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

Peter W. Schuhmann
Department of Economics and Finance
Cameron School of Business
University of North Carolina Wilmington

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Contents

LIST OF ABBREVIATIONS

AMES	Add-on MRFSS Economic Study
CE	Choice experiment
CFR	Cape Fear River
CFMB	Cape Fear Memorial Bridge
CFRW	Cape Fear River Watch
CSMA	Central/Southern Management Area
CVM	Contingent valuation method
MRFSS	Marine Recreational Fishery Statistical Survey
NCDMF	North Caroline Division of Marine Fisheries
NCWRC	North Carolina Wildlife Resources Commission
UNCW	The University of North Carolina Wilmington
WTA	Willingness to accept
WTP	Willingness to pay

1 Executive Summary

This report summarizes the results of an empirical study of recreational angler preferences, experience, willingness to pay for catch improvements and 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. This information can be used to identify quality improvements that provide the highest welfare gains to recreational anglers and generate economic impacts through spending related to recreational fishing. Results also illustrate the potential revenue that could be garnered from donations by licenced anglers and directed toward improving the quality of habitat and recreational fishing in the Cape Fear River.

To understand preferences and willingness to pay for improvements in recreational fishing quality in the Cape Fear River, a questionnaire was designed and mailed to a random stratified sample of NC recreational fishing license holders. The questionnaire elicited a variety of information from respondents, including demographic characteristics (e.g., age, gender, education, marital status, income), fishing experience, preferences, fishing practices and satisfaction with various aspects of fishing on the Cape Fear River. Anglers were also asked to indicate which factors would cause them to take more recreational fishing trips upstream of the Cape Fear Memorial Bridge, and were asked to complete a choice experiment designed to estimate respondent preferences for different aspects of recreational fishing on the Cape Fear River and willingness to travel to fish on the Cape Fear River under various recreational fishing conditions. Respondents were also asked if they were willing to donate to a special fund administered by Cape Fear River Watch (CFRW) dedicated to improving the ability of migratory species to reach suitable spawning habitat. The survey was mailed to approximately 10,000 recreational fishing license holders in early 2020. Of these, roughly 1,100 were returned due to incorrect address and approximately 400 completed and returned surveys were used in this analysis.

Approximately 17 percent of the sample indicated that they have fished on the Cape Fear River upstream from the Cape Fear Memorial Bridge in the past 12 months, and approximately 75 percent of anglers in the sample would be willing to take more recreational fishing trips on the Cape Fear River upstream of the Cape Fear Memorial Bridge each year if conditions were improved. The most important factors that would induce this increase in participation were knowing that it was safe to eat the fish that were caught and being able to catch more fish.

More than 53 percent of survey respondents were willing to donate some amount of funds to improving the ability of migratory species to reach suitable spawning habitat. Lower bound estimates of the average amount that respondents were willing to donate range from approximately US $18.00 to US $21.00, depending on the method of estimation. Applying these estimates to roughly 136,000 holders of inland or combined coastal and inland recreational fishing licences state-wide suggests that donations to CFRW could total between US $2.5 and US $2.8 million. Applying the most conservative estimate of willingness to pay to the roughly 50,000 recreational licence holders who live in one of the nine NC counties that contain the Cape Fear River, suggests that donations to CFRW could total more than $900,000.

Results from the choice experiment suggest that recreational anglers have strong preferences for avoiding fish consumption advisories and catching more fish and are willing to travel/pay more for higher quality fishing trips. Of the attributes examined (catch of small striped bass, catch of large striped bass, catch of shad, being able to keep the striped bass that were caught and the presence of a fish consumption advisory), anglers' willingness to pay was highest for avoiding fish consumption advisories.

2 Introduction

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 (Earll 1987; Chestnut and Davis 1975). Migratory fish populations within the Cape Fear River have declined substantially over the past two centuries (Smith and Hightower 2012). At the beginning of the 20th century, the Cape Fear River was one of the most productive rivers in North Carolina for American shad, but 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 locations on the Cape Fear River, which likely include Smiley Falls, located upstream of the three Lock and Dams near Erwin, N.C. (Figure 1), and other areas in the Deep River, are blocked by several major dams (Cape Fear River Partnership, 2013).[1] Several initiatives have been undertaken in recent years 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.

Improved recreational fishing opportunities can create economic benefits. For example, despite the dramatic declines in commercial landings, Hadley (2015) shows that the American shad fishery provides upwards of $106,000 in annual net benefits and can support $650,000 in industry output and business sales in the state economy. In aggregate, fisheries of the Cape Fear River support an estimated 467 jobs, $14.2 million in income, and $35.7 million in business sales.

Past research has demonstrated that recreational anglers derive economic benefits from fishing and are willing to pay for improvements in the quality of fishing experiences, especially improved catch rates. In a summary paper, Johnston et al. (2006) apply meta-analysis to 391 estimates of willingness-to-pay for recreational catch improvements from 48 valuation studies conducted between 1977 and 2001. The authors find that the value of catching an additional fish averages approximately $17.00 (2003 dollars) and ranges from a minimum value of less than 10 cents per fish to a maximum value of over $600.00 per fish. Variation in willingness-to-pay per fish is found to be associated with study methodology, geographic region, species type and angler characteristics.

[1] The upper limit of historic spawning habitat for striped bass, Atlantic sturgeon and shortnose sturgeon in the Cape Fear River is generally unknown, but is presumed to be coincident with the generally accepted historical spawning grounds for American Shad and the upper limit on the spawning habitat for river herring, near Smiley Falls (Cape Fear River Partnership, 2013).

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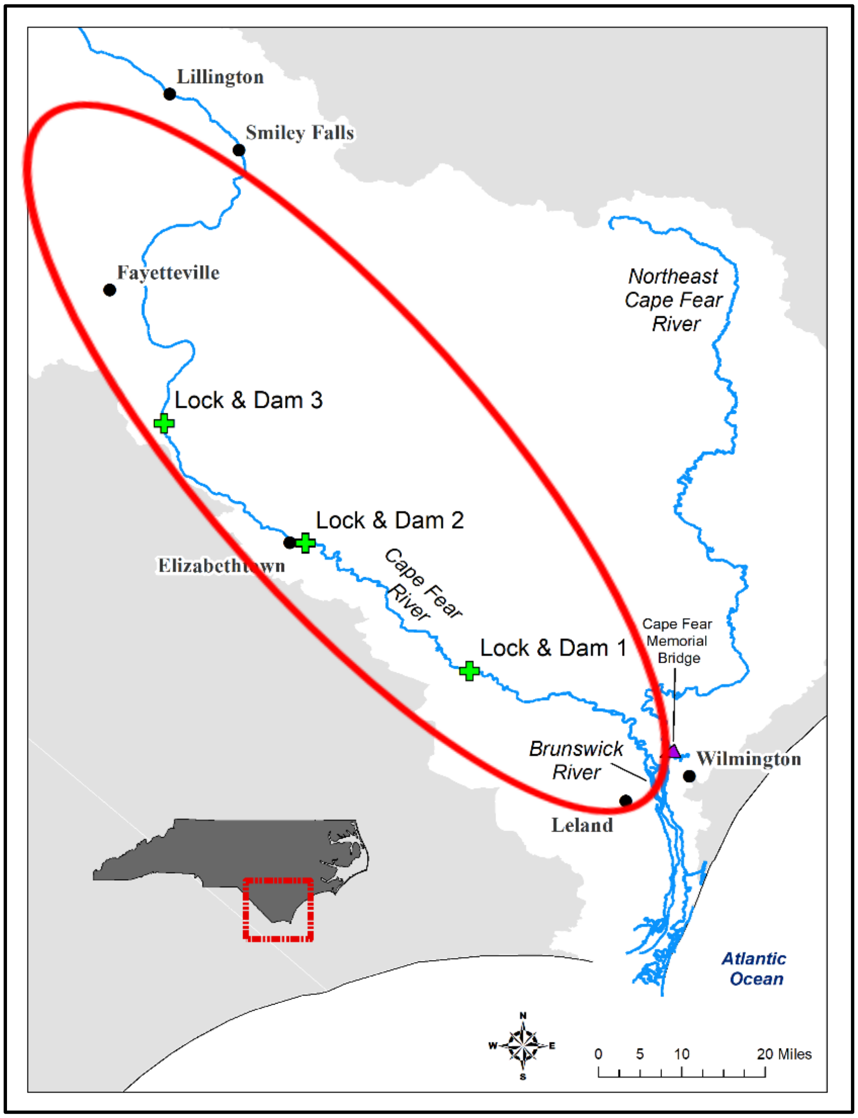
Figure 1: Study Area



For example, based on data from the Central/Southern Management Area (CSMA) creel survey, Hadley (2015) finds that recreational anglers fishing on the Middle Cape Fear River reported consumer surplus (net economic benefits) of $8.84 per trip, which sums to roughly $188,500 for all recreational fishing trips on the Cape Fear River in 2013 and approximately $61,200 in 2014. Hadley also estimates that spending by recreational anglers on the Cape Fear River supports roughly 374 jobs, $12.2 million in income and $31 million in output. Schuhmann and Schwabe (2004) applied a random utility model of site choice to angler intercept data from the Roanoke River to estimate net gains from a 25 percent improvement in the catch of striped bass, finding benefits to catch-and-keep anglers would range from $2.67-$9.74 per trip and from $6.60-$36.98 per trip for catch-and-release anglers.

