ROANOKE RIVER STRIPED BASS CREEL SURVEY AND ESTIMATION OF ECONOMIC IMPACTS, 2015

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Abstract.—Creel clerks conducted 957 angler interviews to assess angler characteristics and harvest of Striped Bass *Morone saxatilis* from the Roanoke River Management Area (RRMA) in 2015. During the 64-day harvest period (1 March – 3 May), angler parties expended an estimated 111,418 angler hours (SE = 17,372) for Striped Bass. Estimated harvest was 20,031 Striped Bass (SE = 3,450), which weighed 26,745 kg (SE = 3,119) or 58,962 lb (SE = 6,876 lb) and this harvest estimate was 85.7% of the 2015 Total Allowable Landings (TAL) of 68,750 pounds. Including harvested Striped Bass, anglers caught an estimated 98,432 Striped Bass (SE = 17,491) during the harvest period. Approximately 64% of the total harvest was composed of the 2011 year class (age 4) comprised of female (42%) and male Striped Bass (22%). During 4–19 May, anglers expended 12,229 angler-hours (SE = 4,813) for an estimated released catch of 29,839 Striped Bass (SE = 12,236); anglers indicated that 61% were less than 18 inches, 36% were between 18-22 inches, 2% were in the protected slot limit, and four Striped Bass were greater than 27 inches. Angler origin was summarized for the entire creel survey period, and about 27% of the anglers from parties interviewed were from five counties bordering the Roanoke River; 65% were from another 67 NC counties, and 8% were non-residents of 19 states and 2 countries. Estimated angler trip expenditures contributed approximately $1.7 million in economic output in North Carolina. Adaptive management strategies that address sustainable harvest scenarios and adequate spawning regimes contribute to the persistence of the popular recreational Striped Bass fishery on the Roanoke River.

The North Carolina Wildlife Resources Commission (Commission) is responsible for the annual reporting of the recreational harvest of anadromous Striped Bass *Morone saxatilis* in the Roanoke River Management Area (RRMA). Assessment of the recreational harvest as well as population characteristics from this system are summarized each year and submitted to the North Carolina Division of Marine Fisheries (NCDMF). This compiled information is utilized for updates to the Estuarine Striped Bass Management Plan for North Carolina (NCDENR 2013) and included in the North Carolina annual Striped Bass status report to the Atlantic States Marine Fisheries Commission (ASMFC). This information is required from North Carolina by the ASMFC as mandated under conditions set forth within the interstate fisheries management plan for Striped Bass established for the eastern United States (ASMFC 1981) and associated amendments (ASMFC 2003) and addendum (ASMFC 2014).

Annual compliance with this plan is necessary to protect and enhance the Striped Bass populations within coastal North Carolina for the benefit of recreational and commercial fishermen. Striped Bass harvest for the Albemarle/Roanoke River stock is managed with a Total Allowable Landings (TAL) allocation system. The 2015 TAL for the entire stock was 275,000 lb where the Albemarle Sound Management Area (ASMA) commercial sector was allocated 50% (137,500 lb) of the TAL, 25% (68,750 lb) was allocated to the ASMA recreational sector, and 25% (68,750 lb) was allocated to the RRMA recreational sector.

To ensure Striped Bass harvest does not exceed the RRMA TAL, the recreational fishery in the Roanoke River is regulated through a limited open harvest season, daily possession limits, and length limits. Since 1997, anglers have been required to use only a single, barbless hook during 1 April–30 June between the Roanoke Rapids Dam and the US Hwy 258 Bridge. The single barbless hook regulation, angler education efforts (distribution of catch-and-release brochures and numerous popular articles), and the promotion of circle hooks were implemented to minimize catch-and-release mortality of Striped Bass while they are in the RRMA. Since 2003, the daily creel limit was two fish, the minimum length limit was 18 inches (TL), and a protective slot size limit between 22 and 27 inches (TL) was in effect. In addition, only one Striped Bass greater than 27 inches could be retained in the daily creel limit of two Striped Bass. In 2007, a unified harvest season implemented for the RRMA represented a deviation from past years when the harvest season opened and closed separately among specified zones of the RRMA. The intention of the unified season was to distribute angling effort among boating access areas to reduce congestion while providing additional harvest opportunities.

Our report will encompass estimates of Striped Bass effort, catch, and harvest as well as trip expenditures, angler origin, and other characterizations of the 2015 Roanoke River Management Area creel survey. Survey results from the Roanoke River contained in this document will be combined with separate estimates of Striped Bass catch and harvest as well as angling effort collected by NCDMF in the Albemarle Sound Management Area to estimate

recreational harvest. This information coupled with analysis of population dynamics is critical for determining the appropriate TAL from the Albemarle/Roanoke Striped Bass fishery while still allowing for stock preservation and growth.

Methods

Study Site and Survey Design

The RRMA includes the Roanoke River from Roanoke Rapids Lake dam at river kilometer (rkm) 227 downstream to Albemarle Sound including the Cashie, Middle, and Eastmost rivers and tributaries (Figure 1). Commission staff used a non-uniform probability stratified access-access creel survey design (Pollock et al. 1994) to estimate recreational fishing effort (angler hours), harvest of Striped Bass from 1 March to 3 May 2015, and numbers of Striped Bass caught and released from the RRMA during 1 March–19 May 2015. The creel survey was stratified by area (upper zone or lower zone), time (AM or PM), and type of day (weekdays and weekend days). The upper zone included the river segment from Roanoke Rapids Lake dam downstream to the U.S. Highway 258 Bridge near Scotland Neck. The lower zone extended from U.S. Highway 258 Bridge downstream to Albemarle Sound. Because past analyses depict differential catch rates through progression of the open harvest season, the survey was stratified into four, two-week sample periods. A fifth sample period was also established to describe catch statistics within the 3-day season extension (1–3 May). Within periods, samples and estimates were further stratified by type of day because fishing effort and catch is also known to vary as a function of day type. Selection of access points where interviews occurred was based upon probability of boat trailer counts generated from prior RRMA creel surveys and available access areas for 2015. Probabilities of fishing activity for time of day (0.4 for AM and 0.6 for PM during periods one and two, and equal probabilities during all other periods) were estimated based upon prior experience with the RRMA Striped Bass fishery.

