Appalachian State University

Department of Economics Working Paper

Number 18-10 | July 2018

Citizen Preferences for Ecosystem-based Fisheries Management: The Case of Atlantic Menhaden

Jane L. Harrison
North Carolina Sea Grant

Alexandra Naumenko
North Carolina State University

John C. Whitehead
Appalachian State University

Department of Economics
Appalachian State University
Boone, NC 28608
Phone: (828) 262-2148
Fax: (828) 262-6105
www.business.appstate.edu/economics

Citizen Preferences for Ecosystem-based Fisheries Management:

The Case of Atlantic Menhaden[1]

Jane L. Harrison

North Carolina Sea Grant

North Carolina State University

Alexandra Naumenko

Department of Agricultural and Resource Economics

North Carolina State University

John C. Whitehead

Department of Economics

Appalachian State University

July 30, 2018

[1] A previous version of this paper was presented in seminars at James Madison University and Appalachian State University and in the AERE "Fisheries" session at the 2017 Southern Economics Association Meetings in Tampa, Florida. The authors thank participants for helpful suggestions. Funding for this study was provided by the Atlantic States Marine Fisheries Commission.

Citizen Preferences for Ecosystem-based Fisheries Management:

The Case of Atlantic Menhaden

Abstract. We conducted an internet survey with an opt-in panel of over 2000 respondents from Atlantic Coast states. Respondents were placed in hypothetical situations in which they voted on increased menhaden fishery quotas with varying changes in ecosystem impacts. The motivation for the vote was to better inform the Atlantic States Marine Fisheries Commission about the opinions of the general public in the region. We found that increases in ex-vessel price increased the probability that a respondent would vote in favor of a quota increase. After accounting for both stated and inferred attribute non-attendance we found that increases in menhaden quotas and commercial fishing jobs increased the probability that a respondent would vote in favor of a quota increase. Increased quotas that make water quality worse and negatively affect game fish and shore bird populations led to a decrease in the probability of a vote for increased quotas.

Introduction

Atlantic menhaden (*Brevoortia tyrannus*), a species of fish in the herring family, are found in the coastal and estuarine waters from northern Florida to Canada. Younger and smaller fish are found in the Chesapeake Bay and southern coastline while older and larger fish are found along the northern coastline. Juvenile menhaden are about 6 inches long and can grow to 14 inches long and weigh about 1 pound. The Atlantic States Marine Fisheries Commission (ASMFC), an Interstate Compact formed under an agreement by the 15 Atlantic Coast states, is tasked with the conservation and management of nearshore marine fisheries including Atlantic menhaden. The ASMFC manages menhaden to ensure the sustainability of the fishery resource.

The commercial menhaden fishery has the largest landings along the Atlantic coast of any fish species. In 2015 410 million pounds of menhaden were caught and sold for about $38 million. The Atlantic menhaden commercial fishery consists of the bait and reduction sectors. The bait fishery represents a growing proportion of the commercial fishery. Atlantic menhaden are harvested for bait in almost all Atlantic coast states and are used in commercial (e.g. American lobster, blue crab) and sport fisheries (e.g. striped bass, bluefish). The reduction fishery is inherently different from the bait fishery in terms of its temporal and spatial scales (Kirkley 2011; Dudley 2012). Menhaden for the reduction fishery is processed into fish meal and used as feed for livestock, poultry and farm-raised fish; it is also processed into fish oil and used as a human health supplement containing omega-3 fatty acids. In recent years (2007-2013) bait landings have averaged approximately 23% of the total coastwide menhaden landings. This is up from an average of approximately 11% of total landings for the period 1985-2000 (SEDAR 2015). Virginia receives 85% of the Atlantic quota. New Jersey receives 11% of the Atlantic quota. Most of the menhaden landings in Virginia are used for fish oil and fish meal. All of the menhaden landings in the other Atlantic states are used for bait.

The 2010 menhaden stock assessment concluded that overfishing was occurring, but menhaden were not overfished (ASMFC, May 2010).[2] Subsequently, a mistake was found and the stock assessment subcommittee concluded that overfishing was not occurring (ASMFC, revised March 2011). Nevertheless, Amendment 2 to the fishery management plan reduced the 2013 menhaden quota by 25% from the 2011 landings (ASMFC, December 2012). Amendment 2 also initiated the development of ecological reference points, as opposed to single-species biological reference points, which account for menhaden's role in the ecosystem, specifically as feed for forage fish. Subsequent stock assessment updates in 2012 and 2017 reported that menhaden was not overfished and overfishing was not occurring (ASMFC, July 2012, August 2017), prompting a demand to increase the quota by the commercial sector. In 2016, the ASMFC increased the menhaden quota by 6.45% increase in response.

