Chapter A15: Habitat Based Methodology for Estimating Non-Use Values

INTRODUCTION

Aquatic species without any direct uses account for the majority of losses at cooling water intake structures (CWIS). Therefore, non-use value is an important component of value to consider.

This chapter describes a methodology for estimating non-use values for lost aquatic organisms using a benefit transfer of habitat values. EPA explored this approach to estimating non-use values for three case study regions: the North Atlantic, Mid-Atlantic, and Great Lakes regions. However, because of limitations and uncertainties regarding the application of this methodology to the national level discussed in section A15-4, EPA elected not to include benefits based on this approach in the benefit-cost analysis of the final section 316(b) rule.

One way to consider impingement and entrainment (I&E) losses is to value the habitat necessary to replace the lost organisms. The value of fish habitat can provide an indirect basis for valuing the fish that are supported by the habitat. For example, existing wetland valuation studies found that members of the general public are aware of the fish production services provided by eelgrass (submerged aquatic vegetation, SAV) and wetlands, and that they express support for steps that include increasing SAV and wetland areas to restore reduced fish and shellfish populations (Opaluch et al., 1995, 1998; Mazzotta, 1996).

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The method described here first estimates the quantity of different habitats required to replace fish and shellfish lost to I&E, and then assesses respondents' values for these habitats. These data are then combined to yield an estimate of household values for improvements in fish and shellfish habitat, which provides an indirect estimate of the benefits of reducing or eliminating I&E.

This benefit transfer approach involves four general steps:

1. Estimate the amount of restored habitat needed to produce organisms at a level necessary to offset I&E losses for the subset of species for which potential production information is available.

2. Develop willingness-to-pay (WTP) values for fish production services of habitat ecosystems.

3. Estimate the total value of baseline I&E losses by multiplying the WTP values for fish and shellfish services of restored habitat by the number of acres of each habitat type needed to offset I&E losses.

4. Estimate the total benefits of the final section 316(b) rule, in terms of the value of decreased I&E losses, by multiplying the WTP values for fish and shellfish services of restored habitat by the number of acres of each habitat type needed to offset decreased I&E losses.

The rest of this chapter outlines the methodology.

A15-1 Estimating the Amount of Habitat Needed to Offset Losses for Specific Species

The first step in the analysis involves calculating the area of habitat needed to offset I&E losses for the subset of species for which restoration of these habitats was identified by local experts as the preferred restoration alternative, and for which production information is available (i.e., the habitat that will produce the equivalent quantity of fish impinged and entrained at CWIS). Habitats that support fish and shellfish include seagrasses, tidal wetlands, coral reefs, and estuarine soft-bottom sediments. The analysis may also consider man-made habitat enhancements, such as artificial reefs or fish passageways. The most suitable habitat restoration option was selected for each affected species. For a detailed description of this method, see Chapter F5 of the Brayton Point Case Study report presented at the time of proposal in the final section 316(b) Phase II Case Study Document (DCN 4-0003; U.S. EPA, 2002a).

Using a typical restoration scaling rule, the estimates of the acres of required SAV and wetlands restoration reflect the acreage needed for the species requiring the maximum quantity of habitat restoration to offset its I&E losses. For any given species, the number of acres of restored habitat needed to offset I&E losses is determined by dividing the species average annual age 1 equivalent I&E loss by its estimated abundance per acre in that habitat.[1]

While the acreage needed for the species requiring the maximum amount of habitat may overstate the acreage necessary for other species, local experts using abundance data on additional species that were identified as benefitting from tidal wetland restoration were unavailable to determine the acreage necessary to replace these other species. Because of this uncertainty in developing precise acreage estimates involving the large variation in species and required habitats on a national scale, EPA elected not to present benefits based on this method in the final rule analysis.[2]

A15-2 Development of WTP Values for Fish Production Services of Habitat

EPA's local case study analyses focused on wetlands and eelgrass habitats, as these are the habitats for which data were available. Therefore, the following sections provide examples of the available data and how it would be used in the application of this approach.

EPA points out that it has not attempted to transfer values per acre of habitat to directly value specific species and numbers of fish affected by I&E. Rather, the approach that EPA used is to 1) estimate the number of acres of habitat required to produced fish equivalent to those lost due to I&E; and 2) evaluate citizens' WTP for this *habitat*, not for the fish produced by the habitat. This method is consistent with the preferred methods that NOAA suggests be used for natural resource damage assessment (NRDA) under the Oil Pollution Act (OPA). NOAA's NRDA regulations focus on restoration of injured resources, rather than monetary compensation for damages. In the case of lost interim values pending restoration, additional habitat may be provided, in lieu of money compensation. NOAA refers to this as "compensatory restoration" (DARP, 1997, pp. 2-7 - 2-8).

EPA calculated the amount of "service-to-service" compensatory restoration — in the form of restored acres of wetlands and eelgrass — required to offset losses, and then evaluated WTP for restoring these acres. Whereas NOAA would recommend actually restoring such acreage to provide compensation to the public, EPA is not suggesting that the restoration actually be carried out (thus requiring industry to pay the *costs* of restoring these acres). EPA is instead looking at the *benefits*, in the form of fish, that would be provided by these restored acres.

[1] Note that specific restoration locations were not identified for this analysis. As noted above, the restoration concept is used for developing useful information regarding people's WTP for fish production services of restored habitat.

[2] While this is the primary source of uncertainty, additional sources of uncertainty are discussed in section A15-4.

