Anglers' Willingness to Pay for Recreational Catch Improvements in the Cape Fear River

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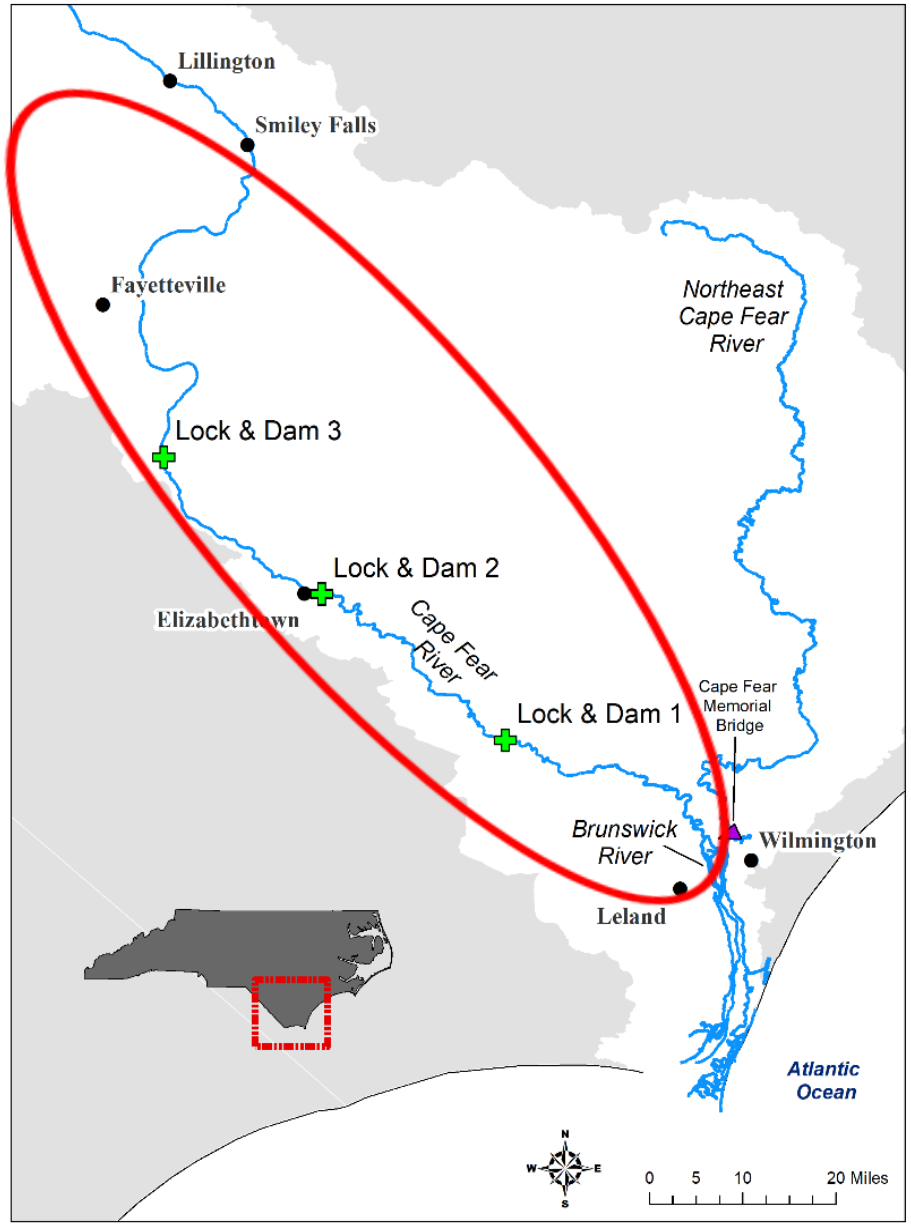
Overview of today's talk

Present the results of a study designed to understand recreational angler…

- Preferences
- Experience
- Willingness to pay for catch improvements
- Willingness to take more fishing trips on the CFR north of the CFM Bridge
- Willingness to donate to a special fund dedicated to improving the ability of migratory species to reach suitable spawning habitat

…. in the Cape Fear River, north of the Cape Fear Memorial Bridge


Lillington
Smiley Falls
Fayetteville
Northeast
Cape Fear
River
Lock & Dam 3
Lock & Dam 2
Elizabethtown
Cape Fear
River
Lock & Dam 1
Cape Fear
Memorial
Bridge
Brunswick
River
Wilmington
Leland
Atlantic
Ocean
N
W
E
S
0
5
10
20 Miles

Why did we do this?

- Migratory fish populations within the Cape Fear River have declined substantially over the past two centuries. Current commercial landings are 87% lower than historic estimates (Smith and Hightower 2012).
- The single largest factor that may be limiting recruitment of migratory fish species is **lack of access to suitable spawning habitat**.
- Historical spawning habitat on the Cape Fear River is located upstream of the three Lock and Dams

Why did we do this?

- Initiatives have been undertaken to promote upstream movement by anadromous species, including the construction of a rock arch fishway at Lock and Dam 1
- Continued modification of navigational obstacles will help migratory fish reach upstream habitats, promote natural recruitment, and improve recreational fishing opportunities

Why did we do this?

- The purpose of this project is to understand the potential economic value of and willingness to pay for changes in recreational catch of finfish in the Cape Fear River
- To understand (some of) the potential economic benefits from improving access to spawning habitat for migratory fish species

Research areas & Research questions

Research Area	Research question(s)
Participation	What is the nature and frequency of participation in recreational fishing trips on the CFR north of the CFMB?
	What factors would induce anglers to take more recreational fishing trips on the CFR north of the CFMB?
Value of Recreational Catch	How much are recreational anglers willing to pay for marginal changes in the catch of small striped bass (< 22”)?
	How much are recreational anglers willing to pay for marginal changes in the catch of large striped bass (> 26”)?
	How much are recreational anglers willing to pay for marginal changes in the catch of shad?
Value of Fish Consumption Advisories	How much are recreational anglers willing to pay to avoid fish consumption advisories (know that fish are safe to eat)?
Value of Open Striped Bass Fishing	How much are recreational anglers willing to pay to keep up to 2 striped bass per trip greater than minimum size?
Preferences for Striped bass minimum size limit	Do anglers show a preference for an 18” vs 26” minimum size limit?
Donations to habitat improvement	Are licenced anglers willing to donate to a special fund dedicated to improving the ability of migratory species to reach spawning habitat?