Menhaden has a number of "indirect" or "nonconsumptive" uses. Menhaden is a significant part of the diet of many important commercial and recreational fish like striped bass, weakfish and bluefish. Menhaden is also a significant part of the diet of shore birds like osprey, pelicans and loons. Menhaden filter pollution from the water through their gills which some scientific evidence suggests may improve water quality (Annis et al. 2009). Amendment 3 to the menhaden fishery management plan was initiated to consider ecosystem interactions (i.e., abundance of prey and predator species when setting overfished thresholds for menhaden) and

---

[2] Overfishing occurs when more fish are taken than can be reproduced from the fish stock leading to a reduction in the stock. Overfished exists when a stock is not at the maximum sustainable yield level.

re-evaluate quota allocation among states. The current process of fisheries management, including Atlantic menhaden, typically involves decision-making on an individual species basis with a focus on static and dynamic stock size. According to the ASMFC (2018):

> "… Amendment [3] maintains the management program's current single-species biological reference points until the review and adoption of menhaden-specific ecological reference points as part of the 2019 benchmark stock assessment process."

The ASMFC is in the process of evaluating multispecies models that can generate these ecological reference points. The models primarily consider the abundance of menhaden and the species role as a forage fish, as well as environmental effects. The ASMFC is considering "ecosystem management" by accounting for interactions among a restricted suite of species – menhaden and certain fish that prey on them (Buchheister, Miller, and Houde 2017).[3]

The research reported in this paper is a summary of one component of the Amendment 3 process. The ASMFC Menhaden Board funded a "Socioeconomic Analysis of the Atlantic Menhaden Commercial Bait and Reduction Fishery" in March 2016 and the Final Report was submitted in May 2017 (Whitehead and Harrison, 2017). During the study period there was ongoing debate on the appropriate total allocation and associated state quotas (ASMFC, October 2017). The purpose of the socioeconomic study was to describe the bait and reduction fisheries using qualitative and quantitative methods. Results of the study were included in the Draft Amendment 3. Public comment began in August 2017 and the final Amendment 3 was approved

[3] Ecosystem based management defined elsewhere could include other elements like habitat, climate, and even ecosystem services like direct uses of the fishery to humans (e.g. menhaden oil health supplements).

in November 2017 (ASMFC, November 2017).

In this paper we present results from the public opinion survey portion of the socioeconomic study. The survey design focused on a discrete choice experiment with tradeoffs between menhaden quota and jobs and three ecological changes (Carson and Czajkowski 2014). The “citizen preferences” approach we use follows that introduced by Blomquist, Newsome and Stone (2000, 2003, and 2004) who ask survey respondents to allocate a fixed government budget across various programs. Similarly, Evans et al. (2017) ask a referendum contingent valuation question with an open ended allocation of funds follow-up question for coastal water quality. Kaplowitz and Lupi (2012) use the citizen preference approach in a discrete choice experiment to assess best management practices for water quality. Mouter, van Cranenburgh and van Wee (2017) compare citizen and consumer preferences in a transportation discrete choice experiment.

Attribute non-attendance (ANA) arises in stated preference surveys when survey respondents ignore choice attributes for a variety of reasons (Hensher, Rose and Greene 2005, Alemu et al. 2013). Attribute non-attendance tends to bias attribute coefficients downwards (in absolute value). Several models have arisen to account for ANA. Stated ANA models rely on survey respondent statements about which attributes they ignored. Inferred ANA models allow the empirical model to provide clues about ANA. One type of inference involves estimation of choice models and employing distributions of coefficients to impose ANA on re-estimated models. Another type of inferred ANA uses the latent class model and imposes attribute coefficient constraints to identify the probability that a survey respondent will ignore attributes (Scarpa, et al. 2009). Scarpa et al. (2012) finds that the equality constrained latent class (ECLC) model outperforms the inferred ANA model based on distributions of coefficients. They do not find a clear winner when comparing stated and inferred ANA models.

In this paper we compare stated and inferred ANA models for citizen preferences for an ecosystem approach to management of Atlantic menhaden. We employ an inferred approach similar to Koetse (2017) who uses the ECLC model with a focus on the cost coefficient to mitigate hypothetical bias. In the baseline model we find that survey respondents ignore economic attributes (i.e., commercial fishing quota and jobs) of the menhaden quota increase but both stated and inferred approaches identify those respondents who make tradeoffs between economic and ecosystem attributes. In the rest of the paper we describe the survey and data. Then we present the empirical model and results. Conclusions follow.

Survey Design

There are 31 questions in the menhaden quota survey. Respondents are first asked for the Atlantic state in which they live. Then we presented some information about the ASMFC and menhaden and asked about their knowledge of the ASMFC and the Atlantic menhaden fishery. We presented information about the annual landings and value of menhaden, and asked about the perceived importance of menhaden to the economy of the Atlantic coast. We defined overfishing, showed the results of the 2012 menhaden stock assessment, and asked for respondent concern about overfishing.

