

An Economic Analysis of Recreational and Commercial Fisheries Occurring in the Middle and Lower Cape Fear River, North Carolina

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ABSTRACT

The Cape Fear River in North Carolina provides multiple ecosystem services for the region's residents and visitors, including supporting fish stocks that drive several recreationally and commercially important fisheries. Using data collected by the North Carolina Division of Marine Fisheries, this study estimates the economic value and impact of fisheries occurring on the Middle and Lower Cape Fear River specifically for American shad as well as for all fisheries combined. Net benefit estimates are derived from data collected from 140 recreational anglers utilizing the Middle Cape Fear River, while the various presented economic impacts are based on estimated trip expenditures for the recreational fisheries and ex-vessel value of seafood landings for the commercial fisheries. Study estimates show that the American shad fishery is variable from year to year but can provide upwards of \$106,000 in net benefits and can support \$650,000 in industry output and business sales in the state economy. When all presented fisheries data are analyzed together, the findings indicate that the fisheries of the Cape Fear River supported an estimated 467 jobs, \$14.2 million in income, and \$35.7 million in business sales. While by no means a comprehensive examination of the ecosystem services provided by the Cape Fear River, this study does provide a baseline economic assessment of fisheries occurring in the Cape Fear River that may be later used in other analyses to gather a more complete representation of the importance of the river to area residents, visitors, communities, and in an more general sense to the state of North Carolina.

INTRODUCTION

The Cape Fear River Basin is the largest river basin in North Carolina, encompassing 9,324 square miles of total land area and 6,204 miles of streams and rivers. Over a fifth of North Carolina's total population lives in the Cape Fear River Basin (NCSU 2006). The Cape Fear River itself is the second longest river in the state, running from the convergence of the Deep and Haw rivers at the county line between Chatham and Lee counties to its confluence with the Atlantic Ocean, approximately three miles west of Cape Fear. The river provides multiple important functions for the region's residents and visitors including providing recreation, a consistent source of water for drinking and irrigating crops, as well as supporting multiple recreationally and commercially important fisheries.

The Middle Cape Fear River is home to many recreationally important species of fish including largemouth bass *Micropterus salmoides*, bluegill *Lepomis macrochirus*, black crappie *Pomoxis nigromaculatus*, channel catfish *Ictalurus punctatus*, and blue catfish *I. furcatus*. Additionally, anadromous species including American shad *Alosa sapidissima* and striped bass *Morone saxatilis* support fisheries as they perform their spawning migration into freshwater sections of the river. Over the past several decades, many populations of anadromous species have declined well below historic levels. While the current major factor limiting the potential of anadromous fisheries resources within the Cape Fear River Basin is the blocking of access to prime spawning locations and habitat by locks and dams, other concerns include poor water quality caused by excessive sediment loading and eutrophication (Ashley and Rachels 2005).

The Lower Cape Fear River includes a large estuary system with a variety of recreationally and commercially important marine species, such as red drum *Sciaenops ocellatus*, southern flounder *Paralichthys lethostigma*, blue crab *Callinectes sapidus*, and striped mullet *Mugil cephalus*. This section of the river flows through the City of Wilmington and other densely developed regions, providing multiple access points to the river for the area's many residents and visitors. Additionally, both striped bass and American shad can be caught in this section of river as well at certain times of the year.

The fishery resources found in the Cape Fear River are of economic and social importance to many of the area's residents, visitors, and communities. These resources support recreational and commercial fisheries that provide a source of leisure, food, employment, and income, among other services. Data on the socioeconomic importance of these fisheries have been relatively scarce and continue to be incomplete. However, it is the intent of this study to combine newly available data collected by the North Carolina Division of Marine Fisheries (NCDMF) and North Carolina Wildlife Resources Commission (NCWRC) with other previously collected data to assess to the extent possible the socioeconomic contributions of fisheries occurring in the Middle and Lower Cape Fear River. This assessment will focus on the American shad fishery as well as a more general application towards all recreational and commercial fisheries occurring in these sections of the Cape Fear River.

METHODOLOGY

MIDDLE CAPE FEAR RIVER

Data Collection

The NCDMF has been surveying recreational anglers in several of the major coastal river systems of the southern and central portion of eastern North Carolina since 2004, with a focus on gathering catch, effort, demographic, and economic information from anglers targeting anadromous species such as striped bass, American shad, and hickory shad. This region is referred to as the Central/Southern Management Area (CSMA) by the Division. The CSMA survey was originally designed to gather data on the striped bass fishery occurring in the region; however, American shad and hickory shad were included in the survey estimates beginning in 2012. In 2013, the Cape Fear River was added to the list of coastal river systems included in this survey (NCDMF 2014).

A comprehensive explanation of the CSMA survey's methodology can be found in the 2014 NCDMF License and Statistics Section Annual Report (NCDMF 2014). For the Cape Fear River, the recreational fishing data are collected using a non-uniform probability-stratified access-point creel survey that is annually conducted from March 1 through May 31. This survey is conducted by NCDMF creel clerks at access sites from approximately Fayetteville, North Carolina downstream to Lock and Dam Number One. Catch and effort data collected from recreational anglers are then expanded by using the sample unit probability to estimate total catch and effort as specified in Pollock et al. (1994; NCDMF 2014).