Methods

- Survey-based non-market valuation
  - Contingent valuation question (willingness to donate to CFRW)
  - Choice experiment (fishing trip choice)

v1

Cape Fear River Recreational Fishing Survey

INTRODUCTION

This survey is part of a study of the economic value of the Cape Fear River. The study is being funded through a partnership with the Cape Fear River Watch and the National Oceanic and Atmospheric Administration (NOAA), with support from the North Carolina Division of Marine Fisheries, the North Carolina Wildlife Resources Commission and the University of North Carolina Wilmington.

Changes in water quality and access to suitable habitat have limited the ability to catch certain species of fish in the Cape Fear River. The purpose of this study is to understand the benefits to fishers if catch rates improve.

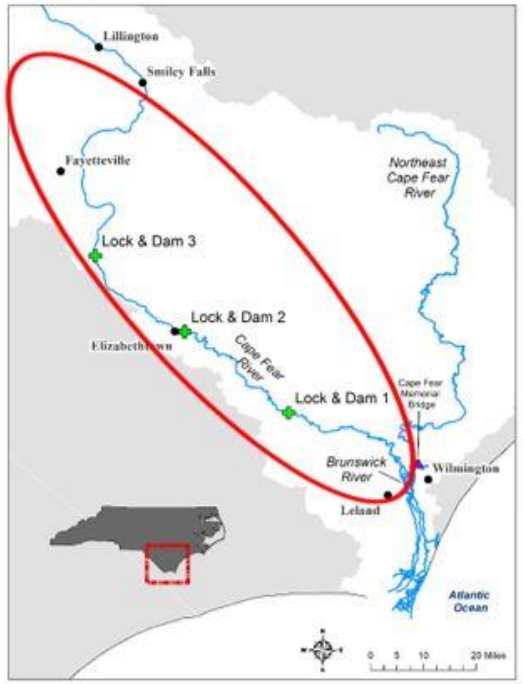
The survey is completely **anonymous and confidential**. We do not require your name, address or phone number. Your participation is **voluntary**, you can stop at any time or refuse to answer any question and your responses will not be treated any differently by the researchers. Your answers are important for future decisions about natural resource management in the Cape Fear River. Please be as truthful and complete as possible.

Please only take this survey if you are 18 years or older.

This survey has 36 questions and should take about 10 minutes to complete.

We have included a self-addressed envelope with current postage paid. Please complete this survey, enclose it in the self-addressed envelope and mail it back to us at your earliest convenience.

Thank you for agreeing to take this survey!



Many questions in this survey ask about your activity and preferences for **fishing in the Cape Fear River upstream of the Cape Fear Memorial Bridge.**

This area includes downtown Wilmington, the Brunswick River and upstream to Smiley Falls at Lillington.

Background: Non-market valuation

- Many/most goods and services provided by the natural environment are not traded in formal markets
- Understanding the value of these goods and services requires that a link be established between changes in the quantity or quality of the resource and changes in the (stated or observed) behavior of people
  - Changes in air quality may result in people moving to another area
  - “Free” disposal of pollutants in water systems affects recreation quality, enjoyment, visitation, probability of return, etc.

Background: Non-market valuation

- Over the past 5+ decades economists have developed techniques to estimate the value of environmental goods and services
- These techniques, which can estimate value for both users as non-users, are being employed intensively throughout the world and are being constantly refined and improved
- Because of the complex nature of many environmental goods and natural resources, more than one type of method may be necessary to gain an understanding of all the components of value

Background: Non-market valuation

Valuation Scenario	Example
Assess the potential for user fees	Will tourists pay more for "environmentally friendly" recreation experiences?
Measure monetary damages from natural resource degradation	What is the economic loss realized as beach width diminishes?
Complete a benefit-cost analysis of a conservation project	Determine the net economic benefit of improving fish passage

Market-based Valuation Methods

The Market Price Method

- Uses market prices and quantities to estimate the economic activity (revenues, jobs, etc.) associated with natural resources

The Replacement Cost Method

- Uses the cost of constructing a man-made replacement for ecosystem service as proxy for the value of the natural service

The Damage Avoidance Method

- Uses the value of damage that would be incurred without the resource to infer its value

Non-Market Valuation Methods

Hedonic Pricing Method

- Estimates the contribution of environmental quality or natural resource amenities to the market value of real estate

Travel Cost Method

- Costs incurred to travel to natural resource sites is used as a proxy for the price people are willing to pay for associated environmental amenities

Contingent Valuation Method

- People's stated preferences are used to infer the value of environmental change by asking questions about willingness to pay or accept

Choice Modeling / Choice Experiments

- People's stated choices are used to infer the value of environmental amenities

Non-Market Valuation Methods

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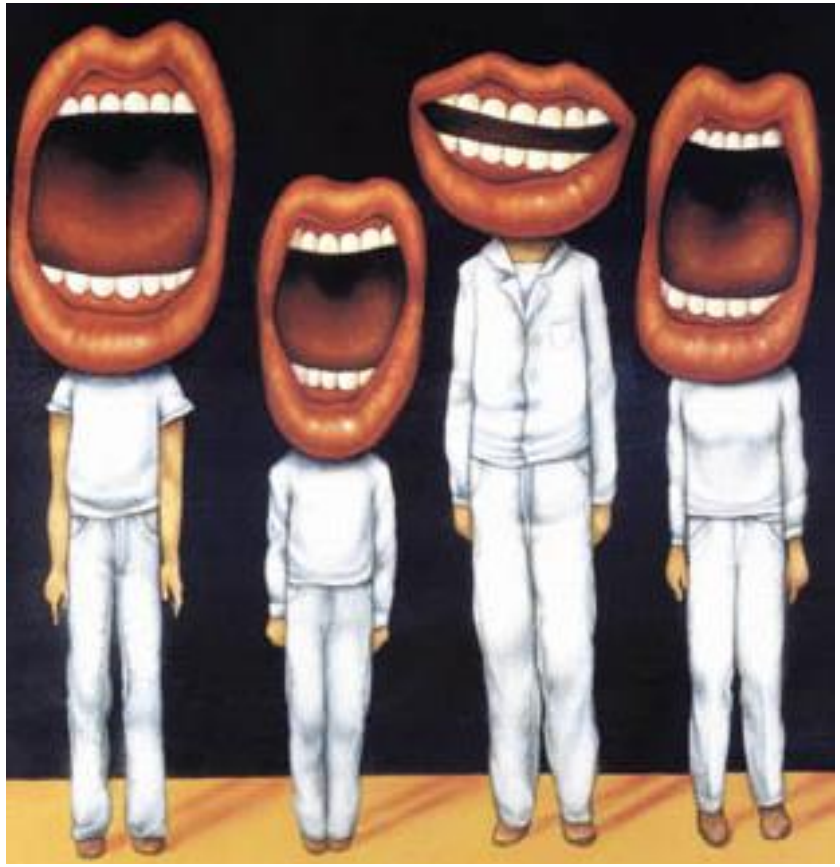
Stated Preference Methods

