ESTIMATING ECONOMIC BENEFITS

of Cleaning Up Contaminated Sediments in Great Lakes Areas of Concern

John R. Stoll
Richard C. Bishop
J. Philip Keillor

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University of Wisconsin Sea Grant Institute
1975 Willow Drive, Madison, WI 53706-1177

Grants

Great Lakes Protection Fund: Grant AOC594-1905 (to the University of Wisconsin-Madison), Grant AOC594-1906 (to the University of Wisconsin-Green Bay), Grant AOC594-1905 (to the University of Minnesota-Duluth), Grant AOC594-1904 (to the University of Windsor-Ontario).

U.S. Environmental Protection Agency: Grant GL985062-01-0 (to the University of Wisconsin-Madison).

Wisconsin Sea Grant Program: Grant No. GLPF-01

Sea Grant
University of Wisconsin

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Publication of this work was funded by the University of Wisconsin Sea Grant Institute under grants from the National Sea Grant College Program, National Oceanic & Atmospheric Administration, U.S. Department of Commerce, and from the State of Wisconsin. Federal Grant No. NA86RG0047, Project C/C-1.

WISCU-T-02-001

Edited by Elizabeth White
Designed by Carol Bracewell
Cover design by Amy Kittelson

PRICE: $5.00

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Communications Office
UW Sea Grant Institute
Goodnight Hall, 2nd Floor
1975 Willow Drive
Madison, WI 53706-1177
USA

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First Printing: January 2002
Printed in the USA

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Executive Summary

Sediment remediation has come to the Great Lakes Basin. In the past 13 years, 17 of 43 Great Lakes Areas of Concern (AOCs) have had 38 sediment remediation projects at a cost of nearly $600 million (SedPAC 1999; Zarull 1999). Most of these projects were the result of regulatory actions in which a specified mass of contaminated sediment had to be removed. Current interest in the economic analysis of benefits from remediation is indicated by a recent paper from a committee of the International Joint Commission (SedPAC 2000).

This booklet provides a critical look at possible methods for studying the economic benefits of sediment remediation. A two-stage approach based on the needs of decision-makers has been outlined. As a first stage, a simple scoping study based on easily acquired data and available studies done elsewhere may be all that is necessary to make a reasonably good judgment about whether benefits are likely to exceed expected costs or vice versa. If not, then a second stage involving a deeper investigation of benefits and costs can be conducted.

Scoping study results can be helpful in judging which valuation methods are most promising for arriving at useful, practical results. In this booklet, an example of proposed cleanup of PCBs from Wisconsin's Fox River in Wisconsin serves to illustrate how this would work in practice. In this case, high estimated remediation costs indicated that a scoping study alone would probably not be sufficient to judge whether or not benefits will exceed costs. It appeared that most of the benefits will be associated with recreation and nonuse values. The additional benefits of sediment cleanup associated with Great Lakes shipping and other potential beneficiaries are not well understood.

There are formidable technical problems to be overcome in estimating recreational benefits based on a travel cost analysis. Even if a good metric could be found, the resulting benefit estimates would likely fall far short of the expected remediation costs. However, the total value of the benefits, including nonuse values, could be larger than these costs. Therefore, in the case of Fox River sediment cleanup, it appears that the wisest strategy for evaluating the cleanup will be to do a contingent valuation study so that nonuse as well as use values can be considered in estimating the benefits of sediment cleanup.

Results from a contingent valuation study of potential Fox River cleanup showed that remediation of contaminated sediments is valued by citizens in the Fox-Wolf watershed, and beyond the watershed. These citizens are willing to put a dollar value on cleanup of these waters. Estimates from the contingent valuation survey indicate a "willingness to pay" range of $100 to $300 per household, annually. The estimates include a perceived $222 per household per year benefit from achieving 100% of the "desired state" in the Fox River/Green Bay AOC. Estimates vary depending upon the models and assumptions used.

Many citizens use the Fox-Wolf Basin and lower Green Bay, and they are concerned about the quality of its waters. A full 60% of all respondents indicated that they were worried or very worried about health problems that could be associated with eating fish caught in the Fox-Wolf Basin and lower Green Bay.

The information generated in this case study of the economic benefits for the Fox River/ lower Green Bay AOC provides a first step in evaluating the merits of contaminated sediment remediation. Benefit estimation for remediation projects will be hampered by a lack of information about how cleanup of specific sites will affect the larger ecosystem and the economic benefits tied to the larger ecosystem. In the case of the Fox River/lower Green Bay AOC, the consequences of sediment remediation on contaminant concentrations in fish were modeled in the prior Fox River/Green Bay Mass Balance Study (DePinto 1994, USEPA 1992 and 1993, WDNR 1991).

The problem about what to do with contaminants in the environment will often separate citizens into two camps. On the one side will be environmentalists who may be convinced that remediation should be carried out regardless of costs. From an economic perspective, they are assuming that benefits are very large or even infinite. On the other side will be economic interests who will be strongly oriented toward use values and particularly use values of market goods. This latter group may quickly come to the conclusion that benefits are small. A well-designed scoping study, followed where necessary by deeper second stage studies tailored to the situation, will help arrive at economically sound decisions by providing more objective information about the magnitude of some of the benefits of sediment remediation projects.

An approach described in this booklet uses the question: "Do we expect that the benefits of sediment cleanup will be larger than the cost for a particular alternative on a per household or individual basis?" This question gets beyond the more usual question: "What are the benefits of remediation?"

This approach makes a focus upon the costs of alternative remediation options a much more defensible one. Defensible, that is, as long as it is recognized that one needs to both choose the most cost-effective manner of achieving a given remediation goal and consider whether the goal itself is one which can be reasonably expected to yield benefits in excess of its minimized achievement costs. This approach to sediment remediation indicated that the costs of remediation, which at first glance seem quite intimidating, are more reasonable than one might initially expect. A critical variable in such an approach is a determination of how widely, and in what manner, the costs of remediation should be shared among responsible parties and those incurring cost savings from remediation.

If the per household cost of sediment remediation would equal the cost of milk in a month, a decision to remediate may seem reasonable. If the cost of sediment remediation per household would equal annual food expenditures, one might question whether households would find such a remediation decision acceptable.

There are other economic issues that can arise in considering sediment remediation projects. The issue of who would pay for sediment cleanup was not examined in this paper. Concerns about plant closings and loss of jobs arise if private parties pay the cleanup costs. This issue, though important, is beyond the scope of this booklet.

The best strategy for economic analysis may be different for other Great Lakes Areas of Concern (AOCs). If a scoping study shows that recreational, shipping, or other benefits are likely to predominate, a method or combination of methods other than contingent valuation could be applied where technically feasible.

There is a need to identify how to get the most benefits out of a sediment remediation effort. This suggests that the benefits and costs methodologies in a remediation decision framework should be used interactively in a manner allowing perceived benefits to alter options considered and vice versa.

This perceived need suggests that a benefits module should be written and incorporated into the REMSIM (REMediation SIMulation) software that was created in the project funded by the Great Lakes Protection Fund, the USEPA Great Lakes National Program Office, and Wisconsin Sea Grant. This software would allow a user to compare expected benefits and expected costs of sediment remediation in an AOC. A new benefits module in the software would incorporate the scoping approach discussed in this booklet. In addition, it would provide for usage of benefits transfer estimation based upon other studies of remediation benefits. The usefulness of such a module (and the methodology that supports it) will grow as case histories of the benefits of sediment remediation at other locations become available for module "calibration" and revision.

The economic benefits analysis described in this booklet can contribute to the current policy debate about natural resource valuation and damage assessment, and the benefits of sediment remediation in the Fox River valley and in the rest of the Great Lakes region. The general framework can enable the issues to be discussed in a more coherent fashion. All choices have both costs and benefits. There are opportunity costs associated with both the decision to remediate and the decision not to remediate contaminated sediments. The failure to make a decision to remediate is, in fact, a decision; it is a decision not to remediate. It is hoped that this booklet will assist citizens throughout the Great Lakes' region in making the "hard" choices in remediation issues reasonably and wisely.

Introduction

This booklet is drawn from a much larger *framework report* (Keillor et al. 2000) that documents the current state of development of a decision framework for sediment remediation, intended for use in Great Lakes AOCs. The framework was developed in 1995-1997 by research groups at four university campuses: The University of Windsor (Ontario, Canada); the University of Minnesota (Duluth), and the University of Wisconsin (Green Bay and Madison). This work was funded by the Great Lakes Protection Fund under Grant Number AOC594-1904, 1905, 1906; by the U.S. Environmental Protection Agency under Grant Number GL985062-01-0; and by the University of Wisconsin Sea Grant Institute under grants from the National Sea Grant Program, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, and from the State of Wisconsin. Federal Grant Number NA46RG0481, Project Number A/AS-24.

This booklet describes the work that was done to satisfy one of the project objectives: *to develop an economic analysis approach to benefits and costs of sediment remediation*. The authors of the booklet are: Dr. John Stoll, Director, Center for Public Affairs, University of Wisconsin, Green Bay (Section II, III, and Appendix); Dr. Richard Bishop, Department of Agricultural and Applied Economics, University of Wisconsin, Madison (Section I); and Philip Keillor, Sea Grant Institute, University of Wisconsin, Madison (project manager, executive summary and introduction).

The terms *framework* or *decision framework* refer to the entire assembly of developed benefits and costs methodologies plus the empty places where additional methodologies are needed to help make logical, coherent and comprehensive evaluations of options to remediate, or not to remediate, contaminated sediment deposits. The cost side of the framework consists of one or more chains (or trains) of linked steps in remediation from site investigation to disposal. The benefits side of the framework consists of one or more stages of economic analysis followed by a comparison with cost side estimates in an attempt to answer the question: Are the apparent economic costs of remediation justified by the economic benefits of remediation? The rationale for the framework is described in Keillor (1996).

Some of the Economic Benefits of Sediment Remediation

Interest in resource valuation has increased in recent years, including the Great Lakes Basin (SedPAC 2000). This includes interest in the economic benefits of sediment remediation. It was this interest in 1995-1997 on the part of the Great Lakes Protection Fund, the USEPA Great Lakes National Program Office and Wisconsin Sea Grant that led to funding of the benefits analysis that this booklet describes. Project economists have found the prediction of economic benefits to be a major challenge, given the very short history of sediment remediation.

There has been insufficient time for case histories and a "track record" of remediation benefits to develop and become available for analysis. In remediation projects, little attention has been paid to economy of effort, and to cost-effectiveness. As a result, there has been unanticipated cost growth (Keillor, 1993). Remediation has usually been mandated by governments and the magnitude of economic benefits of remediation have not been addressed.

Section II in this booklet outlines a two-stage approach to the benefits question, based on the needs of decision-makers. In the first stage, a simple scoping study based on easily acquired data and available studies done elsewhere may be all that is necessary to make a reasonably good judgment about whether benefits exceed expected costs or vice versa. If a simple study is not adequate, a deeper investigation of benefits and costs is needed. Contingent valuation appears to be one of the most promising ways to investigate the possible benefits of cleaning up contaminated sediments. Contingent valuation is a method of estimating total values (including nonuse values) that has gained substantial (but not universal) acceptance among economists (DOI 1994; Hanemann, 1994; Portney, 1994; NOAA, 2000; SedPAC 2000).

Section II also contains a scoping study example is given for calculating remediation costs over time on a per household basis. The example considers very large remediation costs ($700 million to $1 billion) for sediment cleanup in the Fox River/lower Green Bay Area of Concern (AOC), spent over five to ten years, and providing benefits for many decades. If costs are calculated on an annual basis, per household in the AOC region, then average annual costs per household may be within the range of benefits that result from the cleanup, as perceived by residents. This seems to be particularly true if costs are spread over multiple decades, similar to the expected time span of benefits.

Section III describes the economic analysis and methods used for a contingent valuation survey that was done in the Green Bay Area of Concern. The sampling strategy was based partly on the expectation that remediation benefits the population as a whole.

However, the residents of the counties closest to the area to be remediated will place a higher value on increased environmental quality in the area as a result of remediation because they have greater access and cause to use the affected resources, than those living further from the area. This group of residents, when surveyed, will demonstrate what is referred to as *use values*. Those residing farthest from the area to be remediated, and least likely to recreate within the remediation area, will probably have more of their valuation of remediation motivated by *existence values*.

Section IV describes the results of the contingent valuation survey that was done in the Green Bay Area of Concern in the spring of 1997, using a three-tiered, random, stratified sample of 1,500 households. The appendices contain the tables of results from the survey and the survey document.

There are other economic issues that can arise in considering sediment remediation projects.

Some of these issues are discussed in SedPAC (2000). The issue of who would pay for sediment cleanup was not examined in the economic analyses described in this booklet. Concerns about plant closings and loss of jobs arise if private parties pay the cleanup costs. This issue is important, and beyond the scope of this study.

The best strategy for economic analysis may be different at other AOCs (SedPAC 2000). Where a scoping study shows that recreational, shipping, or other benefits are likely to predominate, a method or combination of methods other than contingent valuation could be applied where technically feasible.

On the cost side of the decision framework within which our benefits analyses resides, a software program called REMSIM (REMediation SIMulation) was created to make the cost and performance estimates for the various steps in remediation. It seems possible to add a benefits module to the REMSIM software which may allow a user to compare expected benefits and expected costs of sediment remediation in an AOC. The usefulness of such a module and the methodology that supports it will grow rapidly with time as case histories of the benefits of sediment remediation at other locations in the Great Lakes Basin become available.

I

Economic Benefits of Sediment Remediation

A. Economic Analysis of Sediment Remediation

Most sediment remediation projects will involve efforts to remove, cap, or otherwise neutralize sediments containing toxic substances or other materials deleterious to environmental resources and/or humans. Economic analysis can be used to evaluate the costs and benefits of proposals to remediate contaminated sediments. The goal of such cost-benefit analyses is to evaluate the economic justification for sediment remediation. Are there sufficient benefits to society as a whole to justify the expenditure of public and/or private funds on sediment remediation projects?

Consider pending proposals to deal with PCBs in the sediments of Wisconsin's Fox River and lower Green Bay (a subject covered more fully in Section II). PCBs from recycling of carbonless carbon paper and other industrial sources entered the river over many years. Some PCBs were carried downstream to Green Bay immediately. The rest were deposited in river sediments and continue to be washed downstream and into the bay. PCBs have entered Green Bay from other sources, yet experts currently believe that the Fox River is the main source of PCBs now in Green Bay. Green Bay exports PCBs to Lake Michigan. Although production of new PCBs was banned many years ago, some old PCBs remain in the environment and cause various problems in the river and the bay, including contamination of fish consumed by humans and adverse effects on wildlife.

To illustrate how valuation methods might be applied to the Green Bay area, consider dredging Fox River PCB deposits and disposing of them in ways that would do little or no harm to the environment or people. Sediment deposits in Green Bay itself are too dispersed to make dredging feasible there, so current dredging proposals are limited to the Fox River. Though economic analyses of Fox River cleanup are very incomplete, enough is known to use this area as an illustration of how a full economic analysis would work. The economic benefits of other remediation options could be considered in a similar way.

For purposes of this evaluation, *full* cleanup of the Fox River PCBs is intended, meaning that all significant deposits would be removed, not every last pound of PCBs in the Fox River. It is important to recognize that real-world remediation projects can involve any level of cleanup that decision-makers and the public choose. Benefits and costs for a partial cleanup would be different (i.e., lower), but otherwise the analysis would take much the same form.

Our economic study could be planned and conducted in two stages, beginning with what we will term a "scoping study" and concluding with a second-stage study.

B. Scoping Studies

Scoping studies assess what can easily be learned about the potential benefits and costs of proposed projects. A scoping study alone might show that the benefits of a specific project are in all likelihood greater (or smaller) than the costs, or the study might simply help define what sort of more detailed second-stage study is needed before judgments about the relative magnitudes of benefits and costs can be made.

Scoping of Costs

Preliminary cost estimates are a necessary ingredient of a scoping exercise. These estimates require knowledge of the size of the sediment deposits; the alternative technologies available for removal, treatment and disposal; and the estimated costs of the remediation. The majority of this report is devoted to the process of evaluating costs, including the development of the REMSIM (Remediation Simulation) computer software to aid in this process. Costs are not only important in their own right but also serve as an important consideration in scoping out potential benefits, as shown in the "Benchmarking Benefits" section.

The costs of contaminated sediment removal from the Fox River have yet to be fully estimated, but current estimates for removal of all significant deposits range from $250 million to $750 million, taking 5 to 10 years. An alternative would be to roughly estimate the cost at $100 million per year for 10 years, or $1 billion (prior to discounting to a present value equivalent).

Benefits in Concept

Contaminated sediments may contain sufficient concentrations of toxic substances to harm plants, animals, and people through direct contact, but more often harmful effects show up via the mechanisms of bioaccumulation. Fish, birds, and mammals high on the food chain may accumulate levels of these substances sufficient to harm themselves or the people and predators that consume them. Economic losses occur as the use and nonuse values people place on affected resources are reduced. Use values are economic values that people place on their actual use of the resource, such as catching and eating fish and wildlife. Fish and wildlife may pick up PCBs from the sediments of the Fox River and lower Green Bay, transmitting them to humans. Nonuse values are the economic value that people place on a natural resource that they don't directly use. To the extent that natural resources are affected by PCBs, sediment cleanup will affect both use and nonuse values. Both types of values are discussed in following sections on economic methods.

Several categories of benefits from sediment remediation in the Fox River are obvious. Nearly all fish species used by recreational anglers in the river and lower Green Bay are subject to fish consumption advisories (FCAs). FCAs advise anglers and others who might eat their catch how to limit their fish consumption to minimize health risks. Primary emphasis is on protecting the health of fetuses and children, but cancer in adults is also a possible risk. If sediment remediation would help reduce or eliminate FCAs, several benefits might arise. Some potential Green Bay and Fox River anglers may have decided not to fish there because of the FCAs. If so, sediment cleanup and changes in FCAs would increase the number of angler days on the river and bay, thus increasing angling benefits. Additionally, the quality of fishing may have been adversely affected for those who have continued to fish there. They may practice catch-and-release fishing more often than they would prefer, fish for different species, or fish less often in response to the risks described in the FCAs. Therefore, if contaminant remediation leads to lower risks from eating the fish, those who have continued to fish the river and bay despite the health risks may receive benefits that would count as part of the benefits of remediation. Even those who are not anglers or potential fish consumers may benefit if the fish become safer to eat, since they may hold nonuse values for reducing the risks to others from fish consumption.

Though probably smaller in magnitude, similar benefits would probably accrue from reducing or eliminating existing consumption advisories for waterfowl taken by hunters in the area.

PCBs have been linked to other environmental problems as well. If sediment cleanup reduces or eliminates these problems, both use and nonuse benefits may be generated. Bald eagles have poor nesting success along the bay, and scientists believe PCBs are to blame. Similar effects are suspected for two species of terns, including one that is listed as endangered by the state of Wisconsin. Cormorant chicks have been found with deformed bills that limit their survival, although other contaminants may also be contributing to these deformities. PCBs may be partly to blame for different, subtler effects on birds and other wildlife that may be identified in the future. Scientists are currently investigating whether the lack of natural reproduction of lake trout in Green Bay is linked to PCBs. If remediation of Fox River sediments will reduce these various effects, a healthier ecosystem in Green Bay and Fox River may increase the value of these areas to users and nonusers.

Additional benefits might accrue to those involved in water transportation of goods and raw materials. Periodic dredging of shipping channels and harbors is necessary, and disposal of contaminated dredged material is often more expensive than disposal of clean dredged material. Clean dredged material can be reused for various purposes, offsetting some of the dredging and handling costs, whereas contaminated dredged material poses environmental hazards and may incur additional expenses. Cleaning up PCBs in the Fox River should lead to cleaner sediments in the Port of Green Bay and reduce the costs of dredging and disposal to maintain access to port facilities.

In sum, many of the benefits of sediment remediation are likely to be enjoyed by anglers as the FCAs are reduced or removed. However, hunters, nonconsumptive users of wildlife (e.g., bird watchers), property owners, and those who bear the costs of dredging of shipping channels and harbors might also benefit. The citizenry at large may hold nonuse values associated with reduced impacts of PCBs on fish, wildlife, and people.

Benchmarking Benefits

A good place to begin a benefits scoping exercise is to ask how large the benefits would have to be before they would equal, or exceed, costs. This is typically done on a per household or per person basis to place the dollar figures into perspective. If costs per household seem quite modest—say a few dollars or tens of dollars per household—remediation may seem economically justified. If there is widespread public support for remediation, one might judge that in all likelihood, benefits, if actually measured, would be very likely to exceed costs. In these cases, it might not be necessary to estimate benefits.

Benefit estimates from other studies of roughly comparable situations might be enough to reach an informed judgment about the economic justification for the remediation project in question. Should the scoping study show that costs per household are larger—say hundreds or thousands of dollars per household—the economic justification for remediation would be less clear. In this latter situation, more detailed second-stage studies to evaluate actual benefits should be considered, at a minimum, before casting judgment upon economic feasibility.

The Fox River-Green Bay situation can be used to illustrate how benchmarking benefits work. How great would the benefits have to be per household to equal or exceed the costs? For benchmarking purposes I will use the estimated costs of $100 million per year for 10 years mentioned earlier. Let us consider this question from several perspectives involving both the regional and state levels.

Assume that sediment remediation costs will be $100 million per year for 10 years. Assume that the discount rate is 3%. The present value of costs, PV(C), are given by the following equation:

$$PV(C)=(\$100\ million)\sum_{t=1}^{10}(1.03)^{-t}=\$853\ million.$$

Assume that B is the annual benefits of remediation, a fixed amount, accruing each year for a set number of years. For purposes of this analysis, I will assume that the "time horizon" over which benefits are to be counted is 50 years. Setting the time horizon is always somewhat arbitary, but because of discounting, using a longer time horizon would not make a lot of difference to the numbers. Using 50 years, the benchmark level for society as a whole is found by solving the following equation for B:

$$B\sum_{t=1}^{50}(1.03)^{-t} = PV(C) = \$853\ \text{million}$$

Solving, B = $34.12 million per year. B is the annual benefits over 50 years that would be needed before benefits would equal costs that are to be expended during the first 10 years. In order for benefits to exceed costs, *annual benefits would need to exceed $34.12 million*. This is the "aggregate benchmark" for purposes of the scoping study.

