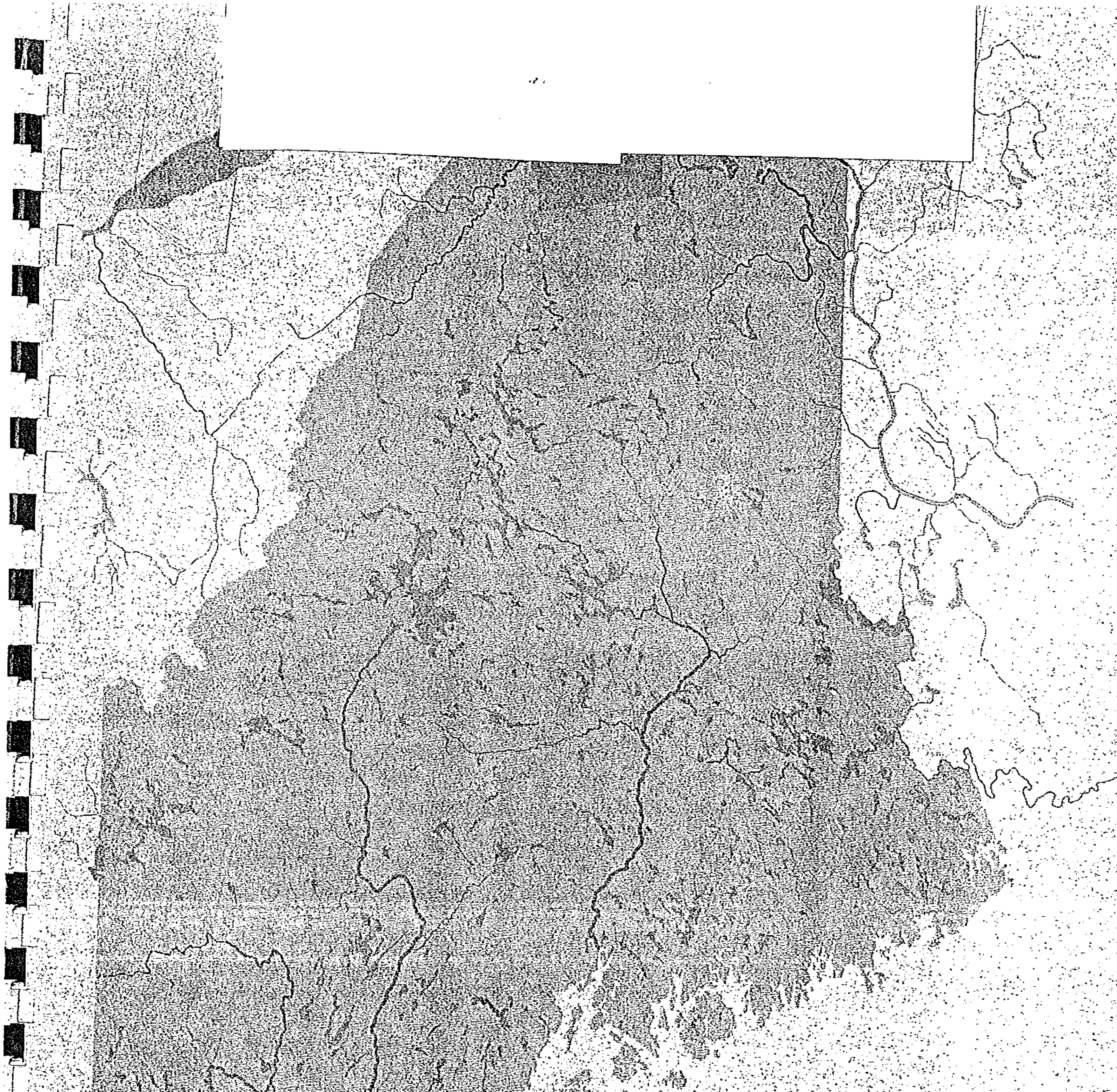

GREAT PONDS PLAY AN INTEGRAL ROLE IN MAINE'S ECONOMY

Kevin Boyle, Associate Professor and Jennifer Schuetz, Graduate Research Assistant
Department of Resource Economics and Policy
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Water Research Institute • University of Maine • REP473 • April 1997

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EXECUTIVE SUMMARY

Introduction

In 1995, the Maine legislature authorized the Great Pond Task Force (GPTF) for the purpose of developing a Great Pond Strategic Management Plan to address numerous existing and newly emerging issues facing Maine lakes. The Governor appointed 22 members to the GPTF; eight from state agencies, four designated members, and ten public members with special interests or expertise concerning Maine lakes. Item (h) of the GPTF legislation instructed the Task Force to '*determine the economic benefit of Great Ponds to the state economy.*' The GPTF membership lacked the expertise to determine the economic benefit of Great Ponds to the state economy. Therefore, members of the University of Maine Department of Resource Economics and Policy were commissioned for this purpose, with funding raised by the University of Maine Water Research Institute from organizations represented on the GPTF.

Objectives

This study was designed and completed to meet the following objectives:

1. Document recreational use and other uses of Maine's Great Ponds by residents and nonresidents.

2. Estimate expenditures associated with uses of Maine's Great Ponds by residents and nonresidents, and compute the economic impact as the money from these expenditures is respent within Maine's economy (direct and indirect sales, income and employment).

3. Estimate net economic values associated with resident and nonresident uses of Maine's Great Ponds. Net economic values represent the amount people are willing to pay to use Great Ponds above what they actually have to pay. This is an economic measure of satisfaction with lake use.

4. Show how net economic values and economic impacts can be affected by changes in water quality of Maine's Great Ponds.

Selected Results

Lake Use

The largest single source of usage of lakes in Maine is associated with potable water. If the number of residents served (Table E1) by public water district residential accounts is multiplied by 365 days, assuming water is used every day of the year, this results in 93.5 million user days. In addition, 73 percent of camps on lakes are used seasonally and the average days of use is 83. This results in an additional 9.8 million user days for drinking water. Ownership of lake-front properties supports over 300 thousand users and an estimated 25.6 million user days. Recreation is the second most important use of Maines lakes, with swimming having the highest participation rate.

Table E1. Total Use of Maine's Great Ponds.

Type of Use	Number of Users			Annual User Days		
	Residents	Nonresidents	All Users	Residents	Nonresidents	All Users
Recreation	NA[1]	NA	NA	10,790,843	1,959,868	12,750,711
Residential Drinking Water	371,852	46,122	417,974	NA	NA	NA
Public, Commercial & Industrial	NA	NA	(14,589 Accounts)	NA	NA	NA
Youth Camps	118,071	55,980	174,051	NA	NA	NA
Lake-Front Properties	231,574	77,191	308,766	NA	NA	NA

[1] NA indicates that the data are not available.

increases in economic activity in Maine, while changes in resident expenditures represent transfers of expenditures within Maine. An equivalent decrease in water quality, a reduction from 3.78 to 2.41 meters would result in larger loss in economic activity due to a nonlinear relationship between water clarity and economic activity.

Conclusions

The data reported here indicate that Maine's Great Ponds are an extremely valuable economic resource as well as a stunning natural resource. If only one message comes out of this work it should be "Do not kill the goose that laid the golden egg." Maine's Great Ponds provide a valuable source of potable water, they contribute to the enjoyment of many Maine residents, they help relive property tax burdens on local people in rural communities, and they support substantial economic activity. Protecting water quality and reducing user conflicts should be a priority of everyone who cares about Maine's Great Ponds.

Lake-Related Expenditures

The total direct expenditures by lake users are estimated to be $1.8 billion annually (Table E2). Of this total $0.3 billion (15 percent) is new money that is brought into the state economy each year by nonresidents. The $1.8 billion in direct expenditures results in over $2.8 billion in total economic activity. Of this total, nearly $0.4 billion (13 percent) is attributable to nonresidents. Overall economic activity associated with Great Ponds represents 5 percent of Maine's gross regional product.

The economic activity associated with lakes leads to over $1.2 billion in annual income for Maine residents and supports over 50,000 jobs (Table E3). The nonresident share of sales provides nearly $0.2 billion in income and over 8,500 jobs. In terms of the total number of jobs, nonresident expenditures support an approximate equivalent to Bath Iron Works. The jobs associated with Great Ponds, however, are likely to be less skilled with lower wages than those at Bath Iron Works.

Table E2. Total Direct Expenditures for All Uses of Maine's Great Ponds.
(July 1996 Dollars)

Type of Use	Aggregate Annual Expenditures		
	Residents	Nonresidents	All Users
Recreation	$928,731,424	$158,652,660	$1,087,384,084
Other Uses[1]	$189,962,159	$23,070,497	$392,170,419
Lake-Front Properties	$262,468,444	$87,489,481	$349,957,925
Total Direct Expenditures[1]	$1,381,162,028	$269,212,638	$1,829,512,429
Direct and Indirect Sales	$2,116,300,000	$392,090,000	$2,857,390,000

[1]Resident and nonresident totals do not sum to the total for all users because these estimates do not include the figure for commercial and industrial uses.