In addition to catch and effort data, socioeconomic data are collected by creel clerks through a series of questions that gather anglers' demographics, residency, fishing behavior, fishing expenses, and perceptions. The socioeconomic questions were altered between the 2013 and 2014 to better capture expenditure and valuation information. A copy of both survey instruments can be found in Appendix 1 and Appendix 2.

Economic Impact Estimation

To estimate the economic impacts of recreational fisheries occurring within the CSMA surveyed region and timeframe, IMPLAN software is utilized. 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 included in the following tables contain *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.

Average expenditures per trip are calculated via data collected from the expenditure questions on the CSMA survey. These expenditures include those for lodging, food, ice, bait, boat fuel and oil, and vehicle fuel. The trip expenditures are then multiplied by the total number of trips to get the estimated total expense per expenditure category. This can be expressed as:

$$TE_{MCF} = (L, F, I, Ba, Bf, V) * TT$$

Where TE_{MCF} is the estimated total expenditures for all fishing trips, L is the average lodging expenditure, F is the average food 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, and TT is the total number of trips. Once total expenditures are estimated, they are input into IMPLAN software under the appropriate industry sector to provide the estimated economic impacts generated by the recreational fishing trips being examined. It is assumed that average trip expenditures did not change drastically from year to year; therefore, average trip expenditures found in the 2014 CSMA survey on the Cape Fear River are used in estimating the economic impacts of recreational fishing trips on the Middle Cape Fear for both 2013 and 2014. Additionally, it is assumed that expenditures on directed for trips American shad can be characterized by the general trip expenditures for all anglers participating in the CSMA survey.

Consumer Surplus and Economic Value Estimation

The economic impact of fisheries provides an estimate of the economic activity that the fishery resource users generate as a result of their fishing trips, which in this case is through their fishing trip expenditures. This is not the same as the total value of the angler's experience, as these values often range above total fishing expenses. The difference between the total value of an angler's experience and the angler's expenses (or costs) is a measure of the angler's consumer surplus, or net benefit (Borisova et al. 2014). This is an important measure in estimating the net value of a resource and can be used in cost-benefit analysis or analysis of economic efficiency (Loomis 2005). In this case, there is no pure market mechanism to provide an estimate of how participants fully value their fishing experience, so survey respondents were asked to state directly how much they would be willing to pay beyond their total trip expenses for their fishing trip. As such, this provides an estimate of the angler's net benefits or, in other words, the consumer surplus from their fishing trip.

This valuation question was added to the CSMA survey in 2014 and the values provided are assumed to be representative of fishing trips taken in 2013 as well. While an admittedly simplistic method, this does provide an approach using minimal data to estimate the consumer surplus per trip and is similar to the methodology that has been previously used when surveying anglers fishing in North Carolina coastal river systems (Ashley and Rachels 2005; McCargo et al. 2007). To get an estimate of total consumer surplus for the fishery being examined on the Cape Fear River, the average consumer surplus per trip is multiplied by the estimated total number of trips. This can be expressed as:

$$T_{CS} = CS * TT$$

Where T_{CS} is the total estimated consumer surplus of fishery participants, CS is the average consumer surplus per trip collected from the survey results, and TT is the total number of trips. In this analysis, the consumer surplus is also added to the output impacts to provide an estimate of total (gross) economic value of the examined resources, as performed in Borisova et al. (2014).

LOWER CAPE FEAR RIVER

Recreational Fisheries

Data Collection

The CSMA survey does not cover the Lower Cape Fear River, as this area is surveyed under the National Marine Fisheries Service (NMFS) Marine Recreational Information Program (MRIP). A description of the MRIP survey methodology can be found in the 2014 NCDMF License and Statistics Section Annual Report (NCDMF 2014). In North Carolina, this survey is conducted by NCDMF creel clerks and covers the entire coastal region of the state, including the Lower Cape Fear River and surrounding area. This survey relies on information collected via telephone to get trip information as well as by site intercept surveys to gather anglers' catch rates and species composition. The effort estimates are computed by five fishing modes, including charter boat, private/rental boat, beach/bank, man-made structures, and head boats. The survey is conducted throughout the year and results can be separated by mode, area fished, and wave. Data characterizing the estimated number of recreational fishing trips taken in the Lower Cape Fear River were provided by the NCDMF Recreational Statistics Program staff. At the time of this analysis, data were not complete for 2014, so only data for recreational fishing trips taken in 2013 are utilized.

Economic Impact Estimation

Estimates of the economic impacts for recreational fisheries occurring in the Lower Cape Fear River are conducted using the NCDMF economic impact model for coastal recreational fishing and IMPLAN software. The NCDMF economic impact model combines effort data with inflation adjusted estimated angler trip expenditures by expenditure category as collected from North Carolina recreational anglers during surveys that have been carried out by the NCDMF Fisheries Economics Program and North Carolina Sea Grant to provide estimated total coastal recreational fishing trip expenditures (Dumas et al. 2009; Crosson 2010; Hadley 2012). The equation to estimate total trip expenditures for the Lower Cape Fear River can be expressed as:

$$TE_{LCF} = (L, G, I, Ba, T, Bf, V, C, Ti, O) * TT$$

Where TE_{LCF} is the estimated total expenditures for all fishing trips, L is the average lodging expenditure, G is the average expenditure on groceries, I is the average ice expenditure, Ba is the average bait expenditure, T is the average tackle expenditure, Bf is the average expenditure on fuel and oil for a boat, V is the average expenditure on fuel for a vehicle, C is the average expenditure on charter fees, Ti is the average expenditure on tips for captains and crew of charter vessels, O represents other miscellaneous expenses, and TT is the total number of trips. Table 1 describes the average trip expenditures by category used for this analysis.

