ECONOMICS OF GREAT LAKES FISHERIES: A 1985 ASSESSMENT

by

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PREFACE AND ACKNOWLEDGMENTS

This publication is intended to update *Current Estimates of Great Lakes Fisheries Values: 1979 Status Report* (Talhelm, et al, 1979). The 1979 publication quickly rose to the top of the "all-time best seller list" of Great Lakes Fishery Commission publications. It has been widely circulated and widely used as a guide to Great Lakes fishery values by the Great Lakes fishery management community, mainly because little other information has been available on this topic.

Managers have been increasingly required over the last decade or two to evaluate fisheries programs and needs by courts, by legislatures and by their own administrations. The 1979 publication was intended as a handy reference to current research findings on Great Lakes fishery values, in response to this need. However, it soon became apparent that more was needed. Managers needed a better explanation of the reasoning behind these evaluations. When economists use market-based ideas to examine non-market situations, either new terminology must be invented, or old terminology must be stretched into a new environment. Things easily get lost in the translation.

This publication, then, is more than just an update. It is also an attempt to explain the reasoning behind these estimates, including some of the subtle differences between closely related values. We realize that one small publication such as this is still insufficient. Managers and administrators must take additional steps if they are to use the full power of economics to their benefit. All members of the committee that worked on this publication look forward to working with members of the management community in an effort to more fully utilize economic information, both on an individual basis and in more formal efforts such as those conducted by the Great Lakes Fishery Commission. We also welcome feedback on the usefulness of this publication, so we can improve the next one.

These estimates were developed by a workshop or "committee" of economists, listed below, who have actively worked on Great Lakes fisheries values and impacts over the last few years. After this publication was drafted, all members were asked to verify and update the information, as well as to comment in any other way. Thus, this publication represents a consensus of a diverse group of economics researchers and practitioners from the region. The author has benefited from comments on earlier versions by almost all members of the group, particularly those of Leroy J. Hushak, as well as from comments by David P. Borgeson, Duane D. DeButts, Randy L. Eshenroder, John Fedkiw, Carlos M.

Fetterolf, Jr., series editor Herbert Johnson, and formal reviewers Tommy L. Brown and David Gillen.

We were gratified to see, in putting these data together, that many new studies have been completed since the 1979 report, and that the results seem to confirm our earlier estimates. These include several new estimates of Great Lakes fisheries values and impacts, including some first estimates of existence values. In 1979, resource economists had not yet even fully developed a rigorous definition of existence value.

We thank the Great Lakes Fishery Commission for funding this effort, and the GLFC Secretariat for helping facilitate it. This publication was long delayed by the delay of the 1980 Great Lakes use estimates. The committee met in 1984, but then had to wait more than a year for the data to be finalized. In the meantime, results of new studies have become available, and had to be considered. We appreciate the patience of the GLFC and the management community with this process.

Members of the workshop or "committee" convened to evaluate current Great Lakes fisheries economics research findings and to establish the values recommended in this report are Nilam Bedi, Ontario Ministry of Natural Resources; Richard C. Bishop, University of Wisconsin; Tommy L. Brown, Cornell University; John Charbonneau, US Fish & Wildlife Service; Jack A. Donnan, Ontario Ministry of Natural Resources; A. P. Lino Grima, University of Toronto; Leroy J. Hushak, Ohio State University; Daniel R. Talhelm, Michigan State University; Archie L. W. Tuomi, Department of Fisheries & Oceans (retired).

EXECUTIVE SUMMARY

Hundreds of millions of dollars are spent annually to manage and protect Great Lakes fisheries and the related ecosystem-some $60 million in fisheries management and protection alone. The public demands accountability and reasonable returns for its hard-earned dollars. Administrative, legislative and judicial branches of government increasingly rely on benefit-cost and related economic and social assessments for this accountability.

This report summarizes the latest estimates of Great Lakes fisheries-related economic values and economic impacts, and describes how to interpret this information in evaluating public sector fisheries management choices.

What Kinds of Values Do We Need to Know?

What sorts of information do we need for these kinds of assessments? The value of the resource? The value of angling and food fishing? The landed value of food fish? Angler expenditures in my state?-in my community? These are all important values for some purposes, but none of these directly addresses the main question above-the accountability for public expenditures.

In accounting for public agency expenditures on the fishery, the important question is not the value of the resource, but the value produced by the agency expenditures-the public's return on its investments. What are the benefits and costs of our public choices in:

- Management: What benefits do we gain from expenditures on management and protection?
- Policy: If we create a new law or policy, what are its advantages and disadvantages?-its economic benefits and costs?
- Protection: If someone damages the resource, exactly how great are the losses? What size damage award would compensate for the public's losses? How much can we afford to require in the way of prevention measures before hurting the public interests in other ways?

We basically want to know which particular actions are in the public's best interests, even if the public must pay for them. If fishery resources were privately owned, management practices would be largely determined by expected dollar returns in relation to costs. Public sector economic accountability asks the same question: Would people literally buy these specific management actions if it were up to them (ie, if the public sector did not do it for them)?

Unfortunately, these values are not observable. Fishery resource management is mostly a government activity. People "buy" fishery management only indirectly. Anglers and food fish harvesters rarely pay directly for particular management practices, and pay little even to use the resource.

Economists resort to indirect measures of the values of the various uses, and then try to estimate how particular changes in management, policy and protection would change those values. The benefits of a particular management action are the difference in the net value of the uses of the resource with vs without the action. We look, not for the resource values or use values, but for the change in the resource values or use values.

Resource values and use values are an intermediate step. Just by knowing those values, however, one can more easily infer what the values of management might be.

ECONOMIC IMPACTS

Economic and social impacts differ greatly from *economic values.* Economic and social impact assessments estimate the incidence of favorable and unfavorable consequences to particular businesses, individuals or communities. They help us further evaluate, beyond the economic value assessments, the pros and cons of management actions, policies and other changes. *Economic impacts* are the changes in sales, income and employment between regions or communities, between economic sectors (e.g., a durables manufacturing sector or an agriculture/forestry/fisheries sector), and in aggregate magnitude. They help us see who gains and who loses, and how severely, as economic conditions change. *Social impacts* are other impacts on people's well being and on social structures-the ways people perceive, organize and do things.

Economic and social impact assessments often partially overlap with economic value assessments. Each may incorporate different parts of the values assessed in the others.

1985 ECONOMIC VALUES AND ECONOMIC IMPACTS

Table 1 lists our best estimates of Great Lakes fisheries economic values and economic impacts in 1985. The full report further explains how to interpret and use this information, how we derived it, and its accuracy.

We estimate that anglers would have been willing to pay up to $1.4 billion (U.S. dollars) in fees to have the 1985 Great Lakes sport fishery rather than to have none. (This is the annual *all-or-none value* of the sport fishery resource or simply the value of the resource.) We also estimate that food fish harvesters and consumers would have been willing to pay up to $21 million (U.S. dollars) to have the 1985 Great Lakes food fishery rather than none.

These values estimate the benefits of current use, but are primarily an intermediate step in evaluating most choices. Fishery management rarely involves choosing all vs none. For instance, higher all-or-none values of angling vs food fishing do not indicate we should reduce the food fishery.

Much more important for public choice purposes are estimates of “management” values: the changes in total resource values/impacts resulting from given changes in the resource or its use. Management activities such as resource enhancement, protection and maintenance usually change the resource only slightly, and only at particular locations. Therefore, instead of this all-or-none value, we usually would rather know the value of changing the fishery in some particular way at some particular location.

Unfortunately, the values of particular changes in the sport fishery vary greatly from site to site. Angling values are influenced by many of the same kinds of factors that influence property values, and in analogous ways. Angler benefits-the willingness of anglers to pay for improvements in angling at a given site-depend on angler preferences for the new and the former fishery conditions, site proximity to anglers, the availability of substitute angling sites, and the availability of complementary facilities and amenities.

This great variation in angling management values means that there is no standard dollar value available for use in benefit-cost analysis of sport fishery management. The values vary too much, and too few empirical results are available, to permit accurate, non-arbitrary rules of thumb at this time. For instance, our best estimate for the sport fishery for salmon in the Great Lakes is that small changes will often be valued at $20-40 per increase or decrease in angler days. Small changes in the non-salmonid fishery appear to be valued at $10-20 per increase or decrease in angler days. Table 1 presents a few sample estimates for such changes. Later, Tables 3 and 4 present more.

Like sport fishery resource values, food fishery resource values depend on consumer preferences for the final products, on the prices of substitutes and complements, and on the technology of production and consumption. However, prices and costs in the food fishery are more uniform throughout the Great Lakes basin than those of the sport fishery because food transportation costs are relatively small. Further, food fishery prices-and therefore the values reported here-are severely constrained by competition from the many varieties of fish in national and international markets. Therefore, food fishery resource values vary much less from location to location, and that mainly because the productivity of the resource varies from site to site.

The total economic impact of the Great Lakes sport and food fishery on the regional economy is $2.3 to $4.3 billion (U.S. dollars). This means that if this fishery were stopped, and anglers and food fish consumers reallocated their $1.1 to $2.1 billion direct expenditures to other purposes, up to $4.3 billion in sales would be shifted from present businesses and individuals, to other businesses and individuals in the region or in other regions. About 35 percent of that would be personal income, shifted to other persons.

TABLE I. Summary of estimated 1985 Great Lakes fisheries economic values and impacts: annual values in U.S. dollars.

ITEM	TOTAL U.S. + CANADA (in U.S.$)
I. ANNUAL TOTAL ECONOMIC VALUES, SPORT FISHERY	
Gross value of angling	$3,400,000,000
(ie, max. potential buying price)	(range: $1.7-3.4 b.)[1]
Total angling price paid	$2,000,000,000
(ie, 1985 cost of angling)	(range: $1-2 b.)[1]
Value of angling resource (gross value minus costs)	$1,400,000,000
(ie, potential buying/selling price for resource)	(range: $.7-1.4 b.)[1]
II. ANNUAL UNIT VALUES PER CHANGE IN ANGLER DAYS, SPORTFISHERY MANAGEMENT	
Protecting the entire sport fishery from total loss	$26
Changing angling quality at a particular location	$0 to $50
Unit values depend on location, quality and substitutes. Non-salmonid values are typically $10-20 per increased/decreased angler day, and salmonid values $20-50 per increased/decreased angler day.[2] Examples:	
Perch/panfish, SE Lake Mich., small change from moderate CPUE, substitutes available ($ per angler day gained/lost)’	$15
Perch/panfish, Mich. Lake Erie, change from high to moderate CPUE, substitutes available ($ per angler day lost)’	$10
Salmon, spring, SE Lake Mich., small change from moderate or high CPUE, substitutes available ($ per angler day gained/ lost)*	$24
Salmon, fall, SE Lake Mich., small change from high CPUE, substitutes available ($ per angler day gained/lost)*	$47
Lake trout, all Mich. Lake Mich., change from high or moderate to low, substitutes distant ($ per angler day lost)*	$47
Lake trout, all Mich. Lake Sup., change from high or moderate to low, substitutes very distant ($ per angler day lost)’	$41
III. ANNUAL TOTAL ECONOMIC VALUES, FOOD FISHERY	
Gross value of food fish	$51,000,000
(ie, max. potential buying price)	(Range: $48-62 mil.)[3]
Total price paid for food fish	$41,000,000
(ie, 1985 cost of landings)	
Value of food fishery resource (gross value minus harvest costs“)	$21,000,000
(ie, potential buying/selling price for resource)	(range: $13-41 mil.)[3]
IV. ANNUAL UNIT VALUES PER CHANGE IN POUNDS LANDED, FOOD FISHERY MANAGEMENT	
Protecting the entire food fishery from total loss	$.21
Changing allowable harvest at a particular location	$0 to $1
(Unit values depend on species, market conditions, and harvest technology. Values may be up to 50% of the change in landed value.)	

(continued)

TABLE I. (continued)

ITEM	U.S.	CANADA (U.S. $)	TOTAL (in U.S.$)
V. ANNUAL ECONOMIC IMPACTS, SPORT FISHERY			
Angler spending (millions)	$1,710	$390 ($290)	$2,000 ($1 ,000-2,000)[5]
Regional economic activity (millions)	$3,420	$780 ($580)	$4,000 ($2,000-4,000)[5]
Employment (worker-years)	64,000	11,000	75,000 (37,500-75,000)5
VI. ANNUAL ECONOMIC IMPACTS, FOOD FISHERY			
Landed value (millions)	$15	$35 ($26)	$41
Final sales value in region (millions)	$49	$113 ($84)	$133
Total regional economic activity (mill.)	$99	$228 ($171)	$270
Employment (worker-years)	3,300	5,700	9,000
VII. ANNUAL TOTAL USE			
Total angler efforts (millions of angler days in 1980)	20-41	7-14	27-55
Total food fish harvest (millions of pounds landed in 1984)	54	47	101
VIII. OTHER FISHERY ECONOMIC VALUES			
Existence values (ie, value of preventing extinction)	Perhaps same order of magnitude as combined resource values above		
Option values (ie, value of insuring future use)	Small percentage of combined resource values above		
Ecological values (ie, contribution from role in ecosystem)	Uncertain ecosystem values at risk		
Passive use values (ie, indirect uses such as viewing)	Up to same order of magnitude as combined resource values above		
Social equity values (ie, value of fairness in public choice)	Perhaps small or moderate percentage of combined resource values above		
Social goals values (ie, contribution to other social goals)	Perhaps small percentage of combined resource values above		
Employment value (ie, value of labor or capital that would otherwise be unemployed; negative if unemployment is increased)	Often important locally, but usually offset by opposite impacts elsewhere in the economy, leaving little or no net economic contribution		

[1] The range of values given for angling reflects uncertainty over the amount of angling for Great Lakes fish. The upper bound is our estimate of values assuming the 1980 U.S. and Canadian angler surveys are accurate in estimating 55 million angler days (see Talhelm, 1988). The accuracy of this estimate is supported by pre-survey studies. The lower bound reflects indirect, contradictory evidence from other studies that actual angling effort could be half, or less, of these 1980 estimates (Talhelm, 1988, Appendix D).

In addition, there is some uncertainty about the magnitudes of the average values per angler day, because these are based on state-level studies using a variety of methods and assumptions. These estimates range about 25% above and below the estimates given here. This kind of uncertainty is not considered in the range in Table 1. See text for farther information.

*These estimates are based on Tables 2 and 3 in the text. CPUE stands for catch per unit of angling effort (ie, fish caught per angler day). The numbers in Table 1 are derived by dividing the total value gain/loss of all anglers by the change in the number of anglers.

[3]The range of values given for the food fishery reflects uncertainty about the estimates. These numbers are extracted from somewhat limited evidence, mostly state-level studies rather than region-wide studies. See explanation in text.

"Harvest costs are defined here as the minimum cost necessary to harvest the fish; an estimated $30 million. Total revenue minus harvest costs equals economic profit: harvesters' potential payments for using the resource.

[5]See first paragraph of footnote 1.

INTRODUCTION

People often ask, "What is the value of Great Lakes fisheries?" This simple question has no simple answer because there are many types of values. The question needs more definition before an answer is possible.

This section briefly examines what we mean by economic value and economic impact, basic principles of economic assessment, and ideal uses of this information in public sector evaluation and decision making.