Table E3. Income and Employment Effects

Type of Use	Aggregate Annual Income and Employment		
	Resident	Nonresident	All Users
Recreation			
Income	$675,700,000	$117,070,000	$792,770,000
Employment	30,920	5,318	36,239
Other Uses			
Income	$133,210,000	$25,580,000	$259,620,000
Employment	4,714	1,429	8,834
Lake-Front Properties			
Income	$125,120,000	$42,000,000	$167,120,000
Employment	5,481	1,835	7,316
All Uses			
Income	$934,030,000	$184,650,000	$1,219,510,000
Employment	41,115	8,582	52,388

[1]Resident and nonresident totals do not sum to the total for all users because these estimates do not include the figure for commercial and industrial uses.

Net Economic Values

The net economic value of Maine's Great Ponds is $6.7 billion dollars (Table E4). Net economic value is the amount of an individuals total value for an activity that is retained after the daily costs of participation are paid. Net economic value is the difference between the individual's total willingness to pay and total daily expenditures. Net economic value is a measure of satisfaction; the cheaper an opportunity, the greater is the retained net economic value. Net economic value is nearly four times greater than direct expenditures, which indicates the high quality of Maine's lakes.

Table E4. Total Net Economic Values Associated with Uses of Maine's Great Ponds. (July 1996 Dollars)

Type of Use	Aggregate Annual Net Economic Values		
	Resident	Nonresident	All Users
Recreation Uses	$173,823,970	$34,366,596	$208,190,567
Other Uses	$110,919,526	$4,036,700	$114,956,227
Lake-Front Properties	$4,803,876,456	$1,601,292,152	$6,405,168,608
Total Net Economic Values	$5,088,619,952	$1,639,695,448	$6,728,315,400

Benefits from Water Quality Improvements

In this section a simulation is conducted to investigate how net economic values, expenditures and use rates might change if eutrophication were reduced in the 189 lakes that experience diminished water clarity. The statewide average minimum water clarity would increase from the current level of 3.78 to 5.15 meters (the average for lakes without compromised water clarity).

Net economic values would be expected to rise by $2.0 billion. Thus, a 1.37 meter increase (a 36 percent increase) clarity during the summer months leads to a 30 percent increase in net economic. The increase in water clarity would be expected to increase recreation use rates by 1.6 million user days; an increase of 13 percent. Reducing eutrophication would increase direct expenditures by $107 million, a six percent increase. The change in nonresident expenditures of, $24.7 million in direct sales, results in $39.0 million in direct plus indirect sales. These increases would increase income of Maine residents by $18.2 million and would provide 825 more jobs. Only nonresident expenditures are considered here because they represent true

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Introduction

In 1995, the Maine legislature authorized the Great Pond Task Force (GPTF) for the purpose of developing a Great Pond Strategic Management Plan to address numerous existing and newly emerging issues facing Maine lakes.[1] The Governor appointed 22 members to the GPTF; eight from state agencies, four designated members, and ten public members with special interests or expertise concerning Maine lakes. In a series of monthly meetings and frequent working group sessions, the GPTF deals with issues ranging from social conflicts over surface use of lakes to water quality protection. Item (h) of the GPTF legislation instructed the Task Force to '*determine the economic benefit of Great Ponds to the state economy.*'

Great Ponds are defined as natural lakes 10 acres or greater in area or impoundments greater than 30 acres. There are 2,800 Great Ponds covering about 1 million acres, or 5%, in Maine.[2] As established by colonial ordinance in the 1600s, the waters and land under Great Ponds belong to the people of Maine. By law, the public has recreational access to all Great Ponds over unimproved land if official public access is not available.

The GPTF membership lacked the expertise to determine the economic benefit of Great Ponds to the state economy. Therefore, members of the University of Maine Department of Resource Economics and Policy were commissioned for this purpose, with funding raised by the University of Maine Water Research Institute from organizations represented on the GPTF.

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[1] The terms "Great Pond" and "lake" are used interchangeably in this report.

[2] There are an additional 3,000 ponds smaller than 10 acres. The state owns the water in these ponds, but not the land under them. For the purposes of this report, only Great Ponds are considered.

The goal of this report is to estimate the economic value of Great Ponds to the citizens of Maine, which includes the contributions of Great Ponds to Maine's economy, using existing data. The multiple uses of Maine lakes contribute a substantial, but previously unquantified, economic benefit to the people of Maine. Forty million people live within a days drive of Maine's clean and scenic lakes. The protection of water quality and the management of multiple surface uses are essential to protect these resources. Fishing, boating, swimming, and site seeing draw tourists to lake regions, with subsequent importance to a host of businesses. Even in the winter, ice fishing is a popular activity on many lakes.

A study in Minnesota estimated that lakes contribute as much as $1.8 billion annually (in 1994 dollars) to local economies from tourism (Markuson, 1996). However, the economic importance of Maine lakes exceeds the lure of tourist dollars. Clean lakes have been shown to increase lake shore property values, contributing to the economic status of entire communities (Michael et al., 1996). Many people receive their drinking water from Great Ponds. Perhaps the most difficult contribution to quantify is the intrinsic, aesthetic value of clean lakes. Mainers have a sense of well-being because their lakes are the cleanest and least crowded in the eastern United States. Even when they do not visit them, lakes are part of Maine's natural heritage, a heritage that is an important part of what makes Maine unique.

Objectives

This study was designed and completed to meet the following objectives:

1. Document recreational use and other uses of Maine's Great Ponds by residents and nonresidents.

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4. Show how net economic values and economic impacts can be affected by the water quality of Maine's Great Ponds.

Addressing these objectives will present a picture of the importance of Great Ponds in terms of the extent of public uses of these resources, the economic activity generated in association with uses of these resources, the satisfaction the public receives from using these resources, and how these beneficial aspects of Great Ponds are affected by a change in water quality.

Users of Great Ponds

Results are reported for residents and nonresidents because these two users groups have an important distinction. Great Ponds contribute to the enjoyment and economic well-being of Maine residents. While nonresidents also enjoy Maine's lakes, nonresident uses bring new money into the state that generates sales, income and jobs. Resident expenditures associated with lake uses represent redistribution of expenditures within Maine, but are not a net addition to Maine's economy. The objectives are addressed using the best available data from Maine or from other states when Maine-specific data are not available. No new data have been collected for this study.

Great Pond users are further divided into two categories in this report: recreation users and other users. Recreation users include swimmers, open water anglers, ice anglers, motorized boaters, nonmotorized boaters and waterfowl hunters. Other users include customers of water districts that extract drinking water from lakes, people with camps who use lakes as a source of private drinking water, and people who attend or visit youth camps located on lakes.[3] Owners of lake-front property who do not obtain their drinking water from lakes are also included.

Site seeing is an important use of Maine's lakes, but it is not included in this analysis because no data exist on the number of people who use Maine lakes for this activity. Site seeing per se is not totally excluded because it is part of the enjoyment other recreation users and lake-front property owners derive from Maine lakes. What is omitted is the site seeing done by people who do not participate in water-based recreation or who do not own lake-front property. Snowmobiling is another recreation use of lakes that is not included here. An economic impact study of snowmobiling in Maine has just been completed by the University of Maine for the Maine Snowmobile Association, but it is impossible to isolate the role of lakes in snowmobiling (Reiling et al., 1997). These omissions are unlikely to affect the magnitude of the economic estimates reported.

Marinas and sporting camps are two types of businesses that depend directly on lakes. These businesses are not directly addressed in the analyses for two reasons. First, data are not available on the total economic activity generated by these businesses in Maine. The second

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[3] It is not known how many of Maine's youth camps are located on lakes. People knowledgeable with this business indicate that most camps are located on Great Ponds. In the analyses reported here it is assumed that all youth camps are located on lakes, somewhat overstating the contribution of this use to the economic value of Great Ponds.

reason is that more accurate data on expenditures associated with recreation uses of Great Ponds can be collected from customers rather than business owners for the type of analyses conducted here. Business owners do not always know whether their sales are actually associated with the use of lakes. In addition, lake users may purchase items from businesses not generally associated with lakes; surveying only lake-related businesses would omit these expenditures. Sales by marinas and sporting camps to recreation boaters and anglers are included in the expenditures reported for these groups of lake users who are major clients of these businesses.

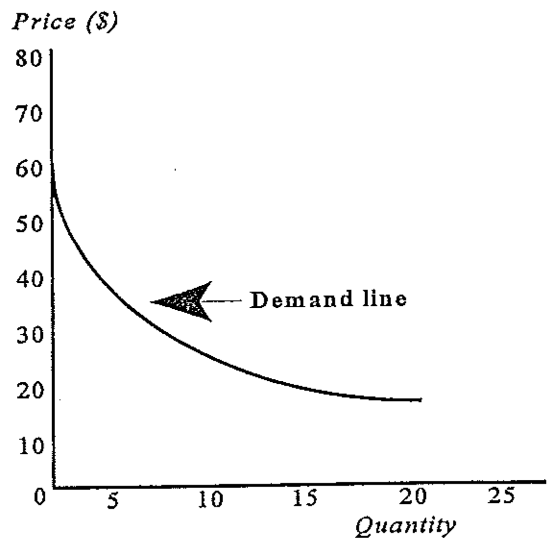
While some agricultural producers irrigate their crops in Maine, Great Ponds are not a significant source of water for agricultural irrigation in Maine (Yarborough, 1996). Use of Great Ponds for agricultural irrigation is not addressed for this reason.