- The basic idea: People can tell us what they value by answering questions
- Empirical approach: Ask people what they are willing to pay or willing to accept or to make hypothetical choices between alternative goods or states of the world



Stated Preference Methods

Main benefits

- Allow for *ex-ante* estimation of economic value from proposed or hypothetical changes in policy or environmental conditions
- Allow for estimation of non-use values

Downside

- Various biases associated with the hypothetical nature of stated preferences

Contingent Valuation Method (CVM)

Survey-based method whereby people indicate willingness to pay (or accept) for changes described in a hypothetical market

- Survey must include:
  - Detailed description of a program or change
  - Mechanism for eliciting value or choice (needed to estimate the economic sacrifice that respondents are willing to make for the program/change)
  - Payment vehicle
  - Information on respondent attitudes and characteristics

CVM Backstory…

- Oil Pollution Act of 1990: President is required to issue regulations establishing procedures for assessing damages to or destruction of natural resources resulting from a discharge of oil covered by the Act
- Under the Comprehensive Environmental Response, Compensation, and Liability Act (1986), which also pertained to natural resource damage assessments, "*passive-use values*" were included among the losses for which trustees could recover
  - Upheld by the D. C. Court of Appeals (State of Ohio v. Department of the Interior, 880 F.2d 432 (D.C. Cir.1989)), as long as they could be reliably measured
- In promulgating the regulations under OPA, NOAA had to decide whether the CVM technique is capable of providing reliable information about lost existence or other passive-use values. Toward this end, NOAA appointed the Contingent Valuation Panel to consider this question and make recommendations.

CVM Backstory…

- Contingent Valuation Panel put forth a series of best practices to be used in designing and implementing CVM surveys
  - Kenneth Arrow (Stanford)
  - Robert Solow (MIT)
  - Paul Portney (RFF)
  - Edward Leamer (UCLA)
  - Roy Radner (NYU)
  - Howard Schuman (U. Michigan)

Contingent Valuation

27. The Cape Fear River, the longest river entirely within North Carolina, once supported thriving stocks of migratory fish including American shad, shortnose and Atlantic sturgeon and striped bass. Migratory fish populations within the Cape Fear River have declined substantially over the past two centuries, in large part due to lack of access to suitable spawning habitat. Modifying navigational obstacles, including the existing locks and dams, will help these fish reach upstream habitats, promote natural recruitment, and improve recreational fishing opportunities.

Modifying the existing locks and dams will require financial resources for planning and construction.

In principle, would you be willing to contribute a one-time donation of $5 to a special fund dedicated to improving the ability of migratory species to reach suitable spawning habitat?

> The fee donation would be collected and used by Cape Fear River Watch (www.capefearriverwatch.org), a nonprofit organization dedicated to protecting and improving the water quality of the Lower Cape Fear River Basin. All funds received from the program would be used to improve fish migration and habitat. These changes are expected to increase the quantity and size of fish in the Cape Fear River.

☐ Yes, I would be willing to donate an additional $5 to improve fish habitat and the quality of recreational fishing in the Cape Fear River.

☐ No, I am not willing to donate an additional $5 to improve fish habitat and the quality of recreational fishing in the Cape Fear River.

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Proposed donation values:
$1.00
$2.00
$5.00
$10.00
$15.00
$20.00
$25.00
$50.00

Stated Preference Methods: Choice Experiments

- Survey-based method whereby respondent preferences are elicited through a series of choices between alternatives
- Alternative “goods” are described in terms of different levels of attributes
  - Survey data must include:
    - Description of 2 or more options for a “good” specified with levels of attributes that make up the product
    - Respondent attitudes and characteristics

Stated Preference Methods: Choice Experiments

- Recognizes that many goods (including many environmental goods) are *composite* goods, made up of a variety of attributes that can take on various levels
  - Allows estimation of the relative importance of multiple attributes and their levels
  - Generates large quantities of data in a single application
  - Alternative model specifications can be used to explore preference heterogeneity

Choice Experiment Step 1: Design

- What is the “good” about which we wish to understand preferences?
- What are the attributes of that good?
  - Attributes to be valued should be based on policy concerns and/or input from focus groups
  - Levels for the attributes should be realistic and should span the range of respondent preferences and/or policy consideration
  - To ease the cognitive burden on respondents, the number of attributes and levels must be kept at a manageable number

Choice Experiment Step 1: Design

Table 2: Choice experiment attributes and levels

Attributes	Levels
Change in travel time (converted to $travel cost)	25% less, no change, 25% more, 50% more
Catch of small striped bass	0, 1, 3, 5
Catch of large striped bass	0, 1, 2, 3
Catch of shad	0, 2, 5, 10
Allowed to keep striped bass	No (catch & release only), yes legal to keep 2
Fish consumption advisory	No (fish are safe to eat), yes (fish not safe to eat)

Choice Experiment Design

Our full CE design included:

- **64** hypothetical fishing trips selected from 1024 possible combinations of attribute levels, grouped into 32 choice panels, and blocked into 8 groups of **4 choice panels** that were assigned to **8 versions of the survey**
- Each survey respondent was presented with 1 of 8 versions of 4 choice panels
- Each choice panel depicted 2 hypothetical fishing trips and asked survey respondents to choose between the two or to select “neither trip”

Choice Experiment: Attribute descriptions

NEXT, PLEASE THINK ABOUT PLANNING A FISHING TRIP TO THE CAPE FEAR RIVER UPSTREAM OF THE CAPE FEAR MEMORIAL BRIDGE. On the following pages you will be offered four choices each with two fishing trip options. Please read each question carefully. Although they look similar, the two trip options in each choice differ in at least one way from the other. Please complete all four choice scenarios using the definitions provided below.

	**Travel Time** is the time it will take you to travel from your home to your preferred fishing location on the Cape Fear River upstream of the Cape Fear Memorial Bridge, compared to your usual travel time that you reported in question 5.
	**Catch of small striped bass** is the average number of striped bass that are 22 inches or less that you can expect to catch on a trip.
	**Catch of large striped bass** is the average number of striped bass that are 26 inches or larger that you can expect to catch on a trip.
	**Catch of shad** is the average number of shad of average size (approximately 16-18 inches) that you can expect to catch on a trip.
	**Striped Bass Regulations** are restrictions on how many striped bass you can legally keep (bag limit). There is currently a moratorium on keeping striped bass caught in the CFR and its tributaries. • "Closed" means that *you may not keep any striped bass.* • "Open" means that you will be able to *legally keep up to 2 striped bass* per trip that are at least **18** inches in length.
	**Fish advisory** indicates whether there is an advisory in place that recommends not consuming fish that you catch.

