RECREATIONAL FISHING DAMAGES FROM FISH CONSUMPTION ADVISORIES IN THE WATERS OF GREEN BAY

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FIGURES

TABLES

ACRONYMS

CATI	computer-assisted telephone interviewing
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CES	constant elasticity of substitution
FCAs	fish consumption advisories
FS	Feasibility Study
LL	linear logit
LMD	Lake Michigan District
MDNR	Michigan Department of Natural Resources
NRDA	Natural Resource Damage Assessment
PCBs	polychlorinated biphenyls
RI	Remedial Investigation
RP	revealed preference
RUM	random utility model
SARA	Superfund Amendment and Reauthorization Act
SP	stated preference
U.S. DOI	U.S. Department of the Interior
U.S. EPA	U.S. Environmental Protection Agency
WDNR	Wisconsin Department of Natural Resources
WTP	willingness to pay

CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

This report assesses compensable values of recreational fishing service flow losses to the public (referred to herein as recreational fishing damages) as a result of releases of polychlorinated biphenyls (PCBs) into the waters of Green Bay. This report was prepared as part of the Lower Fox River/Green Bay Natural Resource Damage Assessment (NRDA) in accordance with the regulations at 43 CFR §11.81-11.84, the “Assessment Plan: Lower Fox River/Green Bay NRDA” noticed at 61 FR 43,558 (August 12, 1996), and the “Lower Fox River/Green Bay NRDA: Initial Restoration and Compensation Determination Plan” (IRCDP) noticed at 63 FR 50,254 (September 21, 1998). As explained in Chapter 5 of the IRCDP, this report uses existing literature and data, as well as data from a new survey of recreational anglers, to identify and quantify impacts of the PCB contamination on recreational fishing through time.

This report computes total recreational fishing damages, including damages both for losses that have already been incurred and for losses that are projected to continue until the FCAs are lifted. The calculation of damages for losses that have already occurred will be incorporated by the U.S. Fish and Wildlife Service (Service) into its determination of the compensable values portion of the NRDA. The estimate of damages for projected future losses is based on remedial scenarios proposed in the draft remedial investigation/feasibility study (WDNR, 1999), and will be revised and incorporated into the Service’s compensable values determination after the U.S. Environmental Protection Agency (U.S. EPA) has issued a record of decision and the Trustees have selected a preferred restoration alternative.

Background

PCBs are hazardous substances that were released into the Lower Fox River of Wisconsin by local paper company facilities as part of the manufacturing, deinking, and repulping of carbonless copy paper that contained PCBs (Sullivan et al., 1983; WDNR, 1998a; Stratus Consulting, 1999b), primarily between the late 1950s and mid-1970s.[1] Through time, PCBs have been and continue to be redistributed into the sediments and natural resources of the Lower Fox River and the Bay of Green Bay. Through the food chain process, PCBs bioaccumulate in fish and wildlife. As a result of elevated PCB concentrations in fish, in 1976 the Wisconsin Department of Health

1. PCBs are a hazardous substance under 40 CFR § 301.4 pursuant to Section 102(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Section 311 of the Federal Water Pollution Control Act.

and Human Services first issued fish consumption advisories (FCAs) for sport-caught fish in the Wisconsin waters of Green Bay, and in 1977 Michigan first issued FCAs for the Michigan waters of Green Bay (Stratus Consulting, 1999a).

These FCAs for the waters of Green Bay continue today, although the specifics of the FCAs have varied through time and vary by location, fish species, and for some species by fish size (see Chapter 2 for an additional discussion). In 1999, sport-caught fish throughout the waters of Green Bay were subject to FCAs. Even with significant removal of PCB contaminated sediment in the Lower Fox River, FCAs are expected to continue for decades; and with no additional sediment removal, the FCAs may continue for 100 years or more (Velleux and Endicott, 1994; WDNR, 1997b). PCBs may also cause injury to fish populations, thereby reducing recreational fish catch (61 FR 43558; ThermoRetec Consulting, 1999b), but these injuries have not been quantified.

There is abundant literature demonstrating that the existence of FCAs cause recreational fishing service flow losses to anglers in that anglers change where and how often they fish, change what they fish for and what they keep, change how they prepare and cook the fish they catch, and experience reduced enjoyment of the fishing experience (see Chapter 2). The literature also demonstrates that the value of these service flow losses (damages) to anglers can be substantial. The potential significance of these losses in the waters of Green Bay is amplified because there are hundreds of thousands of recreational fishing days each year at the site (Chapter 2).

While there is ample literature to confirm that FCAs and any reduction in fish populations diminish the level of recreational fishing services provided by the resource, the literature does not provide site-specific and case-specific information that is sufficient for this assessment. Therefore, we conducted a new recreational fishing study specific to the site and the case.

Report Organization

The remainder of this introduction provides an overview of the recreational fishing study and summarizes key results from the report. Chapter 2 provides background data on the assessment area and FCAs at the assessment area, and illustrates literature that confirms that anglers respond to, and value, the impacts of FCAs and value changes in catch rates. Chapter 3 summarizes the data collection methods, including sampling methods and the survey instruments; and Chapter 4 provides a profile of the surveyed anglers. Chapter 5 provides the choice questions used to value changes in FCAs, Chapter 6 presents the economic model and estimation to value changes in FCAs, and Chapter 7 summarizes the model parameter estimates. Chapter 8 provides lower-bound 1998 damage estimates, and Chapter 9 includes sensitivity analyses to alternative model specifications. Chapter 10 provides total damage estimates and conclusions. The appendices provide detailed models and results, a copy of the survey materials, and supporting data tables.

1.2 SCOPE OF THE RECREATIONAL FISHING ASSESSMENT

Assessment Area

The assessment area for this determination of recreational fishing damages is the waters of Green Bay, which are located in northeastern Wisconsin and in the Upper Peninsula of Michigan (Figure 1-1). The waters of Green Bay include the Bay of Green Bay, all bays within Green Bay (e.g., Little and Big Bay de Noc, Sturgeon Bay), and all rivers feeding into Green Bay up to the first dam or obstruction, including the Lower Fox River from the Dam at De Pere to the Bay of Green Bay. The entire waters of Green Bay are included because PCBs, and fish and wildlife that uptake PCBs, are mobile within the waters of Green Bay and because there are PCB fish consumption advisories for the entirety of Green Bay, including its tributaries. Thus, the PCBs released into the Lower Fox River result in service losses, and therefore damages, throughout the waters of Green Bay. While PCBs from the Lower Fox River are transported to the waters, sediments, and natural resources of Lake Michigan, this assessment does not address any recreational fishing service flow losses from the release of PCBs into Lake Michigan outside of the waters of Green Bay.

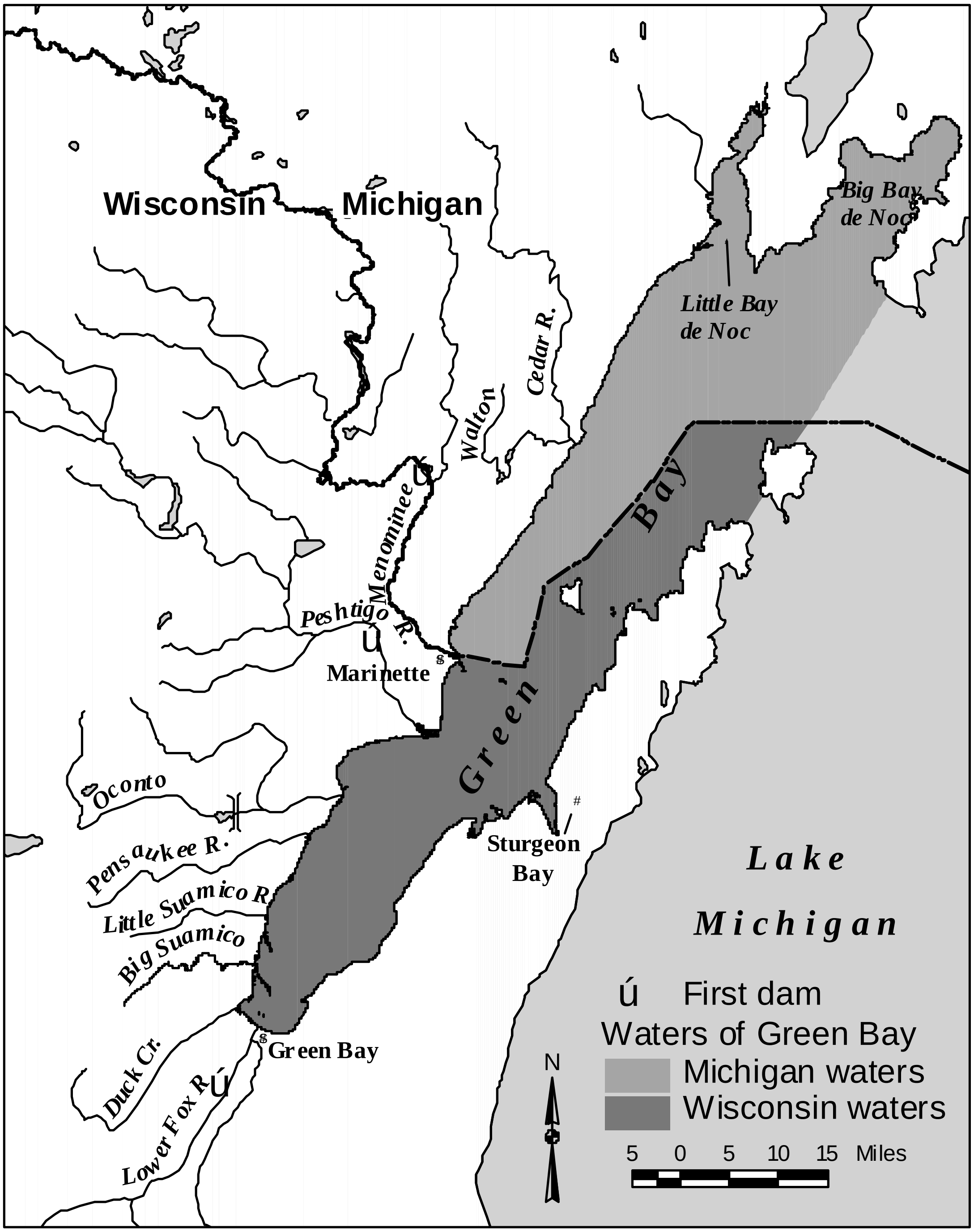
The waters of Green Bay are split into the Wisconsin waters of Green Bay and the Michigan waters of Green Bay (Figure 1-1). The dividing line on the western shore is the state line at the Menominee River, and on the eastern shore it is just above Rock Island.

Throughout this report several terms are used interchangeably to refer to activities in and natural resources and waters of Green Bay (e.g., waters of Green Bay, Green Bay fishery, Green Bay fishing). In the general discussions in Chapters 1, 2, and 10, these terms refer to all of the waters of Green Bay, unless specifically identified otherwise (e.g., Lower Fox River, the Bay of Green Bay, Michigan waters of Green Bay). Chapters 3 through 7, 9, and the appendices focus on assessing damages in the Wisconsin waters of Green Bay and, for presentation ease, refer to these waters without always identifying Wisconsin.

Types and Measures of Service Flow Losses

This report estimates the value of recreational service flow losses (e.g., damages) resulting from the imposition of FCAs in response to PCB contamination in the assessment area. While fish populations may be injured by PCBs, resulting in recreational fishing flow losses through reduced catch rates, these injuries have not been quantified and are not included in the valuation of recreational service losses. However, the damage assessment methods and results are designed to support the valuation of recreational fishing service flow losses from reduced catch rates if such injuries are quantified at a later date, and to compute the value of service flow benefits from increased catch rates if increasing catch rates is part of a restoration package.

Figure 1-1
Wisconsin and Michigan Waters of Green Bay



Recreational fishing service flow losses from FCAs can be classified into the following four categories:

1. ***Reduced enjoyment from current Green Bay fishing days.*** Anglers active at the assessment site may experience reduced enjoyment from their days at the site because of concerns about health safety and displeasure with catching contaminated fish. These concerns can result in changes in fishing locations within the waters of Green Bay, changes in target species type and size, and changes in behavior regarding keeping, preparing, and consuming fish.

2. ***Losses by Green Bay anglers from fishing at substitute sites.*** Because of FCAs, anglers who fish the waters of Green Bay may substitute some of their fishing days from the waters of Green Bay to other fishing sites that, in the absence of FCAs in the waters of Green Bay, would be less preferred sites.

3. ***Losses by Green Bay anglers who take fewer total fishing days.*** Because of FCAs, anglers who fish the waters of Green Bay may take fewer total fishing days than they would otherwise prefer. For example, an angler may still take the same number of days to other sites, but take fewer days to the waters of Green Bay to avoid the FCAs.

4. ***Losses by other anglers and nonanglers.*** Because of FCAs, some anglers may completely forego fishing the waters of Green Bay, in one year or many years. Other individuals who would fish the waters of Green Bay if it did not have FCAs may completely forego fishing.

The approach employed in this report measures the value of service losses within categories 1 and 2, but not for categories 3 and 4. As a result, the calculations understate recreational fishing damages. The magnitude of this omission is unknown, although results presented in Chapter 3 indicate that losses in category 4 are not inconsequential, as the total potential number of anglers who would be active in Green Bay fishing in the absence of FCAs may be as much as 30% larger than occurs with the current FCAs.

Consistent with the Department of Interior regulations for conducting NRDAs, this report measures the value of service flow losses through measuring recreational anglers' willingness to pay (WTP) for changes in FCA levels [43 CFR §11.83 (c)].

Time Period

Consistent with the CERCLA regulations, compensable damages are computed for interim services lost to the public resulting from PCB contamination from 1981, beginning with the 1981 fishing season after the enactment of the Superfund Amendment of Reauthorization Act (SARA) in late 1980, until the service flows are restored to baseline [43 CFR § 11.80 (b)]. For purposes of this determination, which concerns the value of losses to recreational anglers, the service flows are considered to be returned to baseline when there are no longer FCAs. We compute interim damages to include (1) damages for past service flow losses starting at January 1, 1981 through 1999, and (2) damages for future service flow losses beginning in 2000 until FCAs are removed. Future damages are computed under alternative remediation and restoration scenarios. Past damages are computed both from 1981 and 1976, when FCAs were first issued in response to PCB contamination.

1.3 THE DAMAGE ASSESSMENT APPROACH

This assessment is designed to measure damages accurately and cost-effectively using the approach summarized below.

A Mix of Primary Data Collection and Benefits Transfer

The assessment focuses on primary data collection and analysis to estimate open-water recreational fishing damages for a target population of anglers who purchase Wisconsin fishing licenses in eight Wisconsin counties near Green Bay and who are active in Green Bay fishing. Data collection focuses on the Wisconsin waters of Green Bay because PCB loadings and the resultant FCAs are more severe for the Wisconsin waters of Green Bay than for the Michigan waters of Green Bay, and because the recreational fishing activity in the Wisconsin waters of Green Bay is much larger than in the Michigan waters of Green Bay (Chapter 2). Therefore, recreational fishing losses are expected to be greater in the Wisconsin waters of Green Bay than in the Michigan waters of Green Bay. We focus on a target population of anglers who purchase licenses in eight counties near the Bay of Green Bay because these anglers account for the vast majority of anglers and fishing days in the Wisconsin waters of Green Bay (see below and Chapter 2). Data collection focuses on open-water fishing (e.g., non-ice fishing) because it accounts for almost 90% of all fishing on the waters of Green Bay.

Based on the damages per open-water fishing day in the Wisconsin waters of Green Bay, we employ benefits transfer methods [43 CFR § 11.83 (c)(2)(vi)] to compute damages for fishing days in the Michigan waters of Green Bay, and for ice-fishing days in the Wisconsin waters of Green Bay. This provides a high-quality benefits transfer because it applies to the same water body, and to the same or similar fish species and fishing activities.

Focus on Green Bay Fishing by Green Bay Anglers

The primary data collection is from a sample of the target population of anglers who currently fish the Wisconsin waters of Green Bay and focuses on the valuation of changes in fishing conditions in the Wisconsin waters of Green Bay. Through this approach, we estimate the extent and value of service flow losses with a large sample of anglers who are specifically knowledgeable of the resources and injuries of interest, and the survey is designed so that the valuation questions are relevant to respondents. Respondent familiarity and relevant questions specific to the site and conditions of interest, combined with the real world nature of the questions, enhances response accuracy and the applicability of the results to the valuation of service flow losses and the determination of compensable values.

Focus on FCAs, Catch Rates, and Costs

The survey focuses on FCAs and catch rates for four species that account for about 90% of the Green Bay fishing activity, and on fishing costs. Interviews with anglers indicate they are most concerned with changes in these site characteristics, and much less concerned with changes in most other site characteristics such as improving recreational facilities. By focusing on the key target species and key site characteristics, site conditions can be efficiently presented, resulting in a cost-effective assessment that has limited cognitive burden on survey respondents.

Combining Revealed Preference and Stated Preference Data

The assessment is designed to collect and combine data on actual fishing activities under current conditions (e.g., days fishing in the Wisconsin waters of Green Bay and elsewhere), referred to as revealed preference data, with stated preference data on how anglers would be willing to trade-off changes in fishing characteristics, including catch rates, FCAs, and costs, and on how many days anglers would fish Green Bay under alternative conditions for the waters of Green Bay. This combination of data allows the benefits of both types of data to be realized.

Stated preference data are collected using choice questions, which are related to conjoint analysis. The revealed preference and stated preference data, along with site-specific and individual-specific data, are combined in random utility models of recreation demand to estimate damages. These economic methods are recognized in the NRDA regulations at 43 CFR § 11.83 and at 15 CFR Part 990 Preamble Appendix G, and are well established in the literature (see Chapter 6).

1.4 PRIMARY DATA COLLECTION

A primary assessment of damages is performed through new survey research to measure the value of recreational fishing service flow losses for the Wisconsin waters of Green Bay. A three-step procedure was used to collect data from a random sample of individuals in the target population of anglers who purchased licenses in eight counties near Green Bay and who are active in fishing the Wisconsin waters of Green Bay. First, a random sample of anglers was drawn from lists of 1997 license holders in the county courthouses in the eight counties near the Bay of Green Bay: Brown, Door, Kewaunee, Manitowoc, Marinette, Oconto, Outagamie, and Winnebago. This population includes residents of these counties, as well as residents of other Wisconsin counties, and nonresidents who purchased their Wisconsin fishing licenses in these eight counties.

Second, a telephone survey was completed in late 1998 and early 1999. From the courthouse sample, the telephone numbers were obtained and a telephone contact was attempted with 4,596 anglers; 3,190 anglers completed the telephone survey for a 69% response rate. The telephone survey collects data from all anglers on the number of total days fished in 1998, how many days were in the waters of Green Bay, and on attitudes about actions to improve fishing. Anglers who had participated in open-water fishing in the Wisconsin waters of Green Bay in 1998 were recruited for a followup mail survey: 92% of the recruited open-water Green Bay anglers agreed to participate. Data from the telephone survey allow comparisons of anglers who were and were not active in fishing the Wisconsin waters of Green Bay, as well as a comparison of those anglers who completed the mail survey versus anglers who did not complete the mail survey.

Third, a mail survey was used to collect data for estimating damages associated with PCB contamination and the resultant FCAs. The core of this mail survey is a series of eight choice questions used to assess damages for reductions in enjoyment for current open-water fishing days in the Wisconsin waters of Green Bay (Figure 1-2). In each question, respondents are provided two alternatives (A and B), each with different levels of fishing characteristics for the waters of Green Bay, and asked to choose whether Alternative A or Alternative B is preferred. Fishing characteristics include catch rates and FCA levels for yellow perch, trout and salmon, walleye, and smallmouth bass; and an angler's share of a daily fee. By varying the levels of the characteristics (e.g., catch rates, FCA levels, and the amount of fees) across alternatives and questions, the survey provides input data for computing the amount of money the anglers would be willing to pay (or the increases in fish catch rates the anglers would be willing to give up) to reduce or eliminate FCAs, as well as the amount of money the anglers would be willing to pay for increased catch rates (see Chapter 6 for a detailed discussion).

As part of each choice question, a followup question asks how often the respondent would fish the Wisconsin waters of Green Bay under the alternative they select. This followup question allows for the estimation of damages associated with substituting days from the waters of Green Bay to other fishing sites because of FCAs.

The mail survey also updates the angler's fishing activity profile for 1998 by asking how many days fishing occurred since the telephone survey; collects attitude, opinion, and socioeconomic data; and collects other data to evaluate the choice question responses. Of the 820 anglers mailed the survey, 647 (79%) completed and returned the survey.

Based on an evaluation of the sampling plan and available data, adjustments to the sample estimate of average days fished per angler are made to obtain a target population estimate accounting for potential recall, sampling, and nonresponse (Section 3.5.4) biases. Further, the sample can be expected to account for on the order of 90% of recreational fishing days on the Wisconsin waters of Green Bay and to be reasonably representative of the mix of resident and nonresident anglers (Section 3.5.5).

Figure 1-2
Example Choice Question

If you were going to fish the waters of Green Bay, would you prefer to fish the waters of Green Bay under Alternative A or Alternative B? *Check one box in the last row*

	Alternative A ▼	Alternative B ▼
Yellow Perch		
Average catch rate for a typical angler......................	40 minutes per perch	30 minutes per perch
Fish consumption advisory.......	No more than one meal per week	No more than one meal per week
Trout and Salmon		
Average catch rate for a typical angler......................	2 hours per trout/salmon	2 hours per trout/salmon
Fish consumption advisory.......	Do not eat	No more than one meal per month
Walleye		
Average catch rate for a typical angler......................	8 hours per walleye	4 hours per walleye
Fish consumption advisory.......	Do not eat	No more than one meal per month
Smallmouth bass		
Average catch rate for a typical angler......................	2 hours per bass	2 hours per bass
Fish consumption advisory.......	No more than one meal per month	Unlimited consumption
Your share of the daily launch fee............................	Free	$3
Check the box for the alternative you prefer...	❑	❑

1.5 SUMMARY OF ANALYSIS AND RESULTS

Awareness and Impacts

Eighty-five percent of the anglers active in the Wisconsin waters of Green Bay had heard or have read about the FCAs. Generally, the anglers' perceptions of the specific advisory levels (i.e., how often one could eat fish of each species) are generally consistent with the published FCAs, although perceptions tend to understate the actual FCA severity for smallmouth bass.

The majority of the anglers rate the advisories as somewhat to very bothersome to their Green Bay fishing. Seventy-seven percent of the anglers identify behavioral responses to the FCAs in the Wisconsin waters of Green Bay, with 30% of active anglers reporting they spend fewer days fishing the Wisconsin waters of Green Bay because of the FCAs. Over half the anglers have changed the species or size of fish they keep to eat, and over half have changed the way the fish they keep are cleaned, prepared, or cooked.

Per Day and Per Angler Damages

Applying random utility models to the primary survey data, an estimate of damages per fishing day per angler is developed for the population of anglers who purchased a fishing license in the eight targeted counties and who are active in open-water fishing in the Wisconsin waters of Green Bay. Two measures are computed and reported in Table 1-1 for the elimination of existing FCAs.

1. The value of eliminating the current Green Bay FCAs per fishing day spent in the Wisconsin waters of Green Bay in 1998, which measures the value of reduced enjoyment of existing fishing days in these waters. Our primary estimate for this measure is $9.75 per Green Bay open-water fishing day.

2. The value of eliminating the current Green Bay FCAs per fishing day spent at all fishing sites in 1998. This measure includes the value of reduced enjoyment of existing fishing days in the waters of Green Bay (as above) plus the value of services lost when anglers are compelled to substitute to fishing days from Green Bay to other sites (sites that in the absence of FCAs in Green Bay would be less preferred) because of the FCAs at Green Bay. Our primary estimate for this measure is $4.17 per open-water fishing day, and is applied to all open-water fishing days, not just those to Green Bay.

In Table 1-1, the estimated per fishing day values are multiplied by the estimated average number of fishing days per angler in the target population to compare the two value measures on a per angler basis. As shown in Table 1-1, the values for the more comprehensive second damage measure are about 7% larger than for the first measure. In short, the largest values from the elimination of Green Bay FCAs arise from reduced enjoyment of current trips, with modest increases arising from substituting visits to other sites.

Table 1-1
1998 per Day and per Angler Damages for Open-Water Fishing in the Wisconsin Waters of Green Bay
(for anglers active in open-water fishing on the Wisconsin waters of Green Bay)

Measure	Damages per Fishing Day	Applicable Days (average/angler)	Average Annual Damages per Angler
1. WTP^G	$9.75 per Green Bay fishing day	5.25 days in the Wisconsin waters of Green Bay	$51.18
2. WTP^F	$4.17 per fishing day	13.19 total fishing days	$55.00

The per day estimates are computed with our primary economic model. Sensitivity analyses for model assumptions have found the per fishing day value estimate to be very robust (see Chapter 9 and Appendix D). Further, the values per day in the Wisconsin waters of Green Bay do not differ greatly by location of origin of the angler. Thus, modest variations in the composition of the anglers will have little impact on per fishing day value estimates. This stability validates the benefits transfer portion of the assessment.

Damages per day are also computed per fishing day for changes from less stringent FCAs to no FCAs. These values (reported in Chapter 8) are used to evaluate damages through time and to conduct the benefits transfer to ice fishing in Wisconsin waters of Green Bay and to all fishing in Michigan waters of Green Bay.

Total Recreational Fishing Damages

Annual recreational fishing damages in 1998 and the present value of all interim recreational fishing losses from the beginning of 1981 until restoration is complete are summarized in Table 1-2. The values reported in Table 1-2 for Wisconsin open-water fishing are based on damage measure 2 in Table 1-1, and the values reported for Wisconsin ice fishing and Michigan fishing are based on the less comprehensive damage measure 1 in Table 1-1 because we do not have estimates of total fishing days at all sites (as opposed to just at Green Bay sites) for anglers active in these fishing activities.

To compute damages in each past and future year, estimated fishing days for the year are multiplied by an estimate of damages per fishing day for the FCAs that existed in past years or for future years. For example, in 1998, the estimated 641,060 open-water fishing days (to all fishing sites) is multiplied by $4.17 per open-water fishing day for a total open-water fishing damage

Table 1-2
Total Values for Recreational Fishing Service Losses for the Waters of Green Bay Resulting from Fish Consumption Advisories for PCBs
($ millions, $1998, present value to 2000)[a,b]

Damage Category	(A) Wisconsin Waters of Green Bay		(B) Michigan Waters of Green Bay	(C) All Waters of Green Bay (A + B)
	Open-Water Fishing	Open-Water plus Ice	All Fishing	All Fishing
	Primary Study	Primary + Transfer	Benefits Transfer	Primary + Transfer
1998 Value of 1998 Losses	$2.673	$3.127	$0.438	$3.566
1. Present Value of Past Losses:				
a. 1981-1999	$37.8	$44.3	$20.2	$64.5
b. 1976-1980	$5.4	$6.3	$5.8	$12.1
2. Present Value of Future Losses[c]				
a. Intensive Remediation[d]	$30.7	$36.2	$5.3	$41.5
b. Intermediate Remediation[e]	$43.2	$51.0	$7.5	$58.5
c. No Additional Remediation[f]	$62.3	$72.9	$10.2	$83.2
3. Present Value of Total Damages from 1981 to Baseline (1a+2)				
a. Intensive Remediation	$68.5	$80.5	$25.5	$106.0
b. Intermediate Remediation	$81.0	$95.3	$27.7	$123.0
c. No Additional Remediation	$100.2	$117.3	$30.4	$147.7

a. Rounded to the nearest $1,000 for 1998 annual values and to the nearest $100,000 for present value estimates. Totals may not equal sum of elements due to rounding.
b. Values for Wisconsin open-water fishing include reduced quality of current days plus substitution of days to other sites. Values for Wisconsin ice fishing and Michigan fishing include only reduced quality of current days. See text for additional discussion.
c. Present values computed adjusting for changes in FCAs through time, assuming an average fishing activity at 1998 levels, and a 3% discount rate.
d. 20 years of damages = 10 years sediment removal plus 10 years of declining FCAs.
e. 40 years of damages = 10 years sediment removal plus 30 years of declining FCAs.
f. FCAs decline to zero over 100 years due to natural recovery.

estimate of $2.673 million (rounded to the closest $1,000). For Wisconsin ice fishing in 1998, we employ the benefits transfer and select the 1998 open-water fishing value of $9.75 (measure 1 in Table 1-1) times an estimated 46,541 ice-fishing days in the Wisconsin waters of Green Bay for a total of $454,000. For ice fishing we use the same $9.75 per day damage as for open-water fishing days in Green Bay because the ice fishing is in the same waters, for the same species, and the ice anglers predominately are also open-water anglers. The combination of open-water fishing and ice fishing is the total estimate of damages from 1998 recreational fishing service losses in the Wisconsin waters of Green Bay of $3,127,000.

We also apply the benefits transfer values for fishing in the Michigan waters of Green Bay. A value of $2.92 per fishing day in the Michigan waters of Green Bay is selected, reflecting the lower FCA levels in these waters for 1998 as compared to the Wisconsin waters of Green Bay. The per day damage is multiplied by 150,500 fishing days for a Michigan total of $439,000. The 1998 total for all waters of Green Bay is $3,566,000.

The present value of all interim damages from 1981 until restoration is complete is also provided in Table 1-2 (rounded to the closest $100,000). Damages for past service flow losses are computed from 1981 and are continued through 1999. Fishing activity through time is based on WDNR and MDNR estimates for the waters of Green Bay. Damages per Green Bay fishing day are scaled through time to reflect changes in FCAs through time. Generally, the damages per day from FCAs in Wisconsin are the same or less in the past because the FCA levels were the same or less (as a result, anglers may have experienced the same or less loss of enjoyment but experienced increased health risks in the past, which is not included in the damage estimates). In Michigan, however, the FCAs were more restrictive in some past years. Also note that fishing days in the past were often larger than in 1998. Total damages for past service flow losses are estimated to be about $64.5 million, with about 69% of these damages in the Wisconsin waters of Green Bay.

FCAs were first issued in response to PCB contamination in the waters of Green Bay in 1976. Including damages for the period from 1976 to 1980 adds about $6.3 million for all Wisconsin fishing, $5.8 million for all Michigan fishing, and $12.1 million in total, which increases the total past damages by about 19%.

Damages for future recreational fishing service flow losses are computed starting in 2000. The duration and levels of the FCAs depend on the level of remediation efforts to address PCB contaminated sediments, which have not been selected. Therefore, pending final selection of remediation efforts, we have identified three potential remediation scenarios to illustrate how the magnitude of damage estimates for projected future recreational service losses may vary with the selected remediation. The estimation of damages for future service losses will be revised and incorporated into the Service's compensable values determination after the U.S. EPA has issued a Record of Decision and the Trustees have selected a preferred restoration alternative.

The three remediation scenarios reflect the range of options considered in the draft Remedial Investigation/Feasibility Study (RI/FS) (ThermoRetec Consulting, 1999a,b), as well as the October 27, 1997 Fox River Global Meeting Goal Statement (FRGS-97) by the Fox River Global Meeting Participants (1997).

1. ***Intensive remediation.*** All FCAs are removed in 20 years. This is modeled as a 10-year PCB removal period, during which time the FCA-caused service losses and accompanying damages per fishing day are assumed to decline linearly at a natural recovery rate (see Scenario 3), followed by a 10-year accelerated recovery period during which time the FCA-caused service losses and accompanying damages per fishing day are assumed to decline linearly to zero. This scenario closely reflects the FRGS-97 goal, and is similar to the RI/FS scenario of PCB removal to a 250 µg/kg minimum concentration level throughout the Lower Fox River (however, the draft RI/FS suggests the potential for removal of FCAs in less than 10 years after the above removal is complete, which would reduce damages).

2. ***Intermediate remediation.*** All FCAs are removed in 40 years. This is modeled as a 10-year PCB removal period, during which time the FCA-caused service losses and accompanying damages per fishing day are assumed to decline linearly at a natural recovery rate (see Scenario 3), followed by a 30-year accelerated recovery period, during which time the FCA-caused service losses and accompanying damages per fishing days are assumed to decline linearly to zero. This scenario is similar to the RI/FS scenario of PCB removal to a 250 µg/kg average concentration level throughout the Lower Fox River.

3. ***No additional remediation (no action remedy).*** No significant additional PCB removal occurs and the elimination of FCAs occurs due to natural recovery. We model the natural recovery rate to be a linear decline in FCA-caused service losses and damages per fishing day to zero at the end of 100 years. This is a conservative assumption as the draft RI/FS suggests that with no additional remediation, the Wisconsin FCAs may continue with little change for 100 years or more. Using an assumption of no change for 100 years would increase past damages by over 40% and total damages by over 20%.

For all future years we assume that fishing effort remains constant at 1998 levels for all fishing considered, and those levels are based on estimates in this study, as described in Section 8.4. The assumption of current fishing activity levels into the future may or may not be a conservative assumption as fishing effort in the waters of Green Bay was at a decade lowest level in 1997 and 1998. Fishing effort may or may not remain depressed, most likely depending on the future catch rates, changes in FCAs and other water quality measures, and changes in the population of northeast Wisconsin. This assumption can be revisited and revised after the U.S. EPA selection of a Record of Decision and the Trustees have selected a preferred restoration alternative.

The damages per fishing day due to FCAs decline as identified in each scenario. These assumptions are the same for each category of damages considered (open-water and ice fishing in Wisconsin, and all fishing in Michigan). Again, after the U.S. EPA's selection of a Record of Decision and the Trustees' selection of a preferred restoration alternative, the time path of FCAs can be revisited and damages computed based on the projected time path of FCAs and the values for different FCA levels in Table 8-1.

Damages for future recreational fishing service losses range from $41.5 million (under Scenario 1 with intensive remediation) to $83.2 million (under Scenario 3 with no additional remediation). The Wisconsin share of the damages for future service losses is about 87%, reflecting the more significant fishing activity and more restrictive advisories in the Wisconsin waters of Green Bay.

Total damages for past and future service losses range from $106 million under Scenario 1 (with intensive remediation) to $148 million under Scenario 3 (with no additional remediation). The Wisconsin share is about 76% to 79%, depending on the remediation scenario, reflecting the greater number of fishing days and more severe FCAs in these waters.

A 3% discount rate is used to escalate past damages and to discount future damages to the year 2000. A 3% discount rate is consistent with the average real 3-month Treasury bill rates over the last 15 years (Bureau of Economic Analysis, 1998; Federal Reserve, 1998) and is consistent with U.S. DOI recommendations (U.S. DOI, 1995) for NRDAs under CFR §11.84(e).

The present value of past and future service flow losses varies with the discount rate. For example, increasing the discount rate to 6% increases the value of past service flow losses but decreases the value of future service flow losses. The value of the total of past and future service flow losses would increase by about 15% under Scenario 1, increase by about 7% under Scenario 2, and decrease by about 6% under Scenario 3. Decreasing the discount rate to 2% would decrease the value of past and future service flow losses in Scenario 1 by about 3%, increase the value in Scenario 2 by less than 1%, and increase the value in Scenario 3 by about 9%.

These damage estimates are conservative. The computations exclude damages to anglers and nonanglers who do not fish Green Bay at all because of the FCAs, damages from reducing total fishing days by Green Bay anglers, damages due to injuries to Oneida tribal waters, and damages that could result from potential fish population injuries. The computations are based on a conservative selection of per fishing day damage values and conservative estimates of ice-fishing activity. Chapter 10 provides a detailed presentation of the computation of damages through time and of key factors leading to conservative damage estimates.

Chapter 2
Background

This chapter provides background data on fishing activity in the assessment area (Section 2.1), an overview of FCAs for the assessment area (Section 2.2), and a summary of literature about how anglers respond to FCAs (Section 2.3) and how much anglers value changes in FCAs and catch rates (Section 2.4).

2.1 Recreational Fishing in the Waters of Green Bay

The waters of Green Bay are located in northeastern Wisconsin and in the Upper Peninsula of Michigan. The Bay of Green Bay is the largest bay on Lake Michigan and is approximately 190 miles in length extending from the City of Green Bay at the southern tip to the Bays de Noc at the north. Additionally, the waters of Green Bay include all the tributaries leading into the Bay of Green Bay up to their first dam or barrier. Thus, the waters of Green Bay are extensive and support a substantial recreational fishery.

Because of its size, the weather, and the fish available (discussed below), fishing the waters of Green Bay (especially in the Bay of Green Bay) is substantially different from fishing in most inland waters. Further, because the Bay of Green Bay is smaller than and sheltered from Lake Michigan, it also offers a fishing experience that is generally different from fishing in Lake Michigan: fishing the waters of Green Bay is unique.

The Wisconsin Department of Natural Resources (WDNR) conducts a yearly creel survey for open-water fishing in the Wisconsin waters of Green Bay.[1] These data include catch by species, overall effort, and effort by targeted species. The primary purpose of this creel survey is to collect information such as the number of fish caught, the weight and length of the fish, and if the fish was tagged. Information is also collected on what type of fishing (pier, ramp, shore, stream, or ice) occurs; and estimates on how many hours were spent fishing and targeting specific species. The creel survey is supplemented by a mail survey of moored boat owners and a charter boat survey, which provide estimates of fishing hours for these fishing modes. Combined, the creel survey plus the moored and charter boat surveys estimate total fishing effort in hours fished.

1. The open-water creel survey on the bay generally runs from March 15 to October 31, and on the tributaries generally runs from March 1 to May 15 and from September 1 to December 31. All Wisconsin survey data in this chapter were received from Brad Eggold, WDNR Senior Fisheries Biologist, Plymouth Field Station.

The fishing effort data from the WDNR surveys for 1990 through 1998 are shown in Table 2-1, along with fishing effort data from the Michigan Department of Natural Resources (MDNR) creel survey.[2] The Wisconsin data are for the March to December season; the MDNR data are for overall fishing efforts in the Michigan waters of Green Bay for the entire year. The number of hours fishing on both the Wisconsin and Michigan waters of Green Bay has been decreasing in the last few years, but both remain large and important fisheries. The Michigan Green Bay fishery for the entire year averages about 60% the size of the Wisconsin Green Bay open-water fishery from March to December.

The Fox River portion of the Wisconsin waters of Green Bay passes through the City of Green Bay, the region's major city. The WDNR surveys estimate that fishing effort on the Lower Fox River has accounted for about 3% of the open-water fishing in the Wisconsin waters of Green Bay over the last nine years (Table 2-2).

Ice fishing is a significant part of the Wisconsin Green Bay fishery. Table 2-3 shows the ratio of ice-fishing to open-water fishing in the Wisconsin waters of Green Bay from the WDNR surveys, which varies year-to-year depending on the length of the ice-fishing season.

The waters of Green Bay provide a unique mix of target species for recreational fishing. Table 2-4 compares the different fish species as a proportion of total catch for the Wisconsin waters of Green Bay and for Lake Michigan from the 1998 Wisconsin creel survey. Trout and salmon fishing[3] dominates the remainder of the Wisconsin waters of the Lake Michigan fishery, whereas anglers most frequently catch yellow perch on Green Bay and infrequently target and catch perch in Lake Michigan. Walleye and smallmouth bass are important and growing fisheries in Green Bay, while walleye accounted for only 0.1% of the 1998 Lake Michigan catch, and smallmouth bass accounted for 3.1%. Note that these catch statistics do not include the approximately 15% of fishing activity that is from charter boats and moored boats (creel data are not collected for these fishing modes). Therefore, these statistics are viewed as indicative of the percentage of catch and of changes in catch through time.

Historically the yellow perch fishery made up an even greater portion of the catch on Green Bay, but declining fish stocks have both decreased the overall catch in the bay and led to changes in the species that are targeted. Tables 2-5 and 2-6 compare catch and effort breakdowns by species for the 1986 to 1998 angling years. In 1998, only 16% of the hours spent on Green Bay were in the perch fishery, the result of a steady drop in effort starting in 1992. Perch also decreased in its share of the overall total number of fish caught in Green Bay from 94% in 1992 to 73% in

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2. All Michigan Creel data in this chapter were received from Gerald Rakoczy, MDNR Fisheries Research Biologist.

3. Throughout this report, we refer to trout and salmon as a group, which includes coho, chinook, and atlantic salmon, as well as rainbow, brown, brook, and lake trout.

Table 2-1
Hours of Fishing Effort on the Michigan and Wisconsin Waters of Green Bay: 1990-1998

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997[a]**	**1998**	**Average 1990-1998[b]**
Hours of all fishing effort on the Michigan waters of Green Bay (*all year*)	736,599	948,456	692,284	734,400	609,360	666,976	627,900	452,044	532,829	693,601
Hours of open-water fishing effort on the Wisconsin waters of Green Bay (*March to December*)	1,245,291	1,324,911	1,188,588	1,112,877	1,191,252	1,078,522	972,938	886,873	905,762	1,100,779
Michigan effort as a percentage of Wisconsin open-water fishing effort	59%	72%	58%	66%	51%	62%	65%	51%	59%	61%

a. In 1997 there was no winter (January-March) creel survey conducted in Michigan Green Bay and therefore, the harvest and effort estimates for 1997 are not comparable to prior years that included the winter data. Insufficient data were collected at South Haven and Saugatuck during some months and therefore the estimates may not be reliable or comparable to prior years.
b. Excluding 1997 for the Michigan data.

Source: WDNR creel, and moored and charter boat surveys, 1990-1998. Data provided by Brad Eggold, Senior Fisheries Biologist, Plymouth Station. MDNR, 1985-1998. Data provided by Gerald Rakoczy, MDNR Fisheries Research Biologist.

Table 2-2
Open-Water Fishing Hours on the Fox River from Its Mouth to the Dam at DePere: 1990-1998

Angling Hours	1990	1991	1992	1993	1994	1995	1996	1997	1998	Average 1990-1998
Fox River[a]	23,965	21,870	22,131	34,645	27,412	28,186	50,921	46,291	37,404	32,536
All waters of Green Bay[b]	1,245,291	1,324,911	1,188,588	1,112,877	1,191,252	1,078,522	972,938	886,873	905,762	1,100,779
Fox River as a percent of Green Bay	1.9%	1.7%	1.9%	3.1%	2.3%	2.6%	5.2%	5.2%	4.1%	3.1%

a. These data are available only for the ramp, pier, shore, and stream fisheries, omitting the moored and charter fisheries. Charter fishing is limited to the Marinette and Door county regions of Green Bay and therefore is not part of the Fox River effort, but to the extent that the anglers who moor their boats fish on the Fox River, the Fox River as a percent of Green Bay will be underestimated.
b. These data are for ramp, pier, shore, stream, moored, and charter fisheries.

Source: WDNR creel surveys 1990-1998. Data provided by Brad Eggold, Senior Fisheries Biologist, Plymouth Station.

Table 2-3
Ice-Fishing Hours on the Wisconsin Waters of Green Bay: 1990-1998

	1990	1991	1992	1993	1994	1995	1996	1997	1998	Average 1990-1998
Ice fishing	878,269	834,219	448,610	370,664	278,258	316,660	234,617	169,973	29,108	395,598
Open water	1,245,291	1,324,911	1,188,588	1,112,877	1,191,252	1,078,522	972,938	886,873	905,762	1,100,779
All fishing	2,123,560	2,159,130	1,637,198	1,483,541	1,469,510	1,395,182	1,207,555	1,056,846	934,870	1,496,377
Ice fishing as a percent of all fishing	41%	39%	27%	25%	19%	23%	19%	16%	3%	24%
Ice fishing as a percent of open-water fishing	71%	63%	38%	33%	23%	29%	24%	19%	3%	34%

Source: WDNR creel, charter boat, and moored boat surveys, 1990-1998. Data provided by Brad Eggold, Senior Fisheries Biologist, Plymouth Station.

Table 2-4
Percent of Total Catch by Species for the Wisconsin Waters of Green Bay and Lake Michigan: 1990-1998[a]

	Green Bay	Lake Michigan (excluding Green Bay)
Yellow perch	73.3%	18.5%
Trout/salmon	6.0%	78.1%
Walleye	10.3%	0.1%
Smallmouth bass	4.7%	3.1%
All other species	5.8%	0.2%

a. Measured by number of fish. These data are available only for the ramp, pier, shore, and stream fishing hours. The moored and charter fishing is omitted. Percentages are rounded and may not total 100%.

Source: WDNR creel surveys 1990-1998. Data provided by Brad Eggold, Senior Fisheries Biologist, Plymouth Station.

1998. This drop was not as large as the decrease in effort as perch have much higher catch rates than other species, and while the proportion of effort has increased for other species their catch rates and overall effort have also declined. Again, note that the WDNR statistics provided did not include catch data for the approximately 15% of fishing activity that is from charter boats and moored boats. Estimates of time spent per fish caught, by species, are reported in Section 5.2 under the discussion of “catch times.”

Table 2-7 shows the percentage of catch by species for the Michigan waters of Green Bay. In its creel survey the MDNR reports catch only for the four species that dominate the fishery: chinook salmon, brown trout, yellow perch, and walleye.[4] Perch are by far the most frequently caught species in the Michigan waters of Green Bay, but have been declining in both their levels of catch and proportion of overall catch. This trend parallels what has happened in the Wisconsin waters of Green Bay. The MDNR does not collect data on the effort spent targeting specific species, so that comparison cannot be made.

4. From conversations with Gerald Rakoczy, these species account for at least 95% of the catch in the Michigan waters of Green Bay.

Table 2-5
Percent of Open-Water Catch on Wisconsin Waters of Green Bay by Species: 1986-1998[a]

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	Mean 1986-1998
Yellow perch	94%	95%	96%	97%	95%	95%	94%	89%	91%	89%	78%	65%	73%	93%
Trout/salmon	3%	3%	2%	2%	3%	2%	2%	3%	2%	4%	4%	7%	6%	3%
Walleye	2%	1%	2%	0.3%	0.3%	0.3%	1%	3%	3%	2%	3%	11%	10%	2%
Smallmouth bass	0.5%	0.5%	0.6%	0.7%	1%	2%	4%	4%	3%	4%	8%	7%	5%	2%
All other species	0.4%	0.2%	0.1%	0.1%	0.4%	0.4%	0.2%	1%	1%	2%	6%	10%	6%	1%

a. These data are available only for the ramp, pier, shore, and stream fisheries. The moored and charter fishing is omitted. Percentages are rounded and may not total 100%.

Source: WDNR creel surveys 1986-1998. Data provided by Brad Eggold, Senior Fisheries Biologist, Plymouth Station.

Table 2-6
Percent of Targeted Open-Water Angling Hours on Wisconsin Waters of Green Bay by Species: 1986-1998[a]

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	Mean 1986-1998
Yellow perch	55%	63%	55%	58%	64%	66%	61%	48%	49%	49%	35%	19%	16%	49%
Trout/salmon	31%	25%	28%	25%	15%	15%	18%	20%	18%	18%	17%	27%	33%	22%
Walleye	11%	10%	11%	5%	5%	5%	8%	11%	13%	12%	21%	26%	22%	12%
Smallmouth bass	1%	2%	5%	10%	11%	7%	8%	12%	12%	13%	17%	21%	20%	11%
All other species	2%	1%	2%	2%	6%	6%	5%	8%	9%	9%	11%	6%	9%	6%

a. These data are available only for the ramp, pier, shore, and stream fishing hours. The moored and charter fishing is omitted. Percentages are rounded and may not total 100%.

Source: WDNR creel surveys 1986-1998. Data provided by Brad Eggold, Senior Fisheries Biologist, Plymouth Station.

Table 2-7
Percent of Catch on Michigan Waters of Green Bay by Species: 1985-1998

% of Catch	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997[a]	1998	Mean 1985-1998
Yellow perch	95%	94%	91%	90%	85%	89%	92%	94%	69%	75%	62%	82%	48%	80%	82%
Trout/salmon	1%	1%	4%	3%	3%	0%	0%	0%	14%	7%	7%	3%	20%	6%	5%
Walleye	4%	5%	5%	7%	12%	10%	8%	6%	17%	18%	32%	16%	33%	15%	13%

a. In 1997 there was no winter (January-March) creel survey conducted in Michigan Green Bay and therefore, the harvest and effort estimates for 1997 are not comparable to prior years that included the winter data. Insufficient data were collected at South Haven and Saugatuck during some months and therefore the estimates may not be reliable or comparable to prior years. Percentages are rounded and may not total 100%.

Source: MDNR, 1985-1998. Data provided by Gerald Rakoczy, MDNR Fisheries Research Biologist.

2.2 OVERVIEW OF FCAS IN THE ASSESSMENT AREA

PCBs are synthetic substances that were used by the NCR Corporation until 1971 when they were replaced by other emulsion constituents. PCBs continued to be released into the Fox River and accumulated in its sediments for several years until the majority of NCR broke and post-consumer NCR paper had been recycled, some of which migrated downstream and into Green Bay. Fish absorb these PCBs though sediments suspended in the water and through the food they eat. PCBs accumulate in the fat of a fish and are extremely persistent and easily passed through the food chain. As a result, larger, older, or predatory fish, and bottom fish, accumulate higher levels of PCBs in their bodies (Stratus Consulting, 1998).

As a result of PCBs, FCAs for recreational fishing have been in place since 1976 for the Wisconsin waters of Green Bay and Lake Michigan.[5] In this section we summarize the history of FCAs in the waters of Green Bay; for a more extensive discussion, see Stratus Consulting (1998).

Wisconsin

Wisconsin's FCAs for 1997 to 1999 (WDNR, 1997a, 1998b, 1999) explain the health risks from PCB contamination of fish as follows:

> High consumption of PCB-contaminated fish has been linked to slower development and learning disabilities in infants and children born to women who regularly have eaten highly contaminated fish for many years before becoming pregnant. Once eaten, PCBs are stored in body fat for many years. This is true for animals, such as game fish, and humans. Because PCBs are stored in the body for so long, each time you ingest PCBs the total amount of PCB in your body increases. Following the consumption guidelines in this publication can minimize your lifetime build-up of PCBs regardless of your age, sex or physical status.

Further anglers are told:

> Although this advisory is based on reproductive risks rather than cancer, some contaminants do cause cancer in animals. Your risk of cancer from eating contaminated fish cannot be predicted with certainty . . . If you follow this advisory over your lifetime, you will minimize your exposure and reduce whatever cancer risk is associated with those contaminants.

5. Further, because of PCB contamination, the large-scale commercial carp fishery in Green Bay was suspended to interstate commerce in 1975 and closed entirely in 1984 (Kleinert, 1976; Allen et al., 1987).

The Wisconsin FCAs for fish contaminated with PCBs and pesticides are accompanied by advice regarding the preparation of these fish. The preparation advice includes removal of skin and fat, cooking by baking or broiling, and discarding any drippings.

Over time, advice offered in the Wisconsin FCAs has become increasingly specific (Tables 2-8 and 2-9). The initial FCAs were relatively general. Early advisories typically focused on species and simply advised anglers to limit consumption of fish mentioned. As more information about the contamination of sportfish species became available, FCAs were increasingly refined to focus on location, species, and size. Through time the overall level of severity of the advisories have remained generally similar for some species and become more restrictive for other species.

From 1985 through 1996, the Wisconsin FCAs reflected two levels of consumption restrictions. At the more restrictive level, the Wisconsin FCAs advised that some fish, primarily larger fish, as well as fish from locations with higher PCB levels, should not be eaten at all. At the less restrictive level, the Wisconsin FCAs advised that women of childbearing years and children should not eat the fish, and all others should restrict consumption of these fish to one meal a week. Beginning in 1997, the Wisconsin FCAs reflected five levels of consumption advice: (1) unlimited consumption, (2) eat no more than one meal a week, (3) eat no more than one meal a month, (4) eat no more than one meal every two months, and (5) do not eat. While the level of advisory varies for each fish species, overall future changes in FCAs can be expected to generally move in the same direction for all species (e.g., all advisories will remain the same or become less restrictive with changes in PCB contamination and changes in advisory standards).

The 1998 Wisconsin advisories are listed in Table 2-10 (they have remained the same for Green Bay in 1999). Table 2-10 also lists the 1998 Michigan advisories that are discussed below. It is relevant to note that effectively all sport-caught fish in the Wisconsin waters of Green Bay have a PCB advisory. The Lower Fox River advisory levels are more restrictive than those for the remaining waters of Green Bay, reflecting higher concentrations of PCBs in the sediments, water column, and fish.

Michigan

Similar FCAs apply to the Michigan waters of Green Bay. The Michigan FCAs separate the Green Bay waters into three sections: the waters south of Cedar River, the waters in Little Bay de Noc, and the waters between Cedar River and Little Bay de Noc (in this middle region the FCA for Lake Michigan north of Franklin applies; this area includes Big Bay de Noc). The 1988-1997 Michigan advisories for Green Bay south of the Cedar River are shown in Table 2-11 and those for Little Bay de Noc are shown in Table 2-12; they have generally been less restrictive than those issued for PCBs in the Wisconsin waters of Green Bay and more restrictive than the Michigan advisories for Lake Michigan north of Franklin.

Table 2-8
Fish Consumption Advisories for the Wisconsin Waters of Green Bay: 1976-1999

Species	'76	'77	'78	'79	'80	'81	'82	'83	'84	'84+	'85	'85+	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95*	'96*	'97	'98	'99
Yellow Perch All										⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	◊	◊	◊
Trout > 20"	⊖	⊖	⊗[a]	⊗[a]	⊗[a]	⊗[a]	⊗[a]	⊗[a]	⊗[a]																	
Lake Trout All											M															
Lake Trout < 20"												⊙	⊙													
Lake Trout <25										⨸																
Lake Trout 20-25"												⊗	⊗													
Lake Trout > 25"										M		M	M													
Brown Trout All										⨸	M	M	M													
Brown Trout < 12"														⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙			
Brown Trout > 12"														M	M	M	M	M	M	M	M	M	M			
Brown Trout < 14"																								❖		
Brown Trout 14"-21"																								◆		
Brown Trout > 21"																								M		
Brown Trout < 17"																									❖	❖
Brown Trout 17-28"																									◆	◆
Brown Trout > 28"																									M	M
Rainbow Trout All										⨸	⨸	⊙	⊙											❖	❖	❖
Rainbow < 22"														⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙			
Rainbow > 22"														M	M	M	M	M	M	M	M	M	M			
Brook Trout All										⨸	⨸															
Brook Trout < 15"														⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙			
Brook Trout > 15"														M	M	M	M	M	M	M	M	M	M			
Salmon > 20"	⊖	⊖	⊗[a]	⊗[a]	⊗[a]	⊗[a]	⊗[a]		⊗[a]																	
Chinook Salmon All										⨸																

Table 2-8 (cont.)
Fish Consumption Advisories for the Wisconsin Waters of Green Bay: 1976-1999

Species	'76	'77	'78	'79	'80	'81	'82	'83	'84	'84+	'85	'85+	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95*	'96*	'97	'98	'99
Chinook Salmon < 25"											⨸			⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙			
Chinook Salmon > 25"											M	⊗	⊗	M	M	M	M	M	M	M	M	M	M			
Chinook Salmon < 29"																								◊		
Chinook Salmon > 29"																								❖		
Chinook Salmon < 30"																									❖	❖
Chinook Salmon > 30"																									◆	◆
Coho Salmon All										⨸		⊙	⊙													
Coho Salmon < 28"											M															
Coho Salmon >28"											⨸															
Smallmouth Bass All										⨸[c]	M	⊗	⊗	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	❖	❖	❖
Walleye All										⨸	⨸															
Walleye < 20"												⊗	⊗	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙			
Walleye > 20"												M	M	M	M	M	M	M	M	M	M	M	M			
Walleye < 17"																								❖	❖	❖
Walleye 17"-26"																								◆	◆	◆
Walleye > 26"																								M	M	M
Bullheads All			⊗[a,b]	⊗[a,c]	⊗[a,c]	⊗[a,d]	⊗[a,d]	⊗[a,d]	⊗[a,d]	⊙	⨸	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙			
Whitefish All				⊗[a,b]	⊗[a,c]	⊗[a,c]	⊗[a,d]	⊗[a,d]	⊗[a,d]															◆	◆	◆
Carp All	⊖	⊖	⊗[a]	⊗[a]	⊗[a]	⊗[a]	⊗[a]	⊗[a]	⊗[a]	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Catfish All			⊗[a,b]	⊗[a,c]	⊗[a,c]							M	M											◆	◆	◆
White Sucker All										⨸		M	M	M	M	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	❖	❖	❖
White Bass All												M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Splake < 16"														⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	❖	❖	❖
Splake > 16"														M	M	M	M	M	M	M	M	M	M			
Splake 16"-20"																								◆	◆	◆
Splake > 20"																								M	M	M
Northern Pike All										⨸	⨸	⊗	⊗													
Northern Pike < 28"														⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙			

Table 2-8 (cont.)
Fish Consumption Advisories for the Wisconsin Waters of Green Bay: 1976-1999

Species	‘76	‘77	‘78	‘79	‘80	‘81	‘82	‘83	‘84	‘84+	‘85	‘85+	‘86	‘87	‘88	‘89	‘90	‘91	‘92	‘93	‘94	‘95*	‘96*	‘97	‘98	‘99
Northern Pike > 28"														M	M	M	M	M	M	M	M	M	M			
Northern Pike < 22"																								♢	♢	♢
Northern Pike > 22"																								❖	❖	❖
Sturgeon All																				M	M	M	M	M	M	M
White Perch All																								M	◆	◆

⊗ = Limit consumption for general population, no consumption by children aged 6 or under, or by women who are pregnant, nursing, or expect to bear children.
⊕ = No consumption by infants, children, or by women who are pregnant, nursing, or expect to bear children.
⊖ = Limit consumption to 1 meal per week for general population, limit consumption to 1 average size serving per week for pregnant women and children.
⊙ = Remove all fat and skin before cooking, follow cooking and cleaning tips for reducing PCB levels.
♢ = Limit consumption to one meal every week.
❖ = Limit consumption to one meal every month.
◆ = Limit consumption to one meal every two months.
M = No consumption.
+ = This advisory was published in a health guide separate from the fishing regulations pamphlet.
* = Advisories were not reprinted in 1995 and 1996. The 1994 advisory remained in force during these years.
a. Consumption limit for general population is 1 meal (½ pound) per week.
b. Advisory limited to southern Green Bay (south of a line between Pensaukee and Little Sturgeon).
c. Advisory limited to southern Green Bay (south of Peshtigo).
d. Advisory limited to southern Green Bay (south of a line from Pensaukee to Little Sturgeon Bay).

Sources: Stratus Consulting, 1998; WDNR, 1998b, 1999.

Table 2-9
Fish Consumption Advisories for the Lower Fox River between Green Bay and the Dam at DePere

Species	'76	'77	'78	'79	'80	'81	'82	'83	'84	'84+	'85	'85+	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99
Yellow Perch All																								❖	❖	❖
Walleye All														M	M	M										
Walleye < 15"																	⊙	⊙	⊙	⊙	⊙	⊙	⊙			
Walleye 15-18"																	⊗	⊗	⊗	⊗	⊗	⊗	⊗			
Walleye > 18"																	M	M	M	M	M	M	M			
Walleye < 16"																								❖	❖	❖
Walleye 16"-22"																								◆	◆	◆
Walleye > 22"																								M	M	M
Smallmouth Bass All																								◆	◆	◆
White Sucker All														M	M	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	◆	◆	◆
Northern Pike All															⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗			
Northern Pike < 25"																								❖	❖	❖
Northern Pike > 25"																								◆	◆	◆
Black Crappie < 9"																								❖	❖	❖
Black Crappie > 9"																								◆	◆	◆
Bluegill All																								❖	❖	❖
Rock Bass All																								❖	❖	❖
White Perch All																										◆
White Bass All														M	M	M	M	M	M	M	M	M	M	M	M	M
Carp All														M	M	M	M	M	M	M	M	M	M	M	M	M
Catfish All															M	M	M	M	M	M	M	M	M	M	M	M
Drum All															M	M	M	M	M	M	M	M	M			

⊗ = Limit consumption for general population, no consumption by children aged 6 or under, or by women who are pregnant, nursing, or expect to bear children.
⊙ = Remove all fat and skin before cooking, follow cooking and cleaning tips for reducing PCB levels.
◊ = Limit consumption to one meal every week. ◆ = Limit consumption to one meal every two months.
❖ = Limit consumption to one meal every month. **M** = No consumption.
+ = This advisory was published in a health guide separate from the fishing regulations pamphlet.

Sources: Stratus Consulting, 1998; WDNR, 1998b, 1999.

Table 2-10
1998 Wisconsin FCAs for Green Bay[a] and Fox River,[b] and Michigan FCAs for Lower Green Bay,[c] Upper Green Bay,[d] and Little Bay de Noc[e]

		Unlimited	One Meal a Week	One Meal a Month	One Meal Every 2 Months	Do Not Eat
Bluegill	WI Fox River			all sizes		
Brown trout	WI Green Bay			< 17"	17-28"	> 28"
	MI Lower Green Bay		GP<18"	WC<14"	WC14-18"	GP WC>18"
	MI Upper Green Bay	GP<22"		WC<22"		GP WC>22"
Burbot	MI Little Bay de Noc	GP	WC<26"	WC>26"		
	MI Lower Green Bay	GP = unlimited	WC<26"	WC>26"		
Carp	WI Fox River					all sizes
	WI Green Bay					all sizes
	MI Lower Green Bay					GP WC
	MI Upper Green Bay					GP WC
Channel catfish	WI Fox River					all sizes
	WI Green Bay					all sizes
	MI Lower Green Bay		GP		WC	
	MI Upper Green Bay					GP WC
Chinook salmon	WI Green Bay			< 30"	> 30"	
	MI Lower Green Bay	GP		WC		
	MI Upper Green Bay	GP		WC		
Lake trout	MI Lower Green Bay	GP<22"	GP>22"	WC<26"	WC>26"	
	MI Upper Green Bay	GP<22"	GP>22"	WC<26"	WC>26"	
Longnose sucker	MI Little Bay de Noc	GP<14"	GP>14"	WC<14"	WC14-18"	WC>18"
Northern pike	WI Fox River			< 25"	> 25"	
	WI Green Bay		< 22"	> 22"		
	MI Lower Green Bay	WC<22"		WC>22"		
Rainbow trout	WI Green Bay			all sizes		
	MI Lower Green Bay	GP		WC		
	MI Upper Green Bay	GP	WC<18"	WC>18"		

Table 2-10 (cont.)
1998 Wisconsin FCAs for Green Bay[a] and Fox River,[b] Michigan FCAs for Lower Green Bay,[c] Upper Green Bay,[d] and Little Bay de Noc[e]

		Unlimited	One Meal a Week	One Meal a Month	One Meal Every 2 Months	Do Not Eat
Smallmouth bass	WI Fox River				all sizes	
	WI Green Bay			all sizes		
	MI Little Bay de Noc	GP		WC		
Walleye	WI Fox River			< 16"	16-22"	> 22"
	WI Green Bay			< 17"	17-26"	> 26"
	MI Lower Green Bay	GP<18"	GP18-26"	WC<18"	WC18-26"	GP >26" WC >26"
	MI Upper Green Bay	GP<22"	GP>22" WC<18"	WC18-26"	WC>26"	
White bass	WI Fox River					all sizes
	WI Green Bay					all sizes
	MI Lower Green Bay					GP WC
Whitefish	WI Green Bay				all sizes	
	MI Lower Green Bay	GP			WC	
	MI Upper Green Bay	GP	WC<18"	WC18-26"	WC>26"	
White sucker	WI Fox River				all sizes	
	Green Bay			all sizes		
	MI Lower Green Bay	GP		WC		
Yellow perch	WI Fox River			all sizes		
	WI Green Bay		all sizes			
	MI Lower Green Bay	GP	WC			
	MI Upper Green Bay	GP	WC			

GP = general population, WC = women and children.
a. Including tributaries up to the first dam or barrier.
b. From mouth up to the dam at DePere.
c. Michigan waters of Green Bay south of the Cedar River.
d. Michigan waters of Green Bay north of the Cedar River (excluding Little Bay de Noc), same advisories as Lake Michigan north of Franklin.
e. Apply to smallmouth bass, burbot, and longnose sucker.