The 2015 Striped Bass harvest season was open for 64 days from 1 March to 3 May in the entire RRMA. Two, three-hour interview sessions (one in each zone each day) were held on two random weekdays and both weekend days each week when the Striped Bass harvest season was open. Creel clerks interviewed anglers as they completed fishing trips at boating access areas. The creel survey was continued at the Weldon boating access area during 4–19 May to estimate Striped Bass angling effort and catch during a portion of the catch-and-release season.

Data collected from each fishing party interviewed included date and time of the interview, time that the party began fishing, and number of anglers in the party. Creel clerks inquired to the total number of Striped Bass caught and of those, the number of Striped Bass harvested. Creel clerks measured total length (TL, mm), weight (kg), and determined sex of each Striped Bass harvested. Creel clerks also requested the number of Striped Bass released within length limit categories, type of bait used, angler residency, and trip expenditures. Catch

and harvest information for additional species such as American Shad *Alosa sapidissima* and Hickory Shad *A. mediocris* was collected as encountered.

Effort, Catch, and Harvest Data Analysis

Estimates of Striped Bass angler effort (angler hours and anglers), catch (number of Striped Bass), and harvest (number and weight) for each sample day were calculated by expanding interview data by the sample unit probability (product of the access point probability and time of day probability; Pollock et al. 1994, Jones and Pollock 2012). Striped Bass catch, effort, and harvest estimates for weekdays and weekend days were separately averaged within sample periods. The averages were then expanded to the total days of each type for that sample period. Separate estimates of effort (E), total catch (C), and harvest (H) were calculated for each zone, sample period, and season (Harvest or Catch-and-release) using the following basic equations:

$$\hat{E} = \sum_{i=1}^{n} \frac{e_i}{\pi_i}$$

and

$$\hat{C} = \sum_{i=1}^{n} \frac{c_i}{\pi_i}$$

and

$$\hat{H} = \sum_{i=1}^{n} \frac{h_i}{\pi_i}$$

where e_i is the effort, c_i is the total catch, and h_i is the harvest of the ith sampling unit in a sample size n; π_i is the total probability that the ith sampling unit is included in the sample. Approximate standard errors (SE) of the estimates for effort (E), catch (C), and harvest (H) within strata were computed as:

$$\hat{SE}\left(\hat{Estimate}\right) = \sqrt{N^2\left(\frac{s^2}{n}\right)}$$

where s^2 is the variance of the effort observations, n is the number of days sampled, and N is the number of days of that type available for sampling.

Mean (SD) number of anglers, trip length (time entire party fished), and angler-hours (hours fished per angler) were calculated and reported by harvest and catch-and-release (closed) season. Age composition of Striped Bass harvest was estimated from percentages of lengths at age by sex determined from the concurrent 2015 Commission electrofishing spawning stock assessment (Smith et al. 2016). Categories of released catch were quantified and expressed as percentages for the harvest and catch-and-release seasons.

Trip Expenditure and Economic Impacts

We utilized IMPLAN (2013) to estimate the economic impacts of fishing activity occurring during the surveyed region and timeframe. IMPLAN is a commonly employed software package that is used to calculate economic impacts of an activity or group of activities within a region. IMPLAN uses an input-output model to examine monetary exchanges between firms, industries, individuals, and institutions within a region to estimate economic multiplier effects (Dumas et al. 2009). In the case of this analysis, the region being examined is the state of North Carolina. Economic impact estimates presented include *jobs*, *income impacts*, and *output impacts*. *Jobs* represent both full-time and part-time employment positions. *Income impacts* reflect wages, salaries, and self-employment income. *Output impacts* represent total industry production and business sales. All of these estimates are based on the trip expenditures input into the IMPLAN software program.

Anglers were asked to report their party's trip expenditures for food and beverages, ice, bait, boat fuel and oil, vehicle fuel, lodging, and fishing guide fees. These responses were separated into the categories of "private" or "guided", based on whether a fishing guide was hired for the trip. To obtain total estimated expenditures, the trip expenditures for angling parties were broken down to the mean expense per angler hour to match overall effort estimates that were calculated in angler hours. Angler hours per trip were obtained by multiplying the number of anglers in the fishing party by the length of time that the party spent fishing. To estimate expense per angler hour, mean trip expenditures were divided by the mean angler hours for each trip type (private or guided). The average expenditure per angler hour was then multiplied by the total estimated angler hours for each trip type to provide the estimated total expenditures. This can be expressed as:

$$Te = (F, I, Ba, Bf, Vf, L, G) * Th$$

where Te is the estimated total expenditures, *F* is the average food and beverage expenditure, *I* is the average ice expenditure, *Ba* is the average bait expenditure, *Bf* is the average expenditure on fuel and oil for a boat, *V* is the average expenditure on fuel for a vehicle, *L* is the average lodging expenditure, *G* is the average guide fee, and *Th* is the total number of angler hours. Once total expenditures were estimated, they were input into IMPLAN software under the appropriate category to provide the estimated economic impacts generated by the recreational fishing activity examined.

Results and Discussion

Angler Effort, Catch, and Harvest

Harvest Season.—Within the 64-day period open to Striped Bass harvest on the Roanoke River in 2015, 738 angling parties were interviewed at boating access areas in the RRMA, of which 633 angling parties with 1,619 anglers targeted Striped Bass. The mean number of anglers per Striped Bass angling party was 2.5 (SD = 1.1). Mean trip length for targeted Striped Bass parties was 5.0 hours (SD = 2.1). Mean angler-hours expended was 13.3 (SD = 8.9). Anglers reported a released catch of 5,544 Striped Bass with 87% of the released Striped Bass less than 18 inches, 12% between 18-22 inches, 1% in the protected slot limit, and two Striped Bass greater than 27 inches. Striped Bass catch rate varied over time and location with catch rates increasing through period progression as migration continued towards the spawning grounds near Weldon (Figure 2).

