CURRENT ESTIMATES OF GREAT LAKES FISHERIES VALUES:

1979 STATUS REPORT

Daniel R. Talhelm, Michigan State University
Richard C. Bishop, University of Wisconsin-Madison
Kenneth W. Cox, Fisheries and Oceans Canada
Norman W. Smith, Ontario Ministry of Natural Resources
Donald N. Steinnes, University of Minnesota-Duluth
Archibald L. W. Tuomi, Fisheries and Oceans Canada

1451 Green Road
Ann Arbor, Michigan 48105
December 1979

The Great Lakes Fishery Commission was established by the Convention on Great Lakes Fisheries, between Canada and the United States, ratified on October 11, 1955. It was organized in April 1956 and assumed its duties as set forth in the Convention on July 1, 1956. The Commission has two major responsibilities: the first, to develop coordinated programs of research in the Great Lakes and, on the basis of the findings, recommend measures which will permit the maximum sustained productivity of stocks of fish of common concern; the second, to formulate and implement a program to eradicate or minimize sea lamprey populations in the Great Lakes. The Commission is also required to publish or authorize the publication of scientific or other information obtained in the performance of its duties.

FOREWORD

Decisions affecting Great Lakes fisheries will continue to be made incorporating economic impact and benefit-cost as major considerations. The lakes and fisheries have little chance to come out ahead if fishery economic values are the sole consideration in decision making when weighed on a site specific basis against large scale industrial, power-producing, or commercial programs. There are many other benefits associated with thriving populations of desirable, wholesome fish, and these must also be evaluated and considered in the decision train along with the direct and indirect economic activities. Associated benefits are sketched as "other values" on pages 8 and 9 of this report.

The Great Lakes Fishery Commission is approaching the question of evaluating Great Lakes fisheries and their associated benefits from two directions. The first approach involves traditional economics and is short-term in nature. This status report is an example. The Commission contracted with Dr. Talhelm to produce quickly a current evaluation of Great Lakes commercial and recreational fishing in both Canada and the United States based on existing information. The result is intended to serve as an aid towards identifying economic data gaps and research needs, and in planning future programs which will better evaluate Great Lakes fisheries. The report also spans the two directional approach of the Commission towards the question of evaluating associated benefits and long term needs. The Commission will forward this report to its cooperating agencies for review and reaction. Their comments will be evaluated in the Commission framework of the Scientific Advisory Committee (SAC), the Great Lakes Ecosystem Rehabilitation (GLER) project team, the authors of this report, and by Lake Committees, and reported to the Commission.

These groups are also charged to inspect the long term economic data needs and to recommend ways to evaluate the benefits associated with having thriving populations of desirable, wholesome fish throughout the Great Lakes system.

The Commission had a second objective in mind in asking Dr. Talhelm for a status report - - bringing Great Lakes fishery economists together on a common project. Talhelm's cover letter to the team states in part," It is valuable to assemble what we know about Great Lakes fisheries economics. If nothing else, it forces us to look at how skimpy our information is and provides us with a list of what needs to be done in that area. It also has provided a good start for what I hope will be a long and fruitful working relationship between ourselves, and hopefully to include others interested in Great Lakes resource economics." An excerpt from his letter of transmittal to the Commission stated the project "provided a valuable opportunity to work with several colleagues in the region, and the experience has probably benefited us all. This and the GLER project have apparently established the beginnings of a useful network of economists interested in Great Lakes fishery economics." The second objective was achieved very easily: rapport has been established and interest is high.

Carlos M. Fetterolf, Jr.
Executive Secretary

CURRENT ESTIMATES OF GREAT LAKES FISHERIES VALUES: 1979 STATUS REPORT[1]

Daniel P. Talhelm, Richard C. Bishop, Kenneth W. Cox,
Norman W. Smith, Donald N. Steinnes, and Archibald L. W. Tuomi[2]

Citation--Talhelm, D. P., R. C. Bishop, K. W. Cox, N. W. Smith, D. N. Steinnes, and A. L. W. Tuomi. 1979. Current estimates of Great Lakes fisheries values: 1979 status report. Great Lakes Fishery Commission, Ann Arbor, MI, mimeo. rep. 79-1:17 pp.