Table 1. Average angler trip expenditures by mode used in the NCDMF economic impact model for recreational fishing in the Lower Cape Fear River.

Expenditure	Private/Rental Vessel	Charter Vessel	Beach/Bank	Man-Made
Lodging	\$11.98	\$11.98	\$16.27	\$18.02
Groceries	\$5.97	\$5.97	\$6.34	\$12.49
Ice	\$2.13	\$2.13	\$1.50	\$1.32
Bait	\$5.50	-	\$4.98	\$3.61
Tackle	\$5.93	\$5.93	\$5.93	\$5.93
Boat Fuel/Oil	\$14.29	-	-	-
Vehicle Fuel	\$14.94	\$14.94	\$12.83	\$14.68
Charter Fees	-	\$170.50	-	-
Tips	-	\$38.62	-	-
Other	\$1.05	\$1.05	\$3.59	\$1.19
Total	\$61.79	\$251.12	\$51.44	\$57.24

Commercial Fisheries

Data Collection

Commercial fishing in the Cape Fear River only occurs in the coastal and joint waters found in the Lower Cape Fear region. The data used to estimate the economic impact of commercial fisheries occurring in the Lower Cape Fear River originate from the NCDMF commercial trip ticket program. In North Carolina, all seafood that is caught with commercial gear and sold must be reported by a licensed seafood dealer through a trip ticket listing the species and weight sold on each trip. The Trip Ticket Program has divided the state's coastal waters into 31 different water bodies, with the Cape Fear River being one of them. Landings data are mandatory for all seafood that is sold, but the Division also receives voluntary price data, allowing estimates of the ex-vessel, or dockside, value of commercial seafood landings. For more information on the NCDMF Trip Ticket Program, refer to the 2014 NCDMF License and Statistics Section Annual Report (NCDMF 2014).

Economic Impact Estimation

Economic impact estimates for commercial fishing represent those of commercial seafood harvesters, dealers, wholesalers, and retailers. These estimates are a product of IMPLAN software customized with data from the NCDMF as well as economic multipliers originating from the NMFS Commercial Fishing and Seafood Industry Input/Output Model (NOAA 2011). Commercial landings data from the NCDMF Trip Ticket Program are used as the primary input as well as data from North Carolina commercial fishermen and seafood dealers collected during surveys that have been carried out by the NCDMF Fisheries Economics Program (Crosson 2007, 2009, 2010a; Hadley and Crosson 2010; Hadley and Wiegand 2014). Economic impact estimates for the commercial harvesting and seafood dealer sectors are derived from NCDMF data while estimates for seafood wholesalers and retailers originate from the NMFS model. At the time of this analysis, data were not complete for 2014 total commercial landings, so only data for 2013 are utilized. However, since the American shad commercial fishery occurs only in the spring months of each year, the commercial landings data for American shad are available for both 2013 and 2014 and are included in the following analysis.

RESULTS

MIDDLE CAPE FEAR RIVER

Demographics

NCDMF recreational creel clerks completed the socioeconomic sections of the CSMA survey with 140 anglers in 2014. Demographic information was collected from most angler respondents. Surveyed anglers were predominantly male (94%) and Caucasian (71%). It is interesting to note that racial minorities made up a larger portion of the surveyed population than any other surveys previously conducted with recreational anglers by the NCDMF (Crosson 2010b; Hadley 2012). All surveyed anglers indicated that they were residents of North Carolina, with Bladen County (28%) being the most commonly cited county of residence, followed by Cumberland County (17%), Robeson County (14%), New Hanover County (10%), and other counties (31%). The average age of the anglers was 44 years of age, though anglers as young as 17 years and as old as 82 years of age were surveyed. The majority of respondents had personal incomes below \$40,000 (68%).

Table 2. Demographics of surveyed anglers fishing the Middle Cape Fear River, March through May 2014.

Category	Frequency/Value	Percent	Category	Frequency	Percent
<u>Gender</u>			<u>Residence</u>		
Male	131	94%	North Carolina	140	100%
Female	8	6%	Other	0	0%
<u>Race</u>			<u>County of Residence</u>		
Caucasian	89	71%	Bladen	39	28%
African American	32	25%	Cumberland	24	17%
Native America	3	2%	Robeson	20	14%
Asian	1	1%	New Hanover	14	10%
Hispanic	1	1%	Pender	8	6%
<u>Personal Income</u>			Columbus	7	5%
Less than \$40,000	69	68%	Brunswick	6	4%
\$40,000 to \$80,000	31	30%	Sampson	6	4%
\$80,001 to \$120,000	1	1%	Hoke	5	4%
More than \$120,000	1	1%	Duplin	4	3%
<u>Age (Years)</u>			Chatham	2	1%
Average	44		Halifax	1	1%
Maximum	82		Harnett	1	1%
Minimum	17		Henderson	1	1%
			Orange	1	1%
			Wake	1	1%

Fishing Trip and Angler Characteristics

Surveyed anglers were asked a series of questions designed to estimate their per-trip expenditures. Table 3 illustrates the estimated per-trip expenditures and standard deviation of expenditures incurred by category. The total average cost per trip was \$36.62, but expenses varied greatly by respondent, as reflected in the standard deviations that are larger than their corresponding average values. Few surveyed anglers indicated overnight trips (n=4); therefore, lodging expenses were omitted from the average trip expenditures.