The next section defines the economic concepts used in this report. The subsequent sections document estimated use rates, expenditures, economic impacts, net economic values, and the effects of a change in water quality. Conclusions and implications for the Maine economy are presented in the last section.

Measures of Economic Value

The concepts used in this report are quite simple, but it is helpful to define them to avoid potential confusion in interpreting the empirical results. The basic notion that defines the concepts to be measured in this report is economic demand. In the example presented in Figure 1 the representative person would not choose to consume any of the good if the price was $50 or greater, and would consume 20 units if the good was free; at high prices people will choose to consume relatively less of a good or service than they would at lower prices. The demand line

Figure 1. Economic Demand Relationship for an Individual

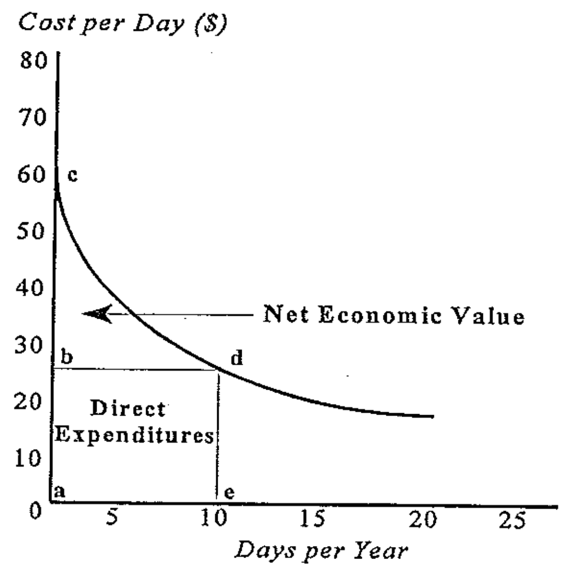


shows how much would be consumed at prices below $50 and greater than $0. From the relationship between price and quantity it is possible to identify consumption or use rates, expenditures and net economic values. These economic concepts are defined below, using recreation boating as a hypothetical example to illustrate the concepts.

Recreation Uses

Use rates reflect both the number of users and the intensity of use. In terms of recreation boating, for example, this would be the number of people who use Maine's lakes for boating and the number of days each goes boating on Maine lakes. Thus, the quantity on the horizontal axis in Figure 1 becomes the days per year an individual chooses to go boating (Figure 2). The number of boaters multiplied by the average number boating days per year provides an estimate of the total number of boating days in Maine each year. While the number of boaters, average

Figure 2. Individual Boater's Demand for Boating Days



days per year and total boating days all may be of interest, it was not possible to obtain data on the number of users for each activity.

Recreation uses of lakes do not have an explicit price or access fee, but the daily cost of participation serves as an implicit price. This implicit price includes the costs of gasoline for a vehicle and/or boat, launch fees, food and beverages, and lodging for overnight trips. Daily expenditures represent the marginal cost of a day of participation. Total expenditures for a season for an individual boater are represented by rectangle abde in Figure 2. Our hypothetical boater spends $25 per day to go boating and goes boating 10 days in a typical year. The total annual expenditure is $250 ($25/day x 10 days).

There are also equipment expenditures associated with recreation boating. These include the purchases of boats, motors, and other gear, the annual maintenance of this gear, and boat registration. While not represented in Figure 2 as part of the daily marginal cost of recreation boating, these so called "fixed costs" of recreation boating are included in the analyses reported here. The total value of all boating equipment in Maine is not recorded in this report because this would vastly overstate annual equipment expenditures associated with recreation boating in Maine. Rather, annual expenditures to buy new or used equipment and annual maintenance costs per boater are divided by the average days of participation per boater. Thus, if average annual equipment expenditures were $300 per boater, the average daily annual expenditure would be $30($300/10).

Both trip and equipment costs are reported as averages per day of participation. Total annual expenditures for each activity are computed by multiplying the trip and equipment cost per day by the total number of user days. If we assume that there is a total of 1,000 boating days, then total annual trip expenditures would be $25,000 ($25 x 1,000) and the comparable figure for equipment would be $30,000 ($30 x 1,000). Daily expenditures and equipment costs are reported for fishing, boating and waterfowl hunting. While there are some durable expenditures associated with swimming (swimsuits, floats, etc.), these expenditures are not included in this report because no data were available. Total direct expenditures are reported for each recreation activity.

Direct expenditures associated with uses of Great Ponds give rise to indirect and expenditures as money is respent within Maine's economy, creating additional sales, income jobs. For example, a boater buys beverages and food from a local convenience store for a day of boating (direct expenditures). The store may buy some of its stock from local suppliers and some of its stock from sources outside of Maine. Expenditures by the store within Maine are indirect sales that also contribute to the total economic activity within Maine that is associated with Great Ponds, while expenditures to purchase supplies outside of the state represents leakages from Maine's economy. This business activity generates income for the store owner and its suppliers within Maine, and provides jobs and income for the employees of these businesses. As income is respent within Maine, induced sales occur.

Multiplier effects (indirect plus induced sales, total income and total jobs) that arise from direct sales were computed by the State Planning Office using the State's REMI model.

As an example, the sales multiplier for recreation expenditures was 1.58. This implies that for each $1 of direct expenditures an additional $0.58 in sales occurs. Another way of saying this is that the $250 in annual trip expenditures for the recreation boating example will generate $395 in total economic activity in Maine ($250 in direct sales and $145 in indirect sales ($250 x 1.58)).

Expenditure and multiplier effects are reported for the state as a whole, not for communities immediately adjacent to Maine lakes. The data available was not sufficient to refine estimates to geographic zones around lakes.

The total value an individual places on a recreation activity is the area below a demand line and to the left of the days of participation, area acde in Figure 2. Net economic value is the amount of total value that is retained area bcd in Figure 2, after the daily costs of participation are paid. Net economic value is the difference between the individual's total willingness to pay and total daily expenditures. As long as the total economic value exceeds the cost of participation, an individual will choose to participate in a recreation activity. The individual represented in Figure 2 will not chose to participate more than 10 days per year because the cost

($25/day) exceeds the value they place on days in excess of 10; the demand line lies below $25. For each day between 0 and 10, the boater would have been willing to pay more than $25 per day (the demand line lies above $25). In this example, net economic value equals $125 {($50-$25 x 10)/2}. Net economic value is a measure of satisfaction; the cheaper an opportunity, the greater is the retained net economic value and the higher the quality for a given cost, the greater the satisfaction. In this example aggregate annual net economic value is $12,500, and is computed using an average daily net economic value per person of $12.50 ($125/10) multiplied by the total number of days individuals participated in boating ($12.50 x 1,000).

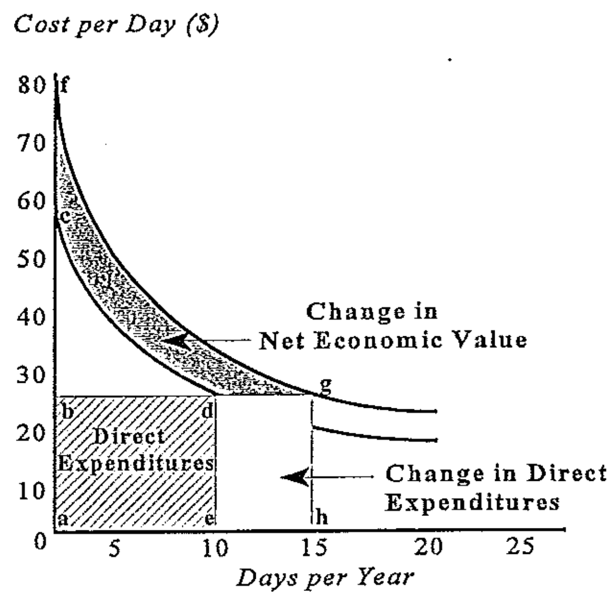
The total economic activity associated with Great Ponds for this boating example is $67,980 ($55,000 in direct expenditures plus $12,980 in indirect and induced expenditures), and the value of Great Ponds to boating participants is $12,500 in net economic value. In this example, no distinction has been made between residents and nonresidents to simplify exposition. Empirical results will be reported for both of these user groups because nonresident users bring new money into the Maine economy. The larger their net economic values (i.e., the greater their satisfaction), the more likely they will be to visit Maine.