Source: MDNR, 1998.

Table 2-11
State of Michigan Fish Consumption Advisories for Green Bay South of Cedar River (advisory applies to Michigan and Wisconsin waters, including the Menominee River from mouth to first dam): 1988-1997

Species	Size	‘88	‘89	‘90	‘91	‘92	‘93	‘94	‘95	‘96	‘97
Rainbow trout	>22"	M	M	M	M	M	M	M	M	M	M
Chinook salmon	>25"	M	M	M	M	M	M	M	M		
Brown trout	>12"	M	M	M	M	M	M	M	M		
	>21"									M	
	≤21"									F[a]	
	>18"										M
	≤18"										F[a]
Brook trout	>15"	M	M	M	M	M	M	M	M	M	
	14-30"										M
Splake	>16"	M	M	M	M	M	M	M	M		
	≤16"	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]		
	>20"									M	
	≤20"									F[a]	
	>18"										M
	≤18"										F[a]
Northern pike	>28"	M	M	M	M	M	M	M	M	M	
	≥26"										M
Walleye	>20"	M	M	M	M	M	M	M	M	M	
Walleye (advisory issued for PCBs and mercury)	≥18"										M
White bass	All	M	M	M	M	M	M	M	M	M	
	≤22"										M
Carp	All	M	M	M	M	M	M	M	M	M	M
White sucker	All	M									
Sturgeon	All						M	M	M	M	
	≥30"										M
Lake trout	≥22"										F[A]
Catfish	All										M

M = No consumption.
F = Limit consumption to 1 meal (½ pound) per week.
a. No consumption of listed fish by children aged 15 and under or by women who are pregnant, nursing, or expect to bear children.

Source: Stratus Consulting, 1998.

Table 2-12
State of Michigan Fish Consumption Advisories for Little Bay de Noc (Lake Michigan): 1989-1997

Species	Size	'89	'90	'91	'92	'93	'94	'95	'96	'97
Longnose suckers	>16"		F [a]	F [a]	F [a]	F [a]	F [a]	F [a]	F [a]	
	≥14"									F [a]
Walleye	>22"	F [b,c]	F [b,c]	F [b]	F [b]	F [b,c]	F [b,c]	F [b,c]		

F = Limit consumption to 1 meal (½ pound) per week.
a. No consumption of listed fish by children aged 15 and under or by women who are pregnant, nursing, or expect to bear children.
b. No more than one meal a month of listed fish by children aged 15 and under or by women who are pregnant, nursing, or expect to bear children.
c. Advisory listed for mercury only.

Source: Stratus Consulting, 1998.

Michigan FCAs changed significantly in structure and content in 1998. Different advisories are now given for (1) women who are pregnant, nursing, or expect to bear children and for children, and (2) for the general population; and more restriction levels have been added. The 1998 levels for Michigan are shown in Table 2-11, along with the 1998 Wisconsin advisories for Green Bay for comparison. Generally the advisories issued in 1998 in Michigan are less restrictive than former Michigan advisories and current Wisconsin advisories as they have the same or similar advisories for women and children, but less restrictive advisories for the remainder of the population.

2.3 IMPACTS FROM FCAs

One intent of FCAs is to educate and warn anglers of potential health risks and to encourage changes in behavior, if and as necessary, to reduce potential health risks. The literature on anglers' behavioral response to FCAs repeatedly shows that anglers change their behavior in response to FCAs. Table 2-13 provides a sample of this literature. These behavioral responses range from reductions in trip taking to changes in how fish are prepared and cooked. These behavioral changes represent recreational fishing services that have been lost (damages) to anglers. Even anglers who do not change their behavior may experience a reduction in enjoyment of their fishing experience and thus experience a loss of services (damages).

Table 2-13
Studies of Behavioral Responses by Anglers to Fish Consumption Advisories

Author	Location and Date of Study	Type of Advisory Considered	Reported Behavioral Response
Hutchinson, 1999	Lower Fox River, Wisconsin, 1997	Lower Fox River -Varies by species, levels include no consumption and limited consumption	64% Had made a change, of these: 71% Travel to other locations to fish 65.9% Do not eat the fish they catch 17.7% Change frequency of fish consumption 9.8% Target and catch different species 7.3% Change the size of fish they keep 2.4% Clean or prepare fish in different ways
West et al., 1989	Michigan, 1988	Michigan Great Lakes and inland waters -Varies by species, levels include no consumption and limited consumption	76% Change cleaning methods 73% Change cooking methods 6% Eat less fish from the site 66% Eat different species
West et al., 1993	Michigan, 1991-1992	Michigan Great Lakes and inland waters -Varies by species, levels include no consumption and limited consumption	75% Change cleaning methods 86% Change cooking methods (Great Lakes anglers) 80% Eat different species (Great Lakes anglers) 46% Eat less fish from the site (overall) 27% Change cooking methods (overall)
Fiore et al., 1989	Lake Michigan, Wisconsin, 1985	Fish caught in Lake Michigan and Green Bay -Varies by species, levels include limited consumption and no consumption	57% Report changing fishing habits and/or fish consumption habits
Silverman, 1990	Lake St. Clair, Detroit River, Lake Erie, 1990	All waters of Michigan, including Great Lakes and inland waters -Varies by species, levels include no consumption and limited consumption	10% Take fewer trips 31% Change fishing locations 21% Change targeted species 56% Change cleaning methods 41% Change the size of fish consumed 28% Change cooking methods 56% Eat less fish from the site 31% Eat different species
Knuth et al., 1996	New York portion of Lake Ontario, 1993	Fish caught in Lake Ontario -Varies by species, levels include no consumption and limited consumption	83% Use risk-reducing cleaning methods 42% Use risk-reducing cooking methods 32% Said they would eat more fish in the absence of advisories

Table 2-13 (cont.)
Studies of Behavioral Responses by Anglers to Fish Consumption Advisories

Author	Location and Date of Study	Type of Advisory Considered	Reported Behavioral Response
Knuth et al., 1993	Ohio River, Illinois, Indiana, Ohio, Kentucky, Pennsylvania, West Virginia, 1992	Fish caught in the Ohio River -Advisories vary throughout the different states and species, levels include no consumption and limited consumption	37% Take fewer trips 26% Change fishing locations 26% Change targeted species 22% Change cleaning methods 17% Change the size of fish consumed 13% Change cooking methods 42% Eat less fish from the site 13% No longer eat fish from the site
Connelly et al., 1992	New York, 1992	All waters of New York -Varies by species, levels include no consumption and limited consumption	18% Take fewer trips 45% Change cleaning methods 25% Change the size of fish consumed 21% Change cooking methods 70% Eat less fish from the site 27% Eat different species 17% No longer eat fish from the site
Connelly et al., 1990	New York, 1987-1988	New York inland waters and Lake Ontario -Varies by species, levels include no consumption and limited consumption	17% Take fewer trips 31% Change fishing locations 46% Change cleaning/cooking methods 51% Eat less fish from the site 17% Eat different species 11% No longer eat fish from the site
Vena, 1992	Lake Ontario, New York, 1990-1991	Fish caught on Lake Ontario -Varies by species, levels include limited consumption and no consumption	16% Take fewer trips 30% Change fishing locations 20% Change targeted species 31% Change cleaning methods 53% Eat less fish from the site 16% No longer eat fish from the site

The study results listed in Table 2-13 show that the responses to FCAs vary by location, FCA severity, and species. The literature cited suggests that the presence of FCAs has resulted in changes in the number and/or quality of recreational fishing days taken. These studies show a range of 10% to 71% of the anglers taking fewer trips to the contaminated sites. These trips may be substituted to other sites that would be considered inferior if the site were not contaminated or substituted from fishing to other, less preferred activities. Anglers may be incurring higher travel costs and/or inferior conditions because of the substitution.

Anglers who remain in the fishery are also impacted. The studies cited in Table 2-13 also found that 6% to 70% of anglers eat fewer fish from the site, 27% to 80% changed the species that they eat, 11% to 66% no longer eat any fish from the site, 2% to 83% changed the way they clean the fish, and 13% to 86% changed the way they cook the fish.

Evidence that anglers have substituted fishing days to other fishing sites is also found in a Wisconsin study, which did not ask about behavioral responses to FCAs (Bishop et al., 1994). Anglers who fished inland waters were asked about the relative importance of various factors that played a part in choosing not to fish in the Great Lakes. "PCB and other contamination in the fish" was identified as a "somewhat important" or "very important" factor by 55% of the respondents. No other single factor was cited by a higher proportion of respondents.

The presence of FCAs may also keep potential anglers from fishing at all. For some individuals, Green Bay may be the only site that they would like to fish because of the convenience of its location or other unique attributes. These individuals may return to fishing in the absence of contamination and the resultant FCAs, and therefore have experienced service flow losses.

The Hutchinson (1999) study cited in Table 2-13 looked at the impacts of PCB contamination on subsistence fishing in the Lower Fox River. Personal interviews were conducted with 70 Hmong or Laotion anglers, 25 Anglo-American anglers, and 7 other minority anglers. This study found that anglers from Hmong/Laotion and other minority groups were more likely than Anglo anglers to eat fish from the Lower Fox River (80%, 72%, and 12%, respectively). About 62% of the non-Anglo anglers ate fish from the Lower Fox River once a month or more. At the time of the study all fish had a minimum restriction of "eat no more than once a month" in the Wisconsin FCAs for the Lower Fox River. When asked about how they reacted to FCAs, 79% of Anglo anglers, 64% of Hmong/Laotion anglers, and 17% of other minorities said they had changed their fishing activity in response to the FCAs.

The identified studies indicate that FCAs impact anglers and their fishing enjoyment. Several of the studies include Green Bay in their study area, but most of the studies that include Green Bay do so as part of a larger area. The Hutchinson (1999) study focuses specifically on the Lower Fox River and the mouth of the Bay around the City of Green Bay, but also focuses on a subset of anglers rather than all recreational anglers.

2.4 ECONOMIC VALUES

In 1996 anglers spent over $900 million on recreational fishing in Wisconsin (U.S. DOI, 1998). Anglers clearly value their fishing experiences, but figures about total expenditures do not tell us what they value about specific sites or fishing days. Models of recreational fishing demand are used to determine the values that anglers place on the different characteristics of fishing sites. In this section we summarize results of the recreation demand literature to value changes in catch rates and for the removal of FCAs. We find the existing literature provides a useful perspective on expected values for the waters of Green Bay, but the literature is not adequate to be relied on solely for this damage assessment.

Values for Changes in Catch Rates

Demand for a fishing day is an increasing function of catch rates. All else being equal, an angler would rather catch more fish. Because catch rates are such an important part of the angling experience, many studies have been done that value catch increases and reductions. Table 2-14 lists a sample of studies that value changes in catch rates in Lake Michigan and Green Bay. These studies indicate that values for changes in catch rates are not inconsequential, but there is large variation in the values these studies produce as there is variation in the location of the studies, the population included, and the species studied. Milliman et al. (1992) surveyed Green Bay anglers in a contingent valuation study that valued additional catch and size of sportfish, but did so when the fishery was at its recent best, and the marginal value of another fish would be low compared to current conditions. The values for the Great Lakes trout/salmon fishery from Lyke's (1993) study were derived from a population of Great Lakes trout/salmon anglers, as well as anglers who did not fish the Great Lakes and would be less concerned with its catch rates. Chen et al. (1999) and Samples and Bishop (1985) both valued increases in trout/salmon species outside of our assessment site.

Chen et al. (1999) modeled fishing choices of Michigan anglers for trips targeting Great Lakes trout and salmon. Each site is a Michigan county, and there are 41 counties that support the fishery. Data on 325 trips from 90 individuals are from their 1994 survey. Value estimates for changing the catch rates in Muskegon County by different amounts are reported in Table 2-14. For doubling the catch rate, the value per user day estimates range from $3.42 to $14.23, depending on the model. For tripling the catch rate, values range from $12.62 to $56.03.

No single previous study values the specific assessment area and specifically addresses anglers' values for changes in catch rates for the species of most interest in this fishery. Thus, the current study provides the basis for measuring accurately values for changes in catch rates for the key species of interest, for addressing potential damages from PCB-induced reductions in catch rates, and for addressing restoration benefits of increased catch rates.

Values for FCAs

While there is relatively extensive literature on the valuation of changes in catch rates, there are fewer studies that value changes in the levels of toxins and the resulting FCAs. Some of these studies are summarized in Table 2-15. The values anglers place on cleaner waters and fish are substantial, but vary across site, type of contamination, levels of contamination, shares of trips affected by the FCAs, substitute sites available, and other factors.

Table 2-14
Selected Valuation Studies for Changes on Catch Rates

Authors	Study Location and Year	Modeled Population	Model	Item Valued	Value Estimates[a] (1998 dollars)
Samples and Bishop, 1985	Lake Michigan, 1979	592 residents of 11 Wisconsin counties adjacent to Lake Michigan	Multiple site travel cost model	10% increase in trout and salmon catch rates	$0.67 per trip $15.15 per additional trout/salmon
Milliman et al., 1992	Green Bay, 1983	250 sport anglers who had been contacted on-site	Dichotomous choice contingent valuation model	Hicksian surplus for yellow perch (catch per trip was at historically high level at time of survey, 1983)	$38.38 per trip $0.29 per additional fish $0.44 per additional inch in length of fish
Lyke, 1993	Wisconsin Great Lakes, 1990	274 Great Lakes trout and salmon anglers 239 inland anglers	Nested logit travel cost model	Avoid a 50% reduction Lake Michigan lake trout catch Avoid a 33% reduction Lake Michigan salmon catch Value of trip to Lake Michigan	$0.07 per trip $0.12 per trip $21.80 per trip
Chen et al., 1999	Michigan waters of Great Lakes, 1994	325 trips from 90 Michigan resident anglers	Multinomial logit and probit repeated random utility models	Increase in trout and salmon catch rates	$3.42 to $14.23 per day for doubling the catch rate, $12.62 to $56.03 per day for tripling the catch rate

a. Per trip (per day) values apply to trips to the impacted fishing site.

Table 2-15
Selected Valuation Studies for the Reduction of Toxins at Fishing Sites

Authors	Study Location	Sample Information	Model	Resource Change	Value Estimates (1998 dollars)[a]
Herriges et al., 1999	Wisconsin waters of Great Lakes	240 Great Lakes trout and salmon anglers, and 247 non-Great Lakes anglers (data from Lyke, 1993)	Kuhn Tucker models	20% reduction in contaminant levels in fish	$66.41 to $81.99 per angler per season $9.08 to $11.22 per Great Lakes fishing day
Chen and Cosslett, 1998	Michigan Great Lakes sites	338 one-day salmon fishing trips	Simulated maximum likelihood is used to estimate a random parameter probit model	Remove area of concern designation at all Michigan Great Lakes sites (total of 14)	$1.19 to $5.61 per trip
Lyke, 1993	Wisconsin Great Lakes	274 Great Lakes trout and salmon anglers, and 239 inland anglers	Contingent valuation -Linear logit (LL) -Constant elasticity of substitution (CES)	Eliminate all contaminants that threaten human health in Wisconsin Great Lakes	$47.08 (LL) to $165.54 (CES) per angler per year $3.88 (LL) to $13.61 (CES) per Great Lakes fishing day
Montgomery and Needelman, 1997	New York	266 anglers and 3,013 nonanglers	Repeated discrete choice RUM	Remove toxic contamination at 23 of 2,586 lakes	$1.98 per trip $0.59 per angler day $83.14 per angler season

Table 2-15 (cont.)
Selected Valuation Studies for the Reduction in of Toxins at Fishing Sites

Authors	Study Location	Sample Information	Model	Resource Change	Value Estimates (1998 dollars)[a]
Hauber and Parsons, 1998	Maine lakes and rivers	143 Maine anglers 2,425 freshwater fishing day trips	Nested logit RUM	Clean up all Maine rivers having FCAs	$1.46 to $1.70 per trip
Jakus et al., 1997	Reservoirs in middle and eastern Tennessee	368 anglers fishing Tennessee reservoirs	Repeated discrete choice RUM (for annual), multinomial logit site-choice model (for per-trip)	Remove FCAs from 6 of 14 eastern Tennessee reservoirs — Remove FCAs from 2 of 14 middle Tennessee reservoirs	$3.15 per trip $52.13 per angler per season — $2.03 per trip $24.15 per angler per season
Jakus et al., 1998	Reservoirs in Tennessee	222 anglers fishing Tennessee reservoirs	Multinomial logit site choice model -Valuation considers whether angler knows about advisories	Remove FCAs from 6 of 14 total Tennessee reservoirs	$7.40 per trip (assumes all anglers know about FCA) $1.51 per trip (across all anglers, but assuming those who do not know have zero loss)
Parsons et al., 1999	Reservoirs in middle Tennessee	143 anglers fishing in middle Tennessee reservoirs	Various RUMs	Remove FCAs from 2 of 14 middle Tennessee reservoirs	$1.95 to $2.05 per trip

a. Per trip (and per day) values in this column apply to all trips taken in the modeled region, not just the trips to the contaminated sites. A lower-bound estimate of annual value could be computed by multiplying the per-trip values by the number of trips to all sites modeled, not just the contaminated sites. The values per trip to contaminated sites only would be greater than the per-trip values reported in this table.

Herriges et al. (1999) developed utility-theoretic Kuhn-Tucker recreation demand models and estimated them using Lake Michigan and Green Bay angling data from 487 anglers collected by Lyke (1993).[6] The models are used to value a 20% reduction in toxins at four aggregate Wisconsin sites, which include Green Bay. The models indicate toxins in Lake Michigan significantly reduce the well-being of Wisconsin anglers. Site-specific values are not presented, but the range of values for a 20% reduction in toxins at all four sites is $66.41 to $81.99 per angler per year ($1998). For comparison to the other studies, we divide the annual values in Herriges et al. by the sample average number of Great Lakes fishing days (7.31) to obtain values per Great Lakes fishing day of $9.08 to $11.22. Similarly for Lyke, using her sample average of 12.16 Great Lakes fishing days, the values per Great Lakes fishing days range from $3.88 to $13.61.

Montgomery and Needelman (1997) estimated a repeated discrete choice model of trips to 2,586 possible fishing sites, 23 of which had toxic contamination. These 23 sites include smaller lakes, as well as portions of larger lakes such as Lake Ontario and Lake Champlain. The population used in this study included 266 New York residents who had fished, and 3,013 who had not fished, between mid-April and October 1989. With 2,586 possible fishing sites, but only 23 contaminated, few angler trips were affected; the impact should be less significant than that of Green Bay FCAs on Green Bay anglers. However, even with a small proportion of sites affected (about 1%) and a population sample that was made mostly of nonanglers, Montgomery and Needelman estimated the value of eliminating toxic contamination at all the toxic sites would be $1.98 per trip ($1998), estimated using only data from anglers. Note that these values applied to all fishing trips taken to all sites, not just trips to the affected sites.

Three studies listed in Table 2-15 (Jakus et al., 1997, 1998; Parsons et al., 1999) estimated the value of reducing toxic contamination to the degree that FCAs could be removed from contaminated reservoirs in Tennessee. These studies concentrated on different geographic regions and included both toxic and nontoxic sites. The models developed were all random utility models, and the population was limited to anglers who used the sites. It should be emphasized that the per-trip values from all of these studies were for trips to all sites modeled, including nontoxic sites. These values did not apply only to the trips taken to the toxic sites.

The values estimated for removing FCAs from two toxic sites within a 14-site region were about $2 per trip. As two sites constituted 14% of 14 sites, a rough first approximation of the per-trip value of cleanup for only the affected sites was approximately $14 ($2/0.14). The values for removing FCAs from 6 toxic sites within a 14-site region were $3.15 per trip from a multinomial logit site-choice model, $1.51 in the same type of model but with the assumption that anglers who did not know about FCAs had zero loss, and $7.40 in the same model with the assumption that all

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6. Other types of models are also estimated, but those models are not utility theoretic and often give implausible results that are not consistent with expectations. However, all estimated models indicate that toxins reduce the amount and quality of fishing services.

anglers knew about FCAs. The 6-site subset represented 43% of the total number of sites, so a rough first approximation of the losses per trip to the contaminated sites ranged from about $3 to $17 [($1.51 to $7.40)/$0.43]. This study showed significant values for removing FCAs but looked at a fishery that was markedly different from Green Bay. The system of reservoirs offered smaller waters with similar nontoxic substitutes to the few reservoirs that were contaminated.

Chen and Cosslett (1998) used data collected on 338 single-day fishing trips targeting trout or salmon. The choice set included 41 possible sites in the Michigan waters of the Great Lakes. They estimated three models of fishing demand: a varying parameter multinomial probit model, an independent multinomial logit model, and an independent multinomial probit model. They valued the cleanup of toxic contamination at 14 sites in the Great Lakes waters of Michigan sufficient to remove the designation of Area of Concern by the International Joint Commission. The values for this cleanup ranged from $1.19 to $5.61 per trip. Again these values are not directly applicable to Green Bay because it was a multisite study limited to trout and salmon anglers in Michigan, and values applied to all trips taken in the 41-site region. These 41 affected sites accounted for 34% of the sites, implying an approximate value per trip to an affected site of about $3.50 to $16.50 [($1.19 to $5.61)/0.34].

None of these studies provided site-specific estimates for the assessment area, or adequately showed how the value of recreational fishing services vary with the levels of FCAs of relevance to this damage assessment. Most were for multiple sites with similar substitutes and/or limited fish species. These studies all indicated the significance of damages from contamination, but did not provide specific values sufficiently useful to transfer to the damage assessment of Green Bay.

CHAPTER 3
PRIMARY DATA COLLECTION

3.1 INTRODUCTION

The principal objective of our assessment is to cost-effectively develop estimates of the value of services lost (damages) as a result of FCAs in the waters of Green Bay. For cost-effectiveness we limited our target population, and therefore our sample, for the primary damage assessment to anglers who purchased Wisconsin fishing licenses in eight Wisconsin counties near Green Bay and who were active in open-water fishing in the Wisconsin waters of Green Bay in 1998. In Chapter 8 we conduct a benefits transfer [43 CFR § 11.83(c)(2)(vi)] to estimate ice-fishing damages in the Wisconsin waters of Green Bay, and to estimate damages for all lost recreational fishing in the Michigan waters of Green Bay. The assessment does not address the value of recreational fishing services lost for anglers who do not fish Green Bay because of FCAs.

By sampling anglers who actively fish Green Bay, we measure damages for those individuals familiar with the site and for whom PCBs and the resultant FCAs are most relevant, which aids in the accuracy of the assessment. We focus on anglers active in the Wisconsin waters of Green Bay where the majority of damages can be expected to occur because the days of recreational fishing in these waters is about double that in the Michigan waters (Chapter 2), and because the PCB concentrations and severity of FCAs are higher in the Wisconsin waters of Green Bay (Chapter 2). We focus on anglers who purchase licenses in eight nearby counties because they can be expected to account for the majority of fishing activities in the Wisconsin waters of Green Bay (Section 3.2). We focus on open-water fishing because it accounts for 85% or more of all fishing on the waters of Green Bay.

A three-step procedure is used to collect data from a sample of anglers in the target population. First, a random sample of anglers was drawn from 1997 license holders in the county courthouses in the eight targeted counties. Second, using the license holder list, a telephone survey was conducted to identify and recruit Green Bay anglers for a followup mail survey and to collect data from a cross-section of anglers. Third, a mail survey was conducted with anglers active in open-water fishing in the waters of Green Bay. The mail survey asked more questions and more complicated questions that would not be desirable to ask by telephone.

In this chapter we address the selection of the target population for the primary assessment and the sampling procedures (Section 3.2), discuss the telephone and mail survey instruments and their implementation (Sections 3.3 and 3.4), and evaluate the sampling plan (Section 3.5).

Throughout this chapter, Green Bay refers to the Wisconsin waters of Green Bay, unless specifically identified otherwise.

3.2 SAMPLING PLAN

3.2.1 Selection of Target Population

The target population for the primary assessment is all resident and nonresident anglers who are active in fishing in the Wisconsin waters of Green Bay in 1998 and who purchased their Wisconsin fishing license in one of eight Wisconsin counties near to the waters of Green Bay. The eight counties include five with shorelines on the waters of Green Bay: Marinette, Oconto, Brown, Kewaunee, and Door; and three nearby counties with relatively large numbers of potential Green Bay anglers: Manitowoc, Outagamie, and Winnebago (Figure 3-1). We limited our target population and sampling to these eight counties because anglers purchasing licenses in these eight counties can be expected to account for most of the fishing activity in the Wisconsin waters of Green Bay, and thus the sample will provide a cost-effective means of data collection. Several pieces of evidence support these conclusions.

The 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. DOI, 1992) indicates that fishing in general tends to be a fairly localized activity. The average one-way distance by in-state residents for a fishing trip is about 34 miles. For Great Lakes fishing, the average one-way distance traveled by in-state residents is about 60 miles. Thus, we expect that a large fraction of fishing trips to the waters of Green Bay and the Lower Fox River originate in the counties around the waters of Green Bay.

A WDNR study of recreational boating patterns in Wisconsin suggests that a large percentage of the fishing effort on Green Bay originates in the counties near Green Bay (Penaloza, 1991, 1992). This is important because boating accounts for as much as 80% of fishing activity on the Wisconsin waters of Green Bay.[1] The Penaloza study explores the origination and destination patterns for boating trips in the state of Wisconsin. For Wisconsin locations, the study finds that the median one-way distance traveled by boaters is 10 miles, while the average one-way distance is 42 miles, again indicating that most boat fishing trips originate from nearby counties.

Penaloza identifies a “Lake Michigan” district, which includes 14 counties adjacent to, or near, Green Bay (Figure 3-2). This district includes the eight counties we include in our sample, plus Florence, Menominee, Shawano, Waupaca, Waushara, and Calumet counties. More than 80% of the respondents residing in the Lake Michigan District (LMD) specify the LMD as a destination

1. WDNR open-water creel surveys 1990-1998. Data provided by Brad Eggold, Senior Fisheries Biologist, Plymouth Field Station.

Figure 3-1
The Eight Targeted Counties

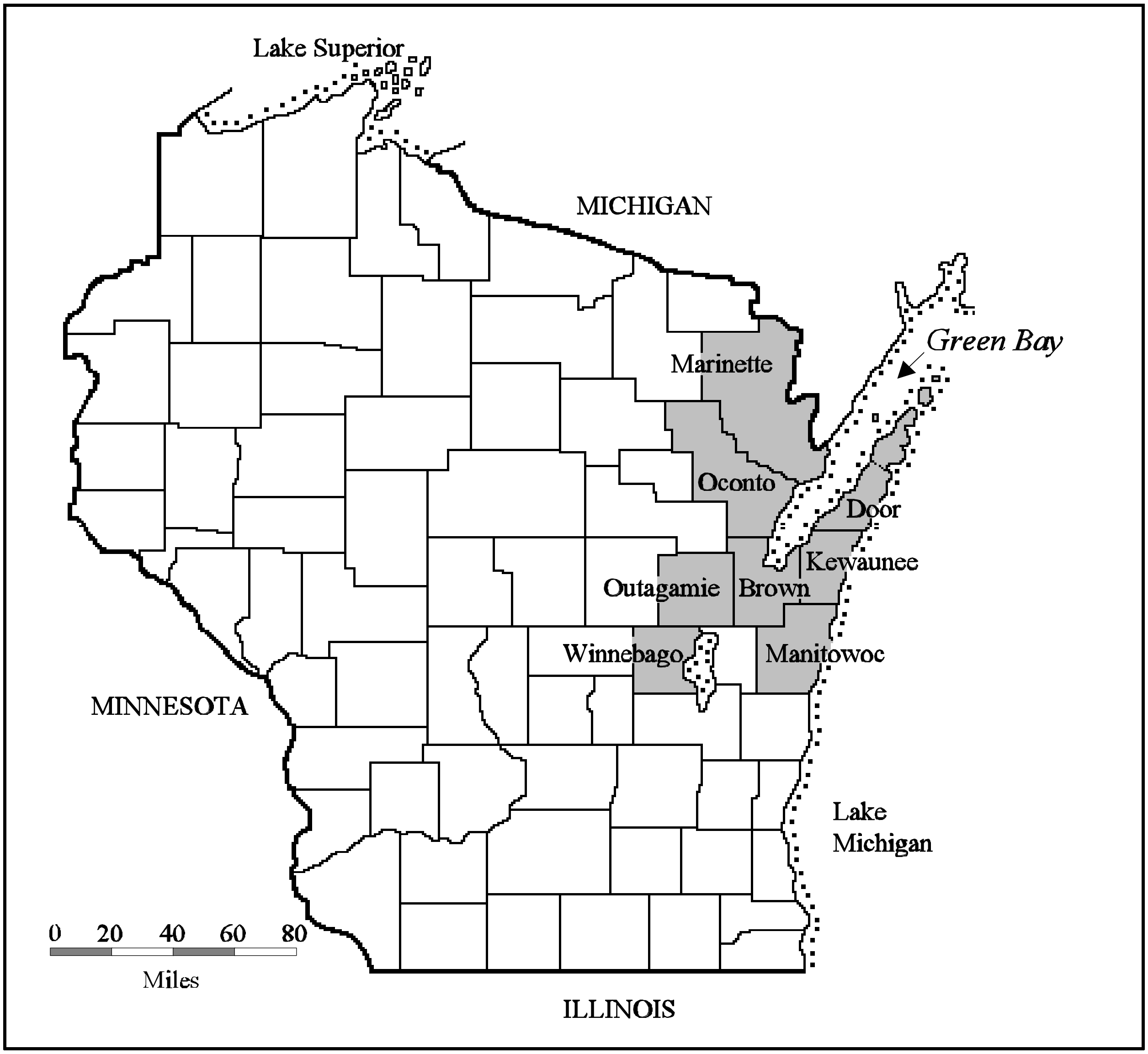
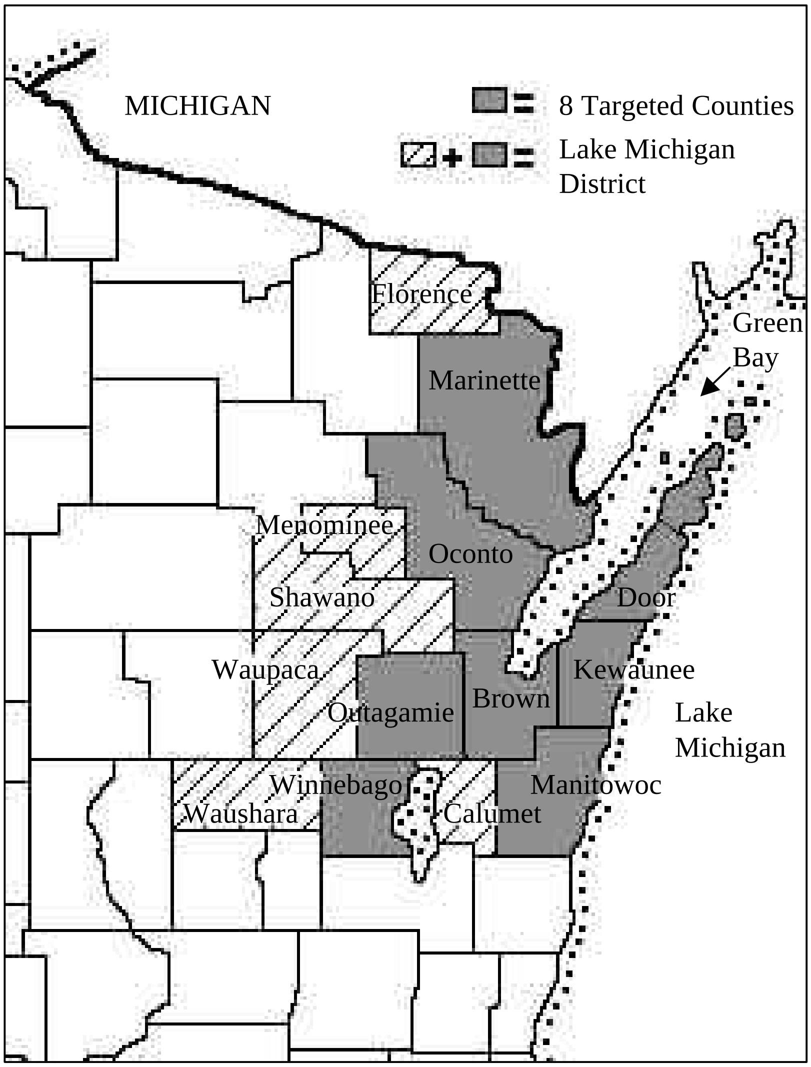


Figure 3-2
Lake Michigan District of Wisconsin



for boating trips involving fishing. This study also finds that about 77% of the individuals choosing the LMD as a destination are residents of the LMD. Since the frequency of use typically decreases as the distance to a site increases, we would expect substantially more than 77% of boating days in the district can be attributed to residents of the district.

The Penaloza survey asked boat anglers to identify their most frequently visited boat fishing site. For residents of the LMD, the percent indicating Green Bay or the Fox River are listed in Table 3-1. Note that the percentage citing Green Bay or the Fox River generally decreases as the county of residence is farther from these waters. The LMD counties that are not included in our

Table 3-1
Percent of Boat Anglers from Lake Michigan District Counties Choosing the Fox River or Green Bay as Their Most Frequently Visited Site

County of Residence	Included in Current Study Counties	Green Bay/Fox River as Most Frequently Visited Site
Brown	Yes	29%
Calumet	No	0%
Door	Yes	83%
Florence	No	0%
Kewaunee	Yes	17%
Manitowoc	Yes	25%
Marinette	Yes	8%
Menominee	No	0%
Oconto	Yes	8%
Outagamie	Yes	3%
Shawano	No	0%
Waupaca	No	0%
Waushara	No	0%
Winnebago	Yes	0%

Source: Based on data from WDNR boating study (Penaloza, 1991, 1992).

target population had no anglers citing the Fox River and Green Bay as their most frequently visited boating site.

Our eight targeted counties contain 83% of the population of the LMD (Wisconsin Legislative Reference Bureau, 1997). Most of the LMD counties not included in the sampling are the farthest from Green Bay, and it is likely that about 95% of the Green Bay fishing days by residents of the LMD are by residents of the eight targeted counties (see Section 3.5.5). By narrowing our sample to the eight targeted counties we significantly reduce the cost of assembling a sample, which requires visits to each county's courthouse because electronic records of fishing licenses do not exist.

By focusing on where anglers purchase their fishing licenses, rather than where they reside, the target population will include anglers who are residents of other Wisconsin counties and who are nonresidents. For instance, nonresidents who fish the Wisconsin waters of Green Bay are most likely to purchase their Wisconsin fishing licenses in Wisconsin counties near Green Bay. The same may be true for Wisconsin residents from other counties who primarily fish at Green Bay or other northeast Wisconsin destinations. Thus, the sample will represent a very large share of anglers who are active in fishing the Wisconsin waters of Green Bay by including residents of those counties, who account for most fishing days in these waters, as well as including residents of other Wisconsin counties and nonresidents who purchase their licenses in these eight counties.

3.2.2 Sample Collection at County Courthouses

Our sample was selected from the population of anglers who purchased 1997-1998 fishing licenses in the eight targeted counties as a cost-effective means to identify and sample anglers in the target population.[2] Potential sample bias due to differences between a sample of 1997-1998 license holders and the target population of 1998 anglers who purchase licenses in these counties is addressed in Section 3.5.1.

We targeted an initial random sample of almost 11,500 anglers in the eight targeted counties to result ultimately in no less than 500 completed mail surveys. This sample size allowed for a conservative estimate of the incidence rate of Green Bay anglers, bad addresses, mail and telephone completion rates, and a substantial contingency for other unknowns.

The sample size targets were created by using the 1996-1997 license sales data from the WDNR (licenses valid from April 1, 1997 to March 31, 1998) to determine the proportions of fishing licenses sold per county for the eight targeted counties (Table 3-2).

Anglers' names and addresses were obtained from copies of 1997-1998 fishing season licenses sold in the eight targeted counties near Green Bay. Vendors keep carbon copies of each license sold until the end of the license season and then turn them over to the county clerk. As of July 1998, the most recent, accessible sample of Wisconsin fishing licenses were those turned in after the 1997 season (which ended in March 1998). To get this sample, each of the eight county clerks was visited over the three-week period from July 20 to August 11, 1998. The dates of these visits and the number of data entry assistants used by county are shown in Table 3-3.

The fishing licenses were randomly sampled so that each angler had a nearly equal probability of being sampled. Licenses were segregated by fishing license type.[3] One type of license was assigned to each data entry person who entered the data into an Excel workbook, keeping a separate worksheet for each type of license. For licenses issued to individuals, every 15th license

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2. 1998-1998 licenses are valid for April 1997 through March 1998. A complete set of 1998 licenses is not available at courthouses, or any other location, until mid-1999.

3. In Kewaunee County licenses are filed by vendor and not by type. In this case, as each data entry person went through the vendor stack, he or she used a list to keep track of a separate count for each license type, and entered the data for each license type into a separate worksheet.

Table 3-2
1997-1998 Angling License Samples Obtained

County	Total Fishing Licenses Sold, 1996[a]	Proportion of 1996 Licenses Sold by Each County[b]	Number of Licenses Needed per County for Sample[c]
Brown	35,110	20%	2,340
Door	21,561	12%	1,437
Kewaunee	10,972	6%	731
Manitowoc	15,701	9%	1,046
Marinette	18,951	11%	1,263
Oconto	12,436	7%	829
Outagamie	26,753	16%	1,783
Winnebago	31,064	18%	2,070
Total	172,548	100%	11,499

a. Includes sales of all types of fishing licenses.
b. Percents may not total 100% due to rounding.
c. Number needed to get a total of about 11,500 licenses, while maintaining the county proportions of total license sales.

Source for fishing licenses sold: Based on WDNR Bureau of Customer Service and Licensing, Report of Fishing Licenses Sold by County, B130-30.

Table 3-3
Timeline for Sampling of Licenses by County

County	City Courthouse	Target Sample Size	Date (1998)	Data Entry Assistants
Brown	Green Bay	2,340	August 5/6	3
Door	Sturgeon Bay	1,437	August 3	2
Kewaunee	Kewaunee	731	July 30	2
Manitowoc	Manitowoc	1,046	July 29	2
Marinette	Marinette	1,263	August 7	3
Oconto	Oconto	829	July 24	2
Outagamie	Appleton	1,783	July 20/21	2
Winnebago	Oshkosh	2,070	August 10/11	3
All targeted counties		11,499		

was input (starting with the 14th license); and for licenses issued to married couples or families, every 7th license was input (starting with the 7th license), alternating between recording the husband's or wife's name. In any case where the selected license record was illegible (15 cases), the next legible license was recorded. The count was then resumed from the original illegible license.

For nonresident licenses, if the selected license record had a nondomestic address (two cases), the next license record with an American address was recorded. The count was then resumed from the original nondomestic address.

For each county, once all license types had been counted through, another count was made of the total number of licenses selected, and this total was compared to the target sample for the county. If the number of licenses selected was more than a few licenses short of the targeted sample, additional licenses were selected from each license type. A new skip interval was calculated for the license types issued to individuals and for the license types issued to married couples or families. The number of licenses obtained by county and license type are shown in Table 3-4.

3.3 TELEPHONE SURVEY

3.3.1 Telephone Survey Instrument

The telephone survey was used to identify the proportion of anglers who fish the waters of Green Bay, to obtain data on total fishing days and Green Bay fishing days, and to identify and recruit anglers who were active in 1998 in fishing the Wisconsin waters of Green Bay to participate in the followup mail survey. The telephone survey also collected information for all anglers in the telephone sample, regardless of whether they fished Green Bay in 1998. This allows a comparison of activity levels and attitudes for anglers who are active in Green Bay fishing versus anglers who are not, and allows a comparison of those Green Bay anglers who complete the followup mail survey to those who complete the telephone survey but do not complete the followup mail survey. The telephone survey collected the following information.

- ***Fishing activity level.*** Data were collected on the total days of ice-fishing and open-water fishing in 1998 up to the time of the telephone survey and how many of these days were in the waters of Green Bay. Because the survey was implemented in late 1998, over 95% of days fished in 1998 by these anglers are reflected in these data. These days are separated into days fished in the Lower Fox River and elsewhere in the waters of Green Bay (including tributaries up to the first dam or obstruction).

- ***Attitudes about Green Bay fishing.*** Anglers who did not fish Green Bay in 1998 were asked why they did not fish; and, if they would consider fishing Green Bay in the future, what things would have to change to consider fishing in the future. The questions about

Table 3-4
1997-1998 Angling License Sample Obtained

License Type	County								
	Brown	**Door**	**Kewaunee**	**Manitowoc**	**Marinette**	**Oconto**	**Outagamie**	**Winnebago**	**Total**
Resident annual	1,310	321	178	459	650	396	917	1,169	5,400
Husband and wife	671	147	62	220	276	237	637	520	2,770
Sportsman	236	45	34	102	102	56	214	188	977
Two day	49	452	356	146	20	5	2	0	1,030
Nonresident annual	25	115	24	16	80	33	12	12	317
Nonresident 15 day	13	65	12	10	26	18	6	27	192
Nonresident 4 day	41	181	39	52	127	55	27	205	731
Nonresident family annual	2	60	15	7	30	18	5	7	144
Nonresident family 15 day	0	65	7	8	25	14	5	13	152
Patron	0	0	1	14	0	0	0	0	15
Total sample obtained	2,347	1,451	728	1,034	1,336	832	1,825	2,141	11,694
Target	2,340	1,437	731	1,046	1,263	829	1,783	2,070	11,499
Total sample obtained as percent of target	100.3%	101.0%	99.6%	98.9%	105.8%	100.4%	102.4%	103.4%	101.7%

why they did not fish Green Bay and what would have to change are open-ended — potential responses are not provided to the respondent. These questions provide an indication of the share of anglers who are not active in Green Bay fishing who attribute not fishing in Green Bay to PCBs and fish consumption advisories — a damage category that is not otherwise quantified in this assessment. These anglers experience a damage in that the PCBs and resultant FCAs cause them to forgo fishing at a site they would otherwise choose to visit.

- ***Attitudes about fish contamination and fishery management options.*** Questions were asked about catching fish that are free of contamination and about the importance of 10 actions that could be taken to improve fishing in Wisconsin: six for the waters of Green Bay and four for other waters. These actions include increasing catch rates for sport fish and for panfish, cleaning up contaminants, increasing boat ramps and other facilities, improving water quality, and reducing the cost of a fishing trip. These questions identify the relative importance of improvements in different fishing characteristics for all anglers and for Green Bay anglers. The responses to these questions also provide a key point of comparison between those anglers completing the followup mail survey versus all other anglers completing the telephone survey.

- ***Socioeconomic characteristics.*** Questions include years of fishing experience, boat ownership, vacation home ownership with distance from Green Bay, age, employment status, racial group, household composition, and gender. These data assist in the statistical evaluation of group respondents.

- ***Mail survey solicitation.*** For anglers who actively fished Green Bay in 1998, the telephone survey concludes with a solicitation to participate in the followup mail survey; and confirms the correct name and address to which materials would be sent, and a telephone number for any future contact.

3.3.2 Telephone Survey Implementation

The telephone survey was conducted by Hagler Bailly's facility in Madison, Wisconsin. This 26-station centrally monitored interviewing facility uses CASES, a computer-assisted telephone interviewing (CATI) software developed and supported by the University of California, Berkeley. The telephone survey occurred between November 17, 1998 and January 15, 1999.

To ensure the efficient use of resources, the initial sample of license holders collected at county courthouses was split into two segments, with the first segment of 6,799 records (about 60% of the sample) selected to be fielded.[4] The first segment of the collected sample was sufficient to reach the mail survey targets so the second segment of the collected sample was not used.

The fishing licenses provided names and addresses but no phone numbers. Phone numbers were assembled using regular and reverse directories, supplemented by directory assistance. We were unable to obtain phone numbers for about 32% of the anglers in our sample (see Table 3-5). This reflects changes in addresses, residents with unlisted numbers, and potentially invalid license information.

Table 3-5
Proportion of Starting Sample with Available Phone Number

	Total	Percent
Starting sample (part of the courthouse sample initially set up)	6,799	100%
Phone number found	4,597	67.6%
No phone number found[a]	2,202	32.4%

a. After using reverse directory and calling directory assistance.

The telephone survey was implemented with the sample of 4,597 records with an identified telephone number. Overall, the telephone survey was completed with 69% of the license holders with identified telephone numbers (see Table 3-6). At a minimum, eight attempts were used to reach sampled license holders. We attempted to convert all "soft" refusals (e.g., in instances where the angler stated it was an inconvenient time to call, we contacted them at a later time). The reasons given for refusals were 9% said they did not fish anymore, 6% said they do not do surveys, 22% hung up the telephone before an introduction could be read, 50% indicated they were just not interested, 4% asked to have their name taken off the list, and 9% gave miscellaneous other reasons.

Table 3-7 shows a comparison, by county, of the total number of 1997 license holders, the number of licenses in the full sample of 11,694, the number of licenses in the reduced sample of 6,799, and the number of completed telephone interviews. The table confirms that the telephone survey completions by county generally retain the proportion of license holders in the target population for 1997, which is also very similar to the proportion of license holders in 1996 that was used to develop the sampling plan (Table 3-2). Thus, we can expect the proportions to reflect also the proportions of license holders in 1998.

4. All records were assigned a random number, the records were sorted in ascending order by random number, and the first 6,799 records were selected.

Table 3-6
Disposition of Telephone Survey Sample

	Total	Percent of Total	Percent of Completes
A. Disposition of Sample			
Adjusted sample	4,597	100%	—
Refused telephone recruitment screening survey	1,115	24.3%	—
Language barrier/respondent incapable (elderly, ill)	158	3.4%	—
Called minimum of eight times	134	2.9%	—
Completed telephone surveys — total	3,190	69.4%	100%
B. Categorization of Anglers Completing the Telephone Survey			
Did not fish in 1998	520	—	16.3%
1998 angler, but not a Green Bay open-water angler[a]	1,831	—	57.4%
1998 Green Bay open-water angler declining mail survey	67	—	2.1%
1998 Green Bay open-water angler recruited for mail	753	—	23.6%
1998 Green Bay open-water angler eligible to be recruited, but after cutoff date to send the mail survey	19	—	0.6%

a. Includes 67 anglers who only ice fished Green Bay in 1998.

The telephone survey data on 1998 fishing activity were used to categorize anglers by participation in the Green Bay fishery. About 84% of 1997-1998 license holders fished in 1998 (Table 3-6). As seen in Table 3-8, about 26.3% of all 1997-1998 license holders (and 31.4% of the 1997-1998 license holders who fished in 1998) fished the open waters of Green Bay in 1998. Note that 62% of all 1997-1998 license holders have been active in Green Bay fishing in 1998 or at some time in the past.

For subsequent data analysis, we use 31.4% as the percent of anglers in our target population each year who are active in fishing the Wisconsin waters of Green Bay. We assume 1997 license holders who did not fish at all in 1998 are replaced in the population by an equal number of 1998 anglers who were not license holders in 1997. That is, the departing population members are replaced so that the total number in the population remains roughly unchanged (see Section 3.5 for additional discussion of this point).

Table 3-7
Disposition of Sample by County Where License Purchased

County Where 1997 License Purchased	1997 License Sales Reported by WDNR		Initial Sample of License Holders		Reduced Sample of License Holders		Telephone Surveys Completed	
	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Brown	28,800	19.6%	2,347	20.1%	1,407	20.7%	658	20.6%
Manitowoc	13,316	9.1%	1,034	8.8%	609	9.0%	317	9.9%
Marinette	16,920	11.5%	1,336	11.4%	736	10.8%	354	11.1%
Oconto	10,120	6.9%	832	7.1%	502	7.4%	247	7.7%
Outagamie	22,455	15.3%	1,825	15.6%	1,011	14.9%	514	16.1%
Winnebago	25,275	17.2%	2,141	18.3%	1,270	18.7%	554	17.4%
Door	19,457	13.3%	1,451	12.4%	841	12.4%	343	10.8%
Kewaunee	10,233	7.0%	728	6.2%	423	6.2%	203	6.4%
All Targeted	146,576	100%	11,694	100%	6,799	100%	3,190	100%

Source for fishing licenses sold: Based on WDNR Bureau of Service and Licensing, Report of Fishing Licenses Sold by County, B130-30.

Table 3-8
Telephone Survey Respondent Green Bay Fishing Activity in 1998

	1997-1998 License Holders		1997-1998 License Holders Who Fished in 1998	
	Number	Percent	Number	Percent
Fished Green Bay in 1998	906	28.4%	906	33.9%
- Fished Green Bay open water in 1998	839	26.3%	839	31.4%
- Fished Green Bay in 1998, but only ice fishing	67	2.1%	67	2.5%
Fished Green Bay sometime in the past, but not in 1998	1,084	34.0%	862	32.3%
Never fished Green Bay	1,197	37.5%	899	33.7%
Undetermined	3	0.1%	3	0.1%
Total	3,190	100.0%	2,670	100.0%

The telephone survey identified 839 Green Bay open-water anglers in 1998, of which 820 were recruited for the followup mail survey, with 753 (92%) agreeing to participate in the survey (Table 3-6). Nineteen Green Bay open-water anglers were identified too late to be recruited for the mail survey.

3.4 MAIL SURVEY

3.4.1 Mail Survey Instrument

The core of the mail survey is a series of eight choice questions concerning preferred alternatives for fishing conditions in the waters of Green Bay (see Section 1.4 and Figure 1-2), and a followup question to each choice question about how often the respondent would fish the waters of Green Bay under the preferred alternative. These questions provide the stated preference information used to value changes in Green Bay fishing conditions. The details of the choice questions and followup questions are discussed in Chapter 5, and the modeling of and results for the choice questions are discussed in Chapters 6 through 9. The mail survey questions before and after the choice question section support the development and evaluation of the choice questions, and are discussed in the remainder of this section.

The design of the mail (and telephone) survey instrument reflected a neutral presentation. The sponsor(s) of the survey and the intended use of the results for damage assessment were not identified. Cover letters for the mail survey identified that the survey would assist in "important management decisions to be made concerning fishing in and around Green Bay," and that "the results of this study will be made available to government and industry representatives."

In pretests, when respondents were asked who they thought the survey was being conducted for and why, the most frequent answers were they did not know or that it involved the State of Wisconsin to help evaluate what to do in Green Bay. Respondents often stressed to us the importance of their input given their concerns with FCAs, catch rates, costs, and other considerations in the waters of Green Bay. Respondents infrequently raised the potential link to the Superfund or NRDA cases. Given these considerations and the high response rates, we conclude the respondents treated their responses as having important input to management decisions that would affect them and did not consider the work to be for litigation.

Information in the survey was verified as factual, and the facts and survey presentation were repeatedly tested and peer reviewed for presentation and content. The final survey instruments reflected an 18-month process that involved five focus groups and four pretests involving about 200 anglers, most of whom were active in fishing the waters of Green Bay (Table 3-9).

The remainder of this section summarizes the content of the mail survey instrument (see Appendix E for a copy of this survey instrument, and Section 5.4 for additional discussion).

Table 3-9
Recreation Survey Pretesting Steps

Date	Site	Activity	Number of Participants	Type of Respondents	Focus	Investigators
4/22/97	Marinette, Wisconsin	Focus group	12	Anglers who fished Green Bay or Lake Michigan in the past 3 years	Investigate awareness of pollution and PCB issues, health concerns about eating fish, and behavioral responses to perceived pollution in Green Bay and Lake Michigan	Mike Welsh
4/23/97	Marinette, Wisconsin	Focus group	12	Anglers who did not fish Green Bay or Lake Michigan in the past 3 years		
6/23/97	Green Bay, Wisconsin	Focus group	12	Anglers who fished Green Bay or Lake Michigan in the past 3 years	Test survey materials, assess potential attributes and attribute levels for potential choice question, explore role of PCBs in anglers' perception of the Green Bay fishery	Mike Welsh
6/23/97	Green Bay, Wisconsin	Focus group	6	Anglers who did not fish Green Bay or Lake Michigan in the past 3 years		
6/24/97	Green Bay, Wisconsin	Focus group	12	Anglers who fished Green Bay or Lake Michigan in the past 3 years		
12/10/97	Green Bay, Wisconsin	In-depth interview	52	Anglers who fished Green Bay in the past 3 years or who would fish Green Bay in the absence of pollution-related issues	Test choice question survey materials, clarity of questions, and length of survey	Mike Welsh, Edward Morey, Jeff Lazo, Sonya Wytinck
12/11/97	Oshkosh, Wisconsin	In-depth interview	50			
8/16 to 08/30/98	Brown County residents	Mail/ Phone	26	Anglers who fished Green Bay in the past 12 months	Final pretest of survey	Mike Welsh, Sonya Wytinck
9/9/98	Green Bay, Wisconsin	In depth interview	18	Anglers who fished Green Bay in the past 12 months		Mike Welsh, Sonya Wytinck

The Study Area

The mail survey begins by clearly delineating the study area as the "Waters of Green Bay," which include the Bay of Green Bay, Sturgeon Bay, and the rivers and streams that feed into Green Bay up to their first dam, if any. This is reinforced through the cover page title, "What Do You Think About Fishing the Waters of Green Bay? 1998 Angler Survey;" a color map and definition of the study area inside the front page; and Questions 1 and 2, which ask about how the quality of fishing in these waters compared to other locations the anglers fish at.

Fishing Activity

Questions 3 through 6, 39, and 40 complete the respondent's record of Green Bay fishing days in 1998, including the number of additional days fishing the waters of Green Bay since the telephone survey (Q3), and the number of additional days anticipated in 1998 (for surveys mailed before the end of the year, Q39, Q40). Other fishing activity questions include how often they target different species (Q4), what percent of their open-water fishing days are from a boat (Q5), and (if they fish from a boat) how many people are in their typical boat fishing group (Q6). These questions are used to characterize the anglers by type of anglers (e.g., shore anglers for perch, boat anglers for sport-caught fish) and to evaluate further the validity of the data collection. For example, anglers who often target perch would be expected to place more importance on perch catch rates and FCAs than would anglers who seldom target perch.

Fishing Characteristics

The survey focuses on catch rates and FCAs for four species (yellow perch, trout/salmon, walleye, and smallmouth bass), and on costs to visit a Green Bay fishing site. Each of these fishing characteristics is given a consistent presentation to reduce any potential importance bias by stressing a specific characteristic (e.g., FCA levels). Questions 7 through 13 introduce the fishing characteristics to be addressed in the choice questions and thus begin the cognitive process of evaluating how important different levels of these characteristics are to anglers' fishing experiences. These questions also introduce a minimum set of common information, and introduce the concepts of relative importance and tradeoffs between alternative characteristics before the actual choice questions. See Section 5.4 for an additional discussion on the selection of these site characteristics (and omission of other site characteristics), and the selection of the levels of the characteristics.

Question 7 asks the respondent to rate the importance of various actions that can be taken to enhance the Green Bay fishery (similar to telephone survey Question 13), including adding boat launch facilities, shoreline parks, and nature trails; improving water clarity; increasing catch rates; removing PCBs and fish consumption advisories; and other items of concern to the respondent. This question addresses all the characteristics to be traded off in the choice questions and provides a consistency check between the telephone survey and mail survey concerning the relative importance of actions to enhance the Green Bay fishery. Further, items in Question 7 that are not addressed in the choice questions (boat launches, shoreline parks, and trails) are an indirect reminder that there are other alternative (substitute) improvements than those addressed in detail later on.

Question 8 introduces the concept of catch time in terms of how long one fishes on average per fish caught; differentiates catch time from the bag limit; and asks about the importance of increasing fish populations and thus catch rates.

Questions 9 through 11 concern PCBs and FCAs. Question 9 introduces PCBs and the resulting FCAs, and asks whether the respondent was aware of the FCAs. Question 10 further defines FCAs to establish a consistent understanding, and identifies a subset of the potential health risks associated with eating PCB-contaminated fish. The health impacts identified (for women, increased risks of bearing children who have learning disabilities or develop more slowly; and for the total population, increased cancer risks) are consistent with the WDNR FCAs and published information (see Young, 1999 for a brief summary). Question 10 prepares the respondent to evaluate the relative importance of changes in FCAs versus catch rates and fishing costs by asking how bothersome, if at all, it is to fish with advisories of different severity levels.

Question 11 addresses if and how anglers react to the fish consumption advisories in terms of reducing days fished, changing the location of fishing, changing the type and size of fish targeted and kept, and changing methods of fish preparation and cooking. These response categories are similar to the types of impacts typically associated with FCAs (see Chapter 2), and reflect the intent of FCAs — to change behavior, as required, to reduce potential adverse exposure to PCBs.

Question 12 asks for a breakdown of expenses the respondent personally incurs on a typical day of fishing the waters of Green Bay. This question serves as a reminder of the costs the respondent incurs and is asked before the questions addressing tradeoffs between costs, catch rates, and FCA levels.

Question 13 addresses the relative importance of higher boat launch fees, catch times, and PCB contamination. For respondents who do not fish from a boat, this question introduces the concept that they should "think of the daily boat launch fee as a fee you would have to pay to fish the waters of Green Bay" so that the cost variable in the choice questions has a meaning to all respondents. This presentation was tested in the pretests and found to be accepted in a manner consistent with the ultimate choice questions (e.g., trading off costs versus FCA levels and catch rates).

Questions 15 through 34 are the fishing choice and followup questions, which are discussed in Chapter 5. Item 14 is not a question but an information section prior to the fishing choice questions.

Followup and Socioeconomic Questions

Questions 35 through 38 are followup questions to evaluate the responses to the choice questions and other survey questions. Question 35 asks how important each characteristic in the choice questions was to the choices (e.g., perch catch rate, perch FCA, trout catch rate, . . ., daily boat launch, or access fee). Question 35 is used to establish links from:

- attitudes and fishing behaviors to those characteristics anglers state they are most concerned about when making choices among alternatives in the choice questions (e.g., anglers who target perch can be expected to care more about perch catch rates and perch FCAs)

- characteristics anglers state they are concerned about and intended to rank high in their choices (Question 35) and the actual characteristic levels in alternatives selected in the choice questions (e.g., respondents who rank perch catch rates as one of the most important characteristics make choices that show a preference for perch catch rates).

When evaluated across the entire sample and all choice questions (see Section 5.4), these links substantiate that the responses to choice questions are meaningful because they reflect both actual behavior and attitudes, as well as reflecting intended responses to the choice questions.

Question 36 asks about perceived average catch rates, Question 37 asks about perceived FCA levels, and Question 38 asks about perceived average daily boat launch fees — all for the waters of Green Bay. These questions aid in understanding perceptions about fishing conditions in the waters of Green Bay. Note, however, that perceptions may reasonably differ from measured conditions, and may vary across individuals, because of different experiences and expertise; because the FCAs and catch rates have varied through time and vary throughout the Bay of Green Bay (in Wisconsin and Michigan), and between Green Bay and the Lower Fox River (the FCAs even vary by the size of fish for some species); and because of measurement error.

The mail survey concludes with education and household income questions, which were not asked in the telephone survey.

3.4.2 Mail Survey Implementation

The mail survey was also carried out by the Hagler Bailly Survey Center. Ten versions of the mail survey were prepared. These versions differed only in terms of the choice alternatives presented in Questions 19, 21, 23, 25, 27, 29, 31, and 33. Sampled anglers were randomly assigned a version number (1-10) before being called for the telephone screener survey to assure random assignment. The mail survey consisted of the following procedures.

1. ***Initial mail survey package.*** All 1998 Green Bay anglers who agreed to participate in the mail survey were mailed a survey booklet within one week of their completion of the telephone screener survey. This mailing consisted of a cover letter from Hagler Bailly, a mail survey booklet, an incentive (two $1 bills), and a postage-paid return envelope. This mailing was done from October 26, 1998 to January 11, 1999.

2. ***Thank you/reminder postcard.*** All anglers were mailed a postcard within one week of the initial survey mailing. This postcard thanked those who had responded and reminded those who had not responded to please do so.

3. ***Followup survey mailing.*** Approximately two weeks after the thank you/reminder postcard, all nonrespondents were sent a followup survey mailing. This mailing consisted of a cover letter from Hagler Bailly, another copy of the mail survey booklet, and a postage-paid return envelope. (This letter was revised after December 31, 1998, to remove references to the holiday season.)

4. ***Second followup survey mailing.*** Approximately two weeks after the first followup survey mailing, all nonrespondents were sent another followup survey mailing. This mailing consisted of a cover letter from Hagler Bailly, another copy of the mail survey booklet, and a postage-paid return envelope.

5. ***Special third followup survey mailing.*** Nonrespondents who had completed a telephone survey before November 20, 1998, were sent a third survey mailing. This mailing consisted of a cover letter from Hagler Bailly, another copy of the mail survey booklet, and a postage-paid return envelope. This was mailed in January, after the holiday season, and was sent four to six weeks after the second followup survey had been mailed.

6. ***Initial mail survey package to anglers who refused second phase.*** The 68 Green Bay anglers who, in the telephone survey, declined to participate in the second phase of the research were also mailed a survey package, although this initial mailing was not sent until January 8, 1999 (at least one month after their initial refusal). These respondents were thanked for their participation in the initial phase of research, and were asked to reconsider helping out with the second phase. Since the study was near completion, these anglers only received the first three mailings described above. Fifty percent of these respondents completed and returned the survey.

Table 3-10 shows the response rates to the mail survey. In the telephone survey, 839 anglers were identified as having fished the open waters of Green Bay in 1998. Eight-hundred-twenty of these identified anglers were sent a mail survey; 19 were not eligible as they were identified too late in the process to be included in the followup mail survey sample). By the cut off date of February 1, 1999, 647 had returned the mail survey. Overall, completed mail surveys were received from about 79% of the 820 Green Bay open-water anglers to whom the mail survey was

Table 3-10
Disposition of Mail Survey Sample

	Number of Surveys	Percent of Surveys
Number mailed	820	100%
Undeliverable	6	0.7%
Refused	4	0.5%
Not returned before cut-off date	163	19.9%
Completed	647	78.9%

sent and from about 77% of the 839 Green Bay open-water anglers identified in the telephone survey.