Table 3. Average trip expenditures of surveyed anglers fishing the Middle Cape Fear River, March through May 2014.

Trip Expenditure	Average	Standard Deviation
Food	\$5.14	\$11.96
Ice	\$0.73	\$1.55
Bait	\$2.64	\$5.74
Boat Fuel and Oil	\$9.71	\$15.99
Vehicle Fuel	\$18.40	\$25.68
Total	\$36.62	-

Respondents were also asked a variety of questions gathering information on their trip characteristics, fishing activity, and perceptions of their fishing trip. Anglers provided information on how successful their trip was as well as the utility of the trip, including how much they would be willing to spend above their trip expenditures to take the same fishing trip again. On average, anglers traveled approximately 57 miles round-trip and expected to take three or more trips per year for anadromous species (American shad, hickory shad, or striped bass). Anglers generally rated the fishing success of their trip as moderately successful, but indicated a higher level of overall satisfaction with the trip. The additional amount of money that anglers were willing to spend for their fishing trip varied greatly among respondents, but on average, anglers were willing to spend an extra \$8.84 per trip.

Table 4. Trip characteristics and angler perceptions of surveyed anglers fishing the Middle Cape Fear River, March through May 2014.

Angler Perceptions/Trip Characteristics	Average	Standard Deviation
Years Fishing	32.3	16.3
Miles Traveled Roundtrip	56.7	67.9
Expected Trips	3.5	1.7
Overall Happiness	7.6	2.8
Overall Success	4.7	3.8
Additional Willing to Spend	\$8.84	\$22.82

Economic Impacts

The spending activity associated with directed fishing trips for American shad as well as all fishing trips occurring in the spring months on the Middle Cape Fear River in 2013 and 2014 are provided in Table 5. Other recreationally targeted anadromous species such as striped bass and hickory shad are not specified, as the creel sampling in both 2013 and 2014 exhibited very few interactions with either species in this region. American shad were by far the most commonly caught and targeted species of anglers fishing on the Middle Cape Fear River during the months that the survey was administered. For this reason, American shad directed trips are specified in the following analysis in addition to all fishing trips occurring on the Middle Cape Fear in the spring months.

The number of directed trips for American shad as well as the total number of trips and their associated economic impacts varied greatly between the two years examined. In 2013, the American shad fishery on the Middle Cape Fear supported approximately \$442,000 in angler expenditures, six jobs, \$244,500 in income, and \$544,000 in output impacts or industry production and business sales in the state economy. In 2014, the estimated number of directed trips for American shad and overall fishing trips fell drastically from the previous year, with the American shad fishery on the Middle Cape Fear supporting approximately \$110,000 in angler expenditures, two jobs, \$61,000 in income, and \$136,000 in output impacts. Respective expenditures and economic impacts are considerably larger when all fishing trips are taken into account (Table 5).

Table 5. Estimated trips, expenditures, and economic impacts for recreational fishing trips occurring in the middle Cape Fear River in the spring of 2013 and 2014.

Year	Type of Trip	Estimated Trips	Estimated Expenditures (thousands of dollars)	Jobs	Income Impacts (thousands of dollars)	Output Impacts (thousands of dollars)
2013	American Shad	12,081	\$442.4	6	\$244.5	\$544.2
2013	All Trips	21,333	\$781.2	11	\$431.8	\$961.0
2014	American Shad	3,010	\$110.2	2	\$61.2	\$135.9
2014	All Trips	6,931	\$253.8	4	\$141.0	\$313.0

Economic Value

The survey question gathering data on how much anglers would be willing to spend above their trip expenditures was used to gauge the net benefit or consumer surplus generated by fishing trips occurring on the Middle Cape Fear River, with the average reported consumer surplus being \$8.84 per trip. Applying this average value to the total number of trips in 2013 and 2014 allows an estimate of total consumer surplus, or total net economic benefits derived from directed fishing trips for American shad as well as for all examined fishing trips. As such, the estimated total consumer surplus for the American shad directed trips was \$106,796 in 2013 and \$26,608 in 2014. The estimated consumer surplus of all fishing trips occurring on the Middle Cape Fear was \$188,584 in 2013 and \$61,270 in 2014 (Table 6).

Table 6. Estimated consumer surplus of recreational fishing trips occurring in the Middle Cape Fear River from March through May 2014.

Year	Type of Trip	Estimated Trips	Estimated Consumer Surplus
2013	American Shad	12,081	\$106,796
2013	All Trips	21,333	\$188,584
2014	American Shad	3,010	\$26,608
2014	All Trips	6,931	\$61,270

Some economic studies have combined consumer surplus estimates with output estimates generated by the activity-related expenditures to provide an estimate of total (gross) economic value (Borisova et al. 2014). Using this method, the total economic value of fishing trips occurring on the Middle Cape Fear River in 2013 was approximately \$651,000 for directed American shad trips and \$1.15 million for all fishing trips, with respective total values falling to approximately \$162,500 for directed American shad trips and \$374,300 for all fishing trips in 2014 (Table 7).