For each habitat type, EPA used available fish sampling data for the habitats of interest to determine the number of acres required to offset I&E losses. The sources of these data are noted in the individual case study chapters. To estimate public values for fish and shellfish habitat for the North Atlantic and Mid-Atlantic case studies, EPA considered using values from a study of public values for wetlands and eelgrass in the Peconic Estuary, located on the East End of Long Island, New York (Johnston et al., 2001a, 2001b; Opaluch et al., 1995, 1998; Mazzotta, 1996). To estimate public values for habitat for the Great Lakes region, EPA considered using values from a study of the Maumee River Basin, located in the northwestern corner of Ohio near Lake Erie (de Zoysa, 1995). For all three case studies, EPA used additional information from a stated preference study from Narragansett Bay, Rhode Island (Johnston et al., 2002) to estimate the portion of habitat value attributable to fish habitat services of wetlands. These studies are described in detail in the following sections.

A15-2.1 Description of the Peconic Estuary Study

EPA selected the Peconic Estuary study for two reasons:

1. The study elicited the public's total WTP values for coastal wetlands and eelgrass, using the contingent choice method. Wetland and eelgrass habitats are essential for supporting fish and shellfish species. These habitats were frequently identified by an expert panel as the preferred habitats for restoration in order to increase production of species with I&E losses. The survey described eelgrass to respondents as "fish and shellfish habitat" but did not specifically describe wetlands' services.

2. Both eelgrass and wetlands located in the Peconic Estuary support aquatic species that are found in the North and Mid-Atlantic regions and that are likely to be affected by I&E (e.g., bay anchovy, Atlantic silverside, scup, summer flounder, winter flounder, windowpane flounder, weakfish, tautog, bay scallops, and hard clams).[3,4] The Peconic Estuary study thus provides values for eelgrass and wetlands that may be representative of habitat needed to produce many of the species affected by I&E in the North Atlantic and Mid-Atlantic regions.

The Peconic study used an original contingent choice survey to estimate the relative preferences of residents and second homeowners in the study area for preserving and restoring key natural and environmental resources.[5] The study area is the East End of Long Island, New York, which includes the five towns surrounding the Peconic Estuary: Southold, Riverhead, Southampton, East Hampton, and Shelter Island. The primary goal of the survey was to learn about the public's preferences, priorities, and values for the environmental and natural resources of the Peconic Estuary that might be affected by preservation and restoration actions.

The contingent choice survey format asks respondents to choose between bundles of public commodities, which differ across their physical, environmental, aesthetic, and/or monetary dimensions. For example, respondents might compare two environmental policy proposals, each with a different impact on coastal resources and a different monetary cost. By analyzing the choices that respondents make among a variety of potential policies (i.e., their preferences), it is possible to estimate respondents' relative values for environmental commodities (or policy results), and their willingness to trade off elements of policy packages (Cameron, 1988; Hanemann, 1984).

The extensive process to develop the survey over a six-month period, from February to August 1995, included individual interviews, focus groups, and pretests of preliminary versions of the survey. Based on concerns expressed by participants in focus groups, and natural resources identified as important by the Technical Advisory Committee, the survey addressed five natural resources: (1) farmland, (2) undeveloped land, (3) wetlands, (4) shell fishing areas, and (5) eelgrass. The survey objective was to determine respondents' values for improvements in natural resources above a specified baseline level. The baseline is that level that would exist in the year 2020 if no action occurred to preserve or restore the resource. The baseline

[3] Further detail on fish abundance in SAV in the North Atlantic and Mid-Atlantic regions can be found in Wyda et al. (2002), "The response of fishes to submerged aquatic vegetation complexity in two ecoregions of the Mid-Atlantic Bight: Buzzards Bay and Chesapeake Bay."

[4] See Peconic Estuary Program CCMP, Chapter 4, www.savethepeconicbays.org/ccmp (Peconic Estuary Program, 2001) for details.

[5] The values presented here understate total benefits because they do not include values for visitors to the Peconic region, values for other individuals outside the region who may value the resources of this region, producer surplus values to commercial users of the resources, and values to users of the resources in other regions who may benefit from species that are migratory.

was determined in consultation with the Technical Advisory Committee, based on historical declines and the judgment of experts, for each resource.

In the contingent choice questions, each resource was included at three different levels: the projected level for 2020 (the "no new action," or baseline, scenario), and two levels associated with hypothetical programs that would preserve or restore the resource. Eelgrass was presented at the current level of 9,000 acres; the baseline or "no action" level of 8,000 acres; and a high level, with restoration, of 11,000 acres. Wetlands were presented at the current level of 16,000 acres; the baseline or "no action" level of 12,000 acres; and a high level, with restoration, of 17,500 acres.

Each survey question asked respondents to compare the "No New Action" baseline levels of two of the resources to two hypothetical programs to protect or restore these resources.[6] Respondents were asked to select their preferred option, given the program costs. Figure A15-1 shows an example question. A total of 60 different questions were developed, using Addelman's fractional factorial design, to produce orthogonal arrays of attributes (Addelman 1962a, 1962b).[7] Each booklet contained five contingent choice questions.

Respondents completed a total of 968 surveys and answered 4,307 contingent choice questions. The distribution of surveys in various locations within the study area ensured response collection from a wide cross-section of the public.[8] The data were analyzed using a conditional logit model. Based on standard economic consumer theory, the analysis assumed that respondents choose the option that maximizes utility received from attributes of the option, subject to their budget constraint. In this study, the options are described in terms of a set of natural resources and the cost of the option. Based on the model coefficients, relative values for the different resources and dollar values for protecting an additional acre of each resource can be calculated as described by Hanemann (1984). The estimated values are marginal values, or WTP, for an additional acre of each resource.

The study found that the survey sample population was better educated and had higher incomes than the area population. Thus, the estimated values were adjusted to be representative of the general population of the East End in terms of education and income. These adjustments were made to the model coefficients prior to estimating welfare values. The study used separate adjustments for those who live in the area year-round (about 2/3 of the sample) and those who are seasonal area residents.