Choice Experiment: Attribute descriptions

Split sample approach used here to test for preferences for 18” vs. 26” size restriction

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	**Fish advisory** indicates whether there is an advisory in place that recommends not consuming fish that you catch.

Choice Experiment: Trip choice panel

23. Hypothetical choice 1: Suppose that you could only choose from the CAPE FEAR FISHING TRIP OPTIONS BELOW (Trip A, Trip B, or neither trip). **If all other factors were equal, which would you prefer?**

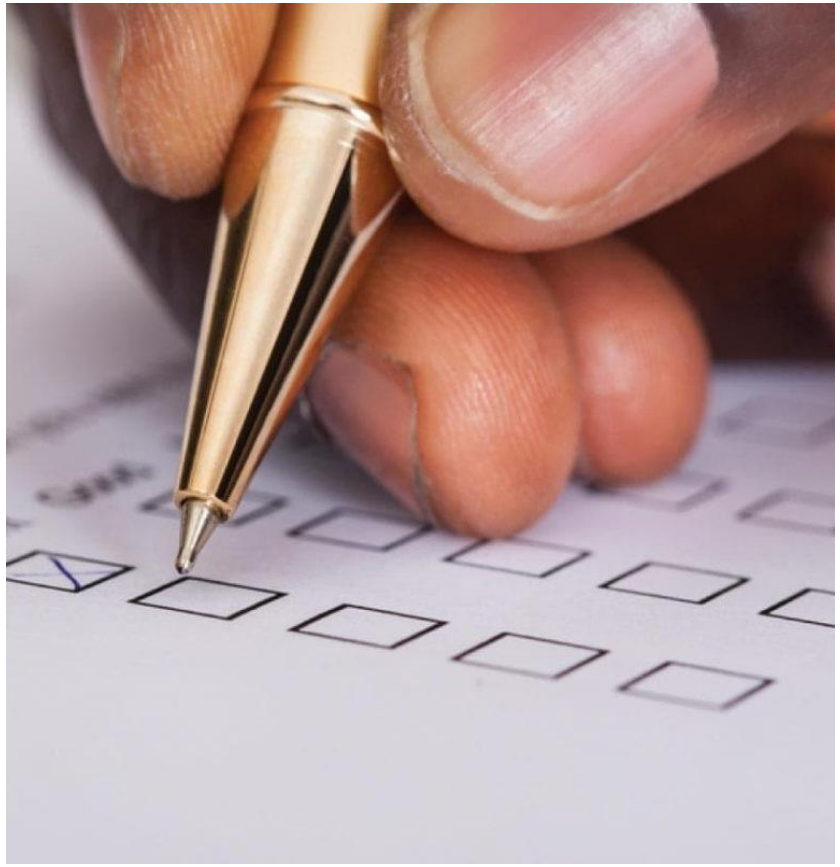
Please choose Trip A, Trip B or neither trip

	Travel Time	Number of small striped bass	Number of large striped bass	Number of Shad	Allowed to keep striped bass?	Fish Consumption advisory	I would choose...
TRIP A	No Change 	5 per trip 	3 per trip 	2 per trip 	Not legal to keep striped bass CATCH & RELEASE FISHING ONLY	No Advisory *Fish are Safe to Eat* 	☐ TRIP A
TRIP B	50% *more* travel time  	1 per trip 	1 per trip 	0 per trip	Yes Legal to keep up to 2 striped bass that are at least 18 inches in length	Advisory **NOTICE!** FISH FROM THESE WATERS MAY BE HARMFUL TO EAT. 	☐ TRIP B
NEITHER TRIP	I WOULD NOT GO ON EITHER OF THESE FISHING TRIPS						☐ NEITHER TRIP

How confident do you feel about choice 1? 1 (not confident) 2 3 4 5 (very confident)

Survey and distribution

- Survey had ~36 questions
- Mailed to a random stratified sample of 10,000 NC recreational fishing license holders in January/February 2020
  - Self-addressed BRM envelope included for return
  - Sample stratified spatially (Coastal, Non-Coastal, Out of State, and **Local**) and by license type (10-day, annual, and lifetime durations for Inland, **Saltwater**, and Inland/Saltwater license holders)
  - Sample draws weighted by the proportion of license type within each area
  - Our sampling strategy purposefully included coastal (saltwater) recreational fishing license holders in order to gauge potential changes in behaviour if fishing conditions in the Cape Fear River improve



Survey response

- Approximately **400** completed surveys were returned via the prepaid business-reply envelope
- More than 1,100 surveys were returned for incorrect address
- Effective response rate ~4.5%

Results: Respondent characteristics

95% NC residents

81% male

High income / high education

83% had been recreational fishing in the past 12 months

70% had been saltwater recreational fishing in the past 12 months

27% had been recreational fishing in the CFR in the past 12 months

17% had been recreational fishing in the CFR upstream of the CFM Bridge in the past 12 months

Results: Changes that would cause respondents to take more recreational fishing trips on the CFR upstream of the CFM Bridge

"I would take more recreational fishing trips if…"	n	Percentage responding
I knew it was safe to eat the fish that I catch	306	48%
I could catch more fish (any species)	304	44%
It was closer to my home	306	44%
The water was cleaner and clearer	306	39%
I could catch bigger fish (any species)	306	34%
I could catch more striped bass	306	32%
There were more public access locations to fish from shore/bank/pier	306	29%
I could catch bigger striped bass	306	26%
There were more public access boat ramps	305	21%
I could keep the striped bass that I catch	304	19%
Other reason[a]	308	16%
It was less crowded at the fishing sites	306	11%

CVM analysis

- Non-parametric and parametric estimation of mean willingness to pay
- Parametric estimation also used to understand the factors associated with willingness to pay

- Non-parametric approach: Turnbull estimation of lower bound mean WTP (Haab and McConnell, 2002)
  - If a respondent answers “yes” to a particular fee/donation value, we can assume that their maximum willingness to pay is at least that value. A “no” response indicates a maximum willingness to pay less than the fee value.