Several studies have shown that recreational anglers value non-catch aspects of fishing quality. For example, Zhang and Sohngen (2018) use results from a choice experiment administered to 767 Ohio Lake Erie recreational anglers and find that anglers are willing to pay $40.00 to $60.00 per trip for a policy that cuts upstream phosphorus loadings (related to harmful algal blooms) by 40 percent, and $65.00 to $96.00 per trip for improving water clarity from murkier conditions to clear.

Other researchers have examined how restrictions such as fish consumption advisories and bag limits affect recreational angler welfare. For example, Jakus et al. (2002) summarize the results of 11 studies focusing on consumption advisories in freshwater environments (mostly lakes) and find that lost economic value per trip from fish consumption advisories ranges from $1.84 to $5.51 per trip. Whitehead (2006) applies both random utility modelling and contingent valuation to data from data from the 1997 Marine Recreational Fishery Statistical Survey (MRFSS) and the Add-on MRFSS Economic Study (AMES) to estimate recreational anglers' willingness to pay for reductions in king mackerel bag limits. Results of this study suggest that willingness to pay to avoid bag limits varies depending on the estimation method. Based on the CVM results, king mackerel anglers are willing to pay approximately $2.45 per year to avoid a one fish reduction in the bag limit, while the RUM results suggest that anglers would pay $2.24 per trip to avoid this reduction.

2.1 Project goals

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 upstream of the Cape Fear Memorial Bridge. Understanding the value of improved catch rates in this area of the CFR will lend insight into the potential economic benefits from improving access to historical spawning habitat for migratory fish species that may be achieved through modifications to the Lock and Dams located approximately 26 miles upstream from Wilmington, NC.

Consultations between the author and Cape Fear River stakeholders, including personnel from Cape Fear River Watch, the North Carolina Division of Marine Fisheries and the North Carolina Wildlife Resources Commission resulted in six primary areas of research (RA1 – RA6) to be addressed through a survey of licensed recreational anglers:

RA1. Current and potential participation in recreational fishing on the Cape Fear River north of the Cape Fear Memorial Bridge.

RA2. The economic value of improvements in recreational catch rates.

RA3. The economic value of fish consumption advisories.

RA4. The economic value or importance of being able to keep striped bass

RA5. Preferences for minimum allowable size for striped bass.

RA6. Potential for generating funds for habitat improvement from recreational fishing license holders.

2.2 Non-Market Valuation

Economic valuation is the process of estimating what something is worth to a group of people or to society at large. In short, valuation is the monetization of the benefits or costs associated with a good or service. We can understand the value of a good or service by observing what most people are willing to give up (i.e., trade) to attain it. There are many situations where measuring and understanding the value of natural resources can be useful. When there is a potential for a trade-off between market values (e.g. the costs of improving fish habitat or migration) and non-market values (e.g. the benefits to recreational anglers from improved fishing quality), economic valuation can serve as a means of facilitating this comparison by expressing all costs and benefits in monetary units. Valuation can also serve to illustrate the economic gains from activities that enhance human wellbeing through impacts on natural systems and can be used to prioritize resources of economic importance that are not directly associated with market activities. Valuation therefore allows for the measurement of net benefits of policy interventions, which serves as a basis of improved decision making and resource allocation.

Several empirical methods are available for the valuation of natural resources and environmental quality. The choice of method depends on several factors, including the type of resource, its impact on human wellbeing, the intended purpose of the value estimates, and data availability. A brief review of the more popular and practical techniques is presented below. For an in-depth discussion on the full range of methods and the history of non-market valuation, see Bockstael, McConnell, and Strand (1989), Bockstael, Hanemann, and Kling (1987) and Braden and Kolstad (1991).

Non-market valuation methods used in this study include the *Contingent Valuation Method* (CVM) and *Choice Experiments* (CE). These methods estimate the value of changes in the quality or quantity of public goods or services and rely on carefully crafted questions to elicit value from the population of interest. CVM relies on direct questions regarding people's willingness to pay for beneficial changes or willingness to accept losses, while CEs ask people to make choices between goods or services that are described in terms of various attributes.

The goal of CVM is to create a realistic, albeit hypothetical, market where peoples' values for a good or service are expressed. A CVM question, typically embedded within a larger survey, consists of four main elements: a description of the program the respondent is asked to pay for or vote upon (e.g, a conservation project); a mechanism for eliciting value or choice (e.g. a simple referendum type question that asks the respondent to vote "yes" or "no" to a specified price, choice of maximum willingness to pay from a predetermined range of values shown on a "payment card"); a "payment vehicle" describing the manner in which the hypothetical payments are collected (e.g. higher taxes or a payment into a trust fund); and questions addressing reasons for "no" responses. The larger survey that contains the CVM question typically collects information on respondent attitudes and characteristics (e.g. socioeconomic variables, environmental attitudes) which can be analysed to measure statistical association with willingness to pay.

While CVM can be a powerful and useful tool in deriving value estimates for natural resources, choice experiments may be more useful in terms of determining the relative value of different attributes that comprise a good or service. The CE approach is increasingly gaining favour in the literature as it avoids many of the inherent biases associated with CVM, and unlike other valuation methods, CEs allow multidimensional attribute changes to be valued simultaneously (Huybers, 2004). Data for a CE analysis are obtained from a survey that guides respondents through a series of paired choice alternatives, each described in terms of different levels of attributes that comprise the product. Based on an experimental design, the descriptions of the alternatives vary across scenarios. Valuation is facilitated by including a monetary attribute (e.g. cost, price) in the description of the alternatives.

CVM and CE data can be analysed using a variety of statistical approaches including the calculation of summary statistics, nonparametric calculation of median willingness to pay, and parametric modelling of responses via regression analysis. The latter method allows the researcher to make inference regarding the effect that various factors have on respondents' choices or willingness to pay.

2.3 Research questions and survey design

To estimate the economic value of efforts to improve fish passage and habitat quality on the CFR a questionnaire was developed to measure recreational anglers' willingness to pay (WTP) for improvements in recreational catch in the Cape Fear River north of the Cape Fear Memorial Bridge using the CVM and CE methodologies. The questionnaire was developed in consultation with CFR stakeholders including the Cape Fear River Partnership, Cape Fear River Watch (CFRW), the North Carolina Division of Marine Fisheries (NCDMF) and the North Carolina Wildlife Resources Commission (NCWRC).

These consultations generated a list of research questions targeted at a better understanding of the economic value of changes in the quality of recreational catch in the Cape Fear River above the Cape Fear Memorial Bridge – the area deemed to be the most affected by changes in fish passage through modifications to existing locks and dams. Research questions pertinent to future management decisions include the value of marginal changes in catch rates, the value of (avoiding) fish consumption advisories (i.e. knowing that fish are safe to eat), the value of being able to keep striped bass that are caught, and relative preferences for 18" and 26" minimum size restrictions for striped bass. Because changes in water quality, habitat and fishing regulations may affect the size and species that are targeted and caught by anglers, an understanding of the value of catching large striped bass (more than 26 inches in length), small striped bass (less than 22 inches in length), and shad were deemed important.

In addition to understanding the value of changes in catch, stakeholders also expressed interest in understanding anglers' willingness to donate to habitat improvement efforts, anglers' satisfaction with various aspects of fishing on the NECFR (e.g. size and nature of catch, water quality, crowding), and the factors that would lead to anglers' taking more recreational fishing trips on the NECFR. A list of the research questions addressed in this research are shown in Table 1.

The final questionnaire contained 36 questions, including a contingent valuation script describing the declines in migratory fish stocks in the CFR due to loss of access to spawning habitat and asking respondents if they were willing make a one-time donation of a specific amount to CFRW to help fund improvements in migratory fish habitat. A dichotomous choice elicitation format was employed for the WTP question, with 8 bid values ranging from $1 to $50 randomly assigned to different versions of the questionnaire. Figure 2 shows the CVM script and WTP question.

A choice experiment (CE) was designed to understand respondent preferences and willingness to pay for improvements in the quality of recreational fishing trips, where attributes describing recreational fishing trips included catch rates of small striped bass, large striped bass and shad, whether anglers could legally keep striped bass (up to a 2 fish limit), and whether fish were safe to eat. A total of 64 hypothetical fishing trips were selected from the full factorial design,[2] grouped into 32 choice panels, and blocked into eight groups of four choice panels that were assigned to eight versions of the survey. Each survey respondent

[2] The CE included six attributes, four with four levels and two with two levels. The size of the full factorial therefore includes 1024 possible combinations of attributes and levels.

was presented with one of eight versions of four choice panels where each choice panel depicted two hypothetical fishing trips and asked survey respondents to choose between the two or to select neither trip. After each choice panel, respondents were asked to indicate their confidence in the choice on a 5-point scale (1 = not confident, 5 = very confident). Attributes and levels used in the CE are shown in Table 2. An example of a single choice panel is shown in Figure 3. The questionnaire was pretested by the authors, personnel from CFRW, NCDMF and NCWRC and two recreational charter fishing captains. Based on stakeholder feedback, the survey was modified to improve exposition and flow.

Table 1: 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?