The original study presented estimates of several statistical models. For the analysis presented below, EPA used the most conservative model, in terms of estimated values, to calculate the per household WTP values per acre of eelgrass and wetlands. This model includes alternative-specific constants, which capture differences between taking action and choosing the "no action" alternative, as well as any unexplained differences between programs A and B.

Table A15-1 presents the Peconic model valuation results for eelgrass and wetlands. To separate users' values from non-users' values for purposes of this analysis, EPA re-estimated the Peconic model with separate coefficients for users and non-users of fishery resources. The Agency defined users as those who stated that they either fish or shellfish. These individuals have both non-use and indirect use values from the fish habitat services of eelgrass and wetlands. EPA estimated non-use values for those who do not fish or shellfish.[9] For eelgrass, the value for non-users is 77.7 percent of the total value for users, and 82.4 percent of the total value estimated for both users and non-users; while for wetlands, the value for non-users is 94.4 percent of the total value for users, and 95.8 percent of the total value for both users and non-users.

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[6] In order to avoid choice questions that are excessively complex, each question included only two of the five resources, plus the cost to each household. The survey instructions led respondents to assume that the three resources not included in each question would not be affected by the program being evaluated, and would thus be at the baseline levels.

[7] The orthogonal design selected did not allow for estimation of interactions among the resources. Such a design would have required a much larger sample size, which was not possible given the project budget limitations.

[8] In order to obtain a wide cross-section of the public, surveys were conducted at over 37 locations around the East End. Four hundred fifty-one surveys were collected at various grocery stores and shopping areas; 248 at public libraries and post offices; 82 surveys at beaches; and 187 at other locations, including the Department of Motor Vehicles, the ferry from New London to Long Island, an aquarium, and a vineyard.

[9] Note that this is not strictly true for wetlands, because other services exist that allow for use values such as birdwatching. The value of wetlands is adjusted to reflect fish production services only in the section on wetlands in section A15-2.4.

Figure A15-1: Example Survey Question from the Peconic Survey

4. If you had to choose one of the 3 options below, which would you choose?

Circle Program A, Program B, or No New Action below.
(Do not compare these to programs on any other page.)

Projected Results for 2020:

No New Action	Program A	Program B
		
25% of wetlands will be **lost or degraded.** About 12,000 unharmed acres will remain.	**Current** wetlands will be preserved at 16,000 acres.	Wetlands will **increase** by 10%, to about 17,500 acres.
		
Eelgrass (fish and shellfish habitat) will **decrease** by 10%, to about 8,000 acres.	Eelgrass (fish and shellfish habitat) will **increase** by 25%, to about 11,000 acres.	Eelgrass (fish and shellfish habitat) will **decrease** by 10%, to about 8,000 acres.
$0 per year	$50 per year	$50 per year
No new cost to each East End household.	Cost to each East End household: $50 per year.	Cost to each East End household: $50 per year.

[15]

Table A15-1: Estimated WTP Values from the Peconic Study (2002$)[10]

	Wetlands[a]		Eelgrass (SAV)	
	$/HH/Acre/Year[b]	**Non-Use Value %**	**$/HH/Acre/Year[b]**	**Non-Use Value %**
All residents	$0.056	95.80%	$0.063	82.40%
Users	$0.057	94.40%	$0.067	77.70%
Non-users[c]	$0.054	100.0%	$0.052	100.0%

[a] Note that wetlands values presented here are WTP for all wetland services, not just fish habitat services. The adjustment for fish habitat values appears below.
[b] Values shown are WTP per household per *additional* (i.e., marginal) acre per year.
[c] Non-users are defined as respondents who neither fish nor shellfish.

The Peconic survey described eelgrass specifically as fish and shellfish habitat. EPA is not aware of other direct uses of eelgrass. Based on focus groups during survey development and pretesting, the Peconic authors concluded that participants were aware of eelgrass and its importance for fish and shellfish production. Thus, EPA assigned all of the estimated WTP for SAV restoration to fish and shellfish production services. Based on these same focus groups and pretests, the authors also concluded that individuals were aware of and valued a number of functions of wetlands, including fish and other wildlife habitat, storm buffering, and aesthetics. Because coastal wetlands provide several services (e.g., habitat, water quality, storm buffering, and aesthetics), EPA assigned only a portion of the estimated WTP for wetlands restoration to fish habitat services.

The survey data available from the Peconic study, however, provide no direct means to estimate the share of total wetland value from fish habitat services alone. Wetland values presented in Table A15-1 reflect all ecological services provided by the wetlands, not just fish habitat services. EPA therefore used a stated preference study from Narragansett Bay, Rhode Island, to adjust wetland values. This study was designed to assess tradeoffs among different services of restored salt water wetlands (Johnston et al., 2002). The results from this study allow estimation of the share of salt water wetland restoration values associated with various services, including fish habitat services. EPA estimated the value of salt water wetlands associated with fish habitat services alone by multiplying this share by the total values in Table A15-1.

A15-2.2 Description of the Maumee River Basin Study

EPA selected the Maumee River Basin study for two reasons:

1. Wetlands located in the Maumee River Basin support aquatic species that are found in Lake Erie and that are likely to be affected by I&E (e.g., yellow perch, gizzard shad, various species of shiner, white bass, carp, sunfish, and fresh water drum). The Maumee River Basin study thus provides values for wetlands that may be representative of habitat needed to produce many of the species affected by I&E in the Great Lakes.