ABSTRACT

We expect about 24 million angler days of sport fishing for Great Lakes fish in 1979. The net economic value to anglers of this fishing in all-or-none terms would be about $525 million per year. The net all-or-none value to fish consumers and commercial fishers of Great Lakes fish should total about $12 million per year in 1979. This means that anglers, consumers, and commercial fishers would be willing to pay a maximum of about $537 million per year (in addition to current expenditures) for access to the fisheries as they are in 1979, rather than to do completely without them. This compares with total management and rehabilitation costs of about $40 million.

Current annual angler expenditures for angling for Great Lakes fish should be around $440 million, about a quarter of which would go toward purchasing boats, motors, boat trailers and related equipment for the purpose of angling. We estimate the total economic impact of angling at about $1 billion. The landed value of Great Lakes commercial fish should be about $25 million in 1979, with a total economic impact of about $160 million. Thus if the fisheries were to stop, about $1.16 billion would shift to other sectors of the regional economy or to other regions.

Reseach is needed to better estimate these values, to better estimate marginal resource values, and to estimate for the first time some other kinds of fisheries values, such as existence values.

---

[1]This report was prepared in 1979 for the Great Lakes Fishery Commission.

[2]The authors' affiliations are Talhelm, Fisheries & Wildlife Dept., Mich. St. Univ.; Bishop, Agr. Econ. Dept., Univ. of Wis.-Madison; Cox, Resource Enforcement Branch, Fish. & Oceans, Ottawa, Canada; Smith, Fisheries Branch, Ont. Ministry of Nat. Resources, Toronto; Steinnes, Economic Dept., Univ. of Minn.-Duluth; and Tuomi, Recreational Fisheries Branch, Fish. & Oceans, Ottawa, Canada. Significant assistance was provided by Charles S. Korson, Graduate Research Assistant, Fisheries & Wildlife Dept., Mich. State Univ.

Millions of dollars are annually spent to manage Great Lakes fisheries. Much more is also spent on fisheries-related activities, such as pollution control and preventing habitat destruction from dredge spoil disposal. In order to allocate these expenditures in the greatest public interest, managers must somehow estimate the values received by the public from these activites. However, these values have been particularly hard to estimate because little market information is available. Even the best market information--for commercial fisheries--is widely dispersed once the fish enter wholesale and retail markets. The first econometric estimates of sport and commercial fishing values in the Great Lakes have recently become available for certain locations. However, accurate estimates of sport fishing effort, which ought to be easier to estimate, are not even available for many areas. Some other kinds of values, such as the "existence" value of an endangered species, pose particularly vexing measurement problems because they are not even related to an observable level of use activity.

The purpose of this paper is to summarize available estimates of the societal values and economic impacts of sport and commercial fishing for Great Lakes fish in 1979. We interpolate estimates for the entire Great Lakes from results of published and unpublished current research. Sport fishing values and impacts are strongly related to sport fishing effort, so we estimate effort first. We also estimate the impact of sport fishing on the boating industry. Finally we recommend further research to clarify the economic values and impacts of Great Lakes fishing.

We interpreted the values only briefly: more detailed interpretations are available in several publications cited, including Talhelm, 1979. Basically the value of anything, including a fishery, is measured by what a buyer would be willing to pay for it rather than do without it. For example, the value of a house is whatever the highest bidder is willing to pay for it. Its value depends upon (1) the tastes and preferences of buyers, (2) their ability to pay, (3) the particular "product" they are evaluating (e.g., kind of house, furnishings, lot, neighborhood, etc.), and (4) the prices of possible substitutes. Similarly, the different values estimated here depend upon what specific aspect of the fishery is being valued, how many "buyers" are available and the availability of substitutes to the respective buyers.