3.5 SAMPLE EVALUATION

This section evaluates the collected sample data in terms of potential sample bias comparing the sample versus the target population for the primary assessment (Section 3.5.1), potential nonresponse bias resulting from less than full participation of the sampled anglers (Section 3.5.2), and potential recall bias on how many days were spent fishing in 1998 (Section 3.5.3). To account for these potential biases, in Section 3.5.4 we apply corrections to the sample estimates for open-water fishing days to determine population estimates of open-water fishing days. No adjustments are made to the estimates of damages per open-water fishing days due to FCAs. In Section 3.5.5 we use the sample results to evaluate what share of all fishing days in the Wisconsin waters of Green Bay are likely to be by the target population.

3.5.1 Sample Bias

Sample bias refers to biases that may result from differences between the sample selected and the target population. The target population for the primary valuation is anglers who purchased licenses in the eight targeted counties and who actively fished Green Bay in 1998. Through the courthouse sampling procedures we have a random sample of 1997 anglers purchasing licenses in these counties without any significant sampling bias. Sample biases may arise from (1) differences between the 1997 license-holder population used to develop the sample and the 1998 population of anglers active in fishing the waters of Green Bay, and (2) differences between those individuals for whom a telephone number could and could not be identified.

1997 License Holders versus 1998 Anglers

Turning to the first issue, the sampling technique captured anglers who purchased licenses in 1997 and fished in 1998, but did not capture any anglers who fished in 1998 but did not purchase licenses in 1997, i.e., “new” anglers. This omission creates four questions: (1) How many of these “new” anglers are there?, (2) What percentage of them fished in Green Bay?, (3) How often did they fish in Green Bay and at all fishing sites?, and (4) How do these “new” anglers value service losses from FCAs compared to repeat anglers?

We address the first question by assuming that the number of “new” anglers in the population is the same as the number of “dropout” anglers who bought licenses in 1997 but did not fish at all in 1998 (otherwise the angling population size would continuously decrease; in fact, the fishing hours slightly increased from 1997 to 1998, as reported in Table 2-3). According to the telephone survey, 16.3% of all 1997 license holders did not fish at all in 1998 (Table 3-6). We assume that an equal number of “new” anglers replaces these “dropout” anglers in 1998.

The second question is the percentage of these “new” anglers who fished in Green Bay in 1998. We have no reason to expect that “new” anglers will prefer or reject Green Bay as a fishing location in greater or lesser proportions than did the telephone survey respondents who fished in 1998. Therefore, we assume that the same percentage of these “new” anglers fished in Green Bay as was reported by the survey respondents, i.e., 31.4% (Table 3-8).

The third question is how often these “new” anglers go fishing (at Green Bay and at all sites), compared to the anglers participating in the telephone survey. Anglers who fish every year may be more avid (i.e., fish more days per year) than anglers who only fish in some years. For example, Table 3-11 identifies that the number of fishing days is about 36% lower for anglers who did not fish Green Bay in 1998 but have in the past (e.g., they may be “intermittent” Green Bay anglers), and Table 3-12 suggests that females may be more likely to be “intermittent” anglers. Female license holders fish about 40% less than do male license holders (Appendix F, Table F-1).

Thus, it may introduce a bias to assume that the “new” anglers not captured by the survey fish the same amount as the survey respondents (who bought licenses in 1997 and were still fishing in 1998). To be conservative and account for this potential bias, we assume that the “new” anglers are less avid than the survey respondents and that they fished only 50% as often (half as many days per year). This assumption is conservative and may result in an underestimate of damages because the 50% assumption produces a larger reduction that other evidence suggests (Table 3-11 and Appendix F, Table F-1), and because the assumption that “new” anglers are less avid than long-time (or repeat) anglers may be false. For example, many of these “new” anglers may be new to the sport because they are recent immigrants to the area who are just as avid as long-time residents.

Table 3-11
Mean Fishing Days to All Sites in 1998 by Green Bay Experience
(telephone survey data)

	Fished Green Bay in 1998[a]	Fished Green Bay, Not in 1998	Never Fished Green Bay
Mean days ice fishing in 1998 (SE)	4.9 (0.29)	3.2 (0.25)	1.8 (0.18)
Mean days open-water fishing in 1998 (SE)	24.1 (0.82)	15.5 (0.67)	12.0 (0.56)
Mean days fishing in 1998 (SE) Median	29.0 (0.97) 20	18.7 (0.79) 10	13.7 (0.64) 6

a. Anglers who participated in open-water fishing on the Wisconsin waters of Green Bay.

The fourth question censors whether these "new" anglers value service losses from FCAs different than do the repeat anglers. We make no adjustment to the value per fishing day for reductions in FCAs as a result of potential sample bias from using a 1997 sample of license holders and 1998 fishing activity. Several pieces of data from the survey suggest that per day fishing values will not be significantly different for these "new" anglers. First, attitudes about enhancements to the Green fishery are very similar for anglers who have (1) never fished Green Bay, (2) fished Green Bay but not in 1998 (and may be intermittent Green Bay anglers), and (3) fished Green Bay in 1998. Table 3-13 shows the average responses to the following question, "I am going to read you 10 actions that might be taken to improve the quality of fishing in Wisconsin. Six of these actions are for the waters of Green Bay and the other four are for other waters. For each statement, please tell me if, compared to other things that could be done to improve fishing, you think taking this action is, 'Not at all important' [= 1], 'Somewhat important' [= 2], or 'Very important' [= 3]." Results from this question are informative to understanding how values for reducing FCAs may vary across anglers and for considering what actions are most important to restore and enhance fishing in the waters of Green Bay and elsewhere in Wisconsin.

In Table 3-13, actions are ordered from the highest to the lowest average ranking given by all respondents, not in the order in which the actions were presented in the telephone interview. The two actions given the highest importance for all those interviewed were cleaning up contaminants in Green Bay and in inland waters so that none of the fish caught are contaminated. About 84% of the respondents ranked these actions as very important, and less than 2% thought they were not at all important.

Table 3-12
Socioeconomic Profile by Green Bay Experience
(telephone survey)

	Fished Green Bay in 1998	Fished Green Bay, Not in 1998	Never Fished Green Bay	All Respondents
Percent male	81.9%	77.2%	65.8%	74.2%
Mean age (SE) (Question 18)	41.5 (0.40)	43.6 (0.35)	41.7 (0.35)	42.3 (0.21)
Percent Caucasian (Question 20)	91.6%	91.8%	90.3%	91.2%
Percent Native American (Question 20)	5.0%	5.2%	5.1%	5.0%
Percent with job for which they receive a wage or salary	84.3%	82.9%	82.3%	83%
Percent — work full-time	77.5%	74.4%	72.3%	74.6%
Percent — work part-time	6.7%	7.8%	9.4%	8.1%
Percent — homemaker	2.0%	1.9%	4.7%	3.0%
Percent — retired	7.1%	8.5%	6.6%	7.4%
Percent — self employed	4.4%	5.0%	3.7%	4.3%
Mean N of people in household (SE) (Question 21)	3.2 (0.05)	3.0 (0.04)	3.2 (0.04)	3.1 (0.02)

The action ranked next in importance was improving the clarity of water in Green Bay, which was slightly more important to those who had never fished Green Bay (about 70% of those who had never fished Green Bay thought it was very important compared to 61% of those who had fished in the waters of Green Bay in 1998). The remaining actions were very important to some anglers but not the majority of anglers. Only 29% of anglers felt increasing panfish catch rates was very important (34% of 1998 Green Bay anglers), and 22% felt that increasing public boat launches on inland waters was very important. Note also that anglers, including Green Bay anglers, felt that additional inland boat ramps were slightly more important than additional Green Bay boat ramps.

Next, evidence here suggests that the anglers that fish less often do not necessarily have significantly lower values per fishing day, if lower values at all, for eliminating FCAs in Green Bay. For example, while female license holders tend to fish about 30% to 40% less often than do male license holders (Table F-1), they have per day values for reducing FCAs that are 40% larger

Table 3-13
Importance Rating of 10 Actions to Improve Wisconsin Fishing
(telephone survey Question 13, where 1 = not at all important, 2 = somewhat important, and 3 = very important; mean and SE reported)

	Fished Green Bay in 1998	Fished Green Bay, Not in 1998	Never Fished Green Bay	All Respondents
Clean up contaminants so that none of the fish caught in Green Bay are contaminated	2.83 (0.01)	2.81 (0.01)	2.87 (0.01)	2.84 (0.01)
Clean up contaminants so that none of the fish caught in the inland waters of Wisconsin are contaminated	2.82 (0.01)	2.79 (0.01)	2.87 (0.01)	2.83 (0.01)
Improve the water clarity in Green Bay	2.51 (0.02)	2.57 (0.02)	2.66 (0.02)	2.59 (0.01)
Increase average catch of panfish like yellow perch on Green Bay	1.95 (0.03)	1.97 (0.03)	1.88 (0.02)	1.93 (0.01)
Provide additional public boat launches on inland waters	1.96 (0.02)	1.90 (0.02)	1.89 (0.02)	1.91 (0.01)
Increase average catch of sport fish like trout, salmon, bass, and walleye on Green Bay	1.88 (0.02)	1.86 (0.02)	1.89 (0.02)	1.88 (0.01)
Provide additional public boat launches on Green Bay	1.89 (0.02)	1.82 (0.02)	1.82 (0.02)	1.84 (0.01)
Make existing boat ramps around Green Bay free	1.80 (0.03)	1.78 (0.02)	1.82 (0.02)	1.80 (0.01)
Reduce the cost of fishing licenses	1.69 (0.03)	1.71 (0.02)	1.76 (0.02)	1.72 (0.01)
Reduce the cost of launching a boat on inland lakes	1.70 (0.02)	1.68 (0.02)	1.75 (0.02)	1.72 (0.01)

(Chapter 9). Anglers who reside farther away from Green Bay tend to fish Green Bay less than anglers who live closer to Green Bay, but are estimated to have similar values per fishing day for the removal of FCAs as those anglers who live closer to Green Bay (see Chapter 9).

Missing Telephone Numbers

The second source of potential sampling bias is that phone numbers could not be identified for about one-third of the anglers identified in the courthouse sample. Some anglers have unlisted phone numbers (approximately 21% of households in the sample area do not have listed phone numbers, which corresponds to about two-thirds of the sample for which phone numbers were not found). Other anglers may have moved out of the area and are replaced by other anglers moving into the area, with no clear bias. Other anglers may have provided inaccurate or invalid addresses, with unknown bias.

A study evaluating the design of the national hunting and fishing survey found that the amount of fishing days by households without telephones was higher than for households with telephones (Westat, 1989, page 6-4). Therefore, the omission of anglers without telephones may result in understated estimates of days per angler.

Research by Piekarski (1989) indicates that households with nonlisted telephone numbers are more likely to be multifamily housing units and renter-occupied than are listed households. In addition, nonlisted households are also more likely to be urban, especially in metropolitan statistical areas with large central cities. Younger persons (both female and male), as well as single, divorced, and separated householders (with and without children), are more likely to be unlisted than other types of households. Retired householders are over-represented, while employed householders are under-represented, in a sample of listed households. Finally, we are unaware of any consistent evidence that household income differs significantly between listed and nonlisted households.

Given the mixed evidence relevant to anglers for whom no phone number could be found, and that the values per fishing day and the number of fishing days (which are multiplied to obtain damages) may be offset for some unlisted anglers (e.g., see discussion of female anglers above), we conclude that no adjustments to the estimates of days per angler, and of the value per fishing day from reductions in FCAs, are warranted because of unlisted phone numbers.

3.5.2 Nonresponse Bias

Nonresponse bias refers to biases resulting from the differences between the respondents and the nonrespondents in the sample of anglers who purchase licenses in the eight sample frame counties and who are active in Green Bay fishing. For the reasons presented below, we conclude that nonresponse bias, if any, would have a very small impact on per day value estimates, but may affect the estimates of fishing days per angler, for which we make an adjustment, as described below.

Telephone Survey

The telephone survey high response rate of 69.4% can be expected to reduce potential nonresponse bias. External data for anglers who purchase their licenses in the eight sample frame counties and who are active in fishing the waters of Green Bay are not readily available against which to compare our telephone sample. The two observable variables we have for our telephone nonrespondents are the county where they purchased their Wisconsin fishing license, and the type of license purchased. The survey participation rates in the telephone survey are very similar regardless of the type of license purchased or the county in which the fishing license was purchased (see Appendix F, Tables F-2 and F-3). While we have no evidence to indicate clearly that nonrespondents to the telephone survey fish any more or less than respondents, it may be the case that anglers who fish less often may find the topic less salient to them and, compared to anglers that fish more often, may be less likely to participate in the telephone survey, which starts by identifying “we are conducting a study of people’s opinions about fishing.”

To be conservative in the damage assessment, while we have no evidence of this potential bias, we assume it exists in the estimate of open-water fishing days and make an adjustment for it. We assume 31.4% of these nonrespondents are Green Bay anglers (as in the sample of active anglers as a whole), but that they fish Green Bay 50% as often as do the anglers who completed the telephone survey (see Section 3.5.4). As noted above, the values for reducing FCAs are similar to (and in some cases larger) than for anglers who fish more often, and therefore we make no adjustment for potential nonresponse in the telephone survey to the per angler estimates of fishing days or damages per fishing day resulting from FCAs.

Mail Survey

The mail survey had a high response rate, with 79% of those mailed the survey (and 77% of all identified 1998 Green Bay anglers in the telephone survey) returning the survey.[5,6] Evaluating these results, we find no basis for a potential response bias and make no adjustments.

There was little difference in fishing avidity between those recent Green Bay anglers who completed and returned the mail survey and those who did not. In fact, Table 3-14 shows that

5. This included 50% of those who were not recruited to receive a mail survey when called for the telephone survey, but who were still sent the mail survey.

6. Item nonresponse is very low at 4% or less for most all questions. The exceptions are 4-11% for the individual species in the target species question (Question 4), 7% for income, and up to 20% for comment questions for which responses were optional.

Table 3-14
Fishing Days in 1998: Mail Respondents versus Nonrespondents
(telephone survey data)

	Returned Mail Survey	**Did Not Return Mail Survey**[a]	**Total**
Number of respondents	647	192	839
Total open-water fishing days (SE)	24.56 (0.96)	23.51 (2.01)	24.32 (0.86)
Mean total fishing days (SE)	28.59 (1.10)	29.37 (2.43)	28.77 (1.02)
Mean Green Bay open-water days (SE)	9.80 (0.55)	10.28 (1.06)	9.91 (0.49)
Mean Green Bay ice-fishing days (SE)	1.18 (0.16)	2.05 (0.37)	1.38 (0.15)

a. This includes 1998 Green Bay open-water anglers who either were not sent the mail survey or who did not return the mail survey. These results exclude 67 anglers who ice fished the waters of Green Bay but did not open-water fish the waters of Green Bay.

nonrespondents were slightly more avid than those who returned the survey, averaging a half-day more of reported fishing in 1998.

Mail survey response rates did not differ much by gender: about 76% for females and 77% for males. Seventy-two percent of the anglers who returned the survey live in a household in which they or someone else owns a boat, compared to 69% of anglers who did not return the survey. While about 27% of both groups own vacation homes, those who returned the survey had vacation homes slightly closer to Green Bay (mean of 84 miles compared to 93 miles).

The two groups, respondents and nonrespondents, were similar socioeconomically with the exception of age. The average age of the nonrespondents was 36.4 years compared to 43.3 years for those who returned the mail survey. About 83% of those who returned the mail survey, and 86% of those who did not respond, work at a job for which they receive wages or a salary. In both cases 92% of the employed respondents were employed full time. Of those who do not receive wages or a salary, homemakers and students were less likely to return the survey (about a 70% response rate compared to the overall 79%), but together make up only 3.2% of the total Green Bay anglers who were sent a mail survey. The racial makeup of both mail respondents and nonrespondents was similar to each other and to the original telephone survey sample.

As shown in Table 3-15 respondents and nonrespondents hold very similar opinions about the 10 actions to improve Wisconsin fishing, with the nonrespondents placing a slightly higher importance on cleaning up contaminants and improving water clarity in Green Bay. When asked how important it is to them that the fish they catch are free of contaminants, 89% of the nonrespondents said very important compared to 79% of the respondents. This suggests that nonrespondents to the mail survey may value removing PCBs and the resultant FCAs more highly than do respondents.

Table 3-15
Importance Rating of 10 Actions to Improve Wisconsin Fishing:
Mail Survey Respondents versus Nonrespondents
(telephone survey Question 13; mean and SE reported)

	Returned Mail Survey (N = 647)	Did Not Return Mail Survey[a] (N = 192)
Clean up contaminants so that none of the fish caught in Green Bay are contaminated	2.82 (0.02)	2.87 (0.03)
Clean up contaminants so that none of the fish caught in the inland waters of Wisconsin are contaminated	2.81 (0.02)	2.87 (0.03)
Improve the water clarity in Green Bay	2.47 (0.03)	2.65 (0.04)
Increase average catch of panfish like yellow perch on Green Bay	1.96 (0.03)	1.99 (0.06)
Provide additional public boat launch facilities on inland waters	1.96 (0.03)	1.92 (0.05)
Increase average catch of sport fish like trout, salmon, bass, and walleye on Green Bay	1.88 (0.03)	1.89 (0.06)
Provide additional public launch facilities on Green Bay	1.89 (0.03)	1.86 (0.05)
Make existing boat ramps around Green Bay free	1.80 (0.03)	1.78 (0.05)
Reduce the cost of fishing licenses	1.67 (0.03)	1.70 (0.05)
Reduce the cost of launching a boat on inland lakes	1.71 (0.03)	1.68 (0.05)

a. This includes all 173 Green Bay open-water anglers who did not return the mail survey and 19 Green Bay open-water anglers who were not mailed the survey because they were identified too late in the process.

In summary, Green Bay open-water anglers who returned the mail survey were on average older, a little less avid about fishing, and only slightly less concerned about contamination than those who did not return the survey. Thus, we conclude that potential response bias, if any, is likely to be very small and could slightly bias downward the damage estimates.

3.5.3 Recall Bias

Due to the timing of our survey in late 1998, we collected data on the annual number of days fishing in 1998 up to the time of the telephone survey and updated the estimates in the mail survey, which added about 2% to the estimates. The process of collecting fishing activity data on an annual recall basis, rather than in sampling waves throughout the year, may be subject to recall bias, and may result in increased estimates of fishing activity. Recall bias in recreation studies is sometimes referred to as "telescoping," where respondents assign events from the past time periods into more recent time periods (Pollock et al., 1995). Recall bias for recreational fishing was examined by Westat (1989; see also Chu et al., 1992) as part of the methods development for the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (National Survey). Westat, with recreation data collected in Wisconsin and Texas, compared estimates of fishing activity using repeated two-week recall versus annual recall (as well as semiannual and quarterly recall).[7] The two-week recall sample was selected by Westat as providing estimates with limited or no recall bias. The ratio of annual fishing days from the repeated two-week recall sample compared to the annual recall sample was 62.2% (adjusted for drop-outs of avid anglers; see Westat pages 6-16 to 6-19).

To account for potential recall bias when computing aggregate damages for the target population, we multiply our best estimates from the mail survey of 9.95 Green Bay fishing days and 24.98 total fishing days per Green Bay angler (see Table 4-1 and discussion in Section 4.2) by 62.2% to adjust for potential recall bias. As discussed in Section 3.5.4, these adjusted fishing day estimates are combined with other sampling adjustments to reduce further the mean sample estimates to be applied to all anglers in the target population.

The Westat study also found a small recall bias in annual recall of fishing participation rates (e.g., they did or did not fish). The Westat study was conducted with the general population, while our study already identified individuals who held fishing licenses in 1997 and who are much more likely to have fished in 1998 than the general population. Thus, any potential participation recall bias in our study is minimized or eliminated, and no correction is made for this potential bias.

7. The Wisconsin sample is particularly relevant as it focused on northeast Wisconsin in a triangular region between Green Bay, Madison, and Milwaukee.

3.5.4 Adjusting the Sample Estimates to the Population Estimates

Based on the above discussion of potential sampling, nonresponse, and recall biases, the sample mean estimates of fishing days are adjusted to be applied to the target population to compute aggregate damages. These adjustments and the resulting population mean estimates are illustrated in Table 3-16. In Table 3-16, the 4,596 anglers in the telephone sample are grouped according to disposition in the telephone survey, and for each group the number of Green Bay anglers and the number of Green Bay open-water fishing days per angler are computed reflecting adjustments for potential recall, sampling, and nonresponse biases, as follows.

1. For the 647 anglers who completed the mail survey (Table 3-16, line 1), their sample mean estimate of 9.95 Green Bay fishing days (Table 4-1) is multiplied by 62.2% to result in a recall-adjusted population mean Green Bay open-water fishing days of 6.19 (9.95 × 62.2%). This is the final estimate for these 647 anglers (last column of Table 3-6).

2. For the 192 Green Bay open-water anglers who completed only the telephone survey (line 2), we assume the same recall-adjusted estimate of 6.19 Green Bay open-water fishing days as for those who also completed the mail survey (e.g., 100% of the mail survey recall adjusted estimate is used). As with the telephone survey, these anglers had actually fished slightly more than respondents who completed the mail survey.

3. For the 1,831 anglers who completed the survey and who were active anglers, but who were not active in fishing Green Bay (line 3), none are Green Bay anglers and there are no Green Bay fishing days.

4. For the 520 1997 license holders who did not fish in 1998 and for the 100 license holders who refused the interview saying they no longer fish (line 4), we assume they are replaced in the population by 1998 license holders who did not have licenses in 1997 (“new” anglers). We assume 31.4% of these “new” anglers are Green Bay anglers, the same as for the 2,370 anglers active in open-water fishing who completed the telephone survey (resulting in 163 + 31 = 194 “new” Green Bay anglers). We assume these “new” anglers fished 50% as many days (adjusted for recall) as the 647 in the mail sample of 1997 license holders who also fished in 1998 for an estimated 3.11 (6.19 × 0.5) open-water fishing days in Green Bay.

5. For the 291 individuals who did not answer the telephone, or for whom language barriers prevented communication, and for the 245 individuals who hung up their telephone before the introduction was read (line 5), we assume 31.4% are Green Bay anglers (as in the population who completed the telephone interview). We assume they fish Green Bay the same number of days as the license holders who completed the mail survey (adjusted for recall) because there is no evidence to suggest these anglers are different from anglers who completed the telephone or mail surveys.

Table 3-16
Adjustment from the Mail Sample Estimated Open-Water Fishing Days to the Population Estimated Open-Water Fishing Days in 1998 for Anglers Active in Open-Water Fishing on the Wisconsin Waters of Green Bay

Telephone Sample Disposition	Number of Anglers in Telephone Survey	Percentage Who Are Green Bay Active	Number Green Bay Anglers	Green Bay Days as % of Recall Adjust. Sample Mean	Final Estimated Green Bay Days per Angler
1. Green Bay anglers who completed telephone and mail survey	647	100%	647	—	6.19[a]
2. Green Bay anglers who completed telephone survey only	192	100%	192	100%[b]	6.19
3. Non-Green Bay anglers who completed telephone survey	1,831	0%	0	—	—
4. Did not open-water fish in 1998					
> Completed telephone survey	520	31.4%	163	50%	3.11
> Refused telephone survey	100	31.4%	31	50%	3.11
5. No contact completed					
> No answer or language barrier	291	31.4%	91	100%	6.19
> Hung up before introduction	245	31.4%	77	100%	6.19
6. Others/refused telephone survey					
> Not interested	558	31.4%	175	50%	3.11
> Take name off list/other	212	31.4%	67	50%	3.11
7. Population estimates of Green Bay open-water fishing days in 1998 (% of mail survey estimate of 9.98)	4,596	31.4%	1,444	—	5.25 (52.8%)
8. Population estimate of total open-water fishing days in 1998					13.19[c]

a. Sample mean of 9.95 (Table 4-1) × 62.2% for recall adjustment (Section 3.5.3) = 6.19 recall adjusted open-water Green Bay fishing days.
b. Note that, through the telephone survey, Green Bay open-water anglers who were nonrespondents to the mail survey had fished slightly more than respondents completing the mail survey (Table 3-14).
c. Equals sample mean of 24.98 (Table 4-1) × 52.8% combined recall, sample, and nonresponse adjustment factor = 13.19.

6. For the 770 (558 + 212) anglers who were contacted by telephone and did not hang up before the introduction, but then refused the telephone survey (line 6), we assume 31.4% were Green Bay open-water anglers who fish half as often as the license holders who completed the mail survey.

Under the above assumptions, in Table 3-16, the total estimated number of Green Bay open-water anglers in the original telephone sample is 1,444, and the weighted average Green Bay open-water days is 5.25, which equals 52.8% of the initial sample best estimate of 9.95 (line 7). About 80% of this difference is because of adjustments for recall bias and about 20% is because of adjustments for sampling and nonresponse bias. We apply this same 52.8% correction factor to the 24.98 sample estimate of total open-water fishing days (Table 4-1) to develop a population estimate of 13.19 total open-water fishing days in 1998 (line 8). Applying the 52.8% correction factor to the total (open-water plus ice) fishing days estimates in Table 4-1 results in adjusted total fishing days per sampled angler of 5.87 on Green Bay and 15.34 at all sites.

By way of comparison, the adjusted target population estimates of 5.87 Green Bay total fishing days per Green Bay angler is nearly equal to the 1996 National Survey estimate for Lake Michigan anglers of 5.8 ± 2.0 days of Lake Michigan fishing, and the 15.34 total fishing days estimate is less than the National Survey estimate of 20.2 ± 8.4 total fishing days per Lake Michigan angler. The National Survey estimates are based on a sample of only 36 anglers.[8] The total fishing day estimate of 15.34 is slightly more than the approximately 14 day estimate from the Westat survey for Wisconsin residents from the same region, which was based on a sample of over 1,700 anglers (although the estimates are over a decade old and include non-Green Bay anglers, who fish less often than do Green Bay anglers — see Table 3-11). Further, these estimates are generally consistent with the WDNR creel estimates of angler activity in the waters of Green Bay for 1998.[9]

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8. The Lake Michigan day estimates are not exactly comparable as Green Bay angling is a subset of Lake Michigan angling. Some Lake Michigan anglers may fish in Lake Michigan inside and outside of Green Bay, and some Green Bay anglers may never fish in Lake Michigan outside of Green Bay.

9. The WDNR does not report the estimated number of open-water fishing days in the waters of Green Bay. An approximation can be developed by dividing the number of open-water fishing hours in the Wisconsin open-water creel survey for 1998 (905,762 from Table 2-1) by the creel estimate of four hours fishing per day, which results in 226,440 days. Dividing that number of fishing days by 48,600 Green Bay anglers in the target population (Chapter 8), who account for the vast majority of these fishing days, results in 4.7 Green Bay open-water days per angler in March through December. Recall the open-water creel survey omits certain time periods (see Footnote 1 in Chapter 1).

3.5.5 Target Population Coverage of All Open-Water Fishing in the Wisconsin Waters of Green Bay

While the target population for the primary assessment is those Green Bay open-water anglers who purchase their Wisconsin fishing licenses in one of eight targeted counties near the waters of Green Bay, data from the WDNR and from our survey indicate that the target population may account for on the order of 90% of all Green Bay open-water fishing days, and our sample generally reflects the distribution of Green Bay open-water fishing days by origin of residence of the anglers. This can be ascertained by examining our sample in three groups: anglers from the Lake Michigan District (see Figure 3-2), anglers from out-of-state, and anglers from the rest of Wisconsin outside of the LMD. For each group, we use data and assumptions to evaluate the approximate share of the group's Green Bay open-water fishing days that is likely to be represented in our target population and approximately what share of the total number of Green Bay open-water fishing days the group is likely to account for.

The computations in the remainder of this Section 3.5.5 are based on a combination of literature data and our survey data and are intended only to indicate the potential magnitude of how the target population covers the entire population of Green Bay anglers, rather than to be precise estimates, either for the total or individual components of this analysis.

Lake Michigan District

The population of the targeted counties is about 83% of the LMD population (Wisconsin Legislative Reference Bureau, 1997). If we assume that the incidence of fishing is the same throughout the LMD, then 83% of all LMD license holders are in the eight targeted counties.[10]

We expect the incidence of Green Bay anglers to be less in the omitted counties than the included counties because the omitted counties are farther from the site. Table 3-17 shows the incidence of Green Bay fishing by county for our sample. Anglers who purchased licenses in a county adjacent to Green Bay (Brown, Door, Kewaunee, Marinette, and Oconto) were about twice as likely to fish Green Bay as those who purchased their licenses in one of the nonadjacent targeted counties. This reflects that resident anglers in nearby counties are more likely to fish Green Bay than are resident anglers from more distant counties (consistent with the evidence presented above that the median travel distance for boat fishing is 10 miles), and some anglers from outside the region who fish in Green Bay purchase licenses near the site. Because the omitted counties are even farther from the site than the three nonadjacent counties in our sample, we can expect an even lower

10. We further assume that LMD anglers purchase their licenses in their county of residence. Because some residents of omitted counties (and all residents of Menominee County) who fish Green Bay may purchase their licenses in one of the eight targeted counties, it may be that over 83% of LMD anglers are covered in our target population.

Table 3-17
1998 Green Bay Angler Incidence Rate by County Where License Purchased

County Where 1997-1998 License Purchased	Number of Screeners Completed	Number of Green Bay Anglers Identified	Green Bay Angler Incidence Rate
Brown County	658	246	37.4%
Door County	343	139	40.5%
Kewaunee County	203	54	26.6%
Manitowoc County	317	63	19.9%
Marinette County	354	113	31.9%
Oconto County	247	60	24.3%
Outagamie County	514	86	16.7%
Winnebago County	554	78	14.1%
All targeted Counties	3,190	839	26.3%
- Adjacent to Green Bay	1,805	612	33.9%
- Not adjacent to Green Bay	1,385	227	16.4%

incidence of Green Bay anglers in these counties. For the omitted LMD counties, we assume the incidence of Green Bay open-water anglers to be 50% as much as for included counties.

Next, we expect the number of open-water fishing days per Green Bay angler to decrease with distance from the site. In a later analysis (Table 4-2) we find that anglers who reside in the three nonadjacent counties report 60% as many Green Bay open-water fishing days per angler as do anglers who reside in the five adjacent counties, and further that anglers from elsewhere in Wisconsin report 55% as many Green Bay open-water fishing days per angler as do anglers who reside in the five adjacent counties. For the omitted LMD counties, we assume the rate of Green Bay fishing days by Green Bay open-water anglers is 55% as large as for included LMD counties.

Combining the above data and assumptions, our target population can be expected to account for about 95% of the Green Bay open-water fishing days by anglers from the Lake Michigan District.[11]

11. 83%/[83%+ (17% × 0.5 × 0.55)] = 94.7%, where 83% and 17% are the population percentages for the included and omitted LMD counties, and 0.5 and 0.55 are the adjustments for reduced incidence and reduced Green Bay fishing days in omitted LMD counties.

Recall that Penaloza (1992) reported about 77% of boat trips in the LMD district originated by anglers in the LMD (these percentages may be even higher in 1998 given that the reduced catch rates from the early 1990s to 1998 may deter anglers who are farther away more than they deter anglers from nearby counties). In our data we find that the percent of boat versus nonboat days does not vary much with distance from the site, so we assume about 77% of all Green Bay fishing days are from anglers residing in the LMD. Thus, the residents from the eight counties in the target population will account for about 73% of all Green Bay fishing days (77% × 95%). Our sample may omit about 4% of the total Green Bay open-water fishing days by excluding five LMD counties from our target population (77% LMD total minus 73% of this total that is expected from the targeted counties).

Table 3-18 identifies our sample number of anglers and reported Green Bay days by residence. About 76% of our sampled anglers, and about 83% of the reported days, are from residents of the eight targeted counties. Thus, our sample has a slightly higher percentage of days by anglers residing in the targeted counties than the above data supports may be likely to occur for all Green Bay fishing days.

Table 3-18
Number and Percent of Sampled 1998 Green Bay Angler Fishing Days by Resident State/County (telephone and mail survey data)

State/County of Residence	Number of Anglers		Green Bay Open-Water Fishing Days		Green Bay Ice-Fishing Days		Green Bay Fishing Days	
Wisconsin	531	82%	5,672	88%	736	96%	6,408	89%
In targeted counties	494	76%	5,381	83%	721	94%	6,102	85%
Not in targeted	37	6%	291	5%	15	2%	306	4%
Michigan	13	2%	266	4%	23	3%	289	4%
Other state	103	16%	502	8%	7	1%	509	7%
All	647	100%	6,440	100%	766	100%	7,206	100%

Out-of-State Anglers

Table 3-18 reports that anglers from out-of-state account for about 18% of the respondents and 12% of the Green Bay fishing days in the sample. This reflects that out-of-state anglers tend to fish Green Bay fewer days than do resident anglers (Table 3-19). The exception is anglers from Michigan who fish more days in Green Bay, which is reasonable as almost all of these 13 anglers live in a county (and in or near the city of Menominee) that is adjacent to Wisconsin and to both the Bay of Green Bay and the Menominee River (which is part of the waters of Green Bay).

Table 3-19
Mean Days Fishing Green Bay in 1998 by Resident State
(telephone survey data)[a]

State of Residence	N	Mean Days Ice Fishing in 1998 (SE)	Mean Days Open-Water Fishing in 1998 (SE)	Mean Days Fishing in 1998 (SE)
Wisconsin	752	1.9 (0.18)	9.8 (0.53)	11.7 (0.60)
Michigan	16	3.1 (1.34)	18.9 (6.38)	22.0 (6.34)
Other states	138	0.2 (0.11)	4.9 (0.39)	5.2 (0.40)
All	906	1.7 (0.15)	9.2 (0.46)	10.9 (0.52)

a. Per-angler days increase slightly in the final mail sample reflecting end-of-year fishing days. See Chapter 4.

Our sample is likely to include most nonresident anglers who fish the waters of Green Bay. This is because nonresident anglers are most likely to purchase their licenses in a county near their fishing destination. In fact, we find that 90% of our sample of out-of-state anglers purchased their licenses in one of the five adjacent counties, and only 10% purchased a license in one of the three nonadjacent counties. Further we find that 99% of reported open-water fishing days in Wisconsin by out-of-state anglers in our telephone sample are on the waters of Green Bay. While a few out-of-state anglers who fish Green Bay may purchase their Wisconsin fishing licenses outside of our targeted counties, is appears likely that most all will purchase their licenses in the targeted counties: we assume 95% of Green Bay fishing days by out-of-state anglers are reflected in our sample. Thus, our sample omits less than 1% of all Green Bay open-water fishing days (5% of the approximately 12% of total Green Bay open-water fishing days by out-of-state anglers).

Anglers from the Rest of Wisconsin

Anglers from the rest of Wisconsin who fish the waters of Green Bay are likely to purchase their licenses near their residences, or near where they plan to fish. Anglers from the rest of Wisconsin account for 6% of our sample anglers and 5% of our sample of Green Bay open-water fishing days (Table 3-18). Our target population omits Green Bay fishing days by those Green Bay anglers who purchase their licenses outside of the targeted counties. The size of this omission is unknown. However, for simplicity, if we assumed 100% coverage of Green Bay fishing days from LMD anglers by residents of our eight targeted counties and 100% coverage of out-of-state anglers, the difference of 6% between the sample share of fishing days by anglers residing in our targeted counties (83%) and the projected share of fishing days by anglers residing in LMD counties (77% or more) would approximately represent the omission of Green Bay open-water fishing days by Wisconsin anglers who reside outside of the eight targeted counties.

Target Population Coverage of All Green Bay Fishing Days

Based on the above computations, selection of our target population is likely to account for about 90% of all Green Bay open-water fishing days. The sample does not account for Green Bay open-water fishing days by LMD residents outside of the eight targeted counties (about 4%), by out-of-state anglers who purchase their licenses outside of the eight targeted counties (less than 1%), and by residents from other counties in Wisconsin who purchase their licenses outside of the eight targeted counties (about 6%).

CHAPTER 4
GREEN BAY ANGLER PROFILE

4.1 INTRODUCTION

This chapter provides data on fishing activity and attitudes for our sample of anglers who actively fished the Wisconsin waters of Green Bay in 1998. These results focus on the 647 anglers who completed both the telephone and mail surveys, and who report over 7,000 Green Bay fishing days and over 18,000 total fishing days in 1998. In this chapter, Green Bay fishing refers to fishing the Wisconsin waters of Green Bay, including all tributaries up to the first dam or obstruction, unless specifically identified otherwise.

The vast majority of anglers active in Green Bay fishing are aware of and show a general knowledge about the PCB FCAs. Anglers express that cleaning up PCBs so that the FCAs can be removed is one of the most important improvements, if not the single most important improvement, that can be made in the Green Bay recreational fishery. Boat launches, improved facilities, and reduced costs are desirable, but much less important than uncontaminated fish and increased catch rates (in that order).

The impacts of PCB contamination and the resultant FCAs are substantial. The majority of current Green Bay anglers indicate that as a result of PCB contamination and FCAs, they have altered their Green Bay fishing behavior. Additionally, over 10% of the sampled anglers that did not fish Green Bay in 1998 express that PCB contamination was a key factor explaining why they did not fish Green Bay in 1998.

These results indicate that the PCB contamination and the FCAs can be expected to result in significant damages to Green Bay anglers and to other anglers who do not currently fish Green Bay.

Section 4.2 provides angler reported data on the number of Green Bay fishing days per Green Bay angler, as well as expenditure data and additional angler characteristics. Section 4.3 provides attitudinal data about the Green Bay fishery as a whole. Section 4.4 discusses anglers' awareness of FCAs, and the impacts of FCAs on recreational fishing behavior and enjoyment are presented in Section 4.5.

4.2 GREEN BAY FISHING ACTIVITY AND EXPENDITURES

Data on the number of days Green Bay anglers fished in 1998 were collected in two parts. First, in the telephone survey anglers were asked how many days they had spent fishing from January 1, 1998, until the time of the telephone interview. Second, in the mail survey they were asked how many days they had fished in 1998 since the day of the telephone interview. The data from these two sources were combined for the total reported days fished in 1998. Unless stated otherwise, the results in this chapter are as reported by respondents and are not adjusted for potential recall, sample, and nonresponse bias (see Section 3.5.4).

The number of reported 1998 fishing days is reported in Table 4-1. These numbers are slightly higher than the reported days in Chapter 3, which were only for fishing activity from January 1, 1998, to the day the telephone survey was completed (between late October and December 1998). As noted in Chapter 3, the total fishing days and Green Bay fishing days estimated in the telephone survey were similar for mail survey respondents and nonrespondents. The number of open-water fishing days by anglers active in Green Bay fishing, as reported in Table 4-1, is used as the basis for the open-water fishing damage computations.[1] In Section 3.5.4, we develop an adjustment factor of 52.8% for potential recall, sampling, and nonresponse biases, and the adjusted numbers, which are reported in the last column of Table 4-1, are used in Chapters 8 and 10 to compute annual damages in 1998 and the present value of damages from 1999 into the future.

These avidity levels are similar to estimates from Bishop et al.'s (1994) study where they found that Lake Michigan anglers averaged 32 fishing days a year with 9 of those days on the Great Lakes. Once adjusted for potential recall, sample, and nonresponse biases, the estimates are comparable to or less than estimates from the 1996 National Survey of Fishing, Hunting and Wildlife Associated Recreation (U.S. DOI, 1998) for anglers active in the Wisconsin waters of Lake Michigan (see Section 3.5.4).

Estimates for Green Bay angling days demonstrate a highly skewed distribution. As seen in Figure 4-1, most individuals fish the open waters of Green Bay only a few times in the season, but many fish almost weekly, and some fish several times a week.

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1. These estimates are based on the entire year of fishing, whereas the telephone survey estimates are based on a larger sample of 839 Green Bay anglers (Table 3-14 "Total" column); they omit up to six weeks of potential fishing for some anglers. The mail survey estimates of 9.95 Green Bay open-water fishing days and 24.98 total open-water fishing days, are, respectively, 0.4% and 2.7% larger than the corresponding telephone survey estimates.

Table 4-1
Number of Days Fishing in 1998 by Mail Survey Respondents
(combined telephone and mail survey data)

	Reported Days					Adjusted Mean Days[a]
	Mean (SE)	Median	Mode	Minimum	Maximum	
Days fishing open waters of Green Bay	9.95 (0.55)	5	2	1	120	5.25
Days ice fishing on Green Bay	1.18 (0.16)	0	0	0	50	.62
Total days fishing on Green Bay	11.14 (0.63)	6	2	1	142	5.88
Total days open-water fishing — all sites	24.98 (0.98)	20	30	1	180	5.88
Total days ice fishing — all sites	4.07 (0.31)	0	0	0	60	2.15
Total days fishing — all sites	29.05 (1.12)	20	10	1	210	15.34

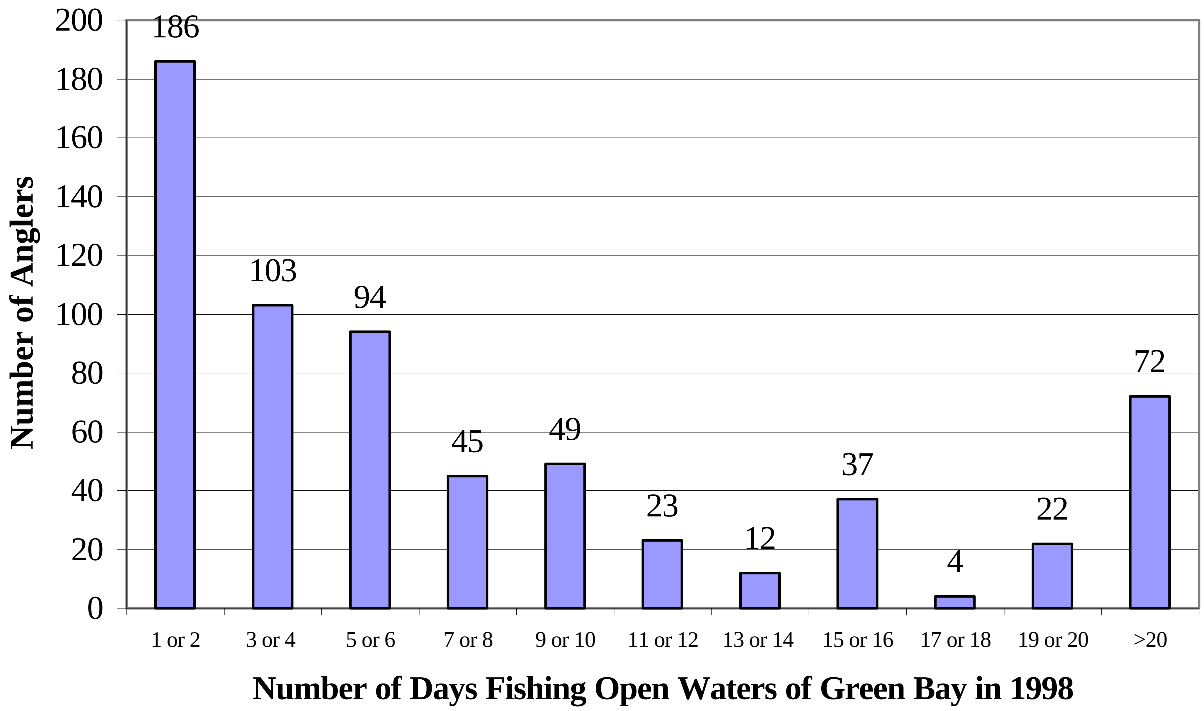
a. Adjusted by a factor of 52.8% for potential recall, sampling, and nonresponse bias (see Section 3.5.4).

Table 4-2 presents per angler estimates of total Green Bay fishing days by angler residence. (The same table for open-water fishing days on the waters of Green Bay is found in Appendix F, Table F-5.) The per angler Green Bay days decrease as the angler's resident county or state is farther from Green Bay. We separated anglers into four basic distance tiers: anglers in a county adjacent to the bay, anglers in a nonadjacent but targeted county, anglers in a nontargeted county, and anglers who live out-of-state.

The Green Bay anglers in adjacent counties averaged between 12.0 and 20.6 total Green Bay fishing days in 1998, whereas anglers in nonadjacent but targeted counties averaged between 8.5 and 9.4 days. This decline continues with distance. Green Bay anglers from Wisconsin but outside of the eight targeted counties averaged 8.3 days fishing Green Bay in 1998, and those from out-of-state averaged 6.8 days. Notice also that Green Bay anglers from Michigan averaged 22.2 days on the Wisconsin waters of Green Bay in 1998. Almost all these anglers live in Michigan counties that are adjacent to Green Bay. This same pattern can be seen for open-water fishing days (see Appendix F, Table F-1) and ice-fishing days.

Table 4-3 shows the proportion of fishing days in the Wisconsin waters of Green Bay that are on the Lower Fox River (from the dam at DePere down to the mouth of the Bay) for total, open-water, and ice-fishing days in 1998. These data are based on fishing days reported through the

Figure 4-1
Distribution of Reported Number of Open-Water Fishing Days on Wisconsin Waters of Green Bay in 1998, for All Mail Survey Respondents (combined telephone and mail survey data)



telephone survey by the 647 respondents who completed both the telephone and mail survey and omit about 2% of total fishing days reported between the telephone and mail survey. About 13.4% of all fishing days are on the Lower Fox River, with the proportion higher for open-water fishing days than for ice-fishing days. This percentage is higher than the 5% reported for the WDNR creel survey for 1998 (Table 2-2). The reason for this divergence in results is uncertain given the otherwise overall consistency between our results and the WDNR results.[2] Similar results for all 906 Green Bay anglers completing the telephone survey are found in Appendix F (Table F-6).

In the mail survey, anglers were asked how often they target specific species when fishing on Green Bay. Figure 4-2 shows the distribution of targeting effort. The percent of anglers who

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2. It would be difficult to explain this difference with sampling variability in either survey. Other plausible explanations could include differences in how WDNR and our respondents assign days between the Bay of Green Bay and the Lower Fox River, or potential undersampling of the Lower Fox River in the WDNR creel survey.

Table 4-2
Total Number of Reported Fishing Days on Wisconsin Waters of Green Bay in 1998, by Residence, for Mail Survey Respondents (combined telephone and mail survey data)

Residence	Number of Anglers	Total Days: Total	Total Days: % of Total Green Bay Fishing Days	Days per Angler: Mean (SE)	Median	Mode	Min.	Max.
Other states								
Total	117	800	11%	6.8 (1.03)	4	2	1	95
Michigan	13	289	4%	22.2 (7.62)	15	1	1	95
Wisconsin, but not eight targeted counties	37	306	4%	8.3 (1.55)	5	2	1	38
Eight targeted counties Total	493	6,100	85%	12.4 (0.77)	6	2	1	142
Brown County	195	2,340	32%	12.0 (1.24)	6	2	1	142
Door County	46	947	13%	20.6 (3.7)	11	4	1	100
Kewaunee County	20	345	5%	17.3 (5.60)	7.5	1	1	90
Manitowoc County	49	462	6%	9.4 (1.64)	7	10	1	76
Marinette County	59	773	11%	13.1 (1.64)	9	2	1	60
Oconto County	37	462	6%	12.5 (2.45)	6	3	1	57
Outagamie County	53	450	6%	8.5 (1.46)	3	1	1	50
Winnebago County	34	321	4%	9.4 (3.09)	4.5	1	1	105
All mail survey respondents	647	7,206	100%	11.1 (0.63)	6	2	1	142

Table 4-3
Number of Reported Fishing Days on the Fox River between the Mouth and DePere Dam as Compared to All Wisconsin Waters of Green Bay in 1998, for Mail Survey Respondents (N = 647)[a] (telephone survey data)

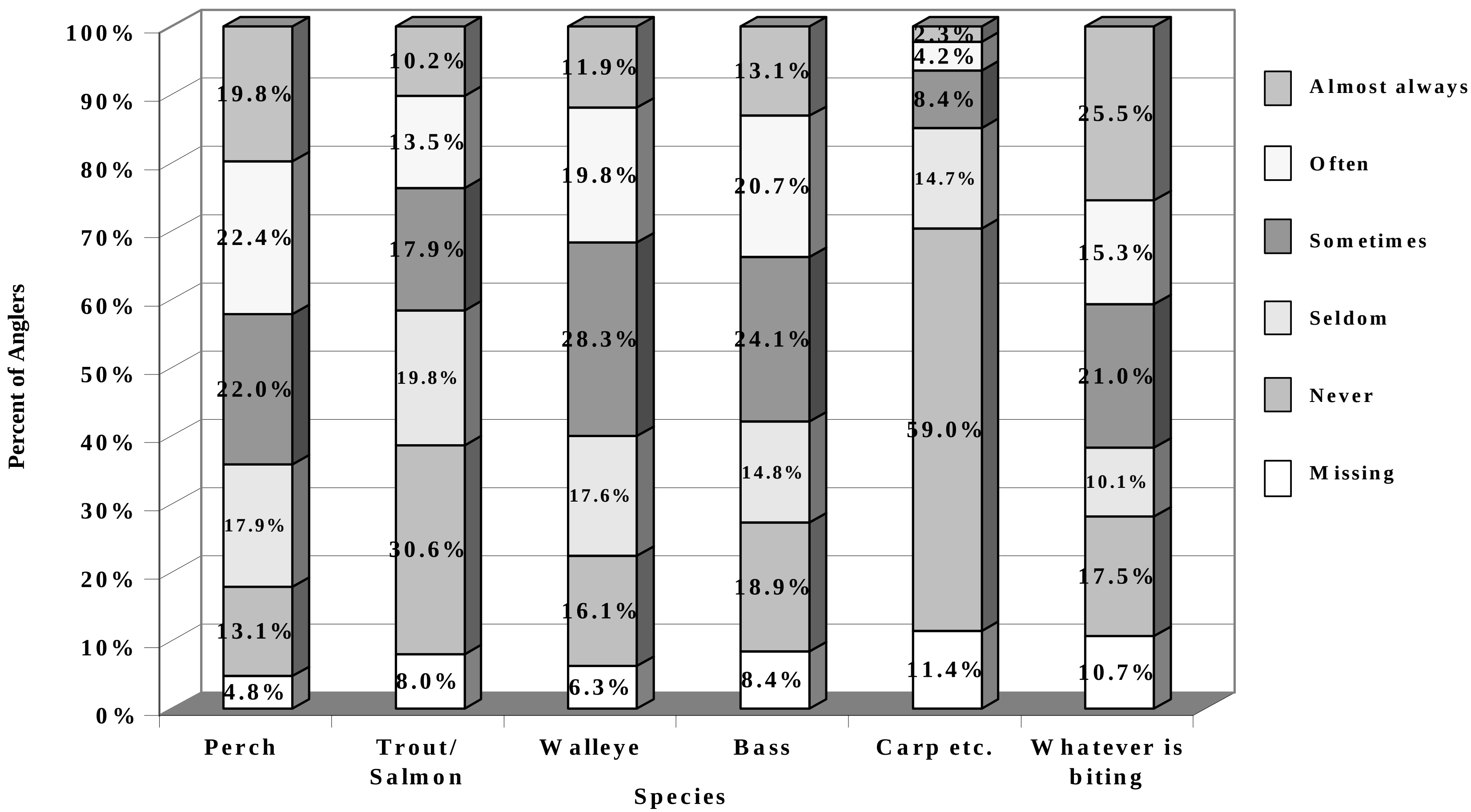
	Sample Days per Angler						
	Total	% of Total Green Bay Fishing Days	Mean (SE)	Median	Mode	Min.	Max.
Green Bay total days							
All sites	7,107	100%	11.0 (0.62)	6	2	1	142
On Fox River	951	13.4%	1.5 (0.28)	0	0	0	130
Green Bay open-water days							
All sites	6,342	89.2%	9.8 (0.55)	5	2	1	120
On Fox River	865	12.2%	1.3 (0.25)	0	0	0	110
Green Bay ice-fishing days							
All sites	765	10.8%	1.2 (0.16)	0	0	0	50
On Fox River	86	1.2%	0.1 (0.05)	0	0	0	20

a. Sample includes anglers who fish the open-water Wisconsin waters of Green Bay. Anglers who only ice fished these waters are excluded.

"often" or "almost always" target each the four key species is 42% for perch, 34% for bass, 32% for walleye, 24% for trout/salmon, 7% for carp/catfish/whitebass, and 41% for "whatever is biting."[3] Note that the percentages of anglers citing "often" or "always" totals to 180%. Adjusted to the 180% total the perch share, for example, is 23% (42%/180%), which is comparable with the percent of activity identified as targeting perch by the WDNR creel survey (Table 2-6). Note also that a large share of anglers are opportunistic and target whatever is biting (41%). Thus,

3. The nonresponse rate for the different species in this question is much higher than other questions in the survey. This is likely because some respondents who never target a particular species left the answer for that species blank. Only 2 of the 647 respondents left all the species blank. The percentages listed are for all anglers, assuming those who left the response blank for a species do not fish for that species. Omitting missing responses increases the percentages to 44% for perch, 37% for smallmouth bass, 34% for walleye, 26% for trout/salmon, and 46% for whatever is biting. The carp percentage is unchanged.

Figure 4-2
How Often Anglers Target a Specific Species on Green Bay
(mail survey Question 4)



while in the long-run an angler may be a perch angler, often or always it appears they will end up targeting what they can catch on any individual day.

Table 4-4 shows mail survey respondents' perceptions on how long it takes to catch various fish species in Green Bay. The order of the perceived catch times per fish (perch, bass, walleye, trout/salmon) parallels the proportions of anglers who target the species (i.e., perch has the lowest catch time and is targeted by the largest group of anglers, and trout/salmon has the highest catch time and is "often" or "almost always" targeted by the fewest anglers).

Table 4-4
Perceived Average Time to Catch a Fish in Green Bay
(hours per fish — mail survey Question 36)

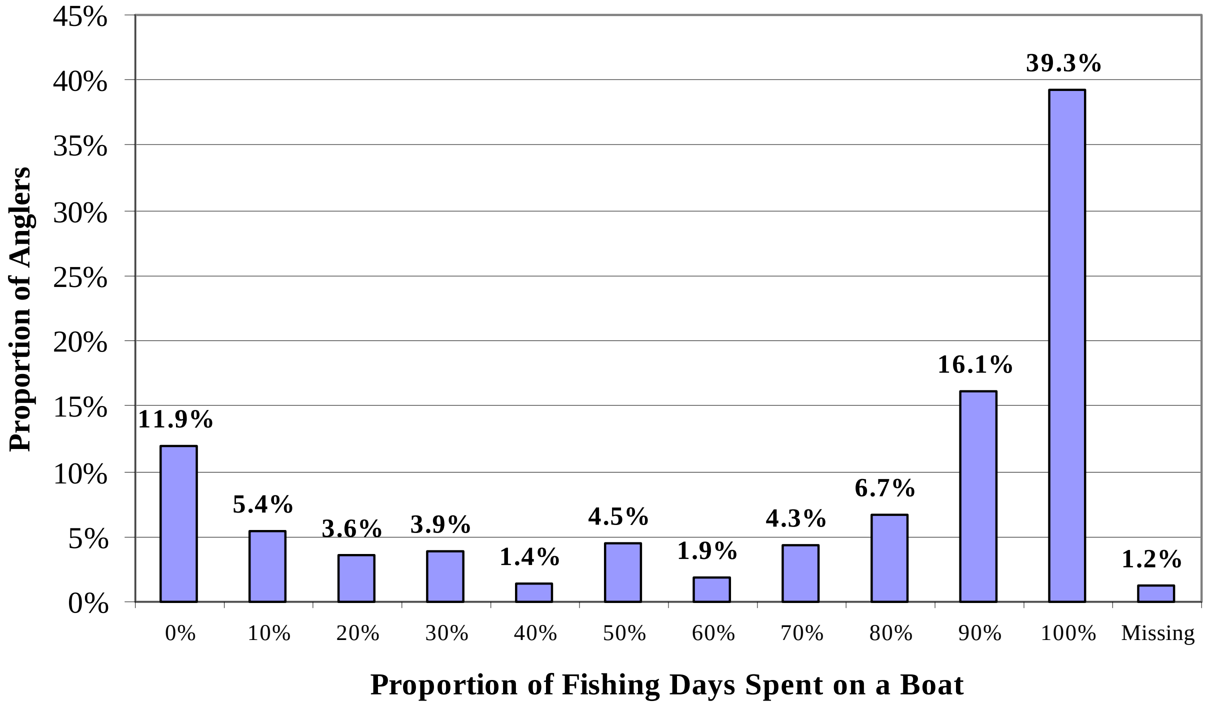
	N	Mean (SE)	Median	Mode	% Missing
Yellow perch	626	0.9 (0.06)	0.5	0.5	3.3%
Trout/salmon	629	2.7 (0.10)	2	2	2.8%
Walleye	625	2.1 (0.08)	1	1	3.4%
Smallmouth bass	617	1.3 (0.07)	0.67	0.5	4.6%

Data from the telephone survey show that 72% of anglers who fished Green Bay in 1998 live in a household where an occupant owns a boat. This compares to 66% of anglers who fished Green Bay, but not in 1998, and 57% of anglers who have never fished Green Bay. The difference between resident Wisconsin anglers and out-of-state anglers was smaller: 65% of the former and 62% of the latter live in households where someone owns a boat.

From the mail survey the majority of the Green Bay anglers spend most or all of their fishing time in a boat (Figure 4-3). About 73% indicate that 50% or more of their Green Bay fishing days are spent in a boat and only 12% report that they never fish from a boat when fishing the waters of Green Bay. These data indicate that about 70% of all fishing effort is from a boat. The percent of angling effort from a boat varies little by the species that anglers are targeting.[4] These estimates match well with the WDNR 1998 creel survey data, which indicate that about 76% of angling in the

4. Here and for the remainder of the report, targeting is defined as targeting one species "often" or "almost always" and not targeting any other species "often" or "almost always" so as to focus on anglers specifically focused on a species. See Table 5-7 for a tally of sample anglers by this definition of targeting.

Figure 4-3
Percent of Green Bay Fishing Days Spent on a Boat
(mail survey Question 5)



waters of Green Bay are from a boat (defined as hours under the categories of ramp, moored, and charter).

Anglers who fish by boat report an average of 2.5 people (including themselves) in the boat for a typical trip. The minimum was 1 person and the maximum was 5 people. The average number of people in a boat varies somewhat among those who target different specific species: 2.6 for perch targeters, 2.8 for trout/salmon targeters, 2.1 for walleye targeters, 2.2 for bass targeters, and 2.4 for those with no specific target.

In Question 12, anglers report expenses for a "typical" day of fishing on the waters of Green Bay. Anglers report spending an average of about $74 per day, with a median of $31 and a mode of $20. The breakdown of these costs is presented in Table 4-5. The 1996 National Survey (U.S. DOI, 1998) reports a yearly expenditure of $328 per angler ($1998) on Great Lakes fishing, with an average of 5 days per angler, resulting in an average of about $65 per day ($1998). Bishop et al. (1994) report per capita expenditure per day of $130 ($1998) for Wisconsin Great Lakes fishing.

Table 4-5
Typical Expenditures on Green Bay Fishing Days
(mail survey Question 12 mean estimate $/day)

	Mean	SE	Median	Mode	Min.	Max.	Missing
Gas for vehicle/boat	21.23	6.97	10	10	0	4000	0.9%
Boat launching fee	2.60	0.11	3	0	0	20	0.9%
Motel/hotel	9.12	1.41	0	0	0	500	0.9%
Fishing gear	15.66	4.48	5	5	0	2000	1.1%
Bait	5.73	0.79	5	5	0	500	1.1%
Food and beverages	12.30	1.74	6	10	0	998	0.9%
Guide or charter fees	5.40	1.36	0	0	0	400	0.9%
Other	5.36	3.94	0	0	0	2500	1.1%
Total[a]	74.32	14.84	31	20	0	8705	0.8%

a. This does not equal the sum of the means of the expenditure items. This is the mean of the total expenditures that was calculated by each respondent.

In the mail survey (Q38), anglers were asked, “What do you think is the average daily boat launch fee for the waters of Green Bay?” The mean of the angler estimates is $4.41, the median is $4.00, and the mode is $3.00. The median reported in Questions 12 and 38 are the same, but the mean is lower in Question 12. Question 12 respondents were asked what they actually pay, and over one-fourth of the anglers do not use a boat on their “typical” day of fishing on the waters of Green Bay (Figure 4-3), and others may launch their boats from their own or free boat launches.

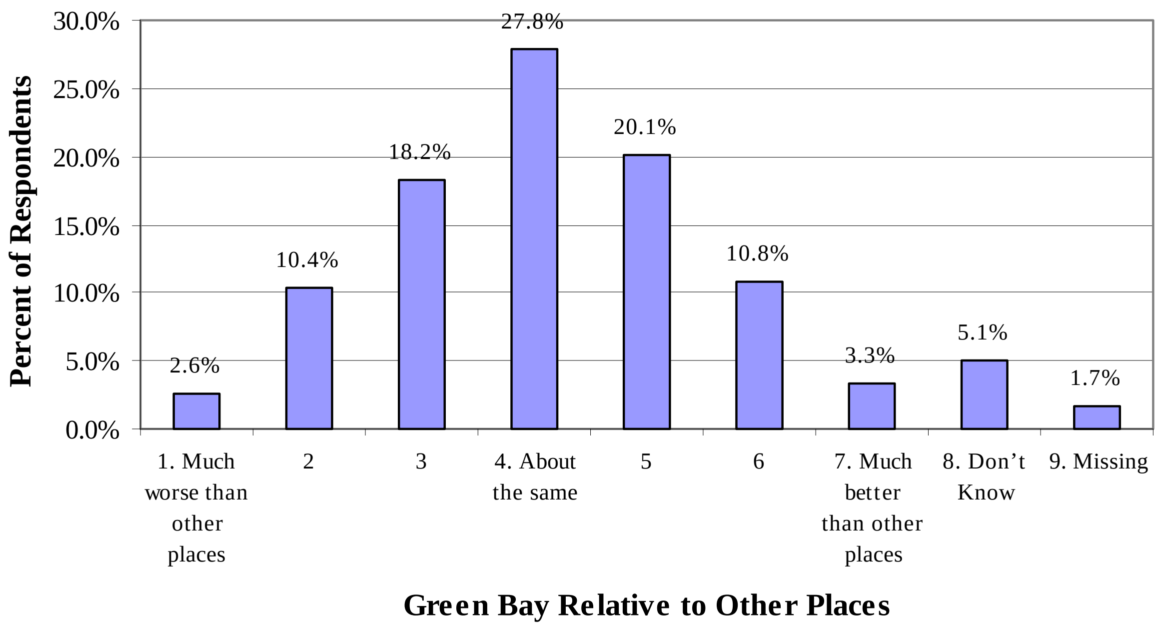
Current Green Bay anglers (those active in Green Bay fishing in 1998) are more likely than other anglers to have a vacation home near Green Bay: 28% of current green Bay anglers own vacation homes, which are on average 90 miles (SE = 12.3) from Green Bay; 29% of anglers who have fished Green Bay in the past, but not in 1998, own vacation homes with an average distance of 107 miles (SE = 8.7); and 25% of anglers who have never fished Green Bay own vacation homes with an average distance of 164 miles from Green Bay. A difference in the location of vacation homes is also seen between anglers who reside in and outside of Wisconsin. About 27% of both groups own vacation homes, but the vacation homes of Wisconsin residents are on average 93 miles (SE = 5.9) from Green Bay, and the vacation homes of nonresidents are on average 266 miles (SE = 30.6) from Green Bay. Compared to all anglers, recent Green Bay anglers are more likely to be male, retired or self-employed, and less likely to be homemakers, but beyond this characteristics are similar to other anglers.