Table 7. Estimated total (gross) economic value of recreational fishing trips occurring in the Middle Cape Fear River from March through May 2014.

Year	Type of Trip	Estimated Trips	Estimated Consumer Surplus (thousands of dollars)	Output Impacts (thousands of dollars)	Total (Gross) Economic Value (thousands of dollars)
2013	American Shad	12,081	\$106,796	\$544.2	\$651.0
2013	All Trips	21,333	\$188,584	\$961.0	\$1,149.6
2014	American Shad	3,010	\$26.6	\$135.9	\$162.5
2014	All Trips	6,931	\$61.3	\$313.0	\$374.3

LOWER CAPE FEAR RIVER

Economic Impacts

Commercial Fisheries

Commercial fishing for American shad and other species in the Cape Fear River takes place in the coastal waters managed by NCDMF and joint-coastal waters which fall under the jurisdiction of both the NCDMF and NCWRC. All of these waters fall in what can be considered the Lower Cape Fear River. Commercial American shad landings were considerably lower in 2013 than in 2014. In 2013, commercial fishermen reported selling approximately 25,000 pounds of American shad with an ex-vessel value of approximately \$29,400, supporting economic impacts of three jobs, \$47,500 in income, and \$113,500 in industry production and business sales. In 2014, the commercial landings of American shad more than tripled, along with the associated ex-vessel value and economic impacts (Table 8).

Table 8. Commercial landings, ex-vessel value and estimated economic impacts for American shad caught in the lower Cape Fear River, 2013 and 2014.

Year	Pounds	Ex-Vessel Value	Jobs	Income Impacts (thousands of dollars)	Output Impacts (thousands of dollars)
2013	24,888	\$29,416	3	\$47.5	\$113.5
2014	83,734	\$98,859 ¹	8	\$159.6	\$381.5

¹Based on 2013 price information

In 2013, commercial fishermen reported landing and selling 621,000 pounds of seafood from the Cape Fear River. These landings had an ex-vessel value of approximately \$958,000 and supported an estimated 82 jobs, \$1.6 million in income, and \$3.7 million in industry production and business sales (Table 9).

Table 9. Commercial landings, ex-vessel value and estimated economic impacts of commercial fishing occurring in the lower Cape Fear River, 2013.

Pounds	Ex-Vessel Value	Jobs	Income Impacts (thousands of dollars)	Output Impacts (thousands of dollars)
621,396	\$958,325	82	\$1,547.2	\$3,698.5

Recreational Fisheries

In 2013, anglers took an estimated 385,388 fishing trips in the Lower Cape Fear River, spending an estimated \$23.5 million on these trips. This spending activity supported an estimated 374 jobs, \$12.2 million in income, and \$31 million in industry production and business sales (Table 10).

Table 10. Estimated trips, expenditures, and economic impacts for recreational fishing trips occurring in the lower Cape Fear River, 2013.

Estimated Trips	Estimated Expenditures (thousands of dollars)	Jobs	Income Impacts (thousands of dollars)	Output Impacts (thousands of dollars)
385,388	\$23,499.3	374	\$12,236.5	\$30,991.7

ALL EXAMINED FISHERIES OCCURING IN THE CAPE FEAR RIVER

Economic Impacts

When looking at the fisheries that the Cape Fear River supports, it is important to examine fisheries occurring in multiple sections of the river. Anadromous species such as the American shad occur throughout the river at certain times of the year. The commercial fisheries for American shad occur in the Lower Cape Fear, mostly by fishermen using large mesh gill nets, while recreational anglers usually target the American shad in the Middle Cape Fear from

Lock and Dam Number One and upstream using hook and line. Combining the economic impacts presented in this study allows the complete examination of the economic impacts of the fisheries occurring in multiple sections of the river. In 2013, the economic impacts of the American shad fishery, both recreational and commercial, supported nine jobs, \$292,000 in income, and \$657,700 in industry production and business sales. In 2014, the economic impacts of the American shad fishery decreased, but output impacts remained above \$500,000 (Table 11). When broadening the focus to all of the recreational and commercial fisheries examined, in 2013 the fisheries of the Cape Fear River supported an estimated 467 jobs, \$14.2 million in income, and \$35.7 million in industry production and business sales in the North Carolina economy (Table 12).

Table 11. Estimated economic impacts of recreational and commercial fishing for American shad in the Cape Fear River, 2013.

Year	Jobs	Income Impacts (thousands of dollars)	Output Impacts (thousands of dollars)
2013	9	\$292.0	\$657.7
2014	10	\$220.8	\$517.4

Table 12. Estimated economic impacts of recreational and commercial fishing occurring in the Cape Fear River, 2013.

Jobs	Income Impacts (thousands of dollars)	Output Impacts (thousands of dollars)
467	\$14,215.5	\$35,651.2

DISCUSSION

Comparison to Findings of Other Studies

On average, anglers participating in the 2014 CSMA survey on the Middle Cape Fear River from March through May indicated trip expenditures of \$36.62 and had an additional estimated \$8.84 in net benefits for their fishing trip. For this time period, the estimated total trip expenditures were \$253,800 and the total net benefit of the fishery was \$61,270. The estimated total gross economic value was \$374,300.