Economics and the Public Interest

Millions of dollars are invested annually in Great Lakes fisheries protection and management. Some $60 million is spent each year in direct Great Lakes fisheries management activities. Hundreds of millions of dollars are spent in managing the overall Great Lakes ecosystem.

In another arena, voters are insisting on lower taxes and less government. Yet, they demand more services from government. They also want increased efficiency, higher quality delivery and more accountability from government. Great Lakes fisheries management programs are no exception.

As a result, legislative, executive and judicial decision makers increasingly rely on benefit-cost, economic impact and related economic and social assessments for this accountability. These assessments are the best objective tools available for estimating changes in public welfare.

Courts and commissions need better evaluations to more objectively assess claims, award fair compensation, and weigh competing policies, programs and allocations. Lawmakers and executives turn to objective assessments to help develop programs that fairly and efficiently serve public needs, and to reject expenditures that are less needed. Assessment tools like zero-based-budgeting and management-by-objective help budget offices and elected officials compare expenditures in such divergent programs as fisheries, child welfare services, public safety and education.

Fisheries managers not only need the best economic assessments available, but also need to know how to use them most effectively in these contexts.

What are Economic Values?

Economic values compare human preferences between certain things. They express the willingness of people to exchange one thing for other things under given circumstances, For example, our daily paper tells us that a particular 9 cubic foot chest freezer equals in value .84 ounces of gold, 108 half gallons of Sealtest ice cream, or 39.9 seafood dinners at a local restaurant.

Economic values also reflect the scarcities of things-the ability of our

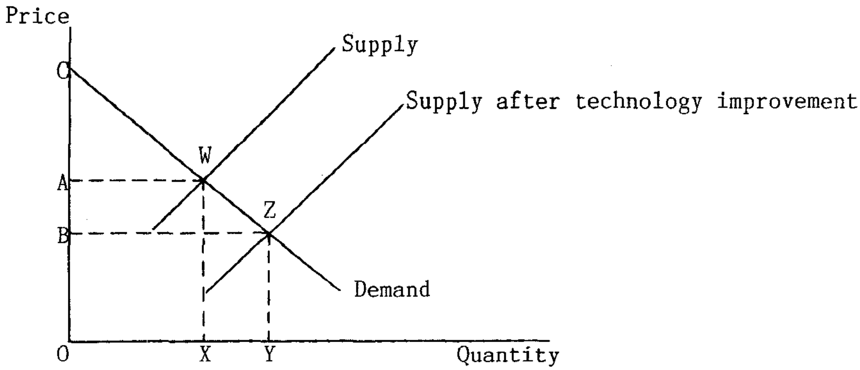

Figure 1. An increase in supply lowers marginal value from A to B and increases consumption of a representative good.

society to produce them. For example, bumper crops lead to lower prices-lower value per unit. This lower value reflects increased farm productivity without any change in consumer needs or preferences. However, even though consumer preferences do not change in this case, consumers buy more in response to lower prices.

Figure 1 explains why. The demand schedule expresses buyer preferences: It shows the maximum quantities buyers would be willing to buy at each given price. The supply schedule expresses seller preferences: It shows the minimum prices at which sellers are willing to sell each given quantity. In many cases, supply schedules express the ability of producers to produce goods from various inputs. These demand and supply forces combine to determine the particular price and quantity sold that we can observe at any time in the market. Stated simply, the balance between consumer preferences and producers' abilities to produce determines the going market price and quantity sold (under competitive conditions).

The increase in productivity mentioned above-resulting in bumper crops -would shift the supply curve to the right, as illustrated in Figure 1. Market price would decrease from A to B, and consumption would increase from X to Y, without any change in consumer preferences. Consumers are better off, with a lower price and higher consumption, but their underlying preferences (which economists think of as a "utility function") are unchanged, and therefore their demand schedule is unchanged, as shown. The main points are, first, that the current market value-price A or B-is not determined by consumer preferences alone, and second, that a lower market value (price) may imply a higher level of consumer well-being (net value received by consumers).

Without going into detail, some notable characteristics of economic values are:

1. Economic values are determined by both demand and supply-by our needs and preferences as well as by our technical ability to produce things. Demand expresses willingness to pay (to buy), whereas supply expresses willingness to accept payment (to sell). In free markets, economic values are established by voluntary exchange between buyers and sellers, hence by demand and supply.
2. Economic values are relative: The value of each thing is expressed in terms of our ability to exchange it for other things. Dollars measure exchange values.
3. Economic values are not constant. They continually change, and they vary from one location to another. Reasons:

    - Needs and preferences in given communities change over time.
    - Technology, weather, and other supply factors vary with time and location.
    - Income varies, changing our ability to express demands, and our need to sell assets.
    - The prices-values-of substitute and complementary goods and services change, affecting demand, supply, or both.

There are other kinds of values besides economic values. In particular, *held* values express attitudes and beliefs, rather than willingness to exchange one thing for another. Held values are our most basic form of preferences or ideals, "and include modes of behavior (eg, bravery, loyalty), end states (eg, freedom, happiness), and qualities (eg, beauty, symmetry)" (Brown, 1984, p. 232). Held values influence economic values, and vice-versa. We can think of held values as one's underlying preferences or *utility function* that in turn shapes one's demands for the various market (and non-market) goods and services. Held values and economic values are essentially different senses of the word "value", even though they are functionally related.

Economic values may be defined as "expressions of rates of exchange between goods or services." "Rates of exchange" here express the quantity of one thing we are willing or able to exchange for other things. Thus, the going price of a certain freezer expresses both the willingness of suppliers to exchange their product for all other market goods (or for money in a monetized economy), and the willingness of demanders to exchange all other goods (money) for that product.

How Can Things That are not Bought or Sold Have Economic Value?

This generic definition of economic value allows us to estimate economic values for some things that are not bought and sold in markets. For instance, the basic fishery resources of the Great Lakes-the ecological productivity of the lakes-are not for sale. Instead they are held in public trust by government. However, we can still observe ways that these resources are diminished, enhanced or appropriated by private interests, in exchange for various economic or social returns. We tolerate some dredging, wetlands filling and disposal of treated sewage in exchange for marinas, shoreline locations for communities, and economic development. De facto exchanges such as this imply certain, measurable economic values for fishery resources and other non-market goods. Some economic valuation methods are based on careful observations of such non-priced, de facto exchanges. Recreation values, existence values and some other non-market values discussed below may be estimated this way.

It may seem strange or unnatural to estimate economic values for such non-market goods or services as sewage disposal and sport fishing. We rarely think of them in economic terms. However, such exchanges-one good for another-by definition establish economic values, even if market operating rules differ.

Economic Values of Fishery Management

In accounting for public expenditures on the fishery, the important question is not the value of the resource, nor the value of the angling or food fishing, although we estimate these values as intermediate steps. The important question is the value produced by the public expenditures-the public's return on its investments. In other words, what are the benefits in relation to the costs-the advantages vs disadvantages-of what we do to the resource? Public choices in fisheries involve:

- Management: What benefits do we gain from expenditures on management and protection?
- Policy: If we create a new law or policy, what are its advantages and disadvantages?-its economic benefits and costs?
- Protection: If someone damages the resource, exactly how great are the losses? How much compensation would just mitigate the public's losses? How much can we afford to require in the way of prevention measures before hurting the public interests in other ways?

Again, we basically want to know which particular actions are in the public's best interests, even if the public must pay for them. If fishery resources were owned by private businesses, management practices would be largely determined by expected dollar returns in relation to costs. Public sector economic accountability asks the same question: Would people literally buy these specific management actions if government were not available to do it for them (instead of paying license fees and taxes into general public funds)? Willingness to pay under ideal conditions is a direct measure of public benefits. (See Appendix for qualifications of this point.)

Unfortunately, these values-the public benefits-are not directly observable. People do not buy fishery management directly. In a sense they buy the results of management: they respond to changes in fisheries. However, they pay only nominal amounts for general license to use the resource, so even this does not tell us in dollar terms how much they benefit from specific actions.

Economists resort to indirect measures of user willingness to pay for their use of the resource, then estimate how particular changes in management, policy and protection would change user willingness to pay. The benefits of a particular management action are the difference in user willingness to pay for their uses of the resource with vs without the action:

Management Value	=	Willingness to pay with management	−	Willingness to pay without management

The maximum willingness of users to pay for use of the resource can be termed the *net all-or-none value of use. All-or-none* refers to the type of choice we are evaluating: a choice of all present use verses none. (In effect that would be equivalent to demanding a ransom before permitting any use; forcing users to pay the highest possible lump sum before permitting use to proceed as usual.) Choices of all vs none of a good and "ransoms" are rarely observed in free markets or in choices made by the public sector, but they represent total economic value or *total welfare,* as economists say. "Net" refers to the fact that users bear other costs other than what they might be willing to pay as access fees or other payments for using the resource. These other costs (such as angler costs for gasoline, equipment, and food) are part of the value of their use, but not part of their willingness to pay (w.t.pay) fees for their use. That is,

Net all-or-none value of any use	=	Total w.t.pay for use rather than have none	−	Associated costs other than user fees or equivalent

We cannot observe the net all-or-none values of the various uses, but we can estimate them indirectly. There are several indirect indicators of how much users would pay if they had to pay market-like prices for using the resource. For instance, we can observe how anglers respond to other kinds of costs associated with angling (eg, gasoline, equipment, food, etc.). Research shows that angling use rates decline as time and money costs of angling increase with travel distance. This relationship describes angler demand, illustrated in Figure 1 as the demand curve. By assuming anglers would respond similarly to access fees, we can predict their willingness to pay for angling, and conversely, their willingness to sell angling. (Willingness to sell estimates fair compensation levels for losses of angling.) Net all-or-none value for angling is the sum of existing access fees plus the triangular area under the demand curve but above existing associated costs, triangles ACW or BCZ in Figure 1. Areas ACW and BCZ are also known as "consumer surplus." (See Appendix for more on valuation methods.)

We can then estimate the values of management actions, policies, and protection by estimating the associated changes in the net all-or-none values of the uses: aggregate net use values with vs without the actions. The result estimates the change in *total public welfare;* the highest amount the public would possibly be willing to pay for the management action. This sum is higher than people would normally have to pay if the services (the management action) were competitively provided in a free market, but it is still a useful bit of information for the public choice process.

An alternative to estimating use values is to estimate the value of the resource. The all-or-none value of the resource for a particular use is the same as the net all-or-none value of use, because the net all-or-none value is the maximum amount users would be willing to pay to purchase the resource for purposes of their use. Management values equal the difference in resource value with vs without the management actions. However, this is no help: We would still have to derive the value of the resource from the values of its uses. The main difference between the two is that resource values might include the discounted values of future use as well as the values of present use we discussed above.

The main point here is that we estimate the benefits of a particular management action, policy or other change as the difference in the net values of uses, or in resource values, with vs without the action. We look, not for the resource values or use values, but for the change in the resource values or use values.

WHAT ARE ECONOMIC IMPACTS?

We use the term *economic impact* to describe how sales, incomes and employment in given locations depend on given levels of economic outputs in each sector. Others sometimes use the term more broadly, to describe other economic consequences of change, including project benefits and costs. Economists generally avoid the latter definition, to help separate economic impact concepts from economic value concepts. Economic impact analysis does not normally provide an estimate of net economic benefits and costs, so is not a substitute for project evaluation. Rather, the social consequences of economic impacts (see next section) are additional inputs into project evaluation.

The most common formal economic impact analysis technique, input/output analysis, traces how the outputs of each economic sector are produced by inputs from the various sectors. In other words, the analysis estimates generalized production equations, describing the amounts of various inputs per unit of output. Economic activity is usually measured in terms of the dollar value of transactions (sales and similar income transfers) over time, and in terms of employment of labor or capital. For example, the annual economic impact of Great Lakes sport fishing on the Great Lakes region is roughly $4 billion (in U.S. dollars). This means that $4 billion of the annual economic activity in the region is attributable directly or indirectly to the fishery: If we summed all of the economic transactions in the region in 1985, we could trace $4 billion of the total to the fishery. About $2 billion is received directly in the region from anglers, as payment for bait, tackle, food, gasoline, boats, charter fishing services, and a host of other items. The remaining $2 billion is received by persons and businesses in the region when those who receive the original $2 billion spend it in the region, then those recipients respend some of their receipts, etc. Not counted are dollars (economic activity) that go outside the region to pay for goods and services, such as for food and gasoline purchases from producers in California, Alberta and elsewhere.

These figures estimate how much our economy - ie, its revenues, personal incomes, and jobs-depends on the fishery. Implicitly, without the fishery individual and business incomes from current sources would drop by $4 billion. Hence the term *economic impact.* A change of some kind is implicitly or explicitly hypothesized in economic impact assessment. In this case the hypothetical change is the difference in the economy with vs without all Great Lakes sport fishing.

The analysis does not necessarily tell us what else the anglers would do with their $2 billion if they could not spend it on Great Lakes angling. However, it can estimate how the economy would change if their spending shifted in given ways. For instance, if they quit spending $2 billion on angling and spent it all on other recreational and other items within the region, the $4 billion loss would be approximately offset by gains in other business and personal incomes in the region. Even if totally offset, it would still represent a tremendous transfer in economic activity within the region: some $4 billion less income for one set of businesses and individuals, and $4 billion more income for another set of businesses and individuals. Surely this would mean business failure and unemployment for some, and business success and employment for others. Yet the aggregate economic impact on the region would be zero; greater analytical detail is needed to document impacts within the region. On the other hand, if anglers spent part of their $2 billion outside the region instead of inside, economic activity would be transferred there instead of being transferred elsewhere within the region. The transfer would change the aggregate level of economic activity in the region. Economic structures would change significantly in either case.

Economic Impact Information in Public Choices

Economic impact analyses tell us how the annual flow of business income (gross revenues), personal income and employment would be redirected, by location and by type of business, as a result of some assumed change. For management purposes, this information is primarily useful as an indicator of (1) how sales, incomes and employment in given regions (or communities) and economic sectors would be affected by the given changes, and (2) which regions and economic sectors can expect to grow more or to grow less in the future as a result.

This information can help show who benefits, who loses, and whether there is an overall gain or loss in sales, income and employment as a result of the change. Positive economic impacts in some regions and in some economic sectors usually will approximately equal any negative impacts in other regions and sectors in the long run, especially if displaced capital and labor find employment again after the change. *(Capital* refers to productive, durable assets, such as boats, public access sites, fish stocks, buildings, and facilities.) Idle and less than fully employed labor and capital represent economic losses, whether short term or long term. If all labor and capital displaced by a project are reemployed, the only long term economic consequence might be that economic growth has been shifted from some locations and economic sectors to other locations and sectors.

Economic impact analysis may also help prevent us from narrowly focusing on just the positive or negative impacts on one region or sector, because it *maps* the countervailing impacts on the other regions and sectors.

Economic impacts-shifts in the economy-are probably slightly undesirable (costly) in aggregate in the short run, but not necessarily undesirable or desirable in the long run. Shifts in economic activities tend to force people to adjust to new economic conditions. This process often temporarily reduces the level of employment for some workers and of some capital, and may entail some other expenses. These effects may not be entirely offset by the increases elsewhere. For instance, if all Great Lakes angling were eliminated, but the $2 billion angler expenditures were shifted to other recreation and products in the region, the economic impact within the region could be about $8 billion. That is, one set of businessess would lose $4 billion in direct and indirect revenue, while another set (with some overlap) would gain $4 billion. However, the net economic cost of the shift would only be a small percentage of $8 billion, and most of that cost would dissipate in the short run as businesses, workers, and others adjust to the change.