In order to gain insight into the perceived importance of the range of potential uses of menhaden (animal feed, human health supplement, bait, forage species and water quality improvement) we briefly described them and asked respondents to rate each of these on an importance scale. Next, we described the 2016 menhaden quota at the state level (quota, price and revenue) and asked about the perceived importance of the menhaden quota to the respondent's home state.

Stated preference surveys elicit preferences by asking survey respondents how they would behave in hypothetical situations. In advance of stated preference questions that address ecosystem-based fisheries management we explained the term and asked respondents how important they feel it is to manage menhaden at the ecosystem level relative to the individual species level. After these preliminary questions, we described the stated preference voting questions with detailed instructions and asked respondents how well they understand them.

There are three quota increase scenarios and three quota decrease scenarios in the survey, each presented in a separate block. The two question blocks of increase or decrease quota scenarios are randomly ordered. In other words, one respondent might be presented with three quota increase scenarios followed by three quota decrease scenarios. Another respondent might receive the quota decrease scenarios first followed by the quota increase scenarios. In each scenario respondents are presented a "Current Quota" and told that "Landings throughout the Atlantic States are expected to be 410 million pounds and landings revenue (R) is expected to be $[$R = P \times 410$] million at an average price of $[$P$] per pound." The three quota change scenarios are differentiated by the ex-vessel price, $[$P$], per pound. The mean, $0.093, is the average annual ex-vessel price of Atlantic menhaden from 2001 to 2014 (in 2014 dollars inflated by the producer price index for farm products, processed foods and feeds). The minimum price per pound is $0.077 and the maximum is $0.107. Within each of the quota question blocks, respondents were randomly assigned 3 possible quota changes: 10%, 20% or 30%.

Respondents were told in the instructions that "Changes in the landings of menhaden will lead to changes in the landing revenues that commercial fishing businesses receive when they sell their catch. Revenues are equal to pounds landed multiplied by the price per pound." The economic impact on each state is described by the change in ex-vessel revenue and industry jobs as a result of the quota change. The change in ex-vessel revenue across the Atlantic states is the product of the ex-vessel price and change in quota. The revenue changes ranged from a low of $3 million (10% quota change, minimum price) to a high of $13 million (30% quota change, maximum price).

In the instructions respondents are told that "Changes in the landings of menhaden will lead to changes in the number of jobs in the commercial fishing industry." The change in the number of jobs is estimated from market data from *Fisheries Economics of the United States* (NMFS, 2014). There are an estimated 34,828 jobs (without imports) in the mid-Atlantic commercial fishing industry (Delaware, Maryland, New Jersey, New York, and Virginia). Menhaden accounts for 7.05% of the commercial fishing revenue in the region. Applying this percentage to the total number of jobs we estimated that there are 2,455 menhaden jobs in the mid-Atlantic. Since the mid-Atlantic region accounts for 99% of the menhaden landings in 2014, we estimated that there are about 2,481 jobs supported by menhaden in the Atlantic States. We assumed that menhaden jobs are proportional to quota so that a 10% change in quota would lead to a 10% change in jobs. The job gains and losses due to the proposed quota changes are estimated to be 248, 496 and 744. We round these numbers to 250, 500 and 750 and randomly assign one of these three job gains/losses in each scenario.

There are three other attributes of the stated preference scenarios: water quality, populations of game fish species and shore birds. These attributes relevant to ecosystem-based management were described in the instructions as: “There is the possibility that changes in menhaden landings will lead to changes in other parts of the ecosystem such as water quality, predator species like striped bass, weakfish and bluefish and waterbirds like osprey, pelicans and loons. There is currently much scientific uncertainty about these relationships. So, we describe the potential effects in very simple terms.” There are two levels of each attribute: no change and increase/decrease (for the decrease/increase quota scenarios, respectively). For each of the quota scenarios there are 72 potential scenario versions for each of the three price scenarios: 3 (quota) x 3 (job) x 2 (water quality) x 2 (game fish) x 2 (shore birds).

The choice question was framed as an advisory referendum vote to the ASMFC: “You will be presented with several of these situations. Please consider each one independently. After each situation is presented you will be asked about which alternative you would vote for. For this question imagine that you have the opportunity to vote on the quota change in an advisory referendum to the ASMFC. If more than 50% of the households in [insert respondent state] vote for the quota change then the ASMFC would consider [insert respondent state] to be in favor.” After the instructions and presentation of each scenario respondents are asked “Would you vote for or against the increased/decreased quota?”

Following the choice questions we asked two debriefing questions. The first was intended to determine the amount of attention paid to each of the attributes and the second was intended to determine how seriously respondents took the voting exercise. The survey concluded with a number of questions about survey salience, socioeconomic factors and an open-ended comment box.