Sport Fishing Effort

We estimate that between 16 and 32 million angler days per year are directed toward Great Lakes fish, including salmon and steelhead in streams. These estimates range widely because statistical estimates are not available for some states and because various survey techniques appear to be greatly biased. For example, recent published and unpublished evidence indicates that Michigan's mail surveys overestimate participation by licensed anglers by a factor of two or three, and overestimate their catch by a factor of about five (Stanford and Talhelm, 1979; Rybicki and Keller, 1978). On the other hand, a telephone survey of Michigan households estimated Michigan's total resident fishing effort at more than twice that of the mail survey, partly because the telephone survey included effort by spouses and children, whereas the mail survey did not (Mich. DNR, 1973). However, effort by spouses and children on the Great Lakes themselves is probably small relative to that on inland waters. At the opposite extreme, Wisconsin's estimates, for example, are based upon creel surveys and may be biased downward for a number of reasons. In general, creel survey estimates are much smaller than mail survey estimates of the same angling effort. Our estimates consider these biases as well as expected changes in angling effort based upon recent trends. Table 1 lists estimates by state and province.

Table 1. Sport fishing effort (millions of angler days) by jurisdiction.

Jurisdiction	"Official" estimate	Year	Survey type	Source	Our estimate for 1979[a]
Minnesota	0.04	1977	creel	Minn DNR, 1978	0.04
Wisconsin	1.3	1977	creel	Wisc DNR, 1977	1.3-3
Michigan	7.9	1978	mail[b]	Jamsen, 1979	5-10
Illinois	2.0	1977	creel	Rogers, 1979	1.5-2.5
Indiana	0.1	1977-78	creel	Koch, 1978, 1979[c]	0.2
Ohio	1.7	1975-77	creel	Ohio DNR, 1978	2.0
Pennsylvania	none				1.0
New York	none	1978	creel[d]	Panek, 1978	1-2
Ontario	12	1975	mail	Brickley, 1977	5-12
Total	25.04+				16-32

[a]Allows for children and other unlicensed anglers, allows for possible survey biases, and for trends over time in angling effort.

[b]In Michigan, spouses of licensed anglers are not required to have a lincense, so they are not included in the survey of licensed anglers.

[c]Koch, 1978, estimates 1977 angling except for summer, 1977. Estimates for the summer, 1978, from Koch, 1979, were substituted.

[d]The only available information was an estimate for the April and May, 1978, nearshore fishery in Lake Ontario.

Sport Fishing Value

The net value to anglers of having the Great Lakes sport fisheries, as opposed to not having them at all, is in the neighborhood of $525 million per year ($300-700 million). In other words, anglers would, if necessary, pay a maximum conceivable amount of about $525 million per year (in addition to their cost of going fishing) to retain access to the Great Lakes fisheries in the present state rather than not have access at all. This potential payment is a "net" value because it does not include any present expenditures by anglers, even the license fees and excise taxes that pay the bulk of management costs in the United States.

From society's perspective (as opposed to the anglers' perspective above) the net value of the sport fishery is the above value minus any management or other costs not paid by anglers. Expenditures not paid by anglers, and taken here as attributable to the sport fishery, were less than $25 million in 1979, primarily for the Great Lakes Fishery Commission and various U.S. and Canadian federal agency expenditures.[3] Given the wide confidence interval associated with our benefit estimates, the effects of these costs on the net value of the resources can more or less be ignored for most practical purposes.