2.4 Data

The final survey was mailed to a sample of 9,999 NC Recreational Fishing Licence holders 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), with sample draws weighted by the proportion of license type within each area. Our sampling strategy was intentionally weighted toward coastal (east of Raleigh NC) and local (counties adjacent to the CFR) strata. Creel survey data from the area of interest indicate that the CFR fishery is localized, hence anglers in counties adjacent to the CFR are expected to utilize the fishery if conditions improve. Coastal (saltwater) recreational fishing license holders were also assumed to be more aware of the CFR fishery and more likely to participate in the fishery. Over-sampling from these two strata was deemed essential to properly gauge potential changes in behaviour if fishing conditions in the Cape Fear River improve. Approximately 400 completed surveys were returned via a prepaid business-reply envelope that was included with the survey form. More than 1,100 surveys were returned for incorrect address, suggesting an effective response rate of approximately 4.5 percent.

Figure 2: The Contingent Valuation Scenario and Willingness to Pay Question

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.

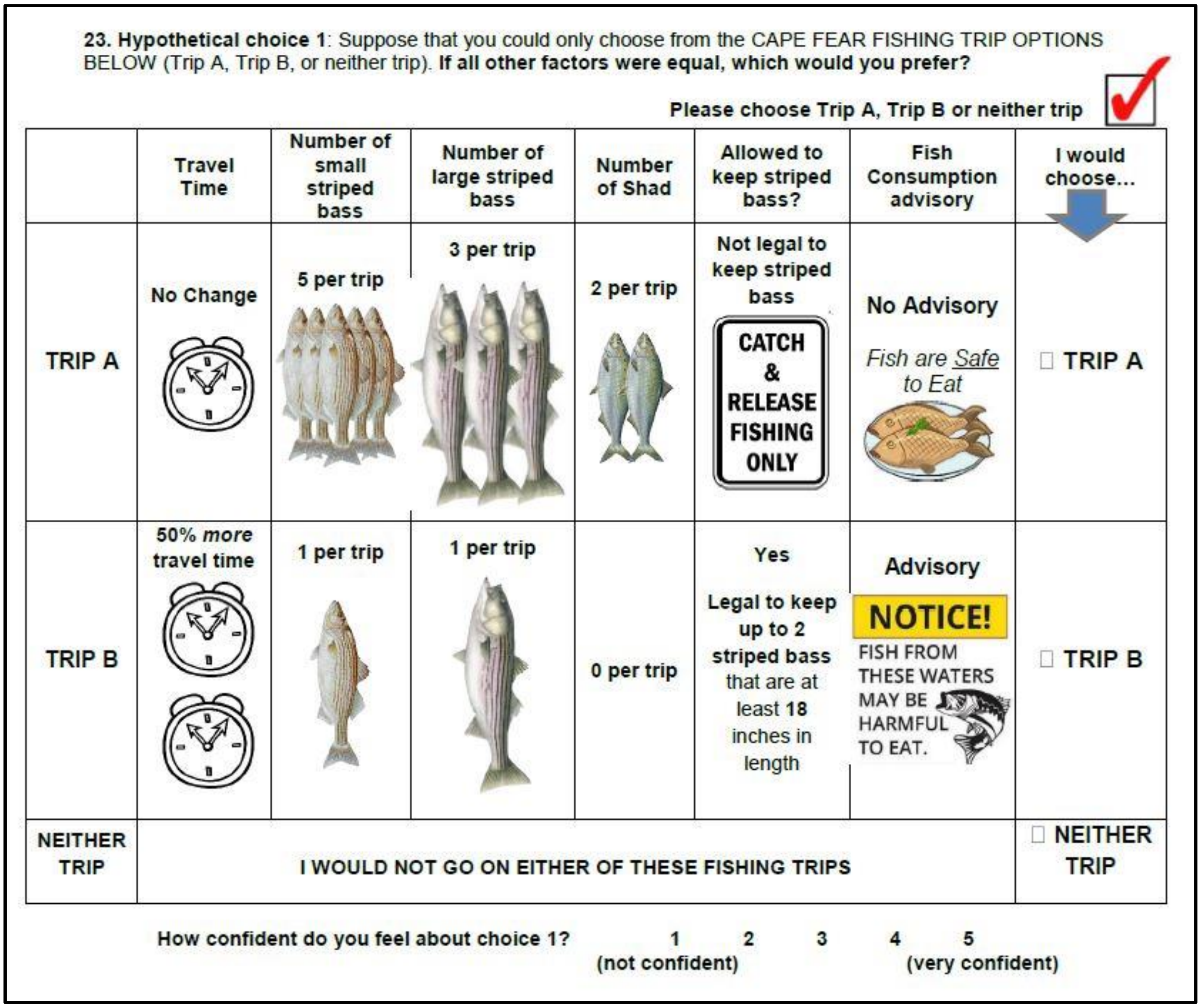
☐ Yes, I would be willing to donate an additional $5 to improve fish habitat and the quality of recreational fishing in the Cape Fear River.

☐ 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.

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)

Figure 3: Choice experiment script and example of a single paired choice in the CE



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)

2.5 **Methods**

2.5.1 Analysis of Choice Experiment Data

The purpose of empirical examination of choice experiment data is to estimate how respondents' choices between alternatives (i.e. trip A, trip B or neither trip) depend on the characteristics (i.e. levels of various attributes) of those alternatives (Huybers, 2004), and to ultimately estimate respondents' willingness to pay for different levels of the attributes. Analysis of CE response data is based on the random utility model (RUM) first introduced by McFadden (1973), which recognizes that an individual's satisfaction or "utility" from a given choice is a function of observable and unobservable characteristics. More formally, the utility derived by an individual from a particular alternative (i) can be represented by a function that contains a deterministic component (V_i) and a random component (e_i):

(1) $$U_i = V_i + \varepsilon_i$$

Given a set of mutually exclusive alternatives (e.g. alternatives presented in each choice set), an individual's choice of alternative (i) over another alternative (j) implies that the utility from the former outweighs that from the latter. Because the utilities include a stochastic component, the probability of choosing alternative (i) can be described as:

(2) $P\{i\} = P\ \{V_i + \varepsilon_i > V_j + \varepsilon_j\}$

The multinomial logit (MNL) regression model can be used to estimate the probability of choosing alternative (i) (McFadden 1973; Ben-Akiva and Lerman 1985):

(3) $P\{i\} = \exp(V_i) / \exp(V_j)$

Estimation of (3) requires the specification of a functional form for the indirect utility function in (1) and the identification of variables which are likely to influence choice, such as the levels of the attributes that comprise each alternative and respondent characteristics.

MNL regression allows the estimation of unique coefficients for each level of the attributes relative to a pre-determined baseline level. These coefficient estimates are referred to as "part-worth utilities", and represent the satisfaction derived from an attribute level compared to a baseline (omitted) level. For example, for the CE described above, with the lowest level of each attribute serving as the base level, utility is estimated as:

(4) $U_i = \beta_1(\text{Travel Cost}) + \beta_2(\text{1 small striped bass}) + \beta_3(\text{3 small striped bass}) + \beta_4(\text{5 small striped bass}) + + \beta_5(\text{1 large striped bass}) + \beta_6(\text{2 large striped bass}) + \beta_7(\text{3 large striped bass}) + \beta_8(\text{1 shad}) + \beta_9(\text{5 shad}) + \beta_{10}(\text{10 shad}) + \beta_{11}(\text{legal to keep up to 2 striped bass}) + \beta_{12}(\text{fish consumption advisory})$

The marginal rate of substitution (MRS) between any two attribute levels can be derived using the ratio of the corresponding parameter estimates. MRS values provide important insight into respondents' willingness to trade attributes and levels. For example, the coefficient on monetary attribute, β_1, represents the marginal utility of income and can be used to derive the value or willingness to pay (WTP) for different levels of the non-price attributes:

(5) $\text{WTP for attribute level a} = - \beta_a / \beta_1$

For each non-price attribute, one level is specified as a baseline or reference level. The monetary attribute is commonly coded as a continuous variable to produce a single dollar-based coefficient and allow estimation of (5) in dollar terms. Two common approaches to coding non-price attribute levels are dummy coding and effects coding. Dummy coding sets baseline levels of non-price attributes at 0 and delineates other levels with a value of 1 if they are present in the alternative. With effects coding, the baseline level of each non-price attribute is set to -1 (rather than 0) to prevent confounding with the opt-out alternative (where all attribute levels are coded as 0) when baseline levels are present in a choice set (Cooper et al. 2012). Data coding has implications for the interpretation of model coefficients. In the case of dummy coding, coefficients on non-baseline levels of each attribute are interpreted relative to the baseline level. With effects coding, coefficients are interpreted relative to the mean for all levels for that attribute. To understand how coding affects our WTP estimates, we examine the CE results using both dummy coding and effects coding.

2.5.2 Analysis of Contingent Valuation Data

Responses to dichotomous choice CVM questions (e.g. Figure 2) can be examined using non-parametric and parametric approaches to estimate willingness to pay and understand the factors associated with willingness to pay. Following Schuhmann et al. (2019) we calculate non-parametric Turnbull lower and upper bound estimates of mean willingness to pay and model the probability of answering "yes" to the willingness to pay question as a function of the fee value and respondent characteristics (Haab and McConnell, 2002). The latter approach allows for an estimate of average WTP that does not rely on distributional assumptions, while the parametric approach provides an alternative measure of average WTP and allows for formal hypothesis testing regarding factors that are associated with WTP.