An estimated 22,827 (SE = 3,577) Striped Bass anglers expended an estimated 111,418 angler hours (SE = 17,372) and caught an estimated 98,432 Striped Bass (SE = 17,491) during the harvest season. Estimated harvest in the RRMA was 20,031 Striped Bass (SE = 3,451), which weighed 26,745 kg (SE = 3,119 kg) or 58,962 lb (SE = 6,877 lb). The 2015 RRMA Striped Bass harvest was 85.7% of the 68,750 lb allocated to the RRMA from the 275,000 lb TAL for the Albemarle/Roanoke Striped Bass stock (Figure 3).

Creel clerks collected length, weight, and sex data for 1,332 of the 1,343 Striped Bass that were harvested during interview sessions. Sex was not obtained for eleven Striped Bass. Male Striped Bass (n = 531) comprised 39.8% of the total harvest, and females (n = 801) made up 60.2% (Figure 4). Mean length of harvested males was 483 mm (19.0 in), and mean length of harvested females was 495 mm (19.5 in). Mean weight for all harvested Striped Bass was 1.3 kg (2.9 lb) and was similar for males and females (1.3 kg and 1.4 kg, respectively). The majority (98%) of harvested Striped Bass was within the legal size limit (18–22 inches), although creel clerks measured 24 sub-legal Striped Bass less than 18 inches (18 males and 6 females) and 7 Striped Bass within the protective slot limit (5 females and 2 males).

Protective length limit regulations for Roanoke River Striped Bass are designed to direct the majority of the harvest to three, four, and five year-old male Striped Bass. Overall, the 2011 year class supported the majority (64%) of Striped Bass harvest, and nearly all harvest (97%) was focused on Striped Bass between age 3 and age 5 (Table 1; Figure 5). In 2015, nearly 60% of the entire harvest was comprised of female Striped Bass, of which 42% was represented by the 2011 (age 4) year class. The remainder of the harvest (40%) was attributed to male Striped Bass, with the majority from the 2011 (age 4) and 2010 year classes (age 5). These year classes also dominated the harvest as age-3 and age-4 Striped Bass cohorts during the 2014 harvest season (McCargo and Dockendorf 2015). In comparison, the 2012 year class (age 3) comprised

less than 14% of the harvest during the 2015 season. Still, anglers reported the majority (74%; n = 8,775) of the released Striped Bass catch (n = 11,910) during the entire season was comprised of Striped Bass less than 18 inches that may have been from the 2012 cohort, yet not available to harvest.

The timing of the Roanoke River Striped Bass harvest season is intended to limit the harvest of female Striped Bass because the harvest season closes before the majority of the female Striped Bass usually arrive on the spawning grounds. Striped Bass were harvested throughout the open harvest season of the creel survey, although harvest during the March periods was much lower (about 10%) than the month of April and the 3-day extension from 1–3 May (Table 2). More than 50% of the observed total harvest occurred in the upper zone in 2015, with most harvest observed from April 16 to May 3. In comparison, a little over 20% of the harvest occurred in the lower zone during the same timeframe. In 2015, the Commission approved by proclamation an additional 3-day harvest period after the season was scheduled to close (30 April) as specified in rule. This season extension was intended to offer additional harvest opportunities as the RRMA TAL had not yet been met. In addition, consideration of water temperatures (below the optimum spawning range) and discharge (low flows from Roanoke Rapids Dam) provided further support for additional harvest. During the 3-day extension, anglers harvested 22% (12,972 lb) of the total estimated harvest in 2015, or about 4,300 pounds of Striped Bass harvested per day during the extension. Closure on 4 May was consistent with the Commission's management objectives to remain at or just below the TAL for the RRMA, while also protecting female Striped Bass in imminent spawning condition. It should also be noted that predictions of harvest during any extension of the season are confounded by a host of interrelated factors, most notably catch rates, weather patterns, and angler effort. While the general intention is to come as close to the TAL each year as possible, any overage will be subtracted from the following year's TAL, a situation that should be avoided whenever possible.

Catch-and-release Season.—During the catch-and-release season (4 May – 19 May), 523 anglers from 213 angling parties were interviewed at the Weldon boating access area; all angling parties targeted Striped Bass. Mean number of anglers per party was 2.5 (SD = 0.9) Mean trip length was 5.6 hours (SD = 1.9) per angling party. Anglers caught an average of 2.4 Striped Bass per hour. Anglers reported a released catch of 6,366 Striped Bass with 61% of the released Striped Bass less than 18 inches, 36% between 18-22 inches, 2% in the protected slot limit, and four Striped Bass greater than 27 inches. An estimated 29,839 Striped Bass (SE = 12,236) were caught and released during 12,229 angler-hours (SE = 4,813) expended by an estimated 2,207 anglers (SE = 871) after the season was closed to harvest.

Estimates of short-term (72-hour) catch-and-release mortality rate for Roanoke River Striped Bass were based on controlled tank experiments at the former Weldon State Fish Hatchery (now Weldon Lands and Water Access Depot) conducted in 1996 (Nelson 1998). Applying the average mortality rate of 6.4% to the estimated number of Striped Bass caught and released during the entire creel survey, an estimated 6,928 Striped Bass may have been removed from the population: 5,018 Striped Bass during the harvest season and 1,910 Striped Bass during the catch-and-release season. Applying an average weight of 2.9 lb per Striped Bass harvested during the 2015 creel survey, this equates to 14,552 lb of estimated discard mortality during the harvest season, and 5,539 lb for the catch-and-release season, for a total estimated discard mortality of 20,091 lb. While estimated discards are not included in the estimated Total Allowable Landings associated with the RRMA, the inclusion of this discard mortality estimate would exceed the TAL in terms of estimated total pounds of Striped Bass removed during this survey period. Angler education efforts to reduce catch-and-release mortality during the Striped Bass spawning run are critical to the sustainability of this popular fishery.