The aggregate benchmark is a starting point for the scoping analysis, but it is not very helpful by itself. We need a way of considering how plausible it is that aggregate benefits exceed the aggregate benchmark. We will do this by considering benchmarks that are stated in terms of annual household benefits. To get per-household benchmarks for benefits, $34.12 million is divided by the population of the area over which benefits are to be counted. Judging the "extent of the market" over which benefits should be counted is an important issue when benefits are actually measured. Because we have very little information about the boundaries of the area where people have a stake in Fox River and Green Bay resources, for purposes of the scoping study it will be necessary to explore the implications of alternative assumptions.

Our first assumption will be that benefits are confined to the 10 Wisconsin counties whose boundaries include or touch on portions of the Lower Fox River and Green Bay. According to the 2000 Census, there were 323,000 households in those counties. If only people in those counties would benefit from sediment remediation, the $34.12 million per year would amount to about $106 per household per year. For scoping purposes, the question then is whether benefits per household are likely to exceed $106 per household per year. We can think of the $106 as the "10-county benchmark."

Assuming that the beneficiaries of remediation would be limited to the 10-county region seems conservative. Surely many people living elsewhere would also benefit. A second assumption would be that all Wisconsonites (2.1 million households in 2000) are potential beneficiaries. Thus, we can calculate a "Wisconsin benchmark" of $16 per household per year and ask whether benefits appear likely to exceed that figure. Notice that this assumption does not require that each and every household in Wisconsin enjoy positive benefits from remediation. Many households could have no benefits so long as the *average* benefits exceed $16 when households having positive benefits are averaged in with those that would receive no benefits.

A third possible benchmark is suggested by the fact that the Bay of Green Bay extends into the state of Michigan. Wisconsin and Michigan combined had 5.9 million households in 2000. Thus, we can calculate a "Wisconsin-Michigan benchmark" of about $6 per household per year.

The question then becomes, what do we know about how actual benefits might compare with these benchmarks? We do have some clues. One source is the work conducted by Stratus Consulting (2000) for several federal agencies, Indian tribes, and the state of Michigan. The study was conducted as a part of a "Natural Resource Damage Assessment" and was designed to serve as a basis for determining how much restoration of natural resources would be necessary to make the public whole for losses incurred because of release of PCBs into the Fox River and Green Bay. However, results from the study can also be used to calculate monetary benefits from remediation of sediments. The results (Status Consulting, 2000, Appendix A, Table 6.2) imply that benefits from an aggressive plan that would reduce the time until PCBs decline to safe levels from 100 years to 20 years would be worth about $116 per household in the 10-county region per year for 10 years. To make this figure comparable to our benchmarks, we need to convert it to an annual value over 50 years. The calculation is equivalent to what you would do if you were considering paying off a major asset in annual payments over 10 years or lower annual payments over 50 years. It turns out that, after accounting for interest as well as principal, $116 per year for 10 years is equivalent to about $40 per year for 50 years. This falls short of our 10-county benchmark of $106, implying that costs exceed benefits. However, it applies only to households near the Lower Fox River and Green Bay. Presumably other people in Wisconsin would benefit as well. So no firm conclusion follows.

Another comparison is provided by a study of the benefits of sediment remediation in the California Bight off of Los Angeles (described as an example in the "Contingent Valuation" section of this chapter). The benefits to California households of capping a deposit of DDT and PCBs amounted to $56 per household as a lump sum (NRDA 1994). This is equivalent to $2.26 per household per year on average over 50 years. This would fall substantially below our Minnesota-Wisconsin benchmark of $6. If people in Wisconsin and Michigan value or benefit from sediment remediation in the Fox River similar to the value or benefit of California Bight cleanup to Californians, then this would leave one skeptical about whether the benefits of Fox River cleanup will exceed the costs.

On the other hand, John Stoll reports a study in detail below where he estimated that Wisconsin households are willing to pay between $100 and $300 per year for sediment remediation in the Lower Fox River. These estimates, though imprecise, compare very favorably with our Wisconsin benchmark of $16. Though this comparison leads to optimism about the possibility that the benefits of cleaning up the Fox River exceed the costs, it also seems to contradict results of the Stratus (2000) study cited above. Recall that the Stratus team's findings implied annual benefits of about $40 per household in the 10-county region. One would expect per-household benefits for the 10-county area to exceed those for the state as a whole. Presumably those living closer to the resource have higher values on average, but this does not happen when the Stoll and Status results are compared. As often happens in economics, it will not be possible to say which result is closest to being correct without further study.

Unfortunately, then, the scoping exercise is inconclusive about how likely it is that benefits would exceed costs for Fox River cleanup. Additional second stage studies would be needed in order to clarify the benefits. This will not always be the result of scoping exercises, however. Had the remediation costs been different in this exercise, the answer might have been clearer. For example, if the remediation costs are expected to be $10 million per year for ten years, it would have been much more likely that benefits will exceed costs. Statewide benefits would only have to be in the ballpark of the California Bight results for this to be true. If the remediation costs are expected to be an order of magnitude larger than what the scoping analysis assumed, the prospects for benefits exceeding remediation costs would be dim indeed.

It turns out, though, that the scoping does clarify what sorts of "second stage" economic valuation studies would help determine the relative magnitudes of benefits and costs.

C. Planning Second-Stage Studies

Scoping study results describe what sorts of benefits could be present, and they may reveal a bit about how large those benefits might be. At the second stage, planners must consider the prospects for successful application of alternative benefit valuation methods and the potential relevance of results in the decision-making process. For example, a study of recreational fishing values with and without FCAs will not reflect benefits of sediment clean-up to those who might otherwise have to deal with contaminated sediments dredged from shipping channels and harbors, for example. Choices among valuation methods will normally be based on the specific characteristics of the problem at hand, technical feasibility, and the size of the research budget. Specific characteristics will vary from site to site.

For example, if the scoping study shows that shipping-related benefits are likely to be predominant, market valuation methods may be most useful. If recreational benefits appear to be paramount, the travel cost method may be most useful. Most methods yield partial estimates of benefits, so it makes sense to measure the benefits that are expected to be large enough to matter in the overall comparison of benefits and costs. Bear in mind that a method that proves useful in one setting may not be feasible in another for technical reasons, as demonstrated in a following section for Fox River sediment cleanup. In some cases, desirable benefit studies may simply be unaffordable.

Assuming that additional benefit studies are being considered for Fox River sediment cleanup, consider the following methods: benefits transfer, market valuation, hedonic, travel cost demand, and contingent valuation.

Benefits Transfer

Benefits transfer is simply the transfer of results from one benefits study to another—clearly an inexpensive method.. The usefulness of benefits transfer for sediment remediation projects will begin when more valuation studies have been completed, especially some of the 37 sediment remediation projects undertaken in 42 Great Lakes Areas of Concern (Zarull 1999).

We did employ informal benefits transfer procedures as part of the scoping exercise when we compared benchmark benefit levels for Fox River sediment cleanup with benefit estimates for cleanup in the California Bight. Without more such studies, benefits transfer lacks the support needed to gain credibility as a standalone benefit estimation approach.

Market Valuation Studies

The commercial fisheries of Green Bay are so small that any benefits to them from Fox River cleanup will be of little consequence compared with remediation costs. Dredging is necessary to give Great Lakes ships access to the Port of Green Bay port facilities, as mentioned in the earlier Scoping Studies section. It is conceivable that Fox River cleanup could eventually reduce contaminant levels in dredged material and reduce the costs of disposal through beneficial reuse of the cleaner material. A thorough scoping study might show that a detailed study to document these benefits is worthwhile. The scoping study would be used to examine the amount of dredging that is likely to be needed in the future under various climate change and water level scenarios and the extent of the possible cost savings if dredged material can be reused. If this scoping effort shows that substantial benefits might be present, further study is needed to estimate the probable magnitude and timing of the benefits, their estimated effects on port survival or growth, and influence on the regional economy.

Hedonic Methods

If environmental amenities like clean air and clean water enhance the quality of life, we ought to be able to see their influence on property values. As home buyers, for example, consider buying property in different neighborhoods with different air quality levels, they can be expected to bid up the prices of homes where the air is cleaner compared to the prices of homes where air quality is poor.

The "hedonic price method" uses data on property values and housing characteristics (including neighborhood environmental quality) to infer the value residents place on environmental amenities. For example, a hedonic study of the Chicago area air quality applied statistical methods to compare property values in areas with relatively poor air quality with property values in areas with relatively good air quality. It was possible to assess how much air quality affected property values when other factors were held constant (NOAA, 2000).

Unfortunately, the relationship between PCBs in sediments and property values appear to be too complex and subtle to make hedonic studies promising. Most hedonic studies have been performed where there are substantial variations in environmental quality within a relatively limited geographic area.

The effects of PCBs are much less localized and variable than those of air quality in Chicago. For example, FCAs are somewhat different for the Fox River than for Green Bay, but within relatively large areas they are the same. To pick up the effects of PCBs on property values it would be necessary to find another region of the state or nation that is more or less comparable to the Green Bay region except for the PCB problem. This is a tall order.

Also, the areas of the Green Bay region where PCB contamination is the worst (in the Fox River and in Green Bay at the mouth of the Fox) also suffer from other water quality problems such as high turbidity and algae blooms, which would not be affected by PCB cleanup. It would be hard to sort out the effect of PCBs on property values, if any, from the effects of these other forms of pollution. Many of the benefits of cleanup, particularly those associated with nonuse values, would be overlooked by a hedonic study.

Travel Cost Demand Estimation

Since PCBs affect fishing, waterfowl hunting, and other outdoor recreation activities, the travel cost method appears applicable to Fox River cleanup, at least in principle. However, pursuing a travel cost study does not seem wise for a number of reasons. In this situation, the travel cost demand method suffers from the same limitations as the hedonic method. The travel cost method uses variations in environmental quality across recreation sites as a basis for teasing out the value of high-quality sites compared with low-quality sites. In essence, people reveal the value they place on high-quality recreation sites by spending extra money to get there.

This would be difficult to measure in the case of Fox River cleanup because there is so little variation in PCB levels across sites. Even if this problem could be overcome, the travel cost method is only capable of estimating recreational benefits of cleanup.

Furthermore, recreational benefits alone are likely to fall far below sediment remediation costs. Consider recreational fishing. A rough estimate is that Green Bay and the Fox River are supporting 300,000 angler-days per year. This number is based on Wisconsin Department of Natural Resources creel census data. Suppose that by improving fishing quality on existing fishing days sediment remediation increases the value of existing fishing by \$10 per angler-day. This would be \$3 million in benefits.

More anglers might be attracted to fishing in the area if the FCAs were reduced or eliminated. Suppose that there would be a 30% increase in angler days and that these new angler days are worth \$30 each. That would be an additional \$2.7 million. Such sums are certainly significant on their own terms. However, even if the hypothetical dollar figures used here are off by a wide margin, the economic benefits from improved fishing seem likely to be a small percentage of sediment remediation costs if those costs are in the hundreds of millions of dollars. The economic benefits of improved waterfowl hunting, bird watching, and other activities are likely to be substantially smaller than angling benefits simply because there are probably fewer people involved in these activities.

Contingent Valuation

Contingent valuation (CV) uses survey methods to estimate values of environmental amenities. In personal or telephone interviews or mail surveys, respondents are asked to make choices contingent upon hypothetical circumstances. For example, would the respondent support remediation of contaminated sediments to a particular level if implementation of the program would cost the respondent's household $50 per year?

These choices can be used to reveal, directly or indirectly, respondents' willingness to pay to achieve environmental improvements or avoid environmental degradation. The more meaningful and well-defined the contingent choices placed before participants, the more their responses reveal about the choices they would make if the situation were real.

Responses are analyzed in various manners to estimate values for the circumstances described by the constructed scenario. Because of their contingent nature and lack of reliance on observed market behavior, CV approaches are applicable to a wider array of policy circumstances than other valuation techniques. CV is useful in estimating both nonuse and use benefits of sediment remediation in the Fox River.

Given the array of nonmarket environmental effects of PCBs in the Fox River and Green Bay and the potential for nonuse values associated with those effects, CV appears promising as a way to investigate the possible benefits of Fox River cleanup. With careful design, a CV study could pick up nonuse benefits associated with effects on fish and birds (including endangered species) and other environmental assets along with recreation values of the affected resources. If decision-makers want or need benefit-cost comparisons, a CV study appears to be the most promising avenue for estimating benefits of contaminated sediment remediation. It is the only method of estimating "total values," including nonuse values, which has gained substantial acceptance among economists. *If* a CV total valuation study is judged to be valid, it allows decisions to be made with consideration of the broader values that the public may hold for environmental amenities, rather than basing choices on use values alone. To many readers, CV may seem rather new and unconventional. Fortunately, a previous application to sediment remediation is available that will illustrate how it works.

D. A Case Study Use of Contingent Valuation in Sediment Remediation

The Problem

Beginning in the 1940s, a plant in Los Angeles manufactured DDT and discharged DDT-contaminated waste into the county sewer system, which discharged to outfalls in the Southern California Bight, an area in the Pacific Ocean off the Palos Verdes Peninsula. PCBs also entered the marine environment through the sewage outfall. Even though discharges to the sewers ended in the 1970s, DDT and PCBs continue to enter the food chain from sediments covering an area about five miles long and two miles wide.

Bald eagles and peregrine falcons are very rare in a large area of southern California, and efforts to reestablish the birds there have been hampered by a nearly total lack of reproduction. Two species of fish, kelp bass and white croaker, have also experienced reproduction problems in areas near where the chemicals were released. Recreational anglers have been warned about the dangers of eating both species, and commercial fishing for white croaker has been banned in the area. Kelp bass are not fished commercially. These environmental problems have been linked directly to the sediments of the Southern California Bight. Other effects are probably present but have been more difficult to document.

A study estimated the benefits of a program to "cap" the contaminated sediments with a layer of clean material that would prevent further uptake of DDT and PCBs into the food chain (Natural Resource Damage Assessment, Inc. 1994). The goal of the study was to estimate the losses the public would suffer as a result of the contaminants, not to estimate the benefits of capping the sediments. Covering perhaps 10 square miles and lying under 100 feet of water, the sediments would be difficult, expensive, and perhaps technically impossible to cap. Therefore, they are expected to continue to affect birds and fish for at least 50 years.

The study was done in the context of a lawsuit brought by the U.S. Department of Commerce and the State of California under the Superfund program. If Californians were willing to pay some amount of money to fix the problem, then this would serve as an estimate of the value lost if the problem cannot be fixed. The researchers who did the study went to great lengths to make the capping project seem plausible to respondents. Although this situation is different from the situation in Green Bay, it provides a glimpse of how the benefits of a real sediment remediation project can be evaluated using CV.

The Valuation Approach

The CV survey began with a couple of questions focusing on how respondents felt about several activities funded by the State of California, including building new prisons, providing public transportation, and improving education. This served as general background data about how each respondent felt about various governmental programs and introduced the topic of government spending. Next came an overview of the capping proposal. This part of the survey was quite long and detailed, and only a brief outline is given here. It began by telling respondents:

> "Proposals are sometimes made to the state for new programs. The state does not want to undertake new programs unless taxpayers are willing to pay for them. One way for the state to find out about this is to give people like you information about a program so that you can make up your own mind about it.
>
> In interviews of this kind, some people think the program they are asked about is not needed; others think it is. We want to get the opinions of both kinds of people."

The survey then introduced the elements of the contamination problem and the capping project, including:

- A description of the reproductive problems of the affected birds and fish and where they were located, including sketches of the organisms and maps.
- An explicit statement that there are many other species of birds and marine life in the area that are not currently affected.
- An explicit statement about the status of the affected species. (The fish were not endangered; whereas both birds were listed as endangered in California and several other states. However, populations of both birds were increasing elsewhere in California and in other states.)
- A description of how the problems for these species are due to DDT and PCBs and how these chemicals got into the environment in the first place.
- A discussion of how such compounds remain in the sediments and continue to get into the food chain many years after their release was discontinued.
- Explanations of how commercial fishing controls and consumption advisories for recreationally caught fish protect human health.
- A discussion of how new clean sediments from natural sources are slowly covering the contaminated sediments and will ultimately form a barrier between the contaminated sediments and the food chain, thus solving

the problem in about 50 years without human intervention.

- A description of a "speed-up program" that would cap the sediments and allow the birds and fish to recover in only 5 years rather than 50 years. (Several diagrams were presented here to make the speed-up program seem realistic.)

- A statement to the effect that the capping project, if carried out, would be paid for by a one-time increase in next year's California income taxes.

Next in the survey came two valuation questions. They were posed as referenda and specified the amount by which the respondent's household income tax bill would increase. Each time, the respondents were asked whether they would vote for or against the proposal. They were then asked about a higher or lower tax, depending on whether they "voted" yes or no to the previous question.

The sample was designed to be representative of English-speaking Californians, 18 years of age and older. In the first half of 1994, trained interviewers from a leading survey firm completed 2,810 personal interviews, which constituted 72.6 percent of the eligible households in the original sample.

Statistical procedures used to analyze responses to the valuation questions were designed to estimate a lower bound on the average value per household, which turned out to be $55.61. This would imply that the total benefits from the capping project are at least $575.4 million (estimated standard error = $27.5 million).

E. Implications for CV Studies

The CV method has some distinct advantages over other methods of answering benefits questions. CV can include a more comprehensive set of environmental values, including both use and nonuse values, held by the public, whereas other methods will limit values to those directly associated with resource uses like recreational fishing. Limiting benefit estimates to use values carries a risk: based on an overly narrow definition of benefits, the costs of remediation projects may be judged to exceed benefits when in fact a more complete accounting of benefits using CV may lead to the opposite conclusion.

Results from the California study underscore the need for a full accounting of benefits. Remediation of sediments in the Southern California Bight would lead to improved fishing and bird watching, but this is only the tip of the iceberg. Results from the CV study indicate that much larger values lie just underneath the surface, values associated not with immediate direct uses of affected resources but with the public's broader concerns about the environment. To a greater or lesser degree, the same conclusion may be true for contaminated sediments in the Great Lakes region. The only way to know is to estimate the full range of values using CV. In this way, CV is capable of contributing much toward sound decision making about where and when to apply remedial measures to contaminated sediments.

F. Summary

At the first stage of evaluating economic benefits, a simple scoping study based on easily acquired data and studies done elsewhere may be all that is necessary to make a reasonably good judgment about whether benefits are likely to exceed expected costs or vice versa. If not, deeper investigation of benefits and costs can be conducted in a second stage. Here, the scoping study results should be helpful in judging which valuation methods are most promising for arriving at useful practical results.

The proposed cleanup of PCBs from the Fox River serves to illustrate how this would work in practice. In this case, high estimated remediation costs indicated that a scoping study alone probably would not be sufficient to judge whether or not benefits will exceed costs. Furthermore, although potential benefits associated with Great Lakes shipping are not well understood, it appeared that most of the benefits will be associated with recreation and nonuse values.

Even if a good measure of recreational benefits could be found based on a travel cost analysis (and here there are formidable technical problems to be overcome) the resulting benefit estimates would likely fall far short of the expected remediation costs. This would leave decision makers and citizens scratching their heads about the economic justification for the cleanup proposal. Recreational benefits seem to be less than the expected remediation costs, but the total value of the benefits, including nonuse values, could be larger than these costs.

Thus, it appears that the wisest strategy for evaluating Fox River sediment cleanup will be to do a contingent valuation study so that nonuse as well as use values can be considered. In Section III we describe the results of a new contingent valuation survey dealing with various water quality issues in the Green Bay Area of Concern (AOC).

This section has focused on methods to evaluate the economic justification for sediment remediation projects in terms of benefits and costs. There are, of course, other economic issues that can arise in considering such projects. For example, the issue of who would pay for sediment cleanup was not examined in this chapter. Concerns about plant closings and loss of jobs arise if private parties pay the cleanup costs. This issue, though important, is beyond the scope of this chapter.

The best strategy for economic analysis may be very different at other Great Lakes AOCs. Where a scoping study shows that recreational, shipping, or other benefits are likely to predominate, a method or combination of methods other than contingent valuation could be applied where technically feasible.

The problem about what to do with contaminants in the environment will often separate citizens into two camps. On the one side will be environmentalists who may be convinced that remediation should be carried out regardless of costs. From an economic perspective, they are assuming that benefits are very large or even infinite.

On the other side will be economic interests who will be strongly oriented toward use values and particularly use values of market goods. This latter group may quickly come to the conclusion that benefits are small. A well-designed benefits scoping study, followed where necessary by deeper second stage studies tailored to the situation, will help arrive at economically sound decisions by providing more objective information about the magnitude of some of the benefits of sediment remediation projects.

II
Economic Analysis of Sediment Remediation on the Fox River

A. A Context for Analysis

The State of the Fox River

What is the state of the Fox River? The answer comes in two parts, and it is important in making an economic analysis. First, it is the state of current conditions as we see them at a point in time—a description of what is the "now." Second, it is the changes in those current conditions as time passes, the "trends" over time, or the projection of the future based upon those things, that we believe are most likely to occur if present patterns of behavior continue. In a sense, these things describe the river as it is. They form our baseline description of the river. In a place like the Fox River, sediment sampling and modeling of sediment and contaminant transport over years and decades make the description of this baseline difficult because of uncertainty about how the baseline is shifting over time.

If the Fox River were a static place,[1] we would only concern ourselves with the "now" and could ignore the "trends" over time. Clearly this would be unrealistic. The river is dynamic, with ever-changing flows and sediment transport. Pollutant loadings change. Occasional storm surges from Green Bay travel up the mouth of the river resuspend and move sediments in the lower reach of the river, as do ships, which enter the riverine harbor and its slips in the City of Green Bay. Occasional riverine floods also resuspend and move sediments.

Shocking the System

The analysis of a proposed change to the river is an analysis of policy. The policy is whatever manner of shock to the system is being considered for implementation. The term "shock" as used here is not meant to be a negative,

[1] As one economist colleague is fond of saying, "if we existed in that 'infinite instant' wherein time is short enough that nothing can change but long enough that all adjustments can take place, we would be in the never-never-world within which much of introductory economic theory resides."

pejorative term. The shock is proposed (or planned[2]) to stimulate a change from the existing state of the river towards an alternative state of the river. Thus, we have two situations. First, the current or "baseline" situation that exists in the absence of the shock and is often termed the "without" situation in economic analyses. The second situation is the alternative situation that would prevail in the presence of the shock, a situation that is often termed the "with" situation.