Primary attention is often focused on expenditures and economic impacts, while net economic values are ignored. After all, expenditures are real money that changes hands. Net economic values that do not represent exchanges in hard currency may seem like "funny money." While this may seem logically intuitive, it ignores real economic values that have been established by decades of research. Ignoring net economic values undervalues the resource and can lead to degradation of water quality in Maine's lakes. Net economic values are a measure of individuals' satisfaction with an experience and should not be ignored. High net economic values associated with uses of Maine's lakes draw nonresident users to Maine and are measures of the enjoyment and pride Maine people take in their lakes. If water quality in Maine's lakes declined, some nonresidents would choose not to come to Maine, reducing the economic impact of Great Ponds. The enjoyment of Maine residents and visitors would be compromised. Enhancing water quality in Great Ponds would have the opposite effects. High net economic values for Maine's lakes also play a distributional role in dispersing tourism dollars throughout the state. Net economic values, therefore, are economic barometers that tell us what is happening to the quality of Maine's lakes.

One way to consider net economic values is to think about improving water quality in Maine's Great Ponds. The most significant threat to water quality in these waters is eutrophication. The Maine Department of Environmental Protection estimates that there are at least 189 lakes in Maine that have compromised water quality (less than 3 meters of minimum water clarity in the summer months) due to eutrophication that is not related to natural coloration. Reducing these effects of eutrophication would enhance net economic values and increase use rates, with consequent increases in expenditures and total economic impacts.

If water quality increased, people's values for water-based recreation would increase. In our boating example, a water quality improvement would shift the demand for boating to the right and increase the boater's days of participation, expenditures and willingness to pay (Figure 3). As a result, net economic value as well as expenditures would increase. Increased water quality increases the individual's net economic value by the area cfgd. Rather than boating 10 days a year, the boater will choose to increase participation to 14 days a year, and expenditures

Figure 3. Shift in Boater Demand Curve for Boating Trips Due to an Increase in Water Quality.



increase by the area of edgh. The total benefit to a boater of the increase in water quality is $120 in net economic value {(60-25)x14/2-((50-25)x 10)/2} plus $100 in expenditures {(14-10)x25}.

Another way to think about this issue is that continued decreases in water clarity due to eutrophication, with costs of participation constant or increasing, would shrink net economic values. Shrinking net economic values would reduce people's desire to visit Maine's lakes. Use rates, and consequently expenditures and total economic impacts, would decline. In this report the economic benefit of reducing the effects of eutrophication on the 189 lakes with compromised water quality is also estimated.

Other Uses

The same concepts that defined economic value for recreation uses apply to other uses, with slight modifications. For example, the total revenue of a public water district constitutes total expenditures by consumers and other uses such as businesses. The revenue of water districts cover the variable costs of daily supplies of water plus depreciation of fixed costs for capital equipment. Thus, revenues include the same categories of costs as recreation activities. Consumers of water from public water districts also have retained net economic values. These are estimated for residential consumers, but not for commercial and industrial accounts because appropriate data were not available.

Adjustments to July 1996 Dollars

Monetary data such as expenditures, net economic value, and benefits of water quality improvements were collected from many documents which reported data in various years. These monetary data was converted to July 1996 dollars to facilitate comparisons across user categories. Adjustment coefficients for monetary data are reported in Appendix B.

Cautionary Note

The total economic activity estimates presented in this report reflect the share of the state economy (direct plus indirect and induced sales) that is related to Maine's Great Ponds. If Maine's Great Ponds were allowed to degrade, not all of the expenditures reported here would be lost from Maine's economy. For example, eutrophication can lead to increased costs of treating lake water for human consumption or might render the source lake unusable for potable water. If public water districts could no longer draw water from lakes, they would likely switch to groundwater sources, and this might actually increase economic activity in the state. Consumers of public water, however, would be paying higher fees and would have lower net economic values; they would be paying more for the same service and would be worse off. On the other hand, degraded water quality could very well lead to nonresidents choosing not to visit Maine with the consequent decrease in economic activity. Thus, reporting estimates according to residency also serves to clarify the share of expenditures that would truly be lost from Maine's economy if lake-water quality were allowed to degrade--nonresident expenditures.

Use of Maine's Great Ponds

Recreation Uses

As might be expected, swimming has the highest participation rate, followed by fishing and then recreation boating (Table 1). Maine's Great Ponds generate nearly 13 million recreation user days each year. This aggregate figure should be interpreted with caution. Use rates for each activity were estimated independently in different studies. We know that some people swim, fish and go recreational boating all on the same day. To the extent that people participate in multiple recreation activities on the same day and these multiple activities are not taken into account in the estimation, user days might be overstated due to double counting. In addition, nearly all categories contain some overestimation error due to recall bias.[4] While the exact magnitude of this error is unknown, 12.75 million user days is not likely to be a gross overestimate.

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[4] Recall bias occurs when people are asked to recall their behavior over an extended period of time, often one year for recreation activities. Activities with frequent participation over an extended period of time sometimes lead to people accidentally over reporting their participation.

Table 1. Recreation Uses of Maine's Great Ponds.

Type of Use (Year Data Collected)	Days Per Year		
	Residents	Nonresidents	All Users
Swimming (1991)	6,109,710	872,816	6,982,526
Open Water Fishing (1994)	1,921,793	733,268	2,655,061
Ice Fishing (1993-94)	692,415	64,041	756,456
Motorized Boating (1991)	1,714,698	244,957	1,959,655
Nonmotorized Boating (1991)	273,181	39,026	312,207
Waterfowl Hunting (1988)	79,046	5,760	84,806
Total User Days	10,790,843	1,959,868	12,750,711

Resident swimming days in Maine lakes were obtained from data prepared by the Maine Department of Conservation (1994). This report did not contain data on nonresident lake swimming days in Maine. However, a Maine Department of Conservation (1989) report of state park and historic site use reported the percentages of resident to nonresident visitors at ten inland beaches. The median percentage of residents was 87.5, yielding a ratio of residents to nonresidents of seven to one (87.5/12.5). This ratio was used to estimate nonresident swimming days. These numbers represent the best available data on resident swimming, and the approximation of nonresident use may overstate nonresident swimming if nonresidents are more likely to use public access at state parks to swim.

Resident and nonresident angler days for fishing on Maine's lakes were obtained from recent surveys of anglers conducted by the University of Maine for the Maine Department of Inland Fisheries and Wildlife (MacDonald et al., 1996; MacDonald et al., 1995). The surveys elicited information from resident and nonresident fishing license holders about their open water and ice fishing efforts in Maine. These numbers represent the best available data on sport fishing in Maine, but may contain a slight overestimation due to recall bias from anglers being asked to recall open water fishing effort over a six-month period (Westat, 1989).

Resident motorized boating days were obtained from the same source as the swimming days (Maine Department of Conservation, 1994). While people may fish and participate in recreation boating, whether motorized or nonmotorized, if a person fished at all, the user days are counted as angler days. To avoid double counting, motorized boating days were multiplied by the percentage of non-anger boating days (33%) estimated by the Departments of Conservation and Inland Fisheries and Wildlife (1995). Recreation boating usage is then understated relative to other recreation uses. Nonresident motorized boating days in Maine were not reported. Resident motorized boating days were divided by seven to obtain an estimate of nonresident motorized boating days, as was done for swimming. There is no reason to believe resident motorized boating days are overestimated or underestimated. Nonresident motorized boating days may be underestimated due to the large number of public boat launches in the state relative to limited public access for swimming.

Resident nonmotorized boating days were also obtained from the same source as swimming days (Maine Department of Conservation, 1994). As was done for motorized boating, nonmotorized boating days were multiplied by 0.33 to remove nonmotorized boating days by anglers. Resident nonmotorized boating days were divided by seven to obtain an estimate of nonresident boating days.

Waterfowl hunting days in Maine were obtained from a 1988 survey of migratory waterfowl hunters who are residents of Maine (Boyle et al., 1990). In order to estimate the number of days spent hunting waterfowl at or near Great Ponds, resident waterfowl hunting days were multiplied by the proportion (75%) of waterfowl hunters who reported hunting inland wetlands such as ponds, marshes, and bogs (Teisl et al., 1991). Nonresident waterfowl hunting days were not estimated from the survey. For this report it was assumed that a nonresident waterfowl hunter hunts the same number of days per year on average as a resident waterfowl hunter. The number of nonresident hunters was multiplied by the average number of days residents hunt waterfowl. These approximations likely overestimate the use of migratory waterfowl hunting, but this overestimation should not significantly affect the overall results because waterfowl hunting is a small percentage (0.6%) of the total recreation use of lakes.

Other Uses

Over 400,000 people use Great Ponds as a source of drinking water and over 150,000 people attend youth camps or visit youth camps (Table 2). In addition, public water districts that draw water supplies from Maine's Great Ponds service 2,078 public accounts, 11,730 commercial accounts and 781 industrial accounts. These accounts are reported in Table 2 in parentheses because they cannot be converted into users. Commercial accounts include stores and other business such as hotels, motels and restaurants that service visitors to Maine. The data for residential, public, commercial and industrial account figures are presumed to be accurate. Seasonal drinking water usage is underestimated because data were not available for Great Ponds in unorganized territories. This omission is not expected to have a large impact on use rates because lakes in the unorganized territories do not contain extensive development. Use by youth

Table 2. Other Uses of Maine's Great Ponds.