Trip Expenditures and Economic Impacts

Trip expenditure information was collected from 794 angling parties (83% of the total number of parties interviewed) during the survey period. Of the 794 parties, 757 parties were on private fishing trips and 37 parties were on guided fishing trips. Average total trip expenditures were $96.53 for private trips and $668.95 for guided fishing trips (Table 3). For private trips, vehicle fuel was the largest single expenditure followed by bait, and food and beverage purchases. On guided trips, the largest single expenditure was the guide fee, followed by food and beverages, and vehicle fuel. An average of 12.79 angler hours were spent by parties fishing on private trips (SE = 0.27 hours) and an average of 20.53 angler hours were spent by parties fishing on guided trips (SE = 1.26 hours). Private trips incurred average expenditures of $7.55 per angler hour while guided trips incurred average expenditures of $32.58 per angler hour (Table 4).

Estimated total trip expenditures for all anglers during the sampled period were examined by region and harvest season for Striped Bass (Table 5). The harvest season saw substantially more angling effort, and as such, the majority of expenditures occurred during this period (88%). While the lower zone represented more overall angling effort, expenditures during the harvest season were almost equally split between the upper zone and lower zone due to the majority of guided trip effort (73%) occurring in the upper zone. The total angling activity supported an estimated $1.22 million in fishing trip expenditures, 20 jobs, $689,000 in income, and $1.71 million in total economic output in North Carolina's economy, not specifically to the region where the fishing activity occurred.

The presented angling expenditures and related economic estimates for recreational fishing on the Roanoke River are likely a conservatively low estimate of the total economic importance of this fishery, as the analyzed angler expenditures for private trips do not include expenses that are made on durable goods related to fishing such as rods, reels, boats, or towing vehicles. While durable goods are purchased with the intention of being used on the Roanoke River, these durable goods often last several years and may be utilized in multiple other fisheries as well as in other activities (e.g., recreational boating, waterfowl hunting). Information on durable goods purchases was not collected and data are not available that would allow this analysis to devote the expenditures on durable goods specifically to fisheries occurring in the Roanoke River during the sampled timeframe, therefore the impacts of these expenditures are not included.

There have been some similar studies previously performed examining expenditures generated by angling activity on the Roanoke River. McCargo et al. (2007) examined data sampled from anglers over a full year on the Roanoke River and estimated mean trip expenditures of $93.44 and a mean expenditure per angler hour of $10.21. The estimated total trip expenditures were $2,545,460 for the entire year with $1,546,332 coming from anglers fishing for Striped Bass during the 2006 harvest and catch-and-release seasons. Schuhmann (1999) examined data collected from striped bass anglers on the Roanoke in the spring of 1998 and estimated that on average catch-and-keep anglers spent approximately $22 per trip while catch-and-release anglers spent approximately $115 per trip. Estimated total trip expenditures for Striped Bass anglers for the season examined were approximately $918,000.

Results of studies describing the economic impacts and contributions of fishing can be used with biological, social, and cultural data to inform decisions on fisheries management (Upneja et al. 2001). This information may be used to communicate the economic effects of fishing to portions of society beyond anglers and others who do not participate or have an interest in fishing (Upneja et al. 2001). Additionally, spending (a component of economic impact analysis) may help partially convey the importance of an activity, in this case recreational Striped Bass fishing during the RRMA season (Wilton and Polovitz-Nickerson 2006).

Although economic impact analyses can communicate some of the effects of an activity, these results do not fully describe the economic benefits or the social and political importance of an activity (Watson et al. 2007, Day 2012). Economic impact analyses solely measures economic activity in a region's economy. In the case of Striped Bass fishing in the RRMA, it would be inappropriate to make resource allocation decisions without also considering the marginal and net benefits of the fishery in addition to the social importance of the different fishing sectors and management areas.

Additional Characterization of the Roanoke River Creel Survey

Species Targeted.—Creel clerks interviewed 119 parties comprised of 287 anglers that also targeted Hickory Shad, especially in the upper zone during the month of March. Creel clerks observed 562 Hickory Shad and 2 American Shad harvested. Anglers also targeted catfish, Largemouth Bass *Micropterus salmoides*, and White Perch *Morone americana*.

Angler origin.—Survey results yielded angler origin information for 2,383 anglers, origin information was not defined for 18 anglers. The majority of anglers providing origin information were residents from North Carolina representing 72 counties (92%; n = 2,195) and the remaining 8% were non-residents from 19 states and 2 countries (Russia and Sweden) (Figure 6; countries other than United States are excluded). Of the 92% of NC residents responding to angler origin, about 27% of anglers (590 of 2,195) were from a county bordering the Roanoke River (Bertie, Halifax, Northampton, Martin, or Washington). It is possible that avid anglers were intercepted on more than one day during the survey period; therefore frequency of angler origin may be influenced by the same anglers interviewed more than once during the survey. An effort to identify repeat anglers intercepted during the survey is warranted to reduce this potential bias in the angler origin counts.

Bait type.—Creel clerks received 1,084 bait type responses from 955 interviews related to all angling trips on the Roanoke River. About 89% (N = 846) of the interviews were targeting Striped Bass on the Roanoke River during the survey period (Table 6). Of these, 362 interviews occurred in the upper zone and 271 interviews in the lower zone from 1 March to 3 May during the harvest season whereas the remaining 213 interviews were conducted in the upper zone at Weldon during the catch-and-release season. In the upper zone during the harvest season, live bait was the most frequent response (68%), followed by artificial bait (24%), and cut bait was the least frequent bait type response (8%). In the lower zone during the harvest season, cut bait was the most frequent response (64%), followed by artificial baits (23%), and live bait was the least frequent response (13%). In the upper zone during the catch-and-release (closed) season, anglers utilized live bait most frequently (61%), whereas artificial bait use (36%) increased compared to the open harvest season in the upper zone, and cut bait use was minimal (3%).

Survey Design Limitations and Future Considerations

This creel survey occurred during the harvest season for Striped Bass as well as during the catch and release season in the upper zone during May, specifically Weldon. Angling effort, released catch, expenditures, and other fishing related activities outside of this creel survey were not included in these estimates. Catch-and-release angling occurs for Striped Bass during winter months in the lower zone and has become popular in recent years (Burleson 2012; Dilsaver 2014). Catch-and-release angling may also occur in the lower river after the harvest

season closes, yet any estimates of this activity would also not be included in our current survey methodology.