4.3 OVERALL ATTITUDES ABOUT THE GREEN BAY RECREATIONAL FISHERY

Overall Attitudes

Anglers were split as to whether they felt the quality of fishing on Green Bay was currently better (34%), worse (29%), or the same (28%) relative to other places they fish (Figure 4-4). Most feel the Green Bay fishery is as good as or better than other places, which explains why they have remained in the fishery. That the 29% who feel the quality of fishing is worse than other sites have remained active in the fishery is evidence that Green Bay is a unique site to these anglers.

Figure 4-4
Quality of Green Bay Relative to Other Places Respondent Fishes



Respondents were asked to write a comment to explain their rating of Green Bay relative to other places they fished. For those who feel Green Bay is worse than other sites, catch attributes, negative conditions at the site (such as weather, the size of, distance to, or facilities on Green Bay) and contamination or pollution problems (including PCBs and not being able to eat the fish) are mentioned most frequently as reasons to prefer other sites (see Appendix F, Table F-4, and accompanying discussion).

In mail survey Question 7, when asked about how important different actions are in terms of enhancing recreational fishing on Green Bay, 70% of anglers indicate that cleaning up PCBs so FCAs could be reduced or eliminated is the most important action resulting in a mean score of 4.4 on a 5 point scale (1 = least important to 5 = most important) (see Table 4-6). The action ranked

Table 4-6
Angler Rating of Importance of Actions in Terms of How the Actions Would Enhance Recreational Fishing on the Waters of Green Bay
(mail survey Question 7 where 1 = Least Important to 5 = Most Important)

Action	Rating							
	1. Least Important	2.	3.	4.	5. Most Important	Missing	Mean (SE)	Median
Adding more boat launch facilities	31.5%	24.1%	24.1%	10.2%	8.7%	1.4%	2.4 (0.05)	2
Adding more shoreline parks, nature centers, and trails	26.9%	20.6%	23.3%	15.3%	12.2%	1.7%	2.6 (0.05)	3
Increasing water clarity	8.7%	8.8%	20.9%	25.8%	34.2%	1.7%	3.7 (0.05)	4
Increasing catch rates	14.8%	14.8%	23.2%	22.6%	22.9%	1.7%	3.2 (0.05)	3
Cleaning up PCBs so fish consumption advisories can be reduced or eliminated	3.7%	3.3%	9.4%	12.8%	70.0%	0.8%	4.4 (0.04)	5

second in importance is improving water clarity in Green Bay, which is on average given a 3.7 with 34% saying it is a most important action by rating it a 5. Increasing catch rates is ranked third in importance, with an average of 3.2 on the 5 point scale and 23% saying it is a most important action. Adding shoreline parks is ranked as a most important action for only 12.2% of respondents, and adding more boat launch facilities is ranked as a most important action for only 8.7% of respondents. This ranking is consistent with the responses to the telephone survey (discussed in Chapter 3) where all the respondents (Green Bay anglers or otherwise) rank cleaning up contaminants as the most important action, followed by improving water clarity, and then increasing catch rates and providing more boat launches.

For most anglers, improving catch rates is rated as less important than removing PCB contamination from Green Bay. However, catch rates still are important to anglers and their fishing experience. Table 4-7 shows how strongly respondents feel about two catch rate issues. Sixty-five percent of respondents agree that efforts should be made to increase Green Bay catch rates, and 80% of the respondents agree that efforts should be made to ensure that fish populations and catch rates do not decline.

Question 13 directly addresses the relative importance of increased catch rates and reduced PCBs in terms of paying higher fees to support these improvements (Table 4-8). Opinion is mixed about

Table 4-7
Statements about Catch Rates
(mail survey Question 8)

	We Should Increase Catch Rates by Increasing Green Bay Fish Populations	We Should Not Let Green Bay Fish Populations Decline because that Would Cause Catch Rates to Decline
1. Strongly Disagree	4.5%	3.9%
2. Disagree	5.9%	2.8%
3. Neither Agree nor Disagree	24.4%	12.7%
4. Agree	27.1%	21.8%
5. Strongly Agree	37.7%	58.3%
Missing	0.5%	0.6%
Mean Rating (SE)	3.9 (0.04)	4.3 (0.04)

Table 4-8
Statements about Boat Launch Fees in Relation to Catch Rates and PCB Contamination
(mail survey Question 13)

	I Would Be Willing to Pay Higher Boat Launch Fees If Catch Rates Were Higher on the Waters of Green Bay	I Would Be Willing to Pay Higher Boat Launch Fees If the Fish Had No PCB Contamination
1. Strongly Disagree	25.0%	18.2%
2. Disagree	11.9%	8.2%
3. Neither Agree nor Disagree	31.4%	24.1%
4. Agree	18.1%	20.9%
5. Strongly Agree	13.5%	28.4%
Missing	0.2%	0.2%
Mean Rating (SE)	2.8 (0.05)	3.3 (0.06)

paying more to increase catch rates, with similar shares of individuals agreeing, disagreeing, and neither agreeing nor disagreeing. The results are different for PCBs, with about 50% agreeing they would be willing to pay more in fees if the fish had no PCB contamination. This is consistent with other survey responses, which all indicate a higher importance and value placed on cleaning up contamination than on improving catch rates.

These mail survey results are consistent with the earlier telephone survey results, where 82% of both Wisconsin and out-of-state anglers feel being able to catch fish free of contaminants is very important (telephone Question 12), and both groups rank cleaning up contaminants in Green Bay, cleaning up contaminants from inland waters, and improving the clarity of water in Green Bay as highest in importance among actions to improve the quality of fishing in Wisconsin (telephone Question 13).

4.4 AWARENESS OF FCAS

The Green Bay anglers who returned the mail survey are both aware and concerned about FCAs for the waters of Green Bay. Eighty-five percent said they had heard or read about the FCAs before receiving this mail survey. This response is consistent with our focus groups and pretest interviews, in which respondents consistently displayed a high level of awareness of and knowledge about fish contamination.

When respondents were asked how much it would bother them to have various levels of FCAs for the fish they target in Green Bay, 24% were “not at all bothered” by an “Eat no more than one meal a week” restriction, and 8.4% were not at all bothered by a “Do not eat” restriction. Conversely, 28.3% found the “Eat no more than one meal a week” restriction very bothersome, and 77% found the “Do not eat” restriction to be very bothersome (Table 4-9). Note that the most frequent response (mode) for all FCA levels is “very bothersome.”

Angler perceptions of advisory levels are generally consistent with the 1998 published advisories, but do reflect variations across individuals. It is important to note that the advisories vary through time, and vary between the Bay of Green Bay, the Lower Fox River (more severe), and in the Michigan waters of Green Bay (less severe). Table 4-10 shows the levels of advisories that respondents thought were closest to the FCAs. The bold, italicized entries show the actual range for the 1998 Wisconsin advisory levels for Green Bay and the Lower Fox River. The final column shows the percent of respondents whose responses are consistent with the 1998 levels for Green Bay and/or the Fox River. Most perch, trout/salmon, and walleye anglers chose one of the current levels for the species they targeted, but many bass anglers underestimated the smallmouth bass restriction.

Table 4-9
How Bothered Anglers Would Be by Different Levels of FCAs for the Fish They Target in Green Bay
(mail survey Question 10 where 1 = not at all bothersome to 5 = very bothersome)

Rating	Level of FCAs		
	Eat No More than One Meal a Week	Eat No More than One Meal a Month	Do Not Eat
1. Not at all bothersome	24.0%	11.3%	8.4%
2.	13.3%	6.2%	1.7%
3.	18.6%	18.1%	4.0%
4.	13.1%	19.3%	4.6%
5. Very bothersome	28.3%	42.0%	77.1%
Missing	2.8%	3.1%	4.2%
Mean rating of how bothersome (SE)	3.1 (0.06)	3.8 (0.05)	4.5 (0.05)
Median rating of how bothersome	3	4	5

Anglers who live in the eight targeted counties are more likely to report an advisory level that is consistent with the 1998 Wisconsin advisory than those who do not live in the eight targeted counties (whether they live in other Wisconsin counties or out-of-state). Michigan anglers (about 2% of our sample) are more likely to underestimate the Wisconsin advisory, which is consistent with the fact that Michigan advisories are generally less severe than Wisconsin's advisories (see Chapter 2 for a comparison). Other anglers in the region may also be influenced by the Michigan advisories.

4.5 IMPACTS OF FCAS

As identified in Chapter 2, PCBs and the resulting FCAs can be expected to impact angler behavior and enjoyment. In our telephone survey we asked anglers who had not fished Green Bay in 1998 why they had not fished Green Bay in 1998 or why they had never fished Green Bay, if they would consider fishing Green Bay if conditions were different and if so, what things would have to change before they would consider fishing Green Bay (telephone survey Questions 10 and 11). About 7.4% of anglers in our telephone sample express that PCBs and FCAs are a key factor in explaining why they did not fish Green Bay in 1998. If these anglers were to become

Table 4-10
Respondent Perception of Current FCAs on Green Bay[a]
(mail survey Question 37)

	Unlimited	One Meal a Week	One Meal a Month	One Meal Every 2 Months	Do Not Eat	Missing	Consistent with 1998 Wisconsin FCA Range
Yellow perch							
All anglers	28.1%	***52.6%***	***12.5%***	1.6%	3.1%	2.2%	65.1%
Perch anglers[b]	25.6%	***61.6%***	***9.6%***	0.8%	0.8%	1.6%	71.2%
Live in 8 county region	28.0%	***54.0%***	***12.4%***	1.4%	3.0%	1.2%	66.4%
Trout/Salmon							
All anglers	3.1%	27.2%	***48.2%***	***10.5%***	***9.0%***	2.0%	67.7%
Trout/salmon anglers	3.2%	33.3%	***44.4%***	***11.1%***	***4.8%***	3.2%	60.3%
Live in 8 county region	2.4%	25.2%	***50.7%***	***10.6%***	***9.3%***	1.8%	70.6%
Walleye							
All anglers	6.8%	38.8%	***35.4%***	***10.5%***	***6.3%***	2.2%	52.2%
Walleye anglers	9.6%	30.8%	***42.3%***	***9.6%***	***7.7%***	0.0%	59.6%
Live in 8 county region	5.1%	36.9%	***39.4%***	***11.0%***	***6.7%***	1.0%	57.1%
Smallmouth bass							
All anglers	11.9%	39.0%	***30.9%***	***7.0%***	8.4%	2.9%	37.9%
Bass anglers	25.4%	39.0%	***22.0%***	***3.4%***	8.5%	1.7%	25.4%
Live in 8 county region	9.9%	38.1%	***34.3%***	***6.9%***	8.7%	2.0%	41.2%

a. The bold, italicized percentage numbers indicate the 1998 Wisconsin advisory levels. There is more than one box shaded for each species as the advisory changes relative to fish size and location.
b. This refers to anglers who target perch, those who said they “often” or “almost always” target perch on Green Bay, but do not “often” or “almost always” target any other species. The same approach applies to “trout/salmon anglers,” “walleye anglers,” and “smallmouth bass anglers.”

active in Green Bay fishing, the number of anglers active in Green Bay fishing from our population would increase by about 24%.[5]

Mail survey Question 11 asked "In response to the existing fish consumption advisories for the waters of Green Bay, do you do any of the following?," and then was followed by a list of potential behavioral responses as identified in Table 4-11. Overall, 77% of respondents identify making one or more of the changes. A significant percent of anglers (30%) change how often they fish in Green Bay and where they fish in Green Bay. Keeping with the FCA recommendation, 40-50% change the target species, change the size of the fish they keep, or change how fish are cleaned or prepared.

Table 4-11
Behavioral Changes in Response to FCAs for Green Bay
(mail survey Question 11)

In response to existing FCAs for the waters of Green Bay, do you do any of the following? . . .	**Percent Who Made this Change**	**Missing**
Spend fewer days fishing the waters of Green Bay	30.0%	2.0%
Change the places I fish on the waters of Green Bay	30.6%	1.9%
Change the species I fish for on the waters of Green Bay	22.9%	1.9%
Change the species of fish I keep to eat from the waters of Green Bay	45.0%	1.9%
Change the size of fish I keep to eat from the waters of Green Bay	47.1%	2.6%
Change the way Green Bay fish are cleaned or prepared	45.4%	2.6%
Change the way Green Bay fish are cooked at my house	24.7%	2.8%
Made one or more of these changes	77.4%	1.6%

5. About 5.3% of the telephone sample reported stopping Green Bay fishing because of the advisories, and 2.1% reported they would consider fishing Green Bay if the contaminants and FCAs were removed. The potential increase in Green Bay anglers is 23.6% [(5.3% + 2.1%) / 31.4%].

CHAPTER 5
THE GREEN BAY CHOICE QUESTIONS

5.1 INTRODUCTION

Choice questions, sometimes called stated-choice questions or attribute-based choice questions, along with data on observed fishing behavior, are used to estimate anglers' willingness to pay (WTP) to reduce or remove Green Bay FCAs. A choice question presents an individual with a number of alternatives, each described in terms of the levels of their common set of characteristics, and asks the individual to state his preferred alternative.[1]

Consider presenting a current Green Bay angler with the following simple choice pair: Green Bay with a $5 launch fee and an average catch rate of one fish per hour, versus Green Bay with an $8 launch fee and an average catch rate of one fish every 30 minutes. If an angler chooses the second alternative (higher cost and catch rate), his WTP per Green Bay fishing day for the doubled catch rate is at least $3. If the angler chooses the first alternative, the WTP is less than $3. Many different choice pairs can be generated by varying the launch fee and catch rates. For example, if there are three launch fees and four catch rates, there are 12 possible alternatives and 66 possible pairs. If site characteristics include cost, catch rate, and FCA level, choice pairs can determine how an angler(s) would trade off less stringent FCAs at the site for higher cost, better catch rates for higher cost, or better catch rates for more stringent FCAs.

We ask this type of Green Bay choice question, then ask a followup question of how often the angler would fish Green Bay if it were as described in his chosen alternative. This followup question gives the angler the opportunity to indicate whether he considers the chosen Green Bay alternative better or worse than current conditions. For example, an angler could choose an alternative and then report he would fish Green Bay less, or even zero times, if the conditions were as in the chosen alternative. Section 5.6 further describes the followup question.

Choice questions are a stated preference (SP) technique for estimating preferences because the respondent is asked to state something about his preferences. In contrast, revealed preference (RP) techniques observe an individual's actual choices in the market or other arenas, and inferences are made about the individual's preferences based on those observed choices; SP data

1. Cost and quality are also defined as characteristics of a commodity or an activity like fishing. Quality characteristics are commonly referred to as attributes, but cost is not an attribute. Later when we discuss choice pairs (Section 5.4), for simplicity of presentation, we refer to characteristics of different Green Bay alternatives to include both attributes and cost.

have advantages over RP data. Morikawa et al. (1990) states, "for example, since SP data are collected in a fully controlled "experimental" environment, such data has the following advantages in contrast with RP data that are generated in natural experiments: 1) they can elicit preferences for nonexisting alternatives; 2) the choice set is prespecified; 3) multicollinearity among attributes can be avoided; and 4) range of attribute values can be extended."[2] Further, because SP data allow the researcher to control more variables and because there are more unknowns influencing the decisions in RP data, the SP data often contain less noise and measurement error (Louviere, 1996).

Revealed preference (RP) data have a potential advantage in that these data reflect actual decisions made and the consequences of those decisions. If the consequences are significant, respondents have incentives to make choices consistent with their preferences (assuming they have adequate knowledge about the choices). With choice questions in SP data, if the respondent does not feel his responses have meaningful consequences, the incentives to carefully respond consistently with one's preference are reduced, which may result in data of reduced accuracy. To address this potential issue with SP data, we designed the survey materials to communicate the importance of the respondents' answers, and we implemented the assessment with anglers who are active in fishing the waters of Green Bay. These anglers are familiar with the site and issues at the site, and can be expected to understand and care that resource managers are evaluating options for the site (see Chapter 3 for an additional discussion).

This chapter is organized as follows: Section 5.2 provides an introduction to choice questions and their use in the valuation of environmental amenities, Section 5.3 discusses the selection of the SP choice questions for our application, and Section 5.4 describes the specific Green Bay choice pairs in our application. Section 5.5 provides a general discussion of the responses to the choice pairs and how they indicate a WTP for an improvement in quality, and Section 5.6 discusses the followup question to each choice pair about how many days they would expect to spend at their preferred alternative.

While this chapter discusses SP questions and data, it is important to remember that to estimate damages we combine the SP data with data on observed fishing days under current conditions, so we use a combination of SP and RP data. This practice is widely supported.[3] SP and RP data provide different information about anglers' preferences, so combining them into an integrated model leads to better estimates of those preferences. The integrated model is presented in Chapter 7. In this chapter, Green Bay refers to the Wisconsin waters of Green Bay, unless specifically identified otherwise.

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2. The same basic list of advantages can be found in Adamowicz et al. (1998).

3. See, for example, McFadden (1986), Ben-Akiva and Morikawa (1990), Morikawa et al. (1990), Cameron (1992), Louviere (1992), Hensher and Bradley (1993), Adamowicz et al. (1994, 1997), Ben-Akiva et al. (1994), Swait et al. (1994), Morikawa et al. (1991), Louviere (1996), Kling (1997), and Mathews et al. (1997).

5.2 CHOICE QUESTIONS ARE WELL ESTABLISHED FOR ESTIMATING TRADEOFFS

Choice question methods have an established basis in the professional literature and are consistent with NRDA regulations. Choice questions evolved from conjoint analysis, a method used extensively in marketing and transportation research.[4] Conjoint analysis requires respondents to rank or rate multiple alternatives where each alternative is characterized by multiple characteristics (e.g., Johnson et al., 1995; Roe et al., 1996). Choice questions require respondents to choose the most preferred alternative (a partial ranking) from multiple alternative goods (i.e., a choice set), where the alternatives within a choice set are differentiated by their characteristics.

There are many desirable aspects of choice questions, not the least of which is the nature of the choice being made. To choose the most preferred alternative from some set of alternatives is a very common decision experience, especially when one of the characteristics of the alternatives is a price. One needs only to walk the aisles of a grocery store to experience this type of decision environment. Morikawa et al. (1990) note that choice questions often contain useful information on trade-offs among characteristics. Quoting from Mathews et al. (1997), "SP models provide valuable information for restoration decisions by identifying the characteristics that matter to anglers and the relative importance of different characteristics that might be included in a fishing restoration program." Johnson et al. (1995) note that, "The process of evaluating a series of pairwise comparisons of attribute profiles encourages respondents to explore their preferences for various attribute combinations." Choice questions encourage respondents to concentrate on the trade-offs between characteristics rather than to take a position for or against an initiative or policy. Adamowicz et al. (1996) note that the repeated nature of choice questions makes it difficult to behave strategically.

Choice questions allow for the construction of goods characterized by characteristics levels that (currently) do not exist. This feature is particularly useful in marketing studies when the purpose is to estimate preferences for proposed goods.[5] For example, Beggs et al. (1981) assess the potential demand for electric cars. Similarly, researchers estimating the value of environmental goods are often valuing a good or condition that does not currently exist, e.g., Green Bay absent PCB contamination and FCAs.

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4. Cattin and Wittink (1982) and Wittink and Cattin (1989) survey the commercial use of conjoint analysis, which is widespread. For survey articles and reviews of conjoint, see Louviere (1988, 1992), Green and Srinivasan (1990), and Batsell and Louviere (1991). Transportation planners use choice questions to determine how commuters would respond to a new mode of transportation or a change in an existing mode. Hensher (1994) provides an overview of choice questions as they have been applied in transportation.

5. Louviere (1994) provides an overview of choice questions as they have been applied in marketing.

Like all elicitation techniques, the responses to choice questions may contain biases or random errors. Choosing can be difficult if the individual is almost indifferent between two alternatives. If each respondent is asked to answer a number of choice questions there can be both learning and fatigue. Respondents can become frustrated if they dislike all of the available alternatives, and they may have no incentive for sufficient introspection to determine their preferred alternative. A number of studies have investigated these issues.[6] Paraphrasing Morikawa et al. (1990, p. 4), other possible reasons for bias or noise include: 1) the respondent chooses solely on the basis of what he or she considers to be the most important attribute, 2) choices are biased toward the status quo, 3) the respondent uses the questionnaire as an opinion statement for his own benefit, 4) the respondent ignores his constraints, and 5) the respondent ignores an attribute if its level lacks credibility. While these are all matters of concern, such decision protocols can also bias or add random noise to actual choices (RP data). Nevertheless, the general consensus is that if SP choice questions are carefully designed and implemented they can elicit important and relevant information about preferences, information that often cannot be deduced solely on the basis of observed behavior.

Choice questions, rankings, and ratings are increasingly used to estimate the value of environmental goods. For example, Magat et al. (1988) and Viscusi et al. (1991) estimate the value of reducing health risks; Adamowicz et al. (1994, 1997), and Morey et al. (1999a) estimate recreational site choice models for fishing, mountain biking, and moose hunting, respectively; Adamowicz et al. (1996) estimate the value of enhancing the population of a threatened species; Layton and Brown (1998) estimate the value of mitigating forest loss resulting from global climate change; and Morey et al. (1999b) estimate WTP for monument preservation in Washington, DC. In each of these studies, a price (e.g., tax, or a measure of travel costs) is included as one of the characteristics of each alternative so that preferences for the other characteristics can be measured in terms of dollars. Other examples of choice questions to value environmental commodities include Swait et al. (1998), who compare prevention versus compensation programs for oil spills, and Mathews et al. (1997) and Ruby et al. (1998) who ask anglers to choose between two saltwater fishing sites as a function of their characteristics. Mathews et al. is an NRDA application.

Alternatively, a number of environmental studies have used ratings, in which survey respondents rate the degree to which they prefer one alternative over another. For example, Opaluch et al. (1993) and Kline and Wichelns (1996) develop a utility index for the characteristics associated with potential noxious facility sites and farm land preservation, respectively. Johnson and Desvousges (1997) estimate WTP for various electricity generation scenarios using a rating scale in which respondents indicate their strength of preference for one of two alternatives within each choice set. Other environmental examples include Rae (1983), Lareau and Rae (1998), Krupnick

6. For more details, see for example, Louviere (1988), Green and Srinivasan (1990), Agarwal and Green (1991), Gan and Luzar (1993), Bradley and Daly (1994), Mazzotta and Opaluch (1995), and Swait and Adamowicz (1996).

and Cropper (1992), Gan and Luzar (1993), and Mackenzie (1993). Adamowicz et al. (1997) provides an overview of choice and ranking experiments as they are applied to environmental valuation. It is argued that choice questions better predict actual choices than do rating questions because choice questions mimic the real choices individuals are continuously required to make, whereas individuals rank and rate much less often.[7]

Choice and rating questions characterize the alternatives in term of a small number of characteristics. For example, Opaluch et al. (1993) characterize noxious facilities in terms of seven characteristics; Adamowicz et al. (1997) use six characteristics to describe recreational hunting sites; Johnson and Desvousges (1997) use nine characteristics to describe electricity-generation scenarios; Mathews et al. (1997) use seven characteristics to describe fishing sites; Morey et al. (1999a) use six characteristics to describe mountain bike sites; and Morey et al. (1999b) use two characteristics to characterize monument preservation programs.

Choice-based damage computation methods as applied here are consistent with U.S. DOI NRDA regulations [43 C.F.R. § 11.83(c)(3)] because they measure WTP. The choice-based method used here combines elements of random utility models used in recreation assessments and contingent valuation methods for determining use values, which are identified as acceptable methods in the U.S. DOI regulations [43 C.F.R. §11.83(c)]. Choice-based methods are explicitly identified (as conjoint methods) in the NOAA NRDA regulations for use in valuing and scaling injuries and restoration (15 C.F.R. Part 990, preamble Appendix B, part G). Mathews et al. (1995) note that conjoint analysis is one of the most promising techniques for making the determination of in-kind compensation.

5.3 VALUATION AND THE USE OF CHOICE QUESTIONS

Choice questions were used to supplement the data on current fishing days because Green Bay is unique. No sites exist that are similar to Green Bay in terms of catch rates, size, and other factors, but that differ from Green Bay in terms of the level of PCB contamination and associated FCAs. Lake Michigan has similar FCAs for PCBs, but it is a much larger water body that generally requires larger boats to fish and that has varying fish species from the waters of Green Bay. The inland lakes are much smaller and do not suffer from PCB contamination; many have FCAs, but not for PCBs. If there were a number of sites similar to Green Bay but with varying catch rates and varying FCA levels, there might be less of a need for choice questions. Instead, one might be able to estimate an angler's WTP for higher Green Bay catch rates or lower Green Bay FCA using only observed trip patterns for existing sites. However, this is not the case, so choice questions are a well-substantiated antidote to a lack of variation in the characteristics of the alternatives available.

7. See, for example, Louviere and Woodward (1983), Louviere (1988), and Elrod et al. (1992).

We have Green Bay anglers focus on preferred Green Bay alternatives and characteristics of Green Bay fishing. These anglers are most familiar with the site and issues and can be expected to give informed judgments, and thus accurate valuations relevant to the specific issue of PCB advisories in the waters of Green Bay.

Finally, as discussed further in the next section, the inclusion of cost and multiple Green Bay attributes allow for a comparison between FCAs and catch rates to assess their tradeoffs as well as dollar valuation. This feature makes the study broader than just an FCA valuation study, and allows for other useful valuation anchors. For example, the valuation of changes in catch rates is prevalent in the literature (see Chapter 2).

5.4 THE GREEN BAY CHOICE PAIRS

Each Green Bay alternative was described to respondents in terms of nine characteristics: a launch fee; the average amount of time necessary to catch a fish (catch time) for each of the four species (yellow perch, trout/salmon, walleye, and smallmouth bass); and an FCA level for each of the four species.

We include catch times (the reciprocal of catch rates) and costs in our characteristics set because a large body of recreational fishing literature has shown consistently that these are important characteristics of site choice. Further, catch times are included to support any subsequent computation of damages from reduced catch times and to compute benefits from increased catch rates if such a program is part of a restoration package. We include FCAs as a key feature of the damages caused by the PCB contamination and because recent literature demonstrates the importance of FCAs to recreational fishing (see Chapter 2). Our focus groups, pretests, and final survey all confirm the importance of these characteristics. The selection of levels for each of these characteristics is described below (see "Choice Set Characteristics").

Supporting recreational facilities, such as more boat launches, picnic tables, and walking trails, are not included as characteristics in the choice questions because anglers in the focus groups and pretests indicate little concern about existing conditions and changes in these site characteristics compared to catch rates and FCAs.[8] We concluded that addressing recreational facilities would

8. For example, in focus groups anglers were asked: "What was the most important factor in your decisions when you first decided to fish Green Bay? What two or three factors contribute most to your enjoyment of fishing trips to Green Bay? What two or three factors detract most from your enjoyment of fishing trips on the waters of Green Bay? If you could change anything about fishing on the waters of Green Bay, what would you change?" Only one angler mentioned launch facilities and no anglers mentioned other facilities. Pretest anglers also rated enhanced facilities for fishing in the waters of Green Bay and as in the final survey (see Tables 3-11, 3-15, and 4-9) recreational facilities always were rated much lower than catch times and FCAs.

not improve the damage assessment, but would complicate survey design and the cognitive burden for respondents.

Figure 5-1 is an example choice pair presented to every angler preceding the choice questions. Note that in this choice pair, Green Bay Alternative B has a less stringent advisory for trout/salmon, walleye, and smallmouth bass, and the catch rate is better for perch and walleye (i.e., the time it takes to catch these species is less). However Alternative B has a launch fee of $3, whereas Alternative A is free. Appendix E contains Version 1 of the survey, including the example pair and eight other pairs. Other versions are identical except that the specific combinations of characteristics in the choice questions presented vary by version (see Section 5.5 and Tables E-1 through E-10).

Note that the Green Bay choice pairs do not ask the individuals where they would fish if they had the choice between different sites, but whether they would prefer to fish Green Bay under conditions A or B; that is, the choice-pair questions ask anglers to choose which Green Bay they would prefer, not how often they would go.[9] Given this, the answers to the choice pairs measure values for changes in site characteristics for existing days at the site, but cannot be used to determine how often an angler would fish Green Bay under different conditions and the related values for changes in site visits. However, when the choice-pair data are combined with the data on how often anglers fish Green Bay under current conditions and the anglers' answers to questions on how often they would fish Green Bay under different conditions, one can better estimate both how anglers would trade off Green Bay characteristics and how often they would fish Green Bay under different conditions, which is what is done in this report.[10] The choice-pair data tell us how an angler would trade off different Green Bay characteristics on a Green Bay fishing day. Therefore, the choice pairs can be used to estimate how much anglers would prefer a Green Bay fishing day with no FCAs to fishing Green Bay under current conditions.

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9. In contrast, one could develop choice pairs where there are two or more sites available and ask which site the individual would visit. Examples include Magat et al. (1988), Viscusi et al. (1991), Adamowicz et al. (1994, 1997), Mathews et al. (1997), Ruby et al. (1998), and Morey et al. (1999a). Choice studies such as this one that ask the individual to choose over different "states" include Johnson et al. (1995), Adamowicz et al. (1996), Roe et al. (1996), Johnson and Desvousges (1997), Morey et al. (1997, 1999b), Stevens et al. (1997), Layton and Brown (1998), and Swait et al. (1998).

10. Many studies use only choice questions to estimate preferences. In these cases, one must be sure that the choice questions provide everything one needs to know about preferences, including how behavior would change if site characteristics change. In this assessment, the choice questions are only one component of the data. Chapter 7 presents the integrated model. In Chapter 9, we consider models based solely on the data from the choice pairs.

Figure 5-1
Example Choice Question

If you were going to fish the waters of Green Bay, would you prefer to fish the waters of Green Bay under Alternative A or Alternative B? *Check one box in the last row*

	Alternative A ▼	Alternative B ▼
Yellow Perch		
Average catch rate for a typical angler......................	40 minutes per perch	30 minutes per perch
Fish consumption advisory.......	No more than one meal per week	No more than one meal per week
Trout and Salmon		
Average catch rate for a typical angler......................	2 hours per trout/salmon	2 hours per trout/salmon
Fish consumption advisory.......	Do not eat	No more than one meal per month
Walleye		
Average catch rate for a typical angler......................	8 hours per walleye	4 hours per walleye
Fish consumption advisory.......	Do not eat	No more than one meal per month
Smallmouth bass		
Average catch rate for a typical angler......................	2 hours per bass	2 hours per bass
Fish consumption advisory.......	No more than one meal per month	Unlimited consumption
Your share of the daily launch fee............................	Free	$3
Check the box for the alternative you prefer..	❑	❑

5.4.1 Choice Set Characteristics

Catch Times

The catch characteristic for each species is defined as the amount of time it would take, on average, to catch a fish, expressed in either minutes or hours (e.g., a perch every 30 minutes, a bass every two hours). Increasing the catch time indicates worsening conditions (e.g., with a trout/salmon catch time of two hours one would expect to catch twice as many fish in a given period than one would expect with catch time of four hours).[11] We will refer to a bettering or worsening of the catch rate as a decrease or increase in the catch time, respectively. For each Green Bay alternative, the perch catch time took one of five levels: every 10, 20, 30, 40, or 60 minutes. For the other species, catch time took one of six levels: a fish every hour, every two hours, four hours, six hours, eight hours, or every twelve hours. In Green Bay, perch take less time to catch than other sport fish. These ranges were chosen on the basis of historical WDNR catch data and feedback from anglers during pretesting, and were chosen to include catch characteristics that are both better and worse than Green Bay conditions in recent years prior to the 1998 survey.

Catch data (catch and fishing time) for the Green Bay fishery in Wisconsin were collected by the WDNR. Table 5-1 reports the total hours spent targeting a species divided by the total catch for that species to obtain the average time to catch each species.[12] The long-run averages (1986-1998) are 31 minutes per perch, 7.8 hours per trout/salmon, 6.9 hours per walleye and 5.0 hours per bass. Average catch time has increased dramatically in recent years.

It is important to note that the WDNR creel survey does not collect catch data for moored boat days or charter boat days, which constituted about 15% of total fishing effort in the waters of Green Bay according to the WDNR estimates of fishing hours. Comparing the data for boat trips from a ramp to nonboat trips (pier, shore, and stream fishing modes) reveals that generally it takes less time to catch a fish from a boat than from nonboat modes. Therefore, as a result of the omission of moored and charter boat mode days, the catch times in Table 5-1 may overstate actual catch times.

11. An alternative way to define catch success is how many fish one can expect, on average, to catch in a given amount of time (e.g., two perch per hour or eight perch per day). In focus group discussions, we found that this definition was occasionally confused with the “bag limit” by anglers accustomed to catching the limit. The bag limit is a legal limit on the number of fish an angler is allowed to keep per day. Alternatively, when we expressed catch rates in terms of the amount of time it would take, on average, to catch each fish, no confusion with bag limits was detected. Defining catch rates in terms of days rather than hours or minutes would have also introduced ambiguity because the number of hours in a “day” of fishing varies across anglers.

12. Total hours targeting a species is computed as total angler hours multiplied by the percent of angler hours targeting the species.

Table 5-1
Average Time to Catch a Fish in Green Bay
(hours per fish)

	1998	Average 1986-1998	Average 1996-1998
Yellow perch	0.75	0.52	0.74
Trout/salmon	19.4	7.8	12.1
Walleye	7.4	6.9	7.6
Smallmouth bass	15.0	5.0	8.9

Source: WDNR creel data. Does not include catch statistics for moored boats or charter boats. As a result, the reported catch times may overstate actual catch times.

Mail survey respondents were asked what they felt were the current average catch times (for all anglers, not just themselves) on the Green Bay waters. The means of the responses are shown in Table 5-2, which indicate that anglers have perceptions about average catch times that are consistent with the WDNR data for perch, but are substantially shorter than the WDNR data for other species. This might be because the respondents overestimate what other anglers catch, are optimistic, are better anglers than most, or because their perceptions correspond to long-run averages. It may also be because catch varies by location or other factors, including measurement error in the creel data due to the omission of boats moored and charter boat fishing days.

Table 5-2
Perceived Average Time to Catch a Fish in Green Bay
(hours per fish — mail survey Question 36)

	N	Mean (SE)	Median	Mode	% Missing
Yellow perch	626	0.9 (0.06)	0.5	0.5	3.3%
Trout/salmon	629	2.7 (0.10)	2	2	2.8%
Walleye	625	2.1 (0.08)	1	1	3.4%
Smallmouth bass	617	1.3 (0.07)	0.67	0.5	4.6%

Fish Consumption Advisories

Consider now the FCA characteristics by species. Generally, for reductions in PCB levels, the FCAs for all species will decrease or remain the same (depending on the change in PCB levels). Generally, it is not the case that with changes in PCB levels, FCAs would become more stringent for some species and less stringent for other species.

The reality of how FCAs will change with changes in PCBs is reflected in the design of the FCA characteristics. We define nine FCA levels covering the FCA for each of our four species of interest (Table 5-3). Level 1 indicates PCB levels are sufficiently low such that all species may be eaten in unlimited quantities; there is no health risk from consumption. Level 9 is the most restrictive: trout/salmon, walleye, and bass should not be eaten, and a perch meal should be consumed once a month at most. In general, the stringency of FCAs for particular species increases or stays the same moving from lower to higher levels, with two exceptions: going from Level 5 to Level 4, the walleye FCA becomes less stringent while the perch FCA becomes more stringent, and going from Level 6 to Level 5, the trout/salmon FCA becomes less stringent while the walleye FCA becomes more stringent. These two exceptions allow for examination of whether respondents are sensitive to the variations within the mix of FCAs across levels; the results show that anglers are.

Note that in the presentation of the pairs (see the example in Figure 5-1), the FCAs in each of the alternatives are reported by species, but because they are based on nine aggregate levels they do not vary in unrealistic ways by species across the alternatives. This design and presentation of the FCA characteristics account for the fact that the FCAs are correlated across species through their underlying cause, PCB contamination, but take into account the fact that FCAs vary by species, and that different anglers might be interested in different species.

The actual FCAs for the waters of Green Bay vary by species, fish size, and location. Table 5-4 shows the 1998 WDNR advisories for the Fox River from its mouth at Green Bay up to DePere Dam, and for the Wisconsin waters of Green Bay (which include all other tributaries up to their first dam) for the species addressed in the survey (see Table 2-10 for a summary of FCAs for all species). Note that the nine FCA levels in Table 5-3 vary by species but not by size. The least restrictive advisories in 1998, by species, are once a week for perch, and once a month for trout/salmon, bass, and walleye. This corresponds to Level 4 in Table 5-3, which is a conservative representation of the current FCA conditions in the Wisconsin waters of Green Bay for each of the four species.

Note that in the WDNR advisory for Green Bay, there is a distinction between once a month and once every two months; this restriction was not used in the choice pairs. Eliminating this category reduces the complexity of the levels and choice tasks. Assuming the current FCA advisory is once a month, if it is once every two months, will also lead to lower damage estimates. In the focus

Table 5-3
Green Bay FCA Levels for an Average Size Fish
(mail survey — see Appendix E)

	Species	Fish Meals Advised
FCA Level 1	Yellow perch Trout/salmon Walleye Smallmouth bass	"Unlimited" "Unlimited" "Unlimited" "Unlimited"
FCA Level 2	Yellow perch Trout/salmon Walleye Smallmouth bass	"Unlimited" "Eat no more than 1 meal a week" "Eat no more than 1 meal a week" "Unlimited"
FCA Level 3	Yellow perch Trout/salmon Walleye Smallmouth bass	"Unlimited" "Eat no more than 1 meal a month" "Eat no more than 1 meal a month" "Eat no more than 1 meal a week"
FCA Level 4	Yellow perch Trout/salmon Walleye Smallmouth bass	"Eat no more than 1 meal a week" "Eat no more than 1 meal a month" "Eat no more than 1 meal a month" "Eat no more than 1 meal a month"
FCA Level 5	Yellow perch Trout/salmon Walleye Smallmouth bass	"Unlimited" "Eat no more than 1 meal a month" "Do not eat" "Eat no more than 1 meal a month"
FCA Level 6	Yellow perch Trout/salmon Walleye Smallmouth bass	"Unlimited" "Do not eat" "Eat no more than 1 meal a month" "Eat no more than 1 meal a month"
FCA Level 7	Yellow perch Trout/salmon Walleye Smallmouth bass	"Unlimited" "Do not eat" "Do not eat" "Eat no more than 1 meal a month"
FCA Level 8	Yellow perch Trout/salmon Walleye Smallmouth bass	"Eat no more than 1 meal a week" "Do not eat" "Do not eat" "Eat no more than 1 meal a month"
FCA Level 9	Yellow perch Trout/salmon Walleye Smallmouth bass	"Eat no more than 1 meal a month" "Do not eat" "Do not eat" "Do not eat"

Table 5-4
1998 Wisconsin FCAs for Green Bay and Fox River for Selected Species

		Unlimited	Once a Week	Once a Month	Once Every 2 Months	Do Not Eat
Yellow perch	Fox River			all sizes		
	Green Bay		all sizes			
Rainbow trout	Green Bay			all sizes		
Chinook salmon	Green Bay			< 30"	> 30"	
Brown trout	Green Bay			< 17"	17-28"	> 28"
Walleye	Fox River			< 16"	16-22"	> 22"
	Green Bay			< 17"	17-26"	> 26"
Smallmouth bass	Fox River				all sizes	
	Green Bay			all sizes		

Source: WDNR creel data.

groups, respondents were largely indifferent between once every two months and once a month. Perceived FCAs and actual FCAs are generally consistent, as discussed in Chapter 4.

Note that the difference between Level 4 and Level 3 is the elimination of the FCA for yellow perch (in both the Lower Fox River and the Bay of Green Bay). The difference between Level 3 and Level 2 is a reduction in severity in each of the trout/salmon, walleye, and smallmouth bass FCAs, with the smallmouth bass FCA going to unlimited. The difference between Level 2 and Level 1 is the reduction of trout/salmon and walleye FCAs from once a week to unlimited.

Daily Fee

One of the characteristics used to describe each Green Bay alternative is the "share of the daily launch fee." For angling trips that did not involve a boat, respondents were told twice they should "think of the daily boat launch fee as a fee you would have to pay to fish the waters of Green Bay," so the cost variable in the choice question has a meaning to all respondents. This presentation strategy was tested in the pretests and found to be accepted in a manner consistent with the design of the choice questions. For each Green Bay alternative, the launch fee took one of nine levels: free, $2, $3, $5, $7, $9, $10, $12, or $15, which includes fees that are lower than and higher than the current average fee. Inclusion of this "cost" characteristic gives the respondent the opportunity to indicate his WTP for better conditions on Green Bay; without it monetary estimates of damages would not be possible.

Green Bay has many boat access points, some run by private marinas or private land owners, some city run, some county run, and some state run. In the summer of 1997, we collected launch fee data for 37 launches. Fifty-one percent of these sites charged $3.00 to launch a boat; the average was $2.84, and the range was $0.00 to $7.00. In the mail survey (Q38), anglers were asked, “Approximately what do you think is the average daily boat launch fee for the waters of Green Bay?” The mean of the angler estimates is $4.41, the median is $4.00, and the mode is $3.00. The anglers’ perceptions of costs were very consistent with the data collected on actual boat fees, again reflecting anglers’ familiarity with fishing in the waters of Green Bay. The cost range in the choice questions is broader than actually observed to allow for higher costs tradeoffs with less stringent FCAs and higher catch rates. The cost range was determined from the focus groups and pretests, and spans the partial range of cost differentials anglers indicated were acceptable for changes in FCAs and catch rates (i.e., some anglers would pay more than $15 for improvements at the site, and thus our range results in conservative value estimates).

5.4.2 Selection of Choice Sets

Given the number of characteristics and the levels they can take, there are 1,620 possible Green Bay alternatives and an extremely large number of possible pairs. Eighty of these pairs were chosen so that there would be sufficient independent variation in the levels of the six different characteristics. Independent variation is required to identify the separate influence of each of the characteristics.

The experimental design for the choice study was accomplished using the conjoint design software of Bretton Clark (1990). This software uses a set of characteristics and the levels of these characteristics as inputs to produce a set of “products,” which in our case is a set of Green Bay alternatives. Each Green Bay alternative in the final set of 80 pairs represents a specific combination of the levels for the FCA, and catch and cost characteristics. The set produced by the conjoint design software represents the smallest possible set of alternatives sufficient to estimate a main effects model; it contains 160 Green Bay alternatives. In other words, the design program produces the smallest possible set of alternatives with sufficient variation in any one characteristic, independent of all the others, to allow estimation of the effect of changes in that characteristic on the probability of selection. The 160 members of the set were randomly divided into 80 pairs, which in turn were randomly allocated among 10 versions of the survey instrument. The simple correlations between the characteristics in the 160 alternatives are reported in Table 5-5. None of the correlations is significantly different from zero, indicating independent variation among the characteristics which aids the estimation of separate values for each characteristic. The specific choice pairs for each survey version are included with the survey materials in Appendix E.

Table 5-5
Pearson Correlation Coefficients between Green Bay Characteristics across the Choice Pairs

	Yellow Perch Catch	Trout/Salmon Catch	Walleye Catch	Smallmouth Bass Catch	FCA	Fee
Yellow perch catch	1.0000	-0.0335	0.0122	0.0062	-0.0104	0.0302
Trout/salmon catch	-0.0335	1.0000	-0.0472	0.0160	0.0228	0.0033
Walleye catch	0.0122	-0.0472	1.0000	-0.0089	-0.0245	0.0541
Smallmouth bass catch	0.0062	0.0160	-0.0089	1.0000	-0.0542	0.0392
FCA	-0.0104	0.0228	-0.0245	-0.0542	1.0000	0.0281
Fee	0.0302	0.0033	0.0541	0.0392	0.0281	1.0000

5.5 EVALUATION OF CHOICES ACROSS ALTERNATIVES

In this section anglers' choices of the preferred alternatives from the choice pairs are summarized and evaluated. Overall, their choices are very consistent with the characteristics they rate as important in other survey questions and with their reported preferences such as species target preference.

Only 138 (2.7%) of the choice pairs were left unanswered. This is consistent with our finding from the focus groups and pretests that most anglers found the survey interesting and the choice tasks reasonable. Remember that we surveyed only current Green Bay anglers.

In 40.5% of sample pairs, anglers chose the more costly alternative, which indicates that Green Bay anglers are willing to pay for better Green Bay conditions. An estimate of this WTP is determined by inputting all of the choice data into a statistical model, along with the data on actual number of Green Bay days under current conditions. The model is outlined in Chapter 6, and the WTP estimates for eliminating Green Bay FCAs are reported in Chapter 8.

In pairs where the only varying characteristic is a higher cost for a less stringent FCA level, one could estimate from that pair how many anglers have a WTP for the specified FCA reduction at least as large as the cost difference. However, there are few such pairs, as most comparisons involve changes in three or more characteristics. To estimate the specific magnitude of WTP for changes in characteristic levels, one must use the data in its entirety.

For most anglers, their chosen alternatives indicate consistent preferences across the choices, i.e., the criteria on which they base the pairwise choices appear to stem from stable preferences. The pairwise choices are also consistent with anglers' answers to other questions in the survey. In practice we do not expect every choice for all anglers to be perfectly consistent, which the method and statistical evaluation are designed to accommodate through the random element in angler choices. In reviewing each angler's response for consistency, only a few anglers in our sample made choices that may indicate that their choices were based on something other than their preferences, such as always choosing the first or second alternative in each of the eight choices. For example, only eight anglers (1.2%) always chose the first or second alternative, and it is possible those alternatives were always their preferred ones.

After the angler answered the eight choice pairs, Question 35 inquired about the importance of each of the Green Bay characteristics in making pairwise choices. The average importance level of each characteristic is reported in Table 5-6, where 1 is "not at all important" and 5 is "very important." FCAs for perch and walleye and perch catch rates are the three characteristics considered to be the most important in choosing among the pairs. Most respondents indicated that perch FCA levels and catch rates were quite important in making their choice decisions, as were walleye FCAs and catch rates. This is to be expected as perch is a frequently targeted and frequently caught species on Green Bay, and fishing activity in Green Bay for walleye has been rapidly growing.

Table 5-6
Importance of Green Bay Characteristics to Choice Pair Decisions
(mail survey Question 35 1 = "not at all important" and 5 = "very important")

Characteristic	N	Mean (SE)	Median	Mode	% Missing
Yellow perch catch rate	638	3.6 (0.05)	4	5	1.4%
Yellow perch FCA level	639	3.7 (0.05)	4	5	1.2%
Trout/salmon catch rate	638	2.8 (0.05)	3	3	1.4%
Trout/salmon FCA level	640	3.1 (0.06)	3	3	1.1%
Walleye catch rate	639	3.5 (0.05)	4	3	1.2%
Walleye FCA level	634	3.7 (0.05)	4	5	2.0%
Smallmouth bass catch rate	633	3.1 (0.05)	3	3	2.2%
Smallmouth bass FCA level	633	3.0 (0.06)	3	1	2.2%
Fee	636	3.1 (0.05)	3	3	1.7%

Table 5-7 shows how the respondents who exclusively target one specific species rated the importance of the different Green Bay characteristics in their choice decisions.[13] For example, 125 anglers, or 23% of the same "often" or "almost always" target perch but not other species. Most anglers (348 or 54%) are not exclusive anglers, which is consistent with a large share (41%) of anglers "often" or "almost always" targeting "whatever is biting" (Figure 4-2). The exclusive anglers indicate that they typically target a particular species rate catch time and the FCA for that species as more important than catch times and FCAs for other species. This shows consistency between angler preferences and their intentions for selecting alternatives in the choice questions. These intentions are reflected in the actual choices made (see Chapter 8).

Table 5-7
Mean Importance of Green Bay Characteristics to Choice Pair Decisions by Target[a]
(mail survey Questions 35 and 4)

Characteristic	Targets Yellow Perch	Targets Trout/Salmon	Targets Walleye	Targets Smallmouth Bass	No Target or Multiple Targets
Number of observations	125	63	52	59	348
Yellow perch catch rate	**4.3 (0.09)**	2.6 (0.18)	3.1 (0.17)	3.0 (0.17)	3.7 (0.07)
Yellow perch FCA level	**4.3 (0.09)**	3.2 (0.21)	3.5 (0.20)	3.4 (0.20)	3.7 (0.07)
Trout/salmon catch rate	2.4 (0.10)	**4.2 (0.14)**	2.3 (0.16)	2.3 (0.15)	2.8 (0.07)
Trout/salmon FCA level	2.9 (0.12)	**4.2 (0.14)**	2.8 (0.21)	2.8 (0.21)	3.1 (0.08)
Walleye catch rate	3.1 (0.10)	2.9 (0.16)	**4.4 (0.12)**	3.1 (0.15)	3.7 (0.06)
Walleye FCA level	3.5 (0.12)	3.6 (0.18)	**4.1 (0.17)**	3.4 (0.19)	3.8 (0.07)
Smallmouth bass catch rate	2.6 (0.11)	2.4 (0.15)	2.5 (0.17)	**4.2 (0.13)**	3.4 (0.07)
Smallmouth bass FCA level	2.8 (0.13)	2.9 (0.21)	2.6 (0.22)	**3.2 (0.21)**	3.1 (0.08)
Fee	3.3 (0.12)	3.2 (0.19)	3.0 (0.20)	3.1 (0.16)	3.0 (0.07)

a. Each target group targets the respective species "often" or "almost always" and does not target any other species "often" or "almost always." Standard errors appear in parentheses. Bold text highlights answers by anglers targeting the identified species.

How important the different characteristics are to the choice pair decisions does not vary greatly by characteristics of the angler other than target species preference, but some small differences can be detected. Women rate the FCAs more important and catch time less important than do

13. In this section we define target angler as one who "often" or "almost always" targets a species, but does not "often" or "almost always" target any other species. We use this definition to identify anglers who are focused on one individual species.

men. A typical result in the risk literature is that women are more risk averse than men (see, for example, Slovic, 1987). This is not surprising since consumption of PCB-contaminated fish by pregnant women can affect a child's development. Anglers with higher education levels generally have lower mean importance ratings, as do anglers with higher income levels. Anglers who fished 15 or more days on the open waters of Green Bay in 1998 have the same or slightly higher importance ratings for all characteristics than those who fished less than 5 days, as reported in Table 5-8.

Table 5-8
Mean Importance of Green Bay Characteristics to Choice Pair Decisions by Avidity in 1998[a]
(mail survey Question 35 1 = "not at all important" and 5 = "very important")

Characteristic	Low Avidity (<5 Green Bay days per year) N = 289	High Avidity (≥15 Green Bay days per year) N = 135
Yellow perch catch rate	3.5 (0.08)	3.8 (0.12)
Yellow perch FCA level	3.7 (0.08)	3.7 (0.12)
Trout/salmon catch rate	2.7 (0.08)	2.9 (0.12)
Trout/salmon FCA level	3.0 (0.09)	3.2 (0.13)
Walleye catch rate	3.4 (0.07)	3.7 (0.10)
Walleye FCA level	3.7 (0.08)	3.8 (0.11)
Smallmouth bass catch rate	3.0 (0.08)	3.3 (0.12)
Smallmouth bass FCA level	2.9 (0.09)	3.0 (0.14)
Fee	3.0 (0.08)	3.3 (0.12)

a. Standard errors appear in parentheses.

While importance increases with avidity, it does not increase as much as for whether the angler targets a particular species; this result suggests that values per day may not vary much by angler avidity, which is confirmed by model results in Chapter 9 and Appendix D. Note also that differences in mean importance ratings of FCAs across avidity groups are generally less than for other characteristics, implying similar values across the groups.

In general, anglers' intentions in Question 35 are consistent with their actual pairwise choices; anglers who report catch as very important tend to choose alternatives with higher catch rates than those who rate catch as unimportant, and anglers who report FCAs as important tend to choose alternatives with less stringent FCA levels. Table 5-9 reports the means and modes of the

Table 5-9
Mean Characteristics Levels for the Preferred Alternatives by Whether the Characteristics Were Important to Choice[a]
(mail survey Question 35)

Characteristic		All Respondents	Characteristic Important (rating = 4, 5)	Characteristic Not Important (rating = 1, 2)
Yellow perch catch time (minutes per fish)	mean (SE) mode	29 (0.25) 10	27 (0.34) 10	31 (0.54) 30
Trout/salmon catch time (hours per fish)	mean (SE) mode	5.2 (0.05) 1	4.9 (0.09) 1	5.4 (0.08) 1
Walleye catch time (hours per fish)	mean (SE) mode	5.2 (0.05) 1	5.0 (0.07) 1	5.6 (0.13) 8
Smallmouth bass catch time (hours per fish)	mean (SE) mode	5.3 (0.05) 1	5.0 (0.08) 2	5.6 (0.10) 12
Yellow perch FCA level (meals per month)	mean (SE) mode	24 (0.15) 30	25 (0.18) 30	23 (0.37) 30
Trout/salmon FCA level (meals per month)	mean (SE) mode	6.6 (0.16) 1	6.9 (0.24) 1	5.8 (0.24) 0
Walleye FCA level (meals per month)	mean (SE) mode	6.6 (0.16) 1	6.8 (0.21) 1	5.7 (0.36) 0
Smallmouth bass FCA level (meals per month)	mean (SE) mode	11.0 (0.19) 1	11.7 (0.30) 1	10.4 (0.29) 1
Fee (dollars)	mean (SE) mode	6.2 (0.06) 2	5.8 (0.10) 2	6.6 (0.11) 2

a. Increasing catch time means it takes longer to catch a fish. Increasing meals per month reflects a less restrictive FCA.

characteristics of the chosen alternatives for all anglers, for those anglers who rated the characteristics as important (rated 4 or 5), and for those anglers that rated the characteristics as unimportant (rated 1 or 2). For example, in the Green Bay alternatives chosen by anglers who reported salmon catch as important, the average trout/salmon catch time is 4.9 hours, whereas for those anglers who reported salmon catch as not important, the average is 5.4 hours. Expected results are also obtained for species' FCA characteristics. The average recommended maximum number of meals for the preferred Green Bay alternatives (based on the average of the FCA characteristics for these choices) is reported in Table 5-9 by species. The maximum is assumed to be 30 (roughly a meal a day), so 30 meals correspond to no FCA, and zero meals correspond to the most restrictive "do not eat" level. Anglers who place more importance on the FCA for a species are more inclined to choose alternatives with less stringent FCAs for that species, allowing more meals per month. For all four species, the average number of meals allowed is higher for anglers placing importance on the FCA characteristic. For example, in Table 5-9, in the alternatives chosen by anglers who reported walleye FCA levels as important, the average of the recommend maximum meals is 6.8 per month, whereas for those who reported walleye FCA levels as unimportant, the average maximum meals per month is less than 5.7.

Table 5-10 shows the same findings when anglers are separated by target species. This table reports the mean characteristics levels for catch rates of the chosen alternatives for anglers who target a specific species (see Footnote 12). In this table we do not report the average FCA levels as FCAs generally change in a consistent manner for all species, so there is little opportunity for an angler to choose alternatives with FCA levels that are low for a target species but high for other species.

Table 5-10
Mean Characteristics Levels for the Preferred Alternatives by Target Species[a]
(mail survey Question 4)

Characteristic	Targets Yellow Perch	Targets Trout/Salmon	Targets Walleye	Targets Smallmouth Bass	No Target or Multiple Targets
Yellow perch catch time (minutes per fish)	**27 (0.56)**	32 (0.84)	29 (0.87)	30 (0.84)	29 (0.35)
Trout/salmon catch time (hours per fish)	5.3 (0.12)	**4.6 (0.15)**	5.5 (0.18)	5.3 (0.17)	5.3 (0.07)
Walleye catch time (hours per fish)	5.6 (0.12)	5.4 (0.16)	**4.5 (0.17)**	5.3 (0.18)	5.1 (0.07)
Smallmouth bass catch time (hours per fish)	5.4 (0.12)	5.3 (0.17)	5.6 (0.19)	**4.5 (0.16)**	5.3 (0.07)

a. Each target group targets the respective species "often" or "almost always" and does not target any other species "often" or "almost always." Standard errors appear in parentheses. Bold text highlights answers by anglers targeting the identified species.

5.6 THE EXPECTED DAYS FOLLOWUP QUESTION TO EACH CHOICE PAIR

After each choice pair, the following followup question about the expected number of days the angler would visit the preferred site was asked:

> How often would you fish the waters of Green Bay if it had the conditions described by the alternative you just chose (A or B)? Your answer could depend on a number of factors:
>
> - How many days you typically fish in a year and how many of those days are spent fishing the waters of Green Bay.
> - How much you enjoy fishing the waters of Green Bay compared to other places you might fish.
> - How far you live from Green Bay compared to other places you might fish.
> - The cost of fishing the waters of Green Bay compared to other places you might fish.
> - Whether you think the conditions for the waters of Green Bay in the alternative you just chose are better, worse, or about the same as current conditions.
> - The more you fish the waters of Green Bay the less time you will have for fishing elsewhere.
>
> Excluding ice fishing, how many days, on average, would you fish the waters of Green Bay in a typical year if the conditions on the waters of Green Bay were those described in the alternative you chose *? Fill in the blank.*
>
> ________ days fishing the waters of Green Bay in a typical year.

The answers to these expected days followup questions, along with the number of days the angler fished Green Bay in 1998, will be used to estimate how the number of fishing days in Green Bay would change if there were a change in its characteristics. One would expect that, for some anglers, an improvement in conditions would lead to an increase in fishing days and that the long-run response to an improvement would be greater than the short-run response, because it takes time for anglers to break habits and initiate change. The answers to the expected days questions likely reflect what anglers would do in the short-run, and therefore are likely to underestimate the long-run response to an improvement.

The expected days question for each pair gives the angler the ability to express possible displeasure with the chosen alternative by reporting that he would reduce or stop fishing Green Bay entirely if it had the conditions of the chosen alternative, for example, if the respondent feels the chosen alternative is inferior to Green Bay under current conditions. That is, the respondent has the ability to "just say no."[14] Alternatively, if the respondent feels the chosen alternative is superior to Green Bay under current conditions, he has the option of saying he will fish more. The angler also can report that he would continue to fish Green Bay his current number of days.

When presented with a pair where both alternatives are unappealing, and with no way to express displeasure with these options, some individuals either may not respond out of protest or may not respond due to an inability to identify the preferred alternative. To avoid such possibilities some authors have advocated a third "opt-out" alternative, such as "would not fish" or "would fish elsewhere."[15] Our expected days question plays the role of such a third alternative, while avoiding one of its disadvantages: giving the respondent an easy way to avoid difficult choices. Choosing will be difficult when the angler is almost indifferent between the two sets of Green Bay characteristics. However, if the individual makes these choices he reveals the rate at which he is willing to trade off site characteristics. There is no fundamental reason individuals cannot choose between alternatives they dislike, or between options both better than the status quo, and such choices provide valuable information about preferences.

In 69.9% of the answered expected days questions, anglers report a number of Green Bay fishing days greater than their current 1998 numbers. If 1998 is assumed to be a typical year and a base for comparison, these responses indicate that anglers feel the preferred alternative in the pair is better than the status quo. In 8.0% of the answered questions, anglers report their current number of Green Bay fishing days. In 22.1%, anglers report an expected number of Green Bay fishing days less than their current numbers, indicating anglers feel the alternatives in the pair are inferior to current conditions. Eighty-five of the anglers (13%) provide an answer of days at trips to Green Bay in response to at least one of their Green Bay alternative choices; that is, they say they would not fish if the conditions were as described in that pair. Zero fishing days was reported for

14. If the angler does not like the alternatives, he also has the option of not choosing from that pair (this happened in less than 3% of the pairs). In addition, 172 (3.3%) of the expected days followup questions were unanswered. Ten anglers (1.5%) left all eight of these followup questions blank, and 53 respondents (8.2%) left one or more of them blank. Blanks on the followup questions were assumed to contain no information about the individual's preferences; they were *not* interpreted as responses of zero days.

15. With questions involving a choice of moose hunting site, Adamowicz et al. (1997) included as a third alternative, "Neither site A nor site B. I will NOT go moose hunting." Along with two water-based recreational sites Adamowicz et al. (1994) included as a third alternative, "Any other nonwater related recreational activity or stay at home." With choice pairs over mountain bike sites, Morey et al. (1999a) included no "opt-out" alternative other than the option of not answering a choice pair. Through focus groups and the survey, they found respondents able and willing to answer most of the pairs. Ruby et al. (1998) investigated the inclusion and form of "opt-out" alternatives, and found that the form of the "opt-out" can matter.

just over 4% of the followup questions. Summary statistics from the expected days questions are compared to reported 1998 Green Bay days in Table 5-11.

Table 5-11
Comparison of Expected Days to Visit Preferred Green Bay Alternative to Reported Days

	Expected Days to Visit Preferred Alternative	Reported 1998 Days
Mean Green Bay fishing days (standard error)	17.81 (0.33)	9.95 (0.55)
Median Green Bay fishing days	10	5
Mode for Green Bay fishing days	10	2
Minimum Green Bay fishing days	0	1
Maximum Green Bay fishing days	300	120

That anglers prefer the chosen Green Bay alternatives, on average, to current Green Bay conditions is not surprising (since the angler gets to choose the preferred site), and is consistent with the study goal of estimating anglers' WTP for an improvement, rather than a deterioration at the site. This preference also indicates a WTP for better conditions because the average launch fee in the chosen alternatives is higher than the current average, indicating anglers prefer the chosen alternative to the status quo, even though it costs more. At the same time, for 22% of the followup questions, respondents reported fewer Green Bay fishing days, which is consistent with the random procedure generating some choice pairs where both choices could be perceived as inferior to current conditions (see discussion of Table 5-12 below).

The characteristics levels in the chosen alternatives are consistent with the chosen alternative being, on average, preferred to current conditions. Over the chosen Green Bay alternatives, the average of the FCAs is Level 4, which is the least stringent representation of current FCA levels. The FCA level chosen most frequently is "unlimited consumption" for perch, as shown in Table 5-9. Over the chosen alternatives, the averages of the catch rates are better than those that WDNR reported for Green Bay in 1998, but worse than anglers' perceptions of the catch rates. In contrast, the modes are better than both the 1998 WDNR catch rates and the averages of the anglers' perceptions. Remember that not all anglers are concerned with all catch rates: a perch angler may be willing to choose an alternative with the worst walleye catch rate to get the best perch catch rate or perch FCA level.

In Table 5-12, the means of the characteristics for the preferred alternatives show that expected days tend to be higher when site quality is better. For example, when anglers report expected days that are greater than the current level, the perch catch time is 28 minutes; when anglers report fewer expected days than current, the perch catch time is 31 minutes. For all nine characteristics, the mean for higher-than-current expected days is better than or the same as the mean for lower-than-current expected days.