Policy analysis consists of a very simple approach: the comparison of "with" and "without" situations or a comparison of some known baseline with some known alternative. The differences between these two states are attributable to the policy or shock to the system, and the merits of this difference, measured in monetary or other terms, are the value of the proposed policy. In effect, we are looking at net differences—the value of a "with" policy situation less the value of a "without" policy situation. This is the logic used to evaluate any choice. It is a logic adopted by economists, and it has been developed into an art termed cost-benefit analysis, an art that has many varieties of practice and procedure (net present value, benefit-cost ratios, internal rates of return, payback periods, etc.). All of them are directed towards achieving the same end—determining whether a "with" policy state is judged to have greater value than a "without" policy state.

Always threatening to upset this orderly process are the unplanned changes (or disasters) that may come to the Fox River. Extreme floods or large storm surges may remove contaminated sediments and relocate them to Green Bay before planned sediment removal can be studied. Awareness of this threat hastens planning to avoid the risk of contaminant dispersion.

The question "What are the benefits of remediation of contaminated sediments?" is a question that presumes that benefits are the difference between the "with remediation" and "without remediation" states. Yet the question of benefits is still of relevance only within a broader context. Only if one presumes there are costs of remediation would one be interested in the magnitude of benefits. It is because there are costs that one is interested in knowing whether the benefits are sufficient to outweigh the costs of remediation activities. Otherwise it would be sufficient to know only that the remediation action itself did not create overall negative impacts.

The policy context in which remediation decisions are made is one of being cognizant that there are, in fact, significant costs to remediating contaminated sediments and that resources are scarce. Remediating contaminated sediments means that something else must be foregone. This could be improved educational facilities, better housing for the poor, new highways for travel, etc. In this context we need to ascertain that benefits are received in excess of the opportunities foregone by directing resources toward the remediation of contaminated sediments and away from alternative uses.

Are the benefits of sediment remediation in the Fox River sufficient to outweigh the costs of "shocking" the system? In order to answer this question, we need to know several things. First, what is the "baseline" or "without" project situation that will prevail in the face of no action to remediate contaminated sediments? Second, what is the "alternative" or "with" project situation that will prevail if actions to remediate contaminated sediments are taken? Not only must these situations be known at a point in time but also they must be known over time. It takes time to implement and to see the results of remediation actions taken relative to the "baseline" situation. The basic framework for assessing the merits of remediating contaminated sediments in any locale requires answers to these questions.

The two questions mentioned above have been at the root of controversy over sediment remediation in the Fox River. There are at least two different predictions of the situation that

[2] Note that policy changes are planned actions that "shock" the world system, and disasters are unplanned changes. Both have impacts, the estimation of which is often of interest to citizens.

will prevail if PCB-contaminated sediments are not removed from the river. One view is that these sediments are, in most locations, being covered up by clean sediments and will remain buried indefinitely. Another view is that these sediments are periodically being resuspended and carried into Green Bay, posing the danger that major flood events will flush out large quantities of PCBs from deposits above the DePere Dam and that strong storm surges will flush out large quantities of PCBs from sediment deposits below the dam, and carry them out into Green Bay.

Time helps and hinders the answering of the two questions. For example, over time, the changing baseline conditions have helped in evaluating the sediment transport modeling done in the lower Fox River. However, the nearly two years that elapsed since sediment sampling was done in contaminated sediment deposit 56/57 created uncertainty about the location of PCB-contaminated sediments that were to be removed during the pilot dredging project in late summer and early fall of 1999.

Use and Nonuse Benefits

In the Lower Fox River/Lower Green Bay AOC, public support for environmental improvements such as sediment remediation may be related not only to use of the Fox River but more generally to a desire for cleanup of the river. Local residents and visitors will benefit directly as users of the river, but many nonusers may also value its cleanup. If this is true, a large share of the benefits of sediment remediation are likely to be nonuse benefits accruing both to local and nonlocal residents. Nonusers who place value upon the river cleanup do not receive use benefits from the cleanup. Their motivations for placing such values may include retaining the option for potential future use, preserving the option for usage by other individuals or generations, or simply returning the river to a cleaner condition with a belief that the river itself has some intrinsic rights for continued existence in a less compromised state. These motivations (and others) determine the nonuse values held by citizens. Placing a use value on Fox River cleanup does not preclude a citizen from also holding a nonuse value for the same cleanup effort in the river.

Regional Economic Impacts

Residents of the Lower Fox River/Lower Green Bay AOC may also enjoy benefits if the regional economy expands as a result of remediation. This will occur if those living outside the region spend more money in the region or move into the region, bringing "new dollars" in response to such inducements as environmental improvements (a cleaner environment) or improved recreational opportunities. In these cases, economic development occurs that would not have occurred without remediation, generating additional jobs and additional regional income. Economic development benefits consist of the additional economic activity generated as a result of remediation activities. Such benefits can be estimated in terms of both dollars and jobs created. For purposes of cost-benefit analysis, these types of benefits are often the most controversial.

In contrast, sediment cleanup in the Fox River is seen by some, perhaps many, people as a threat to jobs leading to possible plant closings. Such a scenario poses a set of possible regional economic costs of remediation that have not been considered in this framework study of benefits. If such reductions in regional economic activity were to occur, they would need to be included in a full analysis of remediation costs along with the direct expenditures for the remediation activity itself.

The direct citizen expenditures for increased usage of a cleaned up Fox River that are attributable to its remediation are captured by markets and measured as direct benefits, such as bait purchases for fishing. However, the indirect or multiplier type effects that accrue in a region due to respending of funds after their initial impact are often self-canceling from a national perspective and, thus, are not counted.

In a reasonably fully employed economy, money that is brought to the region must come from elsewhere. That is, they have an opportunity cost that is reflected by their market price. Respending of moneys received by a bait shop does generate increased regional economic activity, but from a wider perspective, these secondary impacts are not free. If the money had not been initially spent in Wisconsin, for example, then it would have been spent in a different state. Thus, from a national perspective, the secondary impacts that accrue to Wisconsin were given up by that other state. Unless one takes a more narrow regional accounting stance or one makes the argument that there are significant differences in the alternative regional economies and their economic multipliers, the indirect benefits received by Wisconsin would equal those lost by the other state. From a regional perspective, economic development benefits are of interest and may be substantial, but from a national perspective, such benefits may be of less importance and are often treated as having zero magnitude (or as being relatively inconsequential).[3]

Determining the State of the Fox River "With" and "Without" Remediation

A major problem encountered in this benefits study was how to apply theoretical approaches to the practical problem of valuing sediment cleanup. As discussed in the opening pages of this section, benefit measurement and project analysis revolve around a very simple idea that becomes complex in application. Basically, the conceptual approach is used to measure the difference between a "with" remediation situation and a "without" remediation situation.

Valuation requires the assessment of a difference between these two situations and an understanding of the nature of the difference. What is important and relevant to one person may be different for another person. Yet, such differences do in fact need to be conveyed. If there is a perception of no difference, there will be no change in circumstances and nothing to value.

What Changes Will Sediment Remediation Bring?

The likely answers to this question are needed so that economists can craft a contingent valuation survey. Fortunately, there are some answers. This area has been the subject of the Green Bay/Fox River Mass Balance Study and is unique in the degree of information of this type presently available among all Great Lakes AOCs (DePinto 1994). Reports and data from this study are available and provide a unique analysis of the long-term (5- to 25-year) effects of nonaction and various remediation actions on PCB loadings to Green Bay and on PCB concentrations in Green Bay fish (DePinto 1994; USEPA 1988, 1992, 1993). This information was vital in understanding the system and in the continual evolution of recommendations for policy and the remedial action plan (RAP) for the Green Bay AOC.

Typically, RAP reports identify the expected benefits from sediment remediation using qualitative descriptions of the expected improvements to environmental conditions, like "swimmable water, edible fish" (WDNR 1992, 1993). While much is often known, it is quite frequently not in a form that can be clearly and concisely conveyed to respondents for a valuation study.

The results from the Fox River/Green Bay Mass Balance Study are important because they indicate how much improvement to expect from remediation over 5 to 25 years. Yet they do not present a comprehensive picture with certainty of the "with" and "without" states. Much room for judgment remains. It is not realistic to expect other AOCs to have five-year, $12 million mass balance studies like the one undertaken in the Fox River and lower Green Bay. Chapter 2 of this report shows the potential and important contribution that more modest mass balance modeling can make to realistic and useful estimates of benefits from

[3] This is why policy analysts, at times, argue that state competition for the location of federally funded facilities is counterproductive. While individual regions recognize that they will receive substantial economic development benefits, their expenditure of funds in the lobbying process reduces the overall magnitude of net benefits received by the nation as a whole.

sediment cleanup in AOCs throughout the Great Lakes.

How Much Remediation to Anticipate?

One major problem encountered in this benefits study was to predict the nature and extent of changes in an ecosystem that would be caused by sediment remediation. This problem required developing valuation approaches that would be flexible enough to be useful no matter what level of remediation ends up being proposed. The range of possibilities extends from no remediation to total remediation. The uncertainty about remediation levels to be proposed was handled by design of a unique approach that allowed flexibility. Benefit estimates for a variety of potential levels of remediation were developed. We chose to estimate remediation benefits in the case study for levels of remediation at 20%, 40%, 60%, 80% and 100% of the remedial action plan's "desired state" in order to develop a model for prediction over the 0 to 100% range.

The approach adopted to face this problem of valuing sediment cleanup was to use a framework that allows for a range of alternatives and level of specificity. A general description of the situation and the types of impacts that could occur was felt to be better than a very detailed description because the scientific evidence leaves uncertainty on the exact relations between contaminated sediments, their remediation, and the activities and items that are impacted and valued by citizens.

This approach is open to criticism that "the public" does not know enough about the issues to make a decision. However, many decisions are regularly made in this way in the public policy arena. To what extent do citizens understand all the ramifications of voting in public referenda about local events or for political candidates who will make decisions affecting them? Yet, we rely on this information in the belief that citizens have a right to express their opinions about such things, that they themselves are the best judges of what is important, and that they often have a base of current knowledge about the situation from a variety of sources.

In the case of sediment remediation in the Fox River, there have been an abundance of informational meetings, publications, and media stories about the perceived pros and cons of sediment removal by dredging, disposal of dredged material, and alternatives to dredging and disposal. Citizens are certainly the possessors of unequal (and sometimes inadequate) information about sediment remediation, but they are clearly not devoid of information about the issue.

B. Selecting Benefit Estimation Methods

In the Green Bay economic region, we investigated the usefulness of various methods of valuation. The pros and cons of these methods are described in Section I. It was felt that remediation of contaminated sediments would have a variety of impacts, many of which would be outside normal market processes. Changes in current and expected PCB levels in the Green Bay AOC, for example, could affect species of fish and birds in ways that have little direct market impact or effect on travel behavior of citizens within the region and state. Yet these changes would constitute benefits having value. Further, while there are market effects of PCB level changes, such as increased fishing trip activity or cost reductions for commercial water usage and treatment, we felt that a predominant portion of the benefits accruing from remediation would consist of items not directly reflected very well by existing economic markets. Thus our emphasis was placed upon estimation of nonmarket benefits accruing from resource use and nonuse.

Benefits that will accrue through markets are more readily identified by decision-making entities and also represented by interest groups directly perceiving them, e.g., specific industries or communities presently incurring costs due to contamination. However, benefits accruing to the ecosystem and/or those that take on the nature of "public goods" are under-represented in the decision process or not represented at all. It is these types of benefits towards which our original proposal and our research were directed.

The travel cost method and the hedonic pricing method were both considered for application in this study but were ruled out for reasons explained in Section I. A brief, but largely unsuccessful, sojourn into the usage of an existing travel cost study of fishing activity in the State of Wisconsin was made in an attempt to examine whether some manner of isolating effects of water quality upon fishing throughout the state could be accomplished. It was found that Wisconsin anglers in general would receive annual per angler benefits of $87 per year if fish consumption warnings could be removed from Great Lakes fisheries (see Bishop, personal comm. 1988), but this was not specific to the Green Bay AOC.

A "Satisficing Approach" to Remediation Benefits

Understanding the nature of economic benefits received from remediation activities is not an easy task. Accomplishment of a particular aspect of a remediation project does not guarantee any recognition of benefits. Just as there may be thresholds for "real effects" on the system, there may also be thresholds in the minds of respondents as to what constitutes a "change" in the resource services they receive. Our case study approach in the Green Bay economic region is one of valuing proportions of achievement. It is useful only as a rough approximation of remediation benefits.

The last part of this section focuses upon a "satisficing" approach to consideration of economic benefits from contaminated sediment remediation that may be useful to other Great Lakes AOCs as well.[4]

In the Green Bay AOC, the cost estimates for the remediation options have ranged from a low around $200 million to highs in excess of $1 billion. One of the options that appears to be a more likely choice may cost roughly $700 million. Without worrying about the exact details of this option, suffice it to say that exercise of this option seems likely to satisfy state and federal agencies' concerns about PCBs. Seven hundred million dollars is a large number. Is such an expenditure worth it? Here is a *satisficing* approach to answering this question.

In 1990 the population of Brown County, according to the U.S. Census, was roughly 200,000, that of the Fox-Wolf Basin counties was near 1 million, and the entire state of Wisconsin was about 5 million (see Table II.1). In the state, the average number of people per household was 2.6, yielding estimates of household numbers at about 75,000, 400,000, and 1,900,000 for Brown County, the Fox-Wolf Basin, and Wisconsin, respectively.

Now, consider that remediation will not take place immediately but over a series of years. For this example, let's assume that it will take five years to complete sediment remediation and that the $700 million costs will be distributed more heavily in the near years and lightly towards the end: $200 million in Year 1, $150 million in each of Years 2 to 4, and $50 million in Year 5. It is possible that some of these costs may be offset by cost savings, and it is likely that some of these costs will be paid by parties judged to be responsible and liable for some portion of remediation costs. However, for this example, let's assume that all of the costs will be borne by citizen residents of Brown County, the Fox-Wolf Basin, or the state of Wisconsin.

Since these costs are not all borne at the present time, it is necessary to express them in current dollars by discounting to account for the time value of remediation funds. Selection of a rate for discounting is often an area of debate, so here high (10%), medium (7%), and low (4%) rates will be used. The current (present) value of the remediation cost stream is roughly $552 million, $591 million, or $664 million depending upon whether one uses the high, medium, or low discount rate, respectively. What this means is that an amount less than $700 million could be invested now at that rate

[4] Editor's Note: This approach is similar to the benefits required to match costs that was mentioned in Section I. It is meant to be an alternative way to frame the decision-making questions. The focus is on remediation costs and minimal benefit requirements.

Table 1. Green Bay AOC Remediation of Contaminated Sediment Cost Example

	Brown County	Fox-Wolf Basin Counties	State of Wisconsin
Population (1990)	194,594	1,050,312	5,032,089
Persons per Household, Wisconsin (1990)	2.61	2.61	2.61
Households	74,557	402,418	1,928,003
Number of Years of Remediation Activity	5	5	5
Remediation Cost Time Distribution			
Year 1: Remediation Cost	$200,000,000	$200,000,000	$200,000,000
Year 2: Remediation Cost	$150,000,000	$150,000,000	$150,000,000
Year 3: Remediation Cost	$150,000,000	$150,000,000	$150,000,000
Year 4: Remediation Cost	$150,000,000	$150,000,000	$150,000,000
Year 5: Remediation Cost	$50,000,000	$50,000,000	$50,000,000
Present Value of Remediation Cost Stream			
High Discount Rate Scenario (10%):			
Total Remediation Cost	$551,980,429	$551,980,429	$551,980,429
Per-Person Remediation Cost	$2,837	$526	$110
Annualized over Remediation Period (5 years)	$748	$139	$29
Annualized like a Home Mortgage (30 years)	$301	$56	$12
Per-Household Remediation Cost	$7,403	$1,372	$286
Annualized over Remediation Period (5 years)	$1,953	$362	$76
Annualized like a Home Mortgage (30 years)	$785	$146	$30
Medium Discount Rate Scenario (7%):			
Total Remediation Cost	$590,459,969	$590,459,969	$590,459,969
Per-Person Remediation Cost	$3,034	$562	$117
Annualized over Remediation Period (5 years)	$800	$148	$31
Annualized like a Home Mortgage (30 years)	$322	$60	$12
Per-Household Remediation Cost	$7,920	$1,467	$306
Annualized over Remediation Period (5 years)	$2,089	$387	$81
Annualized like a Home Mortgage (30 years)	$840	$156	$32
Low Discount Rate Scenario (4%):			
Total Remediation Cost	$633,657,562	$633,657,562	$633,657,562
Per-Person Remediation Cost	$3,256	$603	$126
Annualized over Remediation Period (5 years)	$859	$159	$33
Annualized like a Home Mortgage (30 years)	$345	$64	$13
Per-Household Remediation Cost	$8,499	$1,575	$329
Annualized over Remediation Period (5 years)	$2,242	$415	$87
Annualized like a Home Mortgage (30 years)	$902	$167	$35

continued on next page

	Brown County	Fox-Wolf Basin Counties	State of Wisconsin
Summary of Benefit Requirements:			
Range of Per-Person Minimum Benefits Necessary to Justify			
One-Time Payment Made Right Now			
Low Estimate	$2,837	$526	$110
High Estimate	$3,256	$603	$126
Series of Equal Payments Made Over 5 Years			
Low Estimate	$748	$139	$29
High Estimate	$859	$159	$33
Series of Equal Payments Made Over 30 Years			
Low Estimate	$301	$56	$12
High Estimate	$345	$64	$13
Range of Per-Household Minimum Benefits Necessary to Justify			
One-Time Payment Made Right Now			
Low Estimate	$7,403	$1,372	$286
High Estimate	$8,499	$1,575	$329
Series of Equal Payments Made Over 5 Years			
Low Estimate	$1,953	$362	$76
High Estimate	$2,242	$415	$87
Series of Equal Payments Made Over 30 Years			
Low Estimate	$785	$146	$30
High Estimate	$902	$167	$35

to yield a time stream of returns equal to the stream of costs that would be expended over the five years.

What might these costs for sediment remediation mean for the average individual or household? For now, focus on the largest expense—the $664 million obtained if we use a discount rate of only 4%. (The discount rate is conservative in that we are assuming we could only receive a 4% return on invested monies at the present time). If we divide the $664 million by the population of Brown County we find that this number amounts to a total expense of $3,256 per resident. Yet most of us think in terms of household budgets. Re-expressing this expense on a per household basis raises the cost of remediation to $8,449 per household. This would be a one-time household expense. Since the remediation would occur over 5 years, let's consider paying the bill in equal one-year instalments for 5 years. Using the same 4% interest rate, this would require five annual payments of $2,242 each from all households in Brown County to pay the entire bill of the $700-million dollar-remediation option being considered. That still seems like a lot of money on a per-household basis. On a weekly basis (dividing by 52), it amounts to a $43 payment each week.

Yet the benefits of remediation certainly accrue to an area broader than Brown County. Doing the same calculations but sharing the expenses equally among the population of the entire Fox-Wolf Basin, the annual expense per household is reduced to $415 dollars ($8 per week) for five years. If the remediation costs were split up among the population of the entire state of Wisconsin, the amount becomes $87 per year (less than $2 per week) per household for each of five years.

Now, for the *satisficing* nature of the question. We started out asking whether the costs of $700 million could be judged as acceptable for remediation of the contaminated sediments (primarily PCB remediation) in the Green Bay AOC. We did not proceed to estimate benefits, but looked at the costs in a different manner. We estimated that the costs would be in the range of $87 to $2,242 per year ($2 to $43 per week) for five years depending on how they are shared among citizens. Instead of estimating benefits directly, let's ask the following *satisficing* question: "Are the benefits of remediation greater than the per-household cost?" If we are uncertain, we should examine the question further.

One problem with the example so far is that the payments for remediation costs are made over five years but the benefits of remediation certainly will extend much longer than the five years it takes to do the remediation. To match the benefits and cost payment time frames, take the one-time payment of $2,242 (from table II.1) and break it into payments that would extend over 30 years (like financing a home). This would break the highest estimate of costs (at a 4% discount rate) down to annual payments of $902, $167, or $35 per household depending on whether the cost was financed by Brown County, the Fox-Wolf Basin, or state of Wisconsin households. As can be seen, adopting higher discount rates will result in lower costs per household. Compare the estimated costs per household in the example with the perceived benefits of Fox River cleanup obtained in the valuation survey described in Section III. The survey indicates that cleanup of the lower Fox River is likely to yield average annual benefits in the range of $100 to $300 per household.

This example used a very simple approach by assuming that all remediation costs would be borne directly by the public. It is much more likely that the *satisficing* approach would be used separately on the proposed private and public shares of the remediation costs. A decision to remediate obviously looks much more favorable when the costs are shared more widely, a distribution that recognises that the benefits of remediation are not distributed solely to the residents of Brown county (or even the state of Wisconsin). Remediation costs paid by responsible parties increase the likelihood of the *satisficing* approach yielding decisions favorable towards remediation of contaminated sediments. A *satisficing* approach used in a responsible party's economic analysis of remediation would include a comparison of costs with the benefits of litigation avoided, positive publicity gained, and possibly the avoidance of future damages payments to claimants.

C. Summary and Implications

Considering the economic benefits of contaminated sediment remediation is not an easy task. There are many difficulties, but progress can and has been made. A framework for considering economic benefits and their context within a sediment remediation context has been developed. An estimation approach that focuses upon the uncertain nature of achieving full remediation was demonstrated for the Green Bay AOC and shown to yield benefit estimates in the range of $100 to $300 per household. Respondents did indicate a concern about pollution problems in the Green Bay AOC and, in written comments on the survey instrument, many indicated frustration that efforts appeared to have resulted in little action to remediate.

A *satisficing* approach to sediment remediation indicated that the costs of remediation, which at first glance seem quite intimidating, are more reasonable than one might initially expect. A critical variable in such approaches is a determination of how widely, and in what manner, the costs of remediation should be shared among responsible parties and those incurring benefits from remediation.

