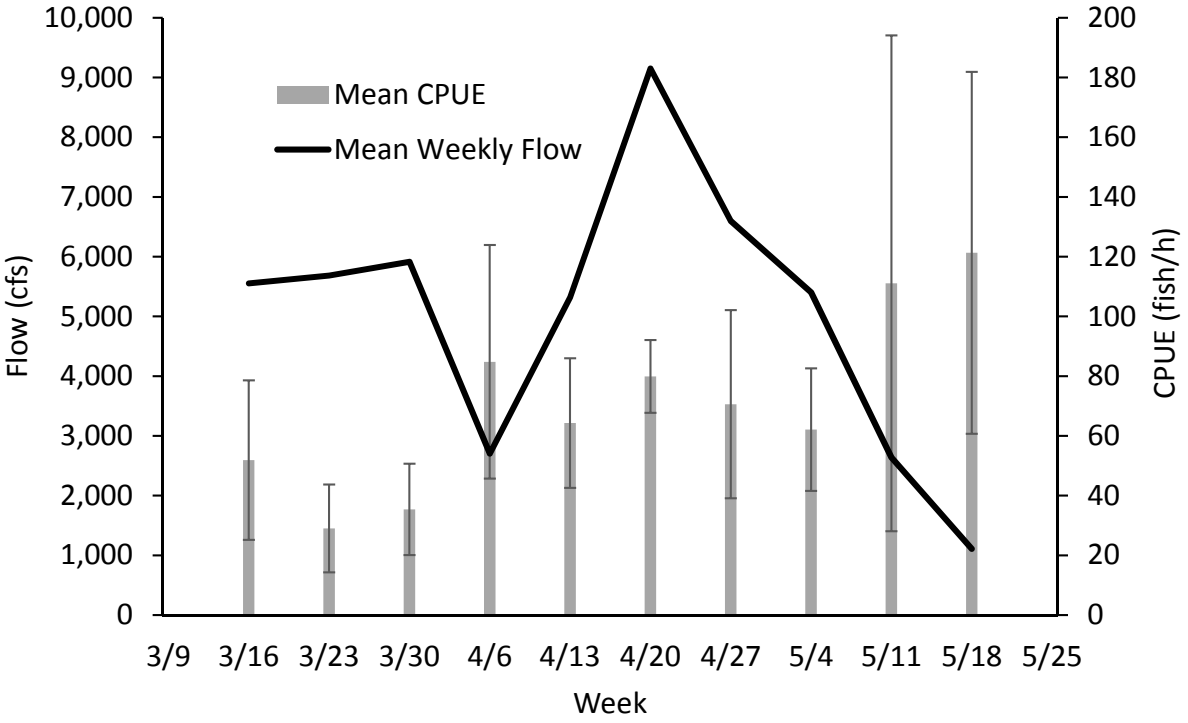

FIGURE 2.—Weekly mean CPUE and standard error of American Shad from the four main sampling sites in the Cape Fear River in 2015. Five of the ten weeks sampled utilized two dip netters (13 April–11 May, 2015; 14 sampling events).

