Integrating Revealed and Stated Preference Data to Improve the Estimation of Baseline Risk Fish Ingestion

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Abstract

Quantifying baseline regulatory risk at sites with fish consumption advisories requires estimating what fish consumption *would be* if the relevant fish consumption advisories were not in force. (Not in force means that no warning sign is present on site and/or no published materials warn anglers about risks from consuming site fish and crab, but all other site conditions remain as they are currently.) Examining what anglers' fishing and consumption decisions would be in the absence of fish consumption advisories involves modeling angler behavior; therefore, accounting for the effect of the fish consumption advisory in the baseline risk assessment requires an angler behavior model that can examine angler choice under counterfactual advisory scenarios. This manuscript presents the results of an angling model evaluating the array of advisories that are most relevant for the policy outcome needed to inform estimates of baseline-risk fish ingestion. The model integrates revealed preference data presented in Bingham et al. (2011) with SP data collected during the 2013 New Jersey Outdoor Recreation Survey. The experimental design developed for the SP component was designed specifically to collect data on anglers' stated preferences regarding fish consumption advisories that could be integrated with the existing revealed preference data presented in Bingham et al. (2011). The integration of the SP data improves the model specification, producing statistically significant coefficients on the policy variables that directly inform the evaluation of changes in anglers' simulated trip-taking behaviors between current and baseline-risk conditions. The model results provide the angler preference function necessary to develop the simulations of changes in angler behavior and consumption presented in Kinnell and Bingham (2014).

1. Introduction

Evaluating alternative remedial options under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires understanding human health risk under regulatory baseline conditions. One of the key parameters influencing estimates of baseline human-health risk is the level of fish consumption at a site.

The regulatory requirement of a baseline risk assessment is to characterize risk in the absence of any site-related controls that might reduce exposure. Under 40 *CFR* 300.430(d)(4), the CERCLA statute states that the "… lead agency shall conduct a site-specific baseline risk assessment to characterize the current and potential threats to human health and the environment." As the preamble to the National Contingency Plan [55 FR 8711] describes, "…one specific objective of the risk assessment is to provide an analysis of baseline risk (i.e., the risks that exist if no remedial action or institutional controls are applied to a site)."[1]

Fish consumption advisories are considered a form of institutional control (U.S. Environmental Protection Agency [USEPA] 2010). Because institutional controls can reduce or preclude exposure while not actively remediating a site, the USEPA considers that their presence ***does not*** represent the baseline risk situation.

Therefore, to assess baseline human-health risk in a specific Study Area, the baseline risk assessment needs to characterize what the Study Area's fish consumption level would likely be if the Study Area's site-specific fish consumption advisory were not in force, but all other site conditions were the same.[2] Specifically, what is the likely angling and consumption behavior, assuming that the site-specific, institutional control of an advisory warning anglers not to consume any fish or crabs is not in force, but all other current site conditions remain, including the urbanized site setting, access, and degraded water and sediment quality?

Because current consumption can be observed, under CERCLA, *current* consumption (and regulatory risk) can be evaluated using traditional on-site survey techniques. In contrast, *regulatory baseline* risk (and consumption) refers to conditions that would exist in the absence of institutional controls that may reduce risk. The implication for sites with fish consumption advisories is that quantifying baseline regulatory risk requires estimating what fish consumption *would be* if the relevant fish consumption advisories did not exist.

Examining what anglers' fishing and consumption decisions would be in the absence of fish consumption advisories involves modeling angler behavior; therefore, accounting for the

[1] The National Contingency Plan provides the blueprint for CERCLA implementation.
[2] By not in force we mean that no warning sign is present on site and/or no published materials warn anglers about risks from consuming site fish and crab, but all other site conditions remain as they are currently.

effect of the fish consumption advisory in the baseline risk assessment requires an angler behavior model that can examine angler choice under counterfactual advisory scenarios (i.e., if the Study Area's current advisory were not in force, but all other site conditions remained the same, the model must be able to determine the increased number of fish-consuming trips that will occur as well as the increased number of anglers taking those trips). Such angler behavior models, referred to as *random utility models* (RUMs), are well established in the environmental economics literature (Caulkins, Bishop, and Bouwes 1986; Bockstael, McConnell, and Strand 1989; Morey, Shaw, and Rowe 1991; Kaoru, Smith, and Liu 1995). Researchers have used them to evaluate the effect of fish consumption advisories on anglers' behavior and welfare (Bingham et al. 2011; MacNair and Desvousges 2007; Parsons, Jakus, and Tomasi 1999; Jakus, Dadaka, and Fly 1998; Chen and Cosslet 1998; Parsons and Hauber 1998; Jakus et al. 1997; Montgomery and Needleman 1997; Jones and Sung 1993). Moreover, researchers have begun to inform both trip-taking and consumption decisions in the presence of advisories by applying RUM data-collection techniques and models to exposure assessments (Jakus and Shaw 2003; Mathews, Gribben, and Desvousges 2002).

With the exception of MacNair and Desvousges (2007), all of these studies use revealed preference (RP) data on anglers' actual site-choice decisions to evaluate the effect of advisories on anglers' welfare. As MacNair and Desvousges (2007) point out, while analysis using RP data receives the benefits of using anglers' actual choices, correlation between the advisory's presence and other site characteristics can make it difficult to model the effect that the complete set of advisories by species can have on anglers' site choices and welfare. When correlation between policy variables exists, researchers often turn to stated preference (SP) data to induce variation in the policy variables of interest.

Adamowicz et al. (1997) combined revealed and stated preference (RP and SP) data to evaluate the effect that perceived versus objective measures of environmental quality have on hunters' welfare. More recently, Truong, Adamowicz, and Boxall (2014) have combined RP and SP data to evaluate the effect of risk perception on hunters' site-choice preferences and choice-set function. In angling applications, MacNair and Desvousges (2007) have used SP data to develop an advisory index and incorporate that index into a revealed preference model for joint estimation. MacNair and Desvousges (2007) develop the SP index because they note that "the array of advisories also makes traditional estimation impractical" (p. 600).

This manuscript presents the results of a jointly estimated model evaluating the array of advisories that are most relevant for the following policy outcome needed to inform estimates of baseline-risk fish ingestion: how many more trips would anglers take if the site-specific fish consumption advisory were not in force, but all other site conditions remained the same? The model integrates RP data presented in Bingham et al. (2011) with SP data collected during the 2013 New Jersey Outdoor Recreation Survey. The experimental design developed for the SP component of the 2013 New Jersey Outdoor Recreation Survey was designed specifically to collect data on anglers' stated preferences regarding fish consumption advisories that could be integrated with the existing RP data presented in Bingham et al. (2011). The goal for the data's inclusion in the model is to estimate advisory variables that would reflect both current and baseline-risk conditions for the Lower Passaic River Study Area (LPRSA). These results provide the ability to simulate how differences between the current and baseline-risk conditions would change LPRSA anglers' trip-taking decisions. The angler preference function estimated in this manuscript is used in a fish-consumption simulation model to predict changes in fish consumption under baseline-risk conditions (Kinnell and Bingham 2014).

2. Background

To develop baseline consumption estimates, this analysis estimates the number of trips and consumption per trip that would likely occur without the site-specific, Do Not Eat advisory in force, but with all other site conditions held constant. One way to understand potential changes in trips involves simulating a change to the current advisory condition within a mathematical model of angler site choice. If this is conducted within a perfectly specified, statistically estimated model, it is possible to accurately predict trips to the LPRSA if there were not a site-specific, Do Not Eat advisory in force. Simulating a change in advisory conditions to the Baseline conditions requires changing the advisory in the model of site choice so that it matched the conditions of the Passaic River north of Dundee Dam, a limited fish consumption advisory that advises eating no more than one meal per week of certain species. This is the condition that is most similar to what the Baseline conditions on the LPRSA would be if the site-specific condition of the Do Not Eat advisory were not in force, but all other conditions remained the same.[3] The difference between LPRSA trips predicted under Current conditions and those predicted under Baseline conditions would be the expected number of additional LPRSA trips under Baseline conditions.