Three consequences of economic shifts may be important in public sector decision making (aside from the direct benefits or other reasons decision makers have for causing the shift, which are not normally estimated in economic impact analyses):

1. net economic costs or benefits resulting from increasing or decreasing the level of unemployment of labor and capital,
2. positive and negative changes in desirable social conditions, such as changes in economic equity due to income shifts, changes in the pattern of economic and urban/rural growth, and impacts on disadvantaged economic, ethnic or other groups, and
3. personal non-economic losses (and gains) resulting from economic dislocation, such as changes in one's way of life.

The net effect of economic shifts on economic benefits and costs is likely small or negligible, as mentioned above. Usually the most important consequence is in the "fairness" of the change: Is the shift in income and employment, from one set of businesses and people to another, socially equitable?

Economic impact analyses only rarely estimate any of these three consequences. Predicting (un)employment benefits (costs) of individual projects is rarely worth the effort because (a) the rate of reemployment after economic dislocation is difficult to predict, (b) underemployment is difficult even to define, and (c) aggregate employment effects of fisheries projects are likely small and temporary. Economic impact analyses are designed to estimate the amounts of economic shifts (the $8 billion, above), but not to estimate the costs of the shifts. The other two consequences seem to be more important in decision making, but are also virtually undocumented. Social impact analyses could evaluate them, but social impacts of fisheries projects are rarely estimated. Usually decision makers are left on their own to evaluate the important social implications of economic impacts.

ECONOMIC VALUES OF SPORT AND FOOD FISHING IN 1985

This chapter lists our best estimates of:

- the economic values of angling/harvesting Great Lakes fish,
- the economic values of Great Lakes sport and food fishery resources and
- the economic values of management, policy and protection of Great Lakes sport and food fisheries.

The latter two are derived from the first, but all three differ greatly. The last kind of value-the value of fishery management-is by far most useful. By "fishery management" we refer to public choices in fishery management, policy and protection. As Chapter I explains, fishery management values are almost always the only economic values relevant to decisions faced by the public sector, whether legislative, administrative or judicial. The first two kinds of values usually only provide intermediate information needed to estimate values of public choices.

Unfortunately, we can provide the least amount of guidance for management values. Each management choice is unique, and the unit values affected by management choices vary greatly, particularly for sport fisheries. Further, all three kinds of values depend on the particular units of the fishery to which we are referring: All fishing? All Great Lakes fishing? Perch fishing through the ice off Toledo? Salmon fishing from a 30 foot boat off Ludington in August? The values differ for each.

This chapter first presents our best estimates of angling and angling resource values together, since they are closely interrelated, then angling resource management values. Then it presents estimates of food fishery values in a similar order. In each case our estimates and their interpretation are followed by an explanation of how we arrived at these estimates, the accuracy of the estimates, and the kinds of methods used in the original research from which our estimates are derived. Basic principles of economic valuation of fisheries were introduced in Chapter I and further explained in the Appendix.

ESTIMATED ECONOMIC VALUES: ANGLING AND ANGLING RESOURCES

We estimate that anglers spent about $2 billion (expressed in U.S. dollars) for angling for Great lakes fish in 1985 (Table 2). In a limited sense this $2

TABLE 2. Estimated 1985 (Annual) Great Lakes Sport Fishery Economic Values, in U.S. dollars,

Gross value *of angling,* given the choice of all vs none. (ie, maximum potential buying/selling price for angling and associated goods and services)	$3,400,000,000 (range: $1.7-3.4 b.)[1]
Total angling price paid. (ie, 1985 cost of goods and services used for angling)	$2,000,000,000 (range: $1-2 b.)[1]
Value of angling resource (gross value minus costs). (ie, maximum potential buying/selling price for the resource or for access to the resource for 1985)	$1,400,000,000 (range: $.7-1.4 b.)[1]

[1]This range of values reflects uncertainty about the amount of angling for Great Lakes fish. See "sources and accuracy of estimates: angling and angling resource value," below, for explanation of this and additional uncertainty.

billion is the total value of angling, depending upon one's definition of terms, as we will see. In this limited sense, $2 billion was the cost of angling-the going rate anglers were paying, so it represents anglers' evaluations of current choices.

The $2 billion is something like total revenue for a market good-total consumer spending for the good-except for one important difference. For market goods, total spending includes only the purchase price, not the associated costs such as the cost of shopping. Angling is just the opposite: There is no purchase price, so we only count associated expenditures for other goods and services. (Actually, anglers pay about $28 million in earmarked taxes and license fees as part of these expenditures. They are almost like a nominal market price.)

Therefore, in another sense almost none of the $2 billion is the value of angling, since very little of it was actually paid for angling. Rather, almost all of it was really used to purchase other goods and services that anglers decided to use for angling. In this sense, the value of angling is either their present payment of roughly $28 million, or the amount anglers would be paying for angling if they had to purchase it in the open market like other goods and services.

The difference in these two points of view is that the first sense defines angling to include food, tackle, gasoline and all other goods and services used for angling; whereas the second sense defines angling as a separate good, distinguished from the other associated goods and services. This semantic difference is a major source of confusion about sport fishery values as well as food fishery values.

This leads us to ask how much anglers would pay for angling if they had to. We estimate that anglers would have paid a maximum of about $3.4 billion (U.S. dollars) for angling for Great Lakes fish, and for associated goods and services in 1985 (Table 2). That is, they would have paid up to $3.4 billion, including the $2 billion actually spent, rather than go entirely without angling for Great Lakes fish for the year. We refer to this as the gross all-or-none value of angling, or simply the gross value of angling.

The difference between the $3.4 billion gross all-or-none value of angling and the $2 billion cost of angling, $1.4 billion, is known as the *net all-or-none value of angling,* or the *all-or-none value of the angling resource,* or, more

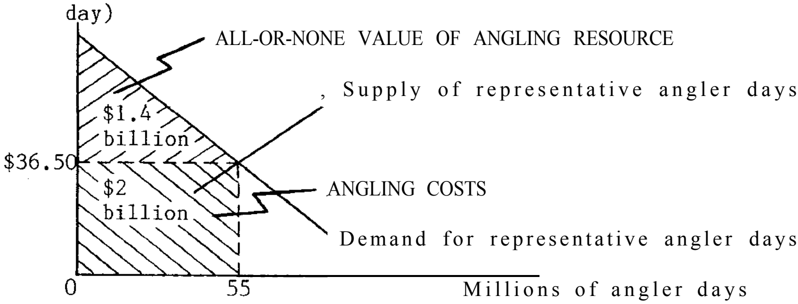

Figure 2. Representative 1985 demand and supply curves for angling for Great Lakes fish. The all-or-none value of angling is $3.4 billion, including angling costs of $2 billion. The $1.4 billion remaining is attributable to the all-or-none value of the angling resource.

often, simply the value *of the angling resource* (Table 2). The $1.4 billion is the maximum annual amount anglers would be willing to spend, say, to prevent a catastrophic loss of the resource, or to purchase the resource from a monopolist who threatens to prohibit all use, assuming each angler pays the most he/she would be willing to pay rather than quit. If anglers did spend $1.4 to save the resource, as in this example, they would still have to pay $2 billion for the associated goods and services necessary to go fishing. Assuming these values continue forever, no inflation, and a discount rate of 2%, the present value, or permanent all-or-none purchase price, of the resource would be $70 billion (U.S. dollars). Figured at 5%, it would sell for a maximum of $28 billion. (From here on, we refer only to annual values.)

These three kinds of values are often confused with each other, so let us view them again in a different way before explaining the sources of the estimates and the ranges of error of the estimates. Figure 2 schematically diagrams the values listed in Table 2. (Figure 2 is purely schematic because it aggregates demand and supply, abstracting from the multitude of individual components of the sport fishery to illustrate the principles behind the estimates.)

The first interpretation asks the going rate for fishing: What is the aggregate value of all the "purchases" of fishing? Our estimate is $2 billion in 1985 (the bottom shaded area in Figure 2). On a smaller scale, the same question is: How much would it cost anglers to add another unit of fishing? Our estimate is an average of $36.50 per angler day. In other words, $36.50 is the *average value of angling* (trips) per angling day, and is the *average cost to anglers of producing angling days* for themselves. Further, if it cost the typical angler $36.50 to produce additional days angling, we could refer to $36.50 as the representative incremental or *marginal value* and *marginal cost* of angling. Since much of the

$36.50 is spent for long-term costs, such as fishing equipment, the marginal value and marginal cost of angling for Great Lakes fish may be somewhat lower. The average cost is equivalent to the price of angling days over the long run, whereas the marginal cost is equivalent to the price of angling days in the short run.

The other interpretation asks how much anglers would pay for use of the fishing resource (or for access to it). If, for example, a fee of $2 per angler day were charged, the demand curve in Figure 2 indicates that slightly less than 55 million angler days would be fished (at a cost of $38.50)[1]. Revenue would be over $100 million per year. Since essentially no price is currently charged for use of the fishery, we have no objective basis for selecting any single user fee level from which to estimate the market value of angling use. Instead, economists often estimate the entire area under the curve above average costs-the upper shaded area in Figure 2; $1.4 billion. That amount estimates the maximum fees anglers would be willing to pay rather than forego all fishing (or the amount anglers would have to be paid to get them to forego all fishing-see Appendix). This $1.4 billion is called *consumer surplus, potential economic rent,* or the *net all-or-none value ofangling.* It is the price of all angling use if sold collectively, as a single unit, instead of bit by bit. The gross all-or-none value is the sum of both shaded areas in Figure 2; $3.4 billion.

The *value of the fishery resource* is the dollar amount users would pay to use that resource-up to $1.4 billion per year-not the amount they pay for the associated goods and services. (It is also indicated by how much people would have to be paid to stop using it. See Appendix.) The marginal value of the fishery resource would be the price of a representative small unit of the resource. A unit of the resource could be defined, say, as a representative county's fishery for a given species. The all-or-none value of the fishery resource would be the price of the entire Great Lakes fishery resource. The all-or-none value of the angling resource is the same as the net all-or-none value of angling, or angler consumer surplus. (The all-or-none value of the food fishery resource includes *producer surplus* as well as *consumer surplus,* as we will see below.) Chapter I and the Appendix discuss the role of fishery resource valuation in fishery management.

SOURCES AND ACCURACY OF ESTIMATES: ANGLING AND ANGLING RESOURCE VALUES

Our estimate of the all-or-none value of the angling resource (the net all-or-none value of angling) is based upon the following estimates of all-or-none values, reported here in 1985 dollars, of major portions of the Great Lakes sport fishery resource: (1) The net all-or-none value of all angling for Great Lakes fish in Michigan in 1976 was estimated to be $209 million for 6.7 million angler days (Talhelm, 1981). Estimates ranged from $160 million to $305 million, depend-

[1] Actual demand curves are constructed in ways that consider the effects of time costs as well as money costs on levels of angling, to remove possible biases in predicting responses to increases in fees rather than travel costs.

ing upon specific assumptions. These estimates were derived from a detailed simulation model of the demand and supply for angling for Great Lakes fish throughout Michigan, using the *product travel cost method* and county-level observations. (2) The net all-or-none value of angling in Wisconsin waters of Lake Michigan in 1978 was estimated to be $23 million for 0.707 million angler days (Kealy and Bishop, 1983, 1986). These estimates were based on a travel cost analysis using a maximum likelihood estimation procedure and county-level observations. (3) The net all-or-none value of angling on New York's Great Lakes coast (including the Niagara and St Lawrence Rivers) in 1976-77 was estimated to be $75 million for 2.75 million angler days (Brown, 1982). Treating single or double counties as independent fisheries in independent travel cost analyses, the average all-or-none values per angler day varied greatly, spanning almost one order of magnitude. (4) The net all-or-none value of private-boat angling (ie, not including charter boat and shore-based anglers) in the western basin of Ohio's Lake Erie for May-November, 1981, was $5 1 million for 1.3 million angler days (Hushak, 1984). The net all-or-none value of private-boat angling in the central basin of Ohio's Lake Erie in 1982 was $2.7 million for .4 million angler days (ibid.). Hushak's travel cost analyses treated each of these areas as an independent single recreation site.

The committee computed net all-or-none values per angler day in these cases for comparison purposes. Most ranged between $23 and $33. Considering differences in assumptions, possible statistical errors, and the relationship between angling values and type of angling, they estimated that if these values were expanded to other portions of the Great Lakes, the overall average would be between $23 and $33, most likely about $26. Multiplying by the estimated 55 million angler days for Great Lakes fish in 1980 (Talhelm, 1988), the all-or-none value of the entire Great Lakes sport fishery resource would be $1.3 to $1.8 billion per year in 1985, most likely about $1.4 billion.

Since the total number of angler days is itself an estimate, with some unknown degree of error, the confidence interval around the $1.4 billion estimate should be even wider. In fact, although pre-survey studies support the accuracy of the 55 million angler days estimate, evidence from other surveys indicates that the actual number of angler days may be only 15 to 30 million. (See Talhelm, 1988, Appendix D, for further explanation and references.) Assuming an average all-or-none value of $26 per angler day, and a range of 27-55 million angler days, aggregate net all-or-none value would be between $.7 and $1.4 billion. Considering both kinds of error together, the actual value could be between $.5 and $1.8 billion.

Estimated angler expenditures in 1980 of $1.76 billion (expressed as U.S. dollars) (from Talhelm, 1988) were increased by the change in the US consumer price index from 1980 to 1985 of 31%, then rounded down from $2.3 billion to $2 billion. We felt that some reduction was warranted because Talhelm reported that 56% of the expenditures were long term outlays, mostly for boats and vehicles, attributed entirely to Great Lakes angling but likely used for other purposes as well. Assuming that expenditures per angler day are accurately estimated, the $2 billion estimate must still be adjusted for the above uncertainty in the estimate of total angling effort. Therefore we estimate that total expenditures attributable to angling for Great Lakes fish in 1985 were between $1 billion and $2 billion.

License fees attributable to angling for Great Lakes fish in 1985 were roughly $18 million (U.S. dollars), and excise taxes roughly $10 million. These figures were obtained by multiplying the corresponding estimates from Talhelm, et al, 1979 (p. 5), times the change in the U.S. consumer price index, and converting Canadian dollars to U.S. dollars at an exchange rate of 1.35. These approximations seem consistent with expenditures reported in Talhelm, 1988.

ESTIMATED ECONOMIC VALUES: SPORT FISHERY MANAGEMENT

The economic values of fishery management, policy and protection-the things people do to the resource and to users of the resource, collectively referred to here as management-are indicated by the resulting changes in the values provided by the fishery. As before, the basic idea is that the economic value of anything is the amount people are willing to pay for it (demand), and the amount for which people are willing to sell it (supply). The difference in this case is that the value of sport fishery management is anglers' willingness to pay for the change in the fishery caused by management. (The supply side of management is its cost and feasibility, which are somewhat predetermined by the rest of the economy, by technology, and by political factors.)