ASMFC staff reviewed the survey for scientific accuracy and policy relevance. A revision of the survey was pretested with a sample of 59 respondents. No issues emerged in the pretest. The survey can be found as an appendix in Whitehead and Harrison (2017) or viewed online at: https://www.research.net/r/menhaden.

Data Summary

In order to collect a large sample of data at relatively low cost we conducted an internet survey with a non-probability panel of respondents. Opt-in panels are becoming popular in social science research but their ability to adequately represent the general public is still unresolved. Yeager et al. (2011) found that non-probability internet samples are less accurate than more representative probability samples for socioeconomic variables. Lindhjem, Henrik, and Navrud (2011) reviewed the stated preference literature and find that internet panel data quality is no lower than more traditional survey modes and internet panel willingness to pay estimates are lower. Kirkley et al. (2013) found that an internet survey with a non-probability panel produces lower willingness to pay values to avoid reductions in menhaden quotas than a random digit dial telephone survey. Following American Association for Public Opinion Research guidelines (Baker et al. 2010): "Respondents for this survey were selected from among those who have registered to participate in Survey Sampling International online surveys and polls. The data have been weighted to reflect the demographic composition of the target population. Because the sample is based on those who initially self-selected for participation in the panel rather than a probability sample, no estimates of sampling error can be calculated."

The survey targeted the two states with the largest menhaden quota: New Jersey and Virginia, and six other key menhaden states. The targeted number of completed responses was 2000, broken down as: VA (400), NJ (400), ME (200), FL (200), NC (200), MD (200), NY (200) and RI (200). The survey was fielded online in October 2016 using the SurveyMonkey platform and Survey Sampling International online panel. We received 2253 responses from the eight Atlantic Coast states. We received 495 and 475 responses from New Jersey and Virginia, respectively. We received 227, 217, 216, 236, 229 and 158 responses from Florida, Maine, Maryland, New York, North Carolina and Rhode Island, respectively. The samples were balanced by gender and race/ethnicity in each state except for Maine for which the panel was too small to achieve this balance. The survey data was weighted by state population in our regression analysis.

Ten percent of the sample knew “a lot” about the ASMFC before the survey, 15% knew “some,” 16% knew “a little” and 59% knew “nothing.” Nine percent of the sample knew “a lot” about Atlantic menhaden before the survey, 15% knew “some”, 15% knew “a little” and 52% knew “nothing.” Forty-seven percent of the respondents thought the Atlantic menhaden commercial fishery was very important to the economy, 45% thought it was somewhat important, 5% thought it was somewhat not important and 3% thought it was not important. Twenty-seven percent of the respondents were very concerned about overfishing of menhaden, 38% were somewhat concerned, 27% were not too concerned and 8% were not at all concerned. Forty-four percent of respondents thought that menhaden were very important for fish meal, 42% for fish oil, 27% as bait for recreational fishing and 35% as bait for commercial fishing. Fifty-nine percent thought that menhaden were very important as food for other fish species, 53% as food for shore birds, and 62% for water quality. Forty-two percent thought that the Atlantic menhaden commercial fishery was very important to their state, 40% thought it was somewhat important, 14% thought it was somewhat not important and 5% thought it was not important. Fifty-three percent thought it was very important to manage menhaden at the ecosystem level instead of the individual species level, 42% thought it was somewhat important, 4% thought it was somewhat not important and 2% thought it was not important.

After being presented with the stated preference instructions, 45% of the survey respondents said that they understood them very well, 45% said they understood them somewhat well and 8% said that they did not understand them very well. Two percent stated that they did not read the instructions. Fifty-one percent of respondents strongly agreed and 28% somewhat agreed that results of the survey would be shared with the ASMFC. Thirty-seven percent strongly agreed and 37% somewhat agreed that the results of the survey could affect ASMFC decisions about menhaden. Forty-four percent strongly agreed and 35% somewhat agreed with the statement that they understand all of the information presented on the proposed alternative menhaden quotas. Forty-nine percent strongly agreed and 33% somewhat agreed that public opinion surveys are a good way for citizens to express their preferences about fisheries policy.

We focus our attention on the increase quota scenarios.[4] After removing individuals who explicitly stated that they did not read the survey directions, we had 2022 respondents, and 6066 total observations since each respondent answered three choice questions. The variable "For" is equal to one if the respondent voted for the increased quota proposal and zero if the vote was "against" or "undecided." Across the three quota increase scenarios, 43%, 44% and 45% of respondents voted to increase the menhaden quota by 10%, 20% or 30%, respectively. Fifteen percent were "undecided" and 41% of the votes were "against" the quota increases. Excluding

[4] A SurveyMonkey programming mistake led to a missing shore bird attribute variable. Whitehead and Harrison (2017) present results from these scenarios with several corrective strategies. They find similar results to those we present here.

undecided votes, a majority voted in favor of quota increases.