In 2013, estimated total trip expenditures were noticeably larger due to higher recreational fishing effort. Total estimated trip expenditures were \$781,200 and the total net benefits were \$188,584 for the recreational fisheries in the Middle Cape Fear River. Estimated total gross economic value was \$1.15 million. Fisheries occurring in the Lower Cape Fear River in 2013 were considerably larger from an expenditure standpoint in the recreational sector and an ex-vessel value standpoint in the commercial sector, with estimated expenditures of approximately \$23.5 million and an ex-vessel value of approximately \$1 million respectively.

In comparison, Ashely and Rachels (2005), which covered a full year of effort and data collected from boating anglers on the Cape Fear River, reported average trip expenditures of \$20.84, with anglers willing to spend an additional \$29.97 for a future fishing trip of similar satisfaction. The additional willingness to spend can be interpreted as a measure of net benefits received by the anglers. The reported total trip expenditures were \$392,777 and anglers were willing to spend an additional \$635,132 for trips of similar satisfaction. The stated total gross economic value was \$1,027,910.

On the Roanoke River in North Carolina, McCargo et al. (2007) found mean trip expenditures of \$93.44 and a willingness to spend an additional \$50.37 for a trip of equal satisfaction per angling party. The estimated total trip expenditures were \$2,545,460 and anglers were willing to spend an additional \$1,625,421 for trips of similar satisfaction. The stated total gross economic value was \$4,170,881. Schuhmann (1999) examined data collected from striped bass anglers on the Roanoke River and estimated that on average catch-and-keep anglers spent approximately \$22 and received \$2.81-\$2.90 in net benefits per trip, while catch-and-release anglers spent approximately \$115 and received \$171.71 in net benefits per trip. Estimated total trip expenditures for striped bass anglers were approximately \$918,000 and the estimated net value of the fishery was between \$796,500 and \$814,000.

Differences in findings between the various studies can be explained by numerous means. The time period, both specific years that sampling occurred as well as the number of months sampled differs from the analysis presented using CSMA data from the Cape Fear River. Additionally, some studies, such as McCargo et al (2007) examined angling party expenditures, while others, such as Schuhmann (1999) and this analysis presented expenditures per angler. Using the nominal data as presented in the various studies, the average trip expenditures presented in this analysis fell above those found by Ashely and Rachels (2005) on the Cape Fear River, below those found for angling party expenses in McCargo et al (2007), and within range of angler trip expenditures presented by Schuhmann (1999). The various measures of net benefits per trip in this analysis fell below those of both Ashely and Rachels (2005) and McCargo et al (2007), but within range of net benefits per trip provided by Schuhmann (1999). Total net benefits presented within this analysis were the lowest values presented among the studies examined. Conversely, when recreational fisheries

occurring in the Lower Cape Fear River in 2013 were examined, this analysis found total estimated expenditures higher than those presented in any of the other discussed studies.

Study Limitations

It is important to recognize the limitations of this study. The timeframe examined is one or two years, depending on the analysis. This does not allow for the comparison of results to other time periods to establish trends or to assess whether or not results are what can be reasonably expected on a yearly basis as the typical impact of fisheries occurring on the Cape Fear River. This is an especially important point when examining the considerably different data presented for 2013 and 2014 on recreational fisheries occurring in the Middle Cape Fear River.

Additionally, it is important to note limitations to the coverage of the effort data (trip estimates) utilized, from both a spatial and temporal standpoint. The CSMA survey on the Cape Fear River is focused on gathering information on the recreational fishery for anadromous species. In doing so, it does gather information on other recreational fisheries occurring in the surveyed area; however, it is not conducted throughout the year nor does it cover areas upstream from approximately Fayetteville, North Carolina. Fishing effort occurring upstream of Fayetteville is not sampled by the survey and therefore not counted in the recreational fishing trips used in this analysis. Furthermore, any fishing effort occurring outside of the sampling period from March through May is not captured by the survey. Recreational fishing effort is sampled year round for the Lower Cape Fear through the MRIP program, but this solely covers areas from slightly upstream of Wilmington, NC to the river's mouth.

The economic value assessment is somewhat simplistic and likely incomplete. Other methods could be employed in future studies to more thoroughly estimate value and net benefits. More advanced econometric analyses may be possible using other valuation methods, such as those presented by Schuhmann (1999), and as more seasons of data are collected to provide a larger data set for analysis. Also, other analyses could be performed utilizing the benefits derived from commercial landings to more thoroughly estimate the total value of the American shad fishery.

Economic impact estimates for recreational fishing are likely imperfect as well, as the analyzed angler expenditures do not include expenses that are made on durable goods related to fishing such as rods, reels, boats, or towing vehicles. While durable goods may be purchased with the intention of being used in the Cape Fear River fisheries, these durable goods often last several years and may be utilized in multiple other fisheries as well as in other activities (recreational boating, waterfowl hunting, transportation, etc.). Data are not available that would allow this analysis to devote the expenditures on durable goods specifically to fisheries occurring in the Cape Fear River. The unquantified economic impacts of durable goods expenditures may be considerably large in comparison to the economic impacts of trip expenditures. One recent economic study examining both recreational fishing trip expenditures and durable goods expenditures for coastal recreational fishing in North Carolina indicated jobs, income, and output impacts stemming from durable goods to be more than twice those stemming from trip expenditures (NOAA, 2014). Nevertheless, this analysis still serves as a starting point and baseline for providing economic value and impact estimates for fisheries occurring in the Cape Fear River.