III

A Contingent Valuation Survey in the Green Bay Area of Concern

A. Introduction to the Survey Region

The development of a set of economic benefit estimates is an exercise that takes place within a particular decision context. In the Green Bay Area of Concern (AOC) there has been substantial interest in the impacts of contaminants within the Fox River. These contaminants, along with a variety of other problems, have contributed to impairments of the water resources in the AOC. The estimation approach adopted for the case study of the Fox-Wolf Watershed region was the contingent valuation method using a referenda-style question format for a series of related remediation scenarios with an open-ended follow-up valuation question for a 100% remediation benefits scenario (see survey instrument in Appendix F). The CV approach is described and reasons for using it are given in Section II.

The Case Study Region

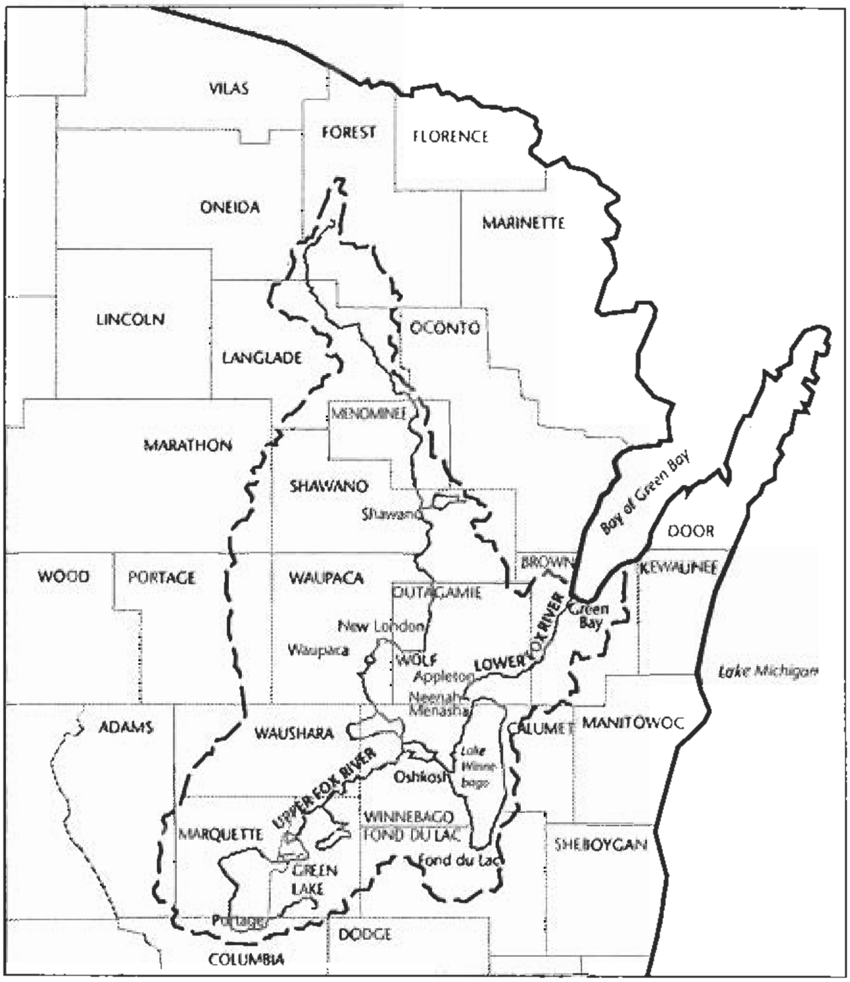
The benefits of prospective contaminated sediment remediation were examined for a substate "economic region" affected by remedial actions. This region includes the entire area of counties that are predominantly within the Fox-Wolf basin. It also includes the Wisconsin counties that are outside the Fox-Wolf basin but border the western and eastern shores of Green Bay (see figure 1).

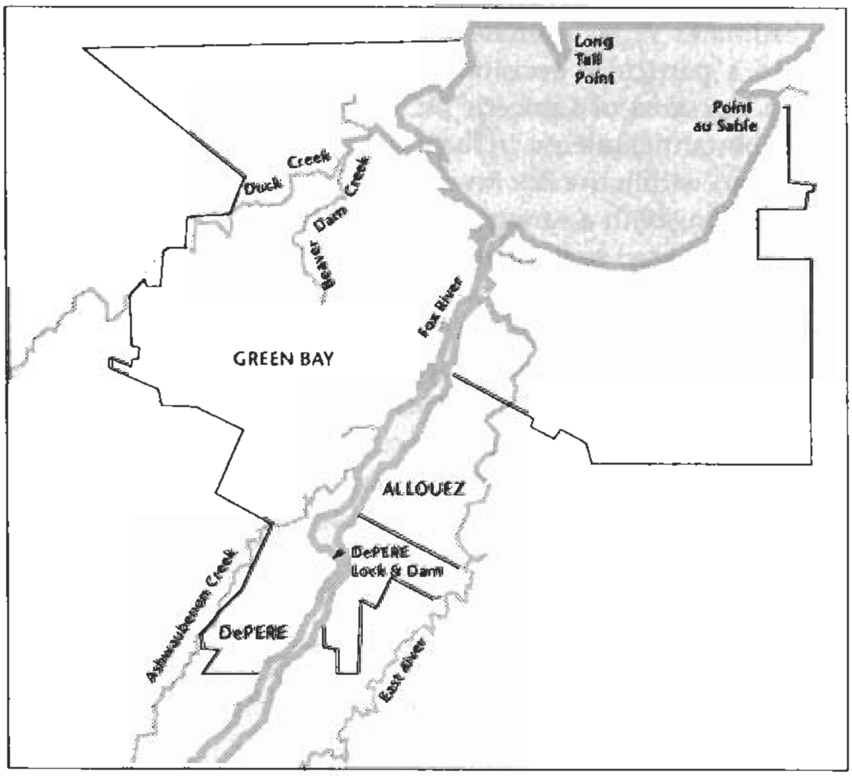
While the focus of this case study was on these areas, it was also recognized that economic benefits might accrue beyond the immediate confines of the AOC. Therefore it was decided to set a statewide scope for estimation of benefits. The study region was broken into three tiers—those counties contiguous to the Fox River and the lower bay of Green Bay, those counties lying within the remainder of the Fox-Wolf Basin, and those counties forming the remainder of the state of Wisconsin (see Appendix 3 for a list of counties in each tier and their populations). The focus of benefit estimation was to target state residents.

The total AOC encompasses approximately 20 square miles and includes the city of Green Bay. Eighteen counties in Wisconsin constitute the 6,600-square-mile drainage area, along with 40 watersheds of the Upper Fox River, Wolf River, and the Fox River Basins, as well as Wisconsin's largest inland lake, Lake Winnebago, and its pool lakes.

Water quality in this area is adversely affected by a high concentration of industry and agriculture within the watershed. In fact, this area has the highest concentration of pulp and paper mills in the world, with 13 plants discharging to the river. There are also 60 municipal sewage discharges, more than 100 other industrial discharges, and many agricultural and urban nonpoint sources of pollution.

The basic problems in the AOC can be broken down into these general categories: toxic substances, biota and habitat, nutrients and eutrophication, and institutional concerns and recreational needs. These problems are all addressed by the 16 key actions and 120 associated recommendations in the remedial action plan (WDNR 1991, 1993). These proposals are for actions to be funded by revenue from federal, state and local government and private sources.





This AOC has been the subject of the Green Bay/Fox River Mass Balance Study and is unique in the degree of information presently available relative to many other Great Lakes AOCs (see map above).

Reports and data from this mass balance study are available and provide a unique analysis of the long-term (5- to 25-year) effects of no-action and various remediation actions on PCB loadings to Green Bay and on PCB concentrations in Green Bay fish (USEPA 1988, 1992, 1993). This information was vital in understanding the system.

In order to estimate benefits from a contemplated remedial action, it is important to know the improvement(s) expected from the action. This must be an early component of any benefit estimation process; one must develop an understanding of the "with" and "without" remediation states. Typically, Remedial Action Plan (RAP) reports identify the expected benefits from sediment remediation as qualitative descriptions of the expected improved environmental conditions like "swimmable water, edible fish" (WDNR 1991). While much is often known, it is quite frequently not in a form, which can be clearly and concisely conveyed to respondents for a valuation study.

As discussed in Section I, benefits from remediation of contaminated sediments include those accruing from changes in direct use of services provided by the environmental resources being affected as well as values not directly linked to use of the resources. These latter types include such things as valuing the retention of ecosystems within their natural state, valuation of species in and of their own right, as well as values placed upon retaining the option for future usage of services from environmental resources. While changes in use require direct visitation to the region where the resources exist, certainly nonuse benefits can be held by anyone. It is reasonable to expect that an average resident of Madison may value the resources of the Green Bay AOC less than an average resident of Green Bay values these resources.

In the Green Bay AOC, interest in Fox River contaminants and other problems that contribute to impairment of the water resources of the AOC led to development of a Remedial Action Plan in the 1980s (WDNR 1991, 1993). In the plan a "desired state" of the AOC was specified in varying level of detail. This "desired state" is a work in progress. As better information is obtained and greater understanding developed of the complexities of the ecosystem, the nature of the "desired state" is continually evaluated. Yet it is generally understood that the "desired state" would remove the impairments to most uses, while the nature and extent of efforts to do so are not fully known. Within the survey instrument, the "desired state" was described in relation to sediments as follows:

> A variety of individuals and groups have called for "total remediation" of contaminated sediments, or at least enough remediation to attain a "desired state" sufficient to restore beneficial uses of the lower Fox River and Southern Bay of Green Bay. Attainment of this goal would enable citizens to make use of water resources without health effects from contaminants as well as ensure the continued existence of a viable ecosystem. Specific goals related to sediments include:
>
> - restore swimming and an edible fishery
> - provide suitable habitat for enhancing and sustaining a diversity of wildlife
> - establish a self-sustaining, balanced and diversified, edible fish community
> - improve the water quality and trophic state of the area to relieve ecological stresses
> - achieve and maintain water quality that protects the ecosystem from toxic substances
> - ensure sustainability of a restored and healthy environment through pollution prevention

The survey reported upon here was designed to evaluate citizen perceptions of the economic benefits attributable to achieving the desired state. A copy of the survey form is found in Appendix F. To this end, valuation responses were for a "good" which entailed more than just the removal of contaminated sediments. Yet the focus was upon this aspect of the problem in terms of the presentation within the survey instrument utilized in this contingent valuation study.

B. Some Overall Results of the Survey

Remediation of contaminated sediments is valued by citizens. Citizens use the Fox-Wolf Basin and lower Green Bay, and they are concerned about the quality of its waters. Survey respondents (33%) in all three tiers indicated that they went fishing in the area during the previous 12 months, and 43% of those adjacent to the Fox River and lower Green Bay indicated the same.

A full 60% of all respondents indicated that they were worried or very worried about health problems that could be associated with eating fish caught in the Fox-Wolf Basin and lower bay of Green Bay. In addition, 17% of those respondents who were anglers indicated that they would make more fishing trips in the region if fish were free of "all pollutants that threaten human health," and an additional 20% indicated that they might make more fishing trips. On average, anglers spent roughly $50 per trip, with those from other areas of the state spending closer to $150 per trip. Increased numbers of fishing trips could lead to both direct and indirect economic impacts within the region. While not immediate, benefits would eventually become recognized as fish quality improved.

Estimates of the value of remediation obtained from a survey in the Fox-Wolf watershed generally range from $100 to $300 per household annually. Estimates vary depending upon the models and assumptions used. A description of the methods and the sampling plan for the survey are described later in this chapter. The referenda-style question eliciting valuations for remediation to achieve various proportions of the desired state (20%, 40%, 60%, 80%, and 100%) yielded annual per-household benefit estimates of $149, $183, $201, $213, and $222, respectively.[5] These results were from a model estimation that incorporated adjustments for sampling proportions from the stratified zones, meaning that aggregation by state population is appropriate. The direct open-ended question for achieving 100% of the desired state yielded an average response of $121 annually per household (unadjusted for sampling proportions from stratified zones).

The most important thing to take away from this case study is that respondents did in fact place positive values upon remediation of contaminated sediments and that values could be elicited for such activities. Further, respondent values of considerably lower magnitudes would generate a substantial amount of support for remediation activity when aggregated to the state level and across years. Remember, these values were elicited in the form of annual costs for achieving the desired state, not one-time values.

Regional Economic Impacts

For the sample as a whole, 33% indicated that they had gone fishing in the Fox-Wolf River Basin or lower Bay of Green Bay during the previous 12 months, and 60% indicated that they were worried or somewhat worried about eating fish caught in the same area (14% very worried). When queried about the likelihood of altering the frequency of fishing trips if the fish were completely free of pollutants that threaten human health, 17% said they would and another 20% said they might change their behavior. The average increase in annual trips was estimated to be 5.33 for responding fishermen, and the current level of fishing trip expenditures in the study region averaged $49.95 per trip. Thus, the typical respondent who would alter fishing behavior is estimated to have an increased expenditure of approximately $250 dollars per year (5 x $50). Using a range of 1.5 to 3.0 for a regional multiplier (fairly typical for a locality and a multicounty region) yields an impact of $375 to $750 annually per angler in the region from elimination of human health impacts associated with fish consumption.

Combining this information with the number of anglers fishing in the region would yield an estimate of overall economic development benefits associated with fishing activities and resultant from contaminated sediment remediation. Alternatively, one could use the direct angler expenditure changes in a regional impact model to estimate these economic development benefits. Yet, as discussed above, this would only represent a partial accounting for economic development benefits, one which would be of regional interest but not necessarily valid from a project justification perspective (depending on whether one were to take a local, wider regional, state, or national perspective on the issues).

C. Survey Design and Administration

The survey allowed us to explore the nature and magnitude of use and nonuse values for remediation of contaminated sediment in Green Bay. Our purpose was to develop an approach that could be used by other AOCs within the Great Lakes system for conducting original economic benefit estimation studies. A further purpose was to begin to lay a foundation for the development of models for assessment of economic benefits that could be used to transfer previous benefit estimates to new remediation contexts,

[5] These estimates are based upon numerical approximation of an estimated logistic function. While valuation offers extended to $3000, the proportion of "no" responses stabilized at a relatively low amount. Further, the number of offers used was concentrated below $300. Thus, a $300 truncation point was used for value estimation in the numerical approximations—a decision that yields more conservative estimates than would otherwise be obtained (see detailed chapter on benefit estimation).

i.e., to begin the development of a database for transferable benefits models.

The design phase for the survey instrument took over a year. The research team held intensive discussions, and collection of background information on the Green Bay AOC was performed. The advisory panel set up by the UW Sea Grant Coordinator of the combined research teams, in consultation with the Great Lakes Protection Fund, was used as a feedback mechanism.

Focus Group

In addition to consultation with colleagues and the advisory panel, two focus group sessions were held to provide feedback on the survey instrument. These focus groups were conducted by an independent contractor who specializes in these types of activities—Dr. Phil Clampitt. One group consisted of citizens of the Green Bay area and was designed to provide feedback from the type of audience that would be receiving the survey instrument in the mail. The second focus group consisted of individuals who were involved in some manner with the efforts to consider various aspects of the remediation decision process within the Green Bay AOC. This latter group included people affiliated with the Remedial Action Plan as well as assorted local, state, federal agencies, and other interested groups. Each focus group consisted of between 5 and 10 people.

After each of these review activities, the survey instrument was revised. The final "Water Resource Survey" instrument had 14 pages and was administered by mail to 1,500 households. It was intentionally not titled "contaminated sediment survey" because its focus was broader than just contaminated sediments. We also were concerned about polarizing respondents into groups based upon their initial reactions to anything that might be titled "contaminated sediments," potentially provoking extreme reactions upon reading the title of the survey. The survey instrument was divided into six sections.

Survey Section 1

The first section was introductory in nature and focused upon recreational uses of water resources in the Fox-Wolf Basin and lower bay of Green Bay. It included questions about where households visited within the watershed region, the types of activities in which they engaged, and their reasons for visiting water resource areas outside of the Fox-Wolf Basin and lower bay of Green Bay.

Survey Section 2

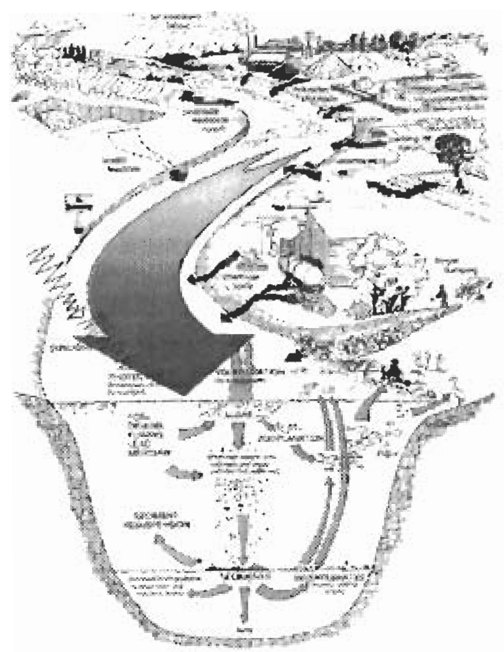
The second section specifically targeted sportfishing activities within the same region. This section was expanded considerably partway into the project as it became known that the statewide survey database created in a previous study by Bishop et al. would not be particularly useful by itself for deriving use benefit measures. It was hoped that some data specific to the Green Bay AOC could be obtained and used to supplement the study by Bishop et al. (1988). The additional information sought included whether household members engaged in recreational fishing, the frequency of such engagement, and the level of expenditures made on a typical fishing trip within the study region. Respondents were also asked whether they were concerned with the quality of fish caught, i.e., concerned about health risks from consumption, and whether reduced risks would cause them to alter their fishing behavior. If so, they were queried regarding the altered level of fishing trips they would potentially make in response to better fish quality. This information would support estimation of changes in regional expenditures, which could occur as a result of contaminated sediment remediation.

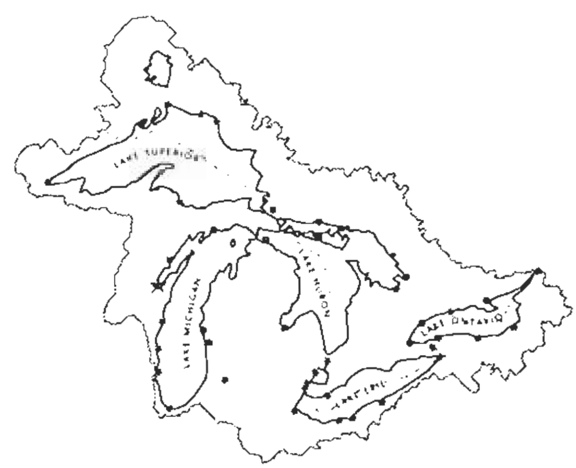
Survey Section 3

The third section of the survey instrument provided a synopsis of watershed pollution problems. See Appendix 2 for the text.

This synopsis was accompanied by a colored illustration that detailed various potential

Sources and Effects of Watershed Pollution





sources of pollutants within a watershed (above). (See page 71 for a larger version.) The illustration was meant to be general in nature while identifying elements that could conceivably occur within the Green Bay AOC. However, the Green Bay AOC was not mentioned within the context of this diagram or the text about watershed pollution problems.

The remainder of this section of the survey instrument was used to query respondents about their level of knowledge regarding water pollution issues in the Fox-Wolf River Basin and lower bay of Green Bay. This section also presented respondents with a series of ranking statements about the importance of more specific pollution issues, e.g., wetland/shoreline destruction, biodegradable toxic substances, and eroded soil suspended in the river. See the survey instrument in Appendix 2.

Survey Section 4

The fourth section of the survey instrument brought the focus to the more specific issues associated with the Green Bay AOC. This section included a map of Green Bay as well as a set of facts about the AOC.

This was followed by a presentation of a schematic of Great Lakes AOCs and a brief discussion indicating that the Green Bay AOC was one of 43 AOCs within the Great Lakes basin.

A following, brief paragraph indicated that much research had been conducted during the 1980s by professors at the University of Wisconsin-Green Bay and that from this and other work the Lower Green Bay Remedial Action Plan (RAP) had emerged in 1988. This paragraph was followed by a set of questions regarding whether the respondent ever intended to use the water resources of the lower Fox River and bay of Green Bay in the future, whether it was important to maintain water resource quality in this area, whether he or she would like to see water resource quality improved, and if so, why.

Finally, there was a question on whether or not it was necessary for the respondent to know who would receive future benefits of water quality improvements or preservation. This latter question was intended to identify whether the respondent felt a stewardship responsibility for maintaining the existence of a quality set of water resources.

Survey Section 5

The fifth section of the questionnaire, "program evaluation," was intended to measure the value respondents placed upon "a watershed program to deal with contaminated sediments" in a manner that would attain the "desired state" of the water quality for the lower Fox River and southern Green Bay AOC. In accordance with the discussion in Section II regarding the importance of understanding the "with" and "without" states, in the present study we sought to inform respondents in an unbiased manner about contaminated sediment issues but recognized that the level of detail would need to be less than some might feel is appropriate. A response to this concern in this case is that the issues examined are ones for which citizens in the immediate areas are subjected to a variety of information on a daily basis through local media and various regional organizations. This is felt to be particularly true for the Green Bay Economic Region, where the pros and cons of sediment remediation are widely debated and publicized in meetings and regional media.

Survey Section 6

The sixth and final section was used to collect information about the respondent's household. This socio-demographic information included age, gender, income, education, ethnicity, etc. In addition, respondents were queried about their perceptions regarding the clarity of the survey instrument and the accuracy of their responses to the policy evaluation questions in section five of the survey instrument.

Survey Administration

The survey was sent to a three-tiered random stratified sample. The first tier consisted of counties contiguous to the Fox River—Brown, Calumet, Fond du Lac, Outagamie and Winnebago counties. The second tier consisted of the 14 counties surrounding those contiguous to the water basin—Door, Florence, Forest, Kewaunee, Marinette, Menominee, Oconto, Shawano, Waupaca, Green Lake, Manitowoc, Marquette, Sheboygan, and Waushara counties. The third and final tier was made up of the remaining counties in the state of Wisconsin.