The ecosystem services variables take on values equal to 0 or 1. If the variable is equal to zero then the respondent is told that there is no environmental impact from the quota change. In other words, if the quota change would lead to no change in water quality, game fish populations or shore bird populations then these variables are equal to 0. If the variable takes a value of 1 then the environmental impact is negative (in the increased quota scenarios) or positive (in the decreased quota scenarios). Each of the mean ecosystem service values are close to 0.50 ("Water quality," "Game fish," and "Shore birds") representing a 50/50 split.

To elicit stated ANA we asked respondents about how much they considered each of the factors when they were making decisions about how to vote. Sixty-three percent stated that they considered water quality "a lot" and 32% stated they considered it "some." Fifty-one percent considered the number of jobs a lot and 41% some. Thirty-seven percent considered game fish populations a lot and 54% considered them some. Thirty-three percent considered shore bird populations a lot and 57% considered them some. The factors that contribute to quota revenue were considered the least. Twenty-six percent and 21% considered the size of the quota and price per pound a lot. Eighteen percent and 29% did not consider the quota or price at all. While not one of the attributes, we also included overfishing in this question list. Forty-one percent considered overfishing a lot and 49% considered it some.

Twenty percent of respondents were members of a recreational, environmental or conservation organization or association. Eleven percent of respondents were currently employed in the commercial fishing or a related industry.[5] Twenty-four percent had participated in recreational saltwater fishing in the previous 24 months. Eighty-three percent of these respondents had participated in recreational saltwater fishing in their home state in the previous 12 months. These respondents fished an average of 22 days in their home state during the previous 12 months. The average household size was three with one person below the age of 18. Fifty-two percent of the sample was female and 68% was white. About two percent of the sample did not finish high school, 18% were high school graduates, 22% went to college but did not get a degree, 11% had an associate degree, 28% had a bachelor's degree, and 19% had a graduate or professional degree. Four percent of respondents had income less than $10,000, 3% had income between $10,000 and $14,999, 7% were between $15,000 and $24,999, 8% were between $25,000 and $34,999, 14% were between $35,000 and $49,999, 17% were between $50,000 and $74,999, 20% were between $75,000 and $99,999, 17% were between $100,000 and $149,999, 5% were between $150,000 and $199,999, and 3% had incomes of $200,000 or more.

Empirical Results

Survey respondents will tend to choose ecosystem-based management plans that provide the most utility. The individual utility from the choice is decreasing in cost and increasing in benefit: $U_i = V_i(P, Q, J, W, F, B) + \varepsilon_i$, where U is the individual indirect utility function, V is the nonstochastic portion of utility, P is ex-vessel price, Q is quota, J is jobs, W is water quality, F is game fish, B is shore birds, ε is the error term, and $i = 1, 2$ alternatives. The random utility model assumes that the individual chooses the alternative that gives the highest utility, $\pi_i =$

[5] This demographic is overrepresented relative to the population but we find that it has no effect on respondent votes in the conditional logit models.

Pr $(V_i + \varepsilon_i > V_j + \varepsilon_j; i \neq j)$, where π_i is the probability that alternative i is chosen. If the error terms are independent and identically distributed extreme value variates then the multinomial logit (MNL) model results. We estimate (MNL models with NLogit version 6 software (www.limdep.com).

In the baseline quota increase models we find that increases in ex-vessel price increased the probability of a vote for a quota increase (Table 1). However, increased quota size and jobs did not affect votes. Increased quotas that make water quality worse and negatively affect gamefish and shore bird populations led to a decrease in the probability of a vote for increased quotas. We include an alternative specific constant for the vote interacted with concern about overfishing, the ordering of the quota question and the ordering of the increased quota block. While we informed respondents that increased quotas would not lead to overfishing, the positive coefficient indicates that respondents who still expressed concern about overfishing were more likely to vote against a quota increase. Respondents were more likely to vote for the first quota question relative to the second and third. Respondents were more likely to vote for each of the quota increases if the quota increase scenarios were presented before the quota decrease scenarios. These last three results hold in each of the models in Table 1.

We next estimate a stated ANA model. Respondents who considered the quota and jobs attributes "a lot", 26% and 51%, are considered to have full preservation (i.e., the respondent attended to each of the attributes) and their utility function is:

$$U = \alpha_P P + \alpha_Q Q + \alpha_J J + \beta_W W + \beta_F F + \beta_B B$$

Respondents may not attend to (i.e., may ignore) the quota attribute, the jobs attribute or both. In this case the utility functions are:

$$U = \alpha_P P + \qquad \alpha_J J + \beta_W W + \beta_F F + \beta_B B$$

$$U = \alpha_P P + \alpha_Q Q + \qquad \beta_W W + \beta_F F + \beta_B B$$

$$U = \alpha_P P + \qquad\qquad \beta_W W + \beta_F F + \beta_B B$$

In the stated ANA quota increase model we again find that increases in ex-vessel price increased the probability of a vote for a quota increase; increased quotas that make water quality worse and negatively affect gamefish and shore bird populations led to a decrease in the probability of a vote for increased quotas (Table 1). When accounting for respondents who stated that they did not consider the quota and jobs attributes “a lot,” these coefficients are now positive and statistically significant. The stated ANA model is statistically preferred to the baseline model with lower log-likelihood and Akaike Information Criterion (AIC) statistics.