Future Research Steps

To address some of the study's limitations, additional research could focus on analyzing more years of data to gather insight on trends occurring within the fisheries. Data collected by MRIP has a usable time series of over a decade, but the CSMA data has only been collected for two fishing seasons. As more seasons of data are collected, additional analysis could be performed. Also, efforts could be made to collect data from anglers fishing on the Middle Cape Fear River during months that are currently un-sampled. Additionally, it is important to tie in research on valuation of other uses and ecosystem services that the Cape Fear River provides to get a more comprehensive picture of the true value of the river system and its importance to North Carolina's citizens and visitors.

Economic Assessment

The provided analysis serves as a limited baseline assessment on the economic impact and the economic value of fisheries occurring in the Cape Fear River. This may be useful in future efforts to gauge the economic performance of these fisheries or in evaluating the implications stemming from changing environmental conditions that many of these fisheries rely on, such as alterations in impediments to fish passage or to water quality. Projects that improve fish passage such as dam removals or alternations may increase fish abundance, especially for anadromous species. With improvements in these fish populations would likely come increases in fishing activity, thereby increasing the economic impact and value of these fishery resources.

The American shad fishery was the focus of several analyses, as this species has seen increasing returns of spawning adults to the Cape Fear River in recent years, which is encouraging. The American shad population is numerous enough to support both recreational and commercial fisheries that contribute upwards of a half a million dollars annually to business sales in the state's economy. Other anadromous species such as striped bass and river herring have not seen such population increases and are currently under a commercial and recreational moratorium that prevents any harvest and limits total fishing pressure.

On a more expansive focus, when including all examined fisheries occurring in the Cape Fear River, it becomes apparent that the fishery resources support noteworthy economic activity. When examining the Lower Cape Fear River, MRIP effort data suggest that in 2013 approximately 8% of all coastal recreational fishing trips occurring in North Carolina took place in this section of the river, contributing millions of dollars in economic activity to the state economy. The Lower Cape Fear River also supported commercial seafood landings of around \$1 million in ex-vessel value. When the economic impacts occurring in 2013 from all fisheries included in this analysis are combined, it is estimated that the fisheries of the Cape Fear River supported approximately 467 jobs, \$14.2 million in income, and \$35.7 million in business sales in the North Carolina economy. Based on this information, these fishery resources clearly serve as an economic driver, supporting jobs, income, and economic activity. This study is by no means a comprehensive examination of the ecosystem services provided by the Cape Fear River; however, it does provide a baseline assessment for fisheries occurring in the Cape Fear River that may be later used in other analyses to provide a more complete illustration of the importance of the river to area residents, visitors, communities, and in an more general sense to the state of North Carolina.

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APPENDIX 1: 2013 CSMA CREEL SURVEY INTERVIEW FORM.

CSMA CREEL SURVEY
Interview Form

1. INTERVIEWER ID	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	5. INTERVIEW TIME (use 2400 clock)	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	8. PERIOD	<input type="text"/>
2. YR/MO/DAY	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	6. FISHING TRIP	1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No	9. REFUSAL	<input type="checkbox"/>
3. INTERVIEW NUMBER	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	4. TYPE OF DAY	<input type="checkbox"/>	7. TIME FISHING BEGAN	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
				10. SITE	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>

11. HOURS FISHED (Hours/Minutes)	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	12. PARTY SIZE	<input type="text"/> <input type="text"/> <input type="text"/>	16. WERE YOU FISHING FOR ANY PARTICULAR KINDS OF FISH TODAY? IF YES, WHAT KINDS?
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13. WERE YOU FISHING FROM:

1 Private Boat 2 Charterboat 3 Shore

1st Target

14. AREA FISHED (Specific waterbody)

2nd Target

15. WATERBODY CLASSIFICATION	17. PRIMARY FISHING METHOD
1 <input type="checkbox"/> Coastal 2 <input type="checkbox"/> Joint 3 <input type="checkbox"/> Inland	1 <input type="checkbox"/> Casting 2 <input type="checkbox"/> Trolling 3 <input type="checkbox"/> Cut Bait 4 <input type="checkbox"/> Live Bait 5 <input type="checkbox"/> Gill Net

UNAVAILABLE CATCH. Did you land any fish that are not here for me to look at? For example, any that you may have thrown back or used for bait?

THROW BACKS

	SPECIES CODE	DISP	# OF FISH
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DISPOSITION CODES

1. Thrown back (legal fish)
2. Thrown back over bag limit
3. Thrown back under size limit
4. In slot (22-27)

AVAILABLE CATCH, COMPLETE TYPE 3 RECORD BY ASKING: May I look at your fish?