Type of Use (Year Data Collected)	Numbers of Users		
	Residents	Nonresidents	All Users
Residential Pubic Drinking Water (1995)	256,181	NE[1]	256,181
Seasonal Private Drinking Water (1990-1995)	115,671	46,122	161,793
Public, Commercial and Industrial (1995)	NE	NE	(14,589 accounts)
Attend Youth Camps (1995)	44,343	21,024	65,367
Visit Youth Camps (1995)	73,728	34,956	108,684
Total Users	489,923	102,102	592,026

[1] NE indicates the numbers were not estimated.

camps is overstated because data were not available on the percentage of youth camps located on Great Ponds, but this percentage is assumed to be small.

Data on customers served by public water districts, which extract water from Great Ponds, were obtained from the 1995 annual reports to the Public Utilities Commission from 46 water districts. Although forty-nine Great Ponds serve as public water supplies (Great Pond Task Force and State Planning Office, 1996), the number of water districts and Great Ponds serving as sources differ because some districts draw water from more than one source. The number of residential customers served by public water districts was estimated by multiplying the total number of residential accounts (112,360) by U.S. Bureau of Census (1990) data on the average number of people per household in Maine (2.28). Because public water districts service public, commercial and industrial accounts, residential use substantially underestimates the total use of water from Maine's Great Ponds.

Seasonal use of lakes for drinking water was drawn from a University of Maine study of the effect of lake water quality on property values (Michael et al., 1996) and a recent survey of lake property owners by the University of Maine that has not been published. According to geographic information data, Maine's Great Ponds in organized communities have 25,973,704 feet of frontage. We assumed 90 percent of this frontage is developable (Bouchard, 1996), or 23,376,334 feet of frontage. Michael found the average lot frontage was 141.5 feet, and 70 percent of the lots have seasonal or year-round residences. The survey data indicate that 52 percent of lake residences draw drinking water from the lake and serve an average of 2.67 people per household. Michael also found that 75 percent of lake-front properties are owned by Maine residences. These data were used to compute the users of seasonal private drinking water supplies. Seasonal drinking water usage from Maine's Great Ponds is substantially underestimated because data on lakes in the unorganized territories were not available.

Information for youth camps was obtained from Belicka (1995) who conducted an economic impact study for the Maine Youth Camping Association. A total of 65,367 youths attended Maine youth camps in 1995. Belicka reported the total number of visitors (e.g., parents or family) for youths attending camps, but did not break this number down by resident status. We assumed that the percentage of visitors who were Maine residents is the same as the percentage of campers who are Maine residents. Use of Great Ponds by youth camps may be slightly overstated because we assumed that all youth camps are located on Great Ponds. We further assumed the Great Ponds are necessary for the existence of youth camps so all economic activity associated with these camps can be attributed to Great Ponds.

Lake-Front Properties

Using the numbers cited in the previous section, there are an estimated 308,766 users of Great Pond lake-front camps (Table 3). These user days can not be added to the numbers in Table 1 because angler days, swimming days, etc. by camp users are already accounted for in Table 1. However, the figures reported in Table 3 understate total use of Great Ponds associated with camps because they exclude people who visit camp owners, people who rent camps and camps on Great Ponds in unorganized territories. Braley et al. (1996) found that 11 percent of camp occupants were renters.

Table 3. Lake-Front Property Ownership on Maine's Great Ponds in Organized Communities.

Total Feet of Lake Frontage	Total Number of Lots	Total Number of Users		All Users
		Residents	Nonresidents	
25,973,704	165,204	231,574	77,191	308,766

Total Lake Use

It is not possible to add the use rates from Tables 1, 2 and 3 to obtain an estimate of the total use of Maine's lakes because the estimates are reported in different units (days, users and accounts) and because of double counting. The largest source of double counting involves lake-front property owners whose fishing effort is reported under open-water and ice fishing and whose use of lakes for drinking water is reported under seasonal private drinking water. Thus, Table 4 presents a summary of estimates that can not be added together because of the limitations of the available data.

Using the data cited in this section, we can estimate that there were 25.6 million user days associated with lake-front properties. Thus, netting out all recreation days (12.8 million) still

Table 4. Total Use of Maine's Great Ponds.

Type of Use	Number of Users			Annual User Days		
	Residents	Nonresidents	All Users	Residents	Nonresidents	All Users
Recreation	NA[1]	NA	NA	10,790,843	1,959,868	12,750,711
Residential Drinking Water	371,852	46,122	417,974	NA	NA	NA
Public, Commercial & Industrial	NA	NA	(14,589 Accounts)	NA	NA	NA
Youth Camps	118,071	55,980	174,051	NA	NA	NA
Lake-Front Properties	231,574	77,191	308,766	NA	NA	NA

[1] NA indicates that the data are not available.

leaves an additional 12.8 million user days not accounted for in recreation day estimates. In addition, lake-front properties on lakes in unorganized territories and people who visit owners of lake-front properties are not reported here. Thus, the largest single source of usage of lakes in Maine is associated with ownership of lake-front properties. (The 25.6 million user days would include rentals of lake-front properties.)

Potable water is perhaps the most important use of Maine's Great Ponds. If the number of residents served by public water district residential accounts is multiplied by 365 days, assuming water is used every day of the year, this results in 93.5 million user days. This is over seven times the number of total recreation user days. In addition, Braley et al., (1996) found that 73 percent of camps on lakes are used seasonally and the average days of use is 83. This results in an additional 9.8 million user days for drinking water (161,793 x 0.73 x 83). Total use of potable water from Maine's lakes exceeds recreation use by a ratio of eight to one.

Direct Expenditures of Great Pond Users

Recreation Uses

In total, recreation uses of Maine's lakes generate almost $1.1 billion in direct sales, with $0.16 billion (15 percent) being new money brought into the state by nonresidents (Table 5). As was reported for recreation user days, recreation expenditure data also contain over reporting caused by a recall bias. Daily expenditures are multiplied by days of use from Table 1, which also contain overestimations, to derive aggregate annual expenditures. Therefore, total sales are likely an upper bound estimate.

Expenditures for resident and nonresident lake swimming were obtained from spending profiles developed for the U.S. Army Corps of Engineers at twelve Corps project sites across the United States (Propst et al., 1992). Expenditures specifically for swimming were not reported. Daily expenditures were reported for all nonboating activities at reservoirs for day and overnight users, which included lodging, food, auto, recreation, and other costs. These estimates were used for swimming. Expenditures by overnight users were divided by the average number of days spent at the site to obtain average daily expenditures. Day user expenditures were multiplied by the percentage of day users, and overnight user daily expenditures were multiplied by the percentage of overnight users to obtain weighted average daily expenditures for residents and nonresidents. There is no reason to believe swimming expenditures are overstated or understated.

Table 5. Direct Expenditures for Recreation Uses of Maine's Great Ponds.
(July 1996 Dollars)

Type of Use (Year Data Collected)	Daily Expenditures Per Person		Aggregate Annual Expenditures		
	Residents	Nonresidents	Residents	Nonresidents	All Users
Swimming Trips (1989)	$38.77	$44.80	$236,866,559	$39,098,343	$275,964,902
Open Water Fishing Trips (1994)	$21.54	$48.66	$41,391,675	$35,677,622	$77,069,297
Ice Fishing Trips (1994)	$23.34	$33.44	$16,163,989	$2,141,778	$18,305,768
Fishing Equipment (1988)	$18.09	$15.21	$47,301,241	$12,124,496	$59,425,736
Motorized and Nonmotorized Boating Trips (1989)	$73.41	$61.10	$145,930,524	$17,352,304	$163,282,827
Boating Equipment (1989)	$217.41	$180.96	$432,178,859	$51,389,514	$483,568,374
Waterfowl Hunting Trips (1989)	$42.39	$95.76	$3,350,565	$551,534	$3,902,098
Waterfowl Hunting Equipment (1989)	$70.19	$55.05	$5,548,013	$317,070	$5,865,082
Total Expenditures	NA[1]	NA	$928,731,424	$158,652,660	$1,087,384,084

[1]NA indicates not applicable

Angler trip expenditures for open water and ice fishing trips were obtained from recent surveys of licensed anglers for the Maine Department of Inland Fisheries and Wildlife; the same data as the user day estimates for fishing (MacDonald et al., 1996a). Trip expenditures include fishing licences, fuel, food and beverages, lodging, commercial transportation, equipment rental, highway tolls, land access fees, bait, and all other expenses incurred while on a trip. Fishing equipment expenditures were obtained from a previous survey of licensed anglers in Maine (Boyle et al., 1990). This study reported equipment expenditures for inland fishing as a whole, not separate estimates for open water and ice fishing. Annual equipment expenditures for residents and nonresidents were divided by the average days of use for resident and nonresident anglers (Boyle and Fenderson, 1994) for the year these data were collected to calculate daily expenditures. Fishing expenditures are likely to be overstated due to recall bias, just as fishing days are likely to be overstated.