We then estimate an ECLC inferred ANA model. We estimate the model with two classes. The first class is the full preservation class and the second imposes attribute non-attendance on the quota and jobs attributes by constraining the coefficients to equal zero:

$$U = \alpha_P P + \alpha_Q Q + \alpha_J J + \beta_W W + \beta_F + \beta_B B$$

$$U = \alpha_P P + \qquad\qquad \beta_W W + \beta_F + \beta_B B$$

We first attempted to estimate the four equation structure similar to the stated ANA model but this led to a negative coefficient on the quota variable and a zero probability for the jobs non-attending class.

Similar to the stated ANA quota increase model we again find that increases in ex-vessel price increased the probability of a vote for a quota increase; increased quotas that make water quality worse and negatively affect gamefish and shore bird populations led to a decrease in the probability of a vote for increased quotas (Table 1). The coefficients on the quota and jobs attributes are positive and statistically significant in the inferred ANA model in the full preservation class. The full preservation class probability is 29%. The quota and jobs non-attendance class, where quota and jobs coefficients are constrained to zero, has a probability of 71%. The inferred ANA model is statistically preferred to the stated ANA model with lower log-likelihood and Akaike Information Criterion (AIC) statistics.

Marginal Rate of Substitution

The logit coefficients are not directly interpretable but are useful for determining tradeoffs among economic and ecosystem variables. The marginal rate of substitution between quota and jobs are computed by taking the absolute value of the ratio of the coefficient of the attribute of interest divided by the coefficient of the quota and jobs variable. The marginal rate of substitution between economic and ecosystem service attributes can be measured as $MRS = -\beta/\alpha$ and is interpreted as the size of the quota or the number of jobs that respondents would be willing to trade for avoiding a decrement in water quality, game fish or shore birds. In this context, MRS is an estimate of the survey respondent's willingness to forgo, on behalf of society, additional quota and jobs if these would lead to a loss in ecosystem services.

In the baseline logit model with statistically insignificant coefficients on quota and jobs, the marginal rate of substitutions are not statistically different from zero. In the ANA models with statistically significant coefficients, these tradeoffs can be more accurately estimated for those who paid attention to the questions. In the stated ANA model respondents are willing to forgo 93 million pounds, 47 million pounds and 50 million pounds in additional quota in order to avoid negative impacts on water quality, gamefish and shore birds, respectively (Table 2). In the inferred ANA model, respondents are less willing to trade economic impacts for ecosystem services. Respondents are willing to forgo 48 million pounds, 31 million pounds and 34 million pounds in additional quota in order to avoid negative impacts on water quality, gamefish and shore birds, respectively. None of the differences across stated and inferred ANA models are statistically significant.

In the stated ANA model respondents are willing to forgo 512, 258 and 367 additional commercial fishing jobs in exchange for avoiding negative impacts on water quality, gamefish and shore birds, respectively (Table 3). The estimates are smaller in the inferred ANA model. Respondents are willing to forgo 189, 121 and 132 jobs in exchange for avoiding negative impacts on water quality, gamefish and shore birds. The differences in jobs for water quality and shore birds are statistically significant across the ANA approaches.

Conclusions

In this study, we have developed information to inform the ASMFC fishery management plan for Atlantic menhaden from a citizen preference survey. Survey respondents were more likely to vote for increased menhaden quotas that generate economic benefits and do not negatively impact the environment. After accounting for attribute non-attendance respondent votes revealed that they recognize tradeoffs among economic impacts and ecosystem services with alternative menhaden quotas. Our results suggest that the general public has significant demand for ecosystem-based fisheries management. The ASMFC is currently working towards developing an ecosystem-based management model (ASMFC, February 28, 2018). As this model is developed over the next several years, the inputs into the citizen preference model should become less uncertain and a better understanding of preferences for quota changes could be incorporated into a citizen preference survey, resulting in more accurate estimates of economic impacts.