This sampling strategy was based on the assumption that although remediation benefits the population as a whole, the residents of the contiguous counties will place a higher value on increased environmental quality in the water basin because they have greater access and cause to use the resources, demonstrating what is referred to as "use value." Those living farthest from the actual resource and least likely to recreate within the study region are expected to have a larger share of their valuation motivated by an "existence" valuation for the resource.

The 1,500 household sample was randomly generated from within each of these three tiers. Fifty-five percent of the sample was drawn from tier one, 25% from tier two, and 20% from tier three. Survey Sampling, Inc. of Fairfield, Connecticut, was contracted to generate the sample. This company uses driver license and registration data as well as telephone number records to compile a pool of eligible individuals from which to construct samples for research and marketing studies.

The survey instrument was administered over a period of several months in the spring of 1997. An initial letter was sent to households informing them of the general purposes of the study and indicating that they would be receiving a questionnaire in the mail over the coming weeks. After this initial mailing, the survey instrument was mailed along with another cover letter requesting the household's assistance with the study. Finally, an additional letter was sent to nonrespondents with another copy of the survey instrument to again request the household's assistance with the study and stressing the need for as much participation as possible. The focus of all the letters was to indicate that participation was voluntary and confidential but needed to enhance reliability of results (Dillman 1978; Salant and Dillman 1994).

D. Survey Results

The overall survey response rate was 35%, ranging from 32% to 38% across the three sample tiers (see Table 1).

Survey Section 1: General Recreational Usage of Basin.

As one would expect, recreational usage of the Fox-Wolf Basin and lower Bay of Green Bay was heaviest by those living within the region (Table 2). Yet even those residing in other areas of the state tended to use the Fox and Wolf Rivers, Lake Winnebago, and the lower area of Green Bay. Close to 13% of those living outside the Fox-Wolf Basin indicated usage of each of these areas.

The most common type of activity was open-water fishing (38%), followed closely by sight-seeing (35%), shore picnicking or camping (30%), and motorized boating (26%). The least common activities were sturgeon spearing and sailing (each 4% of respondents). Breakdowns by each sampling tier and specific recreational activity are provided in Table 3.

When queried as to whether their household members had visited lakes or rivers outside the Fox-Wolf Basin or lower area of Green Bay, 65% indicated that they had (Table 4). The most common reasons for doing so were "for a change of pace," "closer to my home," "better fishing and hunting," and "clearer water."

Survey Section 2: Recreational Fishing in the Basin.

One-third of respondents indicated that they had engaged in fishing activities within the past 12 months in the Fox-Wolf Basin or lower bay of Green Bay (Table 5). The most common types of fish caught were walleye, sheepshead, yellow perch, and panfish (bluegills, crappie, etc.). Many also caught white bass, northern pike, and catfish (Table 6). The proportion of respondents desiring to catch a species and the proportion actually catching it deviated greatest for catfish and white bass; greater proportions caught them than desired catching them. On the other hand, nearly 16% indicated they would like to catch muskie, but only 2% did catch them.

When queried about their fish consumption, 72% indicated that they consumed fish they caught in the Wolf River (Table 5). This proportion dropped to 57% for the bay of Green Bay, to 41% for the upper Fox River and to only 35% for the lower Fox River. Days fished in each area varied from 0.67 to 4.4, with a total of 10.63 days over the 12 previous months. As expected, those living closer to the Fox River and lower bay of Green Bay engaged in more fishing than those residing further away (Table 7). When queried regarding their consumption of fish, the average times per month fish were caught and eaten ranged from 0.33 to 0.79, with fish caught in the Wolf River consumed the most per month (Table 7).

It appears that many anglers are aware of pollution problems, as indicated for the above proportions as well as from another question regarding health risks from fish consumption. When **all** respondents were asked whether they were worried "about having health problems as a result of eating fish caught in the Fox-Wolf River Basin and lower bay of Green Bay," 14% indicated that they were "very worried" and an additional 46% indicated that they were "somewhat worried."

A follow-up question queried respondents as to whether they would have made "a greater number of fishing trips" in the basin in the past 12 months if the "fish were completely free of pollutants that threaten human health." As mentioned in Appendix 1, which discussed Dr. Bishop's travel cost results, approximately 37% said they would have or might have made more trips (Table 6). Those near the Fox River indicated 5.98 additional trips while those outside the Fox-Wolf Basin indicated an increase of 2.74 trips, for an overall average of 5.33 trips (Table 8). This information could be combined with the number of anglers fishing in the region and per angler expenditures to yield an estimate of overall regional economic impact resultant from contaminated sediment remediation. However, as discussed in Section II, this would only represent a partial accounting, one which would be of regional interest but not necessarily valid from a project justification perspective (depending on whether one were to take a local, wider regional, state, or national perspective on the issues).

Respondents indicated they had made an average of 12.8 different fishing trips within the Fox-Wolf Basin and lower region of Green Bay (Table 9). On the last fishing trip made respondents spent an average of $49.95 on assorted items; transportation ($15.68), lodging ($7.36), food and drinks ($17.65), boat fuel and launch fees ($5.70), and miscellaneous other items ($3.58). Expenditures were highest for those residing outside the Fox-Wolf Basin ($156.93).

Survey Section 3: Importance of Basin Pollution Issues.

An array of 10 issues was provided to respondents, and each was asked to provide a ranking of the issue's importance on a 7-point scale (1=very unimportant and 7=very important). Respondents were given the option to indicate they didn't know; these responses were removed from the computation of average reported in Table 9. Generally, all of the issues were judged to be important, and they received average rankings ranging from 4.85 to 5.78 on the 7-point scale. The lowest scoring items were eroded soil suspended in water, regional employment impacts, and land use patterns. The highest scoring items were slowly degrading toxic substances and toxic metal contaminants. As indicated in Table 9, the variation among the segments of the sample was similar.

When asked to assess their knowledge of water pollution issues, fully half of the sample indicated a low knowledge level and only 8% indicated a high knowledge level (Table 10).

Survey Section 4: Water Quality Improvement in the AOC.

Most respondents indicated that they planned to use the water resources of the Green Bay AOC in the future (60%), and 98% indicated that it was important to maintain the quality of these water resources (Table 10). Of those people indicating that maintaining quality of these water resources was important, 98% also indicated that they would like to see the quality of these water resources improved. When queried regarding their motivation for desiring such quality improvements, multiple responses were allowed. Only 57% indicated that they wanted the option to use these water resources in the future, but 80% indicated that they felt future generations may desire to use them. Seventy-two percent wanted to preserve them regardless of whether they were ever used, and 71% wanted to allow other people than themselves to use these water resources in the future. A clear notion of resource stewardship emerges from these responses. When queried regarding whether they would need to know who benefited from their choice to donate funds to promote preservation and quality improvements, 36% indicated that they did not need to know because their interest was in preservation for future generations, and 59% said it would be important for them to know prior to donating (Table 10).

Survey Section 5: Program Evaluation.

One major problem encountered in this study was to predict the nature and extent of changes that would be brought about by sediment remediation activities.

This problem required deciding how to develop valuation approaches that would be flexible enough to be used when one does not know what level of remediation will actually end up being proposed.

The range of possibilities extends from no remediation to total remediation. *The uncertainty about remediation levels to be proposed was handled by using a variety of potential levels of remediation.* We chose to estimate remediation benefits in the case study for levels of remediation at 20%, 40%, 60%, 80%, and 100% of the remedial action plan's "desired state" in order to develop a model for prediction over the 0 to 100% range.

The specific form of the basic valuation question is shown in the sidebar. All respondents

Suppose a watershed program to deal with contaminated sediments could be adopted within the next year that would **improve the quality** of water resources within the lower Fox River and Southern Green Bay AOC. And that over time, possibly 10-20 years, this program would achieve the **60%** of the benefits from the Remedial Action Plan's "**desired state**" for contaminated sediments. Adoption of this program would increase the amount of money spent by households, government and industry on pollution control, and you, the consumer, would eventually have to pay for it. As a result, your household would have **$200 less** per year to spend on other things, beginning next year.

If the adoption of this water resources policy were put to a referendum (a yes/no vote), would you vote to accept this program to improve the present quality of water resources?

1 YES ——> GO TO QUESTION Q-22a

2 NO ——> GO TO QUESTION Q-22b

received this initial question with the cost amount varying from $1 to $3,000 per year.

The next question asked about a different proportion of accomplishment of the "desired state" for the Green Bay AOC. If the response to the initial question was "yes," then the proportion was raised to either 80% or 100%. If the response to the initial question was "no," the subsequent question reduced the proportion of accomplishment to either 40% or 20%. The cost of the program remained the same for a particular respondent throughout the scenarios but varied among respondents.

Q-22a. Suppose instead that it was found this same watershed program would achieve a smaller portion, **40%**, of the benefits from the Remedial Action Plan's "**desired state.**" But again, nothing is free. If adopted, your household would have **$200** less per year to spend on other things, beginning next year.

1 YES

2 NO

Subsequent to this series of close-ended referenda style scenarios, each respondent was also asked an open-ended question on the highest remediation cost he or she would find acceptable. Respondents who failed to respond to the open-ended question or responded with a zero value were queried as to why they did so. This "check question" was used to determine whether the respondent valued the remediation program at "zero" or was registering a protest response to the question scenario (Table 12).

Twenty household annual cost amounts were used in the referenda scenarios. The amounts and responses are shown in Table 11 by specific scenario. The design of the scenario structures ensured that every amount was used in the 60% of the "desired state" scenario but not within the other scenarios.

The respondents indicated that they felt their responses to the valuation scenarios were reasonably accurate (Table 12), with only 6% indicating "inaccurate, very inaccurate, or extremely inaccurate."

A logistic regression model was developed for the referenda question using a pooled data set. Since each respondent provided a response to the 60% scenario and a response to a higher or lower percentage of accomplishment scenarios, the response to the remaining scenario could be inferred. That is, if a respondent said "yes" to a $5 annual cost of achieving 60% of the "desired state," it is clear that he or she would also respond "yes" to the same cost for achieving 80% or 100% of the "desired state." Thus a pooled data set was created wherein each respondent was replicated three times. This data set was then used to perform estimation of the logistic regression. All other analyses were conducted upon the original data set. A multiple regression analysis was also used to estimate a model relating the open-ended scenario response to a variety of other respondent responses as well.

In each of the estimations, a weighted and unweighted model was developed. The weights were based upon the sampling tiers from which an observation came. The data were weighted to reflect the proportion of the state of Wisconsin's population that tier reflected. The weighting process was one contained within StatPac (a statistical survey analysis software produced by StatPac Inc., Minneapolis, Minnesota) that creates replicates of the observations to develop a sample reflective of the state's population. Thus the number of observations shown in the tables for the weighted models is larger than for the unweighted models.

It was expected that respondents' incomes would have a bearing on the amount they were willing to pay. In the multiple regression model, income was a significant explanator of the open-ended willingness-to-pay valuation of the contaminated sediment remediation program. Since the close-ended format used a specific household cost (offer) amount in the scenario, this model used a variable expressing the offer as a percentage of household income.

It was a significant variable in the logistic regression model as well. In both models, the income variable had the expected coefficient sign (positive for the open-ended response, and negative for the close-ended response).

In the close-ended scenario the percentage of accomplishment of the "desired state" varied, but in the open-ended scenario all responses were for achievement of 100% of the "desired state." Thus, the close-ended model used the proportion of the "desired state" as a variable, and an expected sign for the coefficient was obtained (it was positive and significant).

Other variables used in the two models were meant to capture motivations for placing value upon the remediation of contaminated sediments. These included concerns about health problems, future usage of the AOC, and interest in preserving the water resources for future generations. A variable indicating educational level of the respondent was also used. Statistical results for these variables are presented in Tables 13 and 15. Estimated signs are as expected on significant coefficient estimates and are consistent across the models for both the close-ended and open-ended scenarios.

The purpose of these models is two-fold. First, it is used to examine relationships between variables for expected behavior, which allows for a feeling of reasonableness of the data. Second, in the close-ended scenario, it is used to allow for numerical approximations of the estimated logistic function to arrive at benefit estimates from contaminated sediment remediation for various levels of accomplishment of the "desired state."

Estimates of economic benefits from remediation of contaminated sediments are shown in Table 14. The basic scenario question is presented at the top of the table, and the valuation estimates for both unweighted and weighted models are listed for levels of attainment, going from 0.1% (zero can not be used in a logged model) to 100% of the "desired state." The estimates are presented using several levels of truncation of the offer amount for the close-ended scenarios. Because the proportion of "no" responses appeared to become flat and all but three cost amounts in the scenario were below $1000, conservative truncation points were used.

Adopting a $300 dollar truncation point with the weighted estimates yields benefit estimates of $149 for 20% accomplishment and $222 for 100% accomplishment. Comparing these numbers with the mean open-ended response for 100% accomplishment shows that they are somewhat comparable in magnitude. Each indicates that household valuation of the 100% remediation scenario is between $100 and $300 per year.

The open-ended responses for those adjacent to the Fox River and lower Green Bay yield estimates of $152, and those further removed have lower values. It is puzzling that respondents outside the basin had a higher mean response than those within the "other areas of the basin," but the 95% confidence intervals all overlap, indicating that these differences are not significant.

Survey Section 6: Socio-Demographics.

Respondents to the survey were white (98%), predominantly male (76%), and about 51 years old (see Tables 16 and 17). Households had 2.8 members, an average education of 14 years, and a mean income of approximately $46,000.

Respondents generally found the question wording to be fairly clear (4.9 on a 7-point scale). A variety of other comments were received from survey respondents indicating concerns about water resource pollution problems in the Fox-Wolf River Basin and lower Green Bay.

E. Implications

Remediation of contaminated sediments is valued by citizens. Estimates from the contingent valuation survey in the Fox-Wolf watershed generally range in the area of $100 to $300 per household annually. Estimates vary depending upon the models and assumptions used.

Such annual household estimates can become quite significant in magnitude when aggregated across larger populations of citizens. Yet benefit estimates themselves are not enough to make decisions about remediating contaminated sediments. It is also necessary to make comparisons with remediation costs, a task beyond this component of the case study research.

The information generated in this case study of the economic benefits for the Green Bay AOC provides a first step in evaluating the merits of contaminated sediment remediation. Yet, benefit estimation for remediation projects will be hampered by lack of information about how cleanup of specific sites will affect the larger ecosystem and the economic benefits tied to the larger ecosystem. For example, the $222 per year benefit from achieving 100% of the "desired state" in the Fox River/Green Bay AOC, cited above, is interesting and informative. Yet, this benefit cannot, by itself be used to describe the benefit of remediation at specific to sites in the lower Fox River. The $222 value applies to achieving 100% of the "desired state" and is not specific to the remediation of particular contaminants nor components of the AOC system.

Taken in conjunction with the *satisficing approach*, described in Section II, our work can contribute to this benefits area of current policy debate in the Great Lakes region. The general framework can enable the issues to be discussed in a more coherent fashion. It is recognized that all choices have both costs and benefits. There are opportunity costs associated with both the decision to remediate and the decision not to remediate contaminated sediments. The failure to make a decision to remediate is, in fact, a decision—it is a decision not to remediate. It is hoped that our work for the Great Lakes Protection Fund, the U.S. Environmental Protection Agency, and the University of Wisconsin Sea Grant Institute will assist citizens throughout the Great Lakes region in making the hard choices wisely.

The *satisficing approach* makes a focus upon the costs of alternative remediation options a much more defensible one. Defensible, that is, as long as it is recognized that one must both choose the most cost-effective manner of achieving a given remediation goal and consider whether the goal itself is one which can be reasonably expected to yield benefits in excess of its minimized achievement costs.

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Appendix 1
Survey Results

Table 2. Zone from Which Sample Respondent Was Drawn and Response Rate by Zone

	Number of Responses	Percent of Total Responses	Number in Original Sample Frame	Percent of Original Sample Frame
Counties Adjacent to Fox and Bay	310	58.5%	825	37.6%
Other Counties in Fox/Wolf Basin	124	23.4%	375	33.1%
Other Areas of Wisconsin	96	18.1%	300	32.0%
Total	530	100.0%	1500	35.3%

Table 3. Household Recreational Use of Fox-Wolf River Basin and Lower Bay of Green Bay in the Past 12 Months

Fox-Wolf Basin Area	Respondent Residence Group							
	Adjacent to Fox & Bay		Other Basin Counties		Outside Basin		Total	
	N	%	N	%	N	%	N	%
Lower Bay of Green Bay:								
Frequently (more than 2 times per year)	49	18.1	9	8.3	3	3.2	61	12.9
Infrequently (less than 2 times per year)	36	13.3	12	11.0	13	14.0	61	12.9
Never	186	68.6	88	80.7	77	82.8	351	74.2
Lower Fox River:								
Frequently (more than 2 times per year)	54	20.0	6	5.9	5	5.5	65	14.0
Infrequently (less than 2 times per year)	38	14.1	5	4.9	8	8.8	51	11.0
Never	178	65.9	91	89.2	78	85.7	347	74.9
Upper Fox River:								
Frequently (more than 2 times per year)	32	12.2	8	7.5	2	2.2	42	9.2
Infrequently (less than 2 times per year)	31	11.8	5	4.7	10	11.2	46	10.0
Never	200	76.0	93	87.7	77	86.5	370	80.8
Lake Winnebago:								
Frequently (more than 2 times per year)	95	34.3	11	10.5	5	5.6	111	23.5
Infrequently (less than 2 times per year)	37	13.4	15	14.3	7	7.8	59	12.5
Never	145	52.3	79	75.2	78	86.7	302	64.0
Lake Winneconne:								
Frequently (more than 2 times per year)	31	11.7	5	4.8	3	3.3	39	8.5
Infrequently (less than 2 times per year)	23	8.7	4	3.8	5	5.6	32	7.0
Never	210	79.5	95	91.3	82	91.1	387	84.5
Lake Poygan								
Frequently (more than 2 times per year)	40	15.0	8	7.7	3	3.3	51	11.1
Infrequently (less than 2 times per year)	38	14.2	8	7.7	5	5.6	51	11.1
Never	189	70.8	88	84.6	82	91.1	359	77.9
Lake Butte des Morts:								
Frequently (more than 2 times per year)	38	14.4	6	5.8	2	2.2	46	10.1
Infrequently (less than 2 times per year)	25	9.5	5	4.8	4	4.4	34	7.4
Never	200	76.0	93	89.4	84	93.3	377	82.5
Wolf River:								
Frequently (more than 2 times per year)	58	21.5	20	18.0	4	4.4	82	17.4
Infrequently (less than 2 times per year)	55	20.4	7	6.3	10	11.1	72	15.3
Never	157	58.1	84	75.7	76	84.4	317	67.3
Wetlands:								
Frequently (more than 2 times per year)	35	13.4	11	10.5	3	3.4	49	10.7
Infrequently (less than 2 times per year)	38	14.5	5	4.8	4	4.5	47	10.3
Never	189	72.1	89	84.8	82	92.1	360	78.9
Sample Size[1]	310		124		96		530	

[1] The number of nonresponding households for a particular area can be determined by taking the difference between the N for the three response options for an area and the sample size at the bottom of the respective column.

Table 4. Household Recreational Activities in the Fox-Wolf River Basin and Lower Bay of Green Bay

Water-Related Recreation Activities	Respondent Residence Group[1] Adjacent to Fox & Bay		Other Basin Counties		Outside Basin		Total	
	N	%	N	%	N	%	N	%
Open-Water Fishing	139	44.8	40	32.3	23	24.0	202	38.1
Ice Fishing	88	28.4	22	17.7	5	5.2	115	21.7
Sturgeon Spearing	18	5.8	2	1.6	1	1.0	21	4.0
Motorized Boating	109	35.2	20	16.1	11	11.5	140	26.4
Water Sports (waterskiing, jet skis, etc.)	58	18.7	13	10.5	6	6.3	77	14.5
Canoeing	39	12.6	10	8.1	9	9.4	58	10.9
Sailing	13	4.2	5	4.0	3	3.1	21	4.0
Swimming	100	32.3	33	26.6	13	13.5	146	27.5
Shore Picnicking or Camping	108	34.8	31	25.0	19	19.8	158	29.8
Sightseeing	122	39.4	41	33.1	23	24.0	186	35.1
Hunting	52	17.4	16	12.9	6	6.3	76	14.3
Cross-Country Skiing	25	8.1	10	8.1	6	6.3	41	7.7
Hiking along Waterways	49	15.8	18	14.5	8	8.3	75	14.2
Observing/Photographing Wildlife	64	20.6	21	16.9	15	15.6	100	18.9
Other Water-Related Activities	8	2.6	0	0.0	2	2.1	10	1.9
None of the Above Water-Related Activities	74	23.9	46	37.1	51	53.1	171	32.3
Sample Size[2]	310		124		96		530	

[1] Percentages in this table use the number of cases as the base for calculations. Thus, implicitly, this treats nonrespondents to an activity item as though the respondent's household does not participate in that activity. The number of nonresponding households to a particular item can be determined by taking the difference between the N for the item and the sample size at the bottom of the column.

[2] The difference between this number and the category N is equal to the number of missing cases (nonresponses) for that item in the questionnaire.

Table 5. Household Recreational Activities in Wisconsin but outside the Fox-Wolf River Basin and Lower Bay of Green Bay

Other Area Use and Reason	Respondent Residence Group[1]						Total	
	Adjacent to Fox & Bay		Other Basin Counties		Outside Basin			
	N	%	N	%	N	%	N	%
Have you, or others in your household gone to any lakes or rivers in Wisconsin that are not in the Fox-Wolf river Basin or lower Bay of Green Bay for Recreational Activities?								
Yes	198	65.1	73	60.3	67	69.8	338	64.9
No	106	34.9	48	39.7	29	30.2	183	35.1
If "Yes," then the following was asked:[1] For what reasons have you, or others in your household, gone to lake or rivers in Wisconsin that are not in the Fox-Wolf River Basin or lower Bay of Green Bay for water recreation activities?								
Has Clearer Water	76	24.5	11	8.9	6	6.3	93	17.5
Better Public Access	19	6.1	2	1.6	5	5.2	26	4.9
Closer to My Home	19	6.1	39	31.5	48	50.0	106	20.0
Better Fishing or Hunting	69	22.3	15	12.1	6	6.3	90	17.0
Is a Better Experience Overall	34	11.0	8	6.5	10	10.4	52	9.8
For a Change of Pace	106	34.2	27	21.8	11	11.5	144	27.2
Other Reason	73	23.5	14	11.3	12	12.5	99	18.7
Sample Size[2]	310		124		96		530	

[1] Percentages for this item use the number of cases as the base for calculations because the respondent was given the option to choose multiple responses for the question. Thus the percentage indicates the proportion of the sample row total indicating a particular response. That is, for example, 17.5% of all respondents indicated that they used areas outside the study area for recreation because these alternative areas had clearer water.