Although site-choice simulation with a perfectly specified statistical model is an ideal way to proceed, such a model is rarely available. Currently, the best model available in the peer-reviewed literature is the repeated nested logit of New Jersey anglers' fishing preferences presented in Bingham et al. (2011). This model has a (0,1) site characteristic variable representing whether or not a waterbody has a Do Not Eat consumption advisory on any species. Changing this variable from 1 to 0 would represent removing the Do Not Eat advisory condition on the LPRSA. With this change, the participation component of the model would determine new angling trips to the LPRSA and the site-choice component of the model would determine new trips to the LPRSA that had been diverted from other sites.

This specification of the advisory variable has shortcomings with respect to estimating the number of trips that would occur if the site-specific, Do Not Eat advisory on the LPRSA were not in force. The first is that the specification does not appropriately differentiate between the LPRSA, which has a Do Not Eat Advisory on *all* species, and portions of Newark Bay, which

[3] The limited fish consumption advisory on the Passaic River north of Dundee Dam refers to the statewide mercury advisory for specific freshwater species. Because the statewide mercury advisory is not waterbody-specific, its potential impacts on fishing and consuming behavior in the LPRSA is not considered in the analysis of Baseline risk (i.e., how much would trip frequency and consumption per trip change if the statewide mercury advisory were not in force). Rather, we specify that its presence would be part of the conditions that are likely to exist if the LPRSA's site-specific, Do Not Eat advisory were not in force.

have a Do Not Eat Advisory on *some* species. A potential implication is that the advisory specification may underestimate the effect of the LPRSA advisory.

A related issue is that the advisory specification does not directly match the advisory conditions of the studied sites. For example, many sites have advisories to consume with lower frequencies (i.e., once per week or month). Other sites have Do Not Eat advisories on some species, but not all species, and the LPRSA has a Do Not Eat Advisory on all species. An implication is that modeling the reduction of trips attributable to the site-specific, Do Not Eat advisory on the LPRSA should include the mercury advisory that would remain. This is not possible with the current specification.

The final issue reflects the uniqueness of the advisory on the LPRSA. Although a number of sites have Do Not Eat advisories on some species, the four sites in the LPRSA contained in the Bingham et al. (2011) model are the only ones in the statistical model that have a Do Not Eat Advisory on <u>all species</u>. As a result, specifying a Do Not Eat Advisory All Species for the sites on the LPRSA is equivalent to specifying an Alternative Specific Constant (ASC) for the LPRSA.[4] The effect of an ASC in a site-choice model of this sort is to absorb the implications (both positive and negative) of all unmodeled site characteristics. Therefore, if there are (on average) desirable site characteristics common to the four LPRSA sites omitted from the statistical model, a variable representing a Do Not Eat advisory on all species would underestimate the impact of the advisory. If the omitted characteristics are (on average) undesirable, the impact of the Do Not Eat advisory is overestimated.

Figure 1 illustrates the advisories present in 2000 on the LPRSA and other sites in the LPRSA's immediate vicinity, as well as sites throughout New Jersey.[5] Each of the circles in Figure 1 identifies locations where individuals reported taking fishing trips during the 2000 New Jersey Outdoor Recreation Survey. The color coding of each circle represents the fish consumption advisories at the sites where anglers reported taking trips. As the figure shows, the LPRSA has the most stringent advisory of any site, with a Do Not Eat advisory on all species.

[4] An ASC is a specific type of dummy variable that is 1 for a specific site and 0 for all other sites. Because trips to the LPRSA in Bingham et al. (2011) are the only ones that have the Do Not Eat All Species advisory condition, specifying a Do Not Eat All Species dummy variable for the advisory is the same as developing an ASC for the LPRSA.

[5] The 2000 NJ Outdoor Recreation Survey provided the data for the model in Bingham et al. (2011).

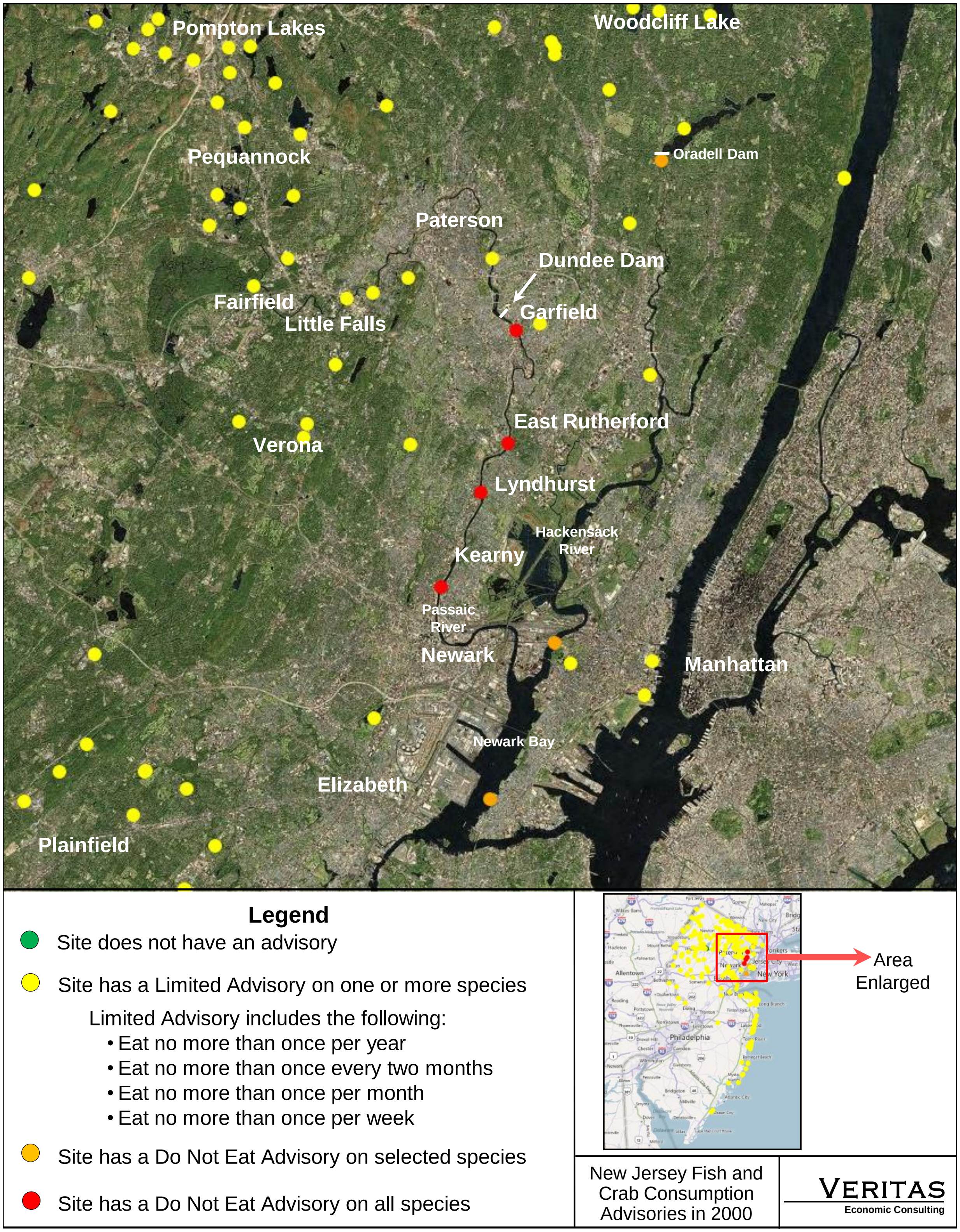


Figure 1: New Jersey Fish and Crab Consumption Advisories during the 2000 NJ Outdoor Recreation Survey and 2000–01 Passaic River Creel/Angler Survey

Sites on Newark Bay and the Hackensack River up to the Oradell Dam have the next most stringent advisory with a Do Not Eat advisory on a subset of species. Sites surrounding the LPRSA, Newark Bay, and the Hackensack River above Oradell Dam have the least stringent advisories on eating selected species from no more than once per year to once per week. One site visited during the 2000 NJ Outdoor Recreation Survey had no consumption advisory—Lake Hopatcong.