The underlying assumption for Turnbull estimation of willingness to pay is that a "yes" response to a particular fee value implies that the respondent's maximum willingness to pay is at least that value. A "no" response indicates that maximum willingness to pay less than the specified value. A lower bound (conservative) estimate of mean willingness to pay is calculated as:

(6) $$E_{LB}\,(WTP) = \sum_{j=0}^{M} t_j \, . \, (F_{j+1} - F_j)$$

Where j indexes the eight donation amounts, tj, M is the maximum fee amount and Fj is the proportion of respondents who faced a particular fee amount and answered "no". Fj is assumed to represent the probability that a randomly chosen respondent will say "no" to fee tj. The term in brackets, F j + 1 - Fj, is therefore the difference between the proportion of "no" responses at a particular fee amount and the proportion of "no" responses at the next lowest fee amount, and is a consistent estimate of the probability that WTP lies between tj and tj+ 1.

The standard deviation of the lower bound estimate is given by:

(7) $$St\ Dev\,[E_{LB}\,(WTP)] = \sum_{j=1}^{M} \frac{F_j\,(1-F_j)}{T_j}\,(t_j - t_{j-1})$$

Where T_j is the number of respondents who were offered each bid amount, t_j.

The nonparametric Turnbull estimates generated by (6) and (7) are useful in their ease of calculation and interpretation. Assessing the relationship between WTP and individual factors such as demographic or attitudinal variables can also be useful for policy in terms of understanding what types of individuals are willing to pay. Following convention in the literature (e.g. Blaine et al. 2005; Casey et al. 2010; Castaño-Isaza et al. 2015; Lee and Han 2002; Loomis and Santiago 2013) we model stated WTP responses (e.g. yes/no responses to the donation question) as a function of individual and trip characteristics.

More specifically, an individual i can be expected to answer "yes" to a particular fee amount tj if their utility (satisfaction) ui with the fee is higher than utility in the absence of the fee:

(8) u1i (yi-tj, Xi, M1, ε1i) ≥ u0i (yi, Xi, M0, ε0i)

Where ui, yi and Xi represent the respondent's utility, income, and demographic or trip characteristics respectively. M captures the impact of additional funding on utility and ε is the error term that captures aspects of utility that are unobservable to the researcher.

The probability of a "yes" response to donating a particular amount is therefore the probability that utility with the donation exceeds utility without the donation:

(9) $P_i(\text{"yes"}) = P\,[u_{1i}(y_i - t_j, X_i, M_1, \varepsilon_{1i}) \geq u_{0i}(y_i, X_i, M_0, \varepsilon_{0i})]$

This probability can be estimated using a binary response model such as a probit or logit (Hanemann 1984) by specifying a functional form for the utility function, including the nature of the error term. First, we assume that utility is linear in the fee amount, t and respondent characteristics, X:

(10) $u_i(t_j, X_i, M) = \beta_0 + \beta_1 t_j + \Sigma\, \beta X_i + \varepsilon_i$

In the case of a logit specification, ε_i is assumed to follow a logistic distribution, and the probability of a "yes" response to the WTP question is given by:

(11) $$P_i(\text{"yes"}) = \frac{\exp(\beta_0 + \beta_1 t_j + \Sigma\, \beta X_i)}{1 + \exp(\beta_0 + \beta_1 t_j + \Sigma\, \beta X_i)}$$

In the probit specification, the error term follows a standard normal distribution (0,1), and the probability of a "yes" response is represented as:

(12) $$P_i(\text{"yes"}) = 1 - \phi(\beta_0 + \beta_1 t_j + \Sigma\, \beta X_i)$$

Where φ is the standard normal cumulative distribution function.

If we further assume that willingness to pay is at least zero, mean willingness to pay can be calculated as:

(13) $$\text{Mean WTP} = \frac{\beta_0 + \Sigma\, \beta X_i \bar{X}}{-\beta_1}$$

Where $\bar{X}_i$ is the mean value of the associated respondent characteristic(s), and β_1 is the coefficient on the donation variable.

3 Results

3.1 Summary statistics: demographic profile of respondents

Roughly 400 surveys were at least partially completed by respondents and returned via prepaid business reply mail in February and March of 2020. While the proportion of each license type in our sample did not perfectly match the proportions in our distribution of surveys, all seven N.C. license types and all four regions are represented in the sample. Table 2 shows summary statistics for demographic and license variables.

A large majority of the respondents were North Carolina residents (94.5 percent), male (81 percent), married (78 percent) and highly educated (approximately 82 percent had completed at least some college). The average age of respondents was approximately 58 years and average household income was approximately $92,000. In terms of participation in recreational fishing, approximately 83 percent of the sample went recreational fishing at least once in the last 12 months, with 70 percent fishing at least once in salt water, 27 percent fishing at least once in the Cape Fear River and 17 percent fishing at least once in the Cape Fear River upstream of the Cape Fear Memorial Bridge. Summary statistics for demographic variables for the full sample and the subsample of fishers who had fished on the Cape Fear River north of the Cape Fear Memorial Bridge in the last 12 months are shown in Table 3. Table 4 includes summary statistics for fishing frequency for the full sample. Characteristics of the subsample of fishers who had fished at on the Cape Fear River north of the Cape Fear Memorial Bridge in the last 12 months are generally similar to those of the full sample, with the former being slightly younger and having marginally higher income and levels of education.

Table 2: Percentage License Type and Region, Respondent Sample, Sampling Target

	Sample Size	Sample Percentage	Sampling Target
License Type			
Inland Fishing 10-Day	19	5%	12%
Unified Inland/Coastal Recreational Fishing Annual	54	13%	12%
Unified Inland/Coastal Recreational Fishing Lifetime	117	29%	20%
Coastal Recreational Fishing Annual	53	13%	12%
Coastal Recreational Fishing Lifetime	67	17%	12%
State Inland Fishing Annual	57	14%	20%
State Inland Fishing Lifetime	35	9%	12%
License Region			
Coastal	144	36%	44%
Local	145	36%	22%
Out of state	30	7%	7%
Non-Coastal	83	21%	27%

Table 3: Demographic characteristics of respondent sample and subsample of anglers who have fished on the Cape Fear River upstream of the Cape Fear Memorial Bridge

Variable	Full sample		Upstream fisher subsample	
	n [a]	Mean or percentage	n [a]	Mean or percentage
NC Resident	348	95%	71	96%
Male	312	80%	64	89%
Married	344	79%	69	80%
Employed	342	52%	68	66%
Highest level of education primary school	345	2%	70	1%
Highest level of education high school	345	16%	70	23%
Highest level of education some college	345	28%	70	24%
Highest level of education college degree	345	36%	70	39%
Highest level of education graduate/professional school	345	18%	70	13%
Income (USD)	317	$92,813.88	62	$95,226
Reside in county bordering/containing the CFR	348	36%	71	51%

[a] n is the sample size (number of respondents) for each survey question. For example, 348 respondents answered the question pertaining to state of residence, 312 respondents answered the questions about gender and 345 respondents answered the question about education.

Table 4: Fishing frequency of full respondent sample: Times fishing in past 12 months and percentage of sample that has engaged in fishing type

Type of fishing	n	% of sample that has been…	Mean number of trips is past 12 months	Standard Deviation	min	max
All recreational	396	83%	16.85	21.81	0	101
Recreational, saltwater	393	70%	10.09	17.35	0	101
Recreational, Cape Fear River	394	27%	2.53	8.83	0	101
Recreational, Cape Fear River north of the Cape Fear Memorial Bridge	391	17%	1.29	6.53	0	101

3.2 Fishing quality changes that would cause respondents to take more recreational fishing trips in the Cape Fear River upstream of the Cape Fear Memorial Bridge

A little over 300 respondents responded to the question (survey question 22) about changes in fishing quality that would cause them to take more recreational fishing trips on the Cape Fear River upstream of the Cape Fear Memorial Bridge each year. Given that more than 75 percent of respondents chose at least one of these factors, we can infer that a large majority of the sample would be willing to take more recreational fishing trips on the Cape Fear River if conditions were improved.

The most frequent response, indicated by 48 percent of respondents, was that they would take more trips if they knew it was safe to eat the fish that they catch. A similar percentage of respondents (44 percent) indicated that they would take more trips if they could catch more fish (any species) and if the Cape Fear River north of the Cape Fear Memorial Bridge (CFMB) was closer to home. Slightly less than 40 percent of respondents suggested that they would take more trips if the water was cleaner and clearer. Responses to this question are summarized in Table 5.

Table 5: Changes that would cause respondents to take more recreational fishing trips on the Cape Fear River upstream of the Cape Fear Memorial Bridge each year

"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%

[a] Other reasons listed by respondents included concern about chemicals in the water, concerns about safety due to logs and other obstructions in the water, and difficulty accessing recreational fishing sites, either due to travel distance or inability to navigate past the locks and dams.

3.3 Anglers' willingness to donate to a conservation fund

Non-parametric and parametric approaches can be applied to CVM data to estimate average willingness to pay and understand the factors associated with willingness to pay. For this analysis, we calculate non-parametric Turnbull lower bound estimates of mean willingness to pay and model the probability of answering "yes" to the willingness to donate question as a function of the fee value and respondent characteristics (Haab and McConnell, 2002).