Table 5-12
Mean Characteristics Levels for the Preferred Alternatives by Whether Respondent Expects to Spend Fewer, the Same as, or More than Current Days[a]

Characteristic	Fewer than Current	Same as Current	More than Current
N of choice occasions	1,107	399	3,498
Yellow perch catch time (minutes per fish)	31 (0.56)	29 (0.90)	28 (0.35)
Trout/salmon catch time (hours per fish)	5.2 (0.11)	5.5 (0.18)	5.2 (0.06)
Walleye catch time (hours per fish)	5.3 (0.11)	5.2 (0.19)	5.1 (0.06)
Smallmouth bass catch time (hours per fish)	5.3 (0.11)	5.3 (0.19)	5.2 (0.06)
Yellow perch FCA level (meals per month)	23 (0.34)	23 (0.57)	24 (0.18)
Trout/salmon FCA level (meals per month)	5.7 (0.32)	5.6 (0.53)	6.4 (0.19)
Walleye FCA level (meals per month)	5.7 (0.32)	5.6 (0.53)	6.5 (0.19)
Smallmouth bass FCA level (meals per month)	9.6 (0.4)	9.7 (0.65)	11.2 (0.23)
Fee (dollars)	7.02 (0.14)	6.47 (0.22)	5.90 (0.08)

a. Standard errors appear in parentheses.

There were 222 respondents (34%) who did not vary their expected days responses throughout the eight pair questions. This is consistent with many of the comments in the focus groups about time constraints, entrenched fishing patterns, and dependencies on fishing partners. It is also consistent with the responses to Question 11 of the mail survey, where 68% of the anglers indicated they had not reduced the number of days spent fishing Green Bay in response to FCAs.

That an angler does not change his or her number of fishing days in response to the change in environmental characteristics does not indicate that he or she would not benefit from an improvement in FCAs or catch rates. If conditions are improved, constraints can keep the angler from increasing fishing days, but each day fished will be enjoyed more. If conditions worsen, the angler still might prefer fishing Green Bay to doing something else, he just prefers it less. When the quality of a product is improved or its price is decreased, many consumers do not buy more of it, but they do get greater benefits from the amount they purchase. Also, if a product's quality decreases or price increases, many consumers will not purchase less in the short run; e.g., one does not immediately reduce gas consumption when its price has risen, even though the price hike makes the individual worse off.

Sixty-six percent of the anglers did vary their answers to the expected days questions over the eight pairs, indicating that for the majority of anglers, the number of days they fish Green Bay will vary as a function of changes in the characteristics of Green Bay, even in the short run. For such anglers, if Green Bay conditions are improved, they are likely to fish Green Bay more days and value each of those days more than they currently value Green Bay fishing days.

CHAPTER 6
A COMBINED REVEALED PREFERENCE AND STATED PREFERENCE MODEL OF GREEN BAY FISHING

6.1 INTRODUCTION

In this chapter we present our main model used to estimate per fishing day values for changes in FCAs and catch times. The technical details of the model are presented in Appendices A and B. The model presented here is considered our main model because it is consistent with traditional recreational demand models and is a straightforward specification that can be expected to provide robust estimates; it uses all of the RP and SP data available. In Chapter 9 we explore the sensitivity of the damage estimates to preselected model variations. These variations, some of which add considerable elaboration, provide results consistent with (and generally not statistically significantly different from) the main model results, supporting the robustness of the main model.

This chapter describes the model developed to explain each angler's observed and stated Green Bay fishing choices as a function of a number of Green Bay characteristics. The parameters on these characteristics represent the relative importance of the Green Bay characteristics in determining the benefits an angler will get from fishing Green Bay. For example, the parameter on launch fee indicates the decrease in benefits from a day of fishing Green Bay if the launch fee is increased $1, and the parameter on average catch time for perch indicates the decrease in benefits from a day of fishing Green Bay if the catch time for perch increases one hour.

In our main model, all of the SP and RP data are combined for the estimation of the model. Three types of preference data are available: 1) anglers' preferred alternatives from the eight Green Bay choice pairs, 2) the expected number of Green Bay fishing days to be spent at the preferred Green Bay alternatives from the eight followup questions to the choice pairs, and 3) the number of fishing days in total to all sites and the number of days each angler fishes Green Bay under current conditions. The first two data types are SP data and the last data type is RP data. The estimates of the model parameters (reported in Chapter 7) are those parameter values that best explain all of the anglers' choices. As noted in Chapter 5, combining RP and SP data is widely supported because of the relative strengths of these two types of data. While both types of data provide information about behavior and tradeoffs, the relative strength of RP data is in predicting trip-taking behavior, and the relative strength of SP data is in determining the rates at which the angler is willing to trade off site characteristics.

This model assumes the angler, when he fishes, chooses the fishing site that gives him the largest net benefit. That is, he will choose Green Bay alternative A over B if he prefers A to B, and then he will choose Green Bay with conditions A over some other site if he expects the net benefit from fishing Green Bay under these conditions is greater than the net benefit from fishing elsewhere. If not, he will fish elsewhere. The model is designed to be a partial model in that it does not explain the angler's total number of fishing days, only the allocation of those fishing days between Green Bay and other sites. That is, the model is not designed to predict how an angler's total number of fishing days might increase if Green Bay conditions are significantly improved. It will, however, predict the extent to which an angler's current number of fishing days would be reallocated to Green Bay if Green Bay were improved.[1]

The model assumes that fishing is separable from nonfishing activities in that it assumes that how an angler chooses between Green Bay and other sites and how an angler chooses between Green Bay under different conditions does not depend on the costs or attributes of other activities. That is, how an angler would choose between Green Bay under different conditions does not depend on the characteristics of other fishing sites, and how an angler would choose between Green Bay and another site does not depend on the characteristics of nonfishing activities. While not always literally true, these are standard modeling assumptions. When examining choices over Green Bay alternatives under different conditions, the characteristics of other sites remain constant.

Because the model is not designed to predict how total fishing days would increase if Green Bay is improved, damage estimates derived from the model will be conservative. The component of benefits associated with the possibility that the angler might fish more, in total, if Green Bay is improved, rather than just fishing Green Bay some increased proportion of some constant number of days, is omitted. It is our intent to be conservative here.

In this chapter, the basics of the model are presented. The extensive technical and mathematical details of model development are presented in Appendices A and B.

6.2 FACTORS AFFECTING UTILITY FROM FISHING GREEN BAY

The utility (satisfaction) an angler receives from a day of fishing Green Bay is modeled to be a function of costs (which include the opportunity cost of travel and on-site time, plus monetary expenses including travel costs and any launch fee); the catch times for four different species groups targeted in Green Bay: trout/salmon, perch, walleye, and bass; and the level of FCAs

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1. We restrictively assume all increased days to Green Bay are substituted from other fishing sites (and vice-versa for decreased fishing days at Green Bay). Actual increases in Green Bay fishing days may also come from increases in total fishing days, not just from substituting days from other sites. The assumption of no increase in total fishing days is more straightforward to model and requires fewer survey questions (e.g., we do not ask if total days change and by how much). The substitution assumption is implemented in the model by holding total fishing days constant, even though increases in fishing days may in fact occur when Green Bay is improved. Further, we restrict any expected increases in Green Bay days in the followup questions to be no more than the total fishing days at other sites under current conditions.

(which can be one of nine levels, including no FCAs). The utility angler *i* gets from fishing Green Bay is assumed to be:

$$U_i = b_y(-FEE) + b_{cp}ACT_p + b_{ct}ACT_t + b_{cw}ACT_w + b_{cb}ACT_b + b_{FCA2}FCA_2 + b_{FCA3}FCA_3 + \ldots + b_{FCA9}FCA_9 + e_{Gi},\ i = 1,\ldots,N \qquad (1)$$

where *FEE* is the launch fee; *ACT* is the average time to catch a fish, indexed by the four species: *p* = perch, *t* = trout/salmon, *w* = walleye, and *b* = bass; *FCA* is a dummy variable indexed by each of the nine FCA levels (β_{FCA1} is fixed at zero for identification), and e_{Gi} is a stochastic term for capturing random effects on utility from fishing Green Bay.[2] The *FCA* variables are dummy variables, which take on a value of one for one of FCA Levels 2-9, and a value of zero for all others. Note again that *ACT* is the reciprocal of the associated catch rate. Money not spent fishing is assumed to be spent on a numeraire, a generic bundle with a price of $1.

Parameter b_y indicates the increase in utility if the cost of the fishing day decreases one dollar and is typically referred to as the marginal utility of money. It is assumed to be a constant. This parameter is expected to have a positive sign, which also implies that the angler prefers a lower launch fee. Downward sloping demand (i.e., demand is a decreasing function of price) is a standard tenet of consumer economic theory and a universally observed phenomenon.

The catch parameters, b_{cp}, b_{ct}, b_{cw}, and b_{cb}, represent the change in utility from an increase in the time it takes to catch the four species. These parameters are expected to be negative (because the variable is catch *time* rather than catch *rate*); anglers like to catch fish, so they prefer to catch a fish in a shorter amount of time, or more fish in the same amount of time.

As also noted in Chapter 3, the answers to the attitudinal questions definitely indicate that anglers place importance on catching fish. For example, when anglers were asked to rate from one to five the importance of increasing catch rates in Green Bay, 68.5% responded with a three or higher. When asked to explain their ratings of Green Bay relative to other sites in the survey (Question 1), 29.1% voluntarily offered catch-related comments as their first explanation, again showing the importance of catch rate.

The b_{FCA}'s represent the change in utility from the different FCA levels. Because eight dummies representing nine possible FCA levels are used, the model allows a nonlinear relationship between severity of the FCA and the angler's utility. This feature, for example, allows the impact on utility of a change from FCA Level 4 to 3 to be different from the impact of a change from Level 9 to 8.

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2. Note that the full budget constraint is $b_y(Y_i - TC_{Gi} - FEE)$, where Y_i is the angler's per-choice occasion income and TC_{Gi} is angler *i*'s trip cost for Green Bay (excluding the launch fee). Since income and trip costs to Green Bay remain constant, they do not influence the probability of choosing one Green Bay alternative over the other, and they are omitted for convenience of presentation.

Because FCAs make anglers worse off, all of these parameters are expected to have a negative sign and to be nondecreasing in absolute value as the stringency of the advisory increases.

Attitudinal questions from the mail survey corroborate the negative effects of FCAs on anglers. When asked to rate the importance of different enhancement activities, such as cleaning up PCBs so that FCAs could be removed, increasing the catch rates, or adding parks or boat launches (Question 7), anglers identify PCB cleanup as more important than any other option. Further, when asked how bothered they are about different FCA levels on a one-to-five scale, the means for all FCA levels are greater than three, and increase with the severity of FCAs.

If in a pair-wise Green Bay choice the utility from alternative B is greater than the utility from alternative A, the angler chooses B. In this model, it is assumed that preferences are homogeneous; that is, all anglers have the same marginal utilities for changes in the site characteristics for Green Bay. This assumption is relaxed in Chapter 9, and while in some cases it is found that different anglers have significantly different preferences, the effect on mean values of allowing preferences to be heterogeneous across anglers is usually found to be very minor.

6.3 FACTORS AFFECTING UTILITY FROM FISHING ELSEWHERE

As stated earlier, the model also predicts the expected allocation of total 1998 fishing days between the Green Bay alternative (with the preferred characteristics) versus all other sites, which is represented as one generic other site. This other generic site may vary across anglers and simplifying assumptions must be made because data on trip costs and other characteristics for the other site are unobserved (but are assumed to remain constant over time). The utility from fishing the other site, U_{Oi} , is assumed to be some constant that is the same for everyone (and estimated as a parameter in the model), plus a stochastic random component for the other site, which varies across anglers:[3]

$$U_{Oi} = b_0 + e_{Oi} \tag{2}$$

For each fishing day, an angler compares the utility from the preferred Green Bay alternative from the choice pair to the utility from the other non-Green Bay fishing site. If the utility from fishing Green Bay with the preferred set of characteristics is greater than the utility from fishing elsewhere, the angler will choose Green Bay for that fishing day, and vice versa. The estimated model parameters (see Chapter 7) are those estimates that best explain the expected allocations of the total 1998 fishing days to the preferred Green Bay alternatives from the choice pairs, each angler's current allocation of fishing days between Green Bay and other sites, and anglers' choices in the eight Green Bay pairs.

3. In Chapter 9 individual-specific characteristics are incorporated into U_o .

6.4 ESTIMATION OF THE MODEL

In the empirical model, parameters are estimated using a mathematical search algorithm that makes the observed anglers' choices most likely. In other words, the estimated parameters maximize the likelihood of observing the anglers' chosen alternatives from the choice pairs, their allocations of current fishing days to the chosen alternatives, and finally, the reported current number of fishing days to Green Bay. The parameter estimates are called *maximum likelihood* estimates because they are estimates of the population parameters that maximize the likelihood of drawing the sample of the observed choices.

The *likelihood function* that is maximized is derived and presented in detail in Appendix A. In short, it is a complex joint probability over all of the individuals in the data set. For a single individual it is computed as the product of the probabilities of the chosen Green Bay alternatives over the eight choice-occasion pairs; multiplied by the product of the probabilities of the expected allocation of 1998 total days to the preferred Green Bay alternatives over the choice-occasion pairs, conditional on the chosen Green Bay alternatives; multiplied by the probability of the current allocation of 1998 total days to Green Bay under actual conditions. Maximizing the likelihood function is equivalent to maximizing the joint probability of observing the collective angler behavior and choices.

CHAPTER 7
THE ESTIMATED MODEL

7.1 INTRODUCTION

This chapter presents an overview of the estimation of the full model. As discussed earlier, the main model uses the SP Green Bay choice pair data, the SP data on the number of days the angler expects to fish the preferred Green Bay site, and the RP data on the actual number of days spent fishing Green Bay to estimate simultaneously the anglers' choices from the choice pairs and the allocation of total fishing days between Green Bay and other sites. The utility from fishing Green Bay and the utility from fishing another fishing site are defined in Chapter 6. The estimated parameters of those utility functions are discussed qualitatively here, and the specific parameter estimates are reported in Appendix B.

These parameters are used to estimate the anglers' values for changes in the characteristics of Green Bay, and to construct value estimates for recreational fishing services lost due to the presence of FCAs in Green Bay. Major conclusions that can be drawn from this chapter and Appendix B are that model parameters are estimated with a high level of accuracy and make sense, and that the model does a good job in explaining angler choices and behavior. Technical results and measures of model goodness-of-fit (i.e., how well the model explains the data) are presented in detail in Appendix B. The estimates here apply to our target population of 1998 anglers active in fishing the Wisconsin waters of Green Bay and who purchased a fishing license in one of eight nearby counties.

7.2 SIGNS AND SIGNIFICANCE OF THE PARAMETER ESTIMATES

An important result from this estimation is that all of the estimated parameters have the correct signs (Table B-2 in Appendix B). The estimated parameters on the catch times and the FCA variables are negative, and the estimated parameter on the launch fee is positive (recall that the fee enters the utility function with a negative sign). These parameter signs indicate anglers are worse off as catch times increase, as FCAs increase, and as costs increase. Further, parameters on the FCA dummy variables tend to increase in absolute value as the FCA level becomes more severe. For example, the parameter for the most severe level, Level 9, is -1.15, whereas the parameter for Level 2 is -0.09. FCA parameter estimates also show that as the severity of FCAs increases, so does the damage, but not necessarily in a linear fashion.

The parameters are estimated by maximum likelihood, so they have desirable statistical properties. In addition, the parameter estimates have small confidence intervals; that is, there is confidence that the estimates of the parameters would not vary much across random samples. Using conventional statistical tests, the parameters are all highly statistically "significant," which means that they differ from zero with a high degree of confidence.

7.3 MEASURES OF MODEL FIT

Several statistical procedures were implemented to assess how well the model explains the data. Overall, the results from these procedures show that the model does a very good job in explaining angler choices and the number of days anglers spend fishing Green Bay under current conditions.

An intuitively appealing test of fit in the A-B choice-pair portion of the model is to examine the proportion of angler choices from the choice pairs that are accurately predicted by the model. The model correctly predicts 73% of the 5,038 choice occasions in the data.[1] A pseudo-R^2 for the choice pairs is 0.43. It is akin to a measure of fit for a simple linear regression model where the value ranges from zero to one and indicates the percentage of variation in the data that is explained by the model. A pseudo-R^2 of 0.43 is quite high for cross-sectional data.

The estimated model also does well in identifying alternatives that are appealing or unappealing to anglers. For example, when the predicted probability of selecting alternative A is less than 0.1, alternative A is chosen in only 5% of the pairs; anglers only rarely choose alternatives that the model indicates are unlikely to be chosen. Conversely, when the predicted probability is greater than 0.9, alternative A is chosen in almost all of the pairs, 96%. The estimated model identifies the Green Bay alternatives anglers actually do prefer as likely candidates to be chosen.

Another measure of model accuracy is a comparison of the mean number of days that anglers would expect to visit the preferred Green Bay alternatives (reported in the followup questions to the choice pairs), with the model's prediction of the mean number of days. The means are almost identical (12.0197 versus 12.0927), although there is significant variation on an individual basis (see Appendix B). The model is also sufficiently flexible to predict perfectly the mean current number Green Bay days from the RP data: 10 predicted and actual.

1. To determine which alternative the model predicts would be chosen from a pair, the estimated parameter values are put into Equation 1 in Chapter 6, along with the Green Bay characteristics from the two alternatives. Whichever alternative gives the highest value for estimated expected utility is the alternative the model predicts will be chosen.

7.4 CHANGES IN GREEN BAY FISHING FROM CHANGES IN FCAS

The model is not only useful in predicting choices based on the pairs and predicting days under current conditions, it can also predict how changes in FCAs or other Green Bay characteristics such as catch time will affect the proportion of fishing days spent at Green Bay versus other sites, and therefore the total number of Green Bay days, holding total fishing days constant.

The model's estimate of the probability that Green Bay will be chosen under current FCA Level 4 conditions (versus another site) is 0.40 for anglers who currently fish in Green Bay and purchased licenses in the eight counties.[2] With the elimination of FCAs in Green Bay, that percentage would increase to almost 0.46, and the number of Green Bay days would increase by 14.5%. As PCBs are gradually removed from Green Bay and FCAs become less stringent in phases, other scenarios may become relevant. For example, the probability of visiting Green Bay would increase to 0.43 if FCAs were at Level 3, and increase to 0.45 at Level 2. Results from catch-time scenarios are presented in Table B-6. An important finding is that catch time for all four species in Green Bay would have to be reduced by almost half for visitation to increase as much as it would if FCAs were completely removed.

2. A conservative interpretation of current FCAs in Green Bay is Level 4, as discussed in Section 5.4 (see Table 5-3 for the FCA level definitions).

CHAPTER 8
LOWER-BOUND ESTIMATES OF 1998 DAMAGES

8.1 INTRODUCTION

This chapter presents lower bound estimates of per fishing day and 1998 aggregate damages resulting from FCAs in the waters of Green Bay. Damages are measured in terms of what an angler would be willing to pay for the absence of FCAs.

In Section 8.2 we introduce two per-day WTP measures: WTP per fishing day and WTP per Green Bay fishing day; we relate them to annual damages per angler and provide estimates of these fishing measures (see also Appendix C). Section 8.3 calculates the 1998 annual damages for open-water fishing in the Wisconsin waters of Green Bay for our target population using the two per fishing day damage measures and estimates of 1998 fishing days for our target population. Section 8.4 applies benefits transfer methods to select per fishing day values for ice fishing in the Wisconsin waters of Green Bay by our target population and for fishing days in the Michigan waters of Green Bay, and computes 1998 annual damages for these fishing activities.

The damage estimates provided in this chapter are lower bound estimates. The per day estimates are for current Green Bay anglers and reflect reduced enjoyment when visiting Green Bay and the substitution of fishing days from Green Bay to other fishing sites, but do not account for the fact that these anglers may increase their total number of fishing days (to all sites and to Green Bay) in the absence of FCAs. The aggregate estimates omit Green Bay anglers who purchase their Wisconsin fishing licenses outside of the eight targeted counties, and omit damages to individuals who do not fish at Green Bay at all because of the FCAs.

8.2 *WTP* PER YEAR, PER FISHING DAY, AND PER GREEN BAY FISHING DAY

Concepts

In this section we define two per day fishing WTP measures, one that applies to Green Bay fishing days and one that applies to all fishing days (including days at Green Bay and all other sites), and two comparable lower-bound estimates of yearly damages for an angler's WTP^Y.

WTP per Green Bay fishing day, WTP^G, is how much an angler would pay per Green Bay fishing day for the absence of injuries. WTP^G multiplied by the angler's current number of open-water Green Bay fishing days (with injuries), D^G, is a lower-bound estimate of that angler's annual willingness-to-pay, WTP^{Y}, for the absence of injuries. It does not account for the possibility that absent injuries, the angler might want to fish Green Bay more. Denote this lower-bound estimate of an angler's yearly damages, WTP^{Y_G}, where $WTP^{Y_G} = WTP^{G} \times D^{G} \leq WTP^{Y}$.

WTP per fishing day, WTP^{F}, is how much an angler would pay per fishing day, not just per Green Bay fishing day, for the absence of injuries to Green Bay. WTP^{F} multiplied by the angler's current total number of open-water fishing days (with injuries), D^{F}, is also a lower-bound estimate of WTP^{Y}, but includes more of the damages than does WTP^{Y_G}. Denote this second lower-bound estimate of yearly damages, WTP^{Y_F}, where $WTP^{Y_F} = WTP^{F} \times D^{F} \leq WTP^{Y}$ and $WTP^{Y_G} \leq WTP^{Y_F} \leq WTP^{Y}$.

When Green Bay is improved there are two ways an angler can increase his number of Green Bay fishing days: he can hold total fishing days constant but increase the proportion of those days to Green Bay, or he can both increase total fishing days and increase the proportion of those days to Green Bay. Unlike WTP^{Y_G}, WTP^{Y_F} incorporates the possibility that with the absence of injuries the proportion of fishing days the angler takes to Green Bay might increase, so $WTP^{Y_F} \geq WTP^{Y_G}$. WTP^{Y_F} is still a lower-bound estimate of WTP^{Y} because it does not account for the possibility that the angler might fish more in total if Green Bay were not injured.

Looking ahead, $WTP^{F} \leq WTP^{G}$, even though $WTP^{Y_F} \geq WTP^{Y_G}$; this is because WTP^{F} applies to all fishing days, whereas WTP^{G} applies to only Green Bay fishing days. An angler will pay no more per fishing day to have the FCAs at Green Bay removed than he would pay per Green Bay fishing day, because all fishing days are not necessarily to Green Bay.

Estimates

WTP^{G} is how much the utility from a Green Bay fishing day would increase if there were no FCAs, converted into dollars by dividing this increase in utility by the marginal utility of money. In the primary model, preferences are assumed not to vary across anglers, so WTP^{G} is the same for all anglers.[1]

Based on the parameter estimates reported in Appendix B (and discussed in Appendix B and Chapter 7), WTP values are reported in Table 8-1 for changes in FCA levels and changes in catch rates. $\widehat{WTP}^{G}$ (the estimated value of WTP^{G}) for reducing FCAs from FCA Level 4 to FCA Level1 (no FCAs) is \$9.75; that is, \$9.75 for every Green Bay fishing day. For comparison, \$9.75 is 13% of the average reported cost of a Green Bay fishing day. The 95% confidence interval on the \$9.75 estimate is \$8.06 to \$11.73.

FCA Level 4 represents FCAs by species that are equal to or less stringent than current levels (see the "Fish Consumption Advisory" subsection of Section 5.4.1 in Chapter 5), so \$9.75 is a

1. In Appendix D, we consider preference heterogeneity.

conservative estimate of the WTP^G for eliminating the need for FCAs. $\hat{WTP}^G$ for reducing FCAs from Level 3 to Level 1 (no FCAs) is \$4.86. For reducing FCAs from FCA Level 2 to no FCAs, it is \$1.81. These latter estimates can be used to estimate damages after partial cleanup.

The value for FCA Level 6 is smaller than for both FCA Levels 4 and 5. Compared to FCA Level 4, FCA Level 6 has a less severe restriction on perch but a more stringent restriction on trout/salmon (see Table 5-3). Here, the perch restriction is likely to apply to more anglers, but the increased trout/salmon restriction of "do not eat" can be expected to be very bothersome, and thus these two changes roughly cancel. Compared to FCA Level 5, FCA Level 6 has a less severe restriction on walleye, but a more stringent restriction on trout/salmon. Because more anglers cited that they "often" or "always" target walleye than trout/salmon (Section 4.2 and Figure 4-2), it is not surprising that the values are larger for FCA Level 5 than for FCA Level 6.

One could offset the current damages from the FCAs with improved catch rather than money. The model estimates indicate that to do this, catch rates for all four species would have to increase by 61%. Note that increasing all catch rates by 61% would not compensate for past damages.

WTP^F is how much the utility from an average fishing day would increase if there were no Green Bay FCAs, converted into dollars by dividing the increase in utility by the marginal utility of money. Based on the parameter estimates reported in Appendix B (and discussed in Appendix B and Chapter 7), $\hat{WTP}^F$ for reducing FCAs from Level 4 to Level 1 (no FCAs) is \$4.17; that is, \$4.17 for every fishing day.[2] Remember that \$4.17 applies to all fishing days, not just Green Bay fishing days, so it is less than $\hat{WTP}^G$, which is \$9.75. The 95% confidence interval on the \$4.17 estimate is \$3.41 to \$5.00. As noted in Chapter 2, there are a number of studies that have estimated WTP per fishing day for reductions in FCAs and contaminants at different sites and for different species (see Table 2-13). The value of \$4.17 falls within the range in the literature. Values of $\hat{WTP}^F$ for different resource changes are also reported in Table 8-1.

$\hat{WTP}^F$ for reducing FCAs from FCA Level 3 to no FCAs is \$2.15, and for reducing FCAs from FCA Level 2 to no FCAs is \$0.82. Per fishing day values for 10% and 100% increases in catch rates from current levels are reported in Table 8-1. Note that these values apply to all anglers taking trips to the Wisconsin waters of Green Bay, not just to the anglers targeting these species.

2. WTP^F is an increasing function of catch rates. The \$4.17 estimate is based on 1998 Green Bay catch rates. Historically, catch rates were better for all species. If instead the 13-year average catch rates from 1986 to 1998 are used, $\hat{WTP}^F$ increases by 16%. WTP^G is not a function of catch rates. Thus, WTP^F should be relied on for the assessment of how catch rates affect FCA values. Therefore, using the 1998 damage estimate as a basis for past damages will understate past damages.

Table 8-1
WTP per Green Bay Fishing Day and per Fishing Day[a,b]

Resource Change	$\hat{WTP}^G$	$\hat{WTP}^F$
FCA Value		
FCA Level 9 → FCA Level 1	$21.71 [$19.00 - $24.81]	$8.52 [$7.48 - $9.50]
FCA Level 8 → FCA Level 1	$19.78 [$17.42 - $22.14]	$7.87 [$6.96 - $8.83]
FCA Level 7 → FCA Level 1	$14.32 [$12.35 - $16.41]	$5.92 [$5.15 - $6.84]
FCA Level 6 → FCA Level 1	$9.91 [$8.14 - $11.81]	$4.23 [$3.54 - $5.02]
FCA Level 5 → FCA Level 1	$11.22 [$9.71 - 13.26]	$4.75 [$4.01 - $5.57]
FCA Level 4 → FCA Level 1[c]	**$9.75** [$8.06 - $11.73]	**$4.17** [$3.41 - $5.00]
FCA Level 3 → FCA Level 1	$4.86 [$3.40 - $6.32]	$2.15 [$1.57 - $2.79]
FCA Level 2 → FCA Level 1	$1.81 [$0.46 - $3.18]	$0.82 [$0.19 - $1.51]
FCA Level 4 → FCA Level 1 (13-year average catch)[d]	$9.75 [$8.15 - $11.39]	$4.83 [$3.99 - $5.84]
Catch Values[e]		
Yellow perch		
– 10% increase	$0.74 [$0.62 - $0.87]	$0.30 [$0.25 - $0.35]
– 100% increase	$3.72 [$3.13 - $4.27]	$1.52 [$1.29 - $1.75]
Trout/salmon		
– 10% increase	$0.77 [$0.53 - $0.99]	$0.31 [$0.23 - $0.40]
– 100% increase	$3.84 [$2.71 - $5.03]	$1.57 [$1.13 - $2.04]
Walleye		
– 10% increase	$0.40 [$0.33 - $0.47]	$0.16 [$0.13 - $0.19]
– 100% increase	$1.98 [$1.64 - $2.34]	$0.80 [$0.65 - $0.95]
Smallmouth bass		
– 10% increase	$0.65 [$0.52 - $0.80]	$0.26 [$0.20 - $0.32]
– 100% increase	$3.24 [$2.63 - $4.01]	$1.32 [$1.06 - $1.65]
All species at once		
– 10% increase	$2.56 [$2.23 - $2.92]	$1.04 [$0.91 - $1.18]
– 100% increase	$12.79 [$11.33 - $14.50]	$5.58 [$4,95 - $6.29]

a. Catch times are set at 1998 levels: perch – 0.75, trout/salmon – 19.4, walleye – 7.4, bass – 15.0.
b. Simulated 95% confidence intervals approximated using Krinsky-Robb procedure with 500 draws in brackets.
c. Bold entry represents the 1998 advisory levels.
d. Average catch times from 1986 to 1998: perch – 0.52, trout/salmon – 7.8, walleye – 6.9, bass – 5.0.
e. Catch rate is inverse of catch time. Computed with FCA level set at 4.

These values follow the pattern for the FCA values, with WTP^G slightly more than double the values for WTP^F. The values for increases in catch reflect the model assumption of decreasing marginal utility of increasing catch (because catch time in the utility function is the reciprocal of the catch rate).[3] The values for a 100% increase in catch rates are about five times the values for a 10% increase in catch rates. The values in Table 8-1 are comparable to the values for the most similar resource changes as reported in the literature [Table 2-14, see Samples and Bishop (1985), Milliman et al. (1992), and Chen et al. (1999)].

Next we compare the two lower-bound annual damage measures on a per angler basis, for which we use the scenario of a reduction in FCAs from Level 4 (current) to Level 1 (no FCAs). The annual value for Green Bay fishing days is WTP^{Y_G} = \$9.75 per Green Bay fishing day × 5.25 Green Bay fishing days = \$51.19 per Green Bay open-water angler. The annual value for all fishing days is WTP^{Y_F} = \$4.17 per fishing day × 13.19 fishing days = \$55.00. As noted above, while $W\hat{T}P^G > W\hat{T}P^F$, the annual damages per angler are reversed with WTP^{Y_F} about 7% larger than WTP^{Y_G}.

8.3 TWO LOWER-BOUND ESTIMATES OF TOTAL 1998 DAMAGES FOR OPEN-WATER FISHING IN THE WISCONSIN WATERS OF GREEN BAY

Annual total damages equal the estimate of total fishing days (either to Green Bay or to all sites) times the corresponding per fishing day damage estimate. These are lower-bound estimates because the damage per day values are lower-bound estimates. First we provide estimates of total fishing days, then we provide estimates of total damages. As noted above, the estimates in this section pertain only to open-water fishing by anglers who are active in Green Bay fishing and who purchased their Wisconsin fishing licenses in eight counties near to Green Bay.

Estimated Open-Water Fishing Days

An estimate of total 1998 Green Bay open-water fishing days by those who purchased licenses in one the eight counties is computed by multiplying the number of these anglers by the estimated mean number of open-water Green Bay fishing days, which is 5.25; its confidence interval is 4.67 to 5.82. The estimate of total 1998 open-water fishing days by these Green Bay anglers is obtained by multiplying the number of these anglers by their estimated mean number of fishing days, 13.19; its 95% confidence interval is 12.18 to 14.20.

The number of anglers who purchased licenses in the eight counties and actively fished Green Bay in 1998 was estimated using county data from WDNR on the number of licenses sold in 1997. Each resident fishing license, sportsman license, nonresident fishing license, nonresident 15-day

3. If a linear relationship were assumed instead, values for small changes in catch rates would be smaller, and values for large changes in catch rates would be larger.

fishing license, and patron license is counted as one angler. Each resident husband-and-wife fishing license, nonresident family fishing license, and nonresident family 15-day fishing license is conservatively counted as two anglers.[4] Finally, each two-day sports license and nonresident 4-day fishing license is conservatively counted as half an angler (i.e., it is assumed each angler purchasing these licenses purchases two on average) because it would not be cost-effective for an individual to buy more than two of these types of licenses (on the other hand, assuming they purchase fewer than two two-day licenses would result in more anglers and higher damages). Given these definitions, in 1997 154,783 anglers purchased their licenses in one of the eight counties (Appendix F, Table F-8). The number of anglers in 1998 is assumed to be the same because 1998 license data are currently unavailable.

Some of these anglers do not fish Green Bay. Based on the telephone screener, the percentage of license holders in the targeted counties that fished Green Bay in 1998 is 31.4% with a 95% confidence interval of 29.6% to 33.2%. Applying 31.4% to the total number of anglers, we estimate that in 1998 approximately 48,602 anglers purchased their license in one of the eight counties and fished Green Bay, which has a 95% confidence interval of 45,877 to 51,327.

Multiplying 48,602 anglers by the estimated mean Green Bay open-water fishing days of 5.25, we estimate that in 1998 there were approximately 255,160 Green Bay open-water fishing days by anglers who purchased their licenses in one of the eight counties. The 95% confidence interval is 224,000 to 287,000. Multiplying 48,602 anglers by the estimated mean total open-water fishing days of 13.19, we estimate approximately 641,060 total open-water fishing days by anglers who purchased their license in one of the eight counties and who fished Green Bay. The confidence interval on this estimate is 580,000 to 702,000.

Annual Open-Water Fishing Damages in Wisconsin Waters of Green Bay

$\hat{WTP}^G$ multiplied by the current number of open-water Green Bay fishing days in 1998 by Green Bay anglers who purchased their licenses in one of the eight counties is a lower-bound estimate on aggregate damages for this group. We estimate in 1998, this group of anglers fished the open waters of Green Bay 255,160 days, so a lower-bound estimate of 1998 damages to this group is $2.49 million ($9.75 × 255,160). The confidence interval on this estimate is $1.93 million to $3.05 million.[5]

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4. It would not be cost-effective to purchase one of these licenses unless two individuals intended to fish.

5. Confidence intervals for aggregate annual damages are approximated assuming the percentage of licensed anglers active at Green Bay, the mean number of days, and estimated *WTP* are uncorrelated random variables. The separate confidence intervals for all of these variables are reported throughout this chapter. The number of license holders is not assumed to be random, and the product of these variables gives aggregate damages. The confidence intervals for aggregate damages (and aggregate days later in the chapter) are approximated using asymptotic variances.

$\hat{WTP}^F$ multiplied by the total number of fishing days in 1998 by Green Bay anglers who purchased their licenses in one of the eight counties is another lower-bound estimate on aggregate damages for this group. We estimate that in 1998 this group of anglers fished a total of 641,060 days on open water, so a second lower-bound estimate of 1998 damages to this group is \$2.67 million (\$4.17 × 641,060). The confidence interval is \$2.13 million to \$3.22 million. It is larger than the other lower-bound estimate because it accounts for the possibility that anglers might spend a larger proportion of their fishing days at Green Bay if it were not injured.

8.4 BENEFITS TRANSFER TO ESTIMATE THE DAMAGES ASSOCIATED WITH THE GREEN BAY ICE FISHERY AND THE MICHIGAN GREEN BAY FISHERY

The benefits transfer approach involves estimating damages for an assessment area by using values derived from the application of primary economic methods in other studies, rather than collecting primary valuation data for the assessment area. In this section, we will apply the unit value method, a benefits transfer approach identified in the U.S. DOI regulations [43 CFR § 11.83 (c)(2)(vi)], to value damages from PCBs and resultant FCAs to ice-fishing days in the Wisconsin waters of Green Bay, and all fishing days in the Michigan waters of Green Bay.

There are two sites involved in a benefits transfer: the targeted site (to which values will be transferred) and the study site (where a primary study of damages has been completed). To assess the suitability of the benefits transfer approach we must compare the targeted site to the study site and consider three questions: are the sites similar, are the populations similar, and are the changes being valued similar?[6] Our primary study site is the Wisconsin waters of Green Bay, our population is Green Bay anglers who purchased their licenses in one of the eight counties, and the change being valued is a reduction in PCBs and resultant removal of FCA restrictions.

Ice Fishing on the Wisconsin Waters of Green Bay

The first transfer of values is to ice-fishing days on the Wisconsin waters of Green Bay. The site is very similar to the study site as it is the exact same location, but at a different time of year. Yellow perch dominates Green Bay ice fishing as it does the open-water fishing, accounting for 90% of the ice-fishing catch in 1998 (WDNR creel). Other species caught are walleye, burbot, and northern pike.

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6. For an overview of the benefits transfer technique see Brookshire and Neill (1992), Boyle and Bergstrom (1992) and Desvouges et al. (1992), all in a special section of *Water Resources Research* devoted to benefits transfer.

The ice-fishing anglers are very similar to the open-water anglers. From our telephone survey we found that 73% of the anglers who ice fished on Green Bay in 1998 also fished the open waters of Green Bay in 1998. Green Bay open-water anglers who also ice fish in the waters of Green Bay are slightly more avid about ice fishing than anglers who only ice fish (averaging 6.4 Green Bay ice-fishing days, SE=0.56, compared to 5.4 Green Bay ice-fishing days, SE=0.72). Therefore, Green Bay open-water anglers in the target population account for about 76% of the ice-fishing days.

The change being valued is the same for the primary study and the targeted area, as FCAs for ice fishing on the Wisconsin waters of Green Bay are the same as those for open-water fishing on the Wisconsin waters of Green Bay.

As such we can apply the estimated WTP per Green Bay fishing day for open-water days, $9.75, to the number of Green Bay ice-fishing days. From our telephone survey we found that Green Bay ice-fishing days were equivalent to 18.24% of Green Bay open-water fishing days for all anglers who had open-water or ice fished on Green Bay in 1998.[7] Our estimate of Green Bay fishing days for 1998 is 255,160. Multiplying this by 18.24% we get an estimate of 46,541 Green Bay ice-fishing days.

Thus, a lower-bound estimate of the 1998 damages associated with the injuries the Wisconsin Green Bay ice fishery for our target population from PCBs and the resultant FCAs is $0.454 million ($9.75 times 46,541 Green Bay ice-fishing days).

All Fishing in the Michigan Waters of Green Bay

The second transfer of values is to the Michigan Waters of Green Bay. This site is very similar to the study site as they are both portions of Green Bay. They share a similar mix of species, with yellow perch, walleye, and trout/salmon making up at least 95% of the Michigan Green Bay fishery (see Section 2.1 for more detail).

The individuals using the fishery are also similar. As discussed in Chapter 3 we expect the fishing in Green Bay to be a fairly localized activity, and that most Michigan Green Bay angling would be done by anglers in nearby counties. Therefore most of the anglers live in a similar region. Comparing the Wisconsin and Michigan counties that surround Green Bay we find similar socioeconomic characteristics, with Michigan having a somewhat higher unemployment and lower per capita income (see Table 8-2).

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7. We use the ratio from the telephone survey because the Green Bay ice-only anglers are not included in the followup mail survey. Note also that by using a ratio, the recall, nonresponse, and sampling bias adjustments are carried forward to the ice-fishing damage calculation.

Table 8-2
Comparison of Wisconsin and Michigan Counties near Green Bay

	Population (7/1/1998)	Percent over 65 Years (1995)	Percent over 25 Years (1990)	Percent High School Grads over 25 (1990)	Percent College Grads over 25 (1990)	Percent Unemployed (1994)	Per Capita Personal Income (1993)
6 Michigan counties near Green Bay[a]	170,746	15%	64%	78%	14%	8%	$16,539
8 Wisconsin counties near Green Bay[b]	727,752	13%	63%	78%	16%	5%	$19,509

a. Alger, Delta, Dickinson, Marquette, Menominee, and Schoolcraft.
b. The eight targeted counties.

Source: U.S. Census Bureau website http://www.census.gove/statab/USA96/.

The Michigan change being valued is different from Wisconsin because FCAs are less restrictive in the Michigan waters of Green Bay. Current levels of FCAs in the Michigan waters of Green Bay are closest to our Level 2 for the general population, and our Level 4 for women who are pregnant, nursing, or expect to bear children, and for children (hereafter, when we refer to FCAs for women, we refer specifically to this subset of women).

FCA Level 2 allows unlimited consumption of yellow perch and smallmouth bass and restricts trout/salmon and walleye to no more than one meal a week. The Michigan advisory for the general population (see Table 2-10) allows unlimited consumption for yellow perch and smallmouth bass, and has a range of restrictions for trout/salmon and walleye from unlimited for chinook salmon and smaller sizes of brown trout and walleye, to do not eat for larger sizes of brown trout and walleye.

FCA Level 4 allows one meal a week for yellow perch, and one meal a month for all other species. The Michigan advisory for women and children allows one meal a week for perch, one meal a month for smallmouth bass, and a range of one meal a week to do not eat for trout/salmon and walleye, dependent on the part of Green Bay and size of fish (one meal a week applies only for walleye and rainbow trout less than 18"). Based on the average size of fish caught in Lake Michigan (Appendix F, Table F-7) the “eat no more than one meal a week” advisory could apply to as much as one-half of the fish caught and kept.

From our primary study, the estimated *WTP* per Green Bay fishing day for a reduction from FCA Level 2 to no FCAs is $1.81, and from FCA Level 4 to no FCAs is $9.75.

The women and children advisories could be a concern to male or female anglers with household members for whom the advisories apply. From our survey we find that about 45% of anglers are of an age most likely associated with having and raising small children: 18 to 40 years old. In fact, about 28% of our sample of anglers are age 18 to 40 and have at least one household member who is less than 16 years old, and thus may be concerned with the advisories aimed at women and children. To be conservative, we assume that 14% of the fishing days (half of the 28% of anglers) are by anglers for whom the women and children advisory would be a concern. This reflects that in some of these households the children may be older and no additional children are expected, and that fish may be consumed in different amounts by different household members. Therefore, we select an average *WTP* per Green Bay fishing days for the absence of PCBs on the Michigan Waters of Green Bay of $2.92 (14% times $9.75 plus 86% times $1.81).

Comparing the WDNR and MDNR creel surveys we found that all fishing on the Michigan waters of Green Bay was equivalent to 58.83% of the March to December fishing on the Wisconsin waters of Green Bay in 1998 (see Table 2-1). Therefore we estimate that there were 150,103 days on the Michigan waters of Green Bay (58.83% times 255,160 Wisconsin Green Bay days).

Thus, a lower-bound estimate of the 1998 damages associated with the Michigan waters of Green Bay from PCBs and the resultant FCAs is $0.438 million ($2.92 times 150,103 Michigan Green Bay fishing days).

CHAPTER 9
TESTING THE SENSITIVITY OF THE WTP ESTIMATES TO MODIFICATIONS TO THE MODEL

9.1 INTRODUCTION

This chapter examines the sensitivity of the value estimates to preselected variations in the specification of the main economic model. Technical details of these model variations are presented in Appendix D. One of the most important conclusions of this sensitivity analysis is that the mean values for changes in FCAs are generally robust (insensitive and statistically insignificantly different from the main model), except in models that introduce random heterogeneity of preferences, which result in higher values for reduced FCAs, and thus higher damages from the existence of the current FCAs.

Table 9-1 summarizes the values for the main model (from Chapter 7) and the model variations. In the first set of model variations, discussed in Section 9.1, we use just the data from the A-B choice questions, omitting data from the followup questions on the expected number of Green Bay fishing days to the preferred alternatives or RP data on the actual number of days under current conditions. These variations can be used only to estimate WTP^G. Variations on the main model with homogeneous preferences include the basic model (excluding the followup question or data on actual days) and two variations examining learning and fatigue (one allowing noise parameters to vary over the choice pairs, and one allowing all parameters to vary). Next, using the A-B choice data, heterogeneity of preferences is incorporated. Classic heterogeneity allows the effect of changes in site characteristics on utility to vary with characteristics of the individual such as distance from the site, gender, target species, and income (through the marginal utility of money). Random heterogeneity allows preferences to vary across anglers without having to explain the source of the variation, and allows choice occasions for a given angler to be correlated.

Additional models, discussed in Section 9.2, use the A-B choice data plus the followup expected days question and some or all of the RP data on reported number of fishing days. These models use two alternative strategies to incorporate preference heterogeneity. Both models provide both WTP^G and WTP^F estimates.

Table 9-1
Comparison of Mean WTP Estimates across Models[a]

Model	Mean WTP^G	Mean WTP^F
Main Model	$9.75 [0%]	$4.17 [0%]
A-B models		
▸ homogeneous		
▫ *basic model*	$10.29 [+6%]	NA
▫ *learning and fatigue*	$9.99 [+2%]	NA
▫ *parameters vary over choice pairs*	$10.94 [+12%]	NA
▸ classic heterogeneity		
▫ *distance and gender*[b]	$10.15 [+10%]	NA
▫ *target species*[b]	$9.72 [-1%]	NA
▫ *marginal utility of $*[c]	$12.36 [+27%]	NA
▸ random heterogeneity		
▫ *normal*[d]	$12.90 [+32%]	NA
▫ *lognormal*[d]	$17.67 [+81%]	NA
Models allowing substitution to other sites		
▸ classic heterogeneity in A-B parameters	$9.31 [-5%]	$4.16 [-1%]
▸ classic heterogeneity in V_O	$10.46 [+7%]	$4.49 [+8%]

a. Percentage difference from mean WTP estimates from full main model in Chapter 8 in brackets.
b. Effect of catch time and FCAs on utility is a function of these variables.
c. Utility varies as a function of income group and gender.
d. Catch time and FCA parameters are assumed to be random variables with either a normal or lognormal distribution.

9.2 A-B MODELS

A-B models are designed to explain only the choices between the Green Bay alternatives presented in the eight choice pairs. As such, they only require the data from that portion of the survey, i.e., the SP responses from the choice questions. They do not use the SP expected days data from the followup questions or the RP data on the current number of Green Bay days or total days. The likelihood function is a simplified version of the one discussed in Chapter 6; it is only the joint probability of observing anglers' choices.

The parameters in the A-B models have the same interpretation as those from the A-B portion of the main model, as defined in Chapter 6. The A-B models have fewer parameters to estimate because the A-B parameters are the only parameters in the models. Estimates of these parameters are still consistent (i.e., a simple definition of consistency is that the parameter estimate equals its true value if the sample is sufficiently large), just as they are in the main model, but are estimated less precisely than when all of the data are used. That is, the additional information on choices not used in the A-B models is used in the main model to improve the accuracy of its estimates, which means that the standard deviations on the parameter estimates get smaller as more data are used in the estimates. Because the A-B models do not model the allocation of current days between Green Bay and other sites, only mean WTP^G can be estimated, not the mean WTP^F .

9.2.1 A-B Models with Homogenous Preferences

The parameter estimates from an A-B model with homogeneous preferences are very similar to the A-B estimates from the main model. As a result, mean WTP^G is also very similar to $9.75: $10.29. This model also examines learning and fatigue effects and positioning bias effects. Through responding to the choice pairs, the respondent may gain better knowledge and understanding of the survey process, and this learning effect may express itself through a decrease in the random noise in the decision-making process. Conversely, if there is a large number of survey choice pairs, a fatigue effect may set in as the respondent tires during the data elicitation process. This effect may be manifested as an increase in random noise for choice pairs toward the end of the process. Results suggest weak but statistically insignificant learning and fatigue effects. The mean WTP^G from the A-B model with learning and fatigue increases to $9.99, only 2% higher than the estimate from the model with all variances restricted to be equal, $9.75. To further investigate the potential for learning and fatigue, the data were divided into three sets: early choice pairs (1 and 2), middle choice pairs (3 through 6), and late choice pairs (7 and 8). The results indicate that parameters do vary across choice occasions when they are not restricted to be the same, but not in a systematic way, which suggests the absence of learning and fatigue effects. The mean WTP^G from the second model examining learning and fatigue is $10.94.

Finally, we cannot reject the null hypothesis of no positioning bias; that is, there is no evidence that respondents systematically select A or B independent of the characteristics. A homogenous preferences A-B model was estimated to investigate whether respondents are drawn to alternative A in the choice pairs simply because it is the first option presented; a dummy variable for Alternative A was not significant.

9.2.2 A-B Models with Classic Heterogeneity

In other variations of the A-B model, heterogeneity is allowed. The classic heterogeneity method is to let the effects on utility from changes in site characteristics vary as a function of individual characteristics. This method has been employed for many years, and a summary discussion can be found in Pollack and Wales (1992). Interactions between Green Bay characteristics and angler characteristics allow preferences for the site characteristics to vary across people as a function of distance (the closest distance from the angler's home or vacation cabin to Green Bay) and gender; other demographic characteristics were not as important in preliminary analyses. The utility function with these interactions is a modification of Equation 1 in Chapter 6 and can be found in Equation 2 in Appendix D. Simply put, the change in utility from a change in a site characteristic is a linear function of distance and gender. In all, or most all model variations (Table 9-1), mean WTP^G for a reduction in FCAs decreases with distance or if the angler is a male, i.e., women and those living closer to Green Bay have stronger preferences for FCA removal. As noted earlier, a possible explanation is linked to the pregnancy risk associated with PCBs for women. Conversely, men care relatively more about catch rates. Although classic heterogeneity incorporated this way led to a significant improvement in the explanatory power of the model, the mean estimate of WTP^G ($10.15) is affected very little. Details on WTP for each demographic group are reported in Appendix D.

Other classic heterogeneity specifications were pursued as well. For example, the effects on utility from changes in FCAs and catch were allowed to vary as a function of the angler's target species. Catch for a species was significantly more important to anglers targeting that species, and perch and walleye anglers care more about FCAs than other anglers. Angler preferences over Green Bay alternatives were not found to vary as a function of the number of current Green Bay days. Finally, the marginal utility of money was allowed to vary as a function of income stratum and gender, and males and the wealthy were found to have a significantly lower marginal utility of money (and therefore higher WTP). Mean WTP did not differ significantly from the estimates from the main model in any of these specifications. In the last model where marginal utility of money varies, mean WTP was about 27% higher, but its confidence interval was also quite large.

9.2.3 A-B Models with Random Heterogeneity

Another completely different method to accommodate heterogeneity of preferences was also used for comparison. With this method, FCA and catch time demand parameters are assumed to be random variables, where the distribution across the population is assumed to be known, and the parameters of that distribution are estimated. Basically, this method assumes that preferences differ over the population of anglers, but in a way unobservable to the researcher. Random parameters allow for heterogeneity without having to determine its source. Further, the method explicitly recognizes that for an angler, choices across the pairs can be correlated. For example, an angler who has a stronger than average preference for catching fish is likely to have larger catch-time parameters not only in one or some of the pairs, but in all of the pairs. Hausman and

Wise (1978) were the first to explicitly model the assumption of uncorrelated random terms, and the method is currently being used widely to value a wide variety of commodities (see, for example, Layton and Brown, 1998; Train, 1998; and Breffle and Morey, 1999).

Both normal and lognormal distributions are assumed for the random parameters. Randomization of the catch and FCA parameters significantly improves model fit, and the estimated parameters of the parameter distributions match well with other literature (see Appendix D, Section D.1.4). Mean WTP^G is higher from the random parameters model: \$12.90 under the normal distribution and \$17.67 under the lognormal distribution.

9.3 HETEROGENEITY IN MODELS ALLOWING SUBSTITUTION

Two additional models were estimated allowing for heterogeneous preferences. In the first case, preferences for catch and FCAs were allowed to vary as a function of distance and gender, in the same fashion as the A-B model discussed above. This model uses the SP data from the choice pairs, the responses to the followup questions to the choice pairs on expected days of visitation, and the RP data on total days to all sites. Most parameters estimates and model results were roughly similar to the model with no heterogeneity, with the one exception being that FCA and catch effects tend to increase in magnitude with distance. Mean WTP^G is \$9.31. Because the model allows substitution to other fishing sites, mean WTP^F can also be estimated, which is \$4.16. In this model, the amount of noise in the stochastic random term for the generic “other” alternative can be compared to that for the Green Bay choice pairs. A greater level of randomness is expected for the “other” site because explicit characteristics of the site are not included in the model, and that result is shown in the estimates.

The second case allows for heterogeneity in the utility from the index of other alternative sites. This model uses all of the SP and RP data. Utility for the other index is assumed to vary with distance to Green Bay and gender, and the utility function is in Equation 13 in Appendix D, Section D.3. Men and those at a greater distance derive more utility from fishing another site. The effect of distance is reasonable, since trip costs to Green Bay increase with distance. The mean WTP^G is \$10.46, and the mean WTP^F is \$4.49.

A random parameters specification for the full model was not pursued for several reasons. First, mean WTP is robust over the model specifications, and second, the higher values from the random A-B models suggest that values from the full nonrandom model are conservative.

CHAPTER 10
TOTAL RECREATIONAL FISHING DAMAGES AND CONCLUSIONS

10.1 INTRODUCTION

This chapter provides the computation of the total value of recreational fishing service flow losses (damages) through time from 1981 until the FCAs are removed, and summarizes key conclusions of the assessment. Section 10.2 discusses the detailed computation of total recreational fishing damages through time. Section 10.3 provides conclusions, including a summary of study design features that indicate the estimated damages are likely to understate the value of recreational fishing service flow losses.

10.2 TOTAL RECREATIONAL FISHING DAMAGES THROUGH TIME

The present value of all interim losses from 1981 until the FCAs are removed is summarized in Table 10-1. These damages, as well as damages for recreation fishing service flow losses from 1976 through 1980, are discussed below. Table 10-1 also includes 1998 annual damages from Chapter 8, which are not discussed again here. To compute damages for service flow losses in each past and future year, estimated fishing activity for the year is multiplied by an estimate of damages per fishing day for the FCAs in that year.

Damages are computed in 1998 dollars and converted to the present value of damages in 2000. A 3% discount rate is used to escalate past damages and to discount future damages to the year 2000. A 3% discount rate is consistent with the average real three-month Treasury bill rates over the last 15 years (Bureau of Economic Analysis, 1998; Federal Reserve, 1998) and is consistent with U.S. DOI implementation guidance (U.S. DOI, 1995) for NRDAs under 43 CFR §11.84(e).

10.2.1 Damages for Past Losses

Damages for past losses are computed from 1981, commencing after the enactment of SARA, and continuing through 1999 (damages for past losses from 1976 through 1980 are discussed at the end of this section). In the past, the FCAs have varied considerably in both the Wisconsin and Michigan waters of Green Bay. For example, sometimes the FCAs were the same for all anglers, and sometimes the FCAs were different for women who were pregnant, nursing, or who expected to bear children, and for children, than for the rest of the angling population. Further, the FCAs often varied by the size of a species of fish, with the sizes varying through time, and the FCAs

Table 10-1
Total Values for Recreational Fishing Service Losses for the Waters of Green Bay Resulting from Fish Consumption Advisories for PCBs
($ millions, $1998, present value to 2000)[a,b]

Damage Category	(A) Wisconsin Waters of Green Bay		(B) Michigan Waters of Green Bay	(C) All Waters of Green Bay (A + B)
	Open-Water Fishing	Open-Water plus Ice	All Fishing	All Fishing
	Primary Study	Primary + Transfer	Benefits Transfer	Primary + Transfer
1998 Value of 1998 Losses	$2.673	$3.127	$0.438	$3.566
1. Present Value of Past Losses:				
a. 1981-1999	$37.8	$44.3	$20.2	$64.5
b. 1976-1980	$5.4	$6.3	$5.8	$12.1
2. Present Value of Future Losses[c]				
a. Intensive Remediation[d]	$30.7	$36.2	$5.3	$41.5
b. Intermediate Remediation[e]	$43.2	$51.0	$7.5	$58.5
c. No Additional Remediation[f]	$62.3	$72.9	$10.2	$83.2
3. Present Value of Total Damages from 1981 to Baseline (1a+2)				
a. Intensive Remediation	$68.5	$80.5	$25.5	$106.0
b. Intermediate Remediation	$81.0	$95.3	$27.7	$123.0
c. No Additional Remediation	$100.2	$117.3	$30.4	$147.7

a. Rounded to the nearest $1,000 for 1998 annual values and to the nearest $100,000 for present value estimates. Totals may not equal sum of elements due to rounding.
b. Values for Wisconsin open-water fishing include reduced quality of current days plus substitution of days to other sites. Values for Wisconsin ice fishing and Michigan fishing include only reduced quality of current days. See text for additional discussion.
c. Present values computed adjusting for changes in FCAs through time, assuming an average fishing activity at 1998 levels, and a 3% discount rate.
d. 20 years of damages = 10 years sediment removal plus 10 years of declining FCAs.
e. 40 years of damages = 10 years sediment removal plus 30 years of declining FCAs.
f. FCAs decline to zero over 100 years due to natural recovery.

varied across years in terms of which species were included. Generally, our nine FCA levels (Table 5-3) do not match the past FCAs, but can be used to understand how per fishing day damages vary with the severity of FCAs. Recognizing the uncertainties in valuing past FCAs, we select per fishing day damage estimates for each year that are expected to be equal to or less than actual values based on comparing the actual past year FCAs to our nine FCA levels (i.e., they are conservative estimates).

Wisconsin Open-Water Fishing

Damages for past losses for anglers active in open-water fishing in Green Bay are computed using the WTP^F value method, which includes values for changes in the quality of open-water fishing days in Green Bay, as well as values related to substituting open-water fishing days across sites. Damages for past losses are computed as follows.

1. In 1998, open-water fishing damages are computed as discussed in Section 8.4, and escalated to a 2000 present value.

2. 1999 open-water fishing damages are set equal to 1998 damages and escalated to 2000 values. This assumes that fishing activity in 1999 is the same as in 1998 (because these data are not yet available) and reflects that the FCAs are largely unchanged.

3. For all other years, we first estimate the open-water fishing days on Green Bay, then multiply these days by a factor to obtain the total open-water fishing days at all sites by anglers who open-water fish in Green Bay. The estimates of open-water fishing activity on Green Bay for 1986 through 1997 are based on the WDNR creel survey estimates because these are the only available estimates (see Table 2-2 for data back to 1990). The creel survey estimates of hours are divided by the creel survey estimate of approximately four hours per fishing day to obtain the number of open-water fishing days. These data are available back to 1986. We use the average of the WDNR 1986 through 1997 fishing levels as the levels for each year from 1981 to 1985 (even though this long-term average is about 25% less than existed in each of the several years immediately after 1985). Next, the total number of open-water fishing days for each year is estimated to equal the Green Bay open-water fishing days for the year multiplied by 2.512, where 2.512 is the 1998 ratio of total open-water fishing days on Green Bay for anglers who are active in open-water fishing in Green Bay (13.19/5.25).

4. The Wisconsin FCAs for the waters of Green Bay have changed through time (e.g., see Tables 2-8 and 2-9). In summary, the selected per fishing day values for the FCAs range from $0.81 to $2.15 for the period 1981 through 1996, and the value is $4.17 for the period from 1997 to 1999. The values are less in 1981 through 1996 than in 1997 through 1999, reflecting the increased completeness (more species included) and severity of the more recent advisories. The detailed selection of values follows.

A. The 1997 and 1999 advisories are very similar to the 1998 advisories, and we select the Level 4 WTP^F of $4.17 for all three years.

B. For 1987 through 1996, the Wisconsin advisories were less restrictive. While the advisories show some variations over time, between the Bay and Lower Fox River, and for some specific species within the trout/salmon group, in general they can be summarized as follows. For yellow perch, smallmouth bass, smaller walleye, and smaller trout/salmon, the FCAs advised the removal of fat and suggested methods of cooking, but did not advise limits on consumption. For larger walleye and trout/salmon, the FCAs advised no consumption. For smaller walleye and trout/salmon, the advisories were similar to our Level 1 of unlimited consumption (WTP^F = $0.00) or our Level 2 ($WTP^F$ = $0.81), reflecting some restrictions on walleye and trout/salmon. For larger walleye and trout/salmon, the advisories are most similar to our Level 7 (WTP^F = $5.92), except that Level 7 includes restrictions for smallmouth bass.

This split advisory by size of trout/salmon and walleye implies that advisory Level 0 or 1 damages apply on days an angler catches, or expects to catch, a smaller trout/salmon or walleye; and advisory Level 7 damages are relevant on days an angler catches, or expects to catch, a larger trout/salmon or walleye. Based on WDNR evidence for 1988 through 1998 on the average size of catch (Table F-7), it appears that, generally, the average size of trout/salmon and walleye measured in the creel surveys is of a size similar to or larger than the advisory cut-off sizes (although this varies by year and species). Thus, advisory Level 7 may apply to roughly 50% of fishing days (sometimes more, sometimes less). To be conservative, and to reflect the inclusion of smallmouth bass in our advisory Level 7, we assume Level 1 damages ($0.00) apply to two-thirds of fishing days and advisory Level 7 damages ($5.92) apply to one-third of fishing days, for a weighted average of $1.97.

C. For 1985 and 1986, the Wisconsin advisories recommend the removal of fat for perch and smaller trout/salmon, limited consumption for smaller walleye and smaller bass, and no consumption for larger trout/salmon, walleye, and bass. These guidelines are a mix of Levels 1, 2, and 9. We select the Level 3 value of $2.15 to conservatively reflect this more complicated mix.

D. For 1984, the advisories differ for women (focusing on women who are pregnant, nursing, or expect to bear children) and children versus the general population. For women and children, the guidelines are most similar to our Level 7 by stressing the removal of fat for perch and “do not eat” for other species. The general population guidelines advise not to eat larger trout/salmon. We select Level 7 to conservatively reflect the advisories for women and children and Level 2 to reflect the advisories for the general population, for a weighted value of $1.53 (14% times

$5.92 plus 86% times $0.81; see Section 8.4 “All Fishing in Michigan Waters of Green Bay” for a discussion on weights for values for advisories for women and children versus advisories for the rest of the angler population).

E. For 1980 through 1983, the FCAs focus on trout/salmon only and recommend no more than one meal a week for the general population, and do not eat for children and for women (who are pregnant, nursing, or expect to bear children). These advisories are similar to but less comprehensive than the 1984 advisories. Therefore, we conservatively select the Level 2 value of $0.81. Level 2 is the same as the general population advisories, except that Level 2 includes a once a week advisory for walleye. However, Level 2 significantly understates the advisories on trout/salmon for women and children.

Wisconsin Ice Fishing

Because we do not have estimates of total ice-fishing days at all ice-fishing sites for anglers who ice fish the Wisconsin waters of Green Bay, we conservatively apply WTP^G values to estimates of ice-fishing days in the Wisconsin waters of Green Bay.

1. 1998 ice-fishing damages are computed as discussed in Section 8.4 (WTP^G = $9.75 times the number of ice-fishing days, which is set equal to 18.24% of open-water fishing days) and escalated to a 2000 present value.[1]!gcfnote!

2. 1999 ice-fishing damages are set equal to 1998 damages and escalated to a 2000 present value. This assumes that ice-fishing activity in 1999 is the same as in 1998, and reflects that the FCAs are largely unchanged.