Table 1. Multinomial Logit Models: Dependent Variable = Vote For Increased Menhaden Quota

	Baseline (MNL)		Stated (MNL)		Inferred (ECLC)	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Price	0.097	0.016	0.061	0.015	0.051	0.013
Quota	-0.00042	0.001	0.0059	0.0012	0.016	0.0022
Jobs	0.000093	0.0001	0.0011	0.00016	0.0040	0.00046
Water quality	-0.528	0.075	-0.549	0.076	-0.750	0.071
Game fish	-0.273	0.071	-0.276	0.072	-0.479	0.071
Shore birds	-0.284	0.071	-0.294	0.072	-0.525	0.071
ASC x Overfishing	-0.414	0.053	-0.390	0.052	-0.474	0.048
ASC x First SP Question	0.262	0.059	0.263	0.062	0.355	0.068
ASC x First SP Block	0.338	0.093	0.322	0.092	0.460	0.086
LL Function	-3981.09		-3861.41		-3694.39	
AIC	7980.2		7740.8		7408.8	
Sample size	2022		2022		2022	
Panel length	3		3		3	
Quota non-attendance			73.54%			
Jobs non-attendance			49.26%			
Quota and Jobs non-attendance					70.70%	

Note: The standard errors are clustered at the individual level

Table 2. Marginal Rate of Substitution between Quota (million lbs) and Ecosystem Attributes

	Stated		Inferred	
	Quota	S.E.	Quota	S.E.
Water quality	92.81	22.17	48.02	7.83
Game fish	46.73	14.97	30.67	6.17
Shore birds	49.77	15.16	33.62	6.40

Table 3. Marginal Rate of Substitution between Jobs and Ecosystem Attributes

	Stated		Inferred	
	Jobs	S.E.	Jobs	S.E.
Water quality	511.51	100.14	188.74	27.79
Game fish	257.56	78.16	120.56	21.87
Shore birds	367.33	75.91	132.14	23.61

References

Alemu, Mohammed Hussen, Morten Raun Mørkbak, Søren Bøye Olsen, and Carsten Lynge Jensen. "Attending to the reasons for attribute non-attendance in choice experiments." Environmental and Resource Economics (2013): 1-27.

Annis, E., Friedland, K., and Uphoff, J., 2009. “Ecosystem-based fisheries management for Chesapeake Bay: Menhaden background and issue briefs.” Maryland Sea Grant UM-SG-TS-2009-08, pp. M/2-9.

Atlantic States Marine Fisheries Commission, “Stock Assessment Report No. 10-02 of the Atlantic Menhaden Stock Assessment and Review Panel Reports,” May 2010, revised March 2011.

Atlantic States Marine Fisheries Commission, “Atlantic Menhaden Stock Assessment Update,” July 2012.

Atlantic States Marine Fisheries Commission, “Amendment 2 to the Interstate Fishery Management Plan for Atlantic Menhaden,” December 2012.

Atlantic States Marine Fisheries Commission, “ASMFC Atlantic Menhaden Board Sets 2017 TAC at 200,000 MT & Approves Draft Amendment 3 Public Information Document for Public Comment,” News Release, October 26, 2016.

Atlantic States Marine Fisheries Commission, “Atlantic Menhaden Stock Assessment Update,” August 2017.

Atlantic States Marine Fisheries Commission. Meeting Summaries & Reports, Board

Proceedings. Retrieved October 2017 from http://www.asmfc.org/species/atlantic-menhaden.

Atlantic States Marine Fisheries Commission, “Amendment 3 to the Interstate Fishery Management Plan for Atlantic Menhaden,” November 2017.

Atlantic States Marine Fisheries Commission, “Data Workshops Scheduled for Atlantic Menhaden Single-Species & Ecological-Based Benchmark Stock Assessments,” News Release, February 28, 2018.

Atlantic States Marine Fisheries Commission, “Atlantic Menhaden,” http://www.asmfc.org/species/atlantic-menhaden, accessed June 14, 2018.

Baker, R., Blumberg, S.J., Brick, J.M., Couper, M.P., Courtright, M., Dennis, J.M., Dillman, D., Frankel, M.R., Garland, P., Groves, R.M. and Kennedy, C., 2010. AAPOR report on online panels. The Public Opinion Quarterly, 74(4), pp.711-781.

Blomquist, G.C., Newsome, M.A., and D.B. Stone. "Public marginal willingness and trade off among water quality programs: Estimates of statewide and watershed-specific budget values." Water Resources Research 36, no. 5 (2000): 1301-1313.

Blomquist, G.C., Newsome, M.A., and D.B. Stone. "Measuring principals' values for environmental budget management: an exploratory study." Journal of Environmental Management 68, no. 1 (2003): 83-93.

Blomquist, G.C., Newsome, M.A., and D.B. Stone. "Public preferences for program tradeoffs: Community values for budget priorities." Public Budgeting & Finance 24, no. 1 (2004):

50-71.

Buchheister, Andre, Thomas J. Miller, and Edward D. Houde. "Evaluating Ecosystem-Based Reference Points for Atlantic Menhaden." Marine and Coastal Fisheries 9, no. 1 (2017): 457-478.

Carson, R., and M. Czajkowski. "The discrete choice experiment approach and environmental contingent valuation." Chapter 9 in Handbook of Choice Modelling, edited by Stephane Hess and Andrew Daly, pp. 202-236, Edward Elgar: Northampton, MA, 2014.