Table 6 shows the distribution of donation values and responses for the full sample, and for the subsample that excludes respondents who answered "No" to the WTP question and claimed that the primary reason they were not willing to pay because they did not believe that the money would be used effectively. Such responses are considered "protest zeros" and reflect the idea that these respondents may indeed be willing to pay if they had more trust in the use of the funds. As is standard practice in the literature, we examine our results with and without these responses included. Because the percentage of "yes" responses does not increase monotonically with the offered donation amount (e.g. the percentage of respondents answering "yes" to the $2.00 donation amount is less than the percentage answering yes to the $5.00 donation amount), calculation of the nonparametric Turnbull estimates in (6), which imposes monotonicity restriction, will require "pooling" of some offer values.

Table 6: Distribution of Donation Amounts and Affirmative WTP Responses

	with protest zeros		without protest zeros	
Donation amount	# offered	% yes	# offered	% yes
$1.00	38	79%	35	86%
$2.00	32	66%	29	72%
$5.00	37	78%	37	78%
$10.00	38	42%	34	47%
$15.00	52	46%	45	53%
$20.00	35	49%	33	52%
$25.00	35	34%	31	39%
$50.00	38	34%	33	39%

Table 7 shows the percentage of reasons for "no" responses. Among the offered reasons for not being willing to donate to CFRW, the most commonly selected primary reason (chosen by 25 percent of those who were not willing to donate) was that the respondent could not afford to pay (the fee was too expensive). 19 percent of respondents who answered "no" to the donation question suggested that they did not believe the money would be used effectively (these responses are deemed "protest zeros"), and 12 percent responded that it was not their responsibility to pay for environmental protection and management in the Cape Fear River. Only 6 percent and 2 percent respectively indicated that they did not believe that modifying locks and dams will improve fish stocks and fishing quality and they did not believe that natural resources in the Cape Fear River need additional protection.

Table 7: Primary reason respondents were not willing to donate to CFRW

Primary reason not willing to donate	number	percentage
Other [a]	53	35%
I cannot afford to pay. The fee is too expensive.	38	25%
I do not believe the money will be used effectively.	29	19%
It is not my responsibility to pay for environmental protection and management of the Cape Fear River.	18	12%
I do not believe that modifying locks and dams will improve fish stocks and fishing quality	9	6%
I do not believe that natural resources in the Cape Fear River need additional protection.	3	2%

[a] Approximately 35 percent of those who were not willing to donate the stated amount selected "other" as their primary reason. Of these 52 responses, a majority (roughly 81%) provided an explanation in the write-in space included in the survey. The most common reason stated (noted by 25 of the 42 "other" write-in responses) was related to not fishing on the Cape Fear River due to distance, other fishing opportunities or no longer participating in recreational fishing. Other reasons included concerns about pollution or chemicals in the River (7 responses) and suggestions that the funds for conservation should come from fishing license fees (5 responses).

3.3.1 Non-parametric Turnbull Estimates of Willingness to Donate to Cape Fear River Watch

The Turnbull approach to estimating willingness to pay (6) allows for a relatively simple estimate of average WTP that does not rely on distributional assumptions. Turnbull estimates of willingness to pay presume that if a respondent answers "yes" to a particular bid (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. Haab and McConnell (2002) and Schuhmann et al. (2019) provide details on Turnbull estimation.

Applying the Turnbull procedure summarized in equations (6) and (7) to the data shown in Table 6 produces lower bound mean willingness to pay estimates of US $18.86 (when protest zero responses are included in the sample) and US $21.51 (excluding protest zero responses). The associated variances of these WTP estimates are US $5.28 and US $6.39. Turnbull WTP values are summarized in Table 8.

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)

3.3.2 Parametric analysis of Willingness to Donate to CFRW

Parametric analysis of willingness to pay allows for formal hypothesis testing regarding the determinants of WTP. We apply Logistic regression analysis to determine the factors influencing the likelihood of a "yes" response to the willingness to donate question. Our analysis included variables that were expected to influence willingness to donate based on economic theory and previous results in the literature. The main factors considered were the size of the donation that the respondent was asked to give, respondent demographics (age, income, marital status, gender, level of education), the respondent's location (e.g. state, county of residence, NC Recreational Fishing License Region), recent participation in recreational fishing (e.g. binary and quantitative measures of recent fishing activity noted in Table 4), fishing license type and factors that would induce the respondent to take more recreational fishing trips on the Cape Fear River north of the Cape Fear Memorial Bridge (binary indicator variables of the responses shown in Table 6).

Numerous specifications of the logit model shown in equation (11) were estimated. Table 8 shows results from four models that include variables that were found to be consistently statistically significant and robust to model specification. Model 1 is a base model, with the donation amount as the only independent variable. Models 2, 3 and 4 include different combinations of other covariates. Table 9 presents a qualitative summary of respondent characteristics found to be statistically associated with willingness to pay, ordered by the strength of the relationship.

As expected, respondents were less willing to donate higher fee amounts. This is shown by the negative and highly significant coefficient on the donation amount variable. Respondents who engaged in any type of recreational fishing in the past 12 months were also more willing to donate. Results similar to Model 2 were found for saltwater fishing, Cape Fear River fishing and fishing on the Cape Fear River north of the Cape Fear Memorial Bridge. Interestingly, while these binary indicators of recent fishing activity were positively associated with willingness to donate, the number of trips taken the past 12 months was not. This implies that occasional fishers are just as likely to donate as avid fishers.

Respondents from New Hanover County appear to be more willing to donate than respondents from other counties, perhaps due to relative familiarity with Cape Fear River Watch. We find evidence that respondents who are employed, those with higher income and higher levels of education are more willing to donate. Because of the strong correlation between these three variables, we cannot separate their individual effects on willingness to donate. Willingness to donate also appears to be positively associated with the number of adults in the household, though this result may be caused by a modest positive correlation between number of adults in the household and household income.

Willingness to donate appears to be related to respondent age in a nonlinear fashion, as indicated by the statistically significant coefficients on age and age squared. The signs of these coefficients indicate that willingness to donate increases with age up to a threshold, then decreases with age. Finally, respondents who suggested that they would take more recreational fishing trips on the Cape Fear River if they could catch more striped bass, if there were more public access boat ramps, if they could catch bigger fish and if they knew the fish were safe to eat were more willing to donate. The strongest of these variables are included in Models 2, 3, and 4.

While not reported in Table 9, we find some evidence that respondents who held Unified Inland/Coastal Recreational Fishing Annual licenses were more willing to donate than holders of other license types. This result was apparent only in the most parsimonious models, indicating that this association is likely due to correlations between this license type and other factors that influence willingness to donate. Generally, there appears to be little variation in willingness to donate across license types.

It is interesting to note that many potential sources of variation in willingness to donate were found to be statistically insignificant. These include intensity of recent recreational fishing, travel distance to the respondent's preferred fishing location on the Cape Fear River upstream of the Cape Fear Memorial Bridge (linear, quadratic and log versions of this variable proved insignificant), gender, marital status, and respondents' home county and region (with New Hanover County being a notable exception).

Table 9: Logit model results for willingness to donate to Cape Fear River Watch

Variable	Coefficient (standard error)			
	Model 1	**Model 2**	**Model 3**	**Model 4**
Intercept	0.716*** (0.177)	-0.254 (0.261)	-0.255 (0.265)	0.253 (0.351)
Donation amount	-0.037*** (0.009)	-0.039*** (0.009)	-0.040*** (0.009)	-0.038*** (0.009)
Income		0.00001*** (0.000002)	0.00001*** (0.000002)	0.00001*** (0.000002)
Indicator variable for New Hanover County Resident			0.875* (0.490)	
Log (number of trips on the CFR upstream of the CFM bridge in past 12 mo)				0.0007** (0.0003)
Pseudo R^2	0.05	0.11	0.12	0.12
n	305	305	253	305

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

Table 10: Characteristics associated with willingness to donate to CFRW

Variable	Relationship with Willingness to Donate to CFRW
Donation level	Respondents were less willing to donate higher amounts.
Fishing experience in past 12 months	Respondents who engaged in all types of fishing were more willing to donate. Having participated in any type of recreational fishing and saltwater fishing produced the most significant results. Anglers who were more avid fishers on the Cape Fear River, including upstream of the CFM bridge, are more willing to donate.
Where respondent lives	Respondents from New Hanover County were more willing to donate.
Income	Respondents with higher incomes were more willing to donate.
Age	Younger anglers appear more willing to donate than older anglers. Willingness to donate decreases with age at an increasing rate.
Would take more trips on the Cape Fear River if fishing conditions improved	Some model specifications indicate that anglers who suggested that they would take more recreational fishing trips on the Cape Fear River if they could catch more striped bass, if there were more public access boat ramps, if they could catch bigger fish and if they knew the fish were safe to eat were more willing to donate.

3.3.3 Logit Model Estimates of Mean Willingness to Donate to Cape Fear River Watch

Using the coefficients in Table 9, we calculate mean willingness to pay using equation (10). Results are reported in Table 11, along with the 95 percent confidence intervals around each estimate. We note that using Model 3, we calculate mean willingness to pay for New Hanover County residents (Table 11, Model 3a) and non-residents (3b).