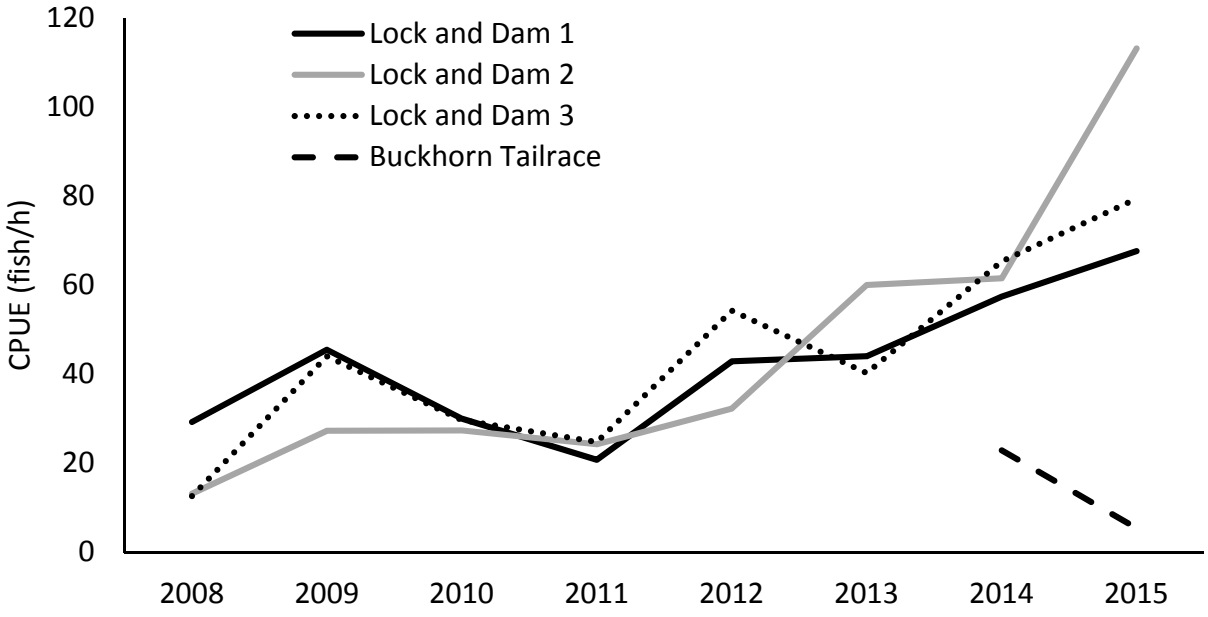

FIGURE 3.—Relative abundance of American Shad collected in the Cape Fear River from 2008–2015. Sampling methods were standardized from 2010 to present.

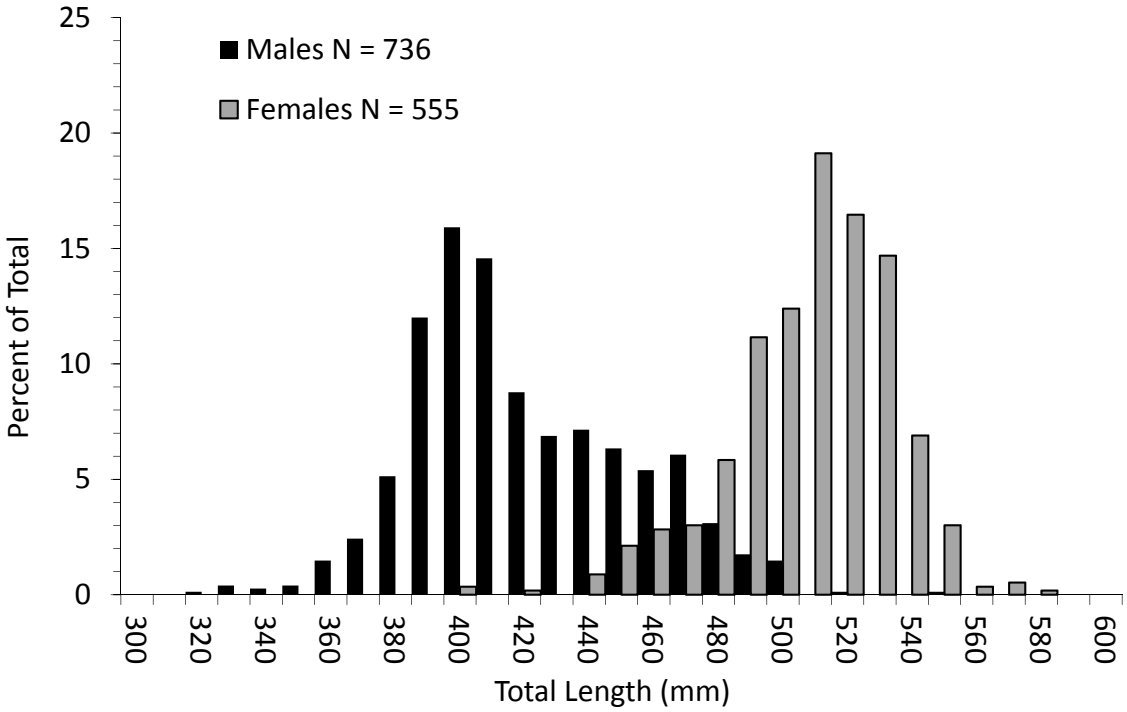

FIGURE 4.—Length-frequency distribution for American Shad collected on the Cape Fear River, spring 2015. Recaptures were omitted.