Results: Anglers' willingness to donate to a CFRW conservation fund (without protest zeros)

Donation amount	# offered	% yes
$1.00	35	86%
$2.00	29	72%
$5.00	37	78%
$10.00	34	47%
$15.00	45	53%
$20.00	33	52%
$25.00	31	39%
$50.00	33	39%

Results: Anglers' willingness to donate to a CFRW conservation fund

Table 8: Turnbull estimates of lower bound mean willingness to donate to Cape Fear River Watch

	Including protest zeros	Excluding protest zeros
Lower bound mean WTP	$18.86	$21.51
Standard Deviation of WTP	$5.28	$6.39
95% Confidence interval (lower bound, upper bound)	($8.50, $29.22)	($8.98, $34.04)

Factors associated with higher willingness to donate to a CFRW conservation fund

- Donation amount (as expected)
- Having fished (any recreational) in the past 12 months (but minimal avidity effect)
- Income, education, employed
- Residents of New Hanover County
- Age (nonlinear)
- Would take more recreational fishing trips on the Cape Fear River if …
    - they could catch more striped bass
    - there were more public access boat ramps
    - they could catch bigger fish
    - they knew the fish were safe to eat

Results: Anglers' willingness to donate to a CFRW conservation fund

Table 11: Parametric estimates of mean willingness to donate to Cape Fear River Watch

	Model 1	Model 2	Model 3b (NHC res)
Lower bound mean WTP	$19.33	$21.46	$41.67
Standard Deviation of WTP	$3.33	$3.46	$12.78
95% Confidence interval (lower bound, upper bound)	(12.80, 25.87)	(14.67, 28.25)	(16.63, 66.72)

Results: Anglers' willingness to donate to a CFRW conservation fund

Apply lowest WTP estimate ($18.86) to:

- ~ 136,000 holders of inland or combined coastal and inland recreational fishing licences in NC => donations to CFRW could total over **$2.5 million per year**
- ~ 50,000 recreational licence holders who live in one of the nine NC counties that contain the Cape Fear River => donations to CFRW could total more than **$940,000 per year**

Choice experiment analysis considerations

Coding response data

- “Dummy” coding
- “Effects” coding
- Continuous coding (when possible)

Model specification (logit regression)

- Standard conditional logit (CL)
- Random parameters logit regression (RPL)
- Latent class logit (LCL)

Results: Choice Experiment

Anglers show strong preferences for:

- Higher catch rates (all species)
- No catch restrictions (legal to keep up to 2 striped bass per trip)
- No fish consumption advisories

23. Hypothetical choice 1: Suppose that you could only choose from the CAPE FEAR FISHING TRIP OPTIONS BELOW (Trip A, Trip B, or neither trip). **If all other factors were equal, which would you prefer?**

Please choose Trip A, Trip B or neither trip

	Travel Time	Number of small striped bass	Number of large striped bass	Number of Shad	Allowed to keep striped bass?	Fish Consumption advisory	I would choose...
TRIP A	No Change	5 per trip	3 per trip	2 per trip	Not legal to keep striped bass CATCH & RELEASE FISHING ONLY	No Advisory *Fish are Safe to Eat*	☐ TRIP A
TRIP B	50% *more* travel time	1 per trip	1 per trip	0 per trip	Yes Legal to keep up to 2 striped bass that are at least 18 inches in length	Advisory NOTICE! FISH FROM THESE WATERS MAY BE HARMFUL TO EAT.	☐ TRIP B
NEITHER TRIP	I WOULD NOT GO ON EITHER OF THESE FISHING TRIPS						☐ NEITHER TRIP

How confident do you feel about choice 1? 1 (not confident) 2 3 4 5 (very confident)

Results: Choice Experiment

Anglers prefer:

- Large striped bass relative to small striped bass
- Small striped bass relative to shad

Table 12: Results of Choice Experiment, Conditional Logit Specification

Attribute	Level	Model 1	Model 2	Model 3	Model 4
		Dummy Coding	Effects Coding	Continuous Coding (linear)	Continuous Coding (quadratic)
Travel Cost	Continuous	-0.0047*** (0.0014)	-0.0047*** (0.0014)	-0.0046*** (0.0014)	-0.0046*** (0.0014)
Catch of small striped bass (baseline = 0)	1	-0.1637 (0.1592)	-0.2602*** (0.0924)		
	3	0.1381 (0.1463)	0.0417 (0.0821)		
	5	0.4110*** (0.1544)	0.3146*** (0.0895)		
	Continuous			0.0959*** (0.0288)	-0.0169 (0.1023)
	Continuous^2				0.0231 (0.0195)
Catch of large striped bass (baseline = 0)	1	0.1767 (0.1442)	-0.15015* (0.0890)		
	2	0 .6243*** (0.1449)	0.2974*** (0.0874)		
	3	0.5064*** (0.1502)	0.1796* (0.0917)		
	Continuous			0.1886*** (0.0480)	0.4184*** (0.1608)
	Continuous^2				-0.0704 (0.0512)
Catch of shad (baseline = 0)	2	0.1426 (0.1421)	-0.1516* (0.0885)		
	5	0.6348*** (0.1465)	0.3406*** (0.0924)		
	10	0.3994*** (0.1458)	0.1052 (0.0928)		
	Continuous			0.0431*** (0.0140)	0.2028*** (0.0526)
	Continuous^2				-0.0158*** (0.0050)
Allowed to keep up to 2 striped bass per trip (baseline = catch & release)		0.5259*** (0.0969)	0.2630*** (0.0484)	0.4918*** (0.0981)	0.2538*** (0.0481)
Fish consumption advisory (baseline = safe to eat fish)		-1.1290*** (0.0989)	-0.5645*** (0.0495)	-1.1533*** (0.1019)	-0.5726*** (0.0491)
Trip A	Alternative specific constant	-0.1574 (0.2204)	0.2585** (0.1179)	-0.0974 (0.1863)	-0.6511*** (0.1997)
Trip B	Alternative specific constant	-0.2341 (0.2148)	0.1818 (0.1230)	-0.1319 (0.1805)	-0.7167*** (0.1958)
Log likelihood		-892.290	-892.290	-830.46	-896.5990
Pseudo R2		0.1134	0.1134	0.1042	0.1091

***, ** and * indicate statistical significance at the α = 0.01, 0.05 and 0.10 levels respectively

Results: Choice Experiment

- Anglers have the <u>strongest</u> preferences for (and highest willingness to pay for) avoiding fish consumption advisories

Table 13: Mixed and latent class logit coefficient estimates from choice experiment.