Table 11: Mean willingness to pay (donate) to Cape Fear River Watch based on logit model estimates

	Model 1	Model 2	Model 3a	Model 3b	Model 4
Mean WTP	\$19.33***	\$21.46***	\$41.67***	\$19.71***	\$36.96***
Standard error of WTP	\$3.33	\$3.46	\$12.78	\$3.44	\$9.42
95% Confidence interval (lower bound, upper bound)	(12.80, 25.87)	(14.67, 28.25)	(16.63, 66.72)	(-12.97, 26.46)	(18.50, 55.42)

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

3.4 Choice experiment results

Of the 407 returned surveys, 305 respondents completed one or more panels in the choice experiment, with a large majority (98 percent) responding to all four choices.[3] The travel time attribute in the CE (Table 2) was used to create respondent-specific variables representing travel time (in minutes) and travel cost (in dollars) using each respondents' stated travel time to their preferred fishing location on the Cape Fear River upstream of the Cape Fear Memorial Bridge. Travel cost was estimated assuming 45 miles per hour

[3] Our sample size is therefore slightly larger than the minimum sample size of 250 suggested by the Orme (1998) rule of thumb (N should be at least as large as 500c / ta, where c is the largest number of levels, a is the number of alternatives and t is the number of choice tasks per respondent).

average driving speed, 57.5 cents per mile travel cost and one-third of the wage rate as the opportunity cost of time.[4]

Equation (4) was estimated using conditional logit (CL), mixed logit (ML) and latent class (LC) specifications. In the CL specification, the coefficients for each level are treated as constant parameters across members of the sample. In the ML specification, model coefficients are specified as random parameters drawn from a predetermined distribution, which allows preferences for attribute levels to be heterogeneous across the sample (Train 1999; Geene and Hensher 2003). Preference heterogeneity can also be investigated by interacting attribute levels with demographic characteristics in the CL or by using the LC specification, which assigns individuals to a finite number of preference groups and estimates utility coefficients separately for each group (Geene and Hensher 2003; Beharry-Borg and Scarpa 2010). Because preferences are unknown a priori, the appropriate number of preference groups in the LC specification is determined by the researcher using statistical criterion and judgement of model parsimony, class probabilities, and the plausibility of parameter estimates and standard errors (Provencher and Bishop 2004; Scarpa and Thiene 2005; Hilger and Hanemann 2006; Domanski and von Haefen 2010).

Conditional logit results are shown in Table 12, for dummy coded (Model 1), effects coded (Model 2) and continuously coded data. For the latter, we estimate linear (Model 3) and quadratic (Model 4) specifications. Mixed and latent class logit results are shown in Table 13. MXL models were estimated assuming all non-cost attributes are normally distributed. Mean and standard deviations of the MXL model coefficients were estimated using 1000 draws from a Halton quasi-random sequence (SAS Institute 2008; Train 1999). To save space, we present only the results from the MXL model estimated with effects coded data, and we do not include standard errors for the MXL coefficients. MXL results with dummy coded data are similar to those shown in Table 12.

To identify the number of preference groups (classes) in the latent class specification, we tested down from five groups to two. Model convergence could not be achieved with more than three classes. Results suggest either three or two preference groups. We present model coefficients from the more parsimonious two-class model and note that a third preference group likely exist as a subset of the larger of these two groups.[5] The two-class specification indicates that both groups of anglers are concerned with catch restrictions and fish consumption advisories. The smaller of these two groups (class 1 in Table 13) appears more likely to opt-out of the presented fishing trips, as indicated by the negative sign on the alternative-specific constants (ASCs). The larger preference group (class 2) appears more concerned with catch rates and is more likely to participate in recreational fishing opportunities (i.e. choose trip 1 or trip 2). Estimation of the latent class models using class probability covariates suggests that anglers who are willing to take more fishing trips if they knew fish were safe to eat are highly likely to be in the former of these two groups.

[4] 57.5 cents per mile was the Federal mileage reimbursement rate in 2020. Wage rates were calculated using respondent income assuming 50 weeks of 40-hour employment for employed respondents. We assume zero opportunity cost of time for unemployed respondents.

[5] For example, the three-class specification estimated with continuous attribute coding suggests that all classes have strong preferences for being able to legally keep striped bass. Two of the groups are averse to fish consumption advisories, with one of these groups having stronger preferences (i.e. a higher aversion to consumption advisories). The third group (roughly 35 percent of the sample) is not averse to consumption advisories but has strong preferences for improved catch rates.

Within the CL specifications, we examined a range of interaction effects to ascertain whether respondent characteristics were associated with preferences and willingness to pay for levels of the trip attributes (results not reported here). We find only limited interactions between respondent demographic variables and trip attributes, indicating that preferences and willingness to pay appear to be generally homogenous across angler ages, marital status and education levels. We do find that younger anglers are marginally more concerned about fish consumption advisories than older anglers.

Notable interaction effects were discovered between trip attributes and the factors that respondents suggested would induce them to take more trips on the Cape Fear River north of the CFMB. Specifically, we find that respondents who indicated that they would take more trips on the Cape Fear River north of the CFMB if they could catch more big fish had stronger preferences and higher willingness to pay for the highest two levels of large striped bass. Respondents who suggested that they would take more trips if they could catch more fish (any species) had stronger preferences and willingness to pay for the highest level of small striped bass, the highest two levels of large striped bass, and the continuous versions of all catch attributes. Respondents who suggested that they would take more trips if they knew the fish were safe to eat were significantly more willing to pay to avoid fish consumption advisories.

Specifications including interaction effects between the 26-inch size limit (as opposed to the base case of an 18-inch size limit) and catch attributes (including catch of large striped bass, both levels and continuous) were also estimated. We also interacted the 26-inch size limit indicator variable with the open-fishing variable (being able to keep up to two striped bass per trip). None of the coefficients on these interaction terms were statistically significant. We therefore find no evidence that anglers who were presented with scenarios involving the higher (26-inch) size limit are more willing to pay for catch improvements than anglers who were presented with scenarios involving the lower (18-inch) size limit.

Willingness to pay measures derived using equation (5) and the Wald procedure in NLOGIT are reported in Table 14 for Models 1-3. WTP estimates for Models 1 and 3 are the easiest to interpret. In the case of Model 1 (dummy coded data), the estimates presented in Table 14 represent average willingness to pay for that level of the attribute relative to the baseline (omitted) level, which is the lowest level for all catch attributes (zero fish per trip). WTP estimates derived using the effects-coded data (Model 2) are interpreted as willingness to pay for that level of the attribute relative to the mean WTP for all levels of that attribute. WTP estimates from Model 3 (continuous coding) represent the average willingness to pay for an additional unit of catch. Results from this model suggest that anglers are willing to pay roughly $40, $20 and $9 more per trip (i.e. in addition to travel costs) for each additional large striped bass, small striped bass and shad respectively, and are willing to pay approximately $100 to be able to legally keep up to two striped bass per trip and approximately $250 to avoid fish consumption advisories.

All models presented below pertain to the full sample of respondents that completed at least one of the four choice experiment panels. These models were re-estimated using the subsample of choice panels where the respondent expressed confidence levels of 3, 4 or 5 (72 choice panels with confidence levels of 1 or 2 were omitted from the analysis). Removing choices where the respondent was not confident resulted in no substantive changes in the magnitude or character of the coefficients or WTP estimates. All WTP estimates generated from the subsample of confident panels were well within the confidence intervals produced by the full sample. We can conclude that preferences for the CE attributes are essentially consistent across different levels of confidence in the choices expressed by respondents.

In the non-continuous models, it is notable that willingness to pay for the highest levels of large striped bass and shad are lower than willingness to pay for the second-highest level. In the case of large striped bass this is likely due to the two-fish limit on catch specified in the questionnaire. Anglers understandably derive less utility from catching a third large fish that must be released than from the second large fish which can be kept. In the case of shad, lower WTP for 10 fish relative to 5 fish may be due to diminishing marginal utility from catch of this species. The magnitude of the coefficients and WTP values for the fish consumption advisory is also noteworthy. Coincident with the finding that anglers would take more fishing trips on the CFR north of the CFMB if they knew the fish were safe to eat, the CE results clearly indicate that anglers in our sample are highly averse to fish consumption advisories. Trips in the CE that did not include fish consumption advisories were consistently selected in favor of those that did. Indeed, this attribute is clearly the most important attribute included in the CE.

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

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

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)

3.5 Choice Experiment Simulations

The choice experiment data and models allow for simulations of hypothetical scenarios depicting one or more changes in the recreational fishing attributes on anglers' willingness to participate in recreational fishing. By imposing hypothetical changes to the trip profiles and quantifying the (simulated) changes in respondent choices, we can make inference regarding the expected change in recreational fishing participation. Of particular interest for this purpose is quantifying the expected changes in respondent choices for one of the two fishing trips relative to the opt-out (neither trip) alternative. Scenarios that increase the probability of choosing the opt-out alternative are predicted to reduce participation in recreational fishing in the Cape Fear River upstream of the Cape Fear Memorial Bridge, and scenarios that decrease the probability of choosing the opt-out alternative are predicted to increased participation.

It should be noted that while predicting changes in respondent choices in the CE is expected to serve as a strong proxy for changes in actual recreational fishing participation, the simulated changes are unlikely to be perfectly correlated with actual changes in fishing behaviour. First, the CE is hypothetical in nature.