2. The study solicited the public's total WTP for wetlands, a necessary input for EPA's habitat-based analysis.

The Maumee River Basin study used an original contingent valuation mail survey to estimate WTP for residents in the study area for protecting groundwater quality, improving surface water quality, and protecting and restoring wetlands.[11] The study area included 15 counties in northwestern Ohio in the Maumee River Basin area. Residents from those counties were divided into two groups: residents in zip codes with primarily rural populations, and residents in zip codes with primarily urban populations. The study also included residents from Columbus and Cleveland who did not live in the Maumee River Basin but who might visit. The primary goal of the survey was to analyze the welfare effects of different farm management strategies in the Maumee River Basin area.

[10] EPA made dollar value adjustments using the Consumer Price Index for all urban consumers for the first half of 2002.

[11] The values presented here understate total benefits because they do not include values for all visitors to the Maumee River Basin region, values for all other individuals outside of the region who may value the resources of this region, producer surplus values to commercial users of the resources, and values to users of the resources in other regions who may benefit from species that are migratory.

The study used the contingent valuation method. There were seven versions of the survey questionnaire, each of which described a different resource conservation program involving groundwater, surface water, wetlands, or some combination thereof. The wetlands program description indicated that the proposed program would restore and protect 3,000 acres of wetlands from a baseline of 10,000 existing acres that are declining. The program description also pointed out that those wetlands provide habitat for water fowl, other birds, and endangered species; provide nursery habitat for fish; and play a role in water purification. Respondents were then presented with a referendum style question that asked if they would be willing to pay a certain price for the program. This question was followed by an open-ended solicitation of maximum WTP for the program. WTP amounts were for a one-time payment.

Out of 1,050 questionnaires mailed to randomly selected households in the study area, 118 were undeliverable, and 476 were returned. Of those returned, 10 were judged incomplete, making the overall response rate 50 percent. The data were analyzed using a probit model based on a log-normal distribution for responses to the WTP question. The model estimates median and lower bound mean WTP for each of the programs.

Although the study includes socioeconomic variables in the model, it does not attempt to account for differences between the survey respondents and the target population. Respondents had a mean household income of $49,537 (2002$); 47 percent were male; and 32 percent had a college degree.

The original study presented WTP value estimates under several different sets of assumptions. For the analysis presented below, EPA used the most conservative estimate to calculate the per household WTP values per acre of wetlands. This model assumed that protest responses meant a no vote, and estimated WTP as a lower bound mean. Also, to be conservative, EPA included WTP values only from the residents of the Maumee River Basin and excluded WTP values from Columbus and Cleveland respondents.

Table A15-2 presents the valuation results for wetlands for rural and urban Maumee respondents. Since the study provided total household WTP for an increase of 3,000 acres of wetlands, EPA divided WTP per household by 3,000 to calculate WTP per marginal acre of wetland per household.

Table A15-2: Estimated WTP Values for Wetlands from the Maumee River Basin Study (2002$)[12, a]

Population	$/HH/Acre/Year[b]
Rural Maumee residents	$0.0254
Urban Maumee residents	$0.0248
All Maumee residents[c]	$0.0249

[a] Note that wetlands values presented here are WTP for all wetland services, not just fish habitat services. The adjustment for fish habitat values appears below.
[b] Values shown are WTP per household per *additional* (i.e, marginal) acre per year.
[c] EPA calculated the value for all Maumee residents by taking a population weighted average of the rural and urban WTP estimates.

The Maumee River Basin survey described wetlands as providing a number of ecological services. Because the survey data from the Maumee River Basin do not provide the information needed to estimate the share of total wetland value from fish habitat services alone, EPA used a stated preference study from Narragansett Bay, Rhode Island, to adjust wetland values. This study was designed to assess tradeoffs among different services of restored salt water wetlands (Johnston et al., 2002). The results from this study allow estimation of the share of salt water wetland restoration values associated with various services, including fish habitat services. Although the Maumee River Basin study evaluated fresh water wetlands, the services provided by both types of wetlands are similar (fish nursery habitat, water purification, bird habitat). Because of these similarities, EPA believes that the Narragansett Bay study can be applied to the values from the Maumee River Basin. EPA estimated the value of salt water wetlands associated with fish habitat services alone by multiplying this share by the total values in Table A15-2.

[12] EPA made dollar value adjustments using the Consumer Price Index for all urban consumers.

A15-2.3 Description of the Narragansett Bay Wetland Restoration Study

The survey instrument, *Rhode Island Salt Marsh Restoration: 2001 Survey of Rhode Island Residents*, was designed to assess tradeoffs among attributes of salt marsh restoration plans. Survey development required more than 16 months and involved extensive background research, interviews with experts in salt marsh ecology and restoration, and over 16 focus groups with more than 100 Rhode Island residents. Numerous pretests, including verbal protocol analysis (Schkade and Payne, 1994), ensured that the survey language and format would be easily understood by respondents, and that respondents would have a common understanding of survey scenarios (cf. Johnston et al., 1995).

Focus groups and pretests led to an in-person survey approach that combined a printed survey booklet with an eight-minute introductory video. This video introduced respondents to information about salt marshes and salt marsh restoration; reminded respondents of tradeoffs involved in salt marsh restoration; reminded respondents of their budget constraint and the implications of choosing to direct funds to restoration programs; emphasized the importance of respondents' choices; and provided basic survey instructions.

Johnston et al. (2002) chose attributes distinguishing restoration plans based on background research, expert interviews, and focus groups. The authors tailored these attributes to reflect primary salt marsh services in the northeast U.S. that would be influenced by restoration activities, and characterized each wetland by the size of the marsh, together with effects of restoration, on (1) habitat for birds, (2) habitat for fish, (3) habitat for shellfish, (4) potential to control mosquito nuisance, (5) recreational access, and (6) household cost.[13] Based on the results of focus groups and expert interviews, habitat and mosquito control services were presented from a standardized, statewide perspective. For example, improvements to fish habitat were characterized as "ecological improvements to RI fish populations…[resulting from a particular restoration project]…as judged by wetlands experts, compared to all other potential salt marsh restoration projects in Rhode Island."