Since management is not bought or sold like market goods and services, we again need to estimate by some means other than observing market transactions how much the public would be willing to pay toward the cost of management if necessary. (Alternatively, the value of a change could be estimated by the amount people would have to be paid to willingly forego the change-see the discussion in Appendix. For simplicity, we will continue to generally refer only to willingness to pay.)

Figures 3 and 4 illustrate how angling values change as a result of changes in angling demand and supply. Figure 3 schematically illustrates how changes in the quality of sport fishing change sport fishing values. Most management activities, such as a fishery enhancement project in this case, change the quality of angling available to anglers by changing the resource or the rules for using it. This changes the supply of angling by changing the product available to anglers.[2] It is analogous to changing the products offered in the open market. For instance, the makes and models of autos available can be thought of either as variations in product quality or as different products. Further, many of the auto products offered change annually. Changing the quality of fishing does not change the basic preferences of anglers, which economists express as a family of demand curves. However, angler preferences for one product differ from their prefer-

[2] Figure 3 does not illustrate the differences in angling supply implied by the different products. Instead, it illustrates a generalized, aggregate supply relationship, representing the increasing costs anglers must incur to reach farther sites or to intensify their use of closer sites. Figure 3 also ignores other factors, particularly the wide variety of other angling products likely available at a number of other sites in the vicinity. See Talhelm, 1984, for a more complete explanation of angling demand and supply.

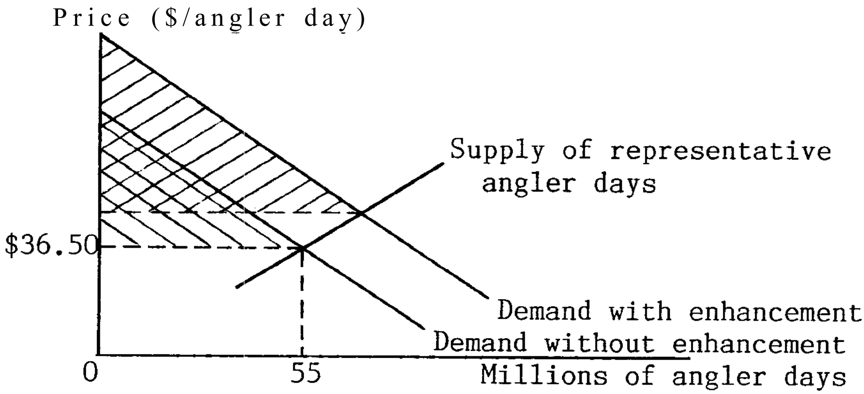

Figure 3. Schematic illustration of the benefits of angling resource management. The maximum willingness of anglers to pay fees for resource enhancement is the difference in net ail-or-none value with vs without enhancement-the difference in the shaded areas.

ences for another product. Anglers must shift from demanding one thing to demanding another thing. Therefore, the demand for the angling available with enhancement differs from the demand for the angling available without it. The two demand curves may even differ in shape. Further, the fact that one demand curve is higher than the other does not imply that all anglers prefer the enhanced angling to the unenhanced; only that aggregate preferences are higher.

Figure 4 illustrates the change in values accompanying a change in the cost of angling. New highways or lower fuel costs, for instance, reduce the cost to anglers of angling, increasing their net willingness to pay and the amount of angling. In economic terms, the demand schedule for the angling remains the same, but the supply increases because the same angling is available at a lower cost. (Economic supply is defined as the schedule of prices at which each given quantity of a good is available.) Lower time or money costs in effect bring the angling closer to anglers. Fishery managers can produce the same effect by providing new angling, sites offering angling identical in quality to that already available elsewhere.

We could estimate the economic values of particular management actions in three different ways: (I) We might be able to require users to pay directly for the management activity through some form of user charge. The management activity would be sold as if in a market, although the amount of management and its sales price would probably not be solely determined by the forces of competition. If users pay solely for the management activity, then the value of the activity is at least as great as the revenue. This would be unusual, however, because anglers usually pay for access rather than for management: They pay to

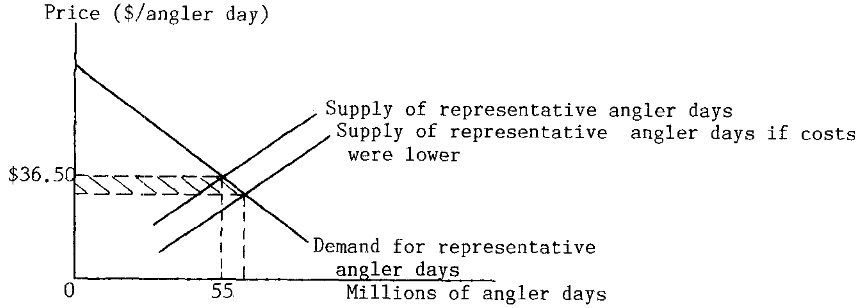

Figure 4. Schematic illustration of the benefits of angling cost reduction. Supply increases, but demand is unchanged because angling quality is unchanged. The shaded area illustrates the maximum willingness of anglers to pay for the cost reduction.

use the resource whether they want the particular management activity or not. (2) We could derive the value of the management from the changes in the user values caused by the management. Here our task is basically to compare the net all-or-none value of use without the change to the net all-or-none value with the change. The result would be an all-or-none assessment of the change; the maximum possible willingness of people to pay for the change. (3) We could ask people in some more direct way-using contingent valuation techniques-how much they would be willing to pay for the management results.

There is no standard unit of management, so there is no standard value of management. Each management instance must be evaluated on a case-by-case basis. At best, we might be able to develop unit day values, then multiply the expected increase or decrease in numbers of angler days by the unit day values.

As a start, economists have estimated the changes in value and in effort that would result from several hypothetical changes in Great Lakes angling. Tables 3 and 4 list the known examples evaluating particular kinds of Great Lakes sport fishery management, other than the all-or-none choices evaluated above. Table 5 summarizes unit day values from Tables 3 and 4. Values per change in angler day range from $55 to $47. Angling resource management values are especially variable because angling values vary greatly. Angling values depend on angler preferences for the quality of angling available at the site, site proximity to anglers, the availability of other angling sites as substitutes, and the availability of complementary facilities and amenities.

Few of the management values in Table 5 are near the $26 average all-or-none angling resource value per angler day (first value listed). People often incorrectly assume that this average estimates management values. Not only is an average value likely to misrepresent the value of a particular choice, but the average is based on an all-or-none type of choice rather than on the incremental

TABLE 3. Selected examples of Great Lakes sport fishery "management" values.

Resource Change	Result (1985 $)	Source
1. Eliminate trout & salmon angling in Mich waters of Lake Mich north of Grand Haven, Lake Superior east of Marquette, and Lake Huron north of Alpena in 1976; assuming angling quality elsewhere is constant.	$17,000,000 and 700,000 angler days lost; 1,800,000 angler days go elsewhere	Talhelm, 1981
2. Change in angling quality due to initial increase of 1,800,000 angler days in remaining Michigan Great Lakes waters after the change in number 1, above.	$17,000,000 and 1,500,000 angler days lost	Talhelm, 1981
3. Fish ladders on Grand River, providing salmon/steelhead angling in four new counties in central Michigan, 1976.	$9,000,000 or more gain, depending on angling quality	Talhelm, 1981
4. Increasing angling success for Michigan's Lake Superior trout/ salmon from low and moderate catch per angler day to high, 1976.	$111,000 and 70,000 angler days gain	Talhelm & Bishop, 1980
5. Increasing angling success for Wisconsin's Lake Michigan trout/salmon from 0.4 fish per angler day to 1.4 in 1979.	anglers willing to pay $2.5-$7 per existing angler day, or $60-$180/year	Talhelm & Bishop, 1980
6. Increasing angling success for all Wis. Lake Michigan angling from 1.34 fish per angler day to 2.34 in 1978.	anglers willing to pay $11.73 per existing angler day	Samples & Bishop, 1983
7. Reducing angling success for Michigan's Lake Erie yellow perch & panfish by 50% (from high to moderate cpue) in 1976.	$4,000,000 and 390,000 angler days lost	Talhelm, 1981a
8. Curtailing' Michigan's Lake Superior lake trout fishery, 1976.	$6,000,000 & 145,000 angler days lost	Young, et al, 1986
9. Curtailing Michigan's Lake Michigan lake trout fishery, 1976.	$11,000,000 & 233,000 angler days lost	Young, et al, 1986
10. Curtailing Michigan's Lake Huron lake trout fishery, 1976.	$2,500,000 & 66,000 angler days lost	Young, et al, 1986
11. Curtailing Michigan's Lake Michigan yellow perch fishery, 1976.	$2,400,000 & 200,000 angler days lost	Young, et al, 1986
12. Curtailing Michigan's Saginaw Bay yellow perch fishery, 1976.	$2,700,000 & 225,000 angler days lost	Young, et al, 1986
13. Curtailing yellow perch angling, Mich. Lake Huron other than Sag. Bay, 1976.	$300,000 & 16,000 angler days lost	Young, et al, 1986

[1] Curtailing means to reduce angler success to the lowest levels observed among Michigan's Great Lakes counties in 1976: Less than .5 lake trout per angler day, or less than 3 perch per angler day (6 in fall period). Catch per unit of effort for other species is assumed constant.

TABLE 4. Marginal value and quantity (angler days) of angling success: Effects of a one percent change in catch per angler day in southern Lake Michigan by species, season and county (1985 dollars).[1]

Species and Season	County: Berrien	Van Buren	Allegan	Ottawa
PANFISH				
I	$2,700/190(L)	$2,700/210(L)	$2,700/200(L)	$4,500/300(M)
II	$16,000/830(H)	$6,300/360(M)	$6,300/350(M)	$8,000/430(M)
III (perch only)	$3,400/240(H)	$680/60(M)	$450/49(L)	$1,600/130(M)
GAMEFISH				
I	$3,800/260(L)	$3,800/280(L)	$3,600/290(L)	$4,700/350(L)
II	$3,800/190(L)	$4,500/180(L)	$4,000/220(L)	$3,200/100(M)
III (non-perch)	$1,800/140(M)	$1,300/95(L)	$340/37(H)	$1,700/160(M)
TROUT				
I	$8,000/270(M)	$11,000/310(M)	$2,500/600(H)	$11,000/360(M)
II	$27,000/930(M)	na(H)	$10,000/640(H)	$27,000/1500(M)
III	$78,000/1400(M)	na(M)	na(M)	na(L)
SALMON				
I	$13,000/550(H)	$19,000/770(M)	$13,000/590(H)	$8,700/400(M)
II	$23,000/800(H)	na(M)	$42,000/1500(H)	$21,000/840(L)
III	$45,000/960(M)	na(M)	na(M)	na(L)
STREAM-RUN SALMON & TROUT				
III	$1,5001150(M)	$12,000/380(H)	$34,000/580(M)	$4,700/150(H)

[1] Analysis based on 1976 data and conditions. Dollar amounts converted to 1985 dollars using U.S. consumer price index (ie, multiplying by a factor of 1.8944). "Na" means not available. Seasons are defined as: 1= Jan. 1 to May 31, II = June 1 to Aug. 31, III = Sept. 1 to Dec. 3 1. Letters in parentheses indicate existing (1976) catch rates: H=high, M=moderate, L=low. Figures are marginal values and quantities. For example, a 1% increase (decrease) in Lake Michigan trout catch per angler day would increase (decrease) the value of the Berrien County- and statewide-winter/spring fishery by about $8,000 and increase (decrease) the total number of angler days in the county by 270. The state total of angler days would increase (decrease) by only part of this amount because there is some shifting between locations fished (omitted to simplify presentation). Values and angler days are additive in all other respects. Each impact is estimated assuming catch rates in the remainder of the state are. unchanged from their 1976 levels. (Source: Talhelm, Jordan and Karwowski, 1985.)

type of choice appropriate to most valuation questions. We expect the value of such a drastic choice-all vs none-to be higher than the typical incremental changes produced by typical management actions.

Despite this variability in management values, managers need some rules of thumb to refer to instead of conducting a detailed, expensive analysis in each case. The few cases examined in Tables 3 and 4 suggest that values of angling for Great Lakes salmonids per increment in angler day are quite variable, but often $20 to $40. Values of angling for Great Lakes nonsalmonids per increment in angler day are often $12 to $15. All values tend to increase with closer proximity to population centers, and angling values seem to be higher during summer.

Not only are angling resource values variable and highly site-specific, but

TABLE 5. Annual unit values per change in angler days. Based on estimates from Tables 3 and 4.

Protecting the entire sport fishery from total loss	$26
Changing angling quality at a particular location Unit values depend on location, quality and substitues. Non-salmonid values are typically $10-20 per increased/decreased angler day, and salmonid values $20-50 per increased/decreased angler day.' Examples:	$0 to $50
Perch/panfish, SE Lake Mich., small change from moderate CPUE, substitutes available ($ per angler day gained/lost)'	$15
Perch/ panfish, Mich. Lake Erie, change from high to moderate CPUE, substitutes available ($ per angler day lost)'	$10
Salmon, spring, SE Lake Mich., small change from moderate or high CPUE, substitutes available ($ per angler day gained/lost)'	$24
Salmon, fall, SE Lake Mich., small change from high CPUE, substitutes available ($ per angler day gained/lost)'	$47
Lake trout, all Mich. Lake Mich., change from high or moderate to low, substitutes distant ($ per angler day lost)'	$47
Lake trout, all Mich. Lake Sup., change from high or moderate to low, substitutes very distant ($ per angler day lost)'	$41

[1]CPUE stands for catch per unit of angling effort; ie, fish caught per angler day. These unit day values are derived by dividing the total value gain/loss of all anglers by the change in the number of angler days.

changes at one site can strongly affect values and use at neighboring sites. For example, following Table 4, after a 10% increase in winter/spring Lake Michigan trout catch rates in Berrien County, Michigan (worth $80,000), a subsequent 1% increase in the winter/spring trout catch rate in neighboring Van Buren County would have less than the $11,000 value indicated. The Van Buren County resource becomes slightly less important to anglers after the improvement in Berrien County. (This is analogous to the reduction in importance to consumers of domestic autos as good foreign substitutes become more available.) Simultaneous increases in the two counties would also be overestimated slightly by these figures. Decreases would have the opposite effect, with a decrease in success rate in a second county increasing in importance (ie, greater loss than indicated here) after a decrease in the first county.

Considerable additional results are needed before reliable rules of thumb can be developed. More-complete rules of thumb will probably consider factors such as angling quality, proximity to population, uniqueness of the angling and the availability of substitute angling sites, as well as the nature of the proposed changes in these factors. These factors in turn are probably fairly well indicated by product uniqueness (ie, the willingness of anglers to choose the quality of angling available at some particular sites over the quality available at others, which in turn is indicated by how many other closer sites anglers forego to reach the ones in question), total use levels, and the additional distances most anglers would have to travel to reach other sites considered close substitutes.