While stated intentions are known to serve as strong indicators of actual behaviour, the possibility for differences between actual and stated behaviour remains. Further, the simulations are carried out by altering one or more attributes in all CE panels and using the estimated choice probabilities to predict how respondents' original choices between the alternatives would be affected. Because other attributes and levels are held constant for each simulation, there may be differences between the simulated changes in fishing quality and how those changes would appear in practice. For example, a simulation of improvements in the catch of large striped bass, holding all other factors at the original levels specified in the CE may be unrealistic due to predator-prey relationships with other species and may not conform to regulatory measures regarding the legality of keeping fish that are caught.

Several factors must be considered before performing simulations, including selecting models to use in the simulations (e.g. Models 1-9 presented above), the scenarios considered for analysis and the appropriate sample over which to apply the hypothetical changes. Here, simulations were conducted using Model 1 (conditional logit specification with dummy coded data) and Model 3 (conditional logit with continuous coding) for ease of interpretation. Simulated scenarios were applied to the full sample of CE responses and two subsamples for whom changes in trip attributes are expected to have the most impact on participation: those respondents who suggested that they would take more fishing trips on the Cape Fear River upstream of the CFM Bridge for at least one of the reasons specified in question 22 of the survey (Table 5), and those respondents who did not choose the opt-out alternative in all four choice panels. These subsamples comprised approximately 93 and 82 percent of the choice experiment sample respectively.

Given the size of the full factorial, it is possible to simulate over 1,000 scenarios depicting different combinations of attributes and levels using Model 1. Because of the continuous nature of the catch attributes used in Model 3, and infinite number of possible scenarios can be simulated. That is, we can simulate the effects on angler participation of specific combinations of catch rates (e.g. a scenario where anglers catch 5 shad per trip, 2 small striped bass and 1 large striped bass) or changes in catch rates (e.g. adding one or more additional fish to the catch rates that have been presented). Approximately 200 scenarios depicting different combinations of catch rates and catch rate improvements, catch restrictions and consumption advisories were simulated to provide a thorough understanding of the potential effects on fishing participation of changes in fishing quality. Results of 38 simulations using Model 3 depicting marginal changes in catch rates, catch restrictions and consumption advisories and applied to the full sample of CE respondents are summarized in Table 15. We note that comparable changes in quality conditions applied to Model 1 resulted in marginally larger changes in participation, hence the Model 3 simulations can be considered more conservative estimates of potential changes in participation.

For context in interpreting simulation results where catch conditions are changed relative to the conditions presented in the CE, average quality conditions for trip 1 and trip 2 used in Model 3 are 4.13 shad per trip, 2.33 small striped bass and 1.5 large striped bass per trip. The fish consumption advisory and catch restrictions were each present in half of the trip scenarios.[6] In Table 15, Scenario 1 can be interpreted as a worst-case scenario, with zero expected catch for all species, catch-and-release fishing only and with a fish consumption advisory in place. Scenario 28 is the most favourable scenario analysed, with all catch rates increased by 2 fish per trip (above the catch rates presented in the CE panels), being able to legally keep up to two large striped bass per trip with no fish consumption advisory in place. As

[6] As expected, simulating this status quo combination of attributes results in no change in participation.

expected, given the signs and significance of the choice experiment coefficients (Tables 12 and 13), higher levels of catch and being able to keep striped bass result in higher fishing participation. Lower levels of catch, not being able to keep up to two large striped bass and having a fish consumption advisory in place decreases participation.

Two important takeaways are clear from these simulations. First, unless combined with significant improvements in catch rates, the presence of fish consumption advisories is expected to negatively impact recreational fishing participation. With all other attributes held at the levels presented in the choice experiment (Scenario 29), the presence of a fish consumption advisory results in the alternative fishing trips being selected approximately 16 percent less frequently. Indeed, even when combined with the removal of catch restrictions and marginal improvements in catch rates (e.g. scenarios 18 and 22) having fish consumption advisories present is expected to result in lower fishing participation. When fish consumption advisories are combined with lower catch rates or catch-and-release restrictions (e.g. Scenarios 2, 5, 6, 9, 10, 13 and 14), the impacts are considerably higher. Even with marginal improvements in catch (e.g. scenarios 17, 18, 25) fish consumption advisories would decrease overall participation in the fishery. The only scenario that resulted in a marginal increase in participation when a fish consumption advisory was present when all catch rates are improved by 2 fish per trip and anglers can legally keep up to two striped bass per trip (scenario 26). Interestingly, while the lack of fish consumption advisories in the choice sets (Scenario 30) results in participation increasing by 8.7 percent, the impact is considerably smaller than the adverse (-16%) impact of advisories being present in all choice sets (Scenario 29).

This last point provides an example of the second important takeaway from the simulations. Across all attributes, anglers' aversion to lower quality conditions appears stronger than their preferences for higher quality conditions. That is, 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. We can broadly infer that anglers are averse to environmental degradation, a result that may be due to general loss aversion or an endowment effect. An important policy implication is that if the economic costs of improving fishing quality on the Cape Fear River are prohibitive, maintaining status quo conditions is essential to preserving current economic value and impacts. Further losses in quality are likely to result in decreased recreational fishing, loss of economic value and lower economic impacts.

Table 16: Results of scenario simulations, continuous model

Scenario	Simulated scenario (change in attribute conditions) [a]	Change in participation
1	0 large SB, 0 small SB, 0 shad, Illegal to keep, fish advisory	-39.0%
2	0 large SB, 0 small SB, 0 shad, legal to keep, fish advisory	-28.0%
3	0 large SB, 0 small SB, 0 shad, illegal to keep, no fish advisory	-11.6%
4	0 large SB, 0 small SB, 0 shad, legal to keep, no fish advisory	+0.4%
5	-2 large SB, -2 small SB, -2 shad, illegal to keep, fish advisory	-37.6%
6	-2 large SB, -2 small SB, -2 shad, legal to keep, fish advisory	-26.4%
7	-2 large SB, -2 small SB, -2 shad, illegal to keep, no fish advisory	-10.3%
8	-2 large SB, -2 small SB, -2 shad, legal to keep, no fish advisory	+0.7%
9	-1 large SB, -1 small SB, -1 shad, illegal to keep, fish advisory	-30.3%
10	-1 large SB, -1 small SB, -1 shad, legal to keep, fish advisory	-18.4%
11	-1 large SB, -1 small SB, -1 shad, illegal to keep, no fish advisory	+2.8%
12	-1 large SB, -1 small SB, -1 shad, legal to keep, no fish advisory	+7.0%
13	-1 large SB, illegal to keep, fish advisory	-27.0%
14	-1 large SB, legal to keep, fish advisory	-15.0%
15	-1 large SB, illegal to keep, no fish advisory	-0.1%
16	-1 large SB, legal to keep, no fish advisory	+9.4%
17	+1 large SB, illegal to keep, fish advisory	-17.8%
18	+1 large SB, legal to keep, fish advisory	-6.1%
19	+1 large SB, illegal to keep, no fish advisory	+7.4%
20	+1 large SB, legal to keep, no fish advisory	+15.0%
21	+1 large SB, +1 small SB, +1 shad, illegal to keep, fish advisory	-14.4%
22	+1 large SB, +1 small SB, +1 shad, legal to keep, fish advisory	-3.0%
23	+1 large SB, +1 small SB, +1 shad, illegal to keep, no fish advisory	+9.8%
24	+1 large SB, +1 small SB, +1 shad, legal to keep, no fish advisory	+16.7%
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%
27	+2 large SB, +2 small SB, +2 shad, illegal to keep, no fish advisory	+14.6%
28	+2 large SB, +2 small SB, +2 shad, legal to keep, no fish advisory	+20.2%
29	Fish consumption advisory	-16.0%
30	No fish consumption advisory	+8.7%
31	Illegal to keep up to 2 striped bass per trip	-5.2%
32	Legal to keep up to 2 striped bass per trip	+5.0%
33	-1 large SB per trip	-4.1%
34	+1 large SB per trip	+3.8%
35	-1 small SB per trip	-2.1%
36	+1 small SB per trip	+2.0%
37	-1 shad per trip	-0.9%
38	+1 shad per trip	+0.9%

[a] For each simulation, the specified attribute levels or change in attribute levels are applied to the two alternative trips (Trip A, Trip B). Attribute levels not listed are held at the levels specified in the original choice panels.

4 Discussion and Conclusions

4.1 Main takeaways

The purpose of this research was to improve our understanding of licensed recreational anglers' willingness to pay for improvements in trip quality in the Cape Fear River upstream of the Cape Fear Memorial Bridge. We assessed this aspect of potential economic value using a survey that included a contingent valuation question asking anglers' their willingness to donate to a special fund, administered by Cape Fear River Watch, dedicated to improving the ability of migratory species to reach spawning habitat, and a choice experiment designed to measure anglers' willingness to pay for improvements in catch rates, being able to keep up to two striped bass per trip and avoiding fish consumption advisories. Survey respondents were also asked to indicate which factors would cause them to take more recreational fishing trips upstream of the Cape Fear Memorial Bridge. The survey was mailed to approximately 10,000 recreational fishing license holders in early 2020. Of these, approximately 400 completed and returned surveys were used in this analysis.

More than half of the survey respondents were willing to donate some amount to the CFRW fund for habitat improvement, with over 70 percent of respondents willing to donate $5.00, $2.00 or $1.00. Lower bound estimates of mean willingness to donate range from US $18.86 to US $21.51 based on the non-parametric Turnbull estimation and from $19.33 to $41.67 based on parametric estimation via logit regression. Willingness to donate was found to be positively associated with income, fishing avidity (including frequency of fishing on the CFR upstream of the CFMB) and being a resident of New Hanover County.