On Figure 1's map, sites with an orange circle had a Do Not Eat advisory on selected species during the administration of the 2000 NJ Outdoor Recreation Survey, and sites with a red circle had a Do Not Eat advisory on all species. The advisory specification in Bingham et al. (2011) identifies all sites with a Do Not Eat advisory on any species (i.e., orange and red circles in Figure 1). This advisory variable specification includes one site on Newark Bay, two sites on the Hackensack River downstream of Oradell Dam, and four sites on the Passaic River downstream of Dundee Dam. The advisory variable for these sites is one in the model and zero for all other sites (i.e., all the yellow circles and the one green circle in Figure 1).

The analysis in the remainder of this manuscript presents the revised advisory specifications that better reflect the variation (by species and severity) in advisory levels at the sites anglers reported visiting during the 2000 NJ Outdoor Recreation Survey. Specifically, an advisory index is created following the specifications of MacNair and Desvousges (2007). The index includes the four advisory categories identified in Figure 1. The improved specification with the advisory index allows more precise distinction of the Do Not Eat All Species—the LPRSA advisory—from the Do Not Eat Some Species that exists in Newark Bay. Also, this specification allows better differentiation of trips under Baseline conditions because it allows simulating the removal of the Do Not Eat All Species advisories that arise from the site-specific LPRSA advisory to the less stringent, limited consumption advisories. However, unlike MacNair and Desvousges (2007), SP data were not collected as part of the 2000 New Jersey Outdoor Recreation Survey. Therefore, the advisory index is estimated with RP data only.

While the advisory index improves the specification of the dichotomous advisory variable, it does not have a direct comparison of the policy relevant scenarios: a dichotomous variable that accounts for the effect of the LPRSA's Do Not Eat fish consumption advisory (the current-risk conditions) and a separate advisory variable that accounts for the effect of the advisory under baseline-risk conditions—a limited fish consumption advisory that advises eating no more than one meal per week of certain species. Therefore, a stated preference, discrete-choice experiment was developed to introduce more variation on the different levels of advisories while accounting for variations in other relevant site characteristics, such as crime, water quality, distance to the site, and catch rates. The discrete choice experiment was conducted as part of the administration of the 2013 NJ Outdoor Recreation Survey. The next section presents the methods and data used to estimate each model and develop improved specifications of the advisory variable.

3. Methods and Data

To characterize urban angling behavior, models of urban angling participation and site choice decisions were developed using a random utility framework. The models presented in this paper are based on the repeated nested logit model (Morey 1999; McFadden 1981). The nested specification is more general and informative than conditional logit as it models sequential decision making. In addition, the nested specification holds an important statistical advantage over the conditional logit model because it accounts for unobserved correlations across sites. This relaxes the restrictive independence of irrelevant alternatives (IIA) assumption inherent in conditional logit models. The repeated aspect of this logit model is also more comprehensive than conditional logit. A particular advantage of this specification is that it employs household production modeling concepts. These include conditioning the choice of how much to fish on the quality of available angling opportunities and subjecting this choice to time constraints. This allows assessing the implications of the quality of available angling opportunities on the total amount of angling.

On the first level of the nesting structure, individuals decide whether or not to fish on any particular choice occasion. Anglers who choose to fish then choose which waterbody type to fish from (fresh, salt, or tidal sites). Finally, subsequent to selecting a waterbody type, anglers decide which site to choose.

In this repeated nested framework, an individual angler's utility, U_{ipwj} (the well-being they receive from a fishing trip), is treated as a random variable composed of a deterministic component and a random component. The utility associated with a recreation trip to site j of waterbody type w after making participation decision p by angler i can be expressed as:

$$U_{ipwj} = V_{ipwj} + \varepsilon_{ipwj} \tag{1}$$

where V_{ipwj} is the deterministic part of the utility function and ε_{ipwj} represents the random terms, which are assumed to be jointly distributed according to the generalized extreme value (GEV) distribution.

For the models presented in this manuscript, V is a function of the following site characteristics (p and w omitted for brevity):

$$V_{ij} = \beta_{TC}\, TC_{ij} + \beta_2\, WD_{ij} + \beta_3 D_j + \textstyle\sum_n \alpha_{1n} UV_{ijn} + \sum_n \alpha_{2n} WB_{jn} + \sum_n \alpha_{3n} \sqrt{CR_{jn}} \tag{2}$$

where TC_{ij} is travel cost to site j by individual i, WD_{ij} is a dummy variable indicating close proximity between site j and individual i, D_j is an alternative specific constant for sites in the

Lower 6 miles site of the Passaic River.[6] UV_{ijn} are urban-related variables, WBV_{jn} are waterbody-related variables (excluding catch rates) for site j, and CR_{jn} are catch rates for species n (square roots are used in model estimation) at site j.

The probability of site choice can be expressed as a product of conditional probabilities.[7] The probability of making participation decision p choosing waterbody type w and site j is as follows (i is suppressed for the sake of notational simplicity):

$$Prob_{pwj} = Prob_{j|wp} \text{ x } Prob_{w|p} \text{ x } Prob_p \tag{3}$$

The first probability is the probability of choosing site j conditional on making participation decision p and choosing waterbody type w and is expressed as the following:

$$Prob_{j|wp} = \frac{\exp(V_j)}{\sum_j \exp(V_j)} \tag{4}$$

The second probability in equation (3) is the probability of choosing waterbody type w conditional on making participation decision p and is expressed as the following:

$$Prob_{w|p} = \frac{\exp(\gamma_w I_{pw} + \lambda_w Z_w)}{\sum_w \exp(\gamma_w I_{pw} + \lambda_w Z_w)} \tag{5}$$

where

$$I_{pw} = \ln[\Sigma_j \exp(V_j)] \tag{6}$$

The third probability in equation (3) is the probability of making participation decision p, that is, whether to go fishing or not:

$$Prob_p = \frac{\exp(\theta_p Q_p + \lambda_p Z_p)}{\sum_p \exp(\theta_p Q_p + \lambda_p Z_p)} \tag{7}$$

where

$$Q_p = ln[\Sigma_w \exp(\gamma_w I_{pw} + \lambda_w Z_w)] \tag{8}$$

Predicted changes in site visitation under the baseline-risk conditions are calculated as

$$\Delta Trips_j = (lnD_1 - ln\, D_0) \tag{9}$$

where

[6] The lower six miles of the Passaic River is an area that has reported annual angling population and trip estimates from a year-long, on-site creel/angler survey. See Kinnell et al. (2007) and Ray et al. (2007a, 2007b) for a complete description of the study and results.

[7] The nested logit model employed here is a non-normalized version as presented in Greene (2008). The normalized version would not converge. Hensher and Greene (2002) compare these alternative specifications.

$$D = \sum_p \left[\sum_w \sum_j \exp\left(\frac{V_j}{\gamma_w}\right)^{\frac{\gamma_w}{\theta_p}} \right]^{\theta_p} \quad \textbf{(10)}$$

and

D_1 is angling demand at site j under baseline-risk conditions.
D_0 is angling demand at site j under current-risk conditions.

3.1 Revealed Preference Model with a Dichotomous Advisory Variable

The model described above was estimated with data collected by the 2000 New Jersey Outdoor Recreation Survey (NJORS). The purpose of the 2000 NJORS was to collect information on actual fishing trips (RP data) by New Jersey anglers residing in Bergen, Essex, Hudson, Passaic, and Union Counties (Five County Area). The sampling frame for the survey included a random-digit dial (RDD) sample of licensed and unlicensed anglers and a licensed angler sample.