Attribute			Mixed Logit		2-class LC (dummy)		2-class LC (effects)		2-class LC (contin.)	
			Model 5	Model 6	Model 7		Model 8		Model 9	
Variable (baseline)	Level		effects coding	contin. coding	Class 1	Class 2	Class 1	Class 2	Class 1	Class 2
Travel Cost	Continuous	Mean	-0.0045*** (0.0016)	-0.0052* (0.0028)	-0.0191*** (0.0055)	-0.0034 (0.0026)	-0.0191*** (0.0055)	-0.0034 (0.0026)	-0.0181*** (0.0056)	-0.0028 (0.0025)
Catch of small striped bass (0)	1	Mean	-0.4451***		-0.6222 (0.6418)	-0.2491 (0.1872)	-0.7057* (0.4117)	-0.2823*** (0.1036)		
		S.D.	0.9523***							
	3	Mean	0.0583		0.7344 (0.5257)	0.0090 (0.1787)	0.6508** (0.3028)	-0.0242 (0.1017)		
		S.D.	0.4925*							
	5	Mean	0.5719***		0.2220 (0.6118)	0.3729** (0.1841)	0.1384 (0.3930)	0.3397*** (0.1071)		
		S.D.	0.0079							
	Continuous	Mean		0.1102*					0.1148 (0.1068)	0.0848*** (0.0308)
		S.D.		0.4507***						
Catch of large striped bass (0)	1	Mean	-0.1673		-0.1158 (0.5497)	0.2081 (0.1646)	-0.3475 (0.3452)	-0.1523 (0.1018)		
		S.D.	0.0625							
	2	Mean	0.4420***		0.4237 (0.7247)	0.6684*** (0.1733)	0.1920 (0.4566)	0.3080*** (0.1054)		
		S.D.	0.0965							
	3	Mean	0.2396*		0.6189 (0.5250)	0.5650*** (0.1801)	0.3872 (0.3172)	0.2046* (0.1122)		
		S.D.	0.5030*							
	Continuous	Mean		0.3206***					0.2174 (0.1815)	0.2026*** (0.0549)
		S.D.		0.8637***						
Catch of shad (0)	2	Mean	-0.2669**		0.29325 (0.5845)	0.1875 (0.1690)	-0.1320 (0.3704)	-0.1425 (0.1064)		
		S.D.	0.0069							
	5	Mean	0.4006***		0.4859 (0.5926)	0.7632*** (0.1770)	0.0606 (0.3435)	0.4333*** (0.1122)		
		S.D.	0.2107							
	10	Mean	0.2248*		0.9220 (0.6237)	0.3691** (0.1674)	0.4967 (0.3654)	0.0391 (0.1075)		
		S.D.	0.0242							
	Continuous	Mean		0.0566*					0.0642 (0.0520)	0.0421*** (0.0158)
		S.D.		0.2553***						
Allowed to keep up to 2 striped bass per trip (catch & release only)		Mean	0.4442***	0.4616***	1.4896*** (0.4422)	0.4601*** (0.1079)	0.7448*** (0.2211)	0.2300*** (0.0539)	0.0265*** (0.2172)	0.1868*** (0.0516)
		S.D.	0.1668	0.3771						
Consumption advisory (fish are safe to eat)		Mean	-0.9937***	-1.233***	-2.3068*** (0.5679)	-1.0734*** (0.1096)	-1.1534*** (0.2840)	-0.5367*** (0.0548)	-1.0064*** (0.2692)	-0.5412*** (0.0528)
		S.D.	1.1209***	1.4371***						
ASCs	Trip A	Mean	-0.2034	-1.142*** (0.3501)	-2.3290*** (0.6987	1.6293*** (0.3890)	-1.9971*** (0.4670	2.0462*** (0.3301)	-2.7986*** (0.6078)	1.2270*** (0.3579)
	Trip B	Mean	-0.3195*	-0.9834*** (0.3214)	-2.5361*** (0.7527	1.5494*** (0.3891)	-2.2042*** (0.5309	1.9662*** (0.3391)	-2.9025*** (0.6299)	1.2280*** (0.3532)
Class Probability					0.325***	0.675***	0.325***	0.675***	0.315***	0.685***
Log likelihood			-851.404	-791.337	-728.400		-728.400		-743.126	
McFadden Pseudo R-squared			0.1549	0.2145	0.2770		0.2770		0.2624	
AIC			1752.8	1608.7	1514.8		1514.8		1520.3	

***, ** and * indicate statistical significance at the α = 0.01, 0.05 and 0.10 levels respectively

Results: Choice Experiment

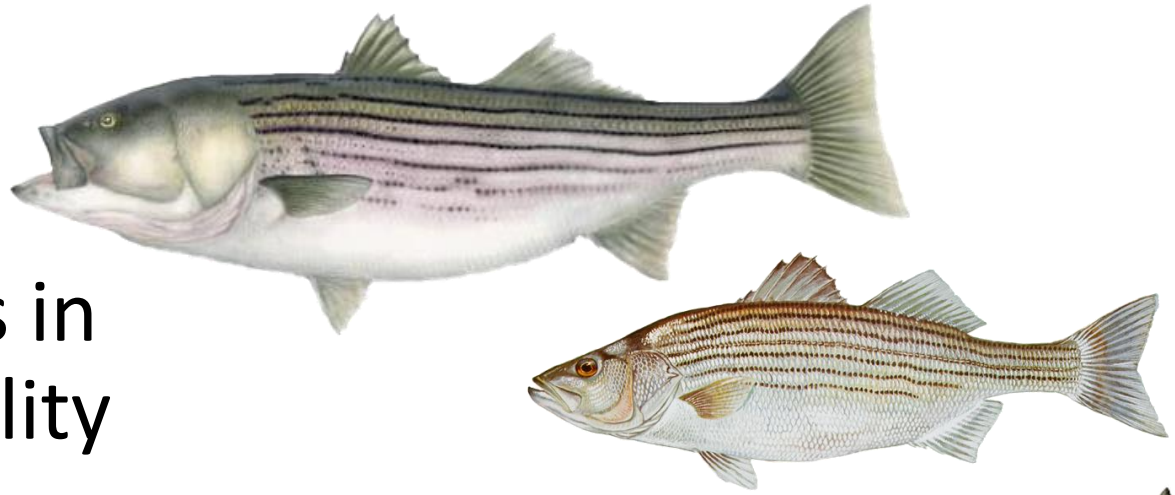
Anglers are averse to catch limits and catch limits affect the satisfaction (and value) of catch:

- The satisfaction from catching 2nd large striped bass exceeds the satisfaction from catching 3rd

Table 14: WTP Results CL (mean WTP, 95% confidence interval)