Applying the lowest of these estimates ($18.86) to roughly 136,000 holders of inland or combined coastal and inland recreational fishing licences state-wide suggests that donations to CFRW could total over $2.5 million. Applying this same conservative estimate to the roughly 50,000 recreational licence holders who live in one of the nine NC counties that contain the Cape Fear River, suggests that donations to CFRW could total more than $940,000.

Analysis of the choice experiment response data suggests that anglers have strong preferences and statistically significant willingness to pay for improvements in the quality of recreational fishing trips on the Cape Fear River north of the Cape Fear Memorial Bridge. Consistent with responses related to factors that would induce respondents to take more recreational fishing trips on the Cape Fear River, anglers in our sample demonstrated the strongest preferences for avoiding fish consumption advisories (i.e. knowing that fish are safe to eat) and being able to keep up to two striped bass per trip. Indeed, willingness to pay to avoid fish consumption advisories was consistently higher (roughly twice the magnitude) than any other attribute included in the CE design.[7] Of the three catch rates examined, results suggest that willingness to pay is highest for large striped bass, followed by small striped bass and shad. Anglers clearly

[7] It is important to note that willingness to pay to avoid fish consumption advisories could stem from angler preferences for a lack of advisories implying that fish can be caught and/or from knowing that fish are safe to eat. Given the large percentage of respondents who indicated that they would take more recreational fishing trips on the Cape Fear River if they knew fish were safe to eat (48%, Table 5), coupled with the significant interaction between that response and willingness to pay to avoid consumption advisories, the latter of these reasons seems more plausible.

value being able to keep striped bass, as indicated by the consistently positive and statistically significant coefficient on the legal-to-keep striped bass attribute, and the nonlinear nature of willingness to pay for additional large striped bass (i.e. willingness to pay for two striped bass exceeded willingness to pay for three, suggesting that fish that can be kept are more valuable than those that must be released).

Simulations of potential changes in angler participation conducted using the choice experiment data support these findings. Even with marginal improvements in catch rates, the presence of fish consumption advisories is expected to result in lower overall fishing participation on the Cape Fear River north of the Cape Fear Memorial Bridge. If anglers know that fish are safe to eat and catch rates are improved, increased recreational fishing participation can be expected, creating additional economic benefits and impacts in the region.

4.2 Research Questions: Conclusions

Results of this study provide important insights related to management of habitat and water quality in the Cape Fear River north of the Cape Fear Memorial Bridge. It seems clear that improvements in the quality of recreational fishing experiences will create economic value through higher trip satisfaction and consumer surplus received by recreational anglers and will create economic impacts by increasing the frequency of recreational fishing trips and associated spending. Anglers derive economic value from all trip attributes examined in our research and are willing to pay for improvements in catch of striped bass and shad, the ability to keep striped bass and avoiding fish consumption advisories. The relative importance of this latter aspect of fishing quality is perhaps the most notable conclusion of this research: of all the attributes examined, survey respondents showed the strongest preferences and willingness to pay for knowing that fish are safe to eat and the presence or lack of fish consumption advisories is expected to have the largest impact on recreational fishing participation.

Answers to specific research questions include the following. Regarding participation, anglers in our sampling frame are not currently actively fishing in the area of interest. While a large majority of our sample (83 percent) were engaged in recreational fishing in the past 12 months, only 17 percent of survey respondents had participated in recreational fishing on the Cape Fear River north of the CFMB, with those anglers averaging slightly more than one trip per year. Despite this low level of participation by anglers in our sample, the potential for increased frequency of recreational fishing in the area of interest appears strong. Approximately 75 percent of survey respondents stated that they would be willing to take more recreational fishing trips on the Cape Fear River upstream of the Cape Fear Memorial Bridge each year if conditions were improved. Simulations of the effects of changes in fishing quality on anglers' willingness to participate in the fishery support this conclusion. Improvements in the catch of striped bass and shad, the ability to legally keep up to two striped bass per fish, and the lack of fish consumption advisories are expected to result in more frequent fishing by recreational anglers. The most important factors that would induce this increase in participation and thus generate economic impacts in the CFR region were knowing that it was safe to eat the fish that were caught (i.e. no fish consumption advisories) and being able to legally keep up to two striped bass per trip.

Results from the choice experiment suggest that recreational anglers in our sample are willing to pay for improvements in the catch of small striped bass, large striped bass and shad. Estimates of willingness to pay for additional catch of large striped bass (more than 26 inches) range from approximately $43.00 per fish per trip (CL specification with continuous coding) to $95.00 per trip (improvement in catch from 1 large bass per trip to 2 per trip, CL specification with dummy coding). Willingness to pay for low levels of small striped bass (less than 22 inches) ranges from $0 (increasing catch from 0 per trip to 4 per trip, CL specification with dummy coding) to roughly $58.00 per trip for improvements from 3 small striped bass per trip to 5 small striped bass per trip (CL specification, dummy coding). Estimates from the CL specification with continuous coding suggest that average willingness to pay for additional small striped bass is approximately $20.50 per fish per trip. Willingness to pay for shad appears considerably lower than for striped bass, but anglers clearly prefer higher catch rates. Based on the CL specification with continuous coding, average willingness to pay for additional catch of shad is approximately $9.00 per fish per trip.

Willingness to pay for improvements in the catch of large striped bass and shad appear to be nonlinear. Willingness to pay increases with the number of fish caught up to a point and then declines, supporting the idea of diminishing marginal benefits from higher catch. In the case of large striped bass this may be due to a 2-fish catch limit included in the experiment (rendering the third fish less valuable than the second) or simply due to diminishing marginal satisfaction.

Anglers appear to be highly averse to fish consumption advisories and are willing to pay more than $100.00 per trip (and perhaps more than $200.00 per trip) to avoid fishing in waters where such advisories are present. Coupled with other results from this research, the strength and magnitude of the coefficients on the fish consumption advisory attribute suggests that the presence of fish consumption advisories would partially or completely offset the increase in demand for recreational fishing on the Cape Fear River north of the CFMB that may result from higher catch rates. In other words, even if recreational catch rates improve markedly, economic value and economic impacts are likely to be severely curtailed by the presence of fish consumption advisories.

Anglers in our sample showed clear preferences for being able to keep up to two striped bass per trip greater than minimum size and are willing to pay between $48.00 and $111.00 per trip for “open” striped bass fishing. This result must also be interpreted in the context of fish consumption advisories. Given the strong aversion to catching fish when consumption advisories are present, the economic value created through open striped bass fishing is likely to be severely diminished if the fish are not safe to eat.

We did not find any evidence of preferences for an 18-inch vs. 26-inch minimum allowable size for striped bass. As discussed above, this may be the result of insufficient variation in this parameter given its dependence on other attributes in the choice experiment.

Results from the contingent valuation portion of the survey suggest that licenced recreational anglers are willing to donate to a special fund dedicated to improving the ability of migratory species to reach spawning habitat in the Cape Fear River. Estimates of mean willingness to donate range from approximately $19.00 to $37.00. Willingness to donate appears to be positively associated with income, fishing avidity and being a resident of New Hanover County.

4.3 Limitations and Directions for Future Research

While this study has provided valuable information regarding the factors that would enhance the quality and economic value of recreational fishing on the Cape Fear River upstream of the CFMB, important limitations must be acknowledged. The most concerning of these is the low survey response rate and representative nature of the sample. While the sample of responses appears largely representative of the target population (anglers who would engage in recreational fishing on the CFR north of the CFMB if trip quality were to improve) and was large enough for statistical significance, a larger sample would likely add variation and would obviously be preferred.

Avenues for future research include data collection efforts with directed questioning to address preferences for alternative minimum allowable size limits for striped bass. This research question was left unresolved by the current survey effort. While it is certainly possible that respondents were indifferent between 18-inch and 26-inch minimum size limits for striped bass, other explanations are plausible. First, due to the nature of the CE design, the minimum size parameter was explicitly relevant only for a fraction of the trip alternatives shown to respondents – those trips where more than one large striped was present and where bass could be legally kept (i.e. the non-baseline levels of the large striped bass and the legal-to-keep attribute were present), and was implicitly relevant only to anglers concerned about the health effects of eating fish, a factor that would influence only half of all trips in the design (i.e. the baseline level of the fish advisory attribute was present). These design and preference effects result in a minority of trip choices being affected by the minimum size restriction. Combined with our small sample size, it seems logical that there was not enough variation to produce statistical evidence of an effect. Further, the minimum size limit parameter was incorporated into the choice experiment in the script defining the levels of each attribute. This script was presented to respondents prior to the choice experiment panels. Because of the heavy amount of script on that page of the survey, it seems plausible that some respondents were not cognizant of the size limit detail.

Finally, future research should attempt to estimate the nature and scope of recreational catch improvements that can reasonably be achieved through policy action. For example, an understanding of how improving fish passage and access to spawning habitat through the modification or removal of locks and dams on the Cape Fear River will affect catch of striped bass and shad, coupled with cost estimates, would allow for cost-benefit analyses for such modifications and would provide important insight into which of the simulated fishing scenarios is plausible. Given the vital role of water quality and cleanliness in affecting recreational angler satisfaction and economic value vis-a-vis fish consumption advisories, future research into the factors associated with fish consumption and human health seems paramount.

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