Following the general approach of Johnston et al. (1999), the conjoint (or multi-attribute choice) survey presented respondents with four sets of discrete choices, each involving two alternative, multi-attribute restoration plans. The authors used fractional factorial design to construct a range of survey questions with an orthogonal array of attribute levels, resulting in 80 contingent choice questions divided among 20 unique booklets. Attributes distinguishing plans were selected based on background research, expert interviews, and focus groups. All attributes were free to vary over their full range for both restoration plans presented in each question, with no imposed ordering of attribute levels between the two plans. Based on these attributes, respondents chose one of the two plans, or chose "Neither Plan."

The survey was conducted from September through December 2001. Respondents were intercepted in person at Rhode Island Department of Motor Vehicle offices, public libraries, and other survey sites. Interviewers did not tell respondents that the survey concerned salt marsh restoration. Rather, interviewers asked respondents to participate in an important survey regarding "environmental issues in Rhode Island," to reduce the potential for topic-related nonresponse. In total, interviewers collected 661 completed surveys, providing complete and usable responses to 2,341 individual contingent choice questions (89 percent of the potential 2,644).

Table A15-3 presents variables incorporated in the analysis of salt marsh restoration choices. These variables include (1) a dummy variable identifying the "neither" option, (2) quadratic interactions between this dummy and certain demographic characteristics, and (3) variables for the restored salt marsh attributes. Mean values for salt marsh attributes (Table A15-3) indicate the mean values of these attributes over all completed surveys included in the analysis. The last column in the table calculates these mean values with "neither plan" data rows excluded. (As noted above, each wetland restoration choice included the option of choosing neither plan. In the multinomial logit data, these options are presented as a "plan" with zeros for all wetland attributes.)

[13] Additional, non-habitat services that may be provided by salt water wetlands include, among others, nutrient transformation, storm buffering, and coastal erosion control. Interviews with experts on salt water wetland functions in New England (and Rhode Island in particular) indicated, however, that wetland restoration would provide negligible impacts on these non-habitat functions in the majority of cases. They based this assessment on the small size of most New England coastal wetlands, and on the fact that restoration may not always increase substantially the ability of a wetland to provide such functions as storm buffering or erosion control. Based on this advice, the survey focused mainly on wetland habitat functions.

Table A15-3: Definitions and Summary Statistics for Model Variables for Narragansett Bay Wetland Restoration Study

Variable Name	Description	Whole Sample Mean (Std. Dev.)	Mean, Excluding "Neither Plan" Scenarios[a]
Neither	Neither=1 identifies "neither plan" options.	0.3333 (0.4714)	0.0000
Environ	Dummy variable identifying respondents with membership in environmental organizations.	0.1900 (0.3923)	0.1900
Taxgrp	Dummy variable identifying respondents with membership in taxpayer associations.	0.0233 (0.1510)	0.0233
Loincome	Dummy variable identifying respondents with household income less than $35,000/year.	0.2450 (0.4301)	0.2450
Hiedu	Dummy variable identifying respondents with greater than a four-year college degree.	0.1817 (0.3856)	0.1817
Birds	Ecological improvement to statewide bird populations resulting from specified salt marsh restoration plan, compared to all other potential salt marsh restoration plans in Rhode Island (0-10 scale).	2.7608 (2.6072)	4.1413
Fish	Ecological improvement to statewide fish populations resulting from specified salt marsh restoration plan, compared to all other potential salt marsh restoration plans in Rhode Island (0-10 scale).	2.9075 (2.6530)	4.3613
Shellfish	Ecological improvement to statewide shellfish populations resulting from specified salt marsh restoration plan, compared to all other potential salt marsh restoration plans in Rhode Island (0-10 scale).	2.9070 (2.6518)	4.3619
Mosquito	Increased ability to control statewide mosquito nuisance resulting from specified salt marsh restoration plan, compared to all other potential salt marsh restoration plans in Rhode Island (0-10 scale).	2.9077 (2.6506)	4.3617
Size	Size of restored salt marsh (minimum 3 acres; maximum 12 acres).	4.8890 (4.3965)	7.3335
Pro-access	Dummy variable indicating that respondent feels that access to salt marshes should be "somewhat limited" or "unlimited."	0.8367 (0.3697)	0.8367
Con-access	Dummy variable indicating that respondent feels that access to salt marshes should be "severely limited" or "prohibited."	0.2266 (0.4187)	0.1633
Platform	Dummy variable indicating that restoration provides "viewing platforms" but no "trails."	0.2215 (0.4153)	0.3400
Both	Dummy variable indicating that restoration provides both "viewing platforms" and "trails."	0.2215 (0.4153)	0.3323
Cost	Annual cost of restoration plan in increased taxes (minimum $0; maximum $200).	63.1694 (70.7816)	94.7542

[a] Each wetland restoration choice included the option of choosing neither plan. In the multinomial logit data, this option is presented as a "plan" with zeros for all wetland attributes. The last column in the table calculates means with the "neither plan" zeros excluded.

The signs of parameter estimates correspond with prior expectations derived from focus groups, where prior expectations exist (Table A15-4). Respondents favor plans that restore larger salt marshes; improve bird, fish, and shellfish habitat; control mosquitoes; provide public access; and result in lower costs to the household. Comparing preferences for habitat improvements and mosquito control (all measured on a 10-point scale), respondents placed the greatest weight on mosquito control, followed by habitat improvements for shellfish, fish, and birds, respectively. The likelihood of rejecting restoration outright (i.e., choosing neither plan) was smaller for members of environmental organizations, and larger for members of taxpayers organizations, lower income individuals, and more highly educated individuals (Johnston et al., 2002). Changes in education and income do not influence the marginal utility of fish and shellfish habitat, or that of other wetland attributes.