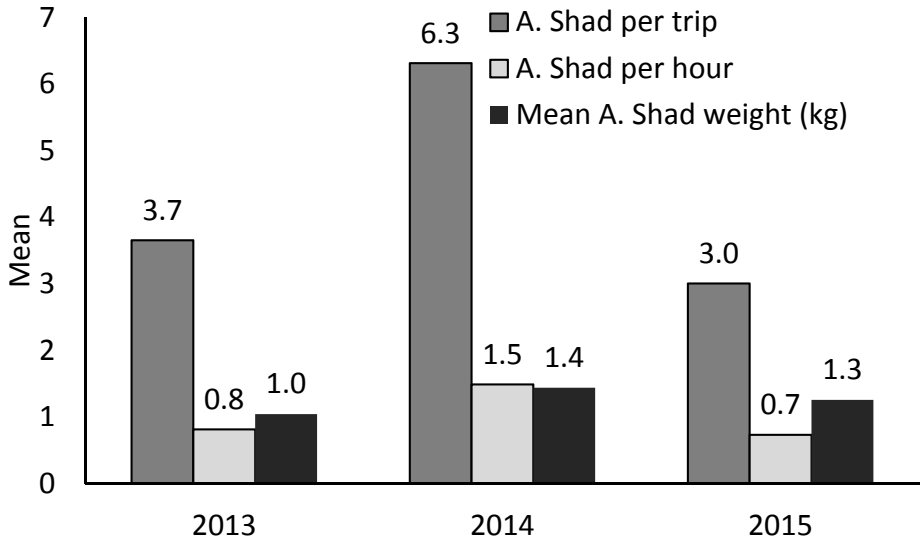

FIGURE 5.—North Carolina Division of Marine Fisheries creel estimates of American Shad catch rates per trip, hour, and mean weight of American Shad per year. Percent of American Shad harvested each year from 2013–2015 was 40%, while release rate for the same time frame was 60%.

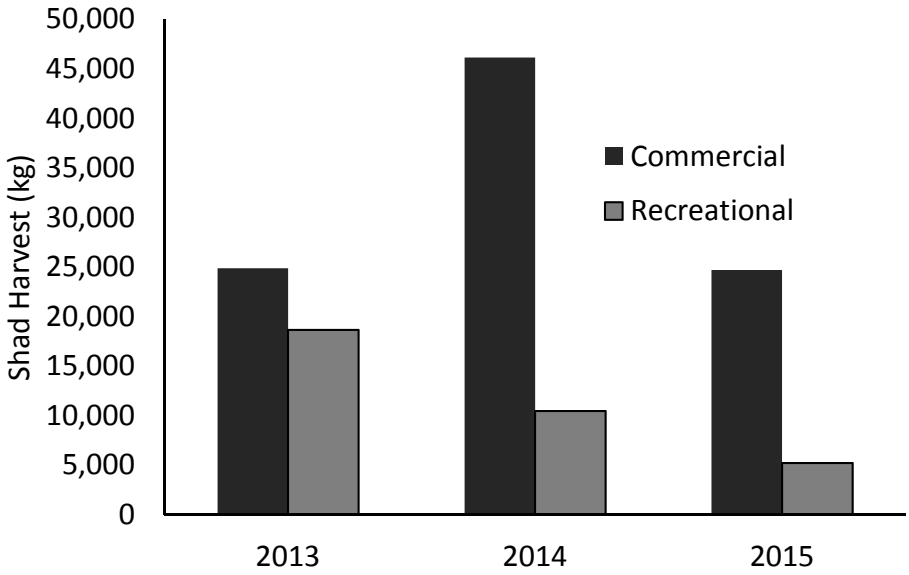

FIGURE 6.—Estimated harvest (kg) of American Shad from 2015 North Carolina Division of Marine Fisheries recreational creel survey and commercial harvest.

APPENDIX A.–2015 Locking schedule for the Cape Fear River.

PHASE I Lock Schedule:

Lock & Dam 2: January 1, 2015 – March 14, and May 21 – Dec 31, 2015.
Lock & Dam 3: January 1, 2015 – March 21, and May 28 – Dec 31, 2015.

- One lockage per week Monday – Friday conducted between 7 am and 6 pm
- 42 weeks, 42 locks for each lock

PHASE II Lock Schedule:

PHASE II (EARLY)

Lock & Dam 2: March 15 – April 1. Lock & Dam 3: March 22 – April 8.
Lock & Dam 3: March 22 – April 8.

- One lockage per day Monday – Friday conducted prior to 10 am
- 13 days, 13 locks for each lock

PHASE II (PEAK)

Lock & Dam 2: April 2 – May 12.
Lock & Dam 3: April 9 – May 19.

- Two lockages per day, one prior to 10 am and the other between 2 pm and 4 pm
- 29 days, 58 locks for each lock

PHASE II (LATE)

Lock & Dam 2: May 13 – May 20.
Lock & Dam 3: May 20 – May 27.

- One lockage per day conducted prior to 10 am
- Upper gates shall remain open for at least 1 hour to release fish.
- 6 days, 6 locks for each lock