KEPT	SPECIES CODE	# OF FISH	LENGTH (mm)	WEIGHT (kg)
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CSMA Creel Socioeconomic Questions

- 1) How old were you on December 31, 200x? _____
- 2) What state do you live in? _____
- 3) If the state is NC, what county do you live in? _____
- 4) Were you born in North Carolina? Yes No
- 5) Are you, Male Female
- 6) What do you consider your ethnic background?
 Hispanic/Latino (all races) Asian-Pacific Islander
 White/Caucasian Native American
 African-American/Black
- 7) What is your marital status?
 Currently married Widowed Separated
 Divorced Never married
- 9) How many people live in your household? (include yourself and others such as students away at school, someone in the hospital, or currently away on business or vacation, etc., but not someone whose main place of residence is somewhere else.)

The following questions ask you about this fishing trip. If you aren't sure of the exact answer, please give your best estimate.

10) How many nights is the trip? (if none, skip 11 and 12).	
11) How many miles did you travel to get here?	
12) How many people who are on the trip are fishing?	
13) How many people who are on the trip don't fish?	
14) How much are you paying for lodging per night?	
15) How much will/did you pay for food?	
16) How much will/did you pay for ice?	
17) How much will/did you pay for bait?	
18) How much will/did you pay for equipment rental?	
19) How much will/did you pay for boat fuel and oil?	

APPENDIX 2: 2014 CSMA CREEL SURVEY INTERVIEW FORM.

CSMA CREEL SURVEY
Interview Form

1. INTERVIEWER ID 5. INTERVIEW TIME (use 2400 clock) 8. PERIOD

2. YR/MO/DAY 6. FISHING TRIP 1 Yes 2 No 9. REFUSAL

3. INTERVIEW NUMBER 4. TYPE OF DAY 7. TIME FISHING BEGAN 10. SITE

11. HOURS FISHED 12. PARTY SIZE 16. WERE YOU FISHING FOR ANY PARTICULAR KINDS OF FISH TODAY? IF YES, WHAT KINDS?

(Hours/Minutes)

13. WERE YOU FISHING FROM:
1 Private Boat 2 Charterboat 3 Shore

14. AREA FISHED (Specific waterbody)

1st Target

2nd Target

15. WATERBODY CLASSIFICATION 17. PRIMARY FISHING METHOD

1 Coastal 2 Joint 3 Inland 1 Casting 2 Trolling 3 Cut Bait 4 Live Bait 5 Gill Net

UNAVAILABLE CATCH. Did you land any fish that are not here for me to look at? For example, any that you may have thrown back or used for bait?

THROW BACKS

	SPECIES CODE										DISP	# OF FISH		
1 _____	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
2 _____	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
3 _____	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
4 _____	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
5 _____	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

DISPOSITION CODES			
1.	Thrown back (legal fish)		
2.	Thrown back over bag limit		
3.	Thrown back under size limit		
4.	In slot (22-27)		

AVAILABLE CATCH, COMPLETE TYPE 3 RECORD BY ASKING: May I look at your fish?

	KEPT	SPECIES CODE										# OF FISH		LENGTH (mm)		WEIGHT (kg)	
1 _____	<input type="checkbox"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
2 _____	<input type="checkbox"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
3 _____	<input type="checkbox"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
4 _____	<input type="checkbox"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
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6 _____	<input type="checkbox"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
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8 _____	<input type="checkbox"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
9 _____	<input type="checkbox"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
10 _____	<input type="checkbox"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

CSMA Creel Socioeconomic Questions

- 1) How old were you on December 31, 2013? _____
- 2) What state do you live in? _____
- 3) If the state is NC, what county do you live in? _____
- 4) Are you, Male Female
- 5) What do you consider your ethnic background? Hispanic/Latino (all races) Asian-Pacific Islander
 White/Caucasian Native American
 African-American/Black
- 6) How many years have you been recreational fishing? _____
- 7) How many fishing trips do you expect to take this year on this river for American shad, hickory shad, or striped bass? (if indicated as target species) _____

The following questions ask you about this fishing trip. If you aren't sure of the exact answer, please give your best estimate.

8) How many nights is the trip? (if none, skip questions 10 and 11).	
9) How many miles did you travel to get here?	
10) How many people who are on the trip are fishing?	
11) How much do you expect to pay for lodging per night on this trip?	
12) How much do you expect to pay for food on this trip?	
13) How much do you expect to pay for ice on this trip?	
14) How much do you expect to pay for bait on this trip?	
15) How much do you expect to pay for boat fuel and oil on this trip?	
16) How much do you expect to pay for vehicle fuel on this trip?	

- 17) Please rate your overall happiness with your fishing trip today on a scale of 1 to 10, with 1 being extremely unhappy and 10 being extremely happy. _____
- 18) Please rate your fishing success today on a scale of 1 to 10, with 1 being extremely unsuccessful and 10 being extremely successful. _____
- 19) The following is a hypothetical question, however will help provide information to better understand the economic value of our fisheries resources. Please be as accurate as possible when providing an answer. Keeping in mind the total expenses that you just mentioned, what is the maximum amount of additional money that you would be willing to spend to be able to take this fishing trip today? _____
- 20) Out of the following income categories, would you be willing to provide your personal pre-tax annual income?

Less than \$40,000 \$40,000 to \$80,000 \$80,001 to \$120,000 More than \$120,000

- 21) Will you be willing to participate in a follow-up survey?, Yes No

First	MI	Last
Street		
City	ST	ZIP