Table A15-4: Conditional Logit Results for Narragansett Bay Wetland Restoration Study

	Parameter Estimate	Std. Error	z	P>|z|
Neither	1.1568	0.1934	5.98	0.0001
Neither x Environ	-1.1820	0.2232	-5.30	0.0001
Neither x Tax	0.8676	0.3651	2.38	0.0170
Neither x Loincome	0.3104	0.1437	2.16	0.0310
Neither x Hiedu	0.4147	0.1686	2.46	0.0140
Birds	0.1191	0.0153	7.78	0.0001
Fish	**0.1465**	**0.0157**	**9.36**	**0.0001**
Shellfish	**0.1587**	**0.0162**	**9.78**	**0.0001**
Mosquito	0.1611	0.0162	9.95	0.0001
Size	0.0510	0.0098	5.22	0.0001
Pro-access x Platform	0.1678	0.0826	2.03	0.0420
Pro-access x Both	0.4310	0.0844	5.11	0.0001
Cost	-0.0072	0.0005	-14.23	0.0001
-2LnL χ^2	1157.56	Prob>χ^2	0.0001	

A15-2.4 Estimating the Portion of Wetlands Value Associated with Fish Habitat

Results of the conjoint analysis (i.e., the public survey results) presented by Johnston et al. (2002) allow policy makers to rank restoration projects based on their estimated influence on residents' welfare. These results also allow assessment of residents' willingness to trade off elements of wetland restoration plans, or WTP for particular wetland attributes. Finally, for any specified restoration plan, provided that incremental gains or losses in wetland services are known, it allows the calculation of the *proportion* of the total gain in social value attributable to a particular service (e.g., fish habitat).

To estimate the proportion of value associated with fish habitat, in a representative, conservative scenario, EPA began with the average wetland restoration scenario considered by the Rhode Island survey sample. The mean values of wetland attributes presented to survey respondents provide the most representative set of results from which value proportions may be estimated, and forecast the value proportions that would result from an average survey respondent confronted with an average wetland restoration scenario, as characterized by the Rhode Island Salt Marsh Restoration Survey data. Excluding all "Neither Plan" scenarios, which offered zero restoration, Table A15-3 summarizes the mean values for services considered by the Rhode Island sample.

Although mean values are used for most attributes (i.e., wetland attributes or services considered by survey respondents in choice scenarios), changes in certain attributes are set to zero to correspond more closely with the policy scenario and with the Peconic study (because the purpose of this analysis is to assess the proportion of the Peconic wetland values that may reasonably be attributed to fish habitat services). For example, because the Peconic study survey did not specify or discuss the provision of viewing platforms or trails at preserved wetlands, EPA assumed that survey respondents to the Peconic study did not consider such unusual provisions when making survey choices. Accordingly, in calculating value proportions in this analysis using the Rhode Island data, EPA assumed that viewing platforms and trails are not provided.

EPA also assumed that any wetland created or restored to provide fish habitat will likely not provide a great degree of additional mosquito control, because a large proportion of existing salt marshes have already been modified to minimize mosquito production.[14] For this reason, modern marsh restoration typically does not provide a significant increase in mosquito control. Rather, it often replaces older, more detrimental (to marsh function and habitat) forms of mosquito control

[14] The mosquito control variable was included in the survey in response to the strong concern of Rhode Island residents over the impact of restoration on mosquitoes and related illnesses for which mosquitoes are the primary vector. Wetlands experts indicated, however, that salt marsh restoration had limited impact on mosquito populations in most cases.

with Open Marsh Water Management (OMWM), in which open water and natural fish predation is used to control mosquito nuisance (Kennish, 2002). OMWM has not been an "unqualified success" at eliminating the mosquito nuisance (New York Conservationist, 1997). Accordingly, for many salt marshes, the positive net effect of restoration on mosquito nuisance, if any, is often minimal. To generate the most conservative estimates, however, and in recognition of the fact that some salt marsh restoration projects may provide significant mosquito control, EPA also estimated value proportions assuming that significant additional mosquito control is provided. For all other wetland attributes included in the Rhode Island survey, EPA used the mean values shown in the final column of Table A15-3.

Estimation of value proportions is based on the estimated utility function $v(\cdot)$, which specifies the utility provided by a wetland restoration plan as a function of the attributes or services provided by that plan (Johnston et al., 2002). That is, following the standard random utility model of Hanemann (1984), the underlying model specifies respondents' choices using the conditional logit specification, in which the probability (P_i) of choosing any wetland restoration plan *i* (plan A, plan B, or neither plan) over the two remaining options (*j* or *k*) is given by:

$$P_i = \frac{\exp[v_i(\cdot)]}{\exp[v_i(\cdot)] + \exp[v_j(\cdot)] + \exp[v_k(\cdot)]} \tag{A15-1}$$

where $v(\cdot)$ represents the relative benefits or utility resulting from each restoration option, including the "neither plan" option. The function $v(\cdot)$ is typically estimated as a simple function of program attributes (in this case wetland restoration); in practice linear, functional forms are often used (Johnston et al., 2002).

From the assumptions and model noted above, the attribute definitions given in Table A15-3, and the model results of Table A15-4, the estimated utility function used to calculate value proportions is specified as:

$$v(\cdot) = 0.1191(birds) + 0.1465(fish) + 0.1587(shellfish) + 0.1611(mosquito) + 0.0510(size) \tag{A15-2}$$

If mosquito control is *not* provided, then *mosquito*=0. Given this linear specification, the proportion of wetland restoration value provided by the gain in fish habitat services is given by:

$$\frac{v(\cdot)_{fish} - v(\cdot)_{fish\,=\,0}}{v(\cdot)_{fish}} \tag{A15-3}$$

where $v(\cdot)_{fish}$ represents the value of $v(\cdot)$ with the gain in fish habitat services set to its mean value (as described above), and $v(\cdot)_{fish=0}$ represents the value of the function with the gain in fish habitat services set to zero.