This survey consisted of telephone recruit and trip diary components. The telephone recruit component was used to enlist Five County Area anglers' participation in keeping a two-month (June and July) fishing trip diary. In addition, the telephone recruit component collected expected monthly angling effort. This information was used to scale the June and July diary trips to annual trips. The telephone recruit also collected demographic data from all individuals, both anglers and non-anglers.

In total, 940 anglers participated in the telephone recruit. Nearly 40 percent took trips in June or July 2000 and provided trip-level data in the mail survey. The mail portion of the survey collected information on the screened participants' June and July 2000 outdoor recreation trips. Of the screened anglers, 295 provided data on 1,331 trips to 236 sites throughout New Jersey. The mail surveys collected trip data on angling trips, including the location visited (i.e., park name, boat launch name, waterbody name), distance traveled, and duration of the trip.

The RUM estimation depends primarily on the site characteristics of the available fishing site choices. Thus, in addition to the trip data collected from the survey, the models are based on specific site characteristic data for the 236 sites visited by the surveyed anglers. Fishing sites are composed of several characteristics that include the distance from the angler's residence, the species and number of fish caught, and the presence of fish consumption advisories, which are posted along fishing access points on the affected waterbodies and are available on the Internet (New Jersey Department of Environmental Protection [NJDEP] 2000). By distilling information about all the fishing sites that anglers visit for all trips, the RUM identifies the relative importance of different site characteristics in anglers' site choices.

The number of fish caught is a site-specific characteristic that affects the probability of an angler visiting a specific site. In practice, specifying expected catch by species for each site/angler combination can be quite challenging. Morey and Waldman (1998) investigated the issue of catch-rate specification and noted that using the averages of a site's observed catch rates as proxies of expected catch rates would bias downward the estimated parameters on catch rates. Morey and Waldman suggested a simultaneous estimation approach to handle the measurement error. However, Train, McFadden, and Johnson (2000) noted that the simultaneous estimation approach does no better than the standard estimation procedure in that the standard procedure is consistent whenever the simultaneous estimation approach is consistent. Based on this observation, we adopt the standard estimation approach, using the average of a site's observed catch rates to proxy expected catch rates. Following the example of Haab, Whitehead, and McConnell (2000), we use the square root of the average catch rate to represent expected catch.

A variety of state, county, and municipal recreation guides; Internet sources; and government reports provided the site-characteristics data for the analysis. Table 1 lists information that was collected and used for the RUM. The variables in Table 1 are included in the RUM because they influence fishing site-choice selection (Jakus et al. 1997; Haab, Whitehead, and McConnell 2000; MacNair and Desvousges 2007). Some variables are expected to have a negative influence, meaning that sites with these characteristics (or a greater magnitude of these characteristics) are less attractive to anglers when all other factors are held constant. Other variables are expected to have a positive influence on site-choice selection, meaning that anglers are more likely to select sites with these characteristics (or with higher levels of these characteristics).

The first variable in Table 1, Travel Cost, accounts for the cost an angler incurs for round-trip travel to a particular site. It includes both an out-of-pocket cost of travel, as well as a component for the opportunity cost of time. To estimate travel costs for each angler to each site, the distance and time traveled for a one-way trip from an angler's home to a particular site is calculated using the shortest route method in PC*Miler, a transportation routing software (ALK Technologies 2010). This software calculates the distance on roadways of the shortest reasonable route between two points. The distance value is doubled to reflect a round trip and then multiplied by US$0.128 per mile, AAA's 2000 operating costs, which include gas, maintenance, and tires.

Table 1
Characteristics of Five County Area Anglers and New Jersey Fishing Sites in 2000
Variables in RP Repeated Nested Logit

Variable	Description	Mean	SD
Travel cost	Cost of a round trip in dollars to a site from the angler's home	27.65	20.33
Proximity	Equal to 1 if PC*Miler shortest distance < 0.5 miles from angler's home, 0 otherwise	0.0017	—
Urban variables			
USEPA facilities (ln)	Natural logarithm of the number of USEPA-regulated facilities within 2 miles of the center of the municipality nearest the fishing site	3.91	1.51
Crime difference	Difference in annual crime between site and angler's hometown. The crime data are from the FBI's 1997 statistics on the number of violent crimes per thousand people in each town.	-1.02	5.37
Population density (ln)	Natural logarithm of the population within 2 miles of the center of the municipality nearest the fishing site	6.67	1. 47
Waterbody variables			
Boat ramp	Equal to 1 if the waterbody has a boat ramp, 0 otherwise	0.07	—
Advisory	Equal to 1 if the waterbody has a Do Not Eat Fish consumption advisory on at least 1 species, 0 otherwise	0.03	—
Trout and shad (sqrt)	Square root of the average of trout and shad caught at each site	0.57	0.81
Panfish (sqrt)	Square root of the average of panfish (yellow perch and crappie) caught at each site	0.61	1.04
Freshwater game (sqrt)	Square root of the average of freshwater game (smallmouth bass, largemouth bass, freshwater striped bass, walleye, and pickerel) caught at each site	0.94	1.28
Other freshwater (sqrt)	Square root of the average of other freshwater game (carp, catfish, other freshwater, and unknown freshwater) caught at each site	0.90	1.24
Other saltwater (sqrt)	Square root of the average of other saltwater game (other saltwater, unknown saltwater, and American eel) caught at each site	0.16	0.61
Saltwater small game (sqrt)	Square root of the average of saltwater small game (bluefish, saltwater striped bass, weakfish, and black sea bass) caught at each site	0.32	0.90
Flatfish (sqrt)	Square root of the average of flatfish (fluke) caught at each site	0.25	0.65
Demographic variables			
Age (ln)	Natural logarithm of the angler's age	3.98	0.24
Boat ownership	Equal to 1 if the angler owns a boat, 0 otherwise	0.44	—
Income ($10,000s)	Angler's income in ten thousands of dollars	5.80	4.15
Fishing license	Equal to 1 if the angler owns a fishing license, 0 otherwise	0.89	—
Non-white	Equal to 1 if the angler is non-white, 0 otherwise	0.09	—

To account for opportunity cost, the shortest time traveled for a one-way trip from an angler's home to a particular site is calculated in PC*Miler. The time traveled value is doubled to reflect a round trip and then multiplied by one-third of the individual angler's wage rate (Cesario 1976).[8] Using a fraction of the wage rate, such as one-third, commonly represents the opportunity cost of time to account for travel being less arduous than work; however, the percentage of the wage rate to be used remains a controversial issue in the literature. MacNair and Desvousges (2007) provide comparisons for welfare estimates using different percentages. The Travel Cost variable represents the implicit price (i.e., opportunity cost of time and travel distance cost) of taking a fishing trip to each available site and is expected to be negative.

The model also includes a dummy variable to indicate whether or not a site is within 0.5 miles of an individual's home. This decision is based on our hypothesis that for very close sites, travel cost can be negligible if anglers can simply walk to the fishing site. Therefore, travel cost affects the site-choice decision process differently than cases where anglers drive to sites. This variable is also included because one goal of the study is to link the preference function estimated from the RUM with on-site survey data collected for the LPRSA's 59 unique fishing sites (Kinnell and Bingham 2014). Nearly all of these sites are within 0.5 miles of a residential area, and this variable can improve the site-specific visitation estimates to each of the LPRSA sites and improve the calibration of results from this population-based study with the on-site survey studies (Law 2011; Kinnell et al., 2007; Ray et al., 2007a; Ray et al., 2007b).

The urban variables included in Table 1 were identified from external sources for all visited sites. The urban variables describe characteristics of the municipality nearest to each waterbody. These variables capture urban attributes associated with that waterbody. The USEPA Facilities site characteristic is based on the listing of regulated facilities on the USEPA website, which indicates the number of USEPA-regulated facilities within a two-mile radius of the municipality associated with each site (USEPA 2000). The USEPA Facilities variable gives an indication of the level of industrialization near each site. The number of USEPA-regulated facilities is expected to have a negative influence on site-choice selection because these facilities affect the aesthetics around the site. In the RUM estimation, we use the natural log of the number of USEPA-regulated facilities anticipating that as the number of nearby facilities increases, the marginal disutility of their presence decreases.