Bank angling opportunities along the mainstem Roanoke River have increased in recent years with the construction of fishing piers in Williamston, Hamilton, and Astoria (Jamesville). Another fishing pier along with a boat ramp under construction at the Lewiston-Woodville location is anticipated to be open for the 2016 RRMA season. Sampling probabilities were based on the count of boat trailers at access areas, although additional information regarding angling activity related to single vehicle use may be related to either bank angling at piers or boat angling parties. Private access areas along the Roanoke River were not surveyed due to restricted access and relatively low use compared to the public boating areas surveyed. Probabilities were adjusted to account for public and private access areas in both zones and a low probability site was surveyed when randomly drawn.

Management Recommendations

1. Continue to manage harvest of Striped Bass in the entire RRMA with a TAL of 68,750 lb during 1 March – 30 April. Harvest management may necessitate either early closure of the established season, or alternatively season extension as issued by proclamation.
2. Maintain the current regulation structure for Striped Bass in the entire RRMA that provides for an 18-inch minimum length limit, a protective slot limit of 22 to 27 inches, and a daily creel limit of two fish per person per day, of which only one fish greater than 27 inches can be retained.
3. Continue to coordinate stock enhancement efforts with the NC Division of Marine Fisheries. This may include providing annual ASMFC compliance information, and reviewing fishery management plans to insure management objectives are being met.
4. Include the newly constructed Lewiston-Woodville Boating Access Area in the lower zone probability matrix for the 2016 RRMA Creel Survey. Identify and exclude any boating access areas slated for renovations or closures.
5. Continue to provide weekly updates on angling activity observed during the creel survey for the Roanoke River coastal river fisheries reports located at www.ncwildlife.org.
6. Coordinate with NCDMF to update estimates of short-term catch-and-release mortality in 2017. Examine the feasibility of this project in 2016 by evaluating the use of an in-river live car for retention of Striped Bass.
7. Continue to collect origin, bait type, and expenditure data from participating anglers.
8. Enhance angler education opportunities in cooperation with Enforcement Division to encourage better catch-and-release practices, and reduce unintentional illegal harvest.
9. Share results with local governments to highlight extent of angler origin and angler expenditures associated with the Striped Bass fishery on the Roanoke River.

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TABLE 1.—Age distribution of male and female Striped Bass harvested by Roanoke River anglers during spring 2015. Ages of angler-harvested Striped Bass measured in the creel survey were calculated by partitioning catch into age groups with the length-at-age key derived from the 2015 spawning stock electrofishing survey (Smith et al. 2016). The estimated number in the recreational harvest was calculated by applying the proportional age distribution to the total Striped Bass harvest estimate of 20,031 fish.

Sex and Year Class	Age	N	Percent Composition by Sex	Overall Percent Composition	Estimated Number in Recreational Harvest
Males					
2012	3	63	11.9%	4.7%	947
2011	4	294	55.4%	22.1%	4,421
2010	5	139	26.2%	10.4%	2,090
2009	6	35	6.6%	2.6%	526
	Total	531	100.0%	39.9%	7,985
Females					
2012	3	120	15.0%	9.0%	1,805
2011	4	561	70.0%	42.1%	8,436
2010	5	113	14.1%	8.5%	1,699
2009	6	7	0.9%	0.5%	105
	Total	801	100.0%	60.1%	12,046

TABLE 2.—Contribution of female and male Striped Bass, by zone and sample period, individually measured during the Roanoke River creel survey in spring 2015. The upper zone of the Roanoke River is bounded by Roanoke Rapids Lake dam downstream to the U.S. Highway 258 Bridge near Scotland Neck; the lower zone is bounded by U.S. Highway 258 Bridge downstream to Albemarle Sound.

		Females		Males		Total	
Zone	Period	Count	Percent	Count	Percent	Count	Percent
Upper							
	1–15 Mar	0	0%	0	0%	0	0%
	16–31 Mar	2	0%	1	0%	3	0%
	1–15 Apr	53	4%	73	5%	126	9%
	16–30 Apr	250	19%	172	13%	422	32%
	1–3 May	204	15%	93	7%	297	22%
	Subtotal	509	38%	339	25%	848	64%
Lower							
	1–15 Mar	17	1%	32	2%	49	4%
	16–31 Mar	42	3%	40	3%	82	6%
	1–15 Apr	63	5%	77	6%	140	11%
	16–30 Apr	104	8%	38	3%	142	11%
	1–3 May	67	5%	5	0%	72	5%
	Subtotal	293	22%	192	14%	485	36%
Both	1–15 Mar	17	1%	32	2%	49	4%
	16–31 Mar	44	3%	41	3%	85	6%
	1–15 Apr	116	9%	150	11%	266	20%
	16–30 Apr	354	27%	210	16%	564	42%
	1–3 May	271	20%	98	7%	369	28%
Total		802	60%	531	40%	1,333	100%

TABLE 3.—Average trip expenditures for private and guided fishing trips on the Roanoke River, 2015. (Standard error in parentheses)

Expenditure Category	Private Trip (N=757)		Guided Trip (N= 37)	
Food and Beverage	$16.74	($1.16)	$51.25	($13.19)
Ice	$1.45	($0.10)	$0.50	($0.42)
Bait	$20.15	($1.10)	$10.00	($5.22)
Boat Fuel and Oil	$14.05	($0.55)	$9.45	($3.25)
Vehicle Fuel	$33.69	($1.14)	$43.53	($8.77)
Lodging	$10.46	($1.12)	$42.68	($10.43)
Guide Fee	n/a		$511.54	($26.75)
Total Estimated Expenditures	$96.53		$668.95	

TABLE 4.—Average expenditures per angler hour for private and guided fishing trips on the Roanoke River, 2015.