Table A15-5 shows the resulting value proportions, in which EPA calculated the proportion of wetland restoration value associated with different wetland services based on mean values of wetland attributes presented to survey respondents, as discussed above. Analogous methods were used to assess value proportions associated with shellfish and other habitat services; Table A15-5 shows these results for comparison. The table also illustrates the results of a sensitivity analysis in which EPA calculated analogous value proportions for wetland habitat services, but allowed wetland size to vary. Wetland size was allowed to vary from its minimum value in the Rhode Island survey data (3 acres) to its maximum value (12 acres), while holding habitat service changes constant. EPA chose these size values to be representative of unrestored salt water wetlands currently existing in Narragansett Bay, which are typically quite small (i.e., less than five acres). The three estimates of acreage are therefore likely closer to the "average" Rhode Island wetland than estimates based on larger acreages. [In actual wetlands, changes in restored acres are typically correlated with larger gains in habitat services (Johnston et al., 2002). To illustrate even more conservative estimates, however, Table A15-5 contains cases in which restored wetland size increases from the mean, without any resultant increase in habitat services.]

Table A15-5: Proportions of Restored Wetland Value Associated with Various Service Categories[a]

Restoration Scenario	Percentage of Value Associated with Service				
	Fish Habitat	Bird Habitat	Shellfish Habitat	Mosquito Control	Other[b]
1a: No additional mosquito control; mean values for all other attributes	**0.2906**	0.2244	0.3149	0.0000	0.1701
1b: No additional mosquito control; mean values for habitat gains; size=3 acres	**0.3231**	0.2494	0.3501	0.0000	0.0774
1c: No additional mosquito control; mean values for habitat gains; size=12 acres	**0.2622**	0.2024	0.2841	0.0000	0.2512
2a: Mosquito control at mean value; mean values for all other attributes	**0.2202**	0.1700	0.2386	0.2422	0.1289
2b: Mosquito control at mean value; mean values for habitat gains; size=3 acres	**0.2384**	0.1840	0.2583	0.2622	0.0571
2c: Mosquito control at mean value; mean values for habitat gains; size=12 acres	**0.2035**	0.1571	0.2205	0.2238	0.1950
3a: Mean over all scenarios	**0.2564**	0.1979	0.2778	0.1214	0.1466

[a] Results assume that restoration does not provide viewing platforms or hiking trails.
[b] Other services may include, among others, nutrient transformation, storm buffering, and coastal erosion control.

a. Results: Proportion of wetland restoration value attributable to fish habitat services

As shown by Table A15-5, the proportion of value associated with fish habitat ranges from 0.2035 to 0.3231, with a mean value over all scenarios of 0.2564. Scenario 1a is perhaps the most representative scenario for estimating value proportions for two reasons: (1) restored wetlands are not expected to provide additional mosquito control, and (2) other wetland attributes are set to their mean values. Its results are somewhat higher than those of scenario 3a, which represents the mean value over all scenarios presented. EPA therefore, to be conservative, used the proportion calculated in scenario 3a (0.2564) as an estimate of the proportion of total wetland restoration value attributable to gains in fish habitat services, given representative, mean values for other wetland services.

Although these numbers are not directly comparable to other results found in the literature, they appear to be reasonable and conservative compared to similar proportions generated for freshwater habitats. For example, Schulze et al. (1995) estimate that between 32.98 percent and 33.44 percent of WTP for resource cleanup in the Clark Fork River Basin was associated with "aquatic resources and riparian habitat" (p. 5-13).

EPA also considered directly the parametric results of Table A15-4 for further support of the soundness of the proposed value proportions. Estimates presented in Table A15-4 indicate that the parametric weights are similar among the dominant wetland services in Narragansett Bay (i.e., bird habitat services, fish habitat services, shellfish habitat services, and mosquito control). In other words, the parameter estimates are very similar among these four variables. This correspondence suggests that restoration providing similar scale improvements for each of these services should produce a roughly equivalent increment to utility. Given the four habitat services considered in the survey (including mosquito control), each service provides roughly one-fourth (or 25 percent) of the total marginal utility associated with the combination of habitat improvements and mosquito control. For wetlands that do not provide substantial access provisions (e.g., boardwalks) and that are of moderate or small size, it would be highly improbable for the proportion of value associated with fish habitat to fall significantly below the 25.64 percent approximation estimated here.

A15-3 Estimating the Value of Habitat Needed to Offset I&E Losses

A15-3.1 Determining the Affected Population

Evaluating the total value per acre of wetlands and SAV for the coastal population of each region requires a definition of the geographical extent of the affected population. The Peconic study defined the affected population as the total number of households in the towns bordering the Peconic Estuary. Similarly, the affected population can be defined as households residing in the counties that abut the waterbodies affected by CWIS. These households are likely to value gains of fish in the affected water body, due to their close proximity to the affected resource.

Households in counties that do not directly abut affected water bodies will also likely value the water body's resources. Analysis of data from the Rhode Island Salt Marsh Restoration Survey (Johnston et al., 2002) reveals that values ascribed to even relatively small-scale salt marsh restoration actions (i.e., 3-12 acres) were stated by respondents from various parts of the state. Thus, it is reasonable to assume in the context of the final section 316(b) analysis that residents within a similar distance from the affected water body as residents in the Johnston et al. (2002) study would have positive values for improving fish habitat. The Agency calculated the average distance from the Narragansett Bay's study locations to the farthest edges of Rhode Island, which totaled 32.43 miles.