The Crime Difference variable represents the difference between crime in the municipality where the fishing site is located and crime in the angler's hometown. Because

[8] The individual's wage rate is calculated by dividing the individual's reported income by 2,080 hours, the annual number of hours associated with a 40-hour work week.

some fishing sites are located in highly urban areas, this variable is expected to be negative as people are expected to be less likely to visit areas with a higher crime rate than their hometown.

The Population Density variable, derived from U.S. Census data, reflects the number of people living within two miles of the center of the municipality nearest the fishing site. While the Population Density specifically accounts for the number of people living in the area, we include it as a proxy for other factors that potentially influence recreation, but are difficult to measure, such as heavy traffic and potential congestion. In urban locations, such as the Five County Area, destinations that are only a few miles away may be difficult to reach because of heavy traffic, but may be within walking distance. Urban locations also have the potential to be more heavily congested than sites in less populated areas, but may be easier to reach. Because of all the potential confounding factors associated with population density, we do not have any *a priori* expectations of the sign on this variable.

The waterbody variables include typical site characteristics, such as the presence of a boat ramp and a fish consumption advisory. The Boat Ramp variable is an indicator that reflects whether or not the site has available access for boats. The variable is equal to "1" if the site contains one or more boat ramps. All boat ramps are regarded the same in this variable regardless of type (unpaved or paved) or quality. Boat Ramp is expected to be positive because the presence of a ramp provides more fishing access for anglers.

The Advisory variable represents whether a Do Not Eat fish consumption advisory is present on at least one species at the site. This variable is expected to be negative because when other factors are held constant, anglers prefer to fish at sites where they can eat the fish they catch. Thus, a site with an advisory will be less attractive than a site without an advisory. However, this effect may be moderated by whether anglers plan to eat the fish they catch and by their practices concerning catch-and-release fishing. Information for modeling catch-and-release versus catch-and-keep angling is not directly available from the survey; therefore, the estimated parameter potentially represents a mixture of preferences.

The models include catch rates for different species groups that are proxies for what anglers expect to catch at each site. When selecting a fishing site, anglers choose the site based on what they expect to catch during their trips, not on what they actually catch. These expectations are based on previous experiences, skill level, and potentially even the weather on the day of the fishing trip. In the 2000 New Jersey Outdoor Recreation Survey, anglers reported the total number of each species they caught on each trip to the site. Species caught include walleye, smallmouth bass, striped bass, bluefish, blue crab, black sea bass, weakfish, carp, catfish, American eel, and yellow perch. Because of the differences between crabbing and fishing trips, trips where anglers reported that they only caught crabs are not included in the model, nor is there a catch rate variable for crabs in either model. The models group these species into seven distinct groups, as can be seen in Table 1. Increases in the expected catch of each species are presumed to positively influence site selection.

A few demographic variables are included in the participation level of the models. Presumably, participation decisions are affected by anglers' demographic characteristics. The demographic variables are age, boat ownership, income, whether the angler has a fishing license, and ethnicity. We expect that anglers with a boat and/or a fishing license are more likely to participate in fishing. We have no *a priori* expectations on the effects of different demographic variables on the decision to participate in fishing or not.

3.2 Revealed Preference Model with an Advisory Index

To improve the advisory specification in this model, we developed an advisory index representing how much of an angler's catch cannot be consumed from trips to a specific site. The advisory index is created by combining information on angler's catch with the advisory at the site following the advisory index approach described in MacNair and Desvousges (2007).[9] The following five steps are used to create the advisory index:

1. Create an average site-specific catch rate for the sites visited by all anglers who visited the site.
2. Calculate the average percentage that each species makes of the total catch across all trips to an individual site (e.g., average trout caught at site divided by the average number of species caught at the site).
3. Create the percentage of species that the anglers cannot consume (e.g., Do Not Eat advisory on striped bass means that 100 percent of the angler's catch is not consumable). If the advisory is Do Not Eat More Than Once per Week, the percentage that is not consumable is 1-(52/365).
4. Calculate the percentage of each species that has an advisory (i.e., multiply the percentage of catch by species by the site's percentage of catch that is not consumable by species).
5. Sum the percentage of catch that is not consumable over all species.

The advisory index ranges from 0 to 1:

- 0 represents the case where the individual either does not eat fish or can eat all the fish caught from the site

[9] MacNair and Desvousges (2007) included results from both RP and SP data in creating their advisory index. Because the survey presented in Bingham et al. (2011) collected only RP data, the advisory index presented in this section is based only on RP data.

- 1 represents the case where the individual cannot eat any of the fish she catches from the site.[10]

Table 2 provides summary statistics for the advisory index. The percentages reflect all choice occasions. The first row in Table 2 shows the distribution of the advisory index across all sites. As the table shows, 40 percent of choice occasions have a value of 0—the angler can eat all catch from that site. Almost 6 percent of choice occasions have a value of 0.5, meaning that the angler can eat half of the catch from that site, and almost 3 percent of choice occasions have a value of 1, meaning that the angler can eat no fish from that trip.

The table also presents the advisory index for individual sites. As the table shows, all of the trips to the Lower Passaic River Study Area (LPRSA) have an advisory index of 1: all caught fish have a Do Not Eat advisory. The last row of the table shows that all of the trips to Lake Hopatcong, which did not have an advisory at the time of the study, have a value of 0, meaning that none of the catch had an advisory. The other sites listed provide other relevant examples of the variation in the advisory index.

[10] The advisory index is created with higher values representing lower amounts of consumable catch so that the index is an economic bad and the expected sign of the coefficient is negative.

Table 2
Advisory Index for Selected Sites

Site	Advisory Description	Number of Trips	Number of Anglers	Advisory Index										
				0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
All Sites		1,331	295	39.8%	10.6%	13.6%	8.9%	5.5%	5.5%	4.7%	2.5%	0.8%	5.5%	2.5%
LPRSA	Do not eat all species	12	7											100.0%
Newark Bay	Do not eat striped bass or blue crab; Do not eat American eel, bluefish (over 6 lbs.), white perch, or white catfish more than once per week	3	2											100.0%
Hackensack River	Do not eat striped bass or blue crab; Do not eat American eel, bluefish (over 6 lbs.), white perch or white catfish more than once per week	2	2	50.0%										50.0%
Passaic River Upstream of Dundee Dam	Do not eat largemouth bass or pickerel more than once per week	11	7	100.0%										
Clinton Reservoir	Do not eat largemouth bass or pickerel more than once per week	15	10					100.0%						
Ramapo River	Do not eat largemouth bass or pickerel more than once per week	52	25	100.0%										
Lake Hopatcong	No advisory	46	25	100.0%										

3.3 Revealed and Stated Preference Model with Dichotomous Advisory Variables

MacNair and Desvousges (2007) include results from both RP and SP data in creating their advisory index. Because the survey presented in Bingham et al. (2011) collected only RP data, the 2013 New Jersey Outdoor Recreation Survey (NJORS) was developed and administered to accomplish the following:

- Collect data to improve the specification of the advisory variable presented in Bingham et al. (2011) and the advisory index developed following the approach in MacNair and Desvousges (2007).
- Collect data on how anglers might change their trip-taking and consumption behavior under baseline risk conditions.

The 2013 NJORS contained a Stated Preference, Discrete Choice Experiment that introduced more variation on the different levels of advisories while accounting for variations in other relevant site characteristics, such as crime, water quality, distance to the site, and catch rates. Using the information from the 2013 NJORS, we revised the advisory specifications to better reflect the amount of variation (by species and severity) in advisory levels at the sites anglers reported visiting during the 2000 NJORS. Specifically, we created advisory variables addressing all of the advisory categories. This improved specification of the advisory variable allows more precise distinction of the Do Not Eat All Species—the LPRSA advisory—from the Do Not Eat Some Species that exists in Newark Bay. Improved specification also allows better differentiation of trips under baseline-risk conditions because it allows simulating the removal of the Do Not Eat All Species advisories arising from the site-specific LPRSA advisory to the less stringent, limited consumption advisories.