We estimate the annual all-or-none value of the Great Lakes commercial food fishery resource (the annual net all-or-none value of food fishing) in 1985 at between $13 and $41 million, or about $21 million (U.S. dollars). This approximates both (1) maximum willingness of fish consumers and harvesters to pay user fees rather than forgo all fishing for and eating Great Lakes fish, and (2) minimum. willingness of fish consumers and harvesters to accept payment in exchange for forgoing all the fishing and eating. In other words, the maximum potential annual purchase price of the entire Great Lakes food fishing resource is about $21 million per year under 1985 conditions. The net present value, or maximum potential permanent purchase price, of the food fishery resource is $1.05 billion (U.S. dollars); assuming these conditions continue forever, no inflation, and an annual discount rate of 2%.

This section describes these and related estimates (all expressed as annual values) in more detail. The next section explains how we arrived at these estimates, and describes the accuracy of the estimates. Finally, another section describes our estimates of food fishery management values.

We estimate that the gross all-or-none value of food fishing for Great Lakes fish was $5 1 million (U. S.) in 1985 (Fig. 5 and Table 6). Landed value was about $41 million, of which an estimated maximum of about $11 million, under ideal conditions, was producer surplus. (Producer surplus in this case is defined as the maximum amount fish harvesters could afford to pay to use the resource-ie, access fees or equivalent-out of their revenues without going out of business in the long term.) The remainder of the $41 million landed value would be the minimum cost of food fishing, which we estimate was $30 million. We estimate that consumer surplus was $10 million. The total of producer surplus and consumer surplus ($21 million) is the net all-or-none value of food fishing, or the all-or-none value of the food fishery resource.

In other words, the value of the food fishing resource is the total value of food fishing minus costs. We estimate that the fish, worth an all-or-none price of about $51 million, could have been harvested at a minimal cost of $30 million (after restructuring the industry to eliminate overcapacity, maximize economic

TABLE 6. Annual total economic values of the food fishery.

Gross value of food fish (ie, max. potential buying price)	$51,000,000 (Range: $48-62 mil.)[1]
Total price paid for food fish (ie, 1985 cost of landings)	$41,000,000
Value of food fishery resource (gross value minus harvest costs') (ie, potential buying/selling price for resource)	$21,000,000 (range: $13-41 mil.)[1]

[1] The range of values given for the food fishery reflects uncertainty about the estimates. These numbers are extracted from somewhat limited evidence; mostly state-level studies rather than region-wide studies.

[2] Harvest costs are defined here as the minimum cost necessary to harvest the fish; an estimated $30 million. Total revenue minus harvest costs equals economic profit or economic rent received by harvesters, and harvesters could afford (under ideal conditions) to pay up to the amount of economic rent for using the resource.

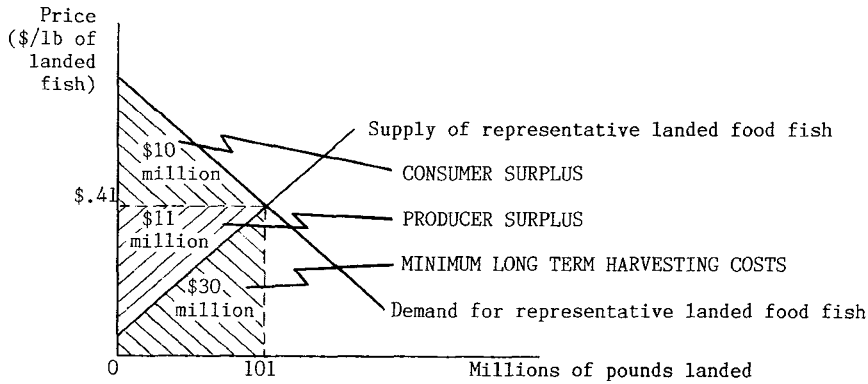

Figure 5. Representative 1985 demand and supply of landings of Great Lakes food fish. The all-or-none value of the landings is $51 million, including $30 million in minimum harvesting costs and $21 million attributable to the all-or-none value of the food fishery resource.

efficiency and eliminate profits-other than normal wages and earnings on investments-for the remaining harvesters), leaving $21 million as the all-or-none value of the food fishery resource.[3] The $21 million includes only the portion of food fish value consumers and harvesters could pay to purchase access to the resource, or alternatively, the portion for which consumers and harvesters would have to be compensated before they would give up their use.

Our analysis focuses on the demand and supply of landed food fish at dockside. That is the only point in the production-consumption process for which relatively complete and uniform price and quantity records are available throughout the Great Lakes. The demand for landed fish is derived from the demands for fish consumption in various forms, as well as from the efficiency with which fish processors, wholesalers, retailers, restaurants and all other intermediaries perform their functions. Assuming these fish handling/selling businesses are at least mildly competitive, the derived demand for landed fish reflects consumer preferences and fish handling/selling technology. Thus, demand, fish consumers, and related terms in our analysis refer to this derived demand for landed fish. Supply in our analysis refers to the economic ability of fish harvesters to supply fish landings.

Like sport fishery resource values, food fishery resource values depend on consumer preferences for the final products, on the prices of substitutes and complements, and on the technology of production and consumption. Food fishery values are severely constrained by competition from high-quality,

[3]This does not imply that profits from food fishing are now $21 million. Profits have actually been found to be very low, or even negative (Pattinson and Talhelm, 1978). However, profits in at least some areas could be higher if the industry were restructured for maximum economic efficiency. About $1 I million of the $21 million is attributable to such potential profits.

inexpensive fish in national and international markets. Prices and costs are fairly uniform throughout the Great Lakes basin because transportation costs are relatively small. Therefore, food fishery resource values vary much less from location to location. They vary mainly with the productivity of the resource, and with decisions to restrict harvesting because of contaminants, rehabilitation needs, conflicts with the sport fishery, or other reasons.

The food fishery values we have estimated so far help us understand the overall importance of the Great Lakes food fishery. However, for most practical purposes we need further information. Instead of just the current all-or-none values, we usually would like to know these values change as we change the food fishery in some particular way at some particular location. For instance, the fact that the net all-or-none value of sport fishing is an estimated 70 times higher than that of the food fishery, $1.4 billion vs $2 1 million, does not indicate whether we could derive even more net benefits by reducing the food fishery in hopes that the sport fishery could expand. In fact, there are many instances in which the food fishery appears not to compete significantly with the sport fishery. If so, reducing the: food fishery would reduce its net benefits without noticeably enhancing sport fishery benefits. The kinds of values needed to answer such questions - ie, food fishery management values-are discussed after the following section.

Sources and Accuracy of Estimates: Food Fishing Values

Our estimates of food fishery values are based upon the following estimates of these values for several major portions of the Great Lakes food fishery resource. We report our estimates here as ratios of consumer and producer surplus (the two components of net all-or-none value) to landed value, to facilitate comparisons. Landings statistics are listed under "estimated economic impacts: food fishing," below.

(1) Talhelm and Ghanbari (Ghanbari, 1977), by econometrically estimating the demand and supply of U.S. lake whitefish landings, estimated that the ratio of consumer surplus to total whitefish landed value in 1973 was .22 (ie, 22 percent), and the ratio of producer surplus to total landed value was .29. (By way of comparison, the ratio of consumer surplus to landed value illustrated in Figure 5 is 1041, or .24; and the ratio of producer surplus to landed value in Figure 5 is 11:41, or .27.) For the entire 1985 Great Lakes fishery these ratios imply $9 million in consumer surplus and $12 million in producer surplus. Using data from Pattinson and Talhelm (1978) on the costs reported by whitefish fishing firms, they estimated that current producer surplus for whitefish fishing in Michigan's (Green Bay was three percent of total revenue. For the entire 1985 Great Lakes fishery this implies only $1 million in producer surplus. Finally, in a bioeconomic "surplus production" analysis, they estimated that if Green Bay (Michigan) whitefish fishing effort were reduced to optimum levels, costs would decrease and catch would increase, increasing producer surplus to 40 to 66 percent of total revenue. This implies a producer surplus of $16 to $27 million for the entire 1985 Great Lakes fishery.

(2) Bishop and Johnson (Johnson, 1981) found similar results in their

analyses of Wisconsin's yellow perch, whitefish and chub fisheries. They found in an econometric analysis that whitefish demand was quite elastic (ie, large percentage increases in landings cause small percentage decreases in price), but that chub and perch demands were inelastic. This implies smaller relative consumer surplus for whitefish than for chubs and perch. They found producer surplus for Wisconsin's yellow perch to generally be about 50 percent of total landings value, based on their analysis of perch fishing (production) costs and the efficiency of transferable landings quotas. In conclusion, they estimated that the ratio of total consumer and producer surplus to total landings value may be .5 to 1.0 (ie, 50-100 percent). These findings imply a consumer surplus of $0 to $20 million and producer surplus of $20 million for the entire 1985 Great Lakes fishery.

(3) Husin (1984) also obtained similar results. In his econometric analysis he estimated that consumer surplus for Michigan whitefish equaled 18% of Michigan's landed value in 1982. Consumer surplus for Michigan's much smaller chub, yellow perch and alewife fisheries roughly equaled total landing value. Like Johnson (1981), he found that whitefish demand was quite elastic, but chub and perch demands inelastic. However, he found that in recent years whitefish demand has become less elastic, and chub and perch demands elastic, apparently due to recent changes in price levels. His estimates of producer surplus from statistical supply equations were unsatisfactory, perhaps because of the rapidly changing state of the fisheries, or because he specified linear supply curves in his analysis.[4] The only exception was that his alewife supply equation estimated producer surplus at 18 percent of total revenue (landings value) in 1982. Using fishing cost data from Pattinson and Talhelm (1978), and a bioeconomic surplus production analysis, he estimated that producer surplus in Michigan's 1982 whitefish fishery was about 15 percent. He also estimated that under optimum conditions it could be increased to 45 percent. These findings imply a consumer surplus of $7 to $41 million and producer surplus of $6 to $18.5 million for the entire 1985 Great Lakes fishery.

ESTIMATED ECONOMIC VALUES: FOOD FISHERY MANAGEMENT

Again, there is no standard unit of management, and no standard value of management. Few estimates are available other than those discussed above under "Sources and accuracy of estimates-food fishery resource value" (see Table 7). All of these studies estimated values of selected changes to portions of the larger Great Lakes fishery. Ghanbari (1977) and Johnson (1981) both found potential producer surplus of about 50% of total revenue. Thus, as a rule of

[4]Evidence is strong that supply curves for these species are backward bending. That is, the curves are nearly vertical at current prices; the quantity supplied decreases at higher prices due to overharvesting; the quantity supplied might actually increase at slightly lower prices, especially if overharvesting decreases; but at very low prices, the quantity supplied must go to zero. Husin's linear supply curves were very steeply positively sloped (price inelastic), predicting little reduction in quantity supplied at even zero price. However, backward-bending supply curves are not necessarily the main reason for these estimation problems. Changing food fishing regulations and treaty rights, significant shifts in species composition and productivity, and serious contamination problems have greatly disturbed Michigan's food fisheries in the 1960s and 1970s.

TABLE 7. Annual unit values per change in pounds landed, food fishery management.

Protecting the entire food fishery from total loss	$.21
Changing allowable harvest at a particular location (Unit values depend on species, market conditions, and harvest technology. Values may be up to 50% of the change in landed value.)	$0 to $1

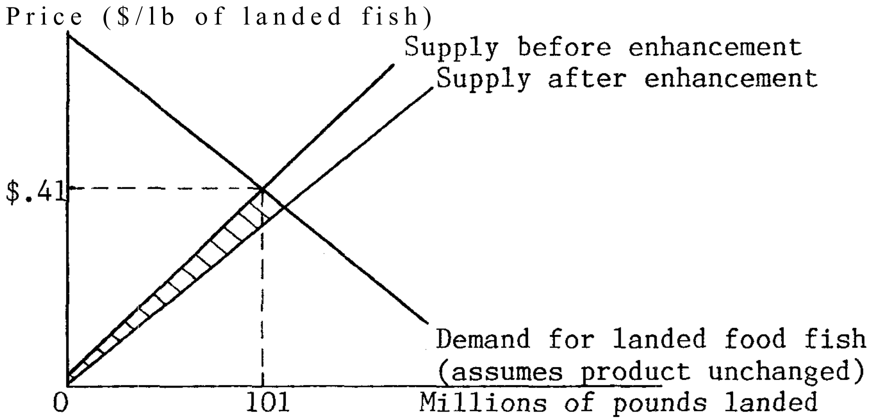

Figure 6. The value of enhancing the food fishery resource is the increase in potential willingness of producers to pay for fishing.

thumb, if harvesting were organized to operate at optimal economic efficiency, the value of food fishery management might be as much as 50% of the change in landed value of the fish. However, the studies indicate considerable overinvestment (ie, fishing effort beyond that needed to harvest the optimal number of fish). If so, most potential benefits would likely be dissipated in excess spending on harvesting equipment and activities; harvesters would be left with little potential ability to pay for the change.

Four common types of changes affecting food fishery resource values may be visualized in Figure 6. (1) Changes in the productivity of the resource change the number of fish harvested for the same cost of effort, shifting the supply curve to the right (more productive), as illustrated, or left (less productive). Similarly, if fish populations are being harvested at levels above or below optimal long term levels, changes in harvest rates can improve the long term economic productivity of the resource, shifting supply to the right. (2) Changes in harvesting technology or in input costs (eg, fuel) change the cost of harvesting the same numbers of fish, shifting the supply curve up or down. Similarly, if harvesting capacity exceeds needs, more effective use of existing harvesting equipment and labor could reduce the costs of harvesting the same numbers of fish. (3) Changes in the efficiency of fish processing, handling, or selling change the cost of using fish once they are landed. If the same numbers of fish can be provided to consumers less expensively (apart from any change in the cost of landing fish), the demand curve for landings would shift up. In other words, consumers could now afford to pay more for landed fish because processing, handling, and/or selling are less expensive. For instance, Hushak (pers. comm.) reports that capacity constraints of Ohio's fish processing firms apparently caused the demand for landed fish in Ohio to be highly inelastic. That is, prices change sharply in response to small changes in the quantity of fish landed because firms have difficulty handling too many fish (lowering their willingness to pay for fish), and also have difficulty reducing processing costs as numbers of fish fall (creating high competition for fish if numbers are below processing firm capacity). (4) Changes in consumer preferences or in the prices of substitutes or complements change the quantity demanded at each given price, shifting the demand curve right or left.

Fishery management generally changes supply rather than demand, producing changes of types 1 or 2. The net change in all-or-none value produced by these types of changes is usually approximately the change in producer surplus (shaded area in Figure 6), hence our reasoning for the above rule of thumb. In any case, the value of management is the net willingness of consumers and producers to pay for the change.

ECONOMIC IMPACTS OF SPORT AND FOOD FISHING

This chapter lists our best estimates of Great Lakes fisheries' roles in providing business and employment in the Great Lakes region. We estimate both direct and indirect economic impacts. As before, we first present our estimates, then our sources and estimates of accuracy.

Government spending and private spending together define the level of economic activity in any region. Fisheries involve both. Consumers spent about $2 billion (measured in U.S. $) to fish for or to purchase Great Lakes fish in the region in 1985, including some $28 million (in U.S. $) in license fees and excise taxes. Much of this $2 billion was re-spent in the region by recipients. For instance, nearly all of the $28 million, plus an additional $26 million (in U.S. $) in public funds, spent by managers for Great Lakes fisheries was spent within the region. In all, some $4 billion per year in spending in the Great Lakes region is directly or indirectly attributable to Great Lakes fisheries.