EPA also reviewed additional studies to identify the effect of distance on WTP for public goods with large non-use values.

1. A study by Pate and Loomis (1997) found that respondents outside the political jurisdiction in which a study site is located were also willing to ascribe stated preference values to the amenity being studied. The study was designed to determine the effect of distance on WTP for public goods with large non-use values. Specifically, the study evaluated environmental programs designed to improve wetlands habitat and wildlife in the San Joaquin Valley. It compared WTP values for households residing in the San Joaquin Valley, California, to values for California households outside the Valley, and to households in Washington State, Oregon, and Nevada. The study found that WTP values for California residents outside the Valley were 97.7 percent of the WTP of the Valley residents, and WTP values for Oregon residents were approximately 27 percent of the WTP of the Valley residents. (The distances to these locations outside the Valley exceed the 32.43 mile radius used in the analysis for Mount Hope Bay.)

2. An NRDA study conducted by Schulze et al. (1995) examined the effect of distance on household WTP to clean up the Clark Fork River Basin in Montana, which had been polluted by hazardous waste from mining activities.[15] The study surveyed Montana residents and asked their WTP for partial and complete cleanup of the site, which would result in improvements to surface water, groundwater, soil, vegetation, and wildlife. More specifically, the partial cleanup program, for example, would improve water quality, but trout populations would remain below normal, and about one-fourth of the habitat lost for wildlife species would be restored. The authors examined the effect of distance on WTP by grouping respondents based on the distance between their residences and the resource site. Respondents residing between 101 and 200 miles from the Clark Fork River Basin were willing to pay 49.7 percent of what those respondents residing within 100 miles were willing to pay. The group of respondents residing more than 500 miles driving distance from the Clark Fork River Basin were willing to pay 18.5 percent of what those respondents within 100 miles were willing to pay.

A15-3.2 Estimating Aggregate Values

The final steps in the analysis are:

1. Multiply the value per acre per household by the total number of households affected.

2. Multiply the estimated number of acres of habitat needed to offset a subset of the I&E losses developed for specific species by the estimated per acre values of SAV and wetlands, to evaluate the benefits of I&E reduction. Another way of presenting these results is to calculate the implied per household WTP for households residing in the two different definitions of the study area.

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15 Schulze et al. prepared this NRDA for the State of Montana Natural Resource Damage Litigation Program.

A15-4 Limitations and Uncertainties

A number of issues are common to all benefit transfers. Benefit transfer involves adapting research conducted for another purpose in the available literature to address the policy questions at hand. Because benefits analysis of environmental regulations rarely affords enough time to develop original stated preference surveys that are specific to the policy effects, benefit transfer is often the only option to inform a policy decision. The following sections discuss specific issues associated with this benefit transfer approach.

A15-4.1 Estimating the Extent of the Affected Population

The extent of the affected population can have a large effect on total values for I&E losses. EPA considered two estimates of the affected human population. EPA believes that both of these estimates are conservative, and that it is likely, based on studies cited in the text above, that people living outside of these areas also would benefit from reduced I&E. This may contribute to an under estimation of non-use benefits.

A15-4.2 All Species and Losses are Not Compensated

As discussed above, there is uncertainty associated with estimating the number and type of habitat needed to compensate for all I&E losses for each large scale region. As a result, some species may be overcompensated, while others are under compensated, or not included at all. In addition, habitat restoration may provide additional benefits, beyond increases in populations of species affected by I&E.

A15-4.3 Use of Abundance Estimates to Estimate Production from SAV and Tidal Wetland Habitats

Ideally, there would be quantified species-specific estimates for the expected increase in age-1 production of fish species for various habitats that could be used in conjunction with the recommendations from a local expert panel identifying preferred categories of habitat restoration actions to pursue in order to scale the acreage estimates of required habitat restoration. Unfortunately, such production estimates were unavailable. Lacking this production information, this analysis assumes that the age-1 equivalent estimates of abundance of fish in SAV and tidal wetland habitats provides an accurate estimate of the age-1 equivalent production of fish that would be realized, on a per-acre basis, if additional acres of these habitats were to be restored. This assumption implies that when restored acres have reached their full potential, they will produce additional age-1 fish in the same mix of species and at the quantities observed in sampling of existing undisturbed habitats. While the relationship between measured abundance of a species in a given habitat is complex and unique for each species, this assumption was necessary given the limited amount of quantitative data on fish species habitat production that is currently available.

A15-4.4 Application of the Approach to Large Geographic Regions

Application of this method on a regional or national scale can be problematic because of both diversity of habitats and species, and diversity of public values across regions. For example, different habitats might be the limiting factor for a single species in different locations, and different species may be important in different locations. Similarly, people may value habitats and their services differently in diverse areas of the country. Therefore, application of this method to all regions to obtain national estimates might require additional regional studies to use for benefit transfer. The studies used by EPA in its exploratory analysis were deemed most appropriate for the North Atlantic and Mid-Atlantic regions, and the Great Lakes region, as the original studies were conducted in these regions and population demographics for the original study areas were found to be quite similar to population demographics for the policy areas.

Application of the Johnston et al. (2002) study to estimate the portion of wetlands value that is attributed to fish habitat might lead to an overestimation or an underestimation of WTP for fish habitat services of wetlands, when applied to other regions. Because the Johnston et al. study was conducted in Rhode Island, it is most appropriately transferred within southern New England and nearby areas of New York state, where both coastal populations (i.e., tastes) and coastal wetland conditions (i.e., ecology) are quite similar. Thus, EPA believes that the application of the Johnston et al. study, and therefore the value estimates, are most appropriate and accurate in southern New England.