---

[3]This figure is a rough approximation. We estimate current annual expenditures for Great Lakes fisheries management at about US $40 million, as follows:

State	US	$10	million
U.S. federal	US	$11-12	million
Ontario	Can	$ 8-9	million
Canadian federal	Can	$11-12	million
Total		$40-43	million

Little information was available about the division between expenditures for Great Lakes fishery management and inland fishery management, or between sport vs. commercial fisheries management. State expenditures were assumed to be equal to license revenue, which was roughly estimated by assuming nine angler days per angler (based upon data in Jamsen, 1977), then multipling the number of Great Lakes anglers in each state (calculated from Table 1) by recent license fees (from Cox, 1978). U.S. federal expenditures in 1975 were about $7.65 million, including $2.1 million for sea lamprey control (Comptroller General, 1977). Current expenditures for sea lamprey control are around $5 million (Lamsa, 1979), and other federal costs have risen as well, probably to a total of $11-12 million. Canadian federal costs for fisheries in Ontario are about $13 million, and Ontario fisheries management costs are also about $13 million although about $5.5 million of that is paid for from sport fishing license revenue (Smith, 1979). However these Canadian costs and revenues include inland as well as Great Lakes fisheries; a rough total of about $20 million is allocated to the Great Lakes. Subtracting license revenue attributable to Great Lakes angling, a net Canadian public expenditure of roughly $17 remains. (Of course, anglers also contribute considerably to sales taxes, but we consider that to be "public" revenue.)

These value estimates are based upon estimates for the state of Michigan of an all-or-none value of $102 million for 6.2 million angler days fishing for Great Lakes fish by Michigan residents in 1976 (Talhelm, Jordan and Korson, 1979). This is an average of about $21 per angler day in 1979 dollars, and is lower than earlier projections of $25 per day made by Talhelm (1979) based upon a 1970 survey of anglers in Michigan. Multiplying $21 by 16 to 32 million angler days gives $336-672 million. The 1976 Michigan estimates employ some conservative assumptions, so perhaps that upper bound of the estimate should be higher, say $700 million or more. While the Michigan figures come from a very detailed study of demand and supply, they are not necessarily representative of the values of fishing elsewhere in the region. No confidence intervals were estimated for the $21 per day estimate because no comparable studies are available for comparison. Sea Grant-sponsored researchers in Michigan (Talhelm), Wisconsin (Bishop), and Minnesota (Steinnes) are currently studying Great Lakes sport fishing values, so more accurate figures should become available late in 1979 and over the next few years.

The all-or-none values here are appropriate benefit estimates for programs that comprise the difference between the present sport fishery and practically no fishery at all. Examples of disturbances that could possibly affect sport fishing that much are (1) unchecked sea lamprey populations, (2) unrestricted commercial fishing, and (3) serious widespread fish contamination. The $21 per angler day value is not appropriate for less drastic changes in the fishery, such as improvements in angling quality, stocking new areas of the Great Lakes, or opening new rivers to salmon and steelhead fishing by building fish ladders. The benefits of these kinds of changes can be evaluated by estimating the willingness of anglers to pay for each specific change. These "marginal values" will vary widely, perhaps exceeding $21 per day in some cases and falling below zero in others, depending upon the nature and location of the change, the availability of substitutes, and anglers' preferences. Talhelm (1973a, 1973b,1976a, 1976b, 1978; Jordan and Talhelm, 1979) has developed simulation models of recreation demand and supply to estimate the values of a wide variety of such changes in Michigan, and his model is currently being adapted and estimated for Wisconsin's Lake Michigan waters as well.

Commercial Fishing Value

The net value to consumers and producers of having Great Lakes commercial fish, as opposed to not having them at all, is in the neighborhood of $12 million per year ($7-18 million). In other words, consumers and producers would, if necessary, pay a maximum conceivable amount of about $12 million per year (in addition to production costs) to retain the ability to produce and purchase Great Lakes fish as they presently do, rather than to lose that ability. This value is comparable to the net all-or-none value of the sport fishery given above, because the cost of fishing and related costs of producing and selling at dockside have been subtracted. The net value to society of the commercial fishery is less than the estimated $12 million after deducting those management costs not paid by the fishery, but attributable to the fishery.[4]