3.3.1 Survey Description

The 2013 NJORS study area included all residents located in the ZIP Codes of the cities bordering the following waterbodies:

- Passaic River from its confluence with Newark Bay to the Great Falls in Paterson
- Newark Bay enclosed by the confluences with the Passaic River, Hackensack River, Arthur Kill, and Kill Van Kull
- The Hackensack River from its confluence with Newark Bay to Oradell Dam
- ZIP Codes in all cities between the Hackensack River up to Oradell Dam and the Passaic River up to Paterson.

The survey was administered as a mixed-mode, mail-internet survey. The mail survey was administered to a Stratified Sampled Area: all the residents in the ZIP Codes of the cities that border the Passaic River from its confluence with Newark Bay up to the Great Falls in Paterson. This Stratified Sampled Area includes more than 910,000 residents. The mail surveys were split in half between two forms of recruitment: questionnaire booklet and internet administration. The recruitment for each follows Dillman, Smyth, and Christian's (2009) survey administration process for maximizing respondent participation.

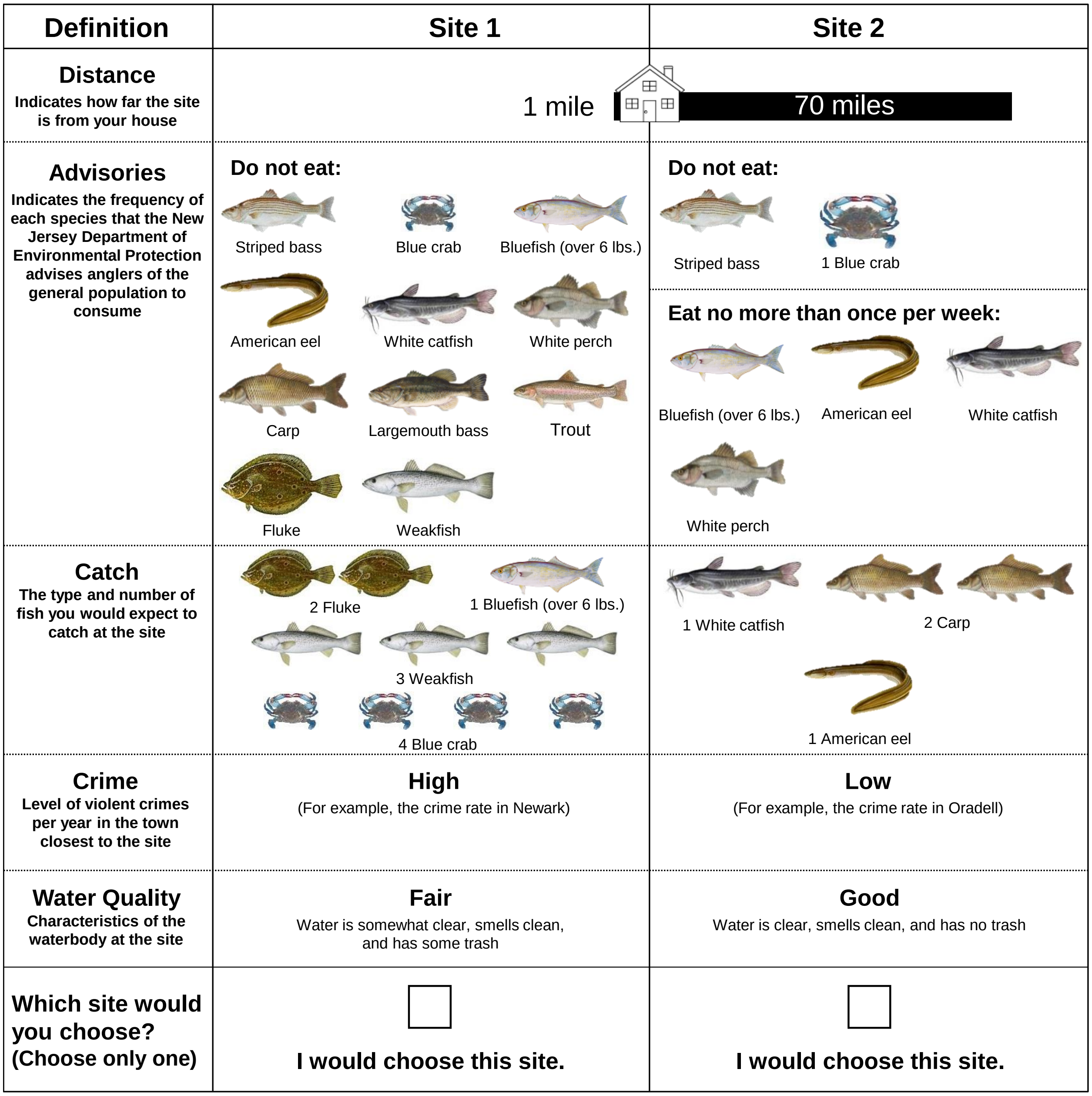
The internet-panel component was administered to residents in the Survey Study Area population. The internet-panel administration recruited anglers from two different groups:

- Harris Interactive's list of pre-identified, pre-screened anglers[11]
- Harris Interactive's panel of the general population.

Demographics (e.g., age, gender, race, education, and income) and fish consumption (i.e., do they eat fish from restaurants or fish caught by friends or family) were collected from both anglers and non-anglers.

As part of the survey, anglers were asked to evaluate eight paired comparisons. Each paired comparison listed two fishing sites, which included different levels of the following attributes: distance, advisories, expected catch, crime, and water quality. The results from the respondents' choice selection for each paired comparison were used to estimate a choice model. Figure 2 presents one of the paired comparisons that the respondents evaluated. In this comparison, a respondent must decide whether he or she will travel 1 mile to a site with a Do Not Eat All Species advisory, high crime, and fair water quality, where he or she would expect to catch two fluke, one bluefish, three weakfish, and four blue crab; or travel to a site 70 miles away with a Do Not Eat Some Species advisory, low crime, and good water quality, where he or she would expect to catch one white catfish, two carp, and one American eel.

[11] Harris Interactive is a survey administration company that maintains a panel for administering internet-based surveys. Veritas used Harris to administer the on-line portion of the mixed-mode survey design.



Definition	Site 1	Site 2
Distance Indicates how far the site is from your house	1 mile	70 miles
Advisories Indicates the frequency of each species that the New Jersey Department of Environmental Protection advises anglers of the general population to consume	**Do not eat:** Striped bass, Blue crab, Bluefish (over 6 lbs.), American eel, White catfish, White perch, Carp, Largemouth bass, Trout, Fluke, Weakfish	**Do not eat:** Striped bass, 1 Blue crab **Eat no more than once per week:** Bluefish (over 6 lbs.), American eel, White catfish, White perch
Catch The type and number of fish you would expect to catch at the site	2 Fluke 1 Bluefish (over 6 lbs.) 3 Weakfish 4 Blue crab	1 White catfish 2 Carp 1 American eel
Crime Level of violent crimes per year in the town closest to the site	**High** (For example, the crime rate in Newark)	**Low** (For example, the crime rate in Oradell)
Water Quality Characteristics of the waterbody at the site	**Fair** Water is somewhat clear, smells clean, and has some trash	**Good** Water is clear, smells clean, and has no trash
Which site would you choose? (Choose only one)	☐ **I would choose this site.**	☐ **I would choose this site.**

Figure 2: Paired Comparison from 2013 NJORS

In addition to evaluating the paired comparisons, respondents provided their current trip-taking and consumption behavior to the LPRSA and to the Passaic River above Dundee Dam. Respondents also provided their awareness of the current LPRSA advisory and were asked if they would change their trip-taking and consumption behavior. Anglers who said they would change their trip-taking or consumption behavior then estimated the additional number of annual trips they would take to the LPRSA and/or the additional number of each species they would consume on an average trip. These data were used to develop baseline trips and consumption by Angler Type.