[2] The difference between this number and the category N is equal to the number of missing cases (nonresponses) for that item in the questionnaire.

Table 6. Household Recreational Activities in Wisconsin but outside the Fox-Wolf River Basin and Lower Bay of Green Bay

Other Area Use and Reason	Respondent Residence Group: Adjacent to Fox & Bay N	%	Other Basin Counties N	%	Outside Basin N	%	Total N	%
In the past 12 months, did you go fishing in the Fox-Wolf River Basin or lower Bay of Green Bay?								
Yes	132	42.7	29	23.6	15	15.6	176	33.3
No	176	57.0	92	74.8	81	84.4	349	66.1
Not Sure	1	0.3	2	1.6	0	0.0	3	0.6
How worried are you about having health problems as a result of eating fish caught in the Fox-Wolf River Basin and lower Bay of Green Bay?								
Not at All Worried	105	34.7	57	47.9	41	49.4	203	40.2
Somewhat Worried	155	51.2	47	39.5	31	37.3	233	46.1
Very Worried	43	14.2	15	12.6	11	13.3	69	13.7
Suppose ... fish were completely free of pollutants that threaten human health, would you have made a greater number of fishing trips within the Fox-Wolf River Basin and lower Bay of Green Bay area than during the past 12 months?								
Yes	65	21.4	12	9.8	9	10.0	86	16.7
Maybe	70	23.0	21	17.2	14	15.6	105	20.0
No	169	55.6	89	73.0	67	74.4	325	63.0
If respondent fished in the past 12 months: Do you typically eat the fish you catch in the Fox-Wolf River Basin and lower Bay of Green Bay?								
Wolf River:								
Yes	71	73.2	14	70.0	8	72.7	93	72.7
No	26	26.8	6	30.0	3	27.3	35	27.3
Upper Fox River:								
Yes	27	37.5	5	45.5	6	66.7	38	41.3
No	45	62.5	6	54.5	3	33.3	54	58.7
Lower Fox River:								
Yes	29	33.7	4	36.4	3	42.9	36	34.6
No	57	66.3	7	63.6	4	57.1	68	65.4
Bay of Green Bay:								
Yes	53	57.0	11	61.1	5	50.0	69	57.0
No	40	43.0	7	38.9	5	50.0	52	43.0
Sample Size[1]	310		124		96		530	

[1] The difference between this number and the category N is equal to the number of missing cases (nonresponses) for that item in the questionnaire.

Table 7. Types of Fish Caught and Desiring to Catch during the Previous 12 Months in the Fox-Wolf River Basin and Lower Bay of Green Bay

Types of Fish	Respondent Residence Group												Total			
	Adjacent to Fox and Bay				Other Basin Counties				Outside Basin							
	Caught		Desired		Caught		Desired		Caught		Desired		Caught		Desired	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Lake Sturgeon	8	6.3	11	8.8	2	6.9	1	4.2	1	7.1	0	0.0	11	6.4	12	7.4
Muskellunge (muskie)	3	2.3	20	16.0	1	3.5	3	12.5	0	0.0	3	21.4	4	2.3	26	16.0
Walleye/Sauger	77	60.2	89	71.2	13	44.8	17	70.8	9	64.3	11	78.6	99	57.9	117	71.8
Sheepshead	66	51.6	2	1.6	12	41.4	1	4.2	2	14.3	0	0.0	80	46.8	3	1.8
White Bass	59	46.1	27	21.6	14	48.3	10	41.7	4	28.6	4	28.6	77	45.0	41	28.2
Largemouth Bass	23	18.0	45	36.0	9	31.0	11	45.8	7	50.0	4	28.6	39	22.8	60	36.8
Smallmouth Bass	37	28.9	43	34.4	13	44.8	12	50.0	9	64.3	6	42.9	59	34.5	61	37.4
Northern Pike	48	37.6	56	44.8	14	48.3	14	58.3	8	57.1	3	21.4	70	40.9	73	44.8
Catfish/Bullheads	55	43.0	16	12.8	15	51.7	7	29.2	7	50.0	3	21.4	77	45.0	26	16.0
Rough Fish (carp, suckers, etc.)	34	26.6	6	4.8	8	27.6	3	12.5	3	21.4	0	0.0	45	26.3	9	5.5
Brown Trout	8	6.3	18	14.4	5	17.2	5	20.8	1	7.1	3	21.4	14	8.2	26	16.0
Yellow Perch	90	70.3	95	76.0	16	55.2	15	62.5	6	42.9	6	42.9	112	65.5	116	71.2
Panfish (bluegills, crappie, etc.)	76	59.4	70	56.0	18	62.1	13	54.2	9	64.3	8	57.1	103	60.2	91	55.8
Other[1] [2]	13	10.2	6	4.8	3	10.3	1	4.2	0	0.0	1	7.1	16	9.4	8	4.9
Number of Respondents[3]	128		125		29		24		14		14		171		163	

[1] "Other" types of fish caught that were mentioned were lawyer, smelt, lake trout, brook trout, rainbow trout, rock bass, white perch, gar, roughy, mud puppy, dog fish, pickerel, steelhead, and salmon, but none were mentioned more than twice except lawyer (mentioned four times).

[2] "Other" types of fish desired included brook trout, rainbow trout, lake trout, salmon and smelt, with salmon mentioned the most (three times).

[3] Base of percentage is the number of cases with one or more responses, 128, 29, 14, and 171, respectively, for type of fish caught and 125, 24, 14, and 163, respectively, for types of fish desired.

Table 8. Frequency of Fishing and Eating Catch in the Fox-Wolf River Basin and Lower Bay of Green Bay, by Respondent Residence Group

Description	Respondent Residence Group						Total	
	Adjacent to Fox and Bay		Other Basin Counties		Outside Basin			
	Mean (std. err.)	N	Mean (std. err.)	N	Mean (std. err.)	N	Mean (std. err.)	N
Days fishing in the past 12 months in the following areas:								
Fox-Wolf River Basin	6.03 (0.90)	306	3.11 (0.90)	122	1.29 (0.61)	96	4.48 (0.58)	524
Lower Bay of Green Bay	1.32 (0.30)	306	0.75 (0.29)	122	0.26 (0.13)	96	0.99 (0.19)	524
Other Parts of Wisconsin	4.42 (0.48)	306	4.79 (1.13)	122	4.30 (0.94)	96	4.49 (0.42)	524
Outside Wisconsin	0.78 (0.14)	306	0.53 (0.20)	122	0.49 (0.16)	96	0.67 (0.10)	524
Total Days Fishing	12.56 (1.33)	306	9.17 (1.56)	122	6.36 (1.36)	96	10.63 (0.90)	524
How many times per month do you eat fish you caught in the following areas?:								
Wolf River	0.72 (0.09)	104	1.13 (0.33)	23	0.67 (0.19)	12	0.79 (0.09)	139
Upper Fox River	0.35 (0.13)	93	0.63 (0.26)	19	0.70 (0.26)	10	0.43 (0.11)	122
Lower Fox River	0.36 (0.09)	100	0.18 (0.13)	17	0.27 (0.19)	11	0.33 (0.08)	128
Bay of Green Bay	0.47 (0.08)	102	0.58 (0.20)	18	0.25 (0.13)	12	0.46 (0.07)	132
If fish were completely free of pollutants which threaten human health, howmany more fishing trips would you have made within the Fox-Wolf River Basin and lower Bay of Green Bay during the past 12 months?	5.98 (0.53)	112	4.46 (0.92)	28	2.74 (0.65)	19	5.33 (0.43)	159

Table 9. Number of Fishing Trips and Expenditures on Most Recent Fishing Trip in the Fox-Wolf River Basin and Lower Bay of Green Bay, by Respondent Residence Group

Description	Respondent Residence Group: Adjacent to Fox and Bay		Other Basin Counties		Outside Basin		Total	
	Mean (std. err.)	N	Mean (std. err.)	N	Mean (std. err.)	N	Mean (std. err.)	N
In the past 12 months, how many different trips to go fishing did you make within the Fox-Wolf River Basin and lower Bay of Green Bay?	13.67 (1.78)	126	11.76 (2.29)	25	7.33 (3.39)	15	12.81 (1.43)	166
On your last fishing trip how much did you spend for each of the following?:								
Transportation (fuel, rental car, taxi, etc.)	$12.39 (1.37)	126	$16.80 (7.83)	25	$43.29 (10.69)	14	$15.68 (1.92)	165
Lodging (hotel, camping, etc.)	4.37 (2.64)	126	1.80 (1.80)	25	44.29 (19.14)	14	7.36 (2.72)	165
Food, Drinks, Ice, etc.	15.47 (2.12)	126	9.52 (2.50)	25	51.79 (11.26)	14	17.65 (2.07)	165
Boat Launch Fees, Fuel, etc.	5.64 (0.92)	126	4.24 (0.95)	25	8.86 (3.86)	14	5.70 (0.79)	165
Other items[1]	3.50 (1.35)	126	1.12 (0.71)	25	8.71 (4.91)	14	3.58 (1.12)	165
Total	41.41 (5.42)	126	33.08 (10.46)	25	156.93 (41.52)	14	49.95 (6.14)	165

[1] The most frequent item listed by respondents was bait. Many respondents did not separately list this item and are assumed to have included it within the "boat launch fees, fuel, etc." category. Other items mentioned included ice, equipment, tackle, license, etc.

Table 10. Importance of Specific Pollution Issues by Respondent Residence Group (1=Very Unimportant; 7=Very Important)

Description	Respondent Residence Group						Total	
	Adjacent to Fox and Bay		Other Basin Counties		Outside Basin			
	Mean (std. err.)	N	Mean (std. err.)	N	Mean (std. err.)	N	Mean (std. err.)	N
Wetland/shoreland habitat destruction	5.36 (0.11)	275	5.23 (0.19)	103	5.53 (0.21)	75	5.36 (0.09)	453
Non-native species invasions (e.g., zebra mussel, purple loosestrive	5.72 (0.10)	272	5.44 (0.20)	97	5.49 (0.21)	73	5.62 (0.08)	442
Slowly degrading toxic substances that accumulate through the food chain (e.g., PCBs)	5.83 (0.10)	270	5.63 (0.19)	104	5.68 (0.23)	73	5.76 (0.08)	447
Biodegradable toxic substances (e.g., ammonia)	5.41 (0.10)	261	5.27 (0.18)	100	5.28 (0.24)	71	5.35 (0.08)	432
Toxic metal contaminants (e.g., mercury, lead, zinc)	5.86 (0.10)	275	5.60 (0.20)	103	5.74 (0.23)	76	5.78 (0.09)	454
Excess nutrients (e.g., phosphorous, nitrates) causing an abundance of algae	5.41 (0.10)	276	5.27 (0.17)	103	5.29 (0.21)	76	5.36 (0.08)	455
Eroded soil suspended in the water (sediment)	4.92 (0.09)	276	4.67 (0.19)	101	4.84 (0.21)	75	4.85 (0.08)	452
Organic waste that lowers oxygen in the water	5.45 (0.10)	274	5.43 (0.17)	105	5.36 (0.22)	76	5.43 (0.08)	455
Regional employment impacts of stricter pollution regulations	5.14 (0.10)	269	5.16 (0.17)	102	5.31 (0.22)	74	5.17 (0.08)	445
Land use patterns	5.11 (0.10)	263	5.16 (0.18)	100	5.19 (0.22)	72	5.14 (0.08)	435

Table 11. Future Use and Motivations for Placing Value upon the Water Resources of the Lower Fox-Wolf River and Bay of Green Bay

Future Use and Valuation Motives	Respondent Residence Group: Adjacent to Fox & Bay		Other Basin Counties		Outside Basin		Total	
	N	%	N	%	N	%	N	%
Knowledge level about water pollution issues:								
Low	135	45.2	53	44.9	66	69.7	250	49.4
Medium	137	45.8	53	44.9	26	29.2	216	42.7
High	27	9.0	12	10.2	1	1.1	40	7.9
Do you ever plan to use these water resources?								
Yes	202	66.4	60	52.2	47	51.1	309	60.5
No	102	33.6	55	47.8	45	48.9	202	39.5
Is it important to maintain the quality of these water resources?								
Yes	297	98.0	110	94.8	88	97.8	495	97.2
No	6	2.0	6	5.2	2	2.2	14	2.8
Would you like to see the quality of these water resources improved?								
Yes	292	99.0	104	95.4	86	97.7	482	98.0
No	3	1.0	5	4.6	2	2.3	10	2.0
If "yes," why do you desire to maintain or improve the quality of these water resources?[1]								
Because I desire to have the option to use them in the future	173	59.7	52	49.1	49	57.0	274	56.9
Because people other than myself may use them in the future	207	71.4	70	66.0	67	77.9	344	71.4
Because future generations may use them	234	80.6	80	75.5	72	83.7	386	80.1
Because they have a right to be preserved regardless of whether they are ever used	213	73.5	72	67.9	62	72.1	347	72.0
Before you would decide to give money to preserve or improve water quality, is it important that you know who receives the benefits from their preservation?								
Yes	182	61.3	68	59.6	45	50.6	295	59.0
No, my interest is in preserving the resource for future generations	108	36.4	41	36.0	39	43.8	188	37.6
No, I have no interest in preserving the resource	7	2.4	5	4.4	5	5.6	17	3.4
Sample Size[2]	310		124		96		530	

[1] Percentage base is number of respondents answering the question since multiple responses were allowed. The percentage bases were 290, 106, 86, and 482, respectively, for the first through fourth column of the question results.

[2] The difference between this number and the category N is equal to the number of missing cases (nonresponses) for that item in the questionnaire.

Table 12. Responses by Offer Amount and Percent of Desired State Achieved for Contaminated Sediments[1]

Offer	Proportion of Contaminated Sediment Desired State Achieved										Total	
	20%		40%		60%		80%		100%			
	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)
	0	1	25	1	29	5	3	2	—	—	57	9
$1	0.0	100.0	96.2	3.8	85.3	14.7	60.0	40.0	—	—		
	16	2	—	—	19	2	—	—	1	1	36	5
$2	88.9	11.1	—	—	90.5	9.5	—	—	50.0	50.0		
	—	—	18	1	19	2	0	2	—	—	37	5
$3	—	—	94.7	5.3	90.5	9.5	0.0	100.0	—	—		
	19	3	—	—	23	4	—	—	2	2	44	9
$5	86.4	13.6	—	—	85.2	14.8	—	—	50.0	50.0		
	—	—	17	1	18	3	1	2	—	—	36	6
$7	—	—	94.4	5.6	85.7	14.3	33.3	66.7	—	—		
	13	4	1	0	18	2	—	—	0	2	32	8
$11	76.5	23.5	100.0	0.0	90.0	10.0	—	—	0.0	100.0		
	—	—	17	5	22	9	2	7	—	—	41	21
$16	—	—	77.3	22.7	71.0	29.0	22.2	77.8	—	—		
	13	3	—	—	17	8	—	—	2	6	32	17
$25	81.3	18.8	—	—	68.0	32.0	—	—	25.0	75.0		
	—	—	9	0	10	7	0	7	—	—	19	14
$37	—	—	100.0	0.0	58.8	41.2	0.0	100.0	—	—		
	10	6	—	—	16	9	—	—	2	7	28	22
$55	62.5	37.5	—	—	64.0	36.0	—	—	22.2	77.8		
	—	—	13	2	15	11	2	9	—	—	30	22
$82	—	—	86.7	13.3	57.7	42.3	18.2	81.8	—	—		
	6	0	—	—	6	9	—	—	2	6	14	15
$122	100.0	0.0	—	—	40.0	60.0	—	—	25.0	75.0		
	—	—	7	2	9	15	2	13	—	—	18	30
$182	—	—	77.8	22.2	37.5	62.5	13.3	86.7	—	—		
	7	5	—	—	12	11	—	—	2	8	21	24
$272	58.3	41.7	—	—	52.2	47.8	—	—	20.0	80.0		
	—	—	4	3	8	25	2	21	—	—	14	49
$405	—	—	57.1	42.9	24.2	75.8	8.7	91.3	—	—		

continued on next page

[1] No adjustments for "reasonableness" or "protest" responses were perfomed on data presented in this table.

Table 12. (continued)

Offer	20% Yes (%)	20% No (%)	40% Yes (%)	40% No (%)	60% Yes (%)	60% No (%)	80% Yes (%)	80% No (%)	100% Yes (%)	100% No (%)	Total Yes (%)	Total No (%)
	Proportion of Contaminated Sediment Desired State Achieved											
	3	4	—	—	6	10	—	—	2	7	11	21
$605	42.9	57.1	—	—	37.5	62.5	—	—	22.2	77.8		
	—	—	7	1	8	8	0	7	0	1	15	18
$903	—	—	87.5	12.5	50.0	50.0	0.0	100.0	0.0	100.0		
	5	0	—	—	5	16	—	—	3	13	13	29
$1347	100.0	0.0	—	—	23.8	76.2	—	—	18.8	81.3		
	—	—	4	1	5	17	2	14	—	—	11	32
$2010	—	—	80.0	20.0	22.7	77.3	12.5	87.5	—	—		
	3	2	—	—	5	22	—	—	4	19	12	43
$3000	60.0	40.0	—	—	18.5	81.5	—	—	17.4	82.6		
Scenario:												
Number	95	30	122	17	270	195	14	84	20	72		
Percent	76.0	24.0	87.8	12.2	58.1	41.9	14.3	85.7	21.7	78.3		

Table 13. Reasons for Zero Responses or Nonresponses to Contaminated Sediment Remediation Scenarios

Reason	Respondent Residence Group: Adjacent to Fox & Bay N	%	Other Basin Counties N	%	Outside Basin N	%	Total N	%
If you answered zero (or failed to answer), please choose the statement below which best describes your reason for not allowing a reduction in your income?								
I place a zero value on achieving the "desired state"	6	5.1	1	2.1	1	2.9	8	4.0
I object to these types of questions	26	22.2	12	25.0	6	17.7	44	22.1
I cannot afford to pay any amount at this time	38	32.5	25	52.1	20	58.8	83	41.7
Not enough information was provided to make a decision	44	37.6	11	22.9	13	38.2	68	34.2
I would never pay for improved water quality	5	4.3	3	6.3	2	5.9	10	5.0
Overall, how understandable did you find the wording of the questions in this survey?								
Exceptionally Unclear	0	0.0	0	0.0	2	2.2	2	0.4
Very Unclear	12	4.0	4	3.4	2	2.2	18	3.5
Unclear	8	2.7	3	2.6	1	1.1	12	2.4
So-So	73	24.3	25	21.4	18	20.0	116	22.8
Clear	141	46.8	53	45.3	38	42.2	232	45.7
Very Clear	52	17.3	25	21.4	26	28.9	103	20.3
Exceptionally Clear	15	5.0	7	6.0	3	3.3	25	4.9
How accurate do you feel your answers were to the questions about household income reductions (questions Q21 to Q23)?								
Exceptionally Inaccurate	7	2.5	1	0.9	3	3.5	11	2.3
Very Inaccurate	7	2.5	3	2.8	2	2.3	12	2.5
Inaccurate	6	2.1	2	1.9	0	0.0	8	1.7
So-So	80	28.3	34	31.5	24	27.9	138	28.9
Accurate	117	41.3	43	39.8	33	38.4	193	40.5
Very Accurate	42	14.8	15	13.9	19	22.1	76	15.9
Exceptionally Accurate	24	8.5	10	9.3	5	5.8	39	8.2
Would you like a summary of the results of this survey?[1]								
Yes	163	52.6	58	46.4	37	38.5	258	48.7
No	147	47.4	66	53.6	59	41.5	272	49.3
Sample Size[2]	310		124		96		530	

1 Individuals who failed to respond to this question were assumed not to desire a copy of summary results.

2 The difference between this number and the category N is equal to the number of missing cases (nonresponses) for that item in the questionnaire.

Table 14. Logistic Regression Pooled Models for Estimation of "Typical" Respondent's Contaminated Sediment Remediation Value[1]

Variable	Dependent Variable is Yes (=1) or No (=0) Response of Respondent to Scenario					
	Unweighted Regression Analysis of Closed-Ended Responses			Weighted Regression Analysis of Closed-Ended Responses		
	Estimate	Std. Err.	Mean	Estimate	Std. Err.	Mean
Intercept	-5.93262***	1.39734	1.0	-5.03720***	0.84183	1.0
Ln (Offer Amount/Income)	-0.07959***	0.01597	-3.02714	-0.09543***	0.00.965	-3.09510
Ln (Percent of Desired State) (from Q21, Q22a, Q22b scenarios)	0.65637***	0.12354	3.97917	0.66024***	0.07305	3.97606
Worried about health problems from eating fish (Q12: 0=no created from option 1, else 1=no)	0.28614**	0.13205	0.61623	0.11703	0.07749	0.58047
Interested in preserving for future generations (Q20: 1=yes created from option 2, else 0=no)	0.63691***	0.13698	0.36362	0.75761***	0.08103	0.37151
Ln(Days fish Basin) (Q5: Sum of days in Fox-Wolf river and days in Lower Bay of Green Bay)	0.09774***	0.01609	-3.44500	0.09455***	0.00994	-3.90880
Ln(Age)	0.55961***	0.22014	3.82817	0.29843**	0.13255	3.84828
Plan to use lower Fox River and Bay of Green Bay for recreation (Q16:1=Yes; 0=No)	0.01620	0.15052	0.29685	-0.03281	0.08848	0.61497
Last year of school completed (Range from 1 to 21 years)	0.48724	0.34328	2.61956	0.52721***	0.20287	2.61569
Number of Observations	1144			3249		
Missing Cases	446			1364		
Log of Likelihood Function	-711.254			-2023.608		
Chi-Squared Statistic	123.899			370.995		
Degrees of Freedom	8			8		
100% Remediation Mean WTP[2]	$222.36			$221.99		

1 Significance levels are denoted as follows:
*** .01 level
** .05 level
* .10 level

[2] Numerical integration was performed over the offer range used for the pooled models and truncating the range of integration at $300. For alternative estimates of WTP with these models, see Table 14.