These value estimates are based upon a study by Talhelm and Ghanbari (Ghanbari, 1977) of the dockside demand and supply of whitefish and lake trout in the U.S. and of the bioeconomics of whitefish production in Michigan waters of Green Bay. The study found that the combination of consumer surplus and producer surplus (i.e., the maximum conceivable willingness of consumers and producers, respectively, to pay for their uses of the resource, not including present market costs to consumers or production costs to

---

[4]See footnote number 3.

producers) was around half as much as the current dockside revenue. As with sport fishing values, these values are subject to verification and further exploration for other species and other locations. Michigan and Wisconsin Sea Grant programs are currently conducting further studies. However, since the annual dockside value of Great Lakes commercial catches is about $25 million, the net value of the resource to consumers and producers was estimated at $12 million.[5] Commercial fishing values are much lower than sport fishing values because of the different market structures involved. The demand for commercially caught Great Lakes fish is more "price elastic" because under present conditions other fish and meat substitutes are available at moderate prices, but few good substitutes are available for Great Lakes angling.

The relatively small benefits associated with commercial fishing should not be interpreted as a reason for eliminating commercial fishing in favor of recreational fishing. For example, there is little interest among anglers in fishing for whitefish and chubs, so there is litte direct conflict with those species. In another example, sport fishing pressure on Lake Superior is so light that it is likely that commercial fishing for "sporting" species such as lake trout is economically justified. Actually, the economics of this issue are quite complex (Bishop and Samples, 1978; Talhelm, 1979) and have not yet been adequately studied by economists in the Great Lakes region or elsewhere. It is interesting to note that a Wisconsin Lake Michigan anglers' survey showed that while they do see commercial fishers as competitive users of the resource, 70 percent agree that commercial fisheries provide a service by making fresh fish available to Wisconsin residents. Adequate assessments of the economic values and trade-offs between recreational and commercial fishing must await further research.

The key economic criterion for evaluating both sport and commercial fishery management alternatives is the relationship between the marginal costs and marginal benefits of the choices. In other words, is the change in societal benefits resulting from a proposed management strategy greater than the change in societal costs? The values used to answer this question will almost never by the all-or-none values estimated here. Instead, each management alternative should be evaluated separately because marginal values are usually unique to each case. As we mentioned in the introduction, values depend upon the particular type and location of the change being considered, and the availability of substitutes.

Sport Fishery Economic Impact

Anglers spend about $440 million ($240-640 million) annually fishing for Great Lakes fish. About one quarter (24%) of angler expenditures ($110 million) is spent to purchase boats, motors and boat trailers. The total impact of the $440 million expenditure on the regional economy is about $1 billion ($480-1,600 million). This means that if the sport fishery for Great Lakes fish were stopped, about $1 billion in incomes would be shifted from present sectors to other sectors of the regional economy or to other regions.

---

[5] This does not imply that the cost of production is $13 million and that profits are $12 million, adding to $25 million. Profits were, in fact, found to be very low or even negative (Pattinson and Talhelm, 1978). However, profits in Green Bay could be much higher if fishing effort were reduced. A little over half of the $12 million is attributable to these potential profits, and the remainder is attributable to Talhelm and Ghanbari's estimate that consumers would be willing to pay about ¼ more than at present, rather than not have whitefish at all.

Obviously such a shift would disrupt many local economies and shift employment, but the long term losses in some sectors would eventually be almost exactly offset by gains in other sectors. Economic disruptions generally have some negative effect on societal values because people must adjust to the changes. These negative values are the temporary losses due to unemployment of labor and capital. However there is probably little other effect on societal values. Therefore, if the fishery was stopped the loss in societal values would only be a fraction of the $1 billion economic impact, and that fraction would soon approach zero as the labor and capital were employed in other sectors. This contrasts with the $525 million annual all-or-none value cited above, which would be a permanent annual loss, the value of which would change only with inflation, angler preferences, ability to pay and the availability of substitutes.