The survey included paired comparisons created through an experimental design program. The first draft was pretested at a central location. The pretests refined the survey questionnaires, forms, and protocols to maximize the efficiency and accuracy of the data collection, minimize respondent and interviewer burden, and maximize angler participation. The pretests involved central location, one-on-one, verbal-protocol interviews.

Using results from the pretest, the paired comparisons were modified and included questions about current and baseline trip-taking and consumption behavior. The revised survey instrument was piloted to a sample of Harris Interactive's panel. The pilot included eight paired comparisons and questions regarding current and baseline trips to the LPRSA and consumption behavior. The pilot was administered to 200 respondents using Harris Interactive's panel list of pre-screened anglers and general population. The results from the pilot were incorporated into the Advisory Index variable. The pilot data were analyzed to ensure that the econometric model estimated a significant advisory index variable. Following this preliminary analysis, an additional level was added to the water quality and site crime attributes.

3.3.2 Experimental Design

To collect the choice data to improve the advisory specification in Bingham et al. (2011), analysts compose attributes and levels into site profiles. These site profiles are then placed into choice sets and presented to the respondents. Analysts' ability to identify interactions (i.e., inter-related effects of varying attributes and levels) depends upon the sample size and experimental design. To maximize efficiency in the estimation of model parameters, the profiles and choice sets are composed into the discrete choice survey using the principles of experimental design, a subspecialty of statistical science.

Experimental designs are developed to maximize the statistical significance of econometrically estimated parameters given study constraints (e.g., budget and sample size). For traditional experimental designs, this is done by creating orthogonal (i.e., uncorrelated) treatments. These orthogonal treatments allow identifying effects independently.[12] The concept of orthogonality is typically used in experimental designs for choice experiments. However, in many cases it is impossible to employ a true orthogonal design because of the number of completely-interacted alternatives. In this case, a typical approach is to develop a "nearly

[12]The earliest designs were agricultural: for example, a design space of attributes for the amount of fertilizer and water to be applied—each with levels high(H) and low(L) would have an orthogonal design of (HH, HL, LH, LL).

orthogonal" design. These nearly orthogonal designs can have much of the efficiency of orthogonal designs, but require far fewer profiles.

Such a nearly orthogonal overall design (sometimes called "D-efficient") must be composed into choice sets to support estimating utility functions. As a result, the traditional approach constitutes only one aspect of design efficiency. Additional criteria include level balance, utility balance, and low overlap. The level balance criterion seeks to ensure that levels of an attribute are not dramatically over or under-represented. The utility balance criteria recognize that the answer to a challenging choice provides much more statistical information than the answer to an easy choice does.

Our experimental design resulted in 24 sets of site profiles (eight paired comparisons for three blocks of respondents). Each paired comparison included various levels of these attributes:

- Distance of the site from the respondent's home
- The advisories for the site by species
- Average expected catch at the site.

This initial set of paired comparisons was used in the pretest. Following the pretest, the experimental design was revised to include two additional attributes: water quality and crime at the site. Following the pilot, the experimental design was revised one additional time to include three levels of water quality and crime at the site, rather than the two levels for each attribute in the pilot. This third group of paired comparisons was used during the final survey administration. Table 3 presents the final list of attributes and levels for the 2013 NJORS full administration.

Table 3
Attributes and Levels for the 2013 NJORS

Attribute	Description	Level
Distance	Indicates how far the site is from the angler's home	1 mile
		17 miles
		51 miles
		70 miles
		92 miles
Advisories	Indicates the frequency of each species that the New Jersey Department of Environmental Protection advises anglers of the general population to consume	Do Not Eat All Species
		Do Not Eat: striped bass and blue crab; Eat no more than once per week: bluefish, American eel, white catfish, and white perch
		Eat no more than once per week: striped bass, bluefish, and American eel
		Eat no more than once per week: striped bass, blue crab, bluefish, American eel, white catfish, and white perch
		Eat no more than once per week: American eel, bass, and pickerel
Catch	The type and number of fish you would expect to catch at the site	1 trout, 1 crappie, 1 smallmouth bass, 1 largemouth bass,1 chain pickerel
		1 trout, 1 yellow perch, 1 crappie
		1 trout, 1 largemouth bass, 1 American eel
		2 fluke, 1 black sea bass, 1 bluefish
		2 fluke, 1 bluefish, 3 weakfish, 4 blue crab
		1 striped bass, 1 bluefish, 10 blue crab
		1 catfish, 2 carp, 1 American eel
		2 fluke, 1 bluefish, 1 blue crab
Crime	Level of violent crimes per year in the town closest to the site	Low (for example, crime in Oradell)
		Average (for example, crime in Garfield)
		High (for example, crime in Newark)
Water Quality	Characteristics of the waterbody at the site	Good (water is clear, smells clean, and has no trash)
		Fair (water is somewhat clear, smells clean, and has some trash)
		Poor (water is murky, smells bad, and has trash)

3.3.3 Survey Administration Results

The full administration of the internet and mail component of the survey was administered following the revision of the experimental design from the preliminary results using the pilot data. Table 4 presents the results of the administration.

Table 4
Results of the 2013 NJORS

Category	Description/Result
Study Population for the 2013 New Jersey Outdoor Recreation Survey	Anglers residing in each of the following: • Towns directly adjacent to the LPRSA • Towns directly adjacent to the Passaic River north of Dundee Dam (Clifton and Garfield) to the Great Falls in Paterson • Towns adjacent to Newark Bay enclosed by the confluences with the Passaic River, Hackensack River, Arthur Kill, and Kill Van Kull • Towns adjacent to the Hackensack River from its confluence with Newark Bay to Oradell Dam • All towns between the Hackensack River up to Oradell Dam and the Passaic River up to Paterson.
Population residing in the Study Area	1,697,213
Number of ZIP Codes in the Study Area	90
Number of Respondents Completing the Survey	2,067
Number of Anglers	1,035 (50%)
Number of Anglers who fish in the Passaic River	305 (15%)
Number of Anglers that fish in the Lower Passaic River Study Area	242 (12%)
Number of LPRSA Anglers that Consume Self-Caught fish from the LPRSA	147 (7%)

The Study Area included all the residents located in the ZIP Codes of the towns that border the following waterbodies:

1. Towns directly adjacent to the LPRSA
2. Towns directly adjacent to the Passaic River north of Dundee Dam (Clifton and Garfield) to the Great Falls in Paterson
3. Towns adjacent to Newark Bay enclosed by the confluences with the Passaic River, Hackensack River, Arthur Kill, and Kill Van Kull
4. Towns adjacent to the Hackensack River from its confluence with Newark Bay to Oradell Dam
5. All towns between the Hackensack River up to Oradell Dam and the Passaic River up to Paterson.

This Study Area has 90 ZIP Codes with almost 1.7 million residents. As Table 4 summarizes, there were 2,067 respondents, including both anglers and non-anglers. Half of the respondents are anglers. Of these 1,035 anglers, 305 stated that they fish in the Passaic River: 242 of the 305 Passaic River anglers fish in the LPRSA. Seven percent of all respondents fish in the LPRSA and consume self-caught fish from the LPRSA.

Table 5 lists the additional variables used in the RP and SP model. Site crime and water quality are specific to the municipality where the site is located. Site crime reflects the crime in the municipality where the site is located. This attribute in the SP data uses three site crime levels from the RP data. The high crime level uses the crime value in Newark; average crime level uses crime value in Garfield; and low crime level uses the crime value in Oradell.

Water quality reflects the characteristics of the waterbody at the site (e.g., appearance, smell, and presence of trash). This variable is a proxy for EPA facilities in the RP data. The levels of water quality in the SP data use three values from the natural log of EPA facilities from the RP data. Good water quality receives a value of 0; fair water quality is assigned the mean of the EPA facilities values in the RP data; the poor water quality is assigned the maximum of the EPA facilities value in the RP data. The joint RP/SP model does not include population or boat ramp because the paired comparisons in the 2013 NJORS did not include these site characteristics.