Table 15. Value Estimates Derived from Referendum and Open-Ended Question Formats

Valuation Scenario	Estimated Mean Value ($200 Truncation)	Estimated Mean Value ($300 Truncation)	Estimated Mean Value ($500 Truncation)	Estimated Mean Value ($700 Truncation)
Basic Scenario: Improve Current Situation to where __% of Remedial Action Plan's "desired state" for contaminated sediments would be achieved within 10-20 years for the Lower Fox River and Southern Green Bay AOC				
<u>Referendum (close-ended) format analysis</u>[1]				
Unweighted Model				
0.1% of desired state	$6.19	$9.00	$14.43	$19.68
20% of desired state	$101.48	$149.81	$244.64	$337.83
40% of desired state	$123.73	$183.31	$300.69	$416.48
60% of desired state	$135.81	$201.61	$331.62	$459.94
80% of desired state	$143.74	$213.65	$351.90	$488.74
100% of desired state	$149.46	$222.36	$366.68	$509.67
Weighted Model				
0.1% of desired state	$6.05	$8.74	$13.90	$18.86
20% of desired state	$101.20	$148.92	$242.15	$333.43
40% of desired state	$123.58	$182.63	$298.57	$412.61
60% of desired state	$135.74	$201.07	$329.71	$456.54
80% of desired state	$143.71	$213.21	$350.30	$485.70
100% of desired state	$149.46	$221.99	$365.26	$506.92

<u>Open-Ended Follow-up Response Analysis:</u>

<u>Mean Response Adjusted for "protests"[2] and "reasonableness"[3]</u>			
All: 100% of desired state (N=390)	$121.42 ($16.72)	95% Confidence Interval $88.64 — $154.20	$20
Adjacent: 100% of desired state (N=220)	$151.91 ($24.92)	95% Confidence Interval $103.08 — $200.75	$35
Other Basin: 100% of desired state (N=94)	$47.78 ($10.43)	95% Confidence Interval $27.34 — $68.22	$10
Outside: 100% of desired state (N=76)	$124.21 ($43.65)	95% Confidence Interval $38.66 — $209.76	$15

[1] Any respondent indicating a "yes" response to an amount larger than 25% of their income or a "no" response due to an "objection to question type" or "not enough information" was treated as a missing value for this analysis (see question Q-23a in survey instrument).

[2] Respondents indicating nonresponse or zero response due to "objection to question type" or "not enough information" were treated as "protest" responses rather than legitimate zero bids and, thus, excluded from the analysis. Those indicating zero or blank responses but indicating they "place a zero value on achieving the desired state," "cannot afford to pay," or "would never pay for improved water quality" were treated as legitimate zero bids.

[3] Respondent answers were checked to see if their response was greater than 25% of household income, with the intent of treating such responses as unreasonable. These responses would have been treated as a missing data for this analysis. However, no responses fit this criterion and all were, thus, included.

Table 16. Regression Model for Estimation of Typical Respondent's Contaminated Sediment Remediation Value from Open-Ended Scenario Responses[1]

Variable	Dependent Variable is Natural Log of Open-Ended Response to Scenario to Achieve 100% of "Desired State" for Contaminated Sediment Remediation			
	Unweighted Regression Analysis of Open-Ended Responses		Weighted Regression Analysis of Open-Ended Responses	
	Estimate	Std. Err.	Estimate	Std. Err.
Intercept	-15.4125***	5.4589	-14.5973***	3.1861
Ln (Income) {ln[(Q30*10,000)-5,000]}	0.9135***	0.3900	0.8697***	0.2264
Seriousness of contaminants {(Q15c+Q15d+Q15e)/3)}	0.4000***	0.1287	0.3996***	0.0713
Plan to use lower Fox River and bay of Green Bay for recreation (Q16:1=Yes; 0=No)	1.2494**	0.5569	1.2268***	0.3129
Interested in preserving for future generations (Q20: 1=yes created from option 2, else 0=no)	1.0349**	0.5226	1.0771***	0.3020
Last year of school completed (Range from 1 to 21 years)	0.2859***	0.1048	0.2650***	0.0605
Number of observations	292		846	
Missing cases	193		550	
R^2	0.15		0.16	
F Statistic	10.1833***		31.5461***	
Degrees of freedom	5 and 286		5 and 840	

[1]Significance levels are denoted as follows:
*** .01 level
** .05 level
* .10 level

Table 17. Demographic Characteristics of Respondents

Characteristic	Respondent Residence Group						Total	
	Adjacent to Fox & Bay		Other Basin Counties		Outside Basin			
	N	%	N	%	N	%	N	%
Are you:								
Asian	0	0.0	0	0.0	0	0.0	0	0.0
African-American	1	0.3	0	0.0	1	1.1	2	0.4
Hispanic	0	0.0	1	0.8	1	1.1	2	0.4
Native American/Indian	0	0.0	1	0.8	0	0.0	1	0.2
White	300	99.3	114	96.6	89	96.7	503	98.2
Other[1]	1	0.3	2	1.7	1	1.1	4	0.8
Which best describes where you live:								
Urban	121	40.1	39	32.8	27	29.3	187	36.5
Suburban	106	35.1	14	11.8	32	34.8	152	29.6
Rural (nonfarm)	54	17.9	47	39.5	19	20.7	120	23.4
Rural (farm)	21	7.0	19	16.0	14	15.2	54	10.5
Last type of school attended[2]:								
Grade School	11	3.6	3	2.5	5	5.4	19	3.7
High School	119	39.1	53	44.5	37	40.2	209	40.6
College/Technical	144	47.4	47	39.5	40	43.5	231	44.9
Graduate School	30	9.9	16	13.4	10	10.9	56	10.9
Household income, from all sources?								
Less than $20,000	42	15.2	22	20.8	21	24.7	85	18.2
$20,000 - $39,999	62	22.5	38	35.8	21	24.7	121	25.9
$40,000 - $59,999	89	32.2	32	30.2	22	25.9	143	30.6
$60,000 - $79,999	52	18.8	9	8.5	11	12.9	72	15.4
$80,000 - $99,999	18	6.5	4	3.8	8	9.4	30	6.4
$100,000 - $119,999	5	1.8	1	0.9	1	1.2	7	1.5
$120,000 - $139,999	4	1.4	0	0.0	1	1.2	5	1.1
$140,000 - $159,999	0	0.0	0	0.0	0	0.0	0	0.0
$160,000 - $179,999	0	0.0	0	0.0	0	0.0	0	0.0
$180,000 - $199,999	2	0.7	0	0.0	0	0.0	0	0.0
$200,000 - $219,999	1	0.4	0	0.0	0	0.0	0	0.0
$220,000 - $239,999	0	0.0	0	0.0	0	0.0	0	0.0
$240,000 - $259,999	0	0.0	0	0.0	0	0.0	0	0.0
$260,000 - $279,999	0	0.0	0	0.0	0	0.0	0	0.0
$280,000 - $299,999	0	0.0	0	0.0	0	0.0	0	0.0
$300,000 or more	1	0.4	0	0.0	0	0.0	1	0.2
Sample Size[3]	310		124		96		530	

[1] "Other" options listed by respondents were "taxpayer," "SLAV (Russian-American)," "European-American," and "White and Native American."

[2] Respondents were grouped according to their responses to question Q29. This tally indicates the last type of school they attended and not whether they actually graduated from that type of school.

[3] The difference between this number and the category N is equal to the number of missing cases (non-responses) for that item in the questionnaire.

Table 18. Demographic Characteristics of Respondents and Self-Asessment of Reponse Information Accuracy

Characteristic	Respondent Residence Group: Adjacent to Fox and Bay Mean (std. err.)	N	Other Basin Counties Mean (std. err.)	N	Outside Basin Mean (std. err.)	N	Total Mean (std. err.)	N
Gender of respondents (proportion male)	0.76 (0.02)	302	0.77 (0.04)	118	0.76 (0.05)	91	0.76 (0.02)	511
What is your age?	49.75 (0.93)	304	53.66 (1.44)	120	53.09 (1.66)	92	51.26 (0.71)	516
How many people live in your household including yourself?	2.77 (0.08)	302	2.96 (0.14)	116	2.66 (0.18)	92	2.80 (0.07)	510
Years of formal education	13.86 (0.16)	304	13.87 (0.27)	119	13.90 (0.32)	92	13.87 (0.12)	515
What is your approximate annual household income, from all sources, before taxes?	50,580 (2,045)	276	38,302 (2,109)	106	43,176 (3,023)	85	46,445 (1,430)	467
Overall, how understandable did you find the wording of the questions in this survey? (1=Exceptionally Unclear to 7=Exceptionally Clear)	4.86 (0.06)	301	4.97 (0.10)	117	4.98 (0.12)	90	4.90 (0.05)	508
How accurate do you feel your answers were to the questions about income reductions? (1=Exceptionally Inaccurate to 7=Exceptionally Accurate)	4.82 (0.07)	283	4.85 (0.11)	108	4.85 (0.13)	86	4.83 (0.05)	477

Appendix 2
Sample Survey Document

Water Resource Survey

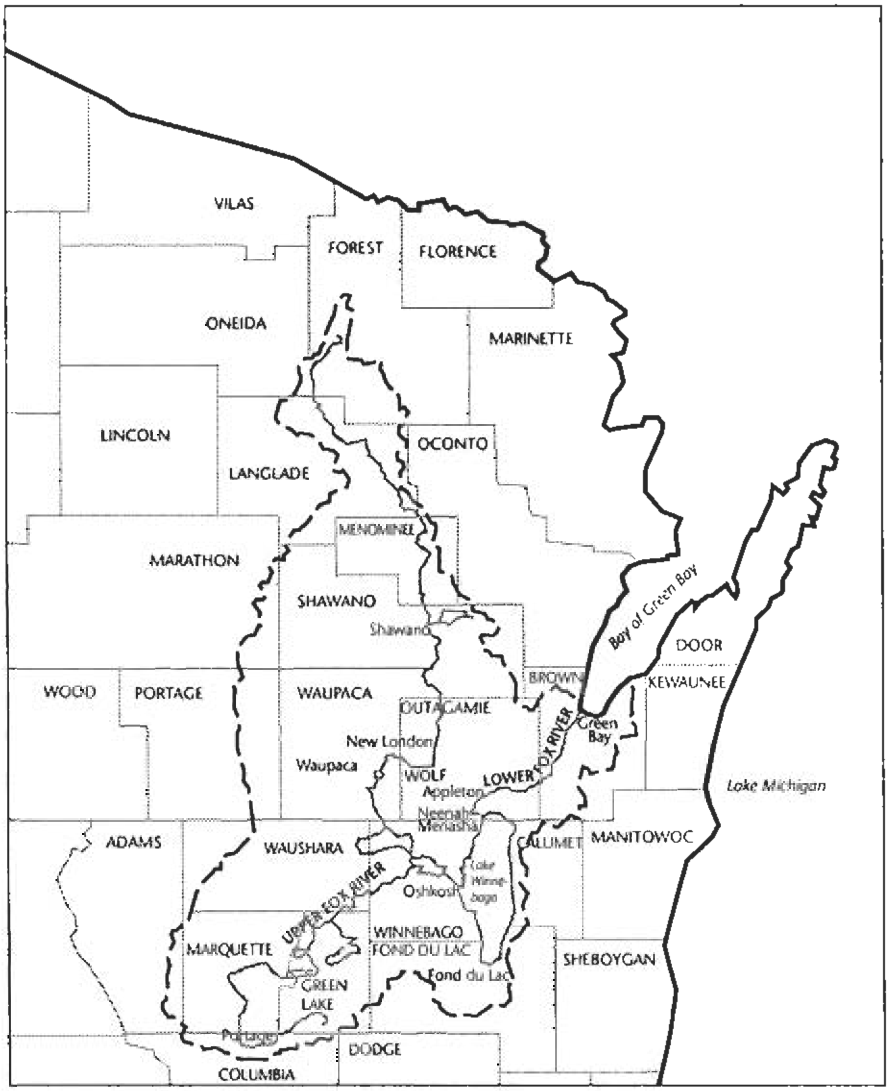


Figure 1

Fox-Wolf River Basin facts:

- Located in northeast Wisconsin
- It encompasses 18 counties — 6,400 square miles of land and water
- Population: 600,000 to 800,000 residents
- Its water system includes:
  three major river basins draining into the Green Bay
  40 watersheds
  Lake Winnebago, the largest inland lake in Wisconsin
- Industry located within the basin:
  pulp and paper mills
  dairy, cash grain, and vegetable farming

SECTION 1. In this first section we would like to ask you about your recreation related uses of water resources in the Fox-Wolf River Basin and lower Bay of Green Bay.

Q-1. During the past 12 months, approximately how frequently have you, or others in your household, used the Fox-Wolf River Basin (see Figure 1) and lower Bay of Green Bay for recreational activities? (Circle one number in each row)

WATER RESOURCE AREA	FREQUENTLY (MORE THAN 2 TIMES PER YEAR)	INFREQUENTLY (LESS THAN 2 TIMES PER YEAR)	NEVER
LOWER BAY OF GREEN BAY	1	2	3
LOWER FOX RIVER (SEE FIGURE 1)	1	2	3
UPPER FOX RIVER (SEE FIGURE 1)	1	2	3
LAKE WINNEBAGO	1	2	3
LAKE WINNECONNE	1	2	3
LAKE POYGAN	1	2	3
LAKE BUTTE DES MORTS	1	2	3
WOLF RIVER	1	2	3
WETLANDS	1	2	3

Q-2. Which of the following water-related recreation activities does your household enjoy doing in the Fox-Wolf River Basin and lower Bay of Green Bay? (Circle as many as apply)

1 OPEN WATER FISHING
2 ICE FISHING
3 STURGEON SPEARING
4 MOTORIZED BOATING
5 WATER SPORTS (WATERSKIING, JET SKIS, ETC.)
6 CANOEING
7 SAILING
8 SWIMMING
9 SHORE PICNICKING OR CAMPING
10 SIGHTSEEING
11 HUNTING
12 CROSS-COUNTRY SKIING
13 HIKING ALONG WATERWAYS
14 OBSERVING/PHOTOGRAPHING WILDLIFE
15 OTHER WATER-RELATED ACTIVITIES: ____________
16 NONE OF THE ABOVE WATER-RELATED ACTIVITIES

Q-3. Have you, or others in your household, gone to any lakes or rivers in Wisconsin that are not in the Fox-Wolf River Basin or lower Bay of Green Bay for water recreation activities?

1 YES
2 NO ——> GO TO SECTION 2

Q-4. For what reasons have you, or others in your household, gone to lakes or rivers other than those in the Fox-Wolf River Basin or lower Bay of Green Bay? (Circle as many as apply)

1 HAS CLEARER WATER
2 BETTER PUBLIC ACCESS
3 CLOSER TO MY HOME
4 BETTER FISHING OR HUNTING
5 IS A BETTER EXPERIENCE OVERALL
6 FOR A CHANGE OF PACE
7 OTHER REASON (PLEASE SPECIFY) ____________

SECTION 2. Now, we would like to ask you specifically about your sportsfishing activities.

Q-5. In the past 12 months, how many days did you go fishing in each of the following areas: (if none, please enter 0)

_______ DAYS IN FOX-WOLF RIVER BASIN (SEE FIGURE 1)
_______ DAYS IN LOWER BAY OF GREEN BAY (SEE FIGURE 1)
_______ DAYS IN OTHER PARTS OF WISCONSIN
_______ DAYS OUTSIDE WISCONSIN (FRESH OR SALTWATER)

_______ TOTAL DAYS FISHING

Q-6. In the past 12 months, did you go fishing in the Fox/Wolf River Basin or lower Bay of Green Bay study region (see Figure 1)?

1 YES
2 NO ——————>GO TO QUESTION Q-12
3 NOT SURE———>GO TO QUESTION Q-12

Q-7. When fishing in the Fox/Wolf River Basin and lower Bay of Green Bay study region what types of fish did you catch during the past 12 months? And, what types of fish did you desire to catch? (Circle all which apply in each column)

CAUGHT DURING PAST 12 MONTHS	DESIRED TO CATCH
1 LAKE STURGEON	1 LAKE STURGEON
2 MUSKELLUNGE (MUSKEE)	2 MUSKELLUNGE (MUSKEE)
3 WALLEYE/SAUGER	3 WALLEYE/SAUGER
4 SHEEPSHEAD	4 SHEEPSHEAD
5 WHITE BASS	5 WHITE BASS
6 LARGEMOUTH BASS	6 LARGEMOUTH BASS
7 SMALLMOUTH BASS	7 SMALLMOUTH BASS
8 NORTHERN PIKE	8 NORTHERN PIKE
9 CATFISH/BULLHEADS	9 CATFISH/BULLHEADS
10 ROUGH FISH (CARP, SUCKERS, ETC.)	10 ROUGH FISH (CARP, SUCKERS, ETC.)
11 BROWN TROUT	11 BROWN TROUT
12 YELLOW PERCH	12 YELLOW PERCH
13 PANFISH (BLUEGILLS, CRAPPIE, ETC.)	13 PANFISH (BLUEGILLS, CRAPPIE, ETC.)
14 OTHER (PLEASE SPECIFY)	14 OTHER (PLEASE SPECIFY)
_______________	_______________
_______________	_______________
_______________	_______________

Q-8. Do you typically eat the fish you catch in the Fox/Wolf River Basin and lower Bay of Green Bay? (Circle one number in each row)

AREA FISH CAUGHT	MEALS PER MONTH?	
WOLF RIVER	1 YES	2 NO
UPPER FOX RIVER	1 YES	2 NO
LOWER FOX RIVER	1 YES	2 NO
BAY OF GREEN BAY	1 YES	2 NO

Q-9. Approximately how many times per month do you eat fish you caught in the Fox/Wolf River Basin and lower Bay of Green Bay? (Circle one number in each row)

AREA FISH CAUGHT	EAT FISH CAUGHT?
WOLF RIVER	_______ TIMES PER MONTH
UPPER FOX RIVER	_______ TIMES PER MONTH
LOWER FOX RIVER	_______ TIMES PER MONTH
BAY OF GREEN BAY	_______ TIMES PER MONTH

Q-10. In the past 12 months, how many different trips to go fishing did you make within the Fox/Wolf River Basin and lower Bay of Green Bay (see Figure 1)?

_______ NUMBER OF FISHING TRIPS

Q-11. On your last trip to the Fox/Wolf River Basin and lower Bay of Green Bay study region for fishing, how much did you spend (or your share) on each of the following items (If zero, please write "0" in the appropriate blank)

Expenditure Category	**Amount**
TRANSPORTATION (FUEL, RENTAL CAR, TAXI, ETC.)	$__________
LODGING (HOTEL, CAMPING, ETC.)	$__________
FOOD, DRINKS, ICE, ETC.	$__________
BOAT LAUNCH FEES, FUEL, ETC.	$__________
OTHER (PLEASE SPECIFY)	
____________________	$__________
____________________	$__________
____________________	$__________
TOTAL (PLEASE ADD ALL ROWS)	$__________

Q-12. How worried are you about having health problems as a result of eating fish caught in the Fox/Wolf River Basin and lower Bay of Green Bay (see Figure 1)?

1 NOT AT ALL WORRIED
2 SOMEWHAT WORRIED
3 VERY WORRIED

Suppose that conditions in the Fox/Wolf River Basin and lower Bay of Green Bay are the same as currently except that fish are completely free of pollutants that threaten human health. Yes, that is probably unrealistic, but suppose that the pollutants could be eliminated that fast.

Q-13. Under these improved conditions, would you have made a greater number of fishing trips within the Fox/Wolf River Basin and lower Bay of Green Bay area than during the past 12 months (see your response to question Q-10 above)?

1 YES
2 MAYBE
3 NO ————————>SKIP TO SECTION 3

Q-13a. How many more fishing trips (than zero or your response to question Q-10 above) would you have made within the Fox/Wolf River Basin and lower Bay of Green Bay during the past 12 months?

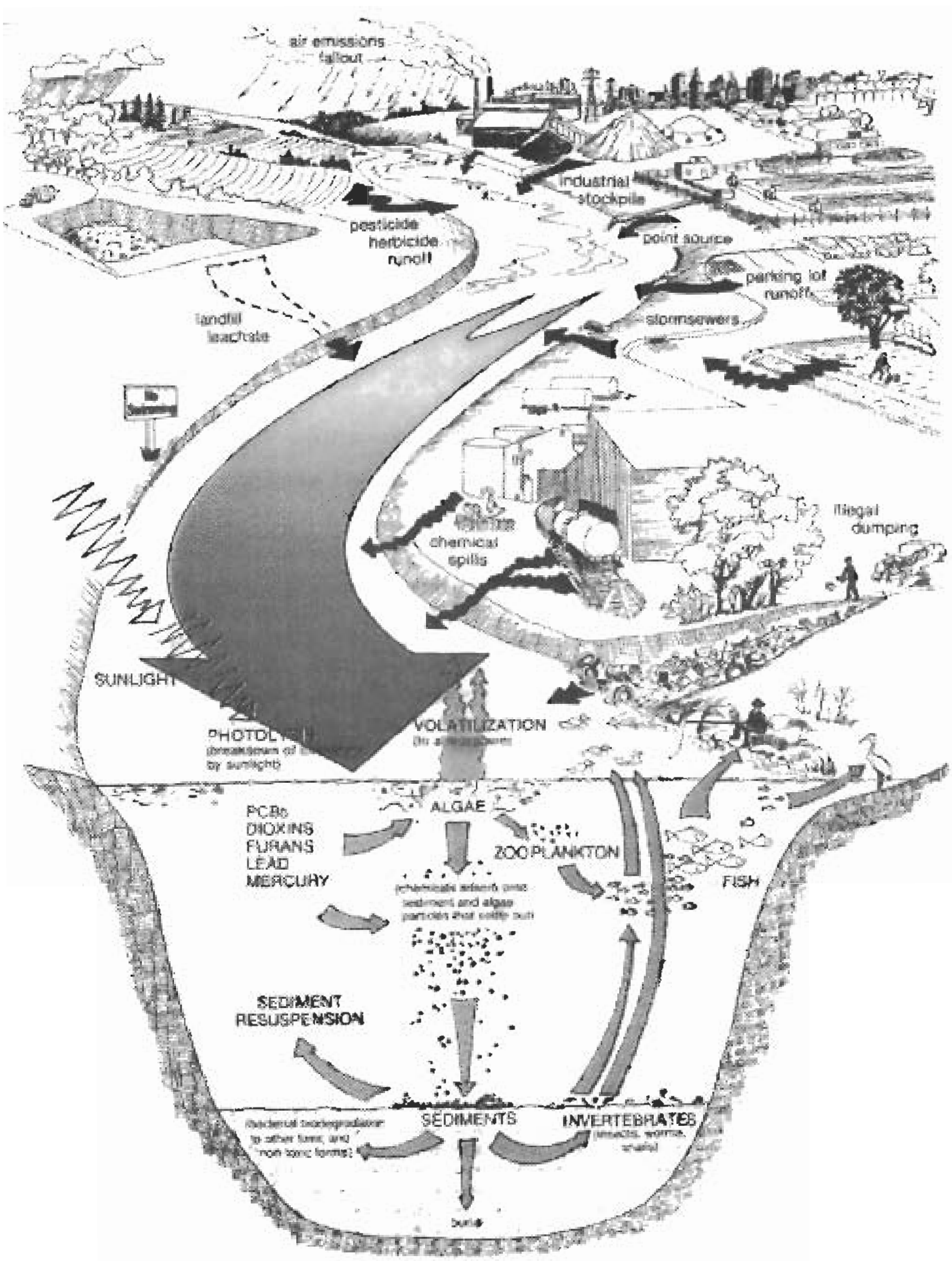
_______ ADDITIONAL FISHING TRIPS

SECTION 3. Here we focus on a hypothetical watershed and sources of pollution. Then we will ask you about your ranking of pollution issues in our study region.