Trip expenditures for resident and nonresident motorized boating and nonmotorized boating were obtained from the same study as the swimming expenditures (Propst et al., 1992). These data did not distinguish between motorized and nonmotorized boating, and for the analyses reported here it is assumed the expenditures for the two types of boating are the same. Daily boating expenditures, for both trips and equipment, were estimated from boating expenditures for day and overnight users, which included lodging, food, auto, boating, and other costs. Expenditures by overnight users were divided by the average number of days spent at the site to obtain their average daily expenditures. Day user expenditures were multiplied by the percentage of day users and added to the overnight user expenditures multiplied by the percentage of overnight users to obtain weighted average daily expenditures. Equipment expenditures for nonresidents were estimated by multiplying resident equipment expenditures for boating by the ratio of nonresident to resident fishing equipment expenditures. While there is no clear evidence to indicate that boating expenditures are overstated, the sheer magnitude of these numbers relative to the others reported in Table 5 and the absence of individual estimates for nonmotorized boating suggests that the daily expenditures are overestimates.

Trip expenditures for waterfowl hunting were obtained from the same study as was used for use rates (Teisl et al., 1991), but only resident expenditures were reported. Nonresident expenditures were estimated by multiplying resident waterfowl hunting expenditures by the ratio of nonresident to resident open water fishing expenditures. Waterfowl equipment expenditures were computed in a manner similar to that of fishing. However, equipment expenditures specifically for waterfowl hunting were not available. It was assumed that waterfowl hunting equipment expenditures are the same as for an average hunter. This assumption likely understates waterfowl hunting equipment expenditures because of the special gear used for this type of hunting. This underestimation should not affect the overall estimate for lake-associated recreation expenditures because of its small proportion of use, and consequently, expenditures attributable to waterfowl hunting. Annual waterfowl hunting equipment expenditures were taken from Boyle et al., (1990) and were divided by days of use (unpublished data) to compute daily equipment expenditures.

Other Uses

Other uses of lake water generated $0.4 billion dollars in direct sales, of which $0.02 billion (6 percent) came from nonresidents (Table 6). The nonresident share is understated because it does not reflect final sales by commercial and industrial users to individuals who are not residents of Maine. These sales are included in the "all users" column. This figure also does not reflect rentals of private camps to nonresidents. Except for private drinking water and visitors to youth camps, these figures are presumed to be accurate. Expenditures by owners of private drinking water supplies for camps are probably underestimated and expenditures by visitors to youth camps are likely overstated. These are the smallest categories in terms of total dollar magnitude, and their errors are not likely to substantially affect the total for other uses reported in Table 6.

Table 6. Direct Expenditures for Other Uses of Maine's Great Ponds.
(July 1996 Dollars)

Type of Use (Year Data Collected)	Aggregate Annual Expenditures		
	Residents	Nonresidents	All Users
Residential Public Drinking Water (1995)	$141,274,383	NE[1]	$ 141,274,383
Seasonal Private Drinking Water (1995)	$178,520	$71,183	$249,703
Commercial and Industrial Uses (1995)	NE	NE	$179,137,763
Attend Youth Camps (1995)	$30,770,122	$14,588,797	$45,358,919
Visit Youth Camps (1995)	$17,739,133	$8,410,517	$26,149,650
Total Expenditures[2]	$189,962,159	$23,070,497	$392,170,419

[1] NE indicates the numbers were not estimated.
[2]Resident and nonresident totals do not sum to the total for all users because these estimates do not include the figure for commercial and industrial uses.

Expenditures by customers of water districts, which extract water from Great Ponds, was defined as annual operating revenues for the water districts. Estimates for operating revenues were obtained from the water districts' 1995 annual reports to the Public Utilities Commission. Sales were reported separately for residential and nonresidential (commercial and industrial) users in the annual reports. These revenue estimates are presumed to be correct.

Expenditures for private drinking water supplies are based on the estimated number of lake residences drawing potable water from the lakes (43,306 resident owned and 17,270 nonresident owned). Braley et al. (1996) estimated that camp owners spend an average of $4 per year to replace or maintain their private water systems. Although the systems are not replaced very often and annual maintenance appears to be minimal, this expenditure appears to be quite low. These estimates omit camps on lakes in unorganized territories.

The revenue figures for youth camp attendees represent the tuition paid to attend youth camps and the expenditures in Maine of visitors to youth camps (Belicka, 1995). Only aggregate figures for all campers and visitors were reported. We used the percentage of resident and nonresident campers to allocate these totals to residents and nonresidents. The total revenue from youth camp attendance is presumed to be correct, but the daily expenditures reported by Belicka for visitors are probably high. Visitors are essentially tourists and their daily expenditures should be in the range reported for recreation activities in Table 5. Belicka reported a daily expenditure of youth camp visitors of $104.70 per day, which is higher than any of the daily trip expenses reported in Table 5.

Lake-Front Properties

Lake-front property owners contribute to economic activity within the state through the taxes they pay and investments they make in their properties that are unique to being located on a lake. These direct expenditures generate $0.3 billion in economic activity annually, with $0.09 billion (25 percent) coming from nonresident property owners (Table 7). These estimates are understated because lake-front properties in unorganized territories are not included due to a lack of data on these properties.

Annual property taxes were computed using the total feet of developable lake-front (23,376,334) on Great Ponds for the organized communities in Maine multiplied by the average

Table 7. Direct Lake-Front Property Expenses for Maine's Great Ponds.
(July 1996 Dollars)

Type of Expenditure (Year Data Collected)	Aggregate Annual Expenditures		
	Residents	Nonresidents	All Users
Taxes (1995)	$176,335,165	$58,778,388	$235,113,553
Purchases and Maintenance (1995)	$86,133,279	$28,711,093	$114,844,372
Total Expenditures	$262,468,444	$87,489,481	$349,957,925

price per foot of frontage of $657.49 from Michael et al. (1996).[55] Tax rates from each community, the feet of frontage in the community and the average price $654.49 per foot were used to calculate tax revenue.

Braley et al. (1996) also found that lake front property owners spent an average of $993 on maintenance and improvements that would not have occurred if the property were not on a lake. This figure nets out boating and drinking water expenditures that are reported previously.

Total Direct Lake-Related Expenditures

The total direct expenditures by lake users are estimated to be $1.8 billion annually (Table 8). Of this total $0.3 billion (15 percent) is new money that is brought into the state economy each year by nonresidents.

[5] In this analysis it is assumed that sales price and assessed values are the same.

Table 8. Total Direct Expenditures for All Uses of Maine's Great Ponds. (July 1996 Dollars)

Type of Use	Aggregate Annual Expenditures		
	Residents	Nonresidents	All Users
Recreation	$928,731,424	$158,652,660	$1,087,384,084
Other Uses[1]	$189,962,159	$23,070,497	$392,170,419
Lake-Front Properties	$262,468,444	$87,489,481	$349,957,925
Total Expenditures[1]	$1,381,162,028	$269,212,638	$1,829,512,429

[1]Resident and nonresident totals do not sum to the total for all users because these estimates do not include the figure for commercial and industrial uses.

Multipliers Effects of Direct Expenditures

The $1.1 indirect recreation expenditures results in $1.7 billion in total economic activity (Table 9). Overall the $1.8 billion in economic activity associated with Great Ponds yields over $2.8 billion in total economic activity. Of this total, nearly $0.4 billion (13 percent) is attributable to nonresidents. Overall, economic activity associated with Great Ponds represents 5 percent of Maine's gross regional product.

This economic activity leads to over $1.2 billion in annual income for Maine residents and supports over 50,000 jobs (Table 10). The nonresident share of sales provides nearly $0.2 billion in income and over 8,500 jobs. In terms of the total number of jobs, nonresident expenditures support an approximate equivalent to Bath Iron Works. The jobs associated with Great Ponds, however, are likely to be less skilled with lower wages than those at Bath Iron Works.

Table 9. Direct and Indirect Sales Associated with Uses of Maine's Great Ponds. (July 1996 Dollars)

Type of Use	Residents	Nonresidents	Total
Recreation			
Direct Sales	$928,730,424	$158,652,660	$1,087,383,084
Direct and Indirect Sales	$1,463,000,000	$253,000,000	$1,716,000,000
Other Uses[1]			
Direct Sales	$189,962,158	$23,070,497	$392,170,418
Direct and Indirect Sales	$363,300,000	$41,090,000	$753,390,000
Lake-Front Properties			
Direct Sales	$262,468,444	$87,489,481	$349,957,925
Direct and Indirect Sales	$290,000,000	$98,000,000	$388,000,000
All Uses			
Direct Sales	$1,381,161,026	$269,212,638	$1,829,511,427
Direct and Indirect Sales	$2,116,300,000	$392,090,000	$2,857,390,000

[1]Resident and nonresident totals do not sum to the total for all users because these estimates do not include the figure for commercial and industrial uses.