Changes in the fishery can change the distribution of this spending throughout the region. Economic impact assessments estimate by how much and where, and how it translates into business reciepts, jobs and personal income.

Economic impact analyses usually complement benefit-cost analyses, rather than duplicating them. Benefit-cost analyses assess whether the taxpayers and feepayers get their money's worth. They assess the public's economic benefits and costs in a manner analogous to an individual deciding whether or not to buy or sell something. Economic impact analyses, rather than estimating the benefits

TABLE 8. Summary of estimated 1985 Great Lakes fisheries economic impacts. The range reported for angling economic impacts reflects uncertainty over the amount of angling activity.

Item	U.S.	Canada (U.S. $)	Total (in U.S.$)
Sport Fishery			
Angler spending (millions)	$1,710	$390($290)	$2,000 (range: $1,000-2,000)
Regional economic activity (millions)	$3,420	$780($580)	$4,000 (range: $2,000-4,000)
Employment (worker-years)	64,000	11,000	75,000 (range: 37,500-75,000)
Food Fishery			
Landed value (millions)	$15	$35($26)	$41
Final sales value in region (millions)	$49	$113($84)	$133
Total regional economic activity (millions)	$99	$228($171)	$270
Employment (worker-years)	3,300	5,700	9,000

and costs of decisions, instead estimate how businesses and residents in an area are impacted by the same decisions-say, by consumer decisions to shift their shopping from store X, downtown, to store Y in the suburbs; or by fishery changes that lead anglers to shift their spending from City A to City B. Economic impact assessments mainly help gauge implications for the economic health of particular locations, although they occasionally help identify some benefits and costs that are difficult to estimate by other means. Chapter I defined and interpreted these concepts in more detail.

In Great Lakes fisheries management, state, provincial and national governments are appropriately more concerned with benefits and costs, since they must decide which management activities are in the public's best interests, and levy the necessary taxes and fees. Local governments, businesses and some individuals are appropriately more concerned with economic impacts, since this determines their economic success. Economic impacts of Great Lakes fishery management are commonly felt at the local level, but are likely approximately offset by opposite impacts on other communities, businesses and individuals within the state, province or nation. Net economic impacts of local changes are likely very small at the state, province and national level because of these offsetting effects.

ESTIMATED ECONOMIC IMPACTS: ANGLING

Anglers spent $1 to $2 billion (U.S. dollars) in 1985 for angling for Great Lakes fish (Table 8). About half of this was spent for long term outlays for boats, vehicles and other angling-related equipment; and half for trip-related outlays for food, lodging, transportation, angling supplies and other trip expenses. Total spending averaged about $36.50 per angler day: about $17.50 for trip expenses and about $19 for long term outlays.

Canadian anglers spent $115 to $230 million (Canadian dollars) for long term outlays (U.S.$85-170 million) and $82 to $164 million (Canadian) for trip-related expenses (U.S.$60-120 million). U.S. anglers spent $435 to $870 million in long term outlays and $420 to $840 million for trip-related expenses.

The total impact of this spending on the regional economy is $2 to $4 billion (U.S. dollars). This means that if the sport fishery for Great Lakes fish were stopped and anglers reallocated their $1-2 billion spending to other purposes, up to $2-4 billion in business revenues (sales) would be lost by present businesses in the region. Much of this business activity would be shifted to other businesses and individuals in the region and other regions, depending on what the (former) Great Lakes anglers purchase.

About $.7 to $1.4 billion of this $2-4 billion, or about 35 percent, is personal income. Of this, $135 to $270 million is Canadian personal income (U.S.$100-200 million), and $600 to $1,200 million is U.S. personal income. About 37,000 to 75,000 worker-years were attributable to the sport fishery in 1985: 5,500 to 11,000 in Canada and 32,000 to 64,000 in the U.S..

SOURCES AND ACCURACY OF ESTIMATES: ANGLING ECONOMIC IMPACTS

Our estimate of spending is based on estimates of spending for angling for Great Lakes fish from the U.S. and Canadian national surveys of 1980 angling (Talhelm, 1988). Statistical errors in these surveys are less than 10 percent at a very high level of confidence. Statistical bias, however, is uncertain, because it is extremely difficult to ascertain. As mentioned earlier (page 18), there is some evidence that the actual amount of angling may be half or less of the amount estimated in these surveys. To allow for this uncertainty we present a range of estimates. The higher amounts in each range are based on Talhelm (1988); the lower amounts are half the higher amounts. These estimates were converted to 1985 dollars by multiplying by 1.309, the change in the U.S. consumer price index. Canadian dollars were converted to U.S. dollars by dividing by 1.35, the approximate currency exchange rate in 1985. Our resulting estimated total was $2.196 billion, including $1.236 billion for long term outlays. However, these long term outlays included equipment that was not necessarily even used for angling for Great Lakes fish. The surveys counted long term outlays for all angling-related equipment by all anglers who fished at least once in the Great Lakes, regardless of where the anglers intended to use the equipment. Therefore, we rounded the $2.196 billion total intended to use the equipment. Therefore, we rounded the $2.196 billion total (long and short term outlays) to $2 billion to more accurately reflect the purpose of the long term outlays. Our estimates of Canadian and U.S. long term outlays were adjusted proportionately.

Our estimated multiplier of 2, for converting direct spending to total economic impact, is based on several studies. In their detailed input-output model of northern Ohio's 1978 economy, Hushak, et al (1983), estimated that the multiplier for angler expenditures in that region was 1.82. A similar model for Ontario estimated that its impact multiplier for angler spending was at least 1.4 (Bedi, 1984). Cox (1979) reported an estimated multiplier for Ontario angler

TABLE 9. Estimated worker-years attributable to the Great Lakes food fishery, 1985.

Occupations	U.S.	Canada	Total
Fishing	300	500	800
Processing & Wholesaling	1,900	3,300	5,200
Secondary	1,100	1,900	3,000
Totals	3,300	5,700	9,000

spending of 1.88. These multipliers measure the number of times a monetary input into a regional economy is re-spent within that economy before the money leaves the region and its effects are dissipated.

Multipliers are larger for larger regions because larger regions provide more opportunities for spending. Multipliers for the entire U.S. or Canada may be around 2.5, whereas multipliers for local economies have usually been found to be 1.5 or lower. For instance, the national multiplier for U.S. saltwater angling was estimated to be 2.5 (Centaur, 1977).

The Ohio model (Hushak, et al, 1983) estimated that the ratio of total Great Lakes angling-related economic activity (direct and indirect) to worker-years was $53,426 (in 1985 dollars), and the ratio of total economic activity to personal income was .35 (ie, 35 percent). We used these ratios to estimate total emp1oymen.t and personal income effects.

ESTIMATED ECONOMIC IMPACTS: FOOD FISHING

The landed value of Great lakes food fish and kindred products in 1985 was an estimated $41 million in U.S. dollars (Table 8). Some 47 million pounds worth $33.7 million (Canadian dollars) were landed in Canada in 1984, mostly from Lake Erie; whereas 54 million pounds worth $14.9 were landed in the U.S. in 1984, mostly from Lake Michigan.

The final sales value of Great Lakes food fish was between $102 million and $164 million (U.S. dollars), or about U.S.$133 million. The total economic impact of the food fishery was between $205 and $328 million (U.S. dollars), or about U.S.$270 million in 1985. This means that if the food fishery for Great Lakes fish were stopped, and if consumers reallocated their $133 million to other purposes, up to about $270 million in business revenues (sales) would be lost. Much of this business activity would be shifted to other businesses in the region and other regions, depending on what the (former) consumers of Great Lakes fish purchase. If consumer spending in this case simply shifted from Great Lakes fish to other fish caught elsewhere, much of the $270 million in economic activity would shift to other regions of the U.S., Canada, and the world.

Roughly 9,000 worker-years were attributable to the food fishery in 1985 (Table 9).

SOURCES AND ACCURACY OF ESTIMATES: FOOD FISHING ECONOMIC IMPACTS

Reports of landed values for Great Lakes fish in 1984 were supplied by the U.S. Fish and Wildlife Service (1986) and the Ontario Ministry of Natural Resources (1986). These figures were converted from 1984 to 1985 dollars by multiplying by 1.038, the change in the U.S. consumer price index. Canadian dollars were converted to U.S. dollars by dividing by 1.35, the approximate currency exchange rate in 1985.

Our estimated combined value added and multiplier of 5 to 8, for converting landed value to total economic impact, is based on several studies in two stages. First, we estimated that the value added by processing, wholesaling, retailing and related activities was 1.5 to 3 times landed value. In other words, total spending on the final products was 2.5 to 4 times the landed value. Second, this amount is re-spent within the region, creating an indirect economic impact equal to the direct spending; in other words, a multiplier of 2. The combined total is 2 times 2.5 to 4, or 5 to 8.

(1) In their detailed input-output model of northern Ohio's 1978 economy, Hushak, et al (1983), estimated a value-added ratio of 3.9 for Ohio's Great Lakes food fish: $3.90 final sales value for each $1 of landed value. They also estimated a multiplier effect of 1.6 within northern Ohio, and an employment multiplier of 1.5. The employment multiplier estimates that the total number of worker-years in the region directly and indirectly employed in food-fishery-related employment is 1.5 times the number of worker-years directly employed in fishing, processing, wholesaling and related primary activities in the region.

(2) Bishop (1984) found a value added effect of just over 2 for Wisconsin's yellow perch fishery. He calculated that landed perch were worth about $1.50 per pound, or the equivalent of about $3.00 per pound of edible portion, and that the edible portion's value increased to $4.50 per pound wholesale and finally to $6.50 retail: a ratio of 2.17 ($6.5 / $3).

(3) Preliminary results of a study of the economic impact of Michigan's commercial fishery on Michigan's economy estimate a value added factor of about 2 and a multiplier of about 2, for a combined total of 4 (Menegay and Pierson, 1979).

(4) A study of the economic impact of the U.S. commercial fishing industry estimated a combined effect of about 7.4 (Centaur, 1977). Another study of the U.S. commercial fish industry estimated a value added factor of 4.2 in 1977 and 4 in 1978, but did not estimate the multiplier effect (U.S. Department of Commerce, 1979). We expect these national multiplier and value added factors **to be higher than regional factors, because the scope of the national economy is** larger. Regional impacts end when a product is transported out of the region.

Our estimated number of worker-years in U.S. Great Lakes fish harvesting was based on the U. S. Department of Commerce's (1977) estimate of 118 full time and 962 part time and casual workers in 1976. Since then, the reported U.S. harvest has declined by about a third, so we estimate that the number of full-time-equivalent workers in harvesting was roughly 300 in 1985. We estimated Canadian harvesting employment at 500, based on the estimated 1,587 workers (full time and part time) in 1979 and 1,505 in 1981 (Ontario Ministry of Natural Resources, 1983). If a similar 89 percent were part time, then 164 worked full time and 1,341 worked part time in 1981. Employment in U . S . Great Lakes region processing plants and wholesale plants was estimated at 2,130 in 1976 (U.S. Dept of Commerce, 1977) and at 1,954 in 1981 (U.S. Dept of Commerce, 1983). We rounded this down to 1,900 for 1985. Not all of this employment is attributable to Great Lakes fish because these plants are not restricted to Great Lakes fish, but we have no information about what proportion was Great Lakes fish. A proportionate number employed in Canada, relative to landed value, would be 3,300 worker-years. Finally, secondary employment, ie, employment resulting from the secondary economic impact of $133 million, was estimated to be half as much as the above primary employment, or 3,000 worker-years, based on Ohio's estimated employment multiplier of 1.5.

Other Fishery Economic Impacts

We have not been able to estimate the economic impacts of other Great Lakes fisheries-related activities. Notably absent are bait-fish harvesting, tourism other than its angling and food fish consumption components, and fisheries-motivated pollution control and habitat management. There may be significant others as well.

Government Expenditures and Revenues for Great Lakes Fisheries

U.S. state and federal expenditures for Great lakes fishery management and protection about equal Canadian provincial and federal expenditures, at about $30 million each, although in U.S. equivalent dollars the Canadian total is about $24 million (Table 10). However, the two nations differ greatly in their sources of revenues supporting these expenditures. The U.S. relies primarily on license fees and earmarked taxes, whereas Canada relies mostly on general revenue funds. This will change somewhat in Canada as Ontario's new resident angling license requirements take effect in 1987, with receipts earmarked for Ontario fishery management.

Table 10. Approximate government spending levels and sources of funds for Great Lakes fishery management in 1985

SOURCE	United States (millions of U.S. $)	Canada (millions of Can $)	Canada (expressed in U.S. $)
License revenue	$15	$4	$3
Earmarked taxes	$10		
General public funds	$5	$27	$21
Total spending	$30	$31	$24

Although some $5 million in the U.S. and $27 million in Canada in general revenue public funds were spent for Great Lakes fishery management and protection, anglers and food fish consumers contributed much more than that into the general revenue funds. We have no estimate of taxes paid by anglers and fish consumers, but if only 3% of their combined direct expenditures of about $2 billion (U.S. $) were in taxes, say a 3% sales tax rate, they would have contributed $60 million. Businesses, workers and owners also pay additional taxes on their incomes.

The estimates in Table 10 are rough approximations. Although some federal funds are spent solely for Great Lakes fishery purposes, most state and provincial expenditures are not clearly separable between Great Lakes and other fishery purposes. For instance, biologists, administrators and law enforcement officers often divide their time between Great Lakes and other fishery matters as needs dictate. Therefore, instead of directly estimating these figures, the rough approximations from Talhelm, et al (1979, p. 5) were converted to 1985 dollars by multiplying by 1.48, the change in the U.S. consumer price index from 1979 to 1985. Talhelm, et al, arbitrarily divided fisheries management expenditures and revenues between Great Lakes and other fisheries, based on limited indicators.

Further research is obviously needed into this topic.

OTHER ECONOMIC VALUES OF GREAT LAKES FISHERY RESOURCES

Several other kinds of values derived from fishery resources may also be important in resource management, beyond the sport and food fishery values we have already described. These are summarized in Table 11. Most are difficult to quantify, and difficult or impossible to observe. Few have been scientifically estimated, but those we discuss below have probably all been included in some way, at least informally, in some past management and political evaluations. Of the values described below, the only one for which Great Lakes fisheries values has been estimated is existence value, and those estimates are based only on initial exploratory studies.

These aspects of the resource are important enough to some people that either they would be willing to pay for them if necessary, or they would not be willing to forgo them without some significant compensation of some kind. For example, some people who do not directly use the Great Lakes in any way still find it important that Lake Erie is not “dying.” Some of these people are willing to pay or to give up some economic opportunities solely to know that Lake Erie and its fish populations are “healthy.” For another, even more obvious example, some people who do not fish enjoy seeing fish. Many Great Lakes communities enjoy significant levels of tourism by people who come to watch fish and/or fishing. We can even measure costs people incur for this purpose. We caution that the types of values listed below may not include all aspects of Great Lakes

TABLE 11. Fishery economic values other than for sport and food fishing.