Water pollution comes from many sources in a watershed system (See Figure 2 on next page). When you look at a river or stream, you might not notice any problem with the water quality. However, topsoil may be slowly eroding into a river or stream, settling downriver into a bay. Nutrients in eroded topsoil from agricultural activities along with urban water pollution can cause problems for everyone who depends upon these water resources. Runoff pollution from rural and urban areas, municipal and industrial wastewater discharges, and degraded habitats may cause a bay to become very fertile with too much algae which affects fishing, boating, swimming, and many other recreational activities.

In addition, when PCB's (polychlorinated biphenyls), heavy metals, and other toxic contaminants exist from current and past activities in a watershed, they are absorbed by the bottom sediments within the system. These "in-place pollutants" can move from the sediment back into the water and the food chain. They can also move downstream to bays as they are scoured (picked up by water) during high river flows. These "contaminated sediments" can result in health effects for both humans an other living things.

Figure 2. Sources and Effects of Watershed Pollution (Figure slightly modified[1] for Report)



[1] The figure used in the actual survey had enlarged, colored arrows to highlight the movement of pollutants within the watershed. There was also a no swimming sign added to the left edge of the river. The main arrow, showing movement of water within the river, started narrow and grew wider as it reached the bottom edge of the river.

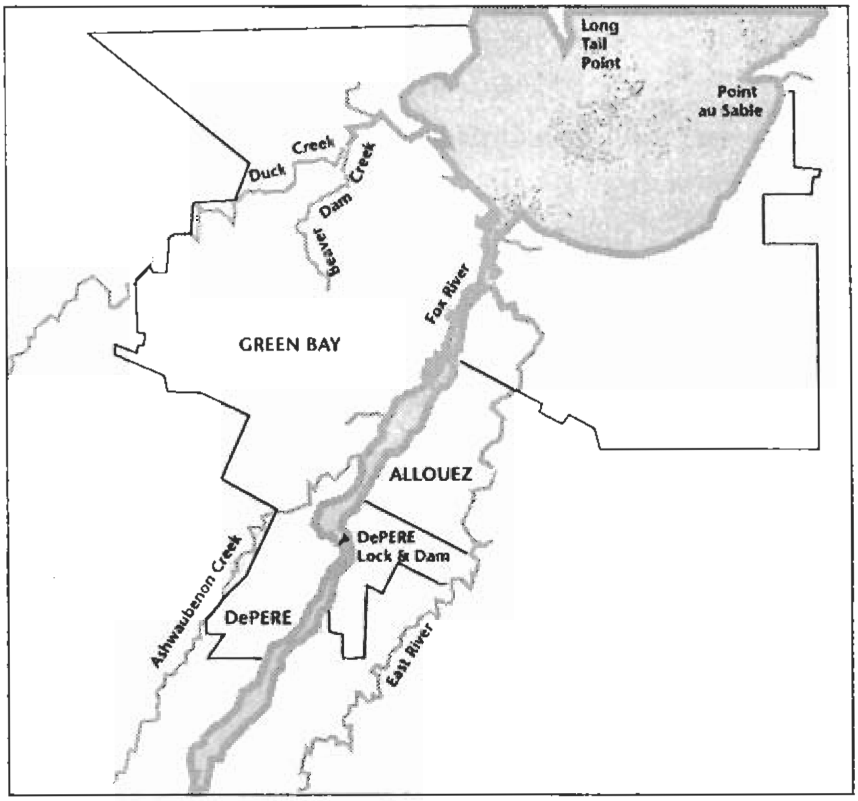
Q-14. How would you rate your own knowledge level about water pollution issues, overall, within the Fox/Wolf River Basin and lower Bay of Green Bay (see Figure 1)? (Circle one)

1 LOW
2 MEDIUM
3 HIGH

Q-15. In the table below, please rank the importance of these specific pollution issues within the Fox/Wolf River Basin (Figure 1) and lower Bay of Green Bay: (Circle one number in each row)

Environmental Pollution Issues in the Fox-Wolf Basin and Lower Bay of Green Bay	Your Ranking of the Importance of this Item: Very Unimportant	Unimportant		Average Importance		Important	Very Important	Don't Know
a. Wetland/shoreland habitat destruction	1	2	3	4	5	6	7	N/A
b. Non-native species invasions (e.g. zebra mussel, purple loosestrife)	1	2	3	4	5	6	7	N/A
c. Slowly degrading toxic substances that accumulate through the food chain (e.g. PCBs)	1	2	3	4	5	6	7	N/A
d. Biodegradable toxic substances (e.g ammonia)	1	2	3	4	5	6	7	N/A
e. Toxic metal contaminants (e.g. mercury, lead, zinc)	1	2	3	4	5	6	7	N/A
f. Excess nutrients (e.g. phorphorus, nitrates) causing an abundance of algae	1	2	3	4	5	6	7	N/A
g. Eroded soil suspended in the water (sediment)	1	2	3	4	5	6	7	N/A
h. Organic waste that lowers oxygen in the water	1	2	3	4	5	6	7	N/A
i. Regional employment impacts of stricter pollution regulations	1	2	3	4	5	6	7	N/A
j. Land use patterns	1	2	3	4	5	6	7	N/A

SECTION 4. **In this section we introduce you to some of the facts about the Green Bay Area of Concern (AOC) and its context within the Great Lakes Ecosystem. Then we'll ask you about the importance you attach to changes in water quality relative to other items towards which you could choose to spend your time and money.**



The Green Bay Area of Concern extends from the DePere dam north to an imaginary line across the bay from Long Tail Point to Point au Sable

FIGURE 3
Lower Fox River and Southern Green Bay "Area of Concern"

The Green Bay Area of Concern (AOC):

- Land area:
  21 square miles of the southern part of the lower Green Bay
  7 miles of the Fox River upstream to the DePere dam
- Description:
  10-15 feet deep
  contains 2 small islands and several other islands or shoals covered by high water
  a confined disposal facility for dredge spoils (Renard Isle)
  low lying areas of wetlands and sandy shores on the western shore
  eastern shore has major residential development along the rocky shoreline
- Water quality:
  poor with excess nutrients which causes:
  green-brown color
  lower oxygen level for fish
  higher water temperature resulting in a lack of aquatic plants

FYI:

The Green Bay AOC is not the only water system that has problems with pollution. The federally-funded International Joint Commission (IJC) has identified a total of 43 areas of concern (AOC) — like Green Bay — within the Great Lakes basin (See Figure 4). These areas are polluted trouble spots in bays, harbors, and river mouths tributary to the Great Lakes. IJC helps local and state agencies resolve issues of water quality and quantity within the Great Lakes region.

FIGURE 4

REMEDIAL ACTION PLAN (RAP) DEFINED POLLUTANTS OF LOWER BAY OF GREEN BAY

In the early 1980s, professors at the University of Wisconsin-Green Bay became concerned with the major pollution problems occurring in the Fox/Wolf River basin. These professors provided much of the scientific knowledge and research which led to the development of the "Lower Green Bay Remedial Action Plan," adopted in 1988. The Remedial Action Plan (RAP) is a long-term, comprehensive community plan which attempts to define ways to restore water quality and all beneficial uses, such as swimming and fishing, to the Green Bay Area of Concern (AOC). Since 1988, the Wisconsin Department of Natural Resources (WDNR), in partnership with local governments, other state agencies, businesses, and several citizens groups, in existence solely to address pollution problems of the Fox River and lower Bay of Green Bay, have been addressing the recommendations outlined in the RAP.

In the remainder of this section, we would like to ask you several questions about the value of water resource management programs. Although you may not be certain of your answers, please provide your best estimate of how you would react in a given situation.

Q-16. Do you ever plan to use the water resources of the lower Fox River and Bay of Green Bay for recreation or other activities?

1 YES
2 NO

Q-17. Do you feel it is important to maintain the water resource quality in the lower Fox River and Bay of Green Bay?

1 YES
2 NO ——> GO TO QUESTION Q-20

Q-18. Would you like to see water resource quality improved in the lower Fox River and Bay of Green Bay?

1 YES
2 NO ——> GO TO QUESTION Q-20

Q-19. Why do you desire to maintain or improve water resource quality in the lower Fox River and Bay of Green Bay ? (Circle all which apply)

1 BECAUSE I DESIRE TO HAVE THE OPTION TO USE THEM IN THE FUTURE
2 BECAUSE PEOPLE OTHER THAN MYSELF MAY USE THEM IN THE FUTURE
3 BECAUSE FUTURE GENERATIONS MAY USE THEM
4 BECAUSE THEY HAVE A RIGHT TO BE PRESERVED REGARDLESS OF WHETHER THEY ARE EVER USED

Q-20. Before you would decide to give money to preserve or improve water resource quality, is it important that you know who receives the benefits from their preservation?

1 YES
2 NO, MY INTEREST IS IN PRESERVING THE RESOURCE FOR FUTURE GENERATIONS
3 NO, I HAVE NO INTEREST IN PRESERVING THE RESOURCE

PROGRAM EVALUATION

The goal of management actions in the Fox/Wolf River Basin and lower Bay of Green Bay is to affect the quality of water resources within the region. Specific contaminated sediment remediation actions and their scope have not been determined at the present time, nor has the desirability of such actions. Yet, many individuals and organizations have been asking what actions, if any, should be taken in the future to restore beneficial uses of these water resources. This means that the desirability of such actions from citizens' perspectives must be considered.

Because specific contaminated sediment remediation plans have not been fully determined, we are focusing on the outcomes of management actions. Contaminated sediment remediation, if implemented, could be done by various levels of government or by private organizations. Our concern is not with who implements such actions, but rather, with the resulting changes in quality of the natural resources and resource related experiences affected by these management actions.

Since specific management actions for remediating contaminated sediments have not yet been determined, we can not determine the magnitude of management costs or how they might be shared by each individual. **However, we do know that nothing is free.** Therefore we are examining various scenarios and asking different individuals about different shares of management costs. Even if the amount we suggest to you seems low or high, please respond carefully. This will allow us to determine whether people believe the outcomes of management decisions and actions are worthwhile, whatever their final costs are determined to be. For this study, it is important that you tell us if you would support or oppose programs to achieve the specific outcomes described, based only on **your personal evaluation** of the changes described and the additional cost to you.

Desired State of the Green Bay Area of Concern (AOC) — See Figure 3:

Water resource quality in the Fox River and Southern Bay of Green has been seriously contaminated. Excessive nutrient loading from within the Fox/Wolf River Basin has lead to algae blooms, reduced water clarity, and lowered dissolved oxygen levels. A significant portion of phosphorous entering the system has come from agricultural activity within the region.

Since 1957, it has also been estimated that 125 tons of PCB's have been deposited in the Fox River's sediments, largely from past pulp and paper production activity in the region. It has been claimed that the Fox River has 9 million to 12 million cubic yards of PCB contaminated sediments spread throughout 39 miles of the river. One study has estimated that it would take a hundred years to naturally bury or remove these PCB contaminated sediments. If the Fox River flushes all of its PCB laden sediment every 50 years, it has been claimed that this would more than double the PCB levels in Lake Michigan fish for about 15 years. While PCB's have been a major focus in efforts to begin remediation of contaminated sediments, there are also other potential contaminants (e.g., cadmium, dieldrin, lead and mercury) which are of concern. More than 100 toxic chemicals have been found in Fox River water, fish and sediments.

The accuracy of these, or any, estimates can be argued. However, the clear indication is that water resource quality in the lower Fox River and Southern Bay of Green Bay has been degraded. General indicators of this degraded water resource quality are lowered water clarity, health issues associated with human consumption of fish, quality of wetland habitats, and the health of fish and wildlife populations (e.g., lowered reproduction, birth defects and tumors.

A variety of individuals and groups have called for "total remediation" of contaminated sediments, or at least enough remediation to attain a "desired state" sufficient to restore beneficial uses of the lower Fox River and Southern Bay of Green Bay. Attainment of this goal would enable citizens to make use of water resources without health effects from contaminants as well as ensure the continued existence of a viable ecosystem. Specific goals related to sediments include:

- restore swimming and an edible fishery
- provide suitable habitat for enhancing and sustaining a diversity of wildlife
- establish a self-sustaining, balanced and diversified, edible fish community
- improve the water quality and trophic state of the area to relieve ecological stresses
- achieve and maintain water quality that protects the ecosystem from toxic substances
- ensure sustainability of a restored and healthy environment through pollution prevention

Q-21. Suppose a watershed program to deal with contaminated sediments could be adopted within the next year that would **improve the quality** of water resources within the lower Fox River and Southern Green Bay AOC. And that over time, possibly 10-20 years, this program would achieve the **60%** of the benefits from the Remedial Action Plan's **"desired state"** for contaminated sediments (See box on opposite page). Adoption of this program would increase the amount of money spent by households, government and industry on pollution control, and you, the consumer, would eventually have to pay for it. As a result, your household would have **$200**[2] less per year to spend on other things, beginning next year.

If the adoption of this water resources policy were put to a referendum (a yes/no vote), would you vote to accept this program to improve the present quality of water resources?

1 YES ——> GO TO QUESTION Q-22a
2 NO ——> GO TO QUESTION Q-22b

Q-22a. Suppose instead that it was found this same watershed program would achieve a smaller portion, **40%**, of the benefits from the Remedial Action Plan's **"desired state"** (See box on opposite page). But again, nothing is free. If adopted, your household would have **$200** less per year to spend on other things, beginning next year.

If the adoption of this water resources policy were put to a referendum (a yes/no vote), would you vote to accept this program to achieve the improved quality of water resources?

1 YES
2 NO

Q-22b. Suppose instead that it was found this same watershed program would achieve a larger portion, **80%**, of the benefits from the Remedial Action Plan's **"desired state"** (See box on opposite page). But again, nothing is free. If adopted, your household would have **$200** less per year to spend on other things, beginning next year.

If the adoption of this water resources policy were put to a referendum (a yes/no vote), would you vote to accept this program to achieve the improved quality of water resources?

1 YES
2 NO

Q-23. Suppose this water resources program could be designed to achieve all (100%) of the benefits from the Remedial Action Plan's **"desired state"** for contaminated sediments (See box on opposite page) within the lower Fox River and Southern Green Bay AOC. As before, this would happen over time, possibly 10-20 years.

[2] Dollar numbers inserted here varied from $1 to $3,000 and were randomly assigned to respondents. The same number was used in Q-21, Q-22a and Q-22b for each respondent. In Q-22a and Q22b the percents used were either 20% and 100% or 40% and 60% for a particular respondent.

What is the largest amount you would allow your income to be reduced per year in order to ensure adoption of this program?

______________________________DOLLARS PER YEAR

Q-23a. If you answered zero (or failed to answer), please choose the statement below which best describes your reason for not allowing a reduction in your income.

1 I PLACE A ZERO VALUE ON ACHIEVING THE "DESIRED STATE"
2 I OBJECT TO THESE TYPES OF QUESTIONS
3 I CANNOT AFFORD TO PAY ANY AMOUNT AT THIS TIME
4 NOT ENOUGH INFORMATION WAS PROVIDED TO MAKE A DECISION
5 I WOULD NEVER PAY FOR IMPROVED WATER QUALITY

SECTION 6. The following questions will help us to learn more about our respondents. The information you provide will remain strictly confidential and you will not be identified with your answers.

Q-24. Are you:
1 MALE
2 FEMALE

Q-25. What is your age?
______ YEARS

Q-26. How many people live in your household, including yourself?
___________ PERSONS

Q-27. Are you: (Please circle only one)
1 ASIAN
2 AFRICAN-AMERICAN/BLACK
3 HISPANIC
4 NATIVE AMERICAN/INDIAN
5 WHITE
6 OTHER (PLEASE SPECIFY) ____

Q-28. Which of the following best describes where you live? (Please circle only one)
1 URBAN
2 SUBURBAN
3 RURAL (NON-FARM)
4 RURAL (FARM)

Q-29. What was the last year of school you completed? (Circle only one number)

GRADE SCHOOL	HIGH SCHOOL	COLLEGE/TECHNICAL	GRADUATE SCHOOL
1 2 3 4 5 6 7 8	9 10 11 12	13 14 15 16 17	18 19 20 21+

Q-30. What is your approximate annual **household** income, from all sources, before taxes? (Please circle only one)

1	LESS THAN $20,000	9	$160,000 - $179,999
2	$ 20,000 - $ 39,999	10	$180,000 - $199,999
3	$ 40,000 - $ 59,999	11	$200,000 - $219,999
4	$ 60,000 - $ 79,999	12	$220,000 - $239,999
5	$ 80,000 - $ 99,999	13	$240,000 - $259,999
6	$100,000 - $119,999	14	$260,000 - $279,999
7	$120,000 - $139,999	15	$280,000 - $299,999
8	$140,000 - $159,999	16	$300,000 OR MORE

Q-31. Overall, how understandable did you find the wording of the questions in this survey? (Circle one number one the following scale)

EXCEPTIONALLY UNCLEAR	VERY UNCLEAR	UNCLEAR	SO-SO	CLEAR	VERY CLEAR	EXCEPTIONALLY CLEAR
1	2	3	4	5	6	7

Q-32. How accurate do you feel your answers were to the questions (Q-21 to Q-23) about household income reductions? (Circle one number one the following scale)

EXCEPTIONALLY INACCURATE	VERY INACCURATE	INACCURATE	SO-SO	ACCURATE	VERY ACCURATE	EXCEPTIONALLY ACCURATE
1	2	3	4	5	6	7

Is there anything else you would like to share with us?

Would you like a summary of the results of this survey?

1 YES
2 NO

Your contribution of time to this study is greatly appreciated. Please return your completed questionnaire as soon as possible. Thank you.

University of Wisconsin - Green Bay
Center for Public Affairs
2420 Nicolet Drive
Green Bay, WI 54311-7001

Appendix 3 Population of Sampling Zones

Population of Wisconsin Counties

	Population 1990	Population 1995
Zone A		
Brown	194,594	209,077
Calumet	34,291	36,824
FondDuLac	90,083	93,388
Outagamie	140,510	150,048
Winnebago	140,320	148,119
Subtotal Area A	**599,798**	**637,456**
Zone B		
Door	25,690	26,025
Florence	4,590	4,822
Forest	8,776	9,004
Green Lake	18,651	18,976
Kewaunee	18,878	19,278
Manitowoc	80,421	82,632
Marinette	40,548	41,684
Marquette	12,321	12,994
Menominee	3,890	4,147
Oconto	30,226	31,747
Shawano	37,157	37,815
Sheboygan	103,877	107,836
Waupaca	46,104	48,428
Waushara	19,385	20,093
Sub Total Area B	**450,514**	**465,481**
Total Areas A & B	**1,050,312**	**1,102,937**
Zone C		
Adams	15,682	16,776
Ashland	16,307	16,615
Barron	40,750	41,772
Bayfield	14,008	14,300
Buffalo	13,584	13,648
Burnett	13,084	13,641
Chippewa	52,360	53,670
Clark	31,647	32,146
Columbia	45,088	47,217
Crawford	15,940	16,003
Dane	367,085	393,857
Dodge	76,559	79,915
Douglas	41,758	42,230

	Population 1990	Population 1995
Dunn	35,909	37,062
Eau Claire	85,183	87,737
Grant	49,266	49,399
Green	30,339	31,064
Iowa	20,150	21,086
Iron	6,153	6,242
Jackson	16,588	17,016
Jefferson	67,783	70,886
Juneau	21,650	22,677
Kenosha	128,181	136,828
La Crosse	97,904	102,269
LaFayette	16,074	16,059
Langlade	19,505	20,238
Lincoln	26,993	28,175
Marathon	115,400	122,095
Milwaukee	959,275	965,257
Monroe	36,633	37,839
Oneida	31,679	33,473
Ozaukee	72,831	77,728
Pepin	7,107	7,178
Pierce	32,765	33,687
Polk	34,773	36,044
Portage	61,405	65,116
Price	15,600	15,997
Racine	175,034	183,365
Richland	17,521	17,471
Rock	139,510	145,374
Rusk	15,079	15,226
St. Croix	50,251	53,395
Sauk	46,975	50,090
Sawyer	14,181	14,816
Taylor	18,901	19,140
Trempealeau	25,263	25,746
Vernon	25,617	26,072
Vilas	17,707	18,655
Walworth	75,000	80,407
Washburn	13,772	14,334
Washington	95,328	106,966
Waukesha	304,715	328,631
Winnebago	140,320	148,119
Wood	73,605	76,014
Subtotal Area C	**3,981,777**	**4,146,763**
State Totals	**5,032,089**	**5,249,700**