Table 10. Income and Employment Effects.

Type of Use	Aggregate Annual Income and Employment		
	Resident	Nonresident	All Users
Recreation			
Income	$675,700,000	$117,070,000	$792,770,000
Employment	30,920	5,318	36,239
Other Uses[1]			
Income	$133,210,000	$25,580,000	$259,620,000
Employment	4,714	1,429	8,834
Lake-Front Properties			
Income	$125,120,000	$42,000,000	$167,120,000
Employment	5,481	1,835	7,316
All Uses			
Income	$934,030,000	$184,650,000	$1,219,510,000
Employment	41,115	8,582	52,388

[1]Resident and nonresident totals do not sum to the total for all users because these estimates do not include the figure for commercial and industrial uses.

Net Economic Value of Maine's Great Ponds

Recreation Uses

The aggregate annual net economic value for recreation uses is $0.21 billion (Table 11), or 19 percent of total recreation expenditures. Daily net economic value estimates represent the best available data and there is no reason to believe these figures are overstated or understated. Aggregate annual net economic values are derived by multiplying daily values by total user days reported in Table 1. Because user days may be overstated, aggregate annual net economic values would be overstated by a similar magnitude.

The daily net economic value for swimming is an estimate for the eastern United States reported in by McCollum et al. (1990). It was assumed that resident and nonresident net economic values for swimming are equal.

Resident and nonresident average annual net economic values per angler for open water and ice fishing were reported by MacDonald et al. (1996a). Average annual net economic values per angler were divided by the average annual fishing days per angler to obtain daily net economic values. Average annual angler days of open water fishing were obtained from MacDonald et al. (1996b) and average annual angler days for ice fishing were obtained from MacDonald et al. (1995). These represent the best estimates of net economic values for inland fishing in Maine, and there is no reason to believe daily net economic values are overestimated or underestimated.

Table 11. Net Economic Values for Recreation Uses of Maine's Great Ponds. (July 1996 Dollars)

Type of Use (Year Data Collected)	Daily Net Economic Values Per Person		Aggregate Annual Net Economic Values		
	Residents	Nonresidents	Residents	Nonresidents	All Users
Swimming (1986)	$14.47	$14.47	$88,395,686	$12,627,955	$101,023,641
Open Water Fishing (1994)	$10.33	$14.48	$19,849,140	$10,621,313	$30,470,454
Ice Fishing (1994)	$14.63	$18.51	$10,132,661	$1,185,516	$11,318,177
Motorized Boating (1987)	$22.55	$31.63	$38,674,896	$7,748,391	$46,423,287
Nonmotorized Boating (1987)	$17.51	$24.56	$4,783,528	$958,363	$5,741,891
Waterfowl Hunting (1988)	$151.66	$212.69	$11,988,059	$1,225,058	$13,213,117
Total Net Economic Values	NA[1]	NA	$173,823,970	$34,366,596	$208,190,567

[1]NA indicates not applicable.

Daily net economic value for motorized boating was obtained from by Bergstrom and Cordell (1991) and applies to motorized boating in the entire U.S. Nonresident net economic value for motorized boating was not reported. Thus, the resident net economic value was multiplied by the ratio of nonresident to resident net economic value for open water fishing to obtain an estimate of net economic value for nonresident motorized boating. The daily net economic value for nonmotorized boating was obtained from the same source as for motorized boating, and the nonresident net economic value for nonmotorized boating was derived in the same manner as was done for nonresident motorized boating. There is no reason to believe these estimates are overstated or understated.

Annual resident net economic value for migratory waterfowl hunters was reported by Boyle et al. (1990). Annual net economic value was divided by the average number of waterfowl hunting days per hunter to obtain a daily net economic value per hunter. Nonresident waterfowl hunting net economic value was not reported. Resident net economic value was multiplied by the ratio of nonresident to resident net economic value for open water fishing to obtain an estimate of net economic value for nonresident waterfowl hunting. There is no reason to believe these estimates are overstated or understated.

Other Uses

Net economic values for other uses is $0.1 billion (Table 12), which is a substantial underestimate. Net economic values that accrue to producers (commercial and industrial users) are not available. Likewise, no data are available for net economic values of youth camp attendees.

Net economic value for public drinking water was derived from an estimated demand function for public water districts in the northeast (Nieswiadomy, 1992). It was assumed that the daily net economic value to private water users was the same as for public residential supplies.

The net economic value for visitors to youth camps was assumed to be the same as that of swimming; both are low intensity recreation activities.

Table 12. Net Economic Values for Other Uses of Maine's Great Ponds (July 1996 Dollars).

Type of Use (Year Data Collected)	Daily Net Economic Values Per Household		Aggregate Annual Net Economic Values		
	Residents	Nonresidents	Residents	Nonresidents	All Users
Residential Pubic Drinking Water (1984)	$2.46	NE[1]	$100,997,495	NE	$100,997,495
Seasonal Private Drinking Water (1984)	$2.46	$2.46	$8,855,182	$3,530,883	$12,386,066
Commercial & Industrial Uses (NA)[2]	NE	NE	NE	NE	NE
Attend Youth Camps (NA)	NE	NE	NE	NE	NE
Visit Youth Camps (1986)	$14.47	$14.47	$1,066,849	$505,817	$1,572,666
Total Net Economic Values	NA	NA	$110,919,526	$4,036,700	$114,956,227

[1] NE indicates the numbers were not estimated.
[2] NA indicates not applicable.

Lake-Front Properties

The net economic value accruing to owners of lake front properties was approximated from the Michael et al. (1996) study of the relationship between property values and lake water clarity, and is based on the current average water clarity for lakes in Maine of 3.78 meters. This estimate is $6.4 billion (Table 13). This result shows that there are tremendous benefits associated with owning lake-front property.

Table 13. Net Economic Values Accruing to Ownership of Properties with Frontage on Maine's Great Ponds. (July 1996 Dollars)

Net Economic Value Per Property	Aggregate Annual Net Economic Values		
	Residents	Nonresident	All Users
$36,611	$4,803,876,456	$1,601,292,152	$6,405,168,608

Total Net Economic Values

The total net economic value of Maine's Great Ponds is $6.7 billion dollars (Table 14). Due to the omissions cited above, this number is an underestimate.

Table 14. Total Net Economic Values Associated with Uses of Maine's Great Ponds. (July 1996 Dollars)

Type of Use	Aggregate Annual Net Economic Values		
	Resident	Nonresident	All Users
Recreation Uses	$173,823,970	$34,366,596	$208,190,567
Other Uses	$110,919,526	$4,036,700	$114,956,227
Lake-Front Properties	$4,803,876,456	$1,601,292,152	$6,405,168,608
Total Net Economic Values	$5,088,619,952	$1,639,695,448	$6,728,315,400

Total Sales and Net Economic Values

A total of $1.8 billion in direct sales and $1.0 billion in indirect sales associated with uses of Maine's Great Ponds occur annually in Maine, for a total economic impact of $2.8 billion annually (Table 15). Within this total, direct sales are likely overestimated due to biases in data collection. Indirect sales, while derived from direct sales, are likely understated due to the use of a conservative margin and conservative multipliers. Net economic values, which are understated due to missing data, are nearly four times greater than total sales. This indicates that users obtain substantial satisfaction from the use of Maine's lakes.

It is interesting to note that 95 percent of the net economic value of total net economic value accrues to lake-front property owners. Thus, those who can afford lake-front property reap

Table 15. Total Economic Effect of Maine's Great Ponds.
(July 1996 Dollars)

Type of Use	Aggregate Annual Economic Effects		
	Resident	Nonresident	Total
	Expenditures		
Recreation Uses	$928,731,424	$158,652,660	$1,087,384,084
Other Uses	$189,962,159	$23,070,497	$392,170,419
Lake-Front Properties	$262,468,444	$87,489,481	$349,957,925
Total Direct Expenditures	$1,381,162,028	$269,212,638	$1,829,512,429
	Direct and Indirect Sales		
Total Direct and Indirect Sales	$2,116,300,000	$392,090,000	$2,857,390,000
	Net Economic Value		
Recreation Uses	$173,823,970	$34,366,596	$208,190,567
Other Uses	$110,919,526	$4,036,700	$114,956,227
Lake-Front Properties	$4,803,876,456	$1,601,292,152	$6,405,168,608
Total Net Economic Values	$5,088,619,952	$1,639,695,448	$6,728,315,400

substantial satisfaction from this ownership. The same lake-front property owners pay substantial property taxes each year, and communities with lakes reap these benefits. At the same time, Braley et al. (1996) estimated that 73 percent of lake-front property owners use their properties seasonally. Thus, lake communities receive a windfall in tax revenue with very little provision of services.

It is not possible to place confidence bounds on the estimates reported here because original data were not collected for this project; available estimates from other studies were used.