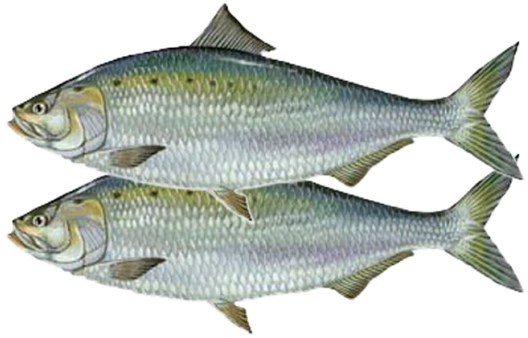
Attribute	Level	Model 1	Model 2	Model 3
Catch of small striped bass (baseline = 0)	1 fish	-$34.60 (-102.98, 33.78)	-$54.97** (-103.66, -6.28)	
	3 fish	$29.19 (-33.74, 92.12)	$8.82 (-25.56, 43.20)	
	5 fish	$86.88** (6.14, 167.61)	$66.51** (13.97, 119.05)	
	Continuous			$20.48** (3.47, 37.50)
Catch of large striped bass (baseline = 0)	1 fish	$37.36 (-25.47, 100.19)	-$31.74 (-72.57, 9.09)	
	2 fish	$131.97*** (39.31, 224.64)	$62.88** (13.47, 112.29)	
	3 fish	$107.06** (22.04, 192.07)	$37.96* (-5.41, 81.33)	
	Continuous			$40.28*** (9.96, 70.60)
Catch of shad (baseline = 0)	2 fish	$30.14 (-31.19, 91.47)	-$32.05 (-72.90, 8.79)	
	5 fish	$134.19*** (36.92, 231.46)	$72.00** (16.08, 127.91)	
	10 fish	$84.44** (7.48, 161.39)	$22.25 (-18.17, 62.67)	
	Continuous			$9.20** (1.23, 17.16)
Allowed to keep up to 2 striped bass per trip (baseline = catch & release)		$111.18*** (38.31, 184.06)	$55.59*** (19.15, 92.03)	$105.03*** (32.74, 177.33)
Fish consumption advisory (baseline = safe to eat fish)		-$238.66*** (-378.81, -98.52)	-$119.33*** (-189.40, -49.26)	-$246.28*** (-396.24, -96.32)

Willingness to pay for marginal improvements in recreational fishing quality



Average willingness to pay per additional catch of…

- Large striped bass = $43.14
- Small striped bass = $20.48
- Shad = $9.08



* Note: “Willingness to *pay*” here represents willingness to incur costs of travel, including the cost of time spent travelling to fishing site.

Willingness to pay for marginal improvements in recreational fishing quality

Allowed to keep striped bass?

Yes

Legal to keep up to 2 striped bass that are at least **18 (26)** inches in length

Average willingness to *pay* to be able to legally keep up to 2 large striped bass per trip =

$48.00 - $110.11

* We found no difference in this effect or WTP amount for 18” vs. 26” size limit

Willingness to pay for marginal improvements in recreational fishing quality

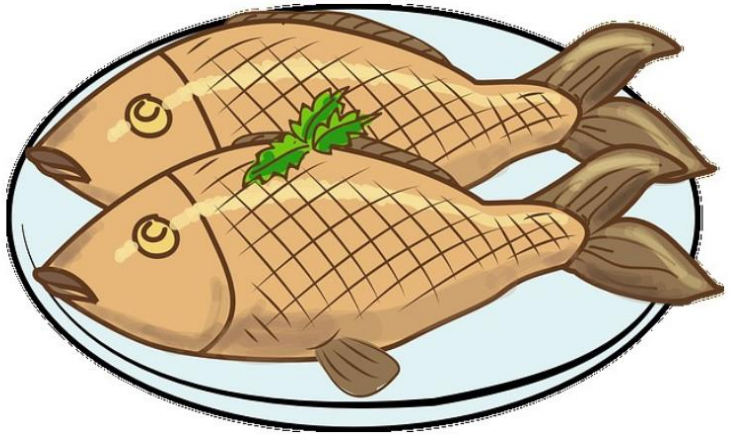
Average willingness to *pay* to avoid fish consumption advisories =

$120.00 - $238.00

Fish Consumption advisory

Advisory

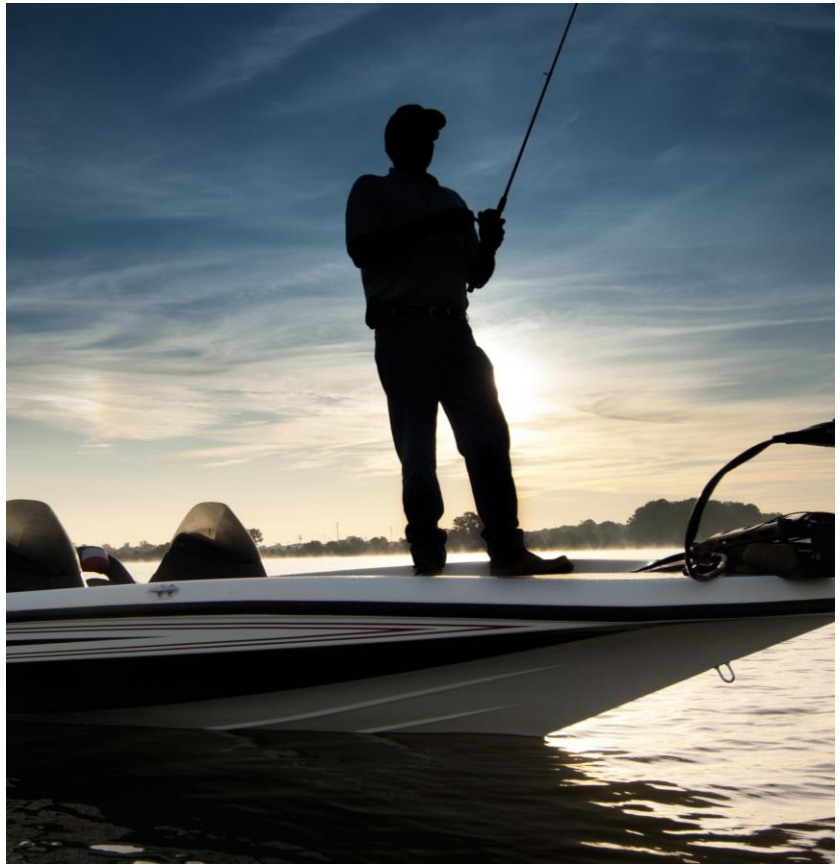
No Advisory
Fish are <u>Safe</u> to eat



Simulations of how changes in fishing quality would affect participation in the fishery

Hypothetical scenarios of improved or diminished quality were used to simulate choices between choosing to fish and not fishing