Expenditure Category	Private Trip	Guided Trip
Food and Beverage	$1.31	$2.50
Ice	$0.11	$0.02
Bait	$1.58	$0.49
Boat Fuel and Oil	$1.10	$0.46
Vehicle Fuel	$2.64	$2.12
Lodging	$0.82	$2.08
Guide Fees	n/a	$24.91
Total Estimated Expenditures	$7.55	$32.58

TABLE 5. —Estimated total angling effort, expenditures, and economic impacts for recreational fishing trips occurring on the Roanoke River Management Area, 1 March through 19 May 2015. Harvest season occurred from 1 March to 3 May. Interviews of catch-and-release parties were conducted at Weldon after the harvest season from 4 May to 19 May.

Category	Total Angler Hours	Estimated Expenditures	Jobs	Income Impacts (thousands of dollars)	Output Impacts (thousands of dollars)
Harvest Season-Upper	50,185	$537,226	8.8	$314.7	$778.8
Harvest Season-Lower	61,233	$538,272	8.4	$289.9	$718.5
Harvest Season-Total	111,418	$1,075,498	17.2	$604.6	$1,497.3
Catch-and-release-Weldon	12,229	$140,783	2.3	$84.6	$209.3
2015 Spring Season	123,647	$1,216,282	19.5	$689.2	$1,706.6

TABLE 6.—Frequency of live, cut, and artificial bait used by anglers targeting Striped Bass during the harvest season in both zones and catch-and-release season in the upper zone during the 2015 Roanoke River creel survey, 1 March to 19 May. Live Bait "Shad" are small herring species purchased from licensed vendors or captured in reservoirs via cast netting by anglers. Cut Bait Shad are adult American Shad or Hickory Shad caught with hook and line and cut for Striped Bass bait.

Zone - Season	Period	Interviews	Responses	Live Bait			Cut Bait			Artificial Bait	
				"Shad"	Minnows	Other	Herring	Shad	Other	Lures	Fly Rod
Upper - Harvest	1-15 Mar	6	7	0	0	1	0	1	1	4	0
	16-31 Mar	10	16	1	2	0	0	4	1	8	0
	1-15 Apr	62	73	16	20	1	0	9	0	24	3
	16-30 Apr	167	179	102	28	7	1	9	2	28	2
	1-3 May	117	129	70	22	4	1	3	2	25	2
	Total	362	404	189	72	13	2	26	6	89	7
Lower - Harvest	1-15 Mar	42	48	0	3	0	13	1	3	27	1
	16-31 Mar	57	67	0	0	0	32	9	1	24	1
	1-15 Apr	77	87	0	13	2	38	18	7	9	0
	16-30 Apr	64	72	0	2	9	50	4	3	4	0
	1-3 May	31	35	6	2	2	11	5	3	6	0
	Total	271	309	6	20	13	144	37	17	70	2
Upper - Catch and Release	4-19 May	213	254	121	31	3	0	5	2	64	28
Total	All	846	967	316	123	29	146	68	25	223	37