Existence values (ie, value of preventing extinction)	Perhaps same order of magnitude as combined resource values above
Option values (ie, value of insuring future use)	Small percentage of combined resource values above
Ecological values (ie, contribution from role in ecosystem)	Ecosystem values at risk
Passive use values (ie, indirect uses such as viewing)	Up to same order of magnitude as combined resource values above
Social equity values (ie, value of fairness in public choice)	Perhaps small or moderate percentage of combined resource values above
Social goals values (ie, contribution to other social goals)	Perhaps small percentage of combined resource values above
Employment value (ie, value of labor or capital that would otherwise be unemployed; negative if unemployment is increased)	Often important locally, but usually offset by opposite impacts elsewhere in the economy, leaving little or no net economic contribution

fishery values, and that these types of value could overlap if not carefully defined.

As discussed in the Introduction, the economic value of anything is the amount buyers would be willing to pay for it, and the amount for which sellers would be willing to sell it, even if actual markets do not exist. All aspects of the fishery resource that people are willing to pay for are part of its economic value.

Existence and option values evaluate some of the uncertainties the public has about the importance of irreversibility in decisions about fisheries and related ecosystems. Other major uncertainties fall in the other categories. Uncertainty about ecological relationships, and therefore about present and future ecological values, is a prime example.

UNREVEALED VALUES: EXISTENCE VALUE AND OPTION VALUE

Unrevealed values are a peculiar subset of non-market values. As we have seen (Introduction and Appendix), consumer choices in free markets establish economic values. Economic values are not readily available for non-market goods-those goods and services not freely traded in markets-but many non-market values can be deduced from consumer and producer behavior. Sport fishery values and food fishery resource values fall into this category. Unrevealed values are non-market values we cannot deduce from consumer and producer behavior. Consumers normally have no choice about them. They receive these positive or negative values whether they want them or not, without allocating any money, time, travel or other resources. With or without the good the consumer's external behavior is exactly the same. For instance, two unrevealed values that may be important in Great Lakes fisheries management are existence value and option value. The only methods we have for estimating unrevealed values are contingent valuation techniques.

Even though Great Lakes fisheries may have important existence and option values, these values are rarely affected by day-to-day management choices. Both are inherently all-or-none values: Something either exists or does not. If existence is not in question, these values change little or not at all. Thus, managers rarely need to estimate existence or option values. When managers do need to estimate them, to evaluate projects like rehabilitating major fisheries, they will probably find that the values reasonably reflect what they already sense about public attitudes toward the existence of important fishery resources.

Existence value may be defined as willingness to pay to maintain the existence of a good (and willingness to accept compensation for loss of its existence), apart from any direct or indirect use of the good. The concepts of existence and uniqueness (of a good) are critical components of this definition.

For instance, if Lake Erie died it would still exist. It would be nutrient enriched and oxygen deprived, such that many of the organisms that now live there would no longer be able to do so. In short, the lake would become a "stinking mess." Apparently the world-wide support for saving Lake Erie was not really existence value for Lake Erie, but existence value for Lake Erie's health. One could easily argue that Lake Erie's health is unique. However, this raises the troublesome question: What is a unique good and what is not?

Uniqueness and similarity are products of the human tendency to generalize. In some respect each plant and each animal is unique, including single-celled plants and animals. Similarly, each square inch of the earth's surface, each snowflake, and each apple, banana and can of baked beans is unique. Humans have developed classification systems and names for plants, animals, chemicals, lakes, oceans, goods, services and economic values to help us organize our lives. We define things as unique if it is important to us to distinguish them from everything else. This suggests that we could arbitrarily define uniqueness - either uniqueness in demand or uniqueness in supply-as the degree of substitutability of one object for another. For instance, should we be more concerned with the existence of an individual lake trout, of a particular race of lake trout, or of the lake trout species, or of salmonids in general? It is a matter of perspective. If our perspective is lake trout as a species, the individual races may be substitutable for each other in our mind. Certainly, the harvest of an individual lake trout would have no particular significance in existence value for the species unless it had some impact on the survival of the species.

This definition of uniqueness implies that virtually anything could have some existence value. The degree of substitutability of an object for all other objects in the eyes of the consumer would partially determine the magnitude of its existence value. If it were someone's pet, we could agree that even an individual lake trout is unique enough to have some existence value.

Uniqueness in the sense of an object's replaceability or irreplaceability also influences existence value. The Statue of Liberty is unique among art objects, but our ability to replace it limits its uniqueness in supply, and therefore limits its existence value. No object is exactly replaceable in the physical sense, but most objects are partially replaceable for human purposes if we are willing to pay enough.

The existence of something is one of a larger class of goods and services economists call pure public goods, or, more precisely, indivisible goods. *Indivisible goods* are goods that cannot be divided between individuals: All individuals receive the services of the goods whether or not they respond in any way to the good's presence. National defense is a classic example. It cannot be divided among recipients. Indivisible goods are called pure public goods because once they are produced, by their nature they are automatically received by the public. Indivisible goods are usually provided by government or by people who believe they are acting in the public interest, because otherwise people have no incentive to produce these goods. Existence and pure social equity (below) are both indivisible goods.

The value of the existence of unique, irreplaceable things-like the existence of a. healthy Lake Erie-is measured in terms of aggregate willingness to pay (or willingness to sell) purely for their existence. Again, this type of value is not relevant to most management evaluations, but may be extremely important in cases in which the existence of unique, irreplaceable fishery resources or fishery uses is threatened. It would be relevant in the decision to rehabilitate Lake Erie, but probably not in the decision to reduce an individual source of pollution in the lake. (For further discussion of existence value concepts, see McConnell, 1983, Randall and Stoll, 1983, and Talhelm, 1983.)

Few Great Lakes fisheries existence values have been estimated. Talhelm and Grether (Grether, 1984) estimated that existence value roughly equaled use value (ie, value of angling and viewing uses) for Great Lakes lake trout. Comparisons were inconclusive, but the existence value of sturgeon was generally close to that of lake trout, whereas its use value was generally much lower. They caution that the study was exploratory; the sample was small and not widely representative, including only a few residents of Ingham and Bay Counties, Michigan.

Option value is the value of an option that keeps available the possible future use of a good, apart from the expected value of future use of the good. *Option* price-the expected value of future use plus option value-is much like the price of insurance. For insurance, we pay the expected value of loss of future uses plus an additional sum representing our willingness to pay for risk reduction. The value of ecosystem rehabilitation, for example, may be greater than the value of expected future use if the rehabilitation gives people more confidence in the future availability of expected future use and possible other uses, even though they may not be sure whether they will need the uses in the future. The value of the increased confidence and flexibility is option value. Option value is not necessarily positive, because people sometimes prefer risk. For instance, state-run lotteries that return only about half the price of the tickets in winnings are highly popular: People pay a premium for risk taking.

Judging by the insurance market, option value probably amounts at most to a small percentage of resource value.

Quasi-option value is the value of information gained by delaying an irreversible decision. This value is observable ex *post facto.* Quasi-option value may be important in decisions such as those about rehabilitating and maintaining fisheries and ecosystems, introducing exotic species, and preserving endangered species.

Ecological Values

Fish and fisheries have certain ecological values, in that their roles in the Great Lakes ecosystem may cause certain beneficial or detrimental effects on people. For example, salmon in Lake Michigan apparently enhance beach-use values by reducing alewife populations, thereby eliminating the massive alewife dieoffs that once fouled Lake Michigan's beaches. Alternatively, fishing might have been able to provide the same benefit by harvesting large numbers of alewife. We differentiate ecological values from others only to emphasize the ecological interconnectedness of fisheries with other aspects of the aquatic environment. The economic theory and estimation methods for ecological values differs little from other market and non-market economics.

Passive Use Values (eg, scenic, historic, and vicarious uses)

Fisheries have historical values, particularly commercial fisheries: People occasionally enjoy seeing history in action-such as an old fishing village or fishing tug. Closely related are values the current commercial and sport fisheries have to spectators who just enjoy watching. Fish have similar values to spectators. People even marvel at some dead fish. Finally, some people vicariously enjoy the thrill and challenge of sport and food fishing. Parents and grandparents are particularly known for their vicarious values. Passive use valuation methods are basically the same as recreation valuation methods; the passive uses are viewed as forms of recreation.

Social Equity

People are concerned that resources be used fairly and equitably, and that public choices treat people fairly and equitably. The economic question is, how much does fairness count in decision making in addition to other values? That is, how much are people willing to pay for it: How much in economic benefits are we willing to forgo for the sake of equity?

Economic values depend upon willingness to buy and sell. Sometimes this willingness is influenced by the equity consequences of our choice. For example, people boycott South African products. More often, however, we buy or sell something solely on its merits relative to our personal needs, ignoring equity consequences. Thus equity evaluations of this type are usually distinctly separate from economic values observed in the market. Many equity values of this nature might be estimated with contingent valuation methods.

However, another type of equity consideration is thoroughly intertwined with willingness to buy and sell: Our ability to buy and sell is strongly influenced by the existing distribution of income and associated rights. If this income distribution is inequitable, then all economic values are to some degree inequitable.

Economists are usually not able to completely assess equity values, in part because all economic values are already influenced by income inequities. This concern has plagued economists and philosophers for centuries; they have not yet devised scientific or objective methods of estimating equity values.

Equity values influence all of Great Lakes fisheries resource management, especially decisions about allocation, regulation, law enforcement, license fees and fisheries-related taxes. Equity values are almost always separate from and additive to the values used in benefit-cost analyses, and almost always partially defy objective measurement.

Social and Individual Goals

Sometimes fisheries influence our ability to attain broader social or private goals in ways not reflected in our direct willingness to pay for fisheries. For example, we might (1) develop fisheries in some locations rather than others to promote certain favored patterns of regional economic growth, (2) favor rules and regulations that promote small rather than large businesses because we think small businesses offer greater economic independence, or (3) subsidize fisheries that we think might increase cultural diversity, decrease crime, or promote better public health. Some of these implied values are similar to social equity values, above.

SUMMING IT UP: HOW DO WE EVALUATE THE TOTAL PUBLIC INTEREST?

Benefit-Cost Analysis

Consumers often compare costs with benefits. If expected benefits are great enough, relative to other possible uses of the money, buyers decide to pay the purchase price. The buyer anticipates being better off with the good than with any other use of the money under existing circumstances.

Similarly, sellers sell when the money is more attractive than retaining the item. Compensation is at least adequate-deemed the best choice under the circumstances.

The fact that a transaction is voluntary implies that all participants-buyers and sellers-expect to be better off, or at least no worse off.

Benefit-cost analysis asks basically the same questions buyers and sellers ask themselves in the market, only simultaneously for a collection of individuals rather than for just one individual. All who expect to receive any benefits are equivalent to prospective buyers in the market; whereas costs for the project are equivalent to the costs borne by the sellers who produce the product for sale. The benefit-cost question is: Would those who benefit still be better off if they had to pay all costs and compensate all others who would have been made worse off?

This would normally be true if benefits exceed costs. If so, we can say the project is clearly desirable on the basis of market criteria (ie, the "potential Pareto improvement" criterion): It would be possible (ignoring transactions costs) to distribute project costs and benefits in such a way that no one would be worse off and some may be better off as a result of the project.

In the public sector, however, choices are imposed on citizens without this particular distribution of costs and benefits. As a result, usually some people gain and others lose. For instance, when tax dollars or license fees pay for fish stocking programs, some anglers or fish producers may benefit far in excess of their tax/fee costs, whereas others who pay may receive little or no benefit, or even negative benefits.

The point is that benefits-public willingness to pay for a project-summarize economic advantages. Costs-public willingness to accept compensation for producing (and tolerating) the project-summarize economic disadvantages. If benefits exceed costs, we can objectively say that the choice increases aggregate economic well-being in the sense that some economic benefits would still remain after all producers and other losers were adequately compensated. However, the implications of any redistribution of economic well-being between particular individuals is ignored.

Competitively-determined market prices, if available, directly estimate willingness to pay and willingness to accept (to sell), since each price is determined by the simultaneous forces of demand and supply. Thus, if all or part of a public project is a market item, local market prices are generally appropriate. For example, estimates of construction costs, labor costs and costs of supplies are usually easily available.

Most fisheries management costs are easily estimated from such market data. However, occasionally some costs are not. For instance, non-market costs may result from the ecological effects of introducing exotic species; the side effects of sea lamprey treatments; and water pollution from fish hatchery effluents. Benefits, on the other hand, are rarely obvious: Neither angling days nor the sport and food fishery resources are bought and sold. For a more detailed discussion of benefit-cost analysis of fisheries management projects, including discounting and other such details, see Everest and Talhelm, 1982.

Usually the most difficult job in benefit-cost analysis is estimating willingness to pay and willingness to sell goods or services that are not bought or sold in the market. Analysts must carefully define the specific products to be evaluated, then estimate willingness to pay or to accept, equivalent to market values. For instance, the benefits to anglers of a specific fish ladder project are the net willingness of anglers to pay for the resulting change in angling opportunities. What are the specific changes (the products of the fish ladder)? A fish ladder may bring closer to some anglers, fishing opportunities similar to those available elsewhere. It may also change the angling quality previously available downstream and upstream of the ladder. Some anglers would respond by fishing here rather than elsewhere, but others, who prefer the angling formerly available, may go elsewhere or fish less. Thus, we must estimate angler willingness to pay to have angling opportunities brought closer, plus angler willingness to pay for changes in the quality of existing opportunities. In this report we refer to these values collectively as the value of management; the value of the fish ladder project in this case. Other values in this report-all-or-none values and angler expenditures-do not evaluate willingness to pay for particular projects such as these. Likewise, angler willingness to pay for the project is not evaluated by angler expenditures associated with the change in angling-either total expenditures or the change in total expenditures.

TOTAL VALUES ASSESSMENT

The idea of benefit-cost analysis in the public sector is to estimate whether the public would be better off with or without each particular expenditure of public funds. The compensation test discussed above is a clear, objective test of project economic benefits and costs: If gainers' willingness to pay is at least great enough to pay all costs (ie, to potentially compensate all "losers"), then benefits clearly exceed costs. However, it should be clear from the above discussion that even if measurement difficulties are overcome, benefit-cost analysis is incomplete as a decision making tool. Some important social benefits and costs are not included.

One of the "hookers" in benefit-cost analysis goes back to the compensation test itself. In public choices, gainers do not actually compensate the losers. The analysis only estimates whether they could, under given circumstances. In reality, virtually all such projects redistribute "well-being" among members of the public: Some people gain and some people lose. The market considers the benefits or costs of income redistribution poorly, if at all. Yet it is part of the broader public interest. Further, some other public interests are also ignored by the market. Therefore, our market equivalent test may insufficiently reflect the whole of the public interest in public decisions. If public choice is to be more than an economic assessment, these broader public interests must be considered.

Since they are incomplete, do benefit-cost and economic impact analyses help or hinder public decision making? Benefit-cost analysis is even incompatible with economic impact analysis. The two could easily disagree, because they evaluate different things. How, then, can decision makers use these highly-rigorous analyses, then add any appropriate missing pieces with their appropriate weights, to arrive at a thoroughly evaluated decision?