Dudley, Mitchell Ryan, The Economics of the Atlantic Menhaden Fishery, Dissertation, North Carolina State University, 2012.

Evans, Keith S., Caroline L. Noblet, Emma Fox, Kathleen P. Bell, and Abigail Kaminski. "Public acceptance of coastal zone management efforts: The role of citizen preferences in the allocation of funds." Agricultural and Resource Economics Review 46, no. 2 (2017): 268-295.

Hensher, David A., John Rose, and William H. Greene. "The implications on willingness to pay of respondents ignoring specific attributes." Transportation 32, no. 3 (2005): 203-222.

Kaplowitz, M.D., and F. Lupi. "Stakeholder preferences for best management practices for non-point source pollution and stormwater control." Landscape and Urban Planning 104, no. 3 (2012): 364-372.

Kirkley, J.E. "An assessment of the social and economic importance of Menhaden (Brevoortia tyrannus) (Latrobe, 1802) in Chesapeake Bay Region." VIMS Marine Resource Report

No. 2011-14, 2011.

Kirkley, J.E., T. Hartman, K.E. McConnell, T.M. Mohr, and J.C. Whitehead, "A Comparative Analysis of the Multi-Mode Chesapeake Bay Menhaden Survey," paper presented at the 2013 NAAFE meetings, 2013.

Koetse, Mark J. "Effects of payment vehicle non-attendance in choice experiments on value estimates and the WTA–WTP disparity." Journal of Environmental Economics and Policy (2017): 1-21.

Lindhjem, H., and S. Navrud. "Using internet in stated preference surveys: a review and comparison of survey modes." International Review of Environmental and Resource Economics 5 (2011): 309-351.

Mouter, Niek, Sander van Cranenburgh, and Bert van Wee. "Do individuals have different preferences as consumer and citizen? The trade-off between travel time and safety." Transportation Research Part A: Policy and Practice 106 (2017): 333-349.

National Marine Fisheries Service. Fisheries Economics of the United States 2014. Retrieved 3/31/17 from https://www.st.nmfs.noaa.gov/Assets/economics/publications/FEUS/FEUS-2014/Report-and-chapters/FEUS-2014-FINAL-v5.pdf.

Scarpa, Riccardo, Timothy J. Gilbride, Danny Campbell, and David A. Hensher. "Modelling attribute non-attendance in choice experiments for rural landscape valuation." European review of agricultural economics 36, no. 2 (2009): 151-174.

Scarpa, Riccardo, Raffaele Zanoli, Viola Bruschi, and Simona Naspetti. "Inferred and stated attribute non-attendance in food choice experiments." American Journal of Agricultural Economics 95, no. 1 (2012): 165-180.

SEDAR. 2015. SouthEast Data, Assessment, and Review 40 – Atlantic Menhaden Stock Assessment Report. SEDAR, North Charleston SC. 643 pp.

Whitehead, John C., and Jane Harrison, "Socioeconomic Analysis of the Atlantic Menhaden Commercial Bait and Reduction Fishery," A Report to the Atlantic States Marine Fisheries Commission, May 3, 2017.

Yeager, D.S., Krosnick, J.A., Chang, L., Javitz, H.S., Levendusky, M.S., Simpser, A., and R. Wang. "Comparing the accuracy of RDD telephone surveys and internet surveys conducted with probability and non-probability samples." Public Opinion Quarterly 75, no. 4 (2011): 709-747.

Figure 1. An example of a stated preference choice question

Current Quota

Menhaden landings throughout the Atlantic States are expected and be 410 million pounds and landings revenue is expected and be $38.13 million at an average price of $0.093 per pound.

Increased Quota

33%	The ASMFC is considering a 10% increase and each state's individual menhaden quota. Throughout the Atlantic States: Landings increase by 41 million pounds and revenues increase by $3.81 million.
33%	The ASMFC is considering a 20% increase and each state's individual menhaden quota. Throughout the Atlantic States: Landings increase by 82 million pounds and revenues increase by $7.63 million.
33%	The ASMFC is considering a 30% increase and each state's individual menhaden quota. Throughout the Atlantic States: Landings increase by 123 million pounds and revenues increase by $11.44 million.
33%	The number of jobs in the menhaden industry increase by 250.
33%	The number of jobs in the menhaden industry increase by 500.
33%	The number of jobs in the menhaden industry increase by 750.
50%	There is no change in striped bass, weakfish and bluefish populations.
50%	There is a decrease in striped bass, weakfish and bluefish populations.
50%	There is no change in osprey, pelican and loon populations.
50%	There is a decrease in osprey, pelican and loon populations.
50%	There is no change in water quality.
50%	There is a decrease in water quality.

11. Would you vote for or against the increased quota?

- ☐ I would vote for the increased quota
- ☐ I would vote against the increased quota
- ☐ I don't know how I would vote