The above estimates are based upon the author's estimate of angler expenditures of $15-20 per day in 1979. Several earlier studies form the basis for our estimates. A study of angling in Ontario waters of the Great Lakes in 1975 estimated angler expenditures at about $11 per day, depending upon the portion of expenditures for boats, camping equipment and other "investments" attributable to angling (Brickley, 1977). Since inflation has increased the U.S. consumer price index by about 1/3 since 1975, these expenditures may be aobut $15 per day in 1979. The 1975 U.S. National Survey of Hunting, Fishing and Related Activities (USDI, 1978) estimated angler expenditures per day at $9.00 for warmwater fishing, $12.45 for coldwater fishing, and $16.65 for saltwater fishing. A 1970 survey of salmon and steelhead angling in Michigan estimated expenditures at $8.77 per day (Ellefson, 1973), or about $16 in 1979 dollars. A study of angling in Ontario waters of Lake St. Clair in 1970 estimated angler expenditures at $24 per day (Melski, Clayton and Byrne, 1973). An as yet unpublished study of Wisconsin Lake Michigan anglers indicated expenditures of $15.50 per angler day in 1978, not including expenditures on boats (Bishop, 1979).

Our estimate that about 24% of angling expenditures go toward purchasing boats, motors and boat trailers is also based upon several studies. The study of Ontario's Great Lakes angling, the most relevant study for our purposes, estimated 24% (Smith, 1979). The 1970 U.S. National Survey of Hunting and Fishing reported 14% for all anglers and 21% for saltwater anglers (USDI, 1972). A study of 1975 angling in all of Canada estimated about 24% (Fisheries and Environment, Can., 1978). A report on U.S. saltwater angling estimated that 18% of their expenditures fall in this category (Centaur, 1977). In other studies it was found that Ontario anglers use their boats 42% of the time for angling and 58% for non-angling purposes (Smith, 1979) and that 60% of Wisconsin's Lake Michigan trout and salmon anglers who own boats[6] use them at least 75% of the time for Lake Michigan angling (and 25% for other uses), another 10% use them 50-75% for angling, and the remaining 30% use them less than half for angling (Bishop, 1979). Also the present market value of boats used by Ontario residents for angling for Great Lakes fish in 1975 was estimated at about $305 million (Brickley, 1977).

We estimated that the multiplier to convert angler expenditures into total direct and indirect expenditures in the Great Lakes region as a whole was 2.0 to 2.5. A current study of Ontario angling impacts estimated a multiplier for the province of 1.88 (Cox, 1979). The national mulitiplier for U.S. saltwater angling was estimated to be 2.5 (Centaur, 1977). These multipliers measure the number of times a monetary input into a regional

---

[6] About half of these anglers responding to the survey said they owned a boat they used angling for Lake Michigan salmon and trout.

economy is respent within that economy before the money leaves the region and its effects are dissipated. A larger region provides more opportunities for respending, so its multiplier will be larger. Multipliers for the entire U.S. or Canada may be around 2.5, while multipliers for local economies have usually been found to be 1.5 or lower. Our estimated multiplier assumes the Great Lakes region to be treated as a whole.

Commercial Fishing Economic Impact

The landed value of Great Lakes commercial fish is about U.S. $25 million in 1979. Landings in 1978 were valued at $10.4 million (U.S. waters) and $15 million (Canadian waters). We estimated this value by converting Canadian dollars to U.S. dollars and correcting the 1978 values for inflation. The actual figure will depend upon landings and prices in 1979.

We estimate that the economic impact of the commercial fishery on the region is about $160 million ($112-200 million) per year. This includes both a "value added" factor of 2.5 to 4 times dockside value and a multiplier of 2, for a combined effect of between 5 and 8. The value added factor refers to the fact that the final market value of Great Lakes fish is an estimated three to four times greater than the dockside value of the fish. The multiplier estimates the relationship between the final sales value of the fish and the flow of income in the region. Therefore both effects must be combined to convert dockside value to economic impact. The societal significance of the economic impact of the commercial fishery should be interpreted the same as that of the sport fishery: if the commercial fishery were stopped, about $160 million in incomes would shift from present sectors to other sectors of the regional economy.