The joint RP/SP model uses six different dichotomous advisory variables that vary in severity (Do Not Eat verses Eat no more than once per week) and species. There are two different Do Not Eat advisories: Do Not Eat All Species and Do Not Eat Some Species. The LPRSA counterfactual is a Limited Advisory (Eat No More Than Once per Week) on American eel, bass, and pickerel. The limited salt advisory is an Eat No More Than Once per Week advisory on American eel, bluefish, and striped bass. The limited tidal advisory is an Eat No More Than Once per Week advisory on striped bass, blue crab, bluefish (over 6 lbs), American eel, white catfish, and white perch. Lastly, the limited fresh advisory is an Eat No More Than Once per Week on American eel, bass, or pickerel. The difference between the LPRSA Counterfactual advisory and the Limited Fresh advisory is that the LPRSA Counterfactual advisory has an Eat No More Than Once per Week advisory on American eel, bass, *and* pickerel, rather than a limited advisory on American eel, bass, *or* pickerel.

Table 5
Description of Additional Model Variables

Variable Name	Description	Mean	SD
Urban Variables			
Site Crime	The crime at the site (based on 1997 FBI statistics on the number of violent crimes per thousand people)	1.31	4.71
USEPA facilities (ln) (Water Quality in SP Data)	Natural logarithm of the number of USEPA-regulated facilities within 2 miles of the center of the municipality nearest the fishing site	3.90	1.55
Waterbody variables			
Do Not Eat Advisory—All Species	1 if site has a Do Not Eat advisory on all species	0.02	—
Do Not Eat Advisory—Some Species	1 if site has a Do Not Eat advisory on some species	0.02	—
LPRSA Counterfactual	1 if site has an Eat No More Than Once per Week advisory on American eel, bass, and pickerel	0.72	—
Limited Advisory—Salt	1 if site has an Eat No More Than Once per Week advisory on American eel, bluefish, and striped bass	0.11	—
Limited Advisory—Tidal	1 if site has an Eat No More Than Once per Week advisory on striped bass, blue crab, bluefish (over 6lbs), American eel, white catfish, and white perch	0.06	—
Limited Advisory—Fresh	1 if site has an Eat No More Than Once per Week advisory on American eel, bass, or pickerel	0.06	—

4. Results

Table 6 presents the results of the following four models:

- Model 1: Conditional logit—revealed preference data (the 2000 NJORS) using the advisory variable presented in Bingham et al. (2011).
- Model 2: Repeated nested logit—revealed preference data (2000 NJORS) using the advisory variable presented in Bingham et al. (2011).
- Model 3: Mixed logit—revealed preference data (2000 NJORS) using the advisory index created following the approach described in MacNair and Desvousges (2007)
- Model 4: Mixed logit—joint revealed preference (2000 NJORS) and stated preference (2013 NJORS) using six dichotomous advisory variables.

Table 6 presents the coefficient and t-statistic in parentheses for the variables included in each model. The first column of Table 6 presents each of the variables included in each of the various models. A general review of the coefficients across the four models shows that the model variables are statistically significant and have the expected signs. The travel cost and EPA facilities variables are negative and highly significant in all four models. Similarly, the crime variable (whether crime difference or site crime) is negative and significant at the 0.01 level, except in Model 1, where crime difference is significant at the 0.05 level. When all other variables are held constant, anglers prefer to fish or crab at sites that are close to home with fewer USEPA-regulated facilities (better water quality) and low crime.

All catch variables in Model 1 and Model 2 are positive and significant at the 0.01 level. In Model 3, the Panfish and Flatfish variables are significant at the 0.05 levels, while the Trout/Shad catch rate is insignificant. All catch variables except for Flatfish are positive and highly significant in Model 4.

The coefficients on the advisory variable specifications yield notable results. The advisory variable is negative and significant at the 0.05 level under Model 1; however, under the repeated nested logit specification (Model 2), the coefficient is insignificant. Model 3 presents the results of the advisory index speciation, which is of the correct sign and statistically significant. Model 4 integrates the RP data presented in Bingham et al. (2011) with the SP data collected during the 2013 NJORS (Model 4). As the results show, the inclusion of the SP data allows for specification improvements. The first improvement is that the inclusion of the SP data produces statistically significant coefficients on every advisory level (i.e., each Do Not Eat and all the limited advisories).

Table 6
Summary of Model Results

Variables	Model 1 Conditional Logit Advisory variable from Bingham et al. (2011)	Model 2 Nested Logit Advisory variable from Bingham et al. (2011)	Model 3 Mixed Logit of RP Data from Bingham et al. (2011) Advisory Index	Model 4 Mixed Logit of Joint RP Data from Bingham et al. (2011) and SP Data from 2013 NJORS 6 Advisory Variables
Travel Cost	-0.04 (-13.43)***	-0.04 (-11.22)***	-0.07 (-16.25)***	-0.02 (-15.31)***
Advisory	-0.60 (-2.16)**	-0.25 (-1.33)	—	—
Advisory Index	—	—	-0.59 (-2.58)***	—
Do Not Eat Advisory—All Species	—	—	—	-1.30(-6.23)***
Do Not Eat Advisory—Some Species	—	—	—	-0.94 (-4.55)***
LPRSA Counterfactual	—	—	—	-0.35 (-2.75)***
Limited Advisory—Salt	—	—	—	-0.38 (-1.94)**
Limited Advisory—Tidal	—	—	—	-0.36 (-1.88)*
Limited Advisory—Fresh	—	—	—	-0.52 (-4.44)***
Proximity	3.66 (19.85)***	3.65 (19.21)***	—	—
EPA facilities	-0.50 (-10.34)***	-0.40 (-7.93)***	-0.66 (-12.81)***	-0.29 (-22.48)***
Crime difference	-0.03 (-2.21)**	-0.05 (-3.37)***	—	—
Site Crime	—	—	-0.07 (-4.20)***	-0.03(-15.21)***
Population	0.27 (4.50)***	0.19 (2.93)***	0.30 (4.56)***	—
Boat Ramp	1.34 (17.12)***	1.39 (17.62)***	1.33 (10.63)***	—
Trout/shad	0.25 (5.98)***	0.30 (6.99)***	0.03 (0.38)	0.18 (3.75)***
Panfish	0.10 (2.97)***	0.13 (3.79)***	0.09 (2.09)**	0.23 (8.84)***
Freshwater game fish	0.16 (7.68)***	0.16 (8.22)***	0.15 (6.84)***	0.16 (10.41)***
Freshwater other	0.12 (3.95)***	0.12 (4.03)***	0.10 (3.38)***	0.26 (11.33)***
Saltwater other	0.31 (7.66)***	0.32 (7.36)***	0.29 (6.64)***	0.23 (7.04)***
Saltwater game fish	0.28 (5.53)***	0.21 (3.74)***	0.28 (3.94)***	0.46 (11.07)***
Flatfish	0.54 (7.08)***	0.75 (8.15)***	0.29 (2.56)**	-0.01 (-0.12)
Log likelihood at convergence	-6293.5	-8286.1	-5633.3	-9083.2

T-statistic presented in parentheses.
*Significant at the 0.10 level
** Significant at the 0.05 level
***Significant at the 0.01 level

The second improvement is that the relative magnitude of each coefficient decreases as the intensity of the advisory decreases. F or example, the Do Not Eat All Species advisory has the largest negative coefficient, followed by the Do Not Eat Some Species advisory and then the limited advisories. This result indicates that the model is matching our expectation of angler behavior: the more stringent the advisory, all else held constant, the less likely the model will be to predict that an angler will take a trip to that site.

The third improvement is that the model produces statistically significant coefficients on the two policy variables directly informing the evaluation of changes in anglers' simulated trip-taking behaviors between current-risk conditions (the Do Not Eat All Species advisory) and baseline-risk conditions (the LPRSA Counterfactual advisory) for the LPRSA. The results from this model provide the angler preference function necessary to develop the simulations of changes in angler behavior and consumption presented in Kinnell and Bingham (2014).

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