3. For all past years, ice-fishing days on Green Bay are estimated as 18.24% of the estimated open-water fishing days on Green Bay. Note that this is potentially very conservative as WDNR data (Table 2-3) suggest that historically this percentage is closer to 34%.

4. For all past years, the FCA value selected is the WTP^G value corresponding to the WTP^F value selected for Wisconsin open-water fishing days. The corresponding WTP^G values are $9.75 for 1997 through 1999, $5.94 for 1987 through 1996 and for 1981 through 1983, and $6.09 for 1984 through 1986.

1. Based on the telephone survey data, the ratio of ice-fishing days by all Green Bay anglers, including those who did not open-water fish, to open-water days is 18.24%.

Michigan Fishing

Damages computed for FCAs in the Michigan waters of Green Bay include both open-water and ice-fishing days. Because we do not have estimates of total fishing days at all sites for anglers who fish the Michigan waters of Green Bay, we conservatively use the WTP^G values, which are multiplied by estimates of fishing days in the Michigan waters of Green Bay. Damages for past losses are computed as follows.

1. 1998 fishing damages are computed as discussed in Section 8.4 [WTP^G = $2.92 times 150,103 fishing days on the Michigan waters of Green Bay (which in 1998 equals 58.83% of Wisconsin open-water fishing days on the waters of Green Bay)] and escalated to a 2000 present value.

2. 1999 open-water fishing damages are set equal to 1998 damages and escalated to a 2000 present value. This assumes that fishing activity in 1999 is the same as in 1998, and reflects that the FCAs are largely unchanged.

3. The estimates of fishing activity on the Michigan waters of Green Bay for 1981 through 1997 are based on the ratio of WDNR creel survey estimates to Michigan creel survey estimates for each year (e.g., see Table 2-1 for data back to 1990). The ratio before 1990, for which data were not available, is set equal to the average ratio for 1990-1998 of 61.42%.

4. The Michigan FCAs for the waters of Green Bay have varied considerably through time (e.g., see Tables 2-10, 2-11, and 2-12). The upper and lower Green Bay advisories have tended to be similar, although the upper Green Bay advisories have, for some species in some years, been less stringent, often in terms of the size of fish that triggers an advisory level. For example, in 1998, for walleye larger than 18", the advisory in lower Green Bay is “eat no more than one meal a month” and in upper Green Bay the advisory is “eat no more than one meal a week.” We summarize the Michigan advisories focusing on lower Green Bay. Because the advisories for upper Green Bay are less stringent for some species in some years, the values selected are likely to be less conservative than for FCAs in the Wisconsin waters of Green Bay.

   In summary, the selected per day values for past years range from $3.56 to $4.86, which are larger than the $2.92 selected for 1998. Compared to 1998, past FCAs were generally more restrictive for women and children by recommending no consumption of any listed species, whereas in 1998 the women and children advisories varied by the size of the fish. The selection of values follows.

   A. The 1988 through 1997 FCAs generally advise no consumption of larger trout/salmon and walleye, generally for all members of the population. We weight

Level 7 by one-third to reflect the advisory for larger fish for a value of $4.77 ($14.32/3). Note this is similar to the Level 3 WTP^G of $4.86.

B. The advisories before 1988 focused on trout/salmon only and were separate for the general population and for women (generally for women who are pregnant, nursing, or expect to bear children) and children, with the age of children for whom the advisory is applied varying through time. The general population advisories in 1986 and 1987 suggested no consumption of larger trout/salmon, and consumption of smaller trout/salmon no more than once a week (with the sizes varying by trout/salmon species); in 1980 through 1985, the advisories suggested consumption of any trout/salmon no more than once a week. From 1980 to 1987, the advisories for women and children generally recommended no consumption of trout/salmon. We apply the Level 7 value to women and children, and conservatively apply the Level 2 value for the general population for a weighted average of $3.56 (14% times $14.32 plus 86% times $1.81).

Total Damages for Past Service Flow Losses

Total past damages from 1981 to 1999 are $64.5 million, with Wisconsin open-water fishing accounting for about 59% of the total, all Wisconsin fishing accounting for 69% of the total, and all Michigan fishing accounting for 31% of the total.

FCAs were first issued in response to PCB contamination in the waters of Green Bay in 1976. To include damages for the period from 1976 to 1980, we assume the computed annual 1981 damages are the same for each year from 1976 to 1980, and escalate the damages to a 2000 present value. These 1976 through 1980 past damages amount to $6.3 million for all Wisconsin fishing, $5.8 million for all Michigan fishing, and $12.1 million in total. The annual estimated annual damages for 1976 through 1981 in Wisconsin are less than for 1981 through 1999 because of the very limited Wisconsin advisories in 1976 through 1980. Including damages from 1976 to 1980 would increase past damages by about 19%, compared to damages for 1981 through 1999.

10.2.2 Damages for Future Service Flow Losses

Damages for future service flow losses are computed starting in 2000. The duration and levels of the FCAs depend on the level of remediation efforts to address PCB contaminated sediments, which have not been selected. Therefore, pending final selection of remediation efforts, we have identified three potential remediation scenarios to illustrate how the magnitude of damage estimates for projected future recreational service losses may vary with the selected remediation. The estimation of damages for future service losses will be revised and incorporated into the Service’s compensable values determination after the U.S. EPA has issued a Record of Decision and the Trustees have selected a preferred restoration alternative.

The three remediation scenarios reflect the range of options considered in the draft Remedial Investigation/Feasibility Study (RI/FS) (ThermoRetec Consulting, 1999a, b), as well as the October 27, 1997 "Fox River Global Meeting" Goal Statement (FRGS-97) by the Fox River Global Meeting Participants (1997).

1. ***Intensive remediation.*** All FCAs are removed in 20 years. This is modeled as a 10-year PCB removal period, during which time the FCA-caused service losses and accompanying damages per fishing day are assumed to decline linearly at a natural recovery rate (see Scenario 3), followed by a 10-year accelerated recovery period during which time the FCA-caused service losses and accompanying damages per fishing day are assumed to decline linearly to zero. This scenario closely reflects the FRGS-97 goal, and is similar to the RI/FS scenario of PCB removal to a 250 µg/kg minimum concentration level throughout the Lower Fox River (however, the draft RI/FS suggests the potential for removal of FCAs in less than 10 years after the above removal is complete, which would reduce damages).

2. ***Intermediate remediation.*** All FCAs are removed in 40 years. This is modeled as a 10-year PCB removal period, during which time the FCA-caused service losses and accompanying damages per fishing day are assumed to decline linearly at a natural recovery rate (see Scenario 3), followed by a 30-year accelerated recovery period during which time the FCA-caused service losses and accompanying damages per fishing day are assumed to decline linearly to zero. This scenario is similar to the RI/FS scenario of PCB removal to a 250 µg/kg average concentration level throughout the Lower Fox River.

3. ***No additional remediation (no action remedy).*** No significant additional PCB removal occurs and the elimination of FCAs occurs due to natural recovery. We model the natural recovery rate to be a linear decline in FCA-caused service flow losses and damages per fishing day to zero at the end of 100 years. This is a conservative assumption as the draft RI/FS suggests that with no additional remediation, the Wisconsin FCAs may continue with little change for 100 years or more.

For all future years we assume that fishing effort remains constant at 1998 levels for all fishing considered, and the levels are based on estimates in this study, as described in Section 8.4. The assumption of current fishing activity levels into the future may or may not be a conservative assumption as fishing effort in the waters of Green Bay was at a decade lowest level in 1997 and 1998. Fishing effort may or may not remain depressed, most likely depending on the future catch rates, changes in FCAs and other water quality measures, and changes in the population of northeast Wisconsin. This assumption can be revisited and revised after the U.S. EPA selection of a Record of Decision and the Trustees have selected a preferred restoration alternative.

As identified in the scenarios, we assume that damages per fishing day due to FCAs decrease over time in a linear fashion. In the no action Scenario 3, damages per day decrease to zero at a natural recovery rate assumed to occur over a 100 year period. In Scenarios 1 and 2, damages per day decrease at the assumed natural recovery rate for the first 10 years during remediation, then decrease at an accelerated, but still linear, rate over the next 10 years (Scenario 1) or 30 years (Scenario 2). This process is the same for each category of damages considered (open water and ice fishing in Wisconsin, and all fishing in Michigan). Again, after the U.S. EPA's selection of a record of decision and the trustees' selection of a preferred restoration alternative, the time path of FCAs can be revisited and damages computed based on the projected time path of FCAs and the values for different FCA levels in Table 8-1.

Estimated damages for future service flow losses range from $41.5 million (under Scenario 1 with intensive remediation) to $83.2 million (under Scenario 3 with no additional remediation). The Wisconsin share of the damages for future service losses is about 87% reflecting the more significant fishing activity and more restrictive advisories in the Wisconsin waters of Green Bay.

10.2.3 Total Recreational Fishing Damages

Total damages for past and future recreational fishing service losses range from $106.0 million under Scenario 1 (intensive remediation) to $147.7 million under Scenario 3 (no additional remediation). The Wisconsin share ranges from 76% to 79% depending on the scenario. Damages for future recreational fishing service flow losses constitute from 39% of the total if intensive remediation is implemented, up to 56% of the total if no additional remediation is undertaken.

The present value of past and future service flow losses varies with the discount rate. For example, increasing the discount rate to 6% increases the value of past service flow losses but decreases the value of future service flow losses. The value of the total of past and future service flow losses would increase by about 15% under Scenario 1, increase by about 7% under Scenario 2, and decrease by about 6% under Scenario 3. Decreasing the discount rate to 2% decreases the value of past and future service flow losses in Scenario 1 by about 3%, increases the value in Scenario 2 by less than 1%, and increases the value in Scenario 3 by about 9%.

10.3 CONCLUSIONS

The value of recreational fishing service losses in the Wisconsin and Michigan waters of Green Bay from PCB releases into the Lower Fox River have been and continue to be substantial, affecting as many as 350,000 fishing days per year in these waters in recent years (and more in past years), and causing anglers to substitute to other fishing sites or to participate less in fishing. The value of losses in the Wisconsin waters of Green Bay is larger than in the Michigan waters of Green Bay, reflecting the increased recreational fishing days and higher PCB concentrations in the Wisconsin waters.

The value of recreational fishing losses (damages) estimated here is consistent with the literature on recreational fishing impacts and damages from FCAs. About three-quarters of those anglers who continue to fish the Wisconsin waters of Green Bay report behavioral responses to the FCAs, and other anglers report no longer fishing the waters of Green Bay due to FCAs — all of which are comparable to other studies about FCAs on the Great Lakes. The damages per angler per year from the FCAs (about $55 for anglers active in Green Bay fishing) are comparable to or even less than values found in the literature (especially when accounting for differences in the scenarios for this study compared to those in the literature). The values for changes in catch rates are also comparable to the literature.

The measured damages per fishing day are robust to multiple variations in model specification. In fact, most of the preselected alternative model specifications provided larger damage estimates.

The estimated damages are expected to be a conservative measure of the total value of lost recreational fishing services; e.g., the damages are understated. The principal factors causing the estimated values to be conservative are presented below and are summarized in Table 10-2. The identified potential percentage impacts on the estimates are indicative, rather than precise, based on available evidence and expert opinion. These factors are not accounted for in the estimated damages, either to be conservative or because of uncertainty about how much adjustment to make.

1. ***Uncertainty in estimates of fishing days in the Wisconsin waters of Green Bay.*** Damages from 1981 through 1997 are computed based on the WDNR estimates of fishing hours in the Wisconsin waters of Green Bay, which are the only estimates available. Future damages are based on estimates from this study. The 1998 estimates in the current study are for anglers who purchased licenses in eight targeted counties and may account for over 90% of fishing days in the Wisconsin waters of Green Bay (Section 3.5.5), but are about 13% larger than in the WDNR data for 1998 (although it is important to note that the two 1998 estimates are not statistically significantly different).[2]!gcfnote! Some of this difference may be attributed to sampling procedures in the WDNR open-water creel survey (e.g., the tributaries are sampled March 1 through May 15 and September 1 through December 31, and omit sampling from May 15 through September 1, which may also explain why the WDNR estimate of the percent of effort on the Lower Fox River for 1998 is lower than found in this study; and the open-water creel study in the bay covers the period March 15 through October 31, omitting early and late season fishing days).

2. The study estimate is 255,200 with a 95% confidence interval of 224,000 to 287,000. The WDNR does not report days, but they can be approximated by dividing the 905,762 hours by 4 hours/day estimated in the creel survey to equal 226,440 days. The confidence interval on the 905,762 hours is ± 70,000 hours, and thus the confidence interval of the approximation of days exceeds 209,000 to 244,000 (given the unknown variance on the hours/day estimate).

Table 10-2
Key Omissions and Biases in the Estimated Values for Recreational Fishing Losses[a,b]

Item	Potential Impact on Item Estimates	Potential Impact on Total Damages
1. Estimates of fishing days in the Wisconsin waters of Green Bay	0% to -10% for Wisconsin damages for past losses *or* 0% to +13% for Wisconsin damages for future losses	-4% to +7%
2. Omission of anglers who do not fish Green Bay but would if PCBs and FCAs did not exist	About -5% for all measures	
3. Omission of nonanglers who would fish if PCBs and FCAs did not exist.	Unknown	
4. Omission of losses from reductions in total fishing days	Unknown	
5. Use of WTP^G, rather than WTP^F, for ice fishing and Michigan fishing	About -7% for Wisconsin ice fishing and for Michigan fishing	About -2% to -3%
6. Omitted losses to Oneida tribal waters	Unknown, but likely to be smaller than the measured damages	
7. Limited subsistence fishing losses	Unknown, but likely to be small relative to measured damages	
8. Understated FCA assumptions	-10% for future years, unknown for past years	
9. Understated past losses due to overstated past catch times	About -16% for damages for past losses	About -7% to -10%
10. Conservative estimate of Wisconsin ice-fishing days	About -80% for Wisconsin ice fishing	About -9%
11. Conservative assumption for national recovery	Up to -6% (Scenario 1) to -40% (Scenario 3) for damages for future losses	Up to -2% (Scenario 1) to -20% (Scenario 3)
12. Omitted health and other potential damages	Unknown	

a. The identified percent of impact on the estimates are indicative measures, rather than precise measures, of the potential impacts based on available evidence and professional judgment.
b. Negative percentages indicate potentially understated damages; positive percentages indicate potentially overstated damages.

If the estimates in the current study are preferred to the WDNR estimates, then past damages may be understated, potentially by about 10%, and total damages may be understated by about 4% to 6% (depending on the remediation scenario). If the WDNR estimates are preferred over using fishing days estimates from this study, future damages may be overstated, potentially on the order of 13%, and total damages overstated by about 5% to 7% (depending on the remediation scenario).

2. ***Omitted service losses to anglers who do not fish Green Bay, but would if PCB contamination and FCAs did not exist.*** About 7.4% of Wisconsin license holders in the telephone survey reported that FCAs were a key reason why they do not fish Green Bay in 1998. If these anglers fished Green Bay, the potential increase in Green Bay anglers would be about 24% (Section 2.4). Even if only a share of these anglers became Green Bay anglers and they fished green Bay less often than other anglers, the potential omission may be on the order of 5% of the quantified damages.[3]!gcfnote! This omission is likely to apply equally to fishing in Michigan waters of Green Bay.

3. ***Omitted service losses to nonanglers who do not fish at all, but would fish if PCB contamination and FCAs did not exist.*** Some individuals, particularly those who live nearby and who would likely fish in the waters of Green Bay in any one year, do not fish at all because of the FCAs. Information on the significance of this omission is not available but because of the size of the nonangling population in any year, it could add several percent to the damages.

4. ***Omitted service losses for reduced total fishing days by Green Bay anglers.*** Our lower bound damage estimates include reduced enjoyment of current days plus losses associated with substituting Green Bay fishing days to other fishing sites that, in the absence of FCAs in the waters of Green Bay, would be less preferred. Damages are omitted for the potential reductions in total fishing because of the FCAs. The magnitude of this omission is unknown. By way of comparison, the estimate of damages associated with substituting fishing days to other sites is about 7% larger compared to estimates that do not allow substitution.

5. ***Use of lower value measure for benefits transfer to ice fishing and fishing in Michigan waters of Green Bays.*** These benefits transfers use the lower value measure, WTP^G, (Section 8.4), which can be expected to produce damage estimates about 5-10% lower than when using the more comprehensive WTP^F value measure because the WTP^G measure does not allow anglers to increase Green Bay days by substituting from other fishing sites (this difference was about 7% for open-water fishing and we assume a similar

3. For example, in the absence of FCAs assume 25% to 50% anglers become active in Green Bay fishing, and they fish half as often as the average. Then, a 24% potential increase in anglers times (0.25-0.50) actual participation rate times 0.5 activity rate = 3% to 6%.

difference is likely for ice fishing and fishing in Michigan waters). Given that ice fishing in Wisconsin waters of Green Bay plus all fishing in Michigan waters of Green Bay account for about 33% of total damages, this may result in a reduction in total damages on the order of 2% to 3%.

6. ***Omitted damages to Oneida tribal waters.*** Recreational fishing by Oneida Nation tribal members on Oneida tribal waters within the Wisconsin waters of Green Bay (portions of Duck Creek and other tributaries) does not require Wisconsin fishing licenses. These damages have not been fully measured, if measured at all. The magnitude of this omission is unknown. While these omitted service losses and damages are likely to be significant to the Oneida Nation because of the cultural significance of the fishing, they are likely to be smaller than the quantified recreational fishing damages in this report given the relative size of impacted fishable waters on reservation lands compared to the total Wisconsin waters of Green Bay and given the relative size of the angler populations in the general population and in the Oneida Nation.

7. ***Limited or omitted subsistence fishing service flow losses.*** While some subsistence anglers may have participated in this study, because of language barriers it is likely that subsistence fishing damages are not well represented in this assessment. Hutchison (1999) addresses the existence and significance of subsistence fishing impacts, but does not quantify damages. While these service flow losses are important to consider, mitigate, and compensate, their omission is likely to be relatively small (in dollars of damage) compared to the quantified recreational fishing damages.

8. ***Understated FCA assumptions.*** Throughout the damage assessment, we conservatively selected the FCA levels in the waters of Green Bay. For example, for the damages from 1998 service flow losses, the per fishing day damage in Wisconsin waters of Green Bay of $9.75 is based on FCA Level 4 in our analysis (Table 5-3), which understates the FCA levels for *every one* of the four focus species.[4]!gcfnote! This omission could understate Wisconsin damages by at least 10% and potentially significantly more.[5]!gcfnote! This understatement is carried forward into the computation of damages for future year losses.

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4. For perch, the assumed "once a week" level understates the advisory level for the Lower Fox River. For trout/salmon, the assumed "once a month" level understates the restrictions for larger salmon and large brown trout. For walleye, the assumed "once a month" only holds for smaller walleye, and understates the restriction for medium and larger walleye (large walleye should not be eaten at all). For smallmouth bass, the assumed "once a month" level understates the advisory for the Lower Fox River.

5. For example, in Table 8-1 comparing Levels 6 and 7, only the walleye advisory becomes more restrictive (from "eat no more than one meal per month" to "do not eat" (as applies to large walleye) and values increase by about 40%. Comparing Levels 8 and 9, perch and smallmouth bass advisories increase from assumed to the actual levels applicable to the Lower Fox River and damages increase by about 8 to 10%.

For damages for past losses we make similar conservative assumptions about the applicable FCA levels to select damages per fishing day from our available estimates in Table 8-1, but the degree of understatement in past damages is more difficult to assess and remains unknown.

9. ***Understated damages for past losses due to overstated past catch times.*** The value of service losses due to FCAs increases as catch times (how long it takes to catch a fish) decrease.[6]!gcfnote! Our per fishing day values are based on 1998 catch time, which were much higher than the average catch times in the past. If the 13-year average catch times were used, damages for past losses would be as much as 16% larger (Section 8.2). Since damages for past losses account for on the order of 44% to 60% of the total damages under the alternative remediation scenarios, this omission could result in total damages understated by as much as 7% to 10%.

10. ***Conservative ice-fishing computation.*** The ratio of ice-fishing days to open-water fishing days in the Wisconsin waters of Green Bay is held constant at 18.24% (measured in our survey data), even thought the past average is closer to 34%. Thus, actual ice-fishing damages may average up to 86% more than measured ice-fishing damages, and thus total damages may be conservative by about 9%.[7]!gcfnote!

11. ***Conservative natural recovery for damages for future service flow losses***. The future scenarios assume natural recovery over a 100-year period. The draft RI/FS suggests that with no additional remediation there may be little or no change in the FCAs. If the assumption of no change in FCAs over a 100-year period were used in the computations, damages for future service flow losses would increase by about 6% to 8% for Scenarios 1 and 2, and by more than 40% for Scenario 3. Total damages would increase by about 3% to 4% for Scenarios 1 and 2, and by more than 20% for Scenario 3.

12. ***Omitted health damages.*** The estimated damages do not include the value of health impacts from eating contaminated fish. This may be particularly relevant where past FCAs were less restrictive than in 1998. This is because past PCB levels in the sediments (and thus in fish) were comparable to current PCB levels, and past FCAs, under current scientific standards may have understated the health risks, leading to over consumption of PCB-contaminated fish.

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6. As an angler catches more fish, the advisories can be expected to be more bothersome as the angler may not be able to eat the increased catch of fish as often as he would like. If the angler catches less fish, some advisories become less restrictive because the angler may not catch enough fish to eat meals of fish very often.

7. Even if the WDNR past estimates were used for each past year, and the average from the past used in the future, rather than using our survey estimates for ice-fishing hours, the 1998 and 1999 damages would decrease slightly, but total damages for past ice fishing would still increase by over 80%, and total damages would increase by nearly 9%.

13. ***Omission of other potential damages.*** Additional potential injuries, for which damages have not been quantified, include impacts of PCBs on fishery populations in the waters of Green Bay, which may reduce recreational fishing catch; and PCBs from the Lower Fox River entering Lake Michigan and contributing to loadings causing FCAs and/or health risks from consuming fish, and potential fishery injuries.

CHAPTER 11
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APPENDIX A
MODELING CONSUMER PREFERENCES FOR GREEN BAY FISHING DAYS AND FISHING DAYS USING STATED AND REVEALED PREFERENCE DATA

A.1 INTRODUCTION

The purpose of this research is to estimate the parameters in two conditional indirect utility functions: one for a Green Bay fishing day, and one for fishing elsewhere. There are two types of data available: stated preference (SP) data and revealed preference (RP) data. The RP data consist of the total number of fishing days for each individual in the sample and the number of those days to Green Bay under current conditions. The SP data consist of the answers to choice questions. Each sampled individual indicated his or her choice between a pair of Green Bay alternatives (Green Bay under different conditions), and then indicated the number of times in *n* choice occasions (fishing days) the preferred Green Bay alternative would be chosen, in a choice set that includes it and all non-Green Bay fishing sites. For each sampled individual, these two questions are repeated *J* times, where the characteristics of the Green Bay alternatives in the pairs are varied over the *J* pairs.

Section A.2 develops the choice probabilities for the two Green Bay alternatives using only the part of the SP data that indicate which Green Bay alternative is chosen. Section A.3 uses all of the SP data and the RP data on the total number of fishing days under current conditions to model how often the preferred Green Bay alternative would be chosen versus some other non-Green Bay site. Section A.4 incorporates the RP data on the total number of fishing days to Green Bay under current conditions, and Section A.5 presents the likelihood function for the model. Section A.6 provides details on the derivation of the probability of choosing the preferred Green Bay alternative over fishing elsewhere, conditional on the utility from the preferred Green Bay alternative being greater than the utility from the Green Bay alternative not chosen.

A.2 CHOICE PROBABILITIES FOR SP GREEN BAY PAIRS

Let utility for the Green Bay alternatives be given by:

$$U_{ij}^{k_{ij}} = b_i' x_{ij}^{k_{ij}} + e_{ij}^{k_{ij}}, \ i = 1, \ \ldots, m; \ j = 1, \ldots, J; \ k_{ij} \in [1, 2], \qquad (1)$$

where $U_{ij}^{k_{ij}}$ is the utility of the *k*-th alternative of pair *j* to individual *i*. That is, *i* indexes the *m* respondents, *j* indexes the *J* pairs, and k_{ij} indicates which of the two alternatives within each pair is chosen. The $L \times 1$ vector $x_{ij}^{k_{ij}}$ contains the characteristics of the alternatives, and hence the elements of the unknown $L \times 1$ vector b can be interpreted as marginal utilities. The first element of $x_{ij}^{k_{ij}}$ is the difference between choice-occasion income for individual *i* and the cost of alternative k_{ij}, and the model is restricted to one with a constant marginal utility of money, which is the first element of b .[1] This specification implies no income effects; that is, the probability of choosing any alternative is independent of income. The term $b_i' x_{ij}^{k_{ij}}$ is the nonstochastic part of utility, while $e_{ij}^{k_{ij}}$ represents a stochastic component. The following assumptions are made:

Assumption 1. $b_i = b$ for all *i* (heterogeneity in the marginal utilities will be considered later); and

Assumption 2. $e_{ij}^{k_{ij}}$ are independent (across *i*) and identically distributed mean zero normal random variables, uncorrelated with $x_{ij}^{k_{ij}}$, with constant unknown variance s_e^2.

For SP data, it is assumed that the individual does not know his stochastic component before actually deciding on the particular alternative. That is, $e_{ij}^{k_{ij}}$ is assumed to be the sum of factors unknown to *both* the individual and the investigator.[2] Let $K_{ij} \in [1,2]$ be the Bernoulli random variable that is the choice for individual *i* on occasion *j*. The individual is assumed to choose alternative k_{ij} with the probability:[3]

$$P(K_{ij} = k_{ij}) = P_{ij}^{k_{ij}} = P(U_{ij}^{k_{ij}} > U_{ij}^{3-k_{ij}}), \tag{2}$$

where k_{ij} is the observed value of K_{ij} . That is, we may think of the individual's choice as a drawing from a Bernoulli distribution with the probability given by Equation 2.

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1. Later, different types of individuals are allowed to have different marginal utilities of money.

2. For RP data, the usual discrete-choice model specification is that the disturbances are known to the individual, and the behavioral assumption is utility maximization. This assumption is also sometimes made for SP data, although the rationale is less clear. Burtless and Hausman (1978) and Moffitt (1986) interpret disturbances unknown to the decision-maker in models with piecewise-linear budget constraints. In those models (and the water demand model of Hewitt and Hanneman, 1995) there is also "heterogeneity" error, which is observed by the decision-maker but unobservable to the investigator. Under the assumption that disturbances are known to the individual a priori, they would perform the conceptual experiment of generating n_i pairs of disturbances and evaluating utility for the two scenarios under the assumption of utility maximization. However, this would produce the identical likelihood.

3. In this notation, if the individual chooses alternative $K_{ij} = 1$ [or 2], then the alternative that was not chosen is $3 - K_{ij} = 2$ [or 1].

From Equations 1 and 2 and assumption 1, the probability of choosing alternative k_{ij} is:

$$\begin{aligned} P_{ij}^{k_{ij}} &= P(b' x_{ij}^{k_{ij}} + e_{ij}^{k_{ij}} > b' x_{ij}^{3-k_{ij}} + e_{ij}^{3-k_{ij}}) \\ &= P\left[e_{ij}^{3-k_{ij}} - e_{ij}^{k_{ij}} < -b'(x_{ij}^{3-k_{ij}} - x_{ij}^{k_{ij}})\right] \\ &= \Phi\left[-b'(x_{ij}^{3-k_{ij}} - x_{ij}^{k_{ij}}) / \sqrt{2}s_e\right] \end{aligned} \tag{3}$$

where $\sqrt{2}s_e$ is the standard deviation of $e_{ij}^{3-k_{ij}} - e_{ij}^{k_{ij}}$ under assumption 2 and $\Phi(\cdot)$ is the univariate standard normal cumulative distribution function. Note that Equation 3 would be the probability in the usual probit model for dichotomous choice under the assumption the individual knows the random component and maximizes utility. This probability will enter into the likelihood function in Section A.5. The parameter vector b is identified only up to the scale factor $\sqrt{2}s_e$, and s_e is not identified, since only the sign and not the scale of the dependent variable (the utility difference) is observed. Nevertheless, we have chosen to list the parameters of the likelihood function (b, s_e) separately. Notice also the *J* observations for each respondent have simply been stacked to produce a data set with *Jm* observations.

A.3 FREQUENCY OF SELECTING THE PREFERRED GREEN BAY ALTERNATIVE VERSUS ANOTHER SITE

Now suppose in addition to the data on k_{ij}, the individual answers a question giving the number of times Green Bay alternative k_{ij} would be chosen compared to some other (non-Green Bay) alternative, in their next n_i choice occasions (fishing days). Utility for the "other" alternative, U_{ij}^0 (fishing elsewhere), is given by Equation 4:

$$U_{ij}^0 = b' x_{ij}^0 + e_{ij}^0, \tag{4}$$

where e_{ij}^0 are disturbances and x_{ij}^0 are the characteristics of the other site. The following assumption characterizes the disturbances:

Assumption 3: The e_{ij}^0 are independent (across *i*) and identically distributed normal random variables, with zero expectation, and $E\left(e_{ij}^0 e_{ij}^{k_{ij}}\right) = s_{e0}$.

In this model, the value of a random variable N_{ij} is known, where N_{ij} is the number of times Green Bay site k_{ij} is chosen over the non-Green Bay site in the next n_i occasions.[4] The nonstochastic parts of the utilities for the two alternatives in this choice set are $b' x_{ij}^{k_{ij}}$ and $b' x_{ij}^0$. The individual knows these, but does not know the random component associated with either alternative because he must decide in advance how he feels at the time of the choice. If $b' x_{ij}^0 < b' x_{ij}^{k_{ij}}$, for example,

4. The parameter n_i is set equal to the number of days individual *i* fished in 1998.

he knows, on average, he would be better off choosing Green Bay site k_{ij} over fishing elsewhere, but he cannot be certain. For some trips, e_{ij}^{0} may be sufficiently larger than $e_{ij}^{k_{ij}}$ so that $U_{ij}^{0} > U_{ij}^{k_{ij}}$. Over a future set of choice occasions, then, it is assumed that he calculates his answer to the number question probabilistically. That is, he calculates the conditional probability that he will prefer alternative k_{ij} over fishing elsewhere (see Equation 6 below) and then reports the closest integer to n_i times that probability.[5] This is the expected number of trips under the assumption made below that the N_{ij} are distributed binomially, and this average number of trips is elicited in the survey.

Since the N_{ij} are counts ranging from zero to n_i, given the behavioral assumption discussed above a plausible stochastic model for the N_{ij} is that they are distributed binomially, $N_{ij} \sim B(n_i, p_{ij}^{0})$, with probability mass function (conditional on the choice of k_{ij}):

$$P(N_{ij} = n_{ij} | K_{ij} = k_{ij}) = \binom{n_i}{n_{ij}} (p_{ij}^{0})^{n_{ij}} (1 - p_{ij}^{0})^{n_i - n_{ij}}, \qquad (5)$$

where n_{ij} are the observed values of N_{ij}.[6] Equation 5 will enter into the likelihood function in Section A.5.

The parameter p_{ij}^{0} in Equation 5 is the probability of choosing Green Bay alternative k_{ij} over the "other" site, conditional on choosing alternative k_{ij} over alternative 3 - k_{ij}:

$$\begin{aligned} p_{ij}^{0} &= P(U_{ij}^{k_{ij}} > U_{ij}^{0} | U_{ij}^{k_{ij}} > U_{ij}^{3-k_{ij}}) \\ &= P[e_{ij}^{0} - e_{ij}^{k_{ij}} < -b'(x_{ij}^{0} - x_{ij}^{k_{ij}}) | e_{ij}^{3-k_{ij}} - e_{ij}^{k_{ij}} < -b'(x_{ij}^{3-k_{ij}} - x_{ij}^{k_{ij}})] \\ &= \frac{\Phi_2[-b'(x_{ij}^{0} - x_{ij}^{k_{ij}}) / s_{0-e},\ -b'(x_{ij}^{3-k_{ij}} - x_{ij}^{k_{ij}}) / \sqrt{2}\, s_e ; r]}{\Phi[-b'(x_{ij}^{3-k_{ij}} - x_{ij}^{k_{ij}}) / \sqrt{2}\, s_e]} \end{aligned} \qquad (6)$$

where $s_{0-e}^{2} = \mathrm{Var}(e_{ij}^{0} - e_{ij}^{k_{ij}}) = s_0^{2} + s_e^{2} - 2s_{e0}$

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5. This is in contrast to assuming the individual repeatedly applies a maximum expected utility decision rule, which would imply a corner solution at either zero or n_i. When we consider revealed preference choices below, we assume that the individual knows his stochastic component and maximizes utility.

6. We are effectively assuming: $P(N_{i1} = n_{i1}, \ldots, N_{iJ}) = \prod_{j=1}^{J} P(N_{ij} = n_{ij})$. A model that explicitly recognizes the fact that the same individual makes all n_{ij} choices exists (it is called the multivariate binomial distribution; see Johnson et al., 1997). It appears to be unwieldy, except possibly for the case $J = 2$. For most if not all formulations of this multivariate distribution the marginals are univariate binomial, so the method of estimating the p_{ij}^{0}'s suggested here is justified. There has been some interest in testing the equality of the p_{ij}^{0} across j (see Westfall and Young, 1989), but that is not the main focus here.

and where r is the correlation between $e^0_{ij} - e^{k_{ij}}_{ij}$ and $e^{3-k_{ij}}_{ij} - e^{k_{ij}}_{ij}$,

$$r = \frac{s^2_e}{\sqrt{2 s^2_e s^2_{0-e}}} \tag{7}$$

and Φ and Φ_2 are the standard univariate and bivariate normal distribution functions, respectively.[7] (For details of the derivation of Equation 6, see Section A.6.)

A.4 INCORPORATING THE RP DATA ON ACTUAL GREEN BAY FISHING DAYS

In addition to the SP data and the n_i, we have for each i the number of fishing days to Green Bay, n^G_i (taken, of course, under current conditions). This RP data may be used with the other data in the estimation of the model parameters. Utility for the d-th actual Green Bay fishing day is given by:

$$U^G_{id} = b' x^G_i + e^G_{id} \tag{8}$$

where x^G_i is a vector of characteristics of Green Bay under actual conditions, and e^G_{id} is a random component with variance s^2_G.

In deciding how many days to fish Green Bay, the individual compares utility at Green Bay to utility at other sites, given by Equation 4. For RP data we assume the individual knows his random component at the time each fishing day's choice is made, so that the probability of going to Green Bay on day d is:

$$\begin{aligned} P^G_i &= P(U^G_{id} > U^0_{ij}) \\ &= P(b' x^G_i + e^G_{id} > b' x^0_{ij} + e^0_{ij}) \\ &= P(e^0_{ij} - e^G_{id} < b' x^G_i - b' x^0_{ij}) \\ &= \Phi[(b' x^G_i - b' x^0_{ij}) / s_{0-G}] \end{aligned} \tag{9}$$

where:

$$s^2_{0-G} = \text{Var}\,(e^0_{ij} - e^G_{ij}) = s^2_0 + s^2_G - 2s_{G0} \tag{10}$$

7. Note that in Equation 6, b appears twice. On one occasion it is normalized by $\sqrt{2} s_e$, and on the other by s_{0-e}. Also note that under the alternative assumption that disturbances are known to the individual a priori, he would perform the conceptual experiment of generating n_i pairs of disturbances, evaluating utility under the two scenarios, and counting the number of Green Bay trips under the assumption of utility maximization. This process would also imply Equations 5-7.

Since P_i^G is a function of b, the information contained in n_i^G is useful in estimation, and is incorporated into the likelihood.

To summarize, the random variable e takes a variety of identifying notations. Table A-1 summarizes the cases.

Table A-1
Summary of Disturbances

Disturbance	**Site**	**Data Type**
$e_{ij}^{k_{ij}}$	Green Bay, proposed	SP
e_{ij}^{0}	Other than Green Bay	SP/RP
e_{ij}^{G}	Green Bay, actual	RP

Disturbances for revealed versus stated preference data may or may not have different variances, which would mean the informational content (toward the estimation of b) would differ. Since we allow correlation among disturbances and can only estimate the variance of the disturbance differences, we cannot assess the relative information content of the different kinds of data.

A.5 THE LIKELIHOOD FUNCTION

The maximum likelihood parameter estimates are consistent. They are also asymptotically efficient under the additional assumption that e_{ij}^0 and $e_{ij}^{k_{ij}}$ are uncorrelated across *j*. The likelihood function is a function of the probabilities of the preferred alternatives from the Green Bay pairs (Section A.2), the conditional probabilities for how often the preferred Green Bay alternatives would be selected versus a non-Green Bay site using RP data on the number of total fishing days (Section A.3), and the probabilities for actually visiting Green Bay using RP data on the number of Green Bay days (Section A.4). The likelihood function is:

$$L(n_{ij}, k_{ij}, n_i^G, i = 1,\ldots,m, j = 1,\ldots,J \mid x_{ij}^1, x_{ij}^2, n_i; b, s_0, s_e, s_G) =$$

$$\prod_{i=1}^{m}\left[\binom{n_i}{n_i^G}(P_i^G)^{n_i^G}(1-P_i^G)^{n_i-n_i^G}\prod_{j=1}^{J}P(N_{ij}=n_{ij}\mid K_{ij}=k_{ij})P(K_{ij}=k_{ij})\right] \qquad (11)$$

Note that in this likelihood b appears in several expressions: in P_i^G normalized by s_{0-G}, in $P(N_{ij} = n_{ij} | K_{ij} = k_{ij})$ normalized by s_{0-e}, and in P_i and $P(K_{ij} = k_{ij})$ normalized by $\sqrt{2}s_e$. The ratios of any two of these three parameters are identified in estimation.[8]

A.6 DERIVATION OF EQUATION 6

Consider the probability of choosing Green Bay site k_{ij} over a non-Green Bay site, conditional on the choice of Green Bay site k_{ij} over Green Bay site 3 - k_{ij}. To ease the notation, suppose alternative 1 is chosen rather than alternative 2, and the individual and choice occasion subscripts are ignored. Under assumptions 2 and 3, the random vector (e^1, e^2, e^0) has a multinormal distribution with zero mean vector and covariance matrix:

$$\begin{pmatrix} s_e^2 & 0 & s_{eo} \\ 0 & s_e^2 & s_{eo} \\ s_{eo} & s_{eo} & s_0^2 \end{pmatrix} \tag{12}$$

This implies:

$$w = \begin{pmatrix} w_1 \\ w_2 \end{pmatrix} \overset{\text{def}}{=} \begin{pmatrix} e^0 - e^1 \\ e^2 - e^1 \end{pmatrix} \sim N(0, \Omega) \tag{13}$$

where:

$$\Omega = \begin{pmatrix} s_{0-e}^2 & s_e^2 \\ s_e^2 & 2s_e^2 \end{pmatrix} \tag{14}$$

The probability in Equation 6 is a conditional probability of a bivariate normal random variable, where the conditioning event does not have zero probability (which is the more usual case).[9] Let $a_1 = -b'(x_{ij}^0 - x_{ij}^{k_{ij}})$ and $a_2 = -b'(x_{ij}^{3-k_{ij}} - x_{ij}^{k_{ij}})$. From Amemiya (1994, pp. 35-36), denoting the joint, marginal, and conditional density functions of w and its elements as *f*, we have:

8. Although all parameters are listed separately, it is evident that normalizations are necessary.

9. It *is* a conditional probability, rather than a conditional expectation, so the Mill's ratio results from the selection literature (e.g., Maddala, 1983, p. 367) cannot be used.

$$f(w_1|w_2 < a_2) = \frac{\int_{-\infty}^{a_2} f(w_1, w_2)dw_2}{P(w_2 < a_2)} \tag{15}$$

so that:

$$P(w_1 < a_1|w_2 < a_2) = \int_{-\infty}^{a_1} f(w_1|w_2 < a_2)dw_1 = \frac{\int_{-\infty}^{a_1}\int_{-\infty}^{a_2} f(w_1, w_2)dw_2 dw_1}{\int_{-\infty}^{\infty}\int_{-\infty}^{a_2} f(w_1, w_2)dw_2 dw_1} \tag{16}$$

This is the ratio of a bivariate normal cumulative distribution function evaluated at a_1 and a_2 to a univariate normal cumulative distribution function evaluated at a_2:

$$P(w_1 < a_1|w_2 < a_2) = \frac{\Phi_2\left(a_1 / s_{0-e}, a_2 / \sqrt{2}s_e; r\right)}{\Phi\left(a_2 / \sqrt{2}s_e\right)}, \tag{17}$$

which is Equation 6.

APPENDIX B
ESTIMATION

B.1 INTRODUCTION

This appendix contains the details of estimation for the full model. The full model uses the binary choice stated preference data, the count data on days to the chosen alternative, and the revealed preference data on the number of Green Bay days. Section B.2 discusses the specification of the conditional indirect utility functions for the Green Bay choices. In Section B.3 we add the elements of the model necessary to incorporate the revealed preference data and the quantitative stated preference data comparing the Green Bay choice to the individual's alternative sites. Section B.4 includes all the pertinent information concerning the maximization of the likelihood, as well as the results from that exercise (parameter estimates, asymptotic t-statistics, etc.). Section B.5 provides a discussion of hypothesis tests and measures of goodness-of-fit. This appendix concludes with a discussion of the exercises the model can be put through, and the results of some of those exercises.

B.2 THE MODEL AND BINARY CHOICE STATED PREFERENCE DATA

To use the binary choice SP data, a particular form for utility of a fishing day at Green Bay (Equation 1 in Appendix A) must be specified, which means in particular the choice of variables in the linear-in-parameters deterministic portion of Equation 1 in Appendix A. To this end it is assumed that utility is linear in the variables representing catch times for the four species, a set of dummy variables that represent the level of FCAs, and the launch fee, if any. The model is:

$$U_{ij}^{k_{ij}} = \sum_{l=p,s,w,b} b_l c_l^{k_{ij}} + \sum_{q=2}^{9} b_{FCAq} FCA_q^{k_{ij}} + b_y (y_i - TC_i - fee^{k_{ij}}) + e_{ij}^{k_{ij}}, \qquad (1)$$

for $i = 1,..., m$; $j = 1,..., 8$, $k_{ij} = 1$ or 2, and where y_i and TC_i are choice occasion income and travel cost for individual i, and average catch times (c_l, $l = p,...,b$) are measured as the time (in hours) it takes on average to catch one fish of a particular species (perch, salmon/trout, walleye, bass). For example, the perch catch time is thought to be approximately 0.75 hours. Therefore, it is expected that the coefficients of the catch times will be negative. The nine FCA levels are represented by a set of eight dummy variables, each representing a certain configuration of fish consumption advisories for the four target species. The FCA levels corresponding to the dummy variables generally increase in severity, so that $FCA_3 = 1$ means more (and/or more severe) restrictions than $FCA_2 = 1$, for example. A value of zero for all of the dummy variables (FCA_2 through FCA_9)

means essentially no restrictions (eat as many of all species as desired), and $FCA_9 = 1$ is a warning not to eat more than one perch meal per month or *any* of the remaining three species at all. The exception is in moving from FCA_4 to FCA_5 and from FCA_5 to FCA_6 with the consumption of some species becoming more restricted and others less restricted (see Section 5.4). Since y_i and TC_i do not vary by k_{ij}, these variables disappear from the relevant utility difference (see, for example, Equation 3 in Appendix A). In the pairs, the launch fees range from $0-$15. Table B-1 summarizes the data for the 10 versions of the survey, each with eight, paired Green Bay scenarios (160 total scenarios).

Table B-1
Data Summary

Variable	Perch	Salmon/ Trout	Walleye	Bass	FCA Level	Launch Fee
Mean	.52	5.55	5.51	5.48	4.5	$7.50
Range	.11 - 1.00	1.0 - 12.0	1.0 - 12.0	1.0 - 12.0	1 - 9	$0 - $15

B.3 ADDING QUANTITATIVE STATED PREFERENCE AND REVEALED PREFERENCE DATA

Since there are no data on the characteristics of the alternative fishing sites for the respondents, utility for the non-Green Bay alternative site (Equation 4 in Appendix A) is assumed to be constant across individuals and choice occasions, with an additive random disturbance:

$$U_{ij}^{0} = g_{O} + e_{ij}^{0}. \qquad (2)$$

This means that variables such as catch time, travel cost, and any fish advisories at other sites (but not income, as it will still drop out) are grouped into the error term. Although a component of travel cost such as distance to the site cannot contribute to a utility difference when the site is Green Bay for both choices, as it is in the binary choice SP data, it could affect the utility differences between other sites and Green Bay. We assume here that the variation in distance to anglers' other sites is not great across anglers. We further assume that any variation is likely to be randomly distributed across anglers (anglers living close to and far from Green Bay have alternative sites both near and far), so that the lack of these data adds noise (in the form of increased variance of the disturbance term in Equation 2), but does not bias parameter estimates.

Other forms of Equation 2 that included person-specific explanatory variables were tested, and these specifications did not materially change results — see Appendix D.

Utility for going to Green Bay under current conditions is given by Equation 3:

$$U_{id}^{G} = \sum_{l=p,s,w,b} b_l c_l + \sum_{q=2}^{9} b_{FCAq} FCA_q + b_y (y_i - TC_i - fee) + e_{id}^{G}, i = 1, \ldots, m, \quad (3)$$

where the values for explanatory variables are perch catch = 0.75, salmon catch = 19.4, walleye catch = 7.4, bass catch = 15.0, FCA Level = 4 (FCA_4 = 1, FCA_m = 0 $\forall$ $m \neq$ 4), and fee = $3.

B.4 OPTIMIZATION AND PARAMETER ESTIMATES

Gauss application model “Maxlik” was used to maximize the likelihood (Equation 11 in Appendix A). To obtain good starting values, we followed a routine: First, the binary probit model treating the 8*m* observations (where *m* is the number of respondents) as independent was fit, with the same catch time and FCA specification discussed above (the stated preference model), and with s_e^2 normalized to $\frac{1}{2}$. These estimates were used as starting values, along with zero for the constant and one for the variance (s_0^2) when the information on number of days to other sites was added, and the probit/binomial model was fit (a model with the other site included). These estimates in turn became starting values, along with various positive constants for the variance of error differences. Convergence was achieved for a variety of starting values, and always at the same point. Estimation was done on a personal computer with a Pentium III chip operating at 450 megahertz, and took approximately four minutes to converge.

Table B-2 provides the estimated values of the parameters and their estimated asymptotic t-statistics.

All parameters have the expected signs and all are statistically significant by conventional standards. The perch catch time has by far the largest parameter of the four species catch times. The pattern of estimated coefficients on the FCA variables is somewhat striking: as the FCA level increases they increase (in absolute value) nearly uniformly, and where they do not, it is as expected (see Section B.2). The same is true for their precision, as measured by their asymptotic t-statistics.

Table B-2
Parameter Estimates from Main Model

Parameter	Estimate	Asy. t-ratio
b_y	0.0535	20.57
b_p	- 0.5307	- 14.99
b_t	- 0.0212	- 7.58
b_w	- 0.0287	- 11.95
b_b	- 0.0231	- 11.44
b_{FCA2}	- 0.0972	- 3.07
b_{FCA3}	- 0.2599	- 7.653
b_{FCA4}	- 0.5215	- 12.92
b_{FCA5}	- 0.6017	- 15.80
b_{FCA6}	- 0.5303	- 13.08
b_{FCA7}	- 0.7660	- 18.91
b_{FCA8}	- 1.0581	- 23.40
b_{FCA9}	- 1.1616	- 24.79
g_0	- 1.1420	- 34.40
s_{0-e}	5.5540	33.15[a]
s_{0-G}	3.5257	17.32[a]
n	647	
$Log - L$	- 19.25833	

a. t-statistics apply to the logged parameter estimates.

The parameters s_{0-e} and s_{0-G} are the standard deviations of the differences $e_{ij}^{0} - e_{ij}^{k_{ij}}$ and $e_{ij}^{0} - e_{ij}^{G}$, respectively. They allow for nonzero covariances (s_{e0} and s_{G0}) between the random components (see Section A.3).[1]

B.5 MEASURES OF GOODNESS-OF-FIT

To assess goodness-of-fit we examine three items based on SP data and two items based on a combination of SP and RP data: 1) the conventional 2 x 2 table of predicted versus actual choices, 2) a pseudo-R^2 calculation, 3) the distribution of the predicted probability of going to a chosen site, 4) a comparison of the stated number of expected days to a chosen Green Bay alternative with the estimated number of Green Bay days to that alternative, and 5) a comparison of the mean number of days to chosen alternatives to the actual mean Green Bay days under current conditions from the RP data.

1. We adopt the convention that a probability greater than 0.5 is a correct prediction. The prediction rate is high: the model predicts choices correctly 73% of the 5,038 occasions (the sum of the diagonal elements of Table B-3). Table B-3 contains the comparison of actual versus predicted choices (in percentage terms).

Table B-3
Predicted vs. Actual Choices — Number (%)

	Predicted A	Predicted B
Chose A	2,270 (45%)	809 (16%)
Chose B	544 (11%)	1,415 (28%)

2. A pseudo-R^2 measure of goodness-of-fit can be calculated for this discrete data (see Maddala, 1983, pp. 76-77) using the counts from Table B-3 and their row and column sums. Normalized on the unit interval, it is equal to 0.435, which is very reasonable for cross-sectional data.

1. Alternatively, one could estimate a model with covariances assumed to be zero. With this restriction, s_0 and s_G (the standard deviations of the respective random components) are separately identified (otherwise they are not), and the estimated value of s_G could be compared to the fixed value of s_e to get a notion of the relative amounts of noise in the RP and SP data. However, this is only possible under the assumption that the random components are uncorrelated. In fact, preliminary analysis implied that the covariances are not zero, so the more general model that allows for this correlation statistically dominates.

3. The mean predicted probability of the preferred alternative from the stated preference experiment is 0.63, with a standard deviation of 0.22. This is calculated over 647 individuals x 8 experiments = 5,176 - 138 missing = 5,038 observations.

In Table B-4, the percentage of pairs that alternative A is actually selected is presented for different ranges of the predicted probability of selecting alternative A. These values show that an alternative is infrequently chosen when its probability of being chosen is small, and frequently chosen when its probability is high. For example, when the predicted probability of selecting alternative A is less than 0.1, A is chosen in only 5% of the pairs; but when the predicted probability is greater than 0.9, A is chosen in almost all of the pairs, 96%.

Table B-4
Predicted Probabilities for Alternative A and the Percent of Pairs A Is Selected

Predicted Probability of Alternative A	Percent of Pairs in Each Range from which Alternative A Selected
0-0.1	5.49%
0.1-0.2	18.29%
0.2-0.3	24.74%
0.3-0.4	34.99%
0.4-0.5	45.83%
0.5-0.6	55.47%
0.6-0.7	65.33%
0.7-0.8	74.57%
0.8-0.9	84.16%
0.9-1.0	96.15%

4. Respondents indicate the number of days they would spend at Green Bay if conditions at Green Bay were the same as their chosen alternative. The parameter estimates from the model can be used to predict the conditional probability of choosing Green Bay under the hypothetical conditions over the individual's other (real) choices. This is Equation 6 in Appendix A. Multiplying this probability by the actual number of open-water days for the respondent produces an estimate of the number of Green Bay days under hypothetical conditions. The means (standard deviations) of the indicated number of Green Bay days (truncated to be no larger than the total days at all sites for each angler) and estimated number of days are 12.0927 (14.8531) and 12.0917 (12.2885), respectively. The closeness

of these numbers means that the model estimates are in accord with the SP frequency data. While the means are very close, there is substantial variation. Table B-5 is a histogram of the differences across the chosen alternatives. For example, the difference between reported and estimated Green Bay days is between ± 4.5 for almost half of the alternatives (48.7%).

Table B-5
Difference between Reported and Estimated Green Bay Days

Difference	Frequency (%)
< -20	267 (5.2%)
-20 to -15	156 (3.0%)
-15 to -10	290 (5.8%)
-10 to -4.5	507 (10.0%)
-4.5 to -3.5	97 (1.9%)
-3.5 to -2.5	126 (2.5%)
-2.5 to -1.5	157 (3.1%)
-1.5 to -0.5	179 (3.6%)
-0.5 to 0.5	507 (9.8%)
0.5 to 1.5	442 (8.8%)
1.5 to 2.5	454 (9.0%)
2.5 to 3.5	348 (6.9%)
3.5 to 4.5	157 (3.1%)
4.5 to 10	851 (16.9%)
10 to 15	360 (7.1%)
15 to 20	145 (2.9%)
> 20	133 (2.6%)

5. The estimated mean number of expected days to the chosen Green Bay alternatives (12.09) is larger than the reported number of days (9.95). Because current conditions are, on average, inferior to the average conditions over the chosen alternatives, this result shows that model estimates are consistent with actual behavior.

The probability of going to Green Bay under current conditions is estimated by the model at 0.40, which when multiplied by the total number of days is exactly equal to the actual number of Green Bay days: 9.95. This is required by the choice of statistical model for number of days (binomial). The standard deviation of the number of days in the data is 14.10, compared to 9.91 for the distribution of the predictions.

B.6 USING THE MODEL

The model can be used to estimate how the probability of fishing Green Bay will change (and hence how the number of days fishing Green Bay will change, holding constant total fishing days) from either a change in catch times or FCA levels. This is done with Equation 9 in Appendix A, repeated here:

$$P_i^G = F\,[(b\,'(x_i^G - x_{ij}^0)\,/\,s_{\,0-G}\,], \tag{4}$$

employing estimates for b and $s_{\,0-G}$. For example, suppose there is an hour increase in the time it takes to catch a perch. The argument of the normal CDF in Equation 4 would then decrease by 0.5307/12.43 = 0.04270, causing a 40% chance of going to Green Bay to decrease to about 38%. Reducing the FCA level from four to one causes the 40% probability of going to Green Bay to increase to about 46% (and the mean number of days to increase 14.5%). Table B-6 provides some behavioral responses to site changes.

Table B-6
Behavioral Response to Changes in Site Characteristics

Change in Site Characteristic	Change in Probability of Going to Green Bay	Change in Mean Number of Green Bay Days
$FCA_4 \rightarrow FCA_1$	40% → 46%	14.5%
$FCA_3 \rightarrow FCA_1$	43%→ 46%	6.8%
$FCA_2 \rightarrow FCA_1$	45% → 46%	2.4%
Double perch catch rate	40% → 42%	5.5%
Quadruple perch catch rate	40% → 43%	8.3%
Multiply perch catch by 10	40% → 44%	10.0%
Double all catch rates	40% → 47%	19.1%

For example, holding constant other site characteristics, the probability of going to Green Bay would increase by 6% if FCAs were eliminated. However, at an existing FCA Level of four, doubling the catch rate for perch would only cause a 2% increase in the probability of going to Green Bay.

The model can also be used to estimate compensating variation resulting from changes in catch rates, fees, or FCA levels (Appendix C).

APPENDIX C
ESTIMATED COMPENSATING VARIATIONS AND EXPECTED COMPENSATING VARIATIONS

C.1 INTRODUCTION

This appendix derives two lower-bound estimates of the aggregate compensating variation for different improvements in the characteristics of Green Bay. An estimate is "lower-bound" if it is an estimate of only a subset of the damages. One of these lower-bound estimates is smaller than the other because it is an estimate of a smaller subset of the damages.

The improvements considered will be for reductions in FCAs and increases in catch rates. Specifically, we estimate individual *i*'s compensating variation for an improvement in the characteristics of Green Bay for a *Green Bay fishing day*. In addition, we estimate individual *i*'s expected compensating variation for an improvement in the characteristics of Green Bay for a *fishing day*. Note that fishing days in the latter case include *all* open-water fishing days, including those to Green Bay and those to other sites.

Denote individual *i*'s expected compensating variation for a season for a change in the characteristics of Green Bay, $E\left(CV_i\right)$. Individual *i*'s $\mathrm{E}\left(CV_i\right)$ for the elimination of Green Bay FCAs is the expected value of the yearly damages to individual *i* from the FCAs. Aggregating these over all individuals, one obtains the expected value of total damages per year from Green Bay PCBs and the resulting FCAs. We do not estimate this; rather we report a lower-bound estimate of these total damages. It is a lower-bound estimate for two reasons: it does not include all of the potential components of each impacted individual's damages, and it does not include all potentially impacted individuals.

Denote individual *i*'s expected compensating variation for a fishing day for a change in the characteristics of Green Bay, $\mathrm{E}\left(CV_i^F\right)$, and denote individual *i*'s compensating variation for a Green Bay fishing day for a change in the characteristics of Green Bay, CV_i^G. The estimated CV_i^G and $\mathrm{E}\left(CV_i^F\right)$, along with estimates of the current number of fishing days and Green Bay fishing days by a subset of those who currently fish Green Bay, will be used to obtain two lower-bound estimates of WTP for the elimination of FCAs for this target population.

For an improvement in Green Bay , CV_i is how much the angler would pay per season (year) for the improvement, whereas CV_i^G is how much the angler would pay per Green Bay fishing day for the improvement, and CV_i^F is how much the angler would pay per fishing day. Note that for an improvement in Green Bay, $0 \le CV_i^F \le CV_i^G$, and for a deterioration in Green Bay,

$CV_i^G \leq CV_i^F \leq 0$. An angler will pay no more per fishing day to have the FCAs at Green Bay reduced than he would pay per Green Bay fishing day because all fishing days are not necessarily to Green Bay.

Explaining further, CV_i^G is individuals *i*'s compensating variation per Green Bay fishing day for an improvement in the conditions of Green Bay. There is no question as to where the angler will fish on a Green Bay fishing day: it is Green Bay. In contrast, CV_i^F is individuals *i*'s compensating variation per fishing day for an improvement in the conditions of Green Bay given that the individual can choose to fish either Green Bay or elsewhere.

For an improvement in Green Bay conditions:[1]

$$CV_i^G \times D_i^{G^0} \leq CV_i^F \times D_i^{F^0} \leq CV_i\ , \tag{1}$$

where $D_i^{G^0}$ is the number of days in a season individual *i* fishes Green Bay under current (injured) conditions, and $D_i^{F^0}$ is the number of days individual *i* fishes (all sites) under current conditions (Morey, 1994).

$(CV_i^G \times D_i^{G^0})$ would be individual *i*'s seasonal compensating variation if he were constrained to fish Green Bay the same number of days with the improvement as he did in the injured state. $CV_i^G \times D_i^{G^0} \leq CV_i$ because he has the ability to take greater advantage of the improvement by increasing the number of days he fishes Green Bay. $(CV_i^F \times D_i^{F^0})$ would be individual *i*'s compensating variation if he were constrained to fish the same total number of days with the improvement as he did in the injured state. $CV_i^F \times D_i^{F^0} \leq CV_i$ because he has the ability to take advantage of the improvement by increasing the number of days he fishes.

$CV_i^G \times D_i^{G^0} \leq CV_i^F \times D_i^{F^0}$ because an individual who is constrained to fish Green Bay the same number of days both before and after Green Bay is improved is more constrained in his ability to take advantage of the improvement than an individual constrained to fish the same number of total days both before and after Green Bay is improved. The latter constraint allows the individual to increase his days to Green Bay by reducing the days to other sites if this makes him better off, whereas the former constraint does not.

1. Given the model, CV^F and CV^G are constants independent of the individual's number of fishing days and Green Bay fishing days. This follows from the assumption that the utility from a fishing day (Green Bay fishing day) is not a function of the number of fishing days (Green Bay fishing days) — see Equations 1 and 3 in Appendix B. In this case, any quality increase can be represented by an equivalent price decrease, and Equation 1 (in this appendix) holds if the marginal utility of money is positive, which it is. That is, Equation 1 holds because the angler will not decrease fishing days if Green Bay improves in quality.

C.2 ESTIMATED COMPENSATING VARIATION PER GREEN BAY FISHING DAY

Typically when estimating compensating variations, the expected value of the compensating variation is estimated rather than the compensating variation itself, because the compensating variation depends on unobservable stochastic terms, so it is a random variable. However, if there is only one alternative in each state of the world, the compensating variation is not a random variable. Since CV_i^G is per Green Bay fishing day and since the only alternative is Green Bay, CV_i^G is not a random variable and can be estimated as $CV_i^G = \mathrm{E}(CV_i^G)$.[2] This is because the random component(s) cancel out of the *CV* formula when the individual chooses the same alternative in each state.[3] In discrete choice models without income effects, the compensating variation can be written as the difference between the maximum utility in the two states multiplied by the inverse of the constant marginal utility of money (see Hanemann, 1984; and Morey, 1999):

$$\begin{aligned} CV_i^G &= \frac{1}{b_y}\left(U_i^{G^1} - U_i^{G^0}\right) = \frac{1}{b_y}\left[\left(b' x_i^{G^1} + e_{id}^G\right) - \left(b' x_i^{G^1} + e_{id}^G\right)\right] \\ &= \frac{1}{b_y}\left(b' x_i^{G^1} - b' x_i^{G^1}\right) \end{aligned} \tag{2}$$

where $U_i^{G^1}$ is the utility from a Green Bay fishing day in the improved state, and $U_i^{G^0}$ is the utility in the current state; that is, G^1 denotes Green Bay under improved conditions and G^0 denotes Green Bay under current conditions.[4]

In addition, $x_i^G = x^G \; \forall \; i$, so:

$$CV_i^G = CV^G \; \forall \; i \tag{3}$$

That is, everyone one has the same CV^G, which we can calculate.[5] The estimate is reported in Chapter 8.

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2. Estimated CV_i^F is a random variable.

3. For details, see Morey (1999), p. 103.

4. Note that any scaling of b in estimation will cancel out of Equation 2.

5. In Appendix D, we consider preference heterogeneity.

C.3 A LOWER-BOUND ESTIMATE OF DAMAGES

Equations 1 and 3 imply:

$$CV^{G} \times D^{G^{0}} \leq N \times CV \qquad (4)$$

where N is the number of individuals in the target population and $D^{G^{0}}$ is the number of Green Bay fishing days by the target population under current conditions, so $(CV^{G} \times D^{G^{0}})$ is a lower-bound estimate of the recreational fishing damages to the target population. The 1998 estimate is reported in Chapter 8.

C.4 EXPECTED COMPENSATING VARIATION PER FISHING DAY

Since CV_i^F is per fishing day and on each fishing day the angler has the choice of two sites: Green Bay or elsewhere, CV_i^F is a function of unobservable stochastic components, and so cannot be estimated. Instead we estimate its expectation:

$$\mathrm{E}\left(CV_i^F\right) = \frac{1}{b_y}\left[\mathrm{E}(\max(U_i^{G^1}, U_i^O)) - \mathrm{E}(\max(U_i^{G^0}, U_i^O))\right] \qquad (5)$$

where U_i^o is the utility from fishing at another site. Given that U_i^G and U_i^o are bivariate normal:

$$\mathrm{E}\left(\max(U_i^G, U_i^O)\right) = g_0 + (b' x_i^G - g_0)\Phi\left(\frac{b' x_i^G}{s_{0-G}} - \frac{g_0}{s_{0-G}}\right) + s_{0-G} f\left(\frac{b' x_i^G}{s_{0-G}} - \frac{g_0}{s_{0-G}}\right) \qquad (6)$$

where $\Phi(\cdot)$ is the univariate standard normal cumulative distribution function, $f(\cdot)$ is the standard normal density function (Maddala, 1983, p. 370), and $s_{0-G}^2 = \mathrm{Var}[e_{ij}^0 - e_{ij}^G] = s_0^2 + s_G^2 - 2s_{G0}$ (see Appendix A).