The multiplier effect (as opposed to value added) for commercial fisheries should be about the same as that for sport fisheries. See the previous section for multiplier documentation. Studies of commercial fisheries we found usually combine the value added and multiplier effects. 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). Preliminary results of a study of the economic impact of Michigan's commercial fishery on Michigan's economy estimate a combined effect of about 4 (Menegay and Pierson, 1979). This may seem low, but much of Michigan's catch is shipped out of the state after little or no processing, resulting in a lower total economic impact on the state.

Other Values

Several other kinds of values derived from fish populations may also be important in resource management. Most are difficult to quantify, and to our knowledge, none have been specifically estimated, but all of these probably enter into the political decision-making process in various ways.

First is the concern that resources be used in a fair and equitable fashion: how much should "fairness" count in decision-making, relative to the resource values we discussed above? Furthermore, income distribution is even more basic a question than that. The values themselves are a function of individuals' abilities to pay, so they are a function of present income distribution patterns. These concerns have plagued economists and philosophers since before economics became a discipline, and the questions have yet to be resolved.

Second, fisheries have certain 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.

Third, fish and fisheries have certain "ecological values", in that their roles in the Great Lakes ecosystem may cause certain beneficial or deterimental effects on people. For example, Great Lakes salmonids may enhance beach-use values by reducing alewife populations, thereby eliminating the massive alewife dieoffs that fouled Lake Michigan's beaches prior to the salmonid program.

Fourth, there is unmeasured but real value in keeping future options available in the Great Lakes. These values stem from the fact that human wants and needs and technology change over time. The values of present opportunities must be weighed against the loss of future opportunites. For example, the extinction of a fish species or variety is irreversible; any possible future recreational, ecological, technological or other uses are foregone (Bishop, 1978).

Fifth, a related value of the fisheries arises from the fact that there are people who do not presently use them for food or recreation, but who derive benefits from knowing that they can angle for or purchase fish in the future if they wish. People are willing to contribute to present resource management efforts to maintain their future options and those of their descendents. These option values are usually not estimated in studies of recreation or food demand.

Sixth, closely related to option values are "existence values": the value of knowing that certain life forms or even ecological systems exist. Evidence of such values may be seen in the public sentiment for whales, porpoises and other animals, for "undisturbed" areas such as wilderness, and in the fact that people are willing to pay taxes to keep Lake Erie from "dying." These values may be unrelated to people's other uses of the resource.

Seventh, the existence of a fishery may preclude certain other direct and indirect uses of the lake. Considerable expense is incurred to prevent pollution and contamination. At least part of these expenditures, including foregone benefits available from DDT, PCB and other chemicals, are incurred for the purpose of maintaining a more valuable fishery. If so, then both expenses and forgone benefits are costs of the fishery. We have not attempted to include such losses here because few cost estimates are available, and we don't know what portions of those costs are attributable to Great Lakes fisheries.

Finally, there may be other values associated with Great Lakes fisheries. Researchers are continuing to explore the various values in an effort to provide more information about their nature and magnitude. In many cases, however, the work has hardly begun.

Research Needs

Each estimate in this report has a wide confidence interval. Additional research is needed in all areas to increase the accuracy of these estimates. Particularly important for management are (1) accurate estimates of angling effort and related basic resource use data, and (2) marginal values of management alternatives. High priority should also be given to developing the economic theory of, and estimating for the first time, some of the unquantified values cited in the last section, particularly existence values, option values and present and future values associated with endangered species.

In addition to new and continuing projects for improving these estimates, we feel that they could also be improved by better communication and coordination among academic and agency researchers, and between researchers and those who look to researchers for information for decision-making. We recommend regular workshops or meetings among researchers in the region to coordinate data gathering efforts, explore methodology and examine current findings. We also recommend occasional workshops including researchers, administrators, and other decision-makers to explore research findings, needed research and agency support for research and data collection.