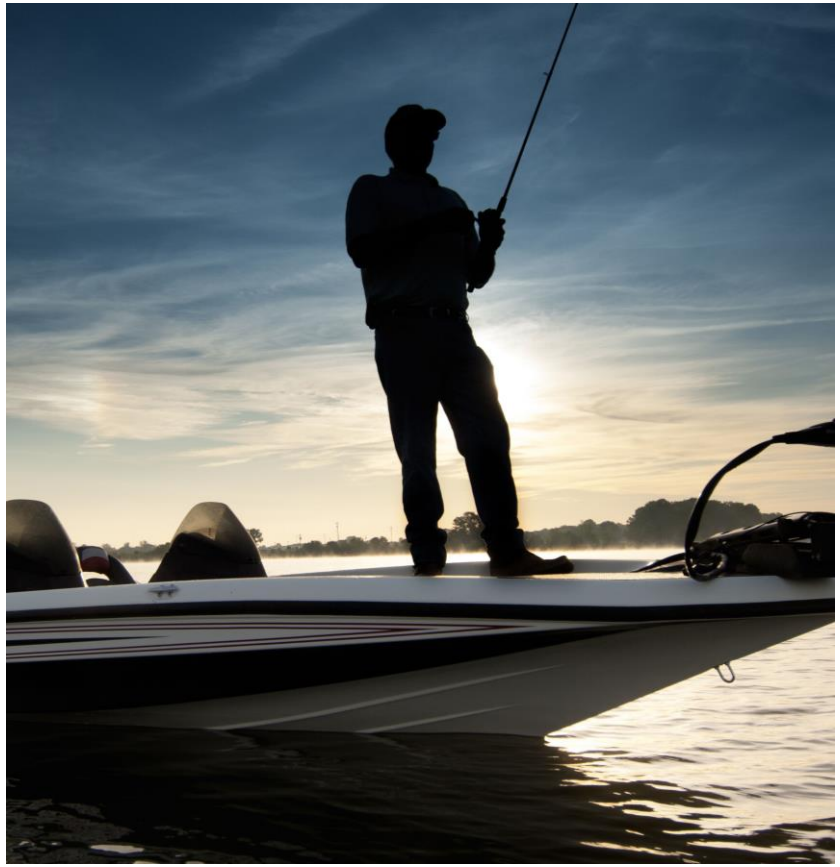
- ~200 simulations conducted
- Worst case scenario (0 large SB, 0 small SB, 0 shad, Illegal to keep, fish advisory) => participation in the fishery will *decrease* by approximately 40%
- Best (realistic?) case scenario (+2 large SB, +2 small SB, +2 shad, legal to keep, no fish advisory) => participation in the fishery will *increase* by approximately 20%



Simulations of how changes in fishing quality would affect participation in the fishery

Unless combined with *significant improvements* in catch rates, the presence of fish consumption advisories is expected to negatively impact recreational fishing participation.

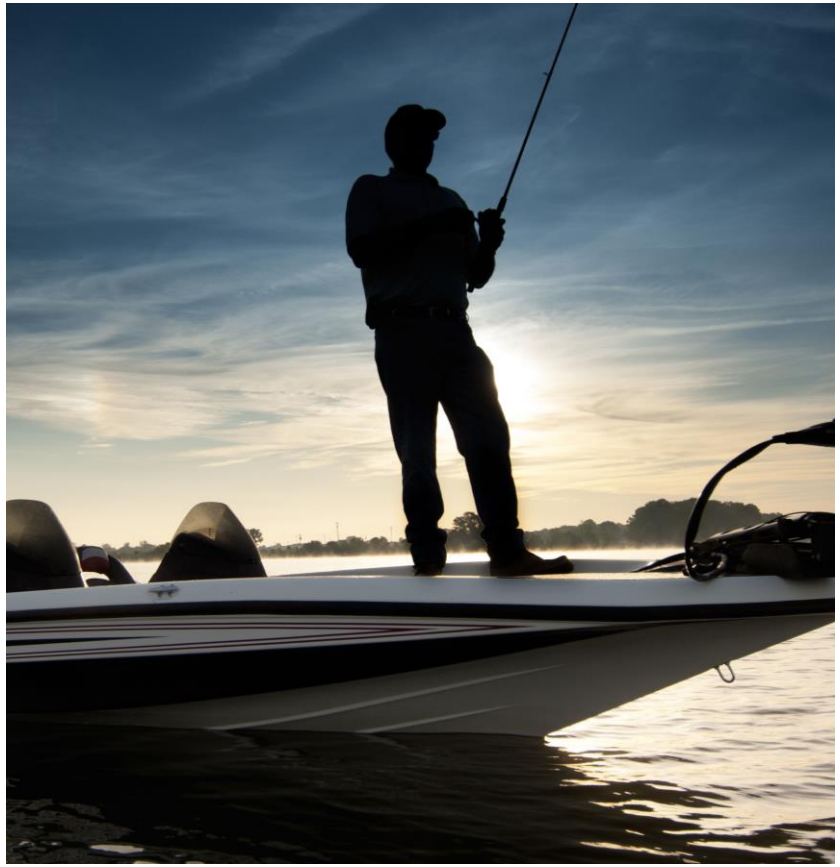
22	+1 large SB, +1 small SB, +1 shad, legal to keep, fish advisory	-3.0%
25	+2 large SB, +2 small SB, +2 shad, illegal to keep, fish advisory	-6.7%
26	+2 large SB, +2 small SB, +2 shad, legal to keep, fish advisory	+3.8%



Simulations of how changes in fishing quality would affect participation in the fishery

Across all attributes, the aversion to lower quality conditions is stronger than preferences for higher quality conditions. The potential negative impacts of reduced fishing quality on anglers' willingness to participate are larger in magnitude that the potential positive impacts of improved quality.

29	Fish consumption advisory	-16.0%
30	No fish consumption advisory	+8.7%
33	-1 large SB per trip	-4.1%
34	+1 large SB per trip	+3.8%



Main takeaways

- Participation in the CFR fishery north of the CFMB is relatively low among NC recreational fishing license holders
- Anglers are willing to pay for habitat improvements that improve the recreational catch
- Anglers will increase their participation in the fishery if catch conditions improve

Main takeaways

- There is strong potential to create economic value and economic impacts by improving access to spawning habitat if those improvements result in healthier stocks and higher recreational catch rates

Main takeaways

- Catch rates matter *much less* than knowing fish are safe for consumption
- The economic value and impacts of improvements in habitat and catch rates (as related to recreational fishing) will be negated or diminished if anglers do not think that fish are safe to eat

Limitations

Low response rate and small sample size

Hypothetical nature of CVM and CE valuation methods

Directions for future research

Improve our understanding of:

- The nature and scope of recreational catch improvements that can reasonably be achieved through policy action and/or habitat modification
- Fish consumption safety & advisories
  - Elevated levels of Per- and Polyfluoroalkyl Substances (PFAS) were found in the blood of striped bass in the lower Cape Fear River (below L&D 1)
  - No consumption advisories in effect
- Angler preferences for 18” vs. 26” size limit
- The economic value of other ecosystem services that are likely to be affected by improved access to spawning habitat

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Thank you!

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