Substituting Equation 6 into 5, and simplifying it one obtains:

$$\begin{aligned} &\mathrm{E}(CV_i^F) \\ &= \frac{1}{b_y}\Big[(b' x_i^{G^1} - g_0) F\left(\frac{b' x_i^{G^1} - g_0}{s_{0-G}}\right) + s_{0-G} f\left(\frac{b' x_i^{G^1} - g_0}{s_{0-G}}\right) \\ &- (b' x_i^{G^0} - g_0) F\left(\frac{b' x_i^{G^0} - g_0}{s_{0-G}}\right) - s_{0-G} f\left(\frac{b' x_i^{G^0} - g_0}{s_{0-G}}\right)\Big] \end{aligned} \qquad (7)$$

Since, in this model, $x_i^G = x^G \ \forall \ i$, $E\left(CV_i^F\right) = E(CV^F) \ \forall \ i$. The estimate of $\mathrm{E}(CV^F)$ is reported in Chapter 8.

C.5 A SECOND LOWER-BOUND ESTIMATE OF DAMAGES

Returning to Equation 1, consider the inequality $CV_i^F \times D_i^{F^0} \leq CV_i$.

Taking the expectation of both sides and noting that $D_i^{F^0}$ is exogenous:

$$\mathrm{E}(CV_i^F) \times D_i^{F^0} \leq \mathrm{E}(CV_i) . \tag{8}$$

Since $E(CV_i^F) = E(CV^F) \ \forall \ i$,this simplifies to $\mathrm{E}(CV^F) \times D_i^{F^0} \leq \mathrm{E}(CV_i)$. Summing over individuals, one obtains:

$$\mathrm{E}(CV^F) \times D^{F^0} \leq \sum_{i=1}^{N} \mathrm{E}(CV_i) \ , \tag{9}$$

where D^{F^0} is the number of Green Bay fishing days by the target population under current conditions, so $\left[\mathrm{E}(CV^F) \times D^{F^0}\right]$ is a second lower-bound estimate of the recreational fishing damages to the target population. It is less constrained than the first estimate, so it is expected to be larger than the first lower-bound damage estimate. Anglers value improvements in Green Bay more highly when they can fish it more. The 1998 estimate is reported in Chapter 8.

APPENDIX D
MODEL VARIATIONS

This appendix presents model variations and reports estimation results. In Section D.1 models explaining choices from the alternative pairs using only the SP data are derived. These models assume both homogeneous and heterogeneous preferences. In Section D.2, heterogeneous preferences are introduced into the full model covered in Appendix B. A general finding in all of these variations is that using only SP choice data or allowing for preferences to vary across individuals has little effect on estimated mean damages from FCAs — in most models mean damages do not vary significantly from each other. The notable exceptions are the random parameters specifications and a specification that allows the marginal utility of money to vary with individual characteristics, both giving higher damage estimates.

Estimated mean compensating variations for many of the models discussed in detail below are summarized in Table D-1 for a change in FCA level from Level 4 to Level 1 (no FCAs). The estimated mean CV^G is reported for all models,[1] and the estimated mean $E(CV^F)$ is reported for the models allowing substitution in and out of Green Bay to other sites. Recall that the estimated mean CV^G for the full model with no heterogeneity is $9.75, and the estimated mean $E(CV^F)$ is $4.17. Along with mean consumer surplus, 95% confidence intervals for the means are reported. These ranges were simulated using 500 parameter draws from the estimated variance-covariance matrix.

Mean predicted Green Bay days under current and baseline conditions are also presented in Table D-1 for all of the models allowing substitution from other sites. They are computed by multiplying the model predicted probability of fishing Green Bay under current conditions by observed 1998 open-water fishing days at all sites in 1998, so total days are held constant.[2] All models closely predict the current mean: over the sample, the mean is 10.0, and predictions range from 10.0 to 10.9. The models are roughly consistent in predicting how mean days will increase with cleanup. Predictions in increased days range from 0.4 to 1.2 days; that is, the increases in percentage terms are from 4% to 15%.

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1. For the random parameters models, estimated mean $E(CV^G)$ is reported.

2. If instead of using the 1998-level catch rates (recall that the catch rate is the reciprocal of the average time to catch a fish), the 13-year averages from 1986 to 1998 were used, predicted days and consumer surplus per fishing day would increase by about 16%. Therefore, using the 1998 levels results in conservative estimates of days and damages.

Table D-1
Summary of Estimated Mean Compensating Variations from Green Bay Models: FCA Level 4 to No FCAs

	Mean CV per Green Bay Fishing Day[a]			Mean E(CV) Fishing Days[a,d]			Predicted Green Bay Days	
	All[b]	Near[c]	Far[c]	All[b]	Near[c]	Far[c]	Current[d]	Baseline[d]
Full model								
No heterogeneity	**$9.75** ($0.0) [$8.06-$11.73]	NA	NA	**$4.17** ($0.0) [$3.41-$5.00]	NA	NA	10.0	11.4
Classic heterogeneity in V_O only[e]	$10.46 ($0.0) [$8.79-$12.35]	NA	NA	$4.49 ($0.72) [$3.96-$5.75]	$4.63	$3.59	10.1	11.4
A-B-other								
Classic heterogeneity in V_O only[e]	$9.57 ($0.0) [$7.57-$11.75]	NA	NA	$4.35 ($0.58) [$3.48-$5.26]	$4.45	$3.68	10.9	11.8
Classic heterogeneity in A-B parameters only[f]	$9.31 ($1.47) [$7.73-$11.68]	$9.20	$10.68	$4.16 ($1.55) [$3.46-$5.27]	$4.29	$3.40	10.4	11.6
A-B								
No heterogeneity	$10.29 ($0.0) [$8.10-$13.22]	NA	NA	NA	NA	NA	NA	NA
Classic heterogeneity[f]	$10.15 ($1.72) [$7.99-$12.51]	$10.23	$9.17	NA	NA	NA	NA	NA
Random heterogeneity (normal)[g]	$12.90 ($0.0) [$8.70-$15.75]	NA	NA	NA	NA	NA	NA	NA
Random heterogeneity (lognormal)[h]	$17.67 ($0.0) [$12.63-$24.72]	NA	NA	NA	NA	NA	NA	NA

a. Weighted average (weighting is by actual days at all sites or Green Bay days) in all models with classic heterogeneity.
b. Standard deviation across sample in parentheses. 95% numerically-simulated confidence interval in brackets.
c. "Near" means shortest driving distance is within the eight targeted counties: 73 mi. "Far" is for households farther than 73 mi.
d. The average time to catch a fish is set at the 1998 level for all species.
e. Utility for *other* (V_O) is a linear function of distance and gender. No classic heterogeneity in A-B parameters.
f. FCA and catch parameters are linear functions of distance and gender.
g. FCA and catch parameters are normally distributed. Results reported for Hermite quadrature using 9 evaluation points. Expected *CV* is reported.
h. FCA and catch parameters are lognormally distributed. Results reported for simulation using 500 draws. Expected *CV* is reported.

D.1 A-B MODELS USING ONLY THE SP DATA FROM THE A-B CHOICE QUESTIONS

In this section models are presented that explain only the choices from the pairs of Green Bay alternatives with different site characteristics, conditional on fishing Green Bay. Only the SP data on site selection from the choice pairs (A versus B) are used; none of the SP or RP data on planned or actual numbers of Green Bay days are used. These models are called A-B models, and while their parameter estimates are consistent, the omission of the additional data on days reduces efficiency of the estimates. Further, because the A-B model does not allow substitution out of Green Bay fishing to other sites, only the *CV* per Green Bay fishing day, CV^G, can be estimated, as was explained in Appendix C.

D.1.1 A-B Model with Homogeneous Preferences

Initially, consider an A-B model with preferences that do not vary across individuals. Assume that the indirect utility function for the choice pairs is identical to that of the full model developed in Appendix B (see Equation 1 in Appendix B). The likelihood function is simply the portion of the likelihood in Appendix A that explains choice of alternative from the SP pairs:

$$L(k_{ij}, i=1,\ldots,m, j=1,\ldots J | x_{ij}^1, x_{ij}^2, b, s_e) = \prod_{i=1}^{m} \prod_{j=1}^{J} P_{ij}^{k_{ij}} \qquad (1)$$

To estimate this model, s_e was fixed at $\sqrt{1/2}$. As a result, the expression $\sqrt{2}s_e$ disappears from the likelihood. Parameter estimates and the asymptotic *t*-statistics are presented in Table D-2. The estimated model predicts approximately 73% of the pairs correctly, and all of the parameters are statistically significant with the expected sign. Also, the parameter estimates are similar to the A-B estimates from the full model (Appendix B). The calculation of CV^G for all A-B models with no income effects is explained in Appendix C.

For a change in FCAs from current Level 4 to no FCAs results in an estimated mean CV^G of $10.29, which does not vary across anglers. This value is only 6% higher than the value from the full model of $9.75. However, the reduction in efficiency in the A-B estimate is reflected in the simulated 95% confidence interval of the mean CV^G: $8.10 to $13.22 for the A-B model, as compared to $8.13 to $11.81. The confidence interval for the A-B model is wider on the high end.

Table D-2
Parameter Estimates from Nonrandom A-B Models

Parameter\Model	Homogeneity	Heterogeneity
	Estimated Parameters (asymptotic *t*-statistics)	
Homogeneous parameters		
β_y	0.0459 (16.891)	0.0466 (15.381)
β_p	-0.5211 (-16.673)	-0.4707 (-4.904)
β_t	-0.0281 (-8.732)	-0.0285 (-3.472)
β_w	-0.0363 (-11.703)	-0.0192 (-2.447)
β_b	-0.0310 (-9.998)	-0.0310 (-3.787)
β_{FCA2}	-0.1770 (-3.672)	-0.2351 (-3.517)
β_{FCA3}	-0.2437 (-4.942)	-0.3210 (-4.935)
β_{FCA4}	-0.4724 (-9.652)	-0.6388 (-9.219)
β_{FCA5}	-0.6698 (-13.703)	-0.8897 (-12.240)
β_{FCA6}	-0.4533 (-8.958)	-0.6030 (-8.975)
β_{FCA7}	-0.7890 (-17.484)	-1.0494 (-12.729)
β_{FCA8}	-1.0772 (-22.733)	-1.4622 (-13.316)
β_{FCA9}	-1.1872 (-21.733)	-1.5970 (-13.866)
Heterogeneous parameters		
β_{pg}		-0.1398 (-1.321)
β_{tg}		0.0031 (0.351)
β_{wg}		-0.0214 (-2.491)
β_{bg}		-0.0008 (-0.086)
β_{FCAg}		-0.2868 (-4.706)
β_{pd}		8.667e-4 (3.574)
β_{td}		-3.455e-5 (-1.594)
β_{wd}		2.424e-6 (0.109)
β_{bd}		1.091e-5 (0.598)
β_{FCAd}		-2.981e-4 (1.944)

D.1.2 Investigating Learning/Fatigue and Positioning Bias

The A-B model with no heterogeneity was then modified to examine whether *learning* or *fatigue* effects exist, and whether there is *positioning bias* toward the A (i.e., the first) alternative. As the respondent gains knowledge and understanding of the survey process, the learning effect may express itself through a decrease in the stochastic variance s_e^2 for initial choice pairs as compared to later ones. Recollect there was a practice pair that was not included in estimation. Similarly, if there are a large number of survey choice pairs, a fatigue effect may set in as the respondent tires of the data elicitation process. This effect may be manifested as an increase in noise for choice pairs toward the end of the process.

Two A-B methods were employed to investigate the presence of learning and fatigue. First, a model was estimated in which s_e was fixed at $\sqrt{1/2}$ for the middle four choice pairs ($j \in [3, 4, 5, 6]$), but s_e was separately estimated as an unrestricted parameter for the first two choice pairs ($j \in [1, 2]$) and the last two ($j \in [7, 8]$). Results suggest weak but statistically insignificant learning and fatigue effects. As compared to 0.707 (= $\sqrt{1/2}$), estimated $s_{ej}, j \in [1,2]$, equals 0.936, and estimated $s_{ej}, j \in [7,8]$, equals 1.052. Based on a likelihood ratio test, the null hypothesis that variances are equal across the choice occasions cannot be rejected. CV^G for this model is $9.99, which is only 2% higher than the estimate from the model with all variances restricted to be the same.

The second method fixes s_e at $\sqrt{1/2}$ for all of the choice occasions, but allows b to vary in an unrestricted fashion over the three choice-occasion groups. This method is less restrictive than the previous method. If *parameter proportionality* holds, where b only varies across choice occasions by a factor of proportionality, learning and fatigue would be evident if the elements of b were all bigger for $j \in [3, 4, 5, 6]$ than for the first two or last two choices. Because s_e is fixed in estimation at the same value for all three groups, and because only the ratio of b and s_e is identified in estimation, more noise would show up as smaller values for b. The results from the three independently estimated models show that parameter proportionality does not hold, because b does not vary systematically across the choice occasions. A likelihood ratio test indicates that b is not proportional across choice occasions at conventional significance levels. However, there is some moderate evidence of fatigue, although no evidence of learning. The estimated CV^G, a weighted average across the choice-occasion groups, is $10.94, which is 12% higher than the estimate from the model restricting b to be the same across choice occasions. As a result, we maintain that $9.75 is a conservative estimate of damages per day. The CV^G estimates separately for the groups are $8.65 for the early choice occasions, $15.02 for the middle choice occasions, and $5.06 for the later choice occasions. Note that relative to the $9.75 estimate from the main model, these are all imprecise estimates.

Finally, an A-B model with no heterogeneity was estimated that included a dummy variable for whether the alternative selected was the first presented, alternative A. This variable was a statistically insignificant determinant of choice, so the null hypothesis of no positioning bias could not be rejected.

D.1.3 A-B Models with Heterogeneous Preferences: Interaction

In this section, A-B model parameters are allowed to interact with observed individual socioeconomic characteristics, the "classic" method of admitting heterogeneous preferences. Consequently, CV_i^G also varies as a function of characteristics. While marginal utilities for changes in site characteristics and consumer surplus vary in plausible ways as a function of individual attributes, we also find that estimated mean CV^G for the sample is quite comparable to that from the full model or to the A-B model with no heterogeneity. Incorporating heterogeneity at the A-B level appears to have little effect on mean damages (see Table D-1).

Preliminary analyses and simple statistics for the sample suggested that the A-B choices vary with gender and distance from Green Bay. Other socioeconomic characteristics were not as important in the preliminary analysis. Therefore, the effects of catch and FCAs were modeled as functions of those two variables. The set of FCA marginal utilities is assumed to vary proportionately as a function of individual characteristics. For example, FCA effects for men are all decreased by the percentage β_{FCAg} (see Equation 2 below) compared to women. The likelihood function is the same as in Section D.1.1, with the only exception that $V_{ij}^{k_{ij}}$ now includes interactions with individual characteristics. Specifically:

$$
\begin{aligned}
V_{ij}^{k_{ij}} &= b_y(-FEE_{jk}) + \sum_{l=1}^{4} ACT_{ljk}[b_l + b_{lg}(GEND_i) + b_{ld}(DIST_i)] \\
&+ \sum_{q=2}^{9} FCAq_{jk}[b_{FCAq} + b_{FCAg}b_{FCAq}(GEND_i) + b_{FCAd}b_{FCAq}(DIST_i)],
\end{aligned} \tag{2}
$$

where l indexes the fish species for catch (l = 1, ..., 4), ACT_l is the average time to catch species l, q indexes the FCA levels (q = 2, ..., 9; β_{FCA1} is fixed at zero for identification), FEE_{jk} is the launch fee for alternative k in pair j, $GEND_i$ equals one if angler i is a male, and $DIST_i$ is the closest distance to Green Bay from either angler i's vacation cabin or home.

This model was found to be statistically superior to the homogeneous A-B model on the basis of a likelihood ratio test, although the proportion of choices predicted correctly did not change appreciably. Parameter estimates are reported in Table D-2. The effects of FCAs and catch for some species were found to vary significantly as a function of gender and distance from Green Bay. Women were found to have larger FCA effects (in absolute value) and therefore larger damages.[3] They care more about FCAs than men. Conversely, men were found to have a larger

3. For example, the mean CV^G for a change from FCA Level 4 to no FCAs for individuals living five miles away is \$13.68 for women and \$9.75 for men. Note that the mean compensating variations for all classic heterogeneous models reported in this appendix are weighted means, where the weights used were either the individual's proportion of the sample number of days to Green Bay in 1998 for CV^G or the proportion of the sample number of days to all sites in 1998 for E(CV^F). These weights were used because we estimate CV per Green Bay fishing day or per fishing day, not per angler.

marginal utility for catching walleye. Marginal utilities for perch catch and FCAs decrease with distance, while the marginal utility for trout and salmon catch increases with distance at a marginal significance level (the *t*-statistic is -1.59). For those traveling to Green Bay from within the eight targeted counties (within 73 miles), the mean CV^G is $10.23, while for those farther away it is $9.17. Over the entire sample, the mean is $10.15, with a standard deviation of $1.72. The simulated 95% confidence interval for mean CV^G is $7.99 to $12.51. Note that this mean is only 4% higher than the mean from the full model.

Other interaction specifications were run as well, and while some of these generalizations were statistically significant, uniformly they do not lead to statistically or substantively different estimates of mean consumer surplus. For example, the effects of FCAs and catch on utility were also allowed to vary as a function of the angler's target species. The effects on utility of catch changes for all four of the target species are all greater for the respective target anglers, and perch and walleye anglers care more about FCAs than other target anglers or anglers who have no target.[4] The effect on damages was small, however. Effects on utility from FCAs and catch were not found to vary significantly as a function of the actual number of Green Bay days.[5] Finally, marginal utility of money was allowed to vary across gender and income groups; males and the wealthy have a significantly lower marginal utility of money. This specification led to a higher estimate of the weighted mean CV^G, $12.36 (27% higher than $9.75). However, the simulated confidence interval on mean CV^G was quite large, [-$19.34 to $35.98], because some draws of the price parameter for affluent males using the estimated covariance matrix are very small and even have the wrong sign. Therefore, it is not possible to conclude that $12.36 is significantly higher than $9.75.

D.1.4 A-B Model with Heterogeneous Preferences: Random Parameters

Two primary issues have motivated the use of random parameters in modeling consumer choice. First, random parameters provide a way to induce correlation in the stochastic components of utility within pairs of alternatives and across an individual's choice occasions. Hausman and Wise (1978) were the first to model explicitly correlated disturbances. Second, random parameters allow for preference heterogeneity across individuals without having to model heterogeneity explicitly as a function of individual covariates. Note that the estimates from our main model,

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4. Note that target is correlated with distance (a much higher percentage of yellow perch anglers live close to Green Bay, and a much higher percentage of salmonid anglers live farther away). An angler is defined here as a target angler for a species if he fishes for that species "often" or "almost always," and does not fish for any other species "often" or "almost always."

5. Along these lines, omitting extremely avid anglers with a large number of days from the data set prior to estimation was also not found to have a notable or significant effect on parameter or per-day consumer surplus estimates.

which does not explicitly model correlation across pairs, are consistent in the presence of such correlation.

Random parameters have been used to model choice-experiment data for a wide array of commodities and environmental amenities, including alternative-fuel vehicles (Brownstone and Train, 1999); appliance efficiency (Revelt and Train, 1998); forest loss along the Colorado Front Range resulting from global climate change (Layton and Brown, 1998); and the level of preservation of marble monuments in Washington, DC (Morey and Rossmann, 1999). Three recreational site-choice examples using simulation with revealed preference data are a partial demand system of fishing site choice in Montana (Train, 1998), and complete demand systems of participation and site choice for Atlantic salmon fishing (Breffle and Morey, 1999) and fishing in the Wisconsin Great Lakes region (Phaneuf et al., 1998).

Model Specification

The random parameters A-B model for Green Bay fishing explicitly estimates the correlation between disturbances within pairs and across choice occasions, in the spirit of Hausman and Wise (1978). Assumption 2 from Appendix A is maintained, but assumption 1 is now replaced by:

$$b_i = b + u_i, u_i \text{ i.i.d.} \sim N(0, \Sigma) \tag{3}$$

where υ_i is an $L \times 1$ random vector that represents heterogeneity of preferences across individuals.[6] An individual's marginal utility of an alternative's characteristic differs from the average by an additive, mean-zero random variable assumed uncorrelated with the model disturbance. All J pairs are evaluated by the individual with these marginal utilities. Then:

$$U_{ij}^{k_{ij}} = b_i' x_{ij}^{k_{ij}} + e_{ij}^{k_{ij}} = b' x_{ij}^{k_{ij}} + (u_i' x_{ij}^{k_{ij}} + e_{ij}^{k_{ij}}), \tag{4}$$

where the new model disturbance is in parentheses. It is straightforward to find the correlation between these disturbances (and hence the utilities) within a pair and across pairings for each individual. Within a pair we have:

$$\text{E}[(u_i' x_{ij}^1 + e_{ij}^1)(u_i' x_{ij}^2 + e_{ij}^2)] = (x_{ij}^1)' S \, (x_{ij}^2), \tag{5}$$

and from pair j to pair l we have:

$$\text{E}[(u_i' x_{ij}^{k_{ij}} + e_{ij}^{k_{ij}})(u_i' x_{il}^{k_{il}} + e_{il}^{k_{il}})] = (x_{ij}^{k_{ij}})' S \, (x_{il}^{k_{il}}). \tag{6}$$

6. This is the usual formulation for the random coefficients model. See Hildreth and Houck (1968), Swamy (1970), and Hsiao (1975).

With correlation allowed, it is now more convenient for the unit of observation to be the individual (i), not the individual-pair (i, j) as in the nonrandom model. The probability of observing the vector of J pair-wise choices is a J-dimensional multinormal probability:

$$P_i = P(K_{i1} = k_{i1},\ldots,K_{iJ} = k_{ij}) = P(U_{i1}^{k_{i1}} > U_{i1}^{3-k_{i1}},\ldots,U_{iJ}^{k_{iJ}} > U_{iJ}^{3-k_{iJ}}). \qquad (7)$$

Substituting the random utility model and the specification for the β_i (Equation 3) into Equation 7 yields, after some rearranging:

$$\begin{aligned}
&P_i = P(K_{i1} = k_{i1},\ldots,K_{iJ} = k_{ij}) = \\
&P[(u_i' x_{i1}^{3-k_{i1}} + e_{i1}^{3-k_{i1}}) - (u_i' x_{i1}^{k_{i1}} + e_{i1}^{k_{i1}}) < -b'(x_{i1}^{3-k_{i1}} - x_{i1}^{k_{i1}}), \\
&(u_i' x_{i2}^{3-k_{i1}} + e_{i2}^{3-k_{i1}}) - (u_i' x_{i2}^{k_{i1}} + e_{i2}^{k_{i1}}) < -b'(x_{i2}^{3-k_{i1}} - x_{i2}^{k_{i1}}), \\
&\vdots \\
&(u_i' x_{iJ}^{3-k_{iJ}} + e_{iJ}^{3-k_{iJ}}) - (u_i' x_{iJ}^{k_{iJ}} + e_{iJ}^{k_{iJ}}) < -b'(x_{iJ}^{3-k_{iJ}} - x_{iJ}^{k_{iJ}})].
\end{aligned} \qquad (8)$$

Although evaluation of this integral is more complicated than the equivalent expression in the nonrandom model, the "equicorrelated" nature of the problem means that P_i can be calculated as the integral of a joint conditional probability over the density of υ_i by standard reasoning.[7] The J events are correlated, but the source of the correlation is the individual-specific parameter error vector υ_i. This common factor design allows for the computational simplification mentioned above. The J events in the probability in Equation 8, conditional on υ_i, are independent, so the joint conditional probability may be written as the product of the J conditional probabilities. Then the resulting product is integrated with respect to υ_i to remove the conditioning:

$$\begin{aligned}
P_i &= \int_{-\infty}^{\infty} P[e_{i1}^{3-k_{i1}} - e_{i1}^{k_{i1}} < -b'(x_{i1}^{3-k_{i1}} - x_{i1}^{k_{i1}}) - u_i'(x_{i1}^{3-k_{i1}} - x_{i1}^{k_{i1}}), \\
&\vdots \\
&e_{iJ}^{3-k_{iJ}} - e_{iJ}^{k_{iJ}} < -b'(x_{iJ}^{3-k_{iJ}} - x_{iJ}^{k_{iJ}}) - u_i'(x_{iJ}^{3-k_{iJ}} - x_{iJ}^{k_{iJ}}) | u_i] f(u_i) du_i \\
&= \int_{-\infty}^{\infty} \prod_{j=1}^{J} P[e_{ij}^{3-k_{ij}} - e_{ij}^{k_{ij}} < -b'(x_{ij}^{3-k_{ij}} - x_{ij}^{k_{ij}}) - u_i'(x_{ij}^{3-k_{ij}} - x_{ij}^{k_{ij}}) | u_i] f(u_i) du_i \\
&= \int_{-\infty}^{\infty} \prod_{j=1}^{J} \Phi[(-\frac{b + u_i}{\sqrt{2} s_e})'(x_{ij}^{3-k_{ij}} - x_{ij}^{k_{ij}})] f(u_i) du_i
\end{aligned} \qquad (9)$$

where ϕ is the L-variate multinormal density function with mean vector **0** and covariance matrix $\sum$:

7. See Butler and Moffitt (1982) and Waldman (1985).

$$f(u_i) = \{2p|\Sigma|\}^{-L/2} \exp\left[-\tfrac{1}{2}u_i'\Sigma^{-1}u_i\right]. \tag{10}$$

The order of magnitude of the integral in Equation 9 is determined by the assumptions made for Var(υ_i) = ∑. Specifically, it is equal to the number of distinct nonzero diagonal elements, which is the number of parameters assumed to be random.[8]

For the model of Equation 3, $\beta_i = \beta + \upsilon_i$, the likelihood of observing $k_{i1}, \ldots, k_{iJ}$ is:

$$L(k_{ij,} i = 1,\ldots,m, j = 1,\ldots,J | x_{ij}^1, x_{ij}^2; b, s_e, \Sigma) = \prod_{i=1}^{m} P_i \tag{11}$$

where the P_i are from Equation 9.

Methods of Estimation

For the purpose of estimation by maximum likelihood, Equation 11 can be evaluated in either of two ways. First, since the kernal of $\phi(\cdot)$ is of the form exp(-[·]^2), the combination of Equations 9 and 10 with a change of variables ($v = u / \sqrt{2}s_u$ for the case of one random parameter) can be written in the form:

$$\int_{-\infty}^{\infty} e^{-n^2} g(n)\,dn\,. \tag{12}$$

This integral can be approximated using Hermite polynomial quadrature, which is fast enough to be a practical computational method (Butler and Moffit, 1982; Waldman, 1985). Quadrature can be made as accurate as necessary. If the order of magnitude of the integral is small, which is the case in the current application [in Hausman and Wise (1978), three parameters are random], the estimation problem is computationally tractable by quadrature. Second, if quadrature is not feasible because the order of magnitude is too large, a simulation method could be used (see Layton and Brown, 1998; Train, 1998; Breffle and Morey, 1999). Using simulation, the integral is approximated in two steps: first, the joint probability is computed many times using a large number of random draws from the distribution of υ, and then the average is computed. Details on Hermite quadrature are relegated to Section D.3.

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8. Under normality and the additional assumption of a diagonal ∑, the multinormal joint density of υ_i, $\phi(\upsilon_i)$, factors into the product over k of $\phi(\upsilon_{ik})$, although no further simplification appears to be possible because each element of υ_i appears in each probability. This means that there is no computational advantage in the additional assumption of a diagonal covariance matrix.

Estimated Random Parameters A-B Model

The four parameters on the catch rates and the eight parameters on the FCA dummy variables are all random, and assumed to be normally distributed with zero covariance. There is no classic heterogeneity in the model. In addition, it is assumed the standard deviations of the catch parameters vary in proportion to their means, and the same is separately true for the FCA parameters. That is, the ratio of the mean parameter to the standard deviation is the same for each of the four catch rates, and for each of the eight FCA levels. Therefore, only two standard deviations are estimated. Assuming that the standard deviation varies in proportion to the mean is a common way of dealing with heteroskedasticity, and allows the model to be more general without making it intractable. This technique is similar to one used by Brownstone and Train (1999) in a random parameters logit model, where the standard deviation was assumed to be equal to the mean. The marginal utility of money is not assumed to be random due to undesirable effects on the distribution of the E(*CV*)s because the price parameter is in the denominator of the *CV* formula (Layton and Brown, 1998; Phaneuf et al., 1998).

Specifically, the conditional indirect utility function for alternative *j* in angler *i*'s *k*-th choice is:

$$V_{ij}^{k_{ij}} = b_y(-FEE_{jk}) + (b_c + n_{ci})\sum_{l=1}^{4} b_l(ACT_{ljk}) + (b_{FCA} + n_{FCAi})\sum_{q=2}^{9} b_{FCAq}(FCAq_{jk}) \qquad (13)$$

where β_c and β_{FCA} are the mean base catch and FCA parameters, respectively; β_l is the deterministic multiplicative factor shifting the mean (and the standard deviation of the random component) of each catch parameters for the four species; β_{FCAq} is the multiplicative factor for FCA level *q*; and β_y is the marginal utility of money. The base standard deviations of the catch and FCA parameters are σ_c and σ_{FCA}, and β_p (for perch) and β_{FCA2} are fixed at one to achieve identification of the model.

This model was estimated using both quadrature and simulation, and parameter estimates are reported in Table D-3. Likelihood ratio tests show that the randomization of the catch and FCA parameters significantly improves model fit relative to the homogenous nonrandom A-B model. Results from various model runs show that 500 draws in simulation and 9 evaluation points (see Section D.3) using quadrature are sufficient for parameter estimates to be stable. That is, at these levels of draws and points, parameter estimates are the same within 2%, and parameters do not change significantly with more draws or evaluation points. Therefore, there is virtually no simulation noise. An interesting finding is that simulation took over three times as much computer time as quadrature for the 2% threshold.

The ratios of the standard deviation to the mean are 0.66 and 0.92, which match well with the ratios for random parameters in other studies valuing environmental improvements. The range over 20 parameters in 3 studies is 0.40 to 14.29, with a mean of 2.28 and a median of 1.43 (Layton and Brown, 1998; Phaneuf et al., 1998; and Train, 1998). The estimated parameters of

Table D-3
Parameters[a] and Consumer Surplus Estimates for Random Parameters A-B Model

Method	Hermite Quadrature	Simulation
Evaluation points/ random draws	9	500
Mean parameters		
β_y	0.0555 (15.267)	0.0556 (15.282)
β_c	-0.645 (-11.607)	-0.648 (-11.607)
β_{FCA}	-0.327 (-4.916)	-0.324 (-4.513)
β_p	1.0 (fixed)	1.0 (fixed)
β_t	0.0480 (6.384)	0.0478 (6.348)
β_w	0.0647 (7.985)	0.0650 (7.989)
β_b	0.0544 (7.295)	0.0544 (7.306)
β_{FCA2}	1.0 (fixed)	1.0 (fixed)
β_{FCA3}	1.618 (6.224)	1.643 (5.774)
β_{FCA4}	2.189 (6.519)	2.215 (5.938)
β_{FCA5}	2.963 (6.151)	3.000 (5.608)
β_{FCA6}	2.463 (5.944)	2.503 (5.437)
β_{FCA7}	3.531 (5.857)	3.578 (5.326)
β_{FCA8}	4.813 (5.607)	4.881 (5.098)
β_{FCA9}	5.300 (5.526)	5.384 (5.035)
Standard deviations[b]		
σ_c	0.428 (-5.270)	0.431 (-5.322)
σ_{FCA}	0.302 (-5.638)	0.296 (-5.238)
E(*CV*)s No FCAs v. *FCA*4	\$12.90	\$12.89

a. Asymptotic *t*-statistics are reported in parentheses.
b. *t*-statistics are for the natural logarithms of the standard deviations. The parameters were exponentiated in estimation to restrict them to be positive.

the normal distributions also imply that 6.6% of the population have catch parameters of the opposite sign (i.e., they value catch reductions) and 14.0% have FCA parameters of the opposite sign.[9] This result is an artifact of the distributional assumption.

E(CV^G) was estimated for a change to no FCAs from FCA Level 4.[10] The computation of E(CV^G) for a random parameters model with no income effects and only one alternative in each state of the world, such as this model, is straightforward. It can be computed as the difference between utility in the two states divided by the marginal utility of money. Because utility is linear in β, the formula for E(CV_i^G) when some parameters are random (but not the price parameter) and there is only one alternative in each state is the same as for the nonrandom model:[11]

$$\begin{aligned} E(CV_i^G) &= \int_{-\infty}^{\infty} \frac{1}{b_y}\left[b_i'(x_i^1 - x_i^0)\right] f(n_i)\, dn_i \\ &= \frac{1}{b_y}\left[b'(x_i^1 - x_i^0)\right], \end{aligned} \tag{14}$$

where β is the vector of the means of the parameters.[12]

Note that because the choice of alternatives is not modeled as a function of individual characteristics, E(CV_i^G) = E(CV) ∀ i. The estimated E(CV^G)s for the two approximation methods are also reported in Table D-3 with the parameter estimates. Estimated E(CV^G) is $12.90 using the model estimated by quadrature, which is higher than $9.75 from the nonrandom model with RP data. The mean parameters for FCAs are about 20% larger than the estimates from the nonrandom model, generating higher damages. It is reasonable to expect that making parameters random may significantly raise or lower E(CV).

The normal specification of υ is only one possibility from many choices. A second random parameters A-B model was estimated under the assumption that the random parameters are lognormally distributed: $\ln(b_{ci}) \sim \mathrm{N}(b_c, s_c)$ and $\ln(b_{FCAi}) \sim \mathrm{N}(b_{FCA}, s_{FCA})$. This distributional assumption restricts the marginal utilities for increases in the time it takes to catch fish and the severity of FCAs to be negative to everybody. Because Hermite quadrature only applies when the distribution is normal, the simulation method was used with 500 draws. The estimated distributions of $\ln(b_C)$ and $\ln(b_{FCA})$ are -1 × N(-0.598, 0.670) and -1 × N(-1.560, 1.286),

9. Because the standard deviations of all random catch parameters are restricted to vary proportionately with their means, and the same is true for FCA parameters, these percentages apply to all catch and FCA parameters, respectively.

10. Note that with random parameters, CV_i^G is a random variable which depends on u_i.

11. In a multi-site random model, E(CV) would need to be numerically approximated just as the joint probability.

12. If a parameter is not random, its value equals the mean for all individuals.

respectively. The estimated E(CV_G) is \$17.67, which is considerably larger than \$9.67. The larger value is not surprising since the mean of a lognormally-distributed random parameter b_i is an increasing function not only of the mean b but also the standard deviation s : $E(b_i) = \exp(b + (s^2/2))$. The mean β_{FCAi} is -0.480 when the distribution is assumed to be lognormal, as compared to -0.327 under the normal assumption. We do not estimate a model in which the price parameter is random.[13]

D.2 VARIATIONS ON MODELS ALLOWING SUBSTITUTION TO OTHER SITES

Classic heterogeneity is incorporated into models allowing substitution in and out of Green Bay in two ways. In the first of these models, the same specification for $V_{ij}^{k_{ij}}$ was used as presented in Equation 2, where the marginal utilities from FCAs and catch are assumed to be functions of gender and distance. This model was estimated using the SP data from the choice pairs, the expected number of days the chosen alternative would be visited from the followup questions to the pairs, and the RP data on total number of days.[14] This model is referred to as an *A-B-other* model in Table D-1.[15] In the second of the two models, the A-B parameters are assumed to be homogeneous, but the utility for *other*, V_{Oi}, is assumed to be a function of gender and distance:

$$V_{Oi} = b_0 + g_1 GEND_i + g_2 DIST_i . \qquad (15)$$

---

13. Note that mean E(CV^G) would have to be simulated if the price parameter is random because the formula is nonlinear in the price parameter. Train (1998) allows the price parameter to be random and lognormally distributed. Layton and Brown (1998), however, warn of undesirable effects on the distribution of the E(*CV*)s as a result (because the price parameter is in the denominator of the *CV* formula), and hold the price parameter fixed. Phaneuf et al. (1998) also hold the marginal utility of money fixed. A small draw of the price parameter from its distribution will cause the E(*CV*) associated with that draw to balloon, which overall will have an upward effect on simulated mean E(*CV*).

14. When the RP data on 1998 Green Bay days were included, the model did not converge. This is not surprising, and nonconvergence does not detract from the quality of estimates from the main model with homogeneous preferences or any of the convergent models with heterogeneity. Introducing a large number of additional variables into a model often results in multicollinearity. As a result, parameters cannot be estimated with precision. The covariance matrix computed as the inverse of the Hessian matrix of numerical approximations of second order partial derivatives of the log-likelihood will not in fact invert if the Hessian is nearly singular (i.e., the likelihood function is virtually flat in some dimensions).

15. Results for another A-B-other model, which allows classic heterogeneity in V_o, are also reported in Table B-1. The parameter and consumer surplus estimates from A-B-other models are similar to the main model. These estimates are consistent but less efficient than the main model because they do not include the RP data on Green Bay days.

In this second specification, the RP data on actual Green Bay days is included. Both of these generalizations significantly increase explanatory power. We were unable to get convergence on a model using all the data with classic heterogeneity in both $V_{ij}^{k_{ij}}$ and V_{Oi}.

Parameters from the A-B-other model with classic heterogeneity are reported in Table D-4 and show similarities and differences when compared to the A-B model with classic heterogeneity. Again, we find that women have a higher WTP for eliminating FCAs in Green Bay. Men have significantly higher values for increasing catch rates for all species than do women.[16] An important difference in the results is that both FCA and catch effects are larger (in absolute value) for anglers at a greater distance. Also, the parameters from the A-B-other model with heterogeneity have much higher *t*-statistics than the parameters from the A-B model with heterogeneity. However, the estimated mean CV^G of \$9.31 is similar to the full model without heterogeneity; it is less than 5% lower.

Also, the amount of noise in the stochastic term for the other index can be compared to that from the Green Bay choice pairs, because they are assumed to be uncorrelated, and s_0^2 is separately estimated. A greater level of randomness is expected for the other site because explicit characteristics of the site are not included in the model. The estimate of s_0^2 is over 10, which is greater than ½, the value of s_e^2.

Results from the full model with heterogeneity in V_O show that men and those at a greater distance are less likely to fish Green Bay. The parameters are in Table D-4. The A-B parameters from this model are close to those from the homogeneous A-B model and main model, as is mean CV^G of \$10.47, which is 7% higher than for the homogeneous full model.[17]

Because these models allow substitution in and out of Green Bay, mean $E(CV^F)$ can also be compared across the models. For the first heterogeneous A-B-other specification, estimated mean $E(CV^F)$ is \$4.16, which is only one cent lower than \$4.17 from the homogeneous full model. For the second heterogeneous specification, mean $E(CV^F)$ is \$4.13, which is 7% lower.

In theory, a random parameters specification for A-B parameters in the full model could be specified and estimated, although that is not done.[18] Because of the complexity and form of the likelihood function for the full model, simulation rather than quadrature as a means of estimation

16. For example, consider a male angler and a female angler who each live 5 miles from Green Bay. A man is willing to pay \$8.74 per Green Bay fishing day for removal of FCAs and \$3.62 for a doubling of the perch catch rate. A woman is willing to pay \$12.14 per Green Bay fishing day for the removal of FCAs, but only \$0.49 for a doubling of the perch catch rate.

17. As with the A-B model with classic heterogeneity, the estimated mean is a weighted average using the proportion of sample days as weights.

18. In contrast, a random term in V_O adds nothing, because $U_{Oi} = V_o + u_i + e_i$ is equivalent to $U_{Oi} = V_o + h_i$.

Table D-4
Parameter Estimates from Heterogeneous Nonrandom Models that Allow Substitution out of Green Bay

Parameter\Model	Heterogeneity in A-B[a]	Heterogeneity in V_O[b]
	Estimated Parameters (asymptotic *t*-statistics)	
Homogeneous parameters		
β_y	0.0446 (10.022)	0.0521 (19.313)
β_p	-0.0545 (-10.527)	-0.5345 (-13.150)
β_t	0.0206 (6.035)	-0.0244 (-9.296)
β_w	0.0386 (5.997)	-0.0294 (-10.294)
β_b	0.0050 (1.227)	-0.0255 (-8.297)
β_{FCA2}	-0.0481 (-14.277)	-0.0846 (-3.425)
β_{FCA3}	-0.2709 (-80.475)	-0.2508 (-5.843)
β_{FCA4}	-0.5409 (-160.440)	-0.5448 (-14.170)
β_{FCA5}	-0.6005 (-177.310)	-0.5853 (-18.225)
β_{FCA6}	-0.5369 (-159.446)	-0.5182 (-12.387)
β_{FCA7}	-0.7633 (-225.195)	-0.7453 (-25.813)
β_{FCA8}	-1.0245 (-300.755)	-1.0403 (-28.068)
β_{FCA9}	-1.2345 (-365.401)	-1.1384 (-24.772)
β_0	-0.7483 (-221.829)	-2.2961 (-24.500)
σ_0 or $\sigma_{0-\epsilon}$	3.199 (690.739)[c]	5.2441 (34.206)[c]
σ_{0-G}	NA[a]	4.1280 (25.304)[c]
Heterogeneous parameters		
β_{pg}	-0.3721 (-107.489)	
β_{tg}	-0.0322 (-5.042)	
β_{wg}	-0.0539 (-14.550)	
β_{bg}	-0.0187 (-5.844)	
β_{FCAg}	-0.2806 (-83.105)	
β_{pd}	-8.067e-4(-39.345)	
β_{td}	-9.212e-5 (-4.946)	
β_{wd}	-1.958e-4 (-7.864)	
β_{bd}	-6.061e-5 (-4.299)	
β_{FCAd}	3.842e-4 (16.472)	
γ_1		1.0450 (13.669)
γ_2		4.581e-3 (16.572)

a. These results are for an *A-B-other* model that allows substitution out of Green Bay, but the RP data on the actual number of days at Green Bay is not included. Therefore, σ_{0-G} is not a parameter in this model. In addition, ϵ_0 and ϵ_{ij} are assumed to be uncorrelated, so σ_0 rather than $\sigma_{0-\epsilon}$ is estimated. See text for discussion.
b. These results are for a full model that does include RP data on the actual number of Green Bay days.
c. σ parameters were exponentiated in estimation to restrict them to be positive. *t*-statistics apply to the logged parameter estimates.

would be necessary. Estimating a full model with random parameters seems unnecessary because: 1) mean consumer surplus is robust across the different nonrandom specifications; and 2) the higher consumer surplus values from the random A-B models suggest that damages estimated by the nonrandom full model are conservative.

D.3 DETAILS ON HERMITE POLYNOMIAL QUADRATURE

Hermite polynomial quadrature is a method of approximating integrals of functions on $(-\infty,\infty)$ with integrands that take the form presented in Equation 12. It is based on standard Gaussian methods. Consider first only one random parameter, in which case the approximation to Equation 12 is:

$$\int_{-\infty}^{\infty} e^{-n^2} g(n)dn = \sum_{m=1}^{M} w_m g(n_m) + R_m . \tag{16}$$

Here, ν_m is the mth zero of the Hermite polynomial $H_m(\nu)$, m is the number of evaluation points, and ω_m is the mth weight, given by:

$$w_m = \frac{2^{m-1} m! \sqrt{p}}{m^2 [H_{m-1}(n_m)]^2} . \tag{17}$$

The remainder is:

$$R_m = \frac{m!\sqrt{p}}{2^m (2m)!} g^{(2m)}(x), 0 < x < \infty . \tag{18}$$

Abramowitz and Stegun (1964) present ν_m and ω_m for various m in tabular form.

Let $\Delta x_{ij} = x_{ij}^{3-k_{ij}} - x_{ij}^{k_{ij}}$ and indicate the elements of this vector with superscripts. That is, Δx_{ij}^k is the k^{th} element of Δx_{ij}^k . Suppose without loss of generality that the single varying parameter is the first. Then $g(\nu)$ is:

$$g(n) = p^{-1/2} \prod_{j=1}^{J} \Phi\left[(2s_e^2)^{-1/2}(-b'\Delta x_{ij} - \sqrt{2}s_u n \Delta x_{ij}^1)\right] \tag{19}$$

Notice the necessary change of variable to accommodate the fact that the normal kernal is $e^{-\frac{u^2}{2s_u^2}}$ and not e^{-u^2} .

For the case of two (or more) varying parameters the elements in the random vector ν_i in Equations 9 and 10 are treated separately (and denoted here by subscript), and the numerical integration is done from the inside out. Without loss of generality, suppose the two varying parameters are the first and the second. Then Equation 11 becomes:

$$P_i = \int_{-\infty}^{\infty}\left[\int_{-\infty}^{\infty}\prod_{j=1}^{J} F\,[(2s_e)^{-1/2}(-b\,'Dx_{ij} - \sqrt{2}s_{u_1}n_{1i}Dx_{ij}^1 - \sqrt{2}s_{u_2}n_{2i}Dx_{ij}^2)]\exp(-n_{2i}^2)dn_{2i}\right]\bullet \exp(-n_{1i}^2)dn_{1i}, \tag{20}$$

where s_{u_k} is the standard deviation of random parameter k. The integral inside the brackets is similar to the single varying parameter case, and can be evaluated in that manner. Call this quantity $h(\nu_1)$. It is a function of β, s_{u_1}, s_{u_2}, and ν_1, but not a function of ν_2 (recall σ_ϵ is not identified in this model). Equation 9 may be written:

$$P_i = \int_{-\infty}^{\infty} h(n_{1i})\exp(-n_{1i}^2)dn_{1i} \tag{21}$$

which again can be evaluated as a single quadrature. The number of function evaluations increases exponentially. That is, if five function evaluations are used when there is a single varying parameter, then 25 are used for two, 125 for three, etc. The approximation of the double integral is:

$$P_i \approx p^{-1}\sum_{m_1=1}^{M_1} w_{m_1}\left[\sum_{m_2=1}^{M_2} w_{m_2}\, g(n_{2m_2}, n_{1m_1})\right] \tag{22}$$

APPENDIX E
SURVEY MATERIALS

This appendix includes survey materials, including:

- Telephone survey instrument.
- Mail survey instrument. Note: only Version 1 is included. All versions are the same except that the choice pairs vary across versions.
- Table of choice pairs by survey version.
- Mail survey first letter, postcard, and second letter.
- Phone survey implementation instructions.

My name is **[fill in]** and I am calling from Hagler Bailly in the University Research Park in Madison, WI. We are conducting a study of people's opinions about fishing. May I speak with ______________________________?

[If R not available schedule a callback]

You are part of a small group of anglers who have been scientifically selected for this study. Your opinions will represent other anglers like you, but who were not selected for this study.

This is not a marketing or sales call. Also, I want to assure you that your name will never be associated with your answers in any way, and that all your responses will be kept confidential. This survey usually takes about 5 minutes. Have I reached a household at [address]?

1. Since January 1 of this year, on how many days did you spend part or all of the day ice fishing? *[Note to interviewers: in this question we are interested in all days of fishing regardless of location]*

    ____ **Days ice fishing** *[IF ZERO, FILL Q3-4 WITH 0 AND GOTO Q5]*

2. Were any of these days ice fishing the waters of Green Bay? When I say the waters of Green Bay I am including the bay of Green Bay, Sturgeon Bay, and the rivers and streams that feed into Green Bay up to their first dam. For example, it would include the Fox River between Green Bay and the dam at DePere.

    1 **Yes**
    2 **No** *[FILL Q3-4 WITH 0 AND GOTO Q5]*

3. On how many days did you spend part or all of the day ice fishing the waters of Green Bay?

    ____ **Days ice fishing waters of Green Bay**

4. On how many days did you spend part or all of the day ice fishing the Fox River between Green Bay and the dam at DePere?

    ____ **Days ice fishing between Green Bay and dam at DePere**

[IF Q4 LE Q3, GOTO Q5; ELSE GOTO Q4_CHK]

<Q4_CHK>

Our definition of the waters of Green Bay includes the Fox River between Green Bay and the dam at DePere. You said that you spent **[fill Q4]** days ice fishing the Fox River between Green Bay and the dam at DePere, but only **[fill Q3]** days ice fishing the waters of Green Bay which would include the Fox River between Green Bay and the dam at DePere.

Did you include the number of days ice fishing the Fox River between Green Bay and the dam at DePere as part of the days ice fishing Green Bay?

1	**Yes**	
2	**No**	*[GOTO Q3]*

<Q4_CHK_YES>

I am sorry, I am unclear about how many days you ice fished Green Bay as a whole, and how many of these days were spent ice fishing on the Fox River between Green Bay and the dam at DePere. *[GOTO Q3]*

5. Since January 1 of this year on how many days did you spend all or part of the day fishing other than ice fishing. [Note to interviewers: in this question we are interested in all days of ice fishing regardless of location]

____ **Days fishing (not ice fishing)** *[IF ZERO, FILL Q7 & 8 WITH 0 AND GOTO CHECK1]*

6. Were any of these non-ice fishing days fishing the waters of Green Bay? When I say the waters of Green Bay I am including the bay of Green Bay, Sturgeon Bay, and the rivers and streams that feed into Green Bay up to their first dam. For example, it would include the Fox River between Green Bay and the dam at DePere.

1	**Yes**	
2	**No**	*[FILL Q7 & 8 WITH 0 AND GOTO CHECK1]*

7. On how many of these non-ice fishing days did you spend part or all of the day fishing the waters of Green Bay?

____ **Days fishing (not ice fishing) waters of Green Bay**

8. On how many of these non-ice fishing days did you spend part or all of the day fishing the Fox River between Green Bay and the dam at DePere?

____ **Days fishing (not ice fishing) between Green Bay and dam at DePere**

[IF Q8 LE Q7 GOTO CHECK1; ELSE GOTO Q8_CHK]

<Q8_CHK>

Our definition of the waters of Green Bay includes the Fox River between Green Bay and the dam at DePere. You said that you spent **[fill Q8]** days fishing the Fox River between Green Bay and the dam at DePere, but only **[fill Q7]** days fishing the waters of Green Bay which would include the Fox River between Green Bay and the dam at DePere.

Did you include the number of days fishing the Fox River between Green Bay and the dam at DePere as part of the days fishing Green Bay?

1 **Yes**
2 **No** *[GOTO Q7]*

<Q8_CHK_YES>

I am sorry, I am unclear about how many days you fished Green Bay as a whole, and how many of these days were spent fishing on the Fox River between Green Bay and the dam at DePere. *[GOTO Q7]*

<CHECK1>
[IF Q3 = 0 AND Q7 = 0 GOTO NOT RECENT; ELSE GOTO Q12]

<NOT RECENT>
9. Have you ever fished on the waters of Green Bay?

1 **Yes**
2 **No** *[GOTO Q11a]*

10. Why haven't you fished the waters of Green Bay since January 1? *[Do not read categories, listen to response and code using the following categories. If unsure of how to code, enter verbatim under "other". The program will accept up to 6 reasons. After each response, probe with "Any other reasons?"]*

- **0 No more mentioned**
- **1 Contaminants in the fish**
- **2 PCBs in fish**
- **3 Fish aren't safe to eat**
- **4 Pollution**
- **5 Fish don't taste good**
- **6 Lost interest**
- **7 No time for fishing anymore**
- **8 There are better places to fish**
- **9 Other ---> ______________________**

11a. Would you consider fishing the waters of Green Bay if conditions were different?

- **1 Yes** *[GOTO Q11B]*
- **2 No** *[GOTO Q12]*

11b. What things would have to change before you would consider fishing the waters of Green Bay? [Do not read categories, listen to response and code using the following categories. If unsure of how to code, enter verbatim under "other". The program will accept up to 6 reasons. After each response, probe with "Any other reasons?"]

- **0 No other mentioned**
- **1 I would not fish Green Bay under any circumstances**
- **2 I would fish Green Bay if I lived closer**
- **3 The catch rates would have to improve on Green Bay**
- **4 Have to clean up Green Bay**
- **5 Have to have cleaner fish in Green Bay**
- **6 Other ______________________________**
- **7 Have to get a boat**
- **8 Need a bigger/different boat**
- **9 Need more time to fish**

12. Anglers have different feelings about how important it is to be able catch fish that are free of contaminants. Would you say it is "Not at all Important", "Somewhat Important" or "Very Important" to you that fish you catch are free of contaminants.

- **1 Not at all important**
- **2 Somewhat important**
- **3 Very important**

13. I am going to read to you 10 actions that might be taken to improve the quality of fishing in Wisconsin. Six of these actions are for the waters of Green Bay and the other four are for other waters. For each statement please tell me if, compared to other things that could be done to improve fishing, you think taking this action is "Not at all Important", "Somewhat Important" or "Very Important".

[Read each action, divide into two blocks, Green Bay actions and non-Green Bay. Randomly select block to use first and systematically vary starting item within block.]

Block 1

Here are six actions that could be taken to improve the quality of fishing on the waters of Green Bay

	Not at all Important	Somewhat Important	Very Important
Increase the average catch of sport fish like trout, salmon, bass and walleye on the waters of Green Bay	1	2	3
Increase the average catch of pan fish like yellow perch on the waters of Green Bay	1	2	3
Clean up contaminants so that none of fish caught in the waters of Green Bay are contaminated	1	2	3
Make existing boat ramps around Green Bay free	1	2	3
Improve the clarity of the water in Green Bay	1	2	3
Provide additional public launch facilities on Green Bay	1	2	3

Block 2

Here are four actions that could be taken to improve the quality of fishing on the inland waters of Wisconsin

	Not at all Important	Somewhat Important	Very Important
Clean up contaminants so that none of the fish caught in the inland waters of Wisconsin are contaminated..........	1	2	3
Provide additional public boat launch facilities on inland waters..........	1	2	3
Reduce the cost of launching a boat on inland lakes	1	2	3
Reduce the cost of fishing licenses..........	1	2	3

14. In what year did you first fish?

    ____ Year first fished

[IF Q9 = 2, GOTO Q16]

15. In what year did you first fish the waters of Green Bay?

    ____ Year first fished waters of Green Bay

16. Do you, or does someone in your household, own a boat?

    1 Yes
    2 No

17. Do you have a vacation home or cabin?

    1 Yes ----> About how many miles is it from your vacation home or cabin to the bay of Green Bay?

    ____ Miles to bay of Green Bay
    0 Less than 1 mile

    2 No

18. What is your age?

_____ Age

19. Do you work at a job for which you receive wages or a salary?

1 Yes ----> Which category best describes your employment status? *(READ LIST)*

1 **Full time**
2 **Part time**

2 No ----> Which category best describes you? *(READ LIST)*

1 **Student**
2 **Retired**
3 **Homemaker**
4 **Unemployed**
5 **Other**
6 **Self employed**

20. Which of the following 5 categories best describes your race? *(READ LIST)*

1 **Native American**
2 **Asian**
3 **African American**
4 **Hispanic**
5 **Caucasian**
6 **Other** *(Please specify ______________________________)*

21. Including yourself, how many people reside in your household?

_____ **Number of people in household**

22. Including yourself, how many of these are 16 or more years old?

_____ **Number of people in household above the age of 16**

23. INTERVIEWER: RECORD GENDER

1 **Male**
3 **Female**

[if q1=0 and q5=0, gbfish=0 (not fished in 1998) goto terminate]
[if q1 gt 0 and q5=0 and q3=0, gbfish=1 (ice fished only, not GB) goto terminate]
[if q1 gt 0 and q5=0 and q3 gt 0, gbfish=2 (ice fished only, GB) goto terminate]
[if q1 ge 0 and q5 gt 0 and q7=0, gbfish=3 (non-ice fished, not GB) recruit]
[if q1 ge 0 and q5 gt 0 and q7 gt 0, gbfish=4 (non-ice fished, GB) recruit]

One purpose of this study is to collect information to help make better decisions about managing fishing in Wisconsin. We would like to contact you by mail to learn more about your opinions about fishing in Wisconsin.

We selected you for this study using records of individuals who purchased fishing licenses in 1997. Can I confirm your name and address to make sure we have the correct address to send the materials? *[IF R IS HESITANT, GOTO HESITANT]*

NAME: @name
STREET ADDRESS: @address
CITY: @city
STATE: @state ZIP: @zip
PHONE NUMBER: @phone

We will be sending you the survey within the next week or two. We can't afford to pay you for your time to complete the survey, but we will include a token of our appreciation along with the survey.

Because we will be combining the answers you gave us today with your answers from the survey, it is important that you, **and not someone else** in your household fill out the mail survey. Some of the questions in the survey will ask how many days you have been fishing since this call. It would be very helpful to us if you could keep track of the number of days you go fishing between now and the time you get our survey.

[GOTO TERMINATE]

<HESITANT>

You have been scientifically selected to participate in this study. By helping us out with this mail survey you will be representing the opinions of other anglers like yourself, but who were not chosen for this study. We can't afford to pay you for your time to complete the survey, but we will include a token of our appreciation along with the survey. Would you be willing to help us out?

[If NO, GOTO TERMINATE]

Can I confirm your name and address to make sure we have the correct address to send the materials?

NAME: @name
STREET ADDRESS: @address
CITY: @city
STATE: @state ZIP: @zip
PHONE NUMBER: @phone

We will be sending you the survey within the next week or two.

Because we will be combining the answers you gave us today with your answers from the survey, it is important that you, **and not someone else** in your household fill out the mail survey. Some of the questions in the survey will ask how many days you have been fishing. It would be very helpful to us if you could keep track of the number of days you go fishing between now and the time you get our survey.

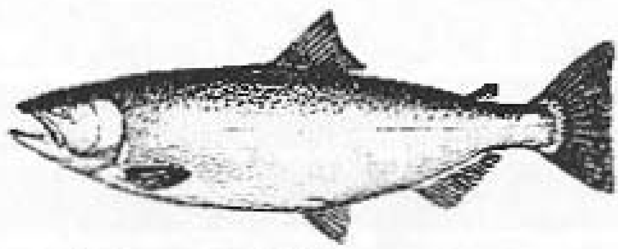
>TERMINATE<

Thanks for your help. That is all the questions we have for you.

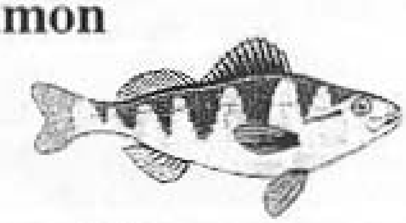
What Do You Think About Fishing the Waters of Green Bay?

1998 Angler Survey

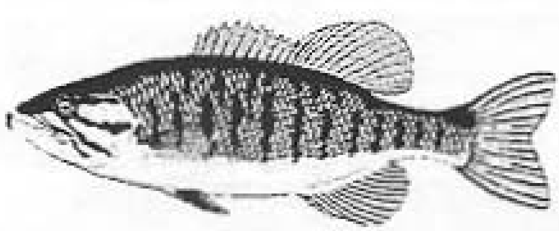
Walleye



Chinook Salmon



Yellow Perch



Smallmouth Bass

Research Conducted by Hagler Bailly
Please return survey to:
Green Bay Fishing Survey
Hagler Bailly, University Research Park
455 Science Drive
Madison, WI 53711-1058

The Waters of Green Bay

For this survey, the "waters of Green Bay" include the bay of Green Bay, Sturgeon Bay, and the rivers and streams that feed into Green Bay up to their first dam. If there are no dams along the tributary, the full length of the tributary is considered to be part of the waters of Green Bay. Tributary rivers are shown on this map, smaller tributary streams are not.

1 **Portions of this survey are about your fishing activities on the waters of Green Bay. For this survey, the "waters of Green Bay" include the bay of Green Bay, Sturgeon Bay, and the rivers and streams that feed into Green Bay up to their first dam (see map).**

On a scale from 1 to 7 where 1 means "Much Worse" and 7 means "Much Better", how do you rate the quality of fishing on the waters of Green Bay compared to other places you fish? *Circle one number*

Much Worse than Other Places			About the Same			Much Better than Other Places	Don't Know
1	2	3	4	5	6	7	8

2 **Please provide a comment that will help us understand your rating in Question 1.** *Fill in the blank*

____

____

____

3 **Have you been fishing since the day we called you about this study? (   )**
Circle one number

1 No

2 Yes → **(If "Yes") Since the day we called you, on how many additional days did you spend all or part of the day fishing . . .**

_____ the waters of Green Bay? *Fill in the number of days*

_____ elsewhere? *Fill in the number of days*

4 **On a scale from 1 to 5 where 1 means "Never" and 5 means "Almost Always", when you fish the waters of Green Bay, how often do you fish for each of the following?** *Circle one letter for each*

	Never	Seldom	Sometimes	Often	Almost Always
Yellow perch......................	1	2	3	4	5
Trout\salmon.......................	1	2	3	4	5
Walleye................................	1	2	3	4	5
Smallmouth bass.................	1	2	3	4	5
Carp\catfish\white bass........	1	2	3	4	5
Whatever is biting...............	1	2	3	4	5

5 **Excluding ice fishing, on what percent of your fishing days on the waters of Green Bay do you fish from a boat?** *Circle one number*

Never										Always
0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

If 0%
skip to 7

6 **When you fish from a boat on the waters of Green Bay how many anglers, including yourself, are typically in the boat?** *Fill in the blank*

______ number of anglers

7 **On a scale from 1 to 5 where 1 means "Least Important" and 5 means "Most Important", how would you rate the following actions in terms of how they would enhance your recreational fishing on the waters of Green Bay?** *Circle one number for each action*

	Least Important				Most Important
Adding more boat launch facilities.............	1	2	3	4	5
Adding more shoreline parks, nature centers, and trails.......................................	1	2	3	4	5
Increasing water clarity..............................	1	2	3	4	5
Increasing catch rates.................................	1	2	3	4	5
Cleaning up PCBs so fish consumption advisories can be reduced or eliminated.......	1	2	3	4	5
Other ---> Please specify ______________________..........	1	2	3	4	5

8 **For this survey we define an average catch rate as how often, on average, a typical angler would catch the type of fish he or she is targeting. For example, an average catch rate might be 2 hours per fish or 30 minutes per fish. Of course, the actual catch rate will vary from day to day and across anglers.**

The average catch rate is *not the same* as the bag limit. The bag limit is the number of fish an angler can legally keep each day.

On a scale of 1 to 5, where 1 means "Strongly Disagree" and 5 means "Strongly Agree", how do you feel about each of the following statements? *Circle one number for each statement*

	Strongly Disagree		Neither Agree nor Disagree		Strongly Agree
We should increase catch rates by increasing Green Bay fish populations..	1	2	3	4	5
We should not let Green Bay fish populations decline because that would cause catch rates to decline............	1	2	3	4	5

9 <u>Fish consumption advisories (FCAs)</u> for the waters of Green Bay are issued when concentrations of PCBs in the fish may cause health problems in humans. Green Bay FCAs tell how often one can safely eat meals of Green Bay fish.