It is not possible to scientifically assess all of the elements to arrive at a single best solution, in part because such decisions require allocating and reallocating income, power and rights in our society. However, it is possible to improve our ability to assess choices, and to better understand the meaning of these assessments in social choice processes. A current project of the Great Lakes Fishery Commission, called Social Assessment of Fishery Resources, is asking social scientists and managers to consider economic and social evaluation questions further, and to develop better procedures and guidelines for Great Lakes fishery managers and other decision makers. One of that project's recommendations is for scientists from all of the social science disciplines to work together to develop methods that more-completely assess choices in fisheries, and for them to more-directly assist fishery managers in using methods and results now available. Here, let us simply illustrate appropriate roles of benefit-cost and economic impact analyses in fisheries decision making.

Assume, for example, that we propose to move salmon stocking sites from one river to another. Biologists think this will increase salmon stocking survival rates, although stocking costs will increase. According to our economic analyst, we can expect 20,000 angler days of salmon angling effort per year to shift from community A to community B as a result, and total angling effort to increase by 5,000 angler days. We also expect annual angler expenditures to decrease in community A by $500,000, and to increase in community B by $490,000. Angling will become less expensive because the new location is closer to more people. The angling success rate will remain high due to the increased stocking success. Total annual economic impacts would be about $900,000 (negative) and $880,000 (positive) in gross sales levels in communities A and B, respectively, when secondary effects are included. No information is available to indicate how quickly employment and businesses in the communities would adjust to the change. Both communities have more than average unemployment. Our economic analyst also estimates annual net benefits to anglers of $115,000, and annual costs to the Department of $12,000. In other words, anglers would be willing to pay up to $115,000 to have the stocking sites moved. When word of the proposal gets out, an angry delegation from community A-of anglers, business leaders, and city, county and state/provincial elected officials-requests an urgent meeting with the Natural Resources Department Director. How would the economic analyst interpret this information for the Director?

- The benefit-cost analysis indicates that the public on the whole would be much better off with the change. More high-quality angling would be produced at a lower cost to anglers. Economists think of this as an increase in economic efficiency due to improved use of resources, whereas fishery managers think of it as a fuller use of fishery resources. The benefits may not be as great in the first few years of the project, until B develops the infrastructure needed to serve the anglers.
- The economic and social costs of shifting economic activity from A to B have not been included in the benefit-cost analysis. Apparently the net effect on the region is slight, because the advantages to B nearly equal the disadvantages to A. The $10,000 decrease in total angler spending will appear elsewhere in our state/provincial or national economy as anglers reallocate their savings to other things. Although unemployment in A may increase, it may decrease a similar amount in B; both have unemployment problems. Again, the net effect may be slight. A net increase in unemployment would reduce project benefits, whereas a decrease in unemployment would increase project benefits.
- This analysis tends to gloss over the injury felt by residents of A. Even though the analysis shows they could do so, the gainers at B will not actually compensate the losers at A. Income and employment will actually be redistributed from residents of A to residents of B. Sociological and

psychological studies show that income losses are felt much more severely than equivalent gains, implying that a one-for-one shift of economic activity may still produce a net social loss. Shifting the economy more gradually may lessen the negative effects.

- B's economic recovery is given a boost, whereas A's is given a boot. As a result of the increased angling quality, B may also attract other economic growth in the future. This growth may improve the economic, social and cultural aspects of B's quality of life, although it may also bring with it some of the disadvantages of increased tourism and economic growth, especially if the residents do not carefully manage the growth. This effect is also not evaluated in the analysis, but instead left to the decision-making process.
- Other factors that should be considered are whether the public as a whole will benefit in other ways (eg, by helping or hindering regional development plans) by shifting economic growth from A to B, and whether the shift will increase or decrease economic and other inequities. Again, this evaluation is left to the decision-making process.

In sum, our analysis shows that the angling resource will be more fully utilized, because benefits exceed costs. The $12,000 per year expenditure for the shift in stocking is justified on economic efficiency grounds. As high quality angling is shifted from A to B, economic growth and related social changes will be shifted as well. Significant negative impacts will be felt at A until A's economy readjusts.

The decision maker must decide for the public whether the net effects of all factors not included in the analysis outweigh the estimated net economic benefits. Perhaps the most difficult aspect of this for the decision maker is weighing the impacts of explicit and implicit reallocation of income, power and rights between individuals. At a broader level, perhaps unconnected with this particular decision, the public and its representatives must also consider other factors such as ethics, social ideals, social norms, impacts on our overall way of life, and how well existing administrative, legal and political structures are managing such social choices.

CONCLUDING COMMENTS

We have emphasized here that economic analysis can describe public preferences for Great Lakes fisheries uses, resources, and management, relative to public preferences for market goods and services. Economic analysis can also describe the roles of fisheries uses in national, regional and local economies, and predict how these roles will shift if fisheries uses change.

We have also tried to make it clear that economic analysis is still only a partial analysis, for several reasons. Economic analysis can generally estimate most of the major benefits and costs reasonably well, but some others it can not estimate well or at all. First, economic analysis generally can not estimate most of the social equity values associated with the distribution of wealth, or with particular distributions of project benefits and costs among the public, At best, it can describe some of these effects. Second, economic analysis cannot evaluate most other social impacts. Third, major changes, social or ecological, are difficult to evaluate by any means because so many variables change simultaneously, including economic units of measure (relative economic values).

Sociologists, anthropologists, political scientists and others can contribute significantly to many of the areas not covered well by economics. However, much work remains before the social science disciplines can significantly integrate their contributions, to more completely assess public preferences. If integrated assessments were easily understood and inexpensive, they might significantly improve public sector decision making processes.

This type of integration is an important area for current and long term research. Researchers and the resource management community can both benefit by working together in developing these methods. The U.S. Forest Service seems to have the lead in developing such assessments, in its forest planning process and associated impact analysis. They develop a few alternative scenarios, and evaluate in parallel the economic effects and social effects of each scenario. The Great Lakes Fishery Commission has also contributed to integration with its Great Lakes Ecosystem Rehabilitation project and its Social Assessment of Fisheries Resources project. The GLFC is currently attempting to improve the applicability of integrated social science research to Great Lakes fishery management in a few other small projects, including one effort with the Lake Michigan Committee that would coordinate and help guide the small social science components of management-related research conducted by the four jurisdictions on Lake Michigan.

Beyond this, some priority economics research needs are:

1. Better means of assessing the values of specific changes in Great Lakes fisheries resources or their uses (ie, management values). This includes market research to better identify non-market products (particularly angling) and user segments.
2. Some initial assessments of existence values, option values and ecological values for Great Lakes fisheries resources that are or might be in jeopardy.
3. Estimates of passive-use values of Great Lakes fisheries.
4. Verification of economic value estimates for non-market goods, including better assessment of the value of time in travel cost models.
5. Assessment of biases in estimates of the uses of the Great Lakes fishery resource, particularly angling use. Estimates of angling from creel surveys, mail surveys, telephone surveys and household interview surveys differ substantially, and no one knows which type is most accurate. This type of error is the greatest contributor to the wide range of uncertainty surrounding the angling values reported here.
6. Additional rigorous analyses of economic values and economic impacts of Great Lakes fisheries would improve the reference results and working models needed to help the administrative, legislative and judicial branches

of government, and others, evaluate public choices in fishery management, policy and protection. Economic simulation models capable of evaluating a wide variety of possible choices would be particularly useful.

Finally, we urge better use of the economic information and methods already available. While there are some notable exceptions, the public sector - administrative, legislative and judicial-generally either fails to use or misuses economic information. The major problem here seems to be a communication gap. Administrators, legislators, and judges and lawyers are generally not trained in economics. Further, they have made few efforts to include economists on their staffs, or to consult with economists at appropriate times. For their part, economists are often more oriented toward talking to other economists. They have difficulty communicating with managers. Other social sciences are also not used effectively for the same reasons.

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APPENDIX
VALUATION OF NON-MARKET GOODS

Willingness to Pay vs Willingness to Sell

We often think of the economic value of the fishery resource as the willingness of users to pay for their uses of the resource; or, in other words, their willingness to buy property rights to the resource if necessary. Yet, for every market transaction there is both a buyer and a seller, who together establish the market price. If the property rights rest with the public trust, then the value of the resource is some value between the maximum willingness of users to pay and the minimum prices at which "the public trust" is willing to allow the uses. At present the public trust permits angling and food fishing at nominal prices so low that economists consider angling and food fishing to be non-priced goods ("non-market" goods).,

Another viewpoint, equally valid in economics, is that if users hold the property rights to their uses, they become sellers rather than buyers; they must be paid to give up any present uses. For instance, polluters would have to compensate anglers for fish killed by pollution. The value of the fishery resource would still be established by the willingness of buyers to pay and sellers to accept payment, but we would be estimating the minimum willingness of users to accept payment to forego their uses and the maximum willingness of others to bid away those use rights.

This report assumes for simplicity that users are buyers rather than sellers, so our explanations are written in terms of willingness of users to pay. However, willingness to sell could be more appropriate in some circumstances, and studies generally find willingness to sell higher than willingness to pay.

Estimating Fishery Resource Values vs Fishery Management Values

The most common scientific method for estimating fishery resource values is to derive the fishery resource values (which we cannot observe) from the demand and supply equations for fishing (which we can observe), using some assumptions about the conditions under which a real market for the resource would operate. The general idea is that if we can observe how fishing activity responds to cost increases, we should be able to predict how users would respond to fees charged for using the resource, and/or how much users would have to be paid to voluntarily reduce their use. These hypothetical user fees and payments mimic the prices for the resource we would observe if the resource itself were bought and sold.

These demand and supply equations are estimated from the variation in prices and quantities of food fish over time, and from the variation in costs and quantities of angling from location to location and over time. The latter method, for angling, is known as the travel cost method. One of the major difficulties with the travel cost method is that time is a major cost of travel and participation in angling, but it is not easy to evaluate this cost in dollar terms. The value of travel time is critical if we are to use observed costs to predict additional angler willingness to pay. If, for example, we assume time has zero dollar value, then our demand equations will predict that anglers respond to fees as if they were identical to additional monetary travel costs. If time really is a factor in angler decisions, this assumption of zero time value would lead us to overestimate reductions in angling effort if fees were imposed. The market value of time is the wage rate (after income taxes), but many studies suggest that people value travel time at a lower rate. Economists still debate the appropriate values of leisure time in the travel cost method.

Another method is to ask users in a more direct way how much they would be willing to pay to use the resource, or how much they would have to be paid to reduce their use. A kind of bidding game for this purpose, known as contingent valuation, is gaining acceptance among economists.

The values of hypothetical choices estimated by either method should be treated with appropriate caution. These methods are valid, scientific approaches to estimating values equivalent to market values under non-market conditions. However, they can easily be misunderstood, and often are, partly because of the complex roles of necessary assumptions about the exact nature of the choice being evaluated: Exactly what is being (hypothetically) bought and sold, what is assumed about the prices and availability of substitutes and all other goods and services, and are there other special assumptions about the sale?

Valuation of non-market goods and services is further complicated by the fact that the products-the goods and services we wish to value-are not easily defined. No market exists to define and label the subtle varieties of products available. For instance, countless varieties of angling are found in the Great Lakes. Fish species and sizes, angler success rates, angler location (shore, surf, pier, boat; bay, islands, near shore, off shore, shallow, deep; rocky, sandy; cold water, warm water, thermocline depth; etc), crowding, noise, and many other factors help define the angling experience.

What is the value of changing the angling at a given location from one variety to another? How much should managers spend to influence the quality of the angling experience, say, by manipulating fish numbers in certain areas? To find out, we must start by defining the types of angling available. Economists begin any demand or supply analysis by defining the goods or services for which demand or supply are to be estimated. Once we define the angling products, we can estimate the demand and supply of each, and derive the economic values of each variety, as mentioned above. The value of the managers' effort would be the change in value caused by the change in angling variety,

Research has verified that Great Lakes angling values vary greatly with angling quality (eg, Talhelm, 1973,[1] 1981; Samples and Bishop, 1983; Hushak, 1984). Further, the same research has shown that Great Lakes angling resources that are equivalent in quality still differ in value from one location to another, and from one season to another.

An active market for Great Lakes angling and food fishing-with competitive prices charged and paid for angling and for food fishing-might have given us much of the same information. Markets not only define the varieties of goods, but also tell us the economic value of each variety at each location. Markets for angling use of fishery resources exist in some parts of the world, notably in the United Kingdom. There, anglers pay some U.S.$200 or more in various stream angling access fees to owners of fishery property rights per Atlantic salmon caught. The amounts vary with angling quality and location. However, imperfections in these markets still limit our ability to interpret this information.

This lack of market information leads many to confuse the value of angling and food fish harvesting with the values of the fishery resource. In contrast, markets easily differentiate between such values-the value of a hundred bushels of corn vs the value of the farm land resource, for example. Angling and food fish are products of the fishery resource, just as corn is a product of the farm land resource. In each case, the value of the resource is derived largely from the values of the products. For instance, in recent years we have seen farm land values drop in response to lower prices for farm products. However, because the land resource is sold separately from its products, it has a distinctly separate value. This report provides estimates of both the values of angling and food fishing, and the values of the fishery resource. We hope to clearly distinguish between the two.

Further, and even more troublesome, this lack of definition leaves most people confused between the value of the resource and its products on one hand, and the amounts of economic activity associated with producing the products on the other hand. The economic activity is the economic impact of the use of the resource (see chapter III). A simple explanation of the difference may be seen in the corn example: The economic impact of corn culture is the value of the total market transactions for the product (ie, total sales value), plus secondary market transactions associated with that payment; whereas the economic value of the agricultural resource-the price of the land-is basically its profitability (total value of the product minus production costs other than the cost of the resource) for its most profitable products over the remaining life of the resource discounted to present time. This profitability is also called economic rent.

Estimates of the all-or-none value of the fishery resource are often the goal of economic studies. However, other than helping us understand the overall

[1] Talhelm, Daniel R., 1973. Defining and evaluating recreation quality. Trans. North Am. Wildl. and Nat. Resour. Conf.. 38:183-191.

importance of a fishery, its all-or-none value has little practical use. It is analogous to the total value of all real estate in North America if it were bought and sold as an all-or-none package. This would give us little insight into actual choices; say, the value of constructing a home on the shore of Lake Superior.

Further, the all-or-none value of real estate per unit of real estate would be a crude, misleading guide to the value of this home. Similarly, the all-or-none value of the fishery per angler day, a figure often used by economists and managers, is also a crude, misleading guide to fishery management values. Individual real estate values vary widely, and so do fishery resource values, for basically the same reasons. Even more misleading is the fact that all-or-none values are higher per unit than normal market values. As explained in Chapter I, all-or-none sales are equivalent in value to ransom payments; the highest possible willingness to pay rather than go entirely without.

A better, but still crude, way of estimating the value of this home construction would be to estimate how much the addition of the home would add to the total value of real estate in North America. Sometimes we must estimate fisheries management values in an analogous manner. However, an even better, more direct approach to estimating values of particular choices at particular locations for real estate and for fisheries is to deduce the values from understandings of local demand and supply conditions. (For details on these methods, see, for example, Freeman, 1979,[2] Sinden and Worrell, 1979,[3] or Talhelm, 1984.)

[2] Freeman, A. Myrick, III, 1979. The economics of environmental improvement. Johns Hopkins Press, Baltimore, MD.

[3] Sinden, J. A., and A. C. Worrall, 1979. Unpriced values: decisions without market prices. Wiley-Interscience, NY.

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