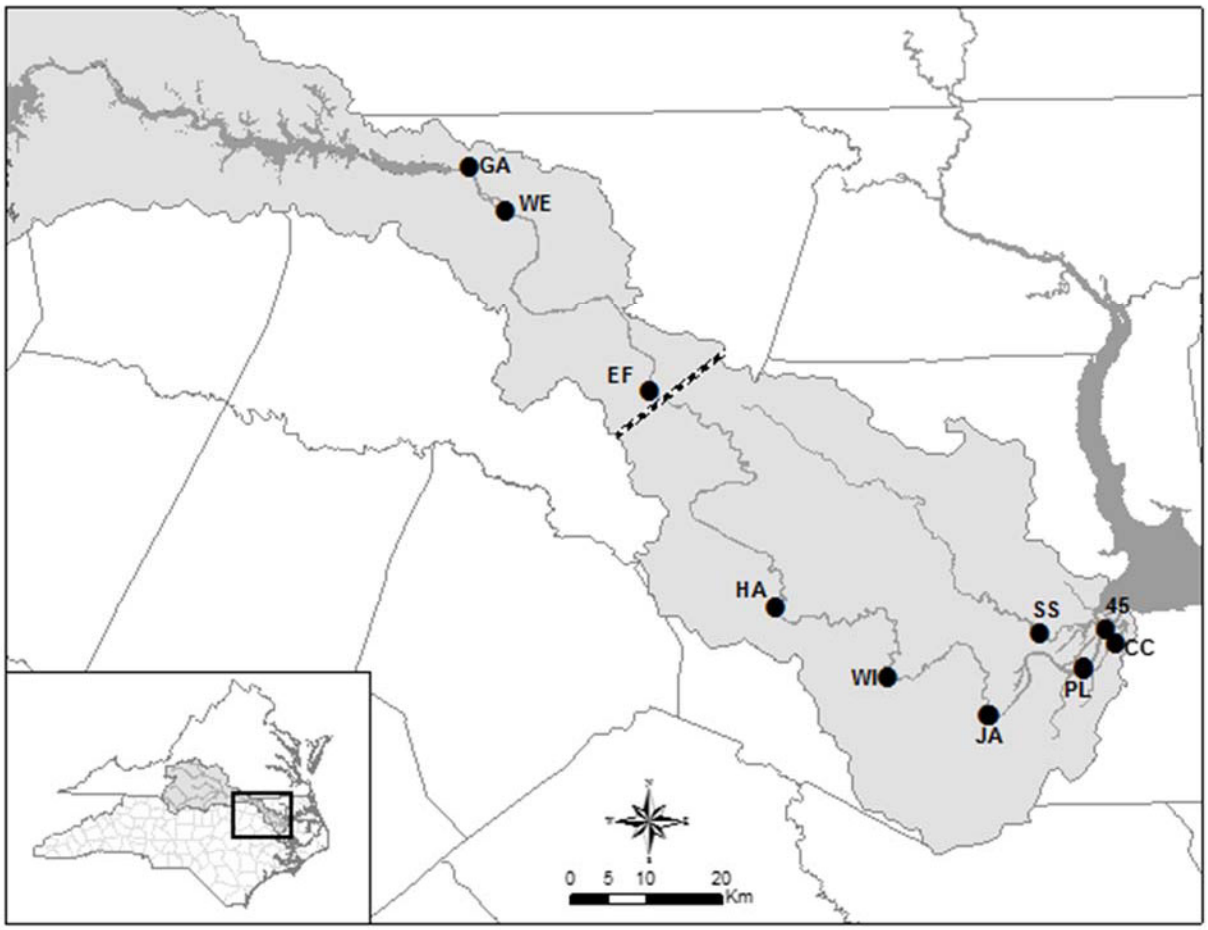

FIGURE 1.—Boating access areas included in the Roanoke River Management Area creel survey 1 March–3 May 2015. Access areas are labeled as follows: GA = Gaston, WE = Weldon, EF = Edward's Ferry, HA = Hamilton, WI = Williamston, JA = Jamesville, PL = Plymouth, 45 = Highway 45, CC = Conaby Creek, and SS = Sans Souci. The dashed bar indicates the demarcation point of the upper zone and the lower zone. (Map Credit: Jeremy McCargo)

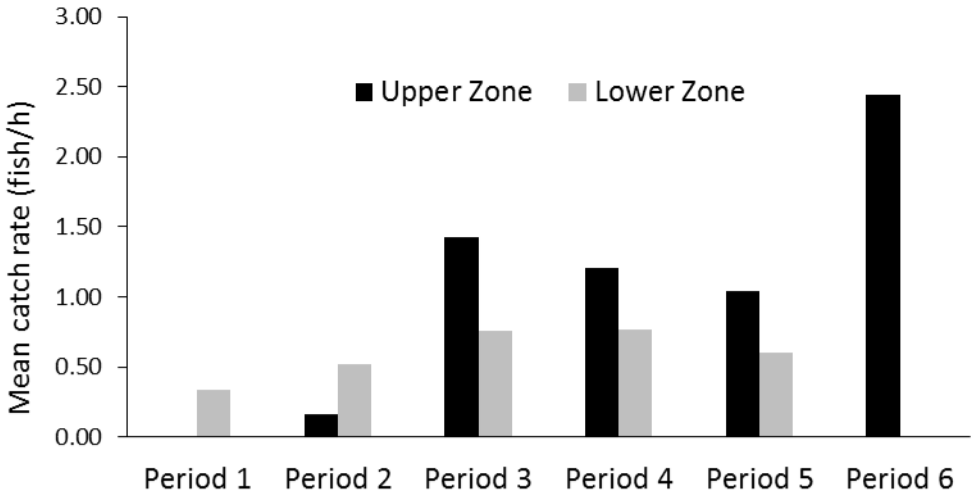

FIGURE 2.—Mean catch rate (fish/h) of Striped Bass anglers during the 2015 Roanoke River Management Area creel survey.

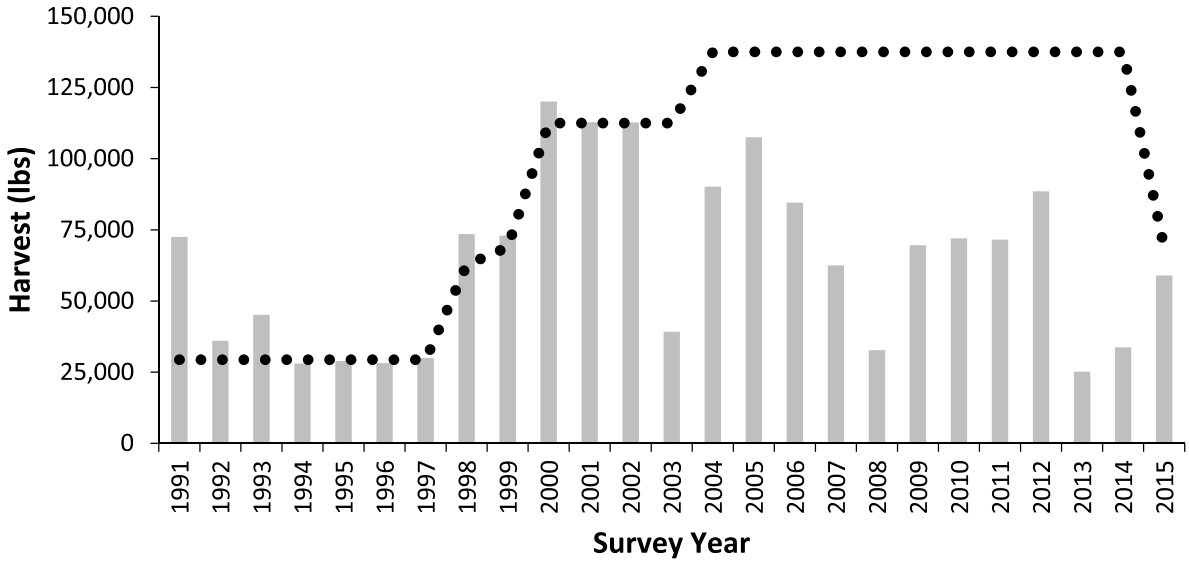

FIGURE 3.—Estimated recreational harvest (lb; bars) and yearly harvest quotas (lb; dotted line) of Striped Bass in the Roanoke River Management Area, 1991–2015.