PCBs are substances that were used by industry until the mid 1970's. PCBs released into the environment accumulate in sediments at the bottom of lakes and streams. PCBs get into fish through the food chain.

Before you received this survey, had you heard or read about fish consumption advisories for the waters of Green Bay? *Circle one number*

1 No

2 Yes

3 Not sure

10 FCAs vary by fish species and fish size. FCAs for PCBs can take these levels:

- Unlimited consumption
- Eat no more than one meal a week
- Eat no more than one meal a month
- Eat no more than one meal every two months
- Do not eat

Eating more fish than is recommended in the FCA for PCBs:

- for women, increases the risk of bearing children who have learning disabilities or develop more slowly.
- for everyone, may increase your risk of cancer.

PCBs *do not* affect the taste or smell of fish, or the appearance, number, or size of fish.

On a scale from 1 to 5 where 1 means "Not at All Bothersome" and 5 means "Very Bothersome" answer the following question. For the fish you would like to fish for in the waters of Green Bay, how much would it bother you, if at all, if PCBs resulted in the following fish consumption advisories? *Circle one number for each advisory*

	Not at All Bothersome				Very Bothersome
Eat no more than one meal a week	1	2	3	4	5
Eat no more than one meal a month	1	2	3	4	5
Do not eat	1	2	3	4	5

11 **In response to the existing fish consumption advisories for the waters of Green Bay, do you do any of the following?** *Circle one number for each statement*

	No ▼	Yes ▼
spend fewer days fishing the waters of Green Bay	1	2
change the *places I fish* on the waters of Green Bay	1	2
change the *species I fish for* on the waters of Green Bay	1	2
change the *species of fish I keep to eat* from the waters of Green Bay	1	2
change the *size of fish I keep to eat* from the waters of Green Bay	1	2
change the way Green Bay fish are *cleaned or prepared*	1	2
change the way Green Bay fish *are cooked* at my house	1	2

12 **On average, how much do you *personally* spend for a typical day of fishing on the waters of Green Bay?**

If you don't typically spend money on an item please put $0.
If you split expenses tell us what *you personally* spend.
If you usually take trips of longer than one day, tell us your average cost per day.

Fill in the blank for each item

Gas for vehicle and/or boat.. $______
Boat launching fee... $______
Motel/hotel.. $______
Fishing gear (lines, lures, hooks, sinkers, etc.)......... $______
Bait.. $______
Food and beverages... $______
Guide or charter fees... $______
Other --->Please specify
______________________________ .... $______

Add up the total .... $______

13 **On a scale of 1 to 5, where 1 means "Strongly Disagree" and 5 means "Strongly Agree", how do you feel about each of the following statements about boat launch fees? If you don't fish from a boat, please think of the daily boat launch fee as a fee you would have to pay to fish the waters of Green Bay.** *Circle one number for each statement*

	Strongly Disagree		Neither Agree nor Disagree		Strongly Agree
I would be willing to pay higher boat launch fees if catch rates were higher on the waters of Green Bay	1	2	3	4	5
I would be willing to pay higher boat launch fees if the fish had no PCB contamination	1	2	3	4	5

14 **The next questions ask you to evaluate a wide range of alternative fishing conditions for the waters of Green Bay. In each question, there are two alternatives, A and B (see 15). For each question, tell us if you would prefer to fish the waters of Green Bay under Alternative A or Alternative B.**

When choosing an alternative keep in mind that the fish consumption advisory is for an average size fish of that species. The boat launch fee is for your share of a daily boat launch fee. If you don't fish from a boat, think of the daily boat launch fee as a daily fee you personally would have to pay to fish the waters of Green Bay.

Please review 15. You will notice Alternative B has:

- **Better catch rates for yellow perch and walleye than Alternative A**
- **Less restrictive consumption advisories for trout/salmon, walleye and smallmouth bass than Alternative A**
- **A higher cost to launch a boat (or a higher daily fee if not fishing from a boat) than in Alternative A**

Some anglers might prefer Alternative B while others might prefer Alternative A. Even if you wouldn't fish the waters of Green Bay under either alternative, tell us which alternative you would prefer. Later you can tell us how often, if at all, you would fish the waters of Green Bay under the alternative you prefer.

15 **If you were going to fish the waters of Green Bay, would you prefer to fish the waters of Green Bay under Alternative A or Alternative B?** *Check one box in the last row*

	Alternative A ▼	Alternative B ▼
Yellow Perch		
Average catch rate for a typical angler................	40 minutes per perch	30 minutes per perch
Fish consumption advisory....	No more than one meal per week	No more than one meal per week
Trout and Salmon		
Average catch rate for a typical angler................	2 hours per trout/salmon	2 hours per trout/salmon
Fish consumption advisory....	Do not eat	No more than one meal per month
Walleye		
Average catch rate for a typical angler................	8 hours per walleye	4 hours per walleye
Fish consumption advisory....	Do not eat	No more than one meal per month
Smallmouth bass		
Average catch rate for a typical angler................	2 hours per bass	2 hours per bass
Fish consumption advisory....	No more than one meal per month	Unlimited consumption
Your share of the daily launch fee.........................	Free	$3
Check the box for the alternative you prefer............	☐	☐

16 **Please comment on how you chose between Alternative A and Alternative B in 15 ?**
Fill in the blanks

____

____

____

17 How often would you fish the waters of Green Bay if it had the conditions described by the alternative you just chose (A or B)? Your answer could depend on a number of factors:

- How many days you typically fish in a year and how many of those days are spent fishing the waters of Green Bay.
- How much you enjoy fishing the waters of Green Bay compared to other places you might fish
- How far you live from Green Bay compared to other places you might fish
- The cost of fishing the waters of Green Bay compared to other places you might fish
- Whether you think the conditions for the waters of Green Bay in the alternative you just chose are better, worse, or about the same as current conditions.
- The more you fish the waters of Green Bay the less time you will have for fishing elsewhere.

Excluding ice fishing, how many days, on average, would you fish the waters of Green Bay in a typical year if the conditions on the waters of Green Bay were those described in the alternative you chose in 15 ? *Fill in the blank*

_______ days fishing the waters of Green Bay in a typical year

18 **Please comment on how you answered 17 .** *Fill in the blank*

____

____

____

____

____

19 **If you were going to fish the waters of Green Bay, would you prefer to fish the waters of Green Bay under Alternative A or Alternative B?** *Check one box in the last row*

	Alternative A ▼	Alternative B ▼
Yellow Perch	30 minutes per perch Unlimited consumption	20 minutes per perch Eat no more than 1 meal a week
Trout and Salmon	12 hours per trout/salmon Eat no more than 1 meal a week	6 hours per trout/salmon Eat no more than 1 meal a month
Walleye	2 hours per walleye Eat no more than 1 meal a week	4 hours per walleye Eat no more than 1 meal a month
Smallmouth bass	4 hours per bass Unlimited consumption	12 hours per bass Eat no more than 1 meal a month
Your share of the daily launch fee	$7	$10
Check the box for the alternative you prefer	☐	☐

20 **Excluding ice fishing, how many days, on average, would you fish the waters of Green Bay in a typical year if the conditions on the waters of Green Bay were those described in the alternative you chose in 19?** *Fill in the blank*

_______ days fishing the waters of Green Bay

21 **If you were going to fish the waters of Green Bay, would you prefer to fish the waters of Green Bay under Alternative A or Alternative B?** *Check one box in the last row*

	Alternative A ▼	Alternative B ▼
Yellow Perch	10 minutes per perch Eat no more than 1 meal a month	1 hour per perch Eat no more than 1 meal a week
Trout and Salmon	2 hours per trout/salmon Do not eat	4 hours per trout/salmon Do not eat
Walleye	6 hours per walleye Do not eat	1 hour per walleye Do not eat
Smallmouth bass	1 hour per bass Do not eat	2 hours per bass Eat no more than 1 meal a month
Your share of the daily launch fee	$12	$3
Check the box for the alternative you prefer	☐	☐

22 **Excluding ice fishing, how many days, on average, would you fish the waters of Green Bay in a typical year if the conditions on the waters of Green Bay were those described in the alternative you chose in 21?** *Fill in the blank*

________ days fishing the waters of Green Bay

23 **If you were going to fish the waters of Green Bay, would you prefer to fish the waters of Green Bay under Alternative A or Alternative B?** *Check one box in the last row*

	Alternative A ▼	Alternative B ▼
Yellow Perch	40 minutes per perch Unlimited consumption	10 minutes per perch Unlimited consumption
Trout and Salmon	1 hour per trout/salmon Do not eat	8 hours per trout/salmon Eat no more than 1 meal a month
Walleye	12 hours per walleye Eat no more than 1 meal a month	8 hours per walleye Eat no more than 1 meal a month
Smallmouth bass	8 hours per bass Eat no more than 1 meal a month	6 hours per bass Eat no more than 1 meal a week
Your share of the daily launch fee	$15	$9
Check the box for the alternative you prefer	☐	☐

24 **Excluding ice fishing, how many days, on average, would you fish the waters of Green Bay in a typical year if the conditions on the waters of Green Bay were those described in the alternative you chose in 23 ?** *Fill in the blank*

________ days fishing the waters of Green Bay

25 **If you were going to fish the waters of Green Bay, would you prefer to fish the waters of Green Bay under Alternative A or Alternative B?** *Check one box in the last row*

	Alternative A ▼	Alternative B ▼
Yellow Perch	1 hour per perch Unlimited consumption	30 minutes per perch Unlimited consumption
Trout and Salmon	2 hours per trout/salmon Unlimited consumption	6 hours per trout/salmon Do not eat
Walleye	4 hours per walleye Unlimited consumption	1 hour per walleye Do not eat
Smallmouth bass	8 hours per bass Unlimited consumption	1 hour per bass Eat no more than 1 meal a month
Your share of the daily launch fee	Free	$5
Check the box for the alternative you prefer	☐	☐

26 **Excluding ice fishing, how many days, on average, would you fish the waters of Green Bay in a typical year if the conditions on the waters of Green Bay were those described in the alternative you chose in 25?** *Fill in the blank*

________ days fishing the waters of Green Bay

27 **If you were going to fish the waters of Green Bay, would you prefer to fish the waters of Green Bay under Alternative A or Alternative B?** *Check one box in the last row*

	Alternative A ▼	Alternative B ▼
Yellow Perch	20 minutes per perch Unlimited consumption	40 minutes per perch Unlimited consumption
Trout and Salmon	4 hours per trout/salmon Do not eat	8 hours per trout/salmon Eat no more than 1 meal a month
Walleye	12 hours per walleye Do not eat	6 hours per walleye Do not eat
Smallmouth bass	4 hours per bass Eat no more than 1 meal a month	2 hours per bass Eat no more than 1 meal a month
Your share of the daily launch fee	Free	$2
Check the box for the alternative you prefer	☐	☐

28 **Excluding ice fishing, how many days, on average, would you fish the waters of Green Bay in a typical year if the conditions on the waters of Green Bay were those described in the alternative you chose in 27**? *Fill in the blank*

_______ days fishing the waters of Green Bay

29 **If you were going to fish the waters of Green Bay, would you prefer to fish the waters of Green Bay under Alternative A or Alternative B?** *Check one box in the last row*

	Alternative A ▼	Alternative B ▼
Yellow Perch	20 minutes per perch Unlimited consumption	40 minutes per perch Eat no more than 1 meal a month
Trout and Salmon	1 hour per trout/salmon Eat no more than 1 meal a month	12 hours per trout/salmon Do not eat
Walleye	2 hours per walleye Do not eat	8 hours per walleye Do not eat
Smallmouth bass	6 hours per bass Eat no more than 1 meal a month	12 hours per bass Do not eat
Your share of the daily launch fee	$5	$3
Check the box for the alternative you prefer	☐	☐

30 **Excluding ice fishing, how many days, on average, would you fish the waters of Green Bay in a typical year if the conditions on the waters of Green Bay were those described in the alternative you chose in 29?** *Fill in the blank*

_______ days fishing the waters of Green Bay

31 **If you were going to fish the waters of Green Bay, would you prefer to fish the waters of Green Bay under Alternative A or Alternative B?** *Check one box in the last row*

	Alternative A ▼	Alternative B ▼
Yellow Perch	1 hour per perch Unlimited consumption	10 minutes per perch Unlimited consumption
Trout and Salmon	8 hours per trout/salmon Eat no more than 1 meal a week	6 hours per trout/salmon Unlimited consumption
Walleye	12 hours per walleye Eat no more than 1 meal a week	2 hours per walleye Unlimited consumption
Smallmouth bass	1 hour per bass Unlimited consumption	2 hours per bass Unlimited consumption
Your share of the daily launch fee	$10	$15
Check the box for the alternative you prefer	☐	☐

32 **Excluding ice fishing, how many days, on average, would you fish the waters of Green Bay in a typical year if the conditions on the waters of Green Bay were those described in the alternative you chose in 31?** *Fill in the blank*

_______ days fishing the waters of Green Bay

33 **If you were going to fish the waters of Green Bay, would you prefer to fish the waters of Green Bay under Alternative A or Alternative B?** *Check one box in the last row*

	Alternative A ▼	Alternative B ▼
Yellow Perch	10 minutes per perch Eat no more than 1 meal a week	30 minutes per perch Eat no more than 1 meal a week
Trout and Salmon	1 hour per trout/salmon Do not eat	4 hours per trout/salmon Eat no more than 1 meal a month
Walleye	4 hours per walleye Do not eat	6 hours per walleye Eat no more than 1 meal a month
Smallmouth bass	4 hours per bass Eat no more than 1 meal a month	8 hours per bass Eat no more than 1 meal a month
Your share of the daily launch fee	$2	$9
Check the box for the alternative you prefer	☐	☐

34 **Excluding ice fishing, how many days, on average, would you fish the waters of Green Bay in a typical year if the conditions on the waters of Green Bay were those described in the alternative you chose in 33?** *Fill in the blank*

_______ days fishing the waters of Green Bay

35 **On a scale from 1 to 5 where 1 is "Not at All Important" and 5 is "Very Important", when you were making your choices in 15 through 34 , how important were each of the following?** *Circle one number for each*

	Not at All Important				Very Important
The average catch rate for *yellow perch*.........................	1	2	3	4	5
The fish consumption advisory for *yellow perch*............	1	2	3	4	5
The average catch rate for *trout/salmon*........................	1	2	3	4	5
The fish consumption advisory for *trout/salmon*...........	1	2	3	4	5
The average catch rate for *walleye*................................	1	2	3	4	5
The fish consumption advisory for *walleye*....................	1	2	3	4	5
The average catch rate for *smallmouth bass*..................	1	2	3	4	5
The fish consumption advisory for *smallmouth bass*.....	1	2	3	4	5
Your share of the *boat launch fee (or daily access fee if not fishing from a boat)*..	1	2	3	4	5

36 **For each of the following kinds of fish, what do you think are the current average catch rates (for all anglers, not just for yourself) on the waters of Green Bay?** *Circle letter corresponding to average catch rate closest to current conditions*

A fish every ....

	10 minutes	20 minutes	30 minutes	40 minutes	1 hour	2 hours	4 hours	6 hours	8 hours	12 hours
Yellow perch....	A	B	C	D	E	F	G	H	I	J
Trout /salmon ..	A	B	C	D	E	F	G	H	I	J
Walleye.............	A	B	C	D	E	F	G	H	I	J
Smallmouth bass..................	A	B	C	D	E	F	G	H	I	J

37 **For each of the following kinds of fish, which advisory level do you think is closest to the current fish consumption advisory for an average size fish of that species on the waters of Green Bay?** *Circle one letter for each type of fish*

	Unlimited consumption	Eat no more than 1 meal per week	Eat no more than 1 meal per month	Eat no more than 1 meal every 2 months	Do not eat
Yellow perch..............	A	B	C	D	E
Trout/salmon.............	A	B	C	D	E
Walleye......................	A	B	C	D	E
Smallmouth bass............................	A	B	C	D	E

OVER ☞

38 **Approximately, what do you think is the average daily boat launch fee for the waters of Green Bay?** *Fill in the blank*

$______ average daily launching fee on Green Bay

39 **Not including ice fishing, how likely are you to go fishing (on the waters of Green Bay <u>and</u> elsewhere) between now and December 31, 1998?** *Circle one number*

1 I *definitely won't* fish
2 I *probably won't* fish
3 I *probably will* fish ☞
4 I *definitely will* fish ☞

> Not including ice fishing, on how many days do you think you will go fishing between now and December 31, 1998? *Fill in the blank*
>
> ______ additional days of fishing

40 **If the ice comes in at the usual time this winter, how likely are you to go ice fishing (on the waters of Green Bay <u>and</u> elsewhere) between now and December 31, 1998?** *Circle one number*

1 I *definitely won't* go ice fishing
2 I *probably won't* go ice fishing
3 I *probably will* go ice fishing ☞
4 I *definitely will* go ice fishing ☞

> On how many days do you think you will go ice fishing between now and December 31, 1998? *Fill in the blank*
>
> ______ additional days of ice fishing

41 **What is the highest grade or level of school you have completed?** *Circle one number*

1 Did not complete high school
2 High school diploma or equivalent
3 Some college, two year college degree (AS) or technical school
4 Four year college graduate (BA, BS)
5 Some graduate work but did not receive a graduate degree
6 Graduate degree (MA, MS, MBA, PhD, JD, MD, etc.)

42 **What was your *household* income (before taxes) in 1997?** *Circle one number*

1 Less than $10,000
2 $10,000 to $19,999
3 $20,000 to $29,999
4 $30,000 to $39,999
5 $40,000 to $49,999
6 $50,000 to $59,999
7 $60,000 to $79,999
8 $80,000 to $99,999
9 $100,000 to $149,999
10 $150,000 or more

Table E-1
Version 1 Choice Pairs

	Pair 1		Pair 5	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	30 minutes	20 minutes	20 minutes	40 minutes
Trout / Salmon catch rate	12 hours	6 hours	4 hours	8 hours
Walleye catch rate	2 hours	4 hours	12 hours	6 hours
Smallmouth bass catch rate	4 hours	12 hours	4 hours	2 hours
FCA level	FCA 2	FCA 4	FCA 7	FCA 5
Your share of daily launch fee	$7	$10	Free	$2
	Pair 2		Pair 6	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	10 minutes	1 hour	20 minutes	40 minutes
Trout / Salmon catch rate	2 hours	4 hours	1 hour	12 hours
Walleye catch rate	6 hours	1 hour	2 hours	8 hours
Smallmouth bass catch rate	1 hour	2 hours	6 hours	12 hours
FCA level	FCA 9	FCA 8	FCA 5	FCA 9
Your share of daily launch fee	$12	$3	$5	$3
	Pair 3		Pair 7	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	40 minutes	10 minutes	1 hour	10 minutes
Trout / Salmon catch rate	1 hour	8 hours	8 hours	6 hours
Walleye catch rate	12 hours	8 hours	12 hours	2 hours
Smallmouth bass catch rate	8 hours	6 hours	1 hour	2 hours
FCA level	FCA 6	FCA 3	FCA 2	FCA 1
Your share of daily launch fee	$15	$9	$10	$15
	Pair 4		Pair 8	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	1 hour	30 minutes	10 minutes	30 minutes
Trout / Salmon catch rate	2 hours	6 hours	1 hour	4 hours
Walleye catch rate	4 hours	1 hour	4 hours	6 hours
Smallmouth bass catch rate	8 hours	1 hour	4 hours	8 hours
FCA level	FCA 1	FCA 7	FCA 8	FCA 4
Your share of daily launch fee	Free	$5	$2	$9

Table E-2
Version 2 Choice Pairs

	Pair 1		Pair 5	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	40 minutes	1 hour	1 hour	10 minutes
Trout / Salmon catch rate	2 hours	12 hours	1 hour	12 hours
Walleye catch rate	1 hour	8 hours	12 hours	1 hour
Smallmouth bass catch rate	12 hours	6 hours	12 hours	8 hours
FCA level	FCA 3	FCA 6	FCA 9	FCA 7
Your share of daily launch fee	$7	$12	$9	$10
	Pair 2		Pair 6	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	20 minutes	30 minutes	20 minutes	40 minutes
Trout / Salmon catch rate	12 hours	2 hours	2 hours	4 hours
Walleye catch rate	1 hour	12 hours	6 hours	2 hours
Smallmouth bass catch rate	1 hour	6 hours	4 hours	6 hours
FCA level	FCA 1	FCA 5	FCA 6	FCA 1
Your share of daily launch fee	$2	$3	$15	$10
	Pair 3		Pair 7	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	1 hour	30 minutes	10 minutes	30 minutes
Trout / Salmon catch rate	6 hours	8 hours	6 hours	8 hours
Walleye catch rate	6 hours	2 hours	8 hours	4 hours
Smallmouth bass catch rate	4 hours	12 hours	1 hour	2 hours
FCA level	FCA 3	FCA 8	FCA 5	FCA 9
Your share of daily launch fee	$5	Free	Free	$15
	Pair 4		Pair 8	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	20 minutes	40 minutes	10 minutes	40 minutes
Trout / Salmon catch rate	1 hour	4 hours	4 hours	8 hours
Walleye catch rate	8 hours	4 hours	12 hours	1 hour
Smallmouth bass catch rate	2 hours	8 hours	12 hours	4 hours
FCA level	FCA 4	FCA 2	FCA 6	FCA 4
Your share of daily launch fee	$7	$12	$5	$12

Table E-3
Version 3 Choice Pairs

	Pair 1		Pair 5	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	1 hour	30 minutes	30 minutes	20 minutes
Trout / Salmon catch rate	2 hours	1 hour	4 hours	2 hours
Walleye catch rate	2 hours	4 hours	6 hours	12 hours
Smallmouth bass catch rate	8 hours	1 hour	4 hours	2 hours
FCA level	FCA 7	FCA 3	FCA 1	FCA 3
Your share of daily launch fee	$2	$3	$10	$12

	Pair 2		Pair 6	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	30 minutes	20 minutes	1 hour	10 minutes
Trout / Salmon catch rate	12 hours	6 hours	6 hours	8 hours
Walleye catch rate	8 hours	6 hours	12 hours	6 hours
Smallmouth bass catch rate	2 hours	6 hours	6 hours	12 hours
FCA level	FCA 2	FCA 8	FCA 4	FCA 7
Your share of daily launch fee	$9	$7	$2	$3

	Pair 3		Pair 7	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	40 minutes	20 minutes	40 minutes	10 minutes
Trout / Salmon catch rate	6 hours	8 hours	4 hours	12 hours
Walleye catch rate	2 hours	8 hours	8 hours	4 hours
Smallmouth bass catch rate	1 hour	8 hours	1 hour	2 hours
FCA level	FCA 6	FCA 8	FCA 9	FCA 4
Your share of daily launch fee	$9	$5	$7	$5

	Pair 4		Pair 8	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	10 minutes	1 hour	30 minutes	20 minutes
Trout / Salmon catch rate	1 hour	12 hours	1 hour	2 hours
Walleye catch rate	1 hour	4 hours	2 hours	1 hour
Smallmouth bass catch rate	6 hours	12 hours	8 hours	4 hours
FCA level	FCA 2	FCA 5	FCA 5	FCA 9
Your share of daily launch fee	Free	$15	$12	$9

Table E-4
Version 4 Choice Pairs

	Pair 1		Pair 5	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	40 minutes	1 hour	10 minutes	30 minutes
Trout / Salmon catch rate	1 hour	8 hours	8 hours	4 hours
Walleye catch rate	6 hours	1 hour	12 hours	1 hour
Smallmouth bass catch rate	2 hours	8 hours	4 hours	6 hours
FCA level	FCA 7	FCA 6	FCA 1	FCA 7
Your share of daily launch fee	Free	$7	$7	$15
	Pair 2		Pair 6	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	30 minutes	40 minutes	40 minutes	1 hour
Trout / Salmon catch rate	2 hours	12 hours	6 hours	1 hour
Walleye catch rate	8 hours	12 hours	4 hours	8 hours
Smallmouth bass catch rate	12 hours	1 hour	12 hours	2 hours
FCA level	FCA 1	FCA 8	FCA 8	FCA 6
Your share of daily launch fee	$2	$15	$12	$10
	Pair 3		Pair 7	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	1 hour	20 minutes	40 minutes	30 minutes
Trout / Salmon catch rate	4 hours	6 hours	2 hours	6 hours
Walleye catch rate	2 hours	4 hours	8 hours	12 hours
Smallmouth bass catch rate	4 hours	6 hours	4 hours	8 hours
FCA level	FCA 3	FCA 2	FCA 2	FCA 9
Your share of daily launch fee	$10	$3	$5	$2
	Pair 4		Pair 8	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	10 minutes	20 minutes	1 hour	20 minutes
Trout / Salmon catch rate	2 hours	12 hours	1 hour	4 hours
Walleye catch rate	2 hours	6 hours	6 hours	4 hours
Smallmouth bass catch rate	1 hour	8 hours	12 hours	1 hour
FCA level	FCA 4	FCA 3	FCA 2	FCA 5
Your share of daily launch fee	$3	Free	$15	$9

Table E-5
Version 5 Choice Pairs

	Pair 1		Pair 5	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	20 minutes	10 minutes	10 minutes	20 minutes
Trout / Salmon catch rate	8 hours	12 hours	2 hours	4 hours
Walleye catch rate	1 hour	2 hours	12 hours	2 hours
Smallmouth bass catch rate	2 hours	6 hours	2 hours	12 hours
FCA level	FCA 1	FCA 9	FCA 8	FCA 2
Your share of daily launch fee	$12	Free	$10	$2
	Pair 2		Pair 6	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	40 minutes	10 minutes	1 hour	10 minutes
Trout / Salmon catch rate	2 hours	4 hours	8 hours	12 hours
Walleye catch rate	4 hours	8 hours	8 hours	4 hours
Smallmouth bass catch rate	6 hours	12 hours	1 hour	4 hours
FCA level	FCA 7	FCA 3	FCA 4	FCA 6
Your share of daily launch fee	$7	$2	Free	$9
	Pair 3		Pair 7	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	1 hour	30 minutes	30 minutes	1 hour
Trout / Salmon catch rate	6 hours	12 hours	6 hours	1 hour
Walleye catch rate	1 hour	6 hours	1 hour	6 hours
Smallmouth bass catch rate	4 hours	1 hour	8 hours	6 hours
FCA level	FCA 5	FCA 8	FCA 3	FCA 1
Your share of daily launch fee	$3	$10	$15	$5
	Pair 4		Pair 8	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	30 minutes	40 minutes	20 minutes	40 minutes
Trout / Salmon catch rate	8 hours	1 hour	1 hour	12 hours
Walleye catch rate	2 hours	12 hours	8 hours	6 hours
Smallmouth bass catch rate	2 hours	8 hours	4 hours	2 hours
FCA level	FCA 6	FCA 4	FCA 7	FCA 5
Your share of daily launch fee	$5	$9	$3	$7

Table E-6
Version 6 Choice Pairs

	Pair 1		Pair 5	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	1 hour	30 minutes	30 minutes	40 minutes
Trout / Salmon catch rate	4 hours	2 hours	1 hour	6 hours
Walleye catch rate	4 hours	1 hour	1 hour	6 hours
Smallmouth bass catch rate	1 hour	12 hours	1 hour	4 hours
FCA level	FCA 9	FCA 6	FCA 2	FCA 4
Your share of daily launch fee	$12	Free	$7	$3
	Pair 2		Pair 6	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	10 minutes	20 minutes	10 minutes	40 minutes
Trout / Salmon catch rate	6 hours	8 hours	8 hours	4 hours
Walleye catch rate	12 hours	2 hours	6 hours	1 hour
Smallmouth bass catch rate	6 hours	8 hours	8 hours	2 hours
FCA level	FCA 7	FCA 9	FCA 2	FCA 9
Your share of daily launch fee	$12	$10	$3	$5
	Pair 3		Pair 7	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	40 minutes	10 minutes	30 minutes	1 hour
Trout / Salmon catch rate	8 hours	4 hours	1 hour	12 hours
Walleye catch rate	4 hours	8 hours	8 hours	2 hours
Smallmouth bass catch rate	6 hours	8 hours	4 hours	12 hours
FCA level	FCA 3	FCA 5	FCA 8	FCA 7
Your share of daily launch fee	$2	$15	$12	$7
	Pair 4		Pair 8	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	20 minutes	1 hour	30 minutes	20 minutes
Trout / Salmon catch rate	12 hours	2 hours	6 hours	2 hours
Walleye catch rate	12 hours	2 hours	4 hours	12 hours
Smallmouth bass catch rate	12 hours	2 hours	6 hours	1 hour
FCA level	FCA 1	FCA 8	FCA 6	FCA 3
Your share of daily launch fee	$5	$9	$10	$15

Table E-7
Version 7 Choice Pairs

	Pair 1		Pair 5	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	1 hour	40 minutes	1 hour	40 minutes
Trout / Salmon catch rate	12 hours	6 hours	2 hours	6 hours
Walleye catch rate	1 hour	8 hours	4 hours	2 hours
Smallmouth bass catch rate	6 hours	8 hours	8 hours	1 hour
FCA level	FCA 4	FCA 1	FCA 2	FCA 1
Your share of daily launch fee	$2	$9	$5	Free
	Pair 2		Pair 6	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	10 minutes	20 minutes	30 minutes	1 hour
Trout / Salmon catch rate	1 hour	4 hours	4 hours	8 hours
Walleye catch rate	6 hours	12 hours	6 hours	8 hours
Smallmouth bass catch rate	1 hour	2 hours	6 hours	4 hours
FCA level	FCA 6	FCA 5	FCA 8	FCA 9
Your share of daily launch fee	$2	Free	$7	$12
	Pair 3		Pair 7	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	20 minutes	10 minutes	20 minutes	10 minutes
Trout / Salmon catch rate	8 hours	2 hours	12 hours	1 hour
Walleye catch rate	4 hours	2 hours	2 hours	4 hours
Smallmouth bass catch rate	12 hours	4 hours	8 hours	2 hours
FCA level	FCA 7	FCA 4	FCA 6	FCA 1
Your share of daily launch fee	$9	$15	$3	$7
	Pair 4		Pair 8	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	30 minutes	40 minutes	40 minutes	30 minutes
Trout / Salmon catch rate	12 hours	1 hour	8 hours	2 hours
Walleye catch rate	12 hours	1 hour	12 hours	6 hours
Smallmouth bass catch rate	2 hours	12 hours	6 hours	12 hours
FCA level	FCA 3	FCA 5	FCA 2	FCA 4
Your share of daily launch fee	$3	$10	$15	$12

Table E-8
Version 8 Choice Pairs

	Pair 1		Pair 5	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	1 hour	10 minutes	20 minutes	30 minutes
Trout / Salmon catch rate	4 hours	6 hours	6 hours	8 hours
Walleye catch rate	8 hours	1 hour	8 hours	12 hours
Smallmouth bass catch rate	1 hour	4 hours	2 hours	4 hours
FCA level	FCA 7	FCA 8	FCA 2	FCA 5
Your share of daily launch fee	$5	$9	$15	$5
	Pair 2		Pair 6	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	20 minutes	30 minutes	1 hour	40 minutes
Trout / Salmon catch rate	2 hours	1 hour	4 hours	2 hours
Walleye catch rate	8 hours	4 hours	1 hour	6 hours
Smallmouth bass catch rate	6 hours	4 hours	12 hours	6 hours
FCA level	FCA 5	FCA 9	FCA 1	FCA 9
Your share of daily launch fee	$10	Free	$3	$9
	Pair 3		Pair 7	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	10 minutes	1 hour	20 minutes	10 minutes
Trout / Salmon catch rate	4 hours	6 hours	1 hour	12 hours
Walleye catch rate	12 hours	6 hours	2 hours	4 hours
Smallmouth bass catch rate	8 hours	2 hours	1 hour	8 hours
FCA level	FCA 4	FCA 3	FCA 8	FCA 7
Your share of daily launch fee	$7	$2	Free	$10
	Pair 4		Pair 8	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	40 minutes	20 minutes	40 minutes	10 minutes
Trout / Salmon catch rate	12 hours	8 hours	12 hours	6 hours
Walleye catch rate	2 hours	1 hour	12 hours	8 hours
Smallmouth bass catch rate	12 hours	1 hour	4 hours	12 hours
FCA level	FCA 3	FCA 6	FCA 2	FCA 9
Your share of daily launch fee	$12	$2	$2	$7

Table E-9
Version 9 Choice Pairs

	Pair 1		Pair 5	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	1 hour	30 minutes	30 minutes	10 minutes
Trout / Salmon catch rate	1 hour	8 hours	6 hours	12 hours
Walleye catch rate	2 hours	4 hours	12 hours	2 hours
Smallmouth bass catch rate	6 hours	1 hour	12 hours	6 hours
FCA level	FCA 3	FCA 4	FCA 2	FCA 9
Your share of daily launch fee	$9	$15	$9	$5
	Pair 2		Pair 6	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	20 minutes	40 minutes	20 minutes	1 hour
Trout / Salmon catch rate	4 hours	2 hours	12 hours	2 hours
Walleye catch rate	6 hours	1 hour	1 hour	4 hours
Smallmouth bass catch rate	2 hours	8 hours	6 hours	1 hour
FCA level	FCA 6	FCA 8	FCA 4	FCA 5
Your share of daily launch fee	$12	$5	$12	$7
	Pair 3		Pair 7	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	30 minutes	1 hour	40 minutes	30 minutes
Trout / Salmon catch rate	2 hours	8 hours	8 hours	4 hours
Walleye catch rate	8 hours	6 hours	2 hours	8 hours
Smallmouth bass catch rate	2 hours	8 hours	2 hours	8 hours
FCA level	FCA 7	FCA 5	FCA 7	FCA 8
Your share of daily launch fee	$3	Free	$10	$2
	Pair 4		Pair 8	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	10 minutes	40 minutes	1 hour	20 minutes
Trout / Salmon catch rate	1 hour	4 hours	6 hours	1 hour
Walleye catch rate	1 hour	4 hours	12 hours	6 hours
Smallmouth bass catch rate	1 hour	4 hours	4 hours	12 hours
FCA level	FCA 1	FCA 6	FCA 3	FCA 1
Your share of daily launch fee	$10	Free	$3	$15

Table E-10
Version 10 Choice Pairs

	Pair 1		Pair 5	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	20 minutes	10 minutes	30 minutes	1 hour
Trout / Salmon catch rate	6 hours	2 hours	2 hours	12 hours
Walleye catch rate	2 hours	1 hour	12 hours	1 hour
Smallmouth bass catch rate	8 hours	2 hours	6 hours	2 hours
FCA level	FCA 9	FCA 2	FCA 6	FCA 9
Your share of daily launch fee	$7	Free	$12	$15
	Pair 2		Pair 6	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	30 minutes	40 minutes	20 minutes	1 hour
Trout / Salmon catch rate	12 hours	8 hours	4 hours	6 hours
Walleye catch rate	6 hours	8 hours	6 hours	4 hours
Smallmouth bass catch rate	1 hour	6 hours	1 hour	8 hours
FCA level	FCA 7	FCA 1	FCA 2	FCA 1
Your share of daily launch fee	$9	$3	$3	$12
	Pair 3		Pair 7	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	10 minutes	1 hour	30 minutes	20 minutes
Trout / Salmon catch rate	4 hours	1 hour	4 hours	12 hours
Walleye catch rate	4 hours	12 hours	2 hours	8 hours
Smallmouth bass catch rate	12 hours	4 hours	2 hours	4 hours
FCA level	FCA 3	FCA 8	FCA 4	FCA 3
Your share of daily launch fee	$5	$15	$2	$10
	Pair 4		Pair 8	
	Alternative A	Alternative B	Alternative A	Alternative B
Yellow perch catch rate	10 minutes	40 minutes	40 minutes	10 minutes
Trout / Salmon catch rate	8 hours	1 hour	6 hours	8 hours
Walleye catch rate	2 hours	8 hours	12 hours	1 hour
Smallmouth bass catch rate	4 hours	12 hours	1 hour	12 hours
FCA level	FCA 5	FCA 4	FCA 7	FCA 5
Your share of daily launch fee	$2	$10	$5	$9

Hagler Bailly

Hagler Bailly Consulting, Inc.
University Research Park
455 Science Drive
Madison, Wisconsin 53711-1058

Tel: (608) 232-2800
Fax: (608) 232-2858

«CASEID»--V«VERSION»
«Recruit_date»

Dear «Fname» «Lname»,

Thank you for talking to us a few days ago about your fishing experiences. Your comments were very helpful. Enclosed are the additional questions we mentioned on the phone. There are many important management decisions to be made concerning fishing in and around Green Bay. This study is being conducted to obtain information from anglers like you to help make these decisions.

It is important that this survey be filled out by you. We could not send this survey to every person who fishes the waters of Green Bay. You are part of a small group of anglers who have been scientifically selected to participate in this survey. Regardless of whether you have fished the waters of Green Bay often or only once, it is important that we hear your opinions. Your answers will represent the views of many other anglers similar to yourself and will allow consideration of your opinions in deciding which Green Bay management options to pursue.

The survey takes most people about 30 minutes to complete, sometimes more, sometimes less. Answers to this survey are confidential; your name will never be revealed. Information from the survey will only be reported in statistical terms. There is an identification number on the back of the survey so that Hagler Bailly, Inc., the firm hired to conduct the survey, can combine the information from your mail survey with the information you provided over the telephone.

A summary of the results of this study will be made available to government and industry representatives. If you would like a summary of the results, simply put your name, address, and "copy of results requested" on the back of the return envelope. We expect to have results in the spring of 1999.

If you have any questions about the study, we would like to hear from you. You can call me collect at 0-608-232-2800. Thank you.

Sincerely,

Pam Rathbun
Hagler Bailly Survey Manager

P.S. We appreciate your help and have enclosed a small gift as a token of our appreciation.

Hello,

A few days ago you should have received a survey asking your opinions about fishing on the waters of Green Bay. If you have already completed and returned the survey, please consider this a "thank you."

It is very important that we hear your opinions. By completing the survey you can make sure that government officials hear your opinion. We cannot survey all Green Bay anglers, so your responses will represent other anglers who are like you, but were not selected to participate in this study.

Thank you for your help.

Pam Rathbun, Hagler Bailly Survey Manager

---

c/o '   'er Bailly   455 Science Drive   Madison, WI 537'   '058

Initial cover letter to anglers
refusing second phase

Hagler Bailly

Hagler Bailly Consulting, Inc.
University Research Park
455 Science Drive
Madison, Wisconsin 53711-1058

Tel: (608) 232-2800
Fax: (608) 232-2858

«caseid»--v«Version»
«Recruit_date»

Dear «fname» «lname»,

Thank you for talking to us late last year about your fishing experiences. Your comments helped us understand the amount of fishing that occurs on the waters of Green Bay. As part of this study, we are sending out a short mail survey that will help us understand how anglers feel about different management options that could affect fishing on the waters of Green Bay.

We are hoping that you can take the time to fill out this survey. You are part of a small group of anglers who have been scientifically selected to participate in this survey. Regardless of whether you fished the waters of Green Bay often or only once in 1998, it is important that we hear your opinions. Your answers will represent the views of many other anglers similar to yourself and will allow consideration of your opinions in deciding which Green Bay management options to pursue.

It is important that this survey be filled out by you. The survey takes most people about 30 minutes to complete, sometimes more, sometimes less. Answers to this survey are confidential; your name will never be revealed. Information from the survey will only be reported in statistical terms. There is an identification number on the back of the survey so that Hagler Bailly, the firm hired to conduct the survey, can combine the information from your mail survey with the information you provided over the telephone.

A summary of the results of this study will be made available to government and industry representatives. If you would like a summary of the results, simply put your name, address, and 'copy of results requested' on the back of the return envelope. We expect to have results in the spring of 1999.

If you have any questions about the study, we would like to hear from you. You can call me collect at 0-608-232-2800. Thank you.

Sincerely,

Pam Rathbun
Hagler Bailly Survey Manager

P.S. We appreciate your help and have enclosed a small gift as a token of our appreciation.

Follow-up mail survey
cover letter

Hagler Bailly

Hagler Bailly Consulting, Inc.
University Research Park
455 Science Drive
Madison, Wisconsin 53711-1058

Tel: (608) 232-2800
Fax: (608) 232-2858
«caseid»--v«Version»
«Recruit_date»

Dear «fname» «lname»,

A few weeks ago, we sent you a survey asking about your fishing experiences. We are pleased that many anglers have returned their survey, but we still would like to hear from you. If you recently mailed our survey back to us, please accept our thanks and disregard this letter.

We realize this is a busy time of the year for many people, and we greatly appreciate your taking the time to help us out. Since we were only able to survey a small number of anglers, your response is very important. Regardless of whether you have fished the waters of Green Bay often or only once, it is important that we hear your opinions. Your answers will represent the views of many other anglers similar to yourself and will allow consideration of your opinions in deciding which Green Bay management options to pursue.

In the event that your survey has been misplaced, a replacement survey and a postage paid, self-addressed envelope are enclosed for your convenience.

A summary of the results of this study will be made available to government and industry representatives. If you would like a summary of the results, simply put your name, address, and "copy of results requested" on the back of the return envelope. We expect to have results in the spring of 1999.

If there is anything we can do to help you complete this survey, please feel free to call me collect at 0-608-232-2800.

Your cooperation in this study is greatly appreciated!

Sincerely,

Pam Rathbun
Hagler Bailly Survey Manager

1999 follow-up mail survey
cover letter

Hagler Bailly

Hagler Bailly Consulting, Inc.
University Research Park
455 Science Drive
Madison, Wisconsin 53711-1058

Tel: (608) 232-2800
Fax: (608) 232-2858

«caseid»--v«Version»
«Recruit_date»

Dear «fname» «lname»,

A few weeks ago, we sent you a survey asking about your fishing experiences. We are pleased that many anglers have returned their survey, but we still would like to hear from you. If you recently mailed our survey back to us, please accept our thanks and disregard this letter.

We greatly appreciate your taking the time to help us out. Since we were only able to survey a small number of anglers, your response is very important. Regardless of whether you have fished the waters of Green Bay often or only once, it is important that we hear your opinions. Your answers will represent the views of many other anglers similar to yourself and will allow consideration of your opinions in deciding which Green Bay management options to pursue.

In the event that your survey has been misplaced, a replacement survey and a postage paid, self-addressed envelope are enclosed for your convenience.

A summary of the results of this study will be made available to government and industry representatives. If you would like a summary of the results, simply put your name, address, and "copy of results requested" on the back of the return envelope. We expect to have results in the spring of 1999.

If there is anything we can do to help you complete this survey, please feel free to call me collect at 0-608-232-2800.

Your cooperation in this study is greatly appreciated!

Sincerely,

Pam Rathbun
Hagler Bailly Survey Manager

Second follow-up mail survey
cover letter

Hagler Bailly

Hagler Bailly Consulting, Inc.
University Research Park
455 Science Drive
Madison, Wisconsin 53711-1058

Tel: (608) 232-2800
Fax: (608) 232-2858

«caseid»--v«Version»
«Recruit_date»

Dear «fname» «lname»,

I am sorry to bother you again, but it is important to hear from you. Good decisions about managing Green Bay can only be made if we know how people like you will be affected. I was able to survey only a small number of anglers. This means that your responses will represent not only you but also the views of other anglers like you. It also means that to get a good understanding of the range of opinions about the issues, I must hear from as many people as possible.

Regardless of whether you have fished the waters of Green Bay often or only once, it is important that we hear your opinions. You can be assured that your responses to this survey will be kept confidential; your name will never be revealed to anyone. Information from the survey will be reported only in statistical terms. The identification number on the back of the survey is used only for tracking purposes so we can avoid re-contacting those people who have already completed the survey.

Because your response is so important, I am enclosing another copy of the survey and a postage-paid, self-addressed envelope for your convenience. If for some reason you can't complete the survey, please write me a note on your survey booklet and return it. When you have completed the survey, simply return it in the postage-paid envelope.

If you have any questions about this study, we would like to hear from you. Please feel free to call me collect at 0-608-232-2800.

Thank you for your help !

Sincerely,

Pam Rathbun
Hagler Bailly Survey Manager

Special third follow-up mail survey
cover letter

Hagler Bailly

Hagler Bailly Consulting, Inc.
University Research Park
455 Science Drive
Madison, Wisconsin 53711-1058

Tel: (608) 232-2800
Fax: (608) 232-2858

«caseid»-v«Version»
«Recruit_date»

Dear «fname» «lname»,

In December we sent you a survey booklet asking about your opinions on fishing the waters of Green Bay. We realize that the holiday season was a busy time of year and your spare time might have been limited. Now that the holidays are over, we are hoping that you can still help us out.

As I mentioned before, I was able to survey only a small number of anglers so it is very important that I hear from all the anglers that I mailed a survey to. Good decisions about managing Green Bay can only be made if we know how people like you will be affected.

Regardless of whether you have fished the waters of Green Bay often or only once, it is important that we hear your opinions. Your responses will be used to represent the responses of other anglers who are similar to you. You can be assured that your responses to this survey will be kept confidential; your name will never be revealed to anyone. Information from the survey will be reported only in statistical terms.

Because your response is so important, I am enclosing another copy of the survey and a postage-paid, self-addressed envelope for your convenience. If for some reason you can't complete the survey, please write me a note on your survey booklet and return it. When you have completed the survey, simply return it in the postage-paid envelope.

If you have any questions about this study, we would like to hear from you. Please feel free to call me collect at 0-608-232-2800.

Thank you for your help !

Sincerely,

Pam Rathbun
Hagler Bailly Survey Manager

THE GREEN BAY FISHING SURVEY
PROJECT MANAGER: PAM RATHBUN
PROJECT NUMBER: T580-889

BACKGROUND/OBJECTIVES

The ultimate goal of this project is to collect data on how anglers feel about fishing conditions on Green Bay. The project consists of two survey efforts: A telephone screening interview and a follow-up mail survey. We will use the telephone screener to identify individuals who have fished the waters of Green Bay since January 1, 1998 and those who have fished since January 1, 1998 but not on the waters of Green Bay. We will then use a mail survey to follow-up with Green Bay anglers and non Green Bay anglers identified in the telephone screening interview.

SAMPLING

The initial sample consists of scientifically selected individuals who purchased fishing licenses in 8 counties in northeast Wisconsin in 1997. To provide a sufficient number of completed mail surveys for statistical analyses, our initial sample we will consist of more than 10,000 licensed anglers. The vast majority of the anglers will reside in Wisconsin.

INTRODUCTION

The Introduction section of the survey introduces the interviewer and the survey. All respondents should be informed of the interviewer's name.

While much of this effort focuses on the issues of fish contamination in the waters of Green Bay, it is important to minimize the emphasis on this issue. We have attempted to minimize this focus in the instrument, however we still have to ask some direct questions about Green Bay and fish contamination. Because of this you might get individuals who ask you questions about the purpose of this study. If asked about the purpose of this study, **do not** mention the Green Bay/ fish contamination issue. Rather, simply restate the purpose of the project as contained in the introduction to the survey "This is a study of peoples' opinions about fishing".

GENERAL INSTRUCTIONS

1. Wording-The questions *must be* read verbatim. Methodological studies have shown that even slight changes in wording, for example, 'should' versus 'could', drastically influence item response. It is very important that you read the questions verbatim which means you cannot delete or add any words to a question. It is incorrect to change a word to clarify a question. Remember the quality of the data depends upon interviewers reading the exact same words, and allowing the respondent to decipher the meaning of the question. If the respondent does not understand the question, re-read it once.

2. Probing Questions Properly-If a respondent does not answer a question properly, you are responsible for probing to get an appropriate answer. You should probe in a neutral or non-leading manner. Effective probing requires knowing the question objective and listening actively to the respondent to decide whether the objectives have been met. If they have not been met you need to probe to get an appropriate response.

3. Codes for Refused Questions-Items in the survey that are refused are coded with an 'r'. Please probe these questions at least once by telling the respondent how important the question is and reminding them that their responses will be kept strictly confidential. All information they provide will be combined with the responses of other households, and their name will not be associated with the final data.

4. Codes for Don't Know-Items in the survey that the respondent does not know need to be coded as a 'd'. Please probe these questions at least once to find out if the respondent really does not know or just needs to think about the answer.

5. 'Other-SPECIFY'- At question 10, 11, 19, and 20 the response codes are not exhaustive. At these questions there are codes designated as 'Other-SPECIFY'. If a respondent gives a response not covered by the pre-coded responses, the interviewer should enter the 'other' code and type out the respondents' verbatim response.

PROCEDURES

We are calling households in this study so the calling hours for this project will be Monday through Friday, 4:00 p.m. until 9:00 p.m, Saturday and Sunday, 12 Noon until 5:00 p.m. Each interviewer should work at least one weekend shift. Each interviewer should complete at least 2 screening surveys per hour. Answering machine messages will be read verbatim as they appear on the computer screen.

CONTACT

If the respondent has any questions about the survey they may speak with Pam Rathbun. Since Pam generally will not be at the office during calling hours, you should try to schedule a time with the respondents for Pam to call them back (fill out a sheet with the nature of the question and the best time to call back in the notebook provided).

RESULTS

The primary use of the data from the this study will be to estimate statistical models explaining how anglers respond to a wide range of possible fishing conditions.

QUESTION-BY-QUESTION INSTRUCTIONS

1- 4 In this section we find out if the respondent has been **ice fishing** since the beginning of the year (January 1, 1998). If the respondent has been ice fishing we find out on how many days the respondents ice fished and where the respondent ice fished. For this survey we are particularly interested in fishing activity on the "waters of Green Bay". When we say the waters of Green Bay we include the bay of Green Bay, Sturgeon Bay, and the rivers and streams that feed into Green Bay up to their first dam. We have included a map for you to see what we mean by the waters of Green Bay. This is a critical definition and you must make sure that you read the definition verbatim in Q2. Note that the Fox River between Green Bay and the dam at DePere is a sub-set of the waters of Green Bay. We expect only a small proportion of the target anglers will report going ice fishing.

5 - 8 In this section we find out if the respondent has been **fishing in the open waters** (not ice fishing) since the beginning of the year (January 1, 1998). If the respondent has been fishing (not ice fishing) we find out on how many days the respondents fished and where the respondent fished. For this survey we are particularly interested in fishing activity on the "waters of Green Bay". When we say the waters of Green Bay we include the bay of Green Bay, Sturgeon Bay, and the rivers and streams that feed into Green Bay up to their first dam. We have included a map for you to see what we mean by the waters of Green Bay. This is a critical definition and you must make sure that you read the definition verbatim in Q6. Note that the Fox River between Green Bay and the dam at DePere is a sub-set of the waters of Green Bay

If the respondent has fished the waters of Green Bay since January 1, 1998, the program will take you to Q12. If the respondent has **not** fished the waters of Green Bay since January 1, 1998, the program will take you to the <NOT RECENT> Section, Q9, Q10 and Q11.

9 In this question we find out if the respondent **ever** fished the waters of Green Bay. If not the program will take you to Q11.

10 Here we find why the respondent hasn't fished the waters of Green Bay since the first of the year. This question is designed to be open-ended. Listen to responses and code them if they fall into one of the categories pre-specified categories, if you are not sure enter the response verbatim under the "other" category. Be sure to prompt the respondent with "Any other reasons?" The program will allow up to 6 reasons.

11 Here we find if the respondent would fish the waters of Green Bay if conditions were different. This question is designed to be open-ended. Listen to responses and code them if they fall into one of the categories pre-specified categories, if you are not sure enter the response verbatim under the "other" category. Be sure to prompt the respondent with "Anything else?" The program will allow up to 6 reasons.

12 Determine how respondent feels about contaminants in fish.

13 Determine how respondent feels about various management actions that could affect fishing in Wisconsin. The order in which these items are presented will change between respondents.

14 - 23 These questions simply collect background characteristics of the respondents. Race (Q20) is sometimes a sensitive question. Please remind the respondent about confidentiality and tell them that it is important for us to get a representative sample of different types of households.

Recruit Two versions of the mail survey are being prepared. The first is for those who have fished the open waters of Green Bay since 1/1/98. The second is for those who have fished in open waters since 1/1/98 but did not fish Green Bay. Thus, the sample for the mail follow-up survey of Green Bay anglers will consist of every angler who has fished the open waters of Green Bay since January 1, 1998 who agrees to receive the mailing. The sample for the mail follow-up survey of non Green Bay anglers will consist of 2 out of every 3 persons who fished in open waters but not in Green Bay (NOTE: the computer will automatically tell you if you are to recruit people or not.)

THE GREEN BAY FISHING SURVEY
PROJECT NUMBER: T580-889
ANSWERS TO COMMON QUESTIONS

Q: Who is Hagler Bailly?
A: Hagler Bailly is a professional survey research firm hired to assist with this study.

Q: How did you get my name?
A: Your name was scientifically selected from a list of people who purchased fishing licenses in 1997.

Q: What do you mean "scientifically" selected?
A: Your name was selected according to a sampling plan. This sampling plan was designed to produce a representative sample of individuals purchasing fishing licenses in North East Wisconsin.

Q: Who is sponsoring this study?
A: This study is being done to provide results to government and industry representatives. To avoid any biases, the sponsors are not named.

Q: Why is this study being done?
A: There are many important management decisions concerning fishing in and around Green Bay. This survey is being conducted to understand anglers preferences to be better able to manage fishing.

Q: Does this have anything to do with the EPA/Superfund business on the Fox River?
A: The results will be useful to the state and federal government, and to industry, for many resource management activities. I was not informed of any more specific purpose for the study.

Q: Do you really want to hear from me? I don't fish very often.
A: Many anglers only fish once or just a few times a year. To obtain input representing all anglers, it is important to have a sample that includes opinions of anglers like you.

Q: Is this confidential?
A: Yes, most definitely! All the information we release is in terms of the percent of respondents that provided certain answers to certain questions. In this form, no individual respondent can be identified. Confidentiality is terribly important to the success of our work, as we do many surveys. Thus, we are very careful to protect an individual's anonymity.

If respondent is not satisfied with these answers or wants more information, please say "That is all the information I have about this study. If you need more information I can arrange to have you speak with one of my supervisors."

If respondent offers comments that are not directly related to any of the questions in the screener, please say "I will make a note of that on the survey form. All results will be made available to all interested parties."

APPENDIX F
SUPPORTING DATA

Table F-1
Avidity for Anglers Who Fished Green Bay in 1998 by Gender
(telephone survey data)

	Telephone Screener Respondents		Mail Survey Respondents	
	Male	**Female**	**Male**	**Female**
Number in sample	742	164	528	119
Mean total days (SE) - Open water	25.7 (0.93)	16.5 (1.58)	26.52 (1.11)	15.9 (1.58)
Mean Green Bay days (SE) - Open water	9.7 (0.52)	7.0 (0.89)	10.5 (0.64)	6.9 (0.82)
Mean total days (SE) - Ice and open water	31.1 (10.7)	19.3 (2.08)	31.0 (1.26)	17.7 (1.84)
Mean Green Bay days (SE) - Ice and open water	11.5 (0.6)	8.0 (0.98)	11.7 (0.73)	7.7 (0.91)

Table F-2
Type of License Purchased by Angler for Telephone Completes vs. Incompletes

Type of License	All Anglers Set Up		Completed Telephone Survey		Did Not Complete Telephone Survey	
	N	%	N	%	N	%
1. Resident	3,149	46.3%	1,456	45.6%	1,693	46.9%
2. Husband and wife	1,593	23.4%	826	25.9%	767	21.3%
3. Sportsman	581	8.5%	312	9.8%	269	7.5%
4. 2 day	608	8.9%	237	7.4%	371	10.3%
5. Nonresident annual	178	2.6%	84	2.6%	94	2.6%
6. Nonresident 15 day	98	1.4%	43	1.3%	55	1.5%
7. Nonresident 4 day	414	6.1%	153	4.8%	261	7.2%
8. Nonresident family annual	93	1.4%	40	1.3%	53	1.5%
9. Nonresident family 15 day	75	1.1%	34	1.1%	41	1.1%
10. Patron	10	0.1%	5	0.2%	5	0.1%
Total	6,799	100.0%	3,190	100.0%	3,609	100.0%

Table F-3
County Where License Purchased for Telephone Completes vs. Incompletes

County Where License Was Purchased	All Anglers Set Up		Completed Telephone Survey		Did Not Complete Telephone Survey	
	N	%	N	%	N	%
1. Brown	1,407	20.7%	658	20.6%	749	20.8%
2. Manitowoc	609	9.0%	317	9.9%	292	8.1%
3. Marinette	736	10.8%	354	11.1%	382	10.6%
4. Oconto	502	7.4%	247	7.7%	255	7.1%
5. Outagamie	1,011	14.9%	514	16.1%	497	13.8%
6. Winnebago	1,270	18.7%	554	17.4%	716	19.8%
7. Door	841	12.4%	343	10.8%	498	13.8%
8. Kewaunee	423	6.2%	203	6.4%	220	6.1%
Total	6,799	100.0%	3,190	100.0%	3,609	100.0%

Table F-4
Comments about Green Bay
(mail survey Question 2)

Reasons for Rating	Rating of Green Bay Relative to Other Places			
	Worse	**Same**	**Better**	**Don't Know**
Number of respondents	202	180	221	33
Site or use of site — negative (weather, location, facilities . . .)[a]	23.8%	8.3%	11.8%	0.0%
Site or use of site — positive (weather, location, facilities . . .)[a]	1.5%	2.8%	12.2%	0.0%
Catch — negative (poor rate, variety, size, limit . . .)[a]	50.5%	15.0%	14.0%	0.0%
Catch — positive (good rate, variety, size, limit . . .)[a]	4.5%	6.7%	49.3%	0.0%
General comment — negative (e.g., I don't like Green Bay/other place . . .)[a]	14.4%	5.0%	3.2%	0.0%
General comment — positive (e.g., I like Green Bay/other place . . .)[a]	1.0%	1.1%	20.4%	0.0%
Don't own a boat	0.0%	0.6%	0.9%	0.0%
Have limited information about Green Bay or other sites	13.9%	10.6%	4.5%	72.7%
Can't eat the fish/PCBs	16.8%	1.1%	4.5%	0.0%
Can eat the fish	0.5%	1.4%	0.0%	0.0%
Other pollution or contamination issues	7.4%	0.0%	1.4%	0.0%
Water is clean/clarity improving	3.0%	1.7%	5.4%	0.0%

a. Though respondents usually made comments about Green Bay relative to another site, some also made comments about other sites relative to Green Bay. Thus, respondents who think Green Bay is worse and respondents who think Green Bay is better, could both be coded as making a negative comment about fishing sites. In the former case the negative comment is about Green Bay and in the latter it is about another site. Most of the negative comments from respondents who rated Green Bay as "worse" pertained to Green Bay; the opposite is true for those rating Green Bay as "better."

Table F-5
Number of Reported *Open-Water Fishing* Days on Wisconsin Water of Green Bay in 1998, by Residence, for Mail Survey Respondents (combined telephone and mail survey data)

Residence	Number of Anglers	Total Trips		Days per Angler				
		Total	% of Total Green Bay Open-Water Days	Mean (SE)	Median	Mode	Min.	Max.
Other states Total	117	770	12%	6.6 (1.0)	4	1	1	95
Michigan	13	266	4%	20.5 (7.63)	10	1	1	95
Wisconsin, but not eight targeted counties	37	291	5%	7.9 (1.4)	4	2	1	30
Eight targeted counties	493	5,379	84%	10.9 (0.67)	5	2	1	120
Brown County	195	2,124	33%	10.9 (1.14)	5	2	1	120
Door County	46	792	12%	17.2 (2.93)	10	4	1	90
Kewaunee County	20	308	5%	15.4 (5.36)	6.5	1	1	90
Manitowoc County	49	382	6%	7.8 (1.36)	5	10	1	62
Marinette County	59	702	11%	11.9 (1.54)	6	5	1	60
Oconto County	37	400	6%	10.8 (2.06)	6	3	1	45
Outagamie County	53	388	6%	7.3 (1.31)	3	1	1	50
Winnebago County	34	283	4%	8.3 (2.28)	4	1	1	75
All mail survey respondents	647	6,440	100%	10.0 (0.55)	5	2	1	120

Table F-6
Number of Reported Fishing Days on the Fox River between the Mouth and DePere Dam as Compared to All Wisconsin Waters of Green Bay in 1998, for Telephone Survey Respondents Who Fished Green Bay in 1998 (N = 906)[a]
(telephone survey data)

	Total Days		Days per Angler				
	Total	% of Total Green Bay Fishing Days	Mean (SE)	Median	Mode	Min.	Max.
Green Bay total days							
All sites	9,832	100%	10.9 (0.52)	5	2	1	142
On Fox River	1,579	16.1%	1.7 (0.26)	0	0	0	130
Green Bay open-water days							
All sites	8,316	84.6%	9.2 (0.46)	5	2	0	120
On Fox River	1,365	13.9%	1.5 (0.23)	0	0	0	110
Green Bay ice-fishing days							
All sites	1,516	15.4%	1.7 (0.15)	0	0	0	50
On Fox River	214	2.2%	0.2 (0.05)	0	0	0	20

a. All anglers who fished the Wisconsin waters of Green Bay, including those who only open-water fished, only ice fished, or did both open-water and ice fishing.

Table F-7
Size of Fish Caught in the Wisconsin Waters of Lake Michigan Waters

Species	Mean Length (inches): 1988-1998[a]	Typical Range[b] (inches)
Coho salmon	21.52	11-26
Chinook salmon	27.34	20-35
Rainbow trout	26.13	20-30
Brown trout	20.87	16-24
Brook trout[c]	13.94	10-16
Lake trout	27.43	17-27
Walleye	Not reported	13-25

a. Source: WDNR, 1999 Wisconsin's 1998 Open Water Sportfishing Effort and Catch from Lake Michigan and Green Bay. http://www/dnr/state/wi/us/org/water/fhp/fish/lakemich.
b. Source: Wisconsin Sea Grant Fish of the Great Lakes. http://h2o.seagrantwisc.edu/communications/publications/Fish.Michpage.html.
c. 1988 through 1995 only. 1993 is the last year more than 100 brook trout were caught on Green Bay. There were no brook trout registered as caught after 1996 through 1998.

Table F-8
Anglers Purchasing Licenses in Eight Targeted Counties in 1997 by License Category

License Category	Number of Licenses	Number of Anglers[a]
1. Resident fishing	76,536	76,536
2. Nonresident fishing	5,575	5,575
3. Nonresident 15-day fishing	2,461	2,461
4. Sportsman	14,182	14,182
5. Patron	2,049	2,049
6. Resident husband and wife fishing	18,405	36,810
7. Nonresident family fishing	1,155	2,310
8. Nonresident family 15-day fishing	940	1,880
9. Two-day sports	15,716	7,858
10. Nonresident 4-day fishing	10,244	5,122
Total	147,263	**154,783**

a. Categories 1 through 5 licenses counted as one angler; categories 6 through 8 licenses counted as two anglers; categories 9 and 10 counted as half an angler.

Source for fishing licenses sold: Based on WDNR Bureau of Customer Service and Licensing, Report of Fishing Licenses Sold by County, B130-30.