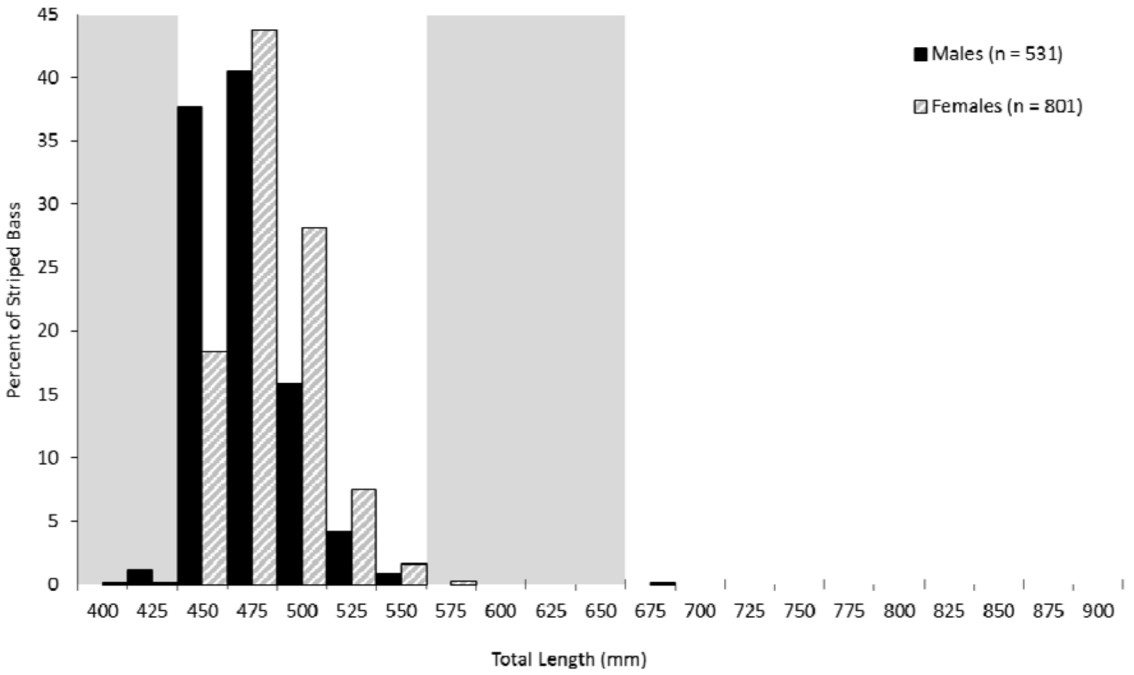

FIGURE 4.—Length frequency distribution of harvested Striped Bass measured during the 2015 Roanoke River Management Area creel survey. Grey bars indicate sizes protected from legal harvest.

FIGURE 5.—Age distribution of harvested Striped Bass measured during the 2015 Roanoke River Management Area creel survey.

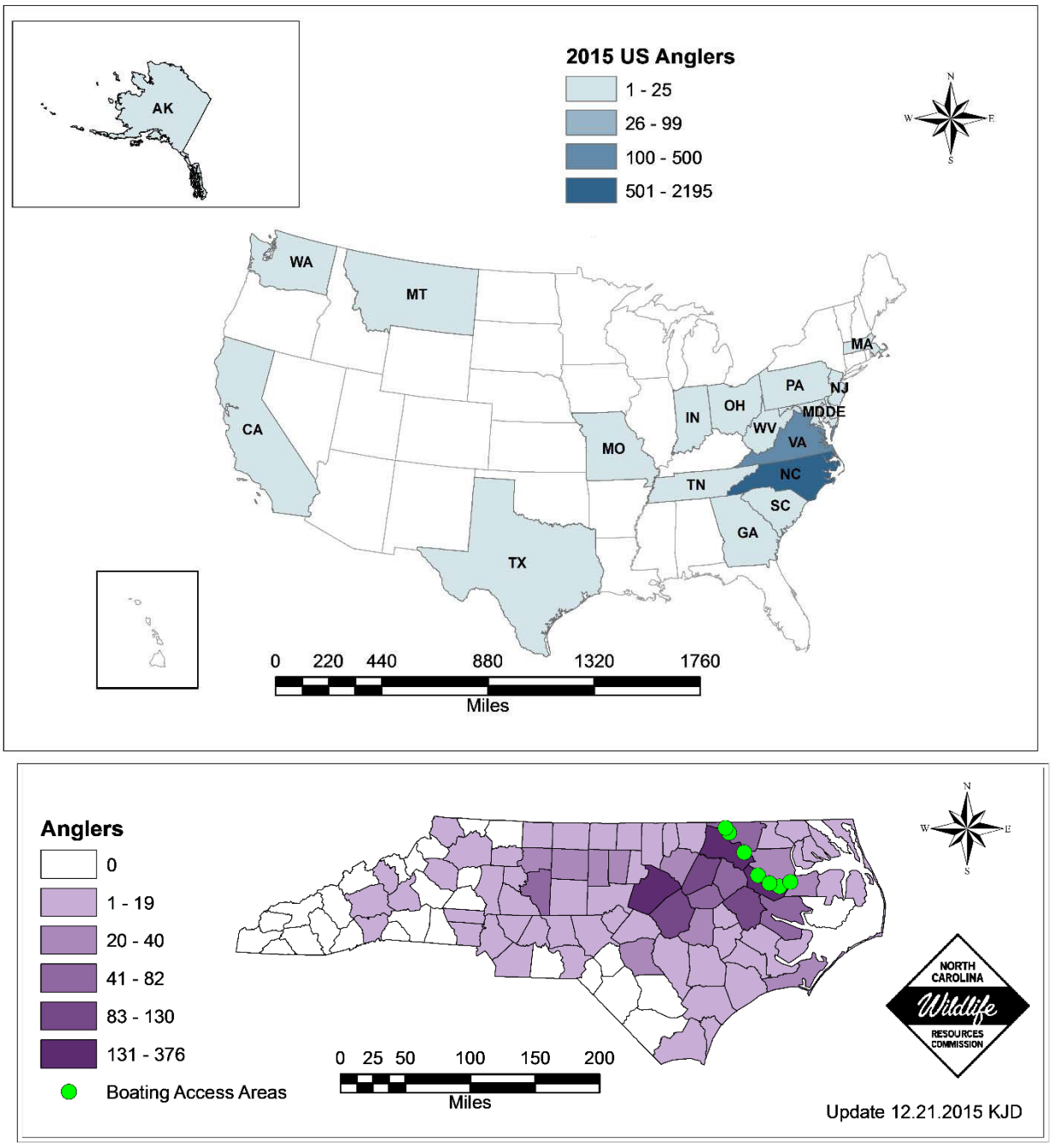

FIGURE 6.—Origin of anglers intercepted at seven boating access areas along the Roanoke River Management area from 1 March to 19 May 2015.