It is safe to say that Maine's lakes generate over a billion dollars each year in economic activity within the state. Maine's lakes are a stunning natural and economic asset to the state.

Benefits from Water Quality Improvements

Eutrophication of Maine's lakes, the primary cause of diminished water clarity and the major threat to Maine's lakes, reduces the desirability of Great Ponds for all recreation activities, including camp ownership. This reduced desirability is reflected by lower net economic values, and consequently, lower use rates and decreased direct and indirect sales.

According to the Maine Department of Environmental Protection there are 189 Great Ponds that have diminished water clarity (less than 3 meters) that is not due, at least in part, to natural coloration of the water. The average minimum water clarity in these waters during the summer months is 2.27 meters. The comparable water clarity for lakes that do not have compromised water clarity is 5.15 meters. The statewide average minimum water clarity for monitored lakes is 3.78 meters during the summer months.

In this section a simulation is conducted to investigate how net economic values, expenditures and use rates might change if eutrophication were reduced in the 189 lakes that experience diminished water clarity. The statewide average minimum water clarity would increase from the current level of 3.78 to 5.15 meters (the average for lakes without compromised water clarity).

In this scenario, it is assumed that all recreation uses, except waterfowl hunting, would be affected. Reducing eutrophication is not expected to affect waterfowl abundance or hunter success; nor would it diminish the quality of waterfowl hunting. Swimmers and boaters would benefit from the enhanced aesthetic quality of the lake waters. Anglers would benefit from improved cold water fisheries (trout and salmon) that are preferred to warm water fisheries (bass and perch), which are more prevalent in eutrophic lakes.

Reducing eutrophication is not expected to affect most public water supplies because the source lakes generally have high a trophic status with water clarity in excess of 3 meters. To the extent that reducing eutrophication does affect public water supplies, purification costs may fall, giving rise to an increase in net economic values.

Reducing eutrophication would enhance seasonal drinking water supplies on the 189 lakes and would enhance water-based activities at youth camps on these lakes. No data are available, however, to address these changes.

Camp owners would also benefit from having a property on a lake with clearer water; their property values would rise, leading to higher property taxes. Reduced eutrophication may also lead camp owners to make improvements to their properties, but no data are available to address this change.

Increases in net economic values are computed from existing studies that have investigated the effect of lake eutrophication on net economic values. It was assumed that use rates and expenditures increased by the same proportions as the reported net economic values.

Changes in Net Economic Values

Net economic values would be expected to rise by $2.0 billion (Table 16). Thus, a 1.37 meter increase, or a 36 percent increase {(5.15-3.78/3.78)x100}, in the average statewide minimum water clarity during the summer months leads to a 30 percent increase in net economic value over the current *in situ* estimate reported in Table 14. This is an underestimate because

Table 16. Increase in Net Economic Values from Reducing Eutrophication in Maine's Great Ponds.
(July 1996 Dollars)

Type of User (Year Data Collected)	Daily Net Economic Value	Aggregate Annual Increases in Net Economic Values		
		Resident	Nonresident	All Users
Swimmers (1989)	$1.77	$10,829,954	$1,547,136	$12,377,090
Open Water Anglers (1989)	$1.55 (res.) $2.23 (nonres.)	$2,971,428	$1,635,943	$4,607,371
Ice Anglers (1989)	$2.46 (res.) $2.82 (nonres.)	$1,700,356	$180,683	$1,881,040
Boaters (1978)	$2.60	$5,169,705	$738,529	$5,908,234
Lake-Front Property Owners (1994)	NA[1]	$1,490,464,950	$496,821,650	$1,987,286,600
Total Net Economic Values	NA	$1,511,136,393	$500,923,941	$2,012,060,335

[1] NA indicates not applicable.

changes in net economic values for some activities could not be calculated. Approximately 25 percent of the increase accrues to nonresidents, and over 98 percent of the increase accrues to lake-front property owners.

The change in daily net economic value for swimming was obtained from a study of improved water quality in New Hampshire (Needelman and Kealy, 1995). Kratzer (1994) reported annual increases in net economic values to anglers gained by elimination of eutrophication in Maine lakes. (The same change in annual net economic value was used for open-water and ice fishing.) Annual values were divided by the average number of fishing days per year from MacDonald (1996b) and MacDonald (1995) to obtain daily net economic value changes. Daily values differ for the two types of fishing and residency due to differences in average number of days of participation per year. Parsons and Kealy (1992) reported daily net economic value changes for boaters, and did not distinguish between net economic values motorized and nonmotorized boaters. The change in net economic value for property owners was approximated using the results from Michael et al. (1996).

Changes in Use Rates

The increase in water clarity would be expected to increase recreation use rates by 1.6 million user days (Table 17); an increase of 13 percent over the in situ estimate reported in Table 1. Fifteen percent of the increase is from nonresident visitation. Swimming and open-water fishing account for over 75 percent of the additional days of use.

Some of the increase in resident visitation may come from residents taking fewer trips outside of Maine, reducing a leakage from the Maine economy, but most of the increase would result form shifts from other activities within Maine. A large increase in lake-front property owners is not expected because lakes experiencing eutrophication are generally heavily developed.

Table 17. Increase in Use Rates from Reducing Eutrophication in Maine's Great Ponds.

Type of Use	Aggregate Annual Increases in Days per Year of Use		
	Residents	Nonresidents	All Users
Swimming	748,542	106,935	855,476
Open Water Fishing	287,694	112,941	400,635
Ice Fishing	116,194	9,760	125,954
Motorized Boating	197,707	20,139	217,846
Nonmotorized Boating	40,572	4,133	44,705
Total User Days	1,390,708	253,908	1,644,617

Changes in Direct Expenditures

Reducing eutrophication would increase direct expenditures by $107 million (Table 18), a six percent increase over the in situ expenditures reported in Table 8. Twenty-three percent ($24.7 million) of the increase in direct sales is attributable to nonresidents and represents new money entering Maine's economy. The vast majority of the resident share ($82.4 million) is not likely to be new money in Maine's economy. Resident expenditures simply represents a transfer between sectors of the economy and regions of the state as residents change their spending pattern within the state.

Of the new money brought into the state, $7 million (28 percent) is property taxes paid by nonresidents. Thus, community actions to protect water quality can have significant benefits by maintaining tax revenues and enhancing future tax revenues.

Table 18. Increase in Direct Expenditures from Reducing Eutrophication in Maine's Great Ponds. (July 1996 Dollars)

Type of Use	Aggregate Annual Increases in Expenditures		
	Residents	Nonresidents	All Users
Swimming Trips	$29,020,125	$4,790,203	$33,810,328
Open Water Fishing Trips	$6,196,359	$5,495,228	$11,691,587
Ice Fishing Trips	$2,712,470	$326,426	$3,038,897
Motorized Boating Trips	$14,513,702	$1,230,577	$15,744,279
Nonmotorized Boating Trips	$2,978,410	$252,531	$3,230,941
Lake-Front Property Taxes	$21,024,802	$7,008,267	$28,033,069
Total Direct Expenditures	$82,376,286	$24,672,356	$107,048,642

Changes in Indirect and Induced Sales

The change in nonresident expenditures of $24.7 million in direct sales results in $39.0 million in direct plus indirect sales. These increases would increase income of Maine residents by $18.2 million and would provide 825 more jobs. Only nonresident expenditures are considered here because they represent true increases in economic activity in Maine, while changes in resident expenditures represent transfers of expenditures within Maine. Lake-front properties account for 36 percent of the nonresident contribution of expenditures and indirect and induced sales.

Total Economic Effect of Reducing Eutrophication

Reducing eutrophication is estimated to bring $24.7 million in additional expenditures and $39.0 million direct plus indirect sales from nonresidents (Table 19). Resident expenditures are not counted here because they are assumed to be transfers within Maine's economy. This is a

10 percent increase over the current estimated sales due to nonresidents reported in Table 10. Net economic values increase by $2 billion, with 75 percent of this increase accruing to resident property owners.

It is important to note that if eutrophication is not reversed and Maine's lakes were allowed to degrade, the losses could be greater than the gains reported here. Michael et al. (1996) has shown that there is a nonlinear relationship between lake-water quality and the economic effects of lakes. Thus, if the average water clarity fell from 3.78 meters to 2.41 meters, a loss of 1.37 meters rather than a gain, the economic loss could be as much as 50 percent greater than the gain reported here. Thus, the economic logic indicates that it is much more cost effective to protect Maine's lakes from eutrophication than it is to attempt to reverse eutrophication once it has occurred. From a practical perspective, reversing eutrophication may not be technically feasible.

Table 19. Change in the Total Economic Effect of Maine's Great Ponds From Reducing Eutrophication.
(July 1996 Dollars)

Use Category	Residents	Nonresidents	All Users
Total Net Economic Values	$1,511,136,393	$500,923,941	$2,012,060,335
Total Direct Expenditures	NA[1]	$24,672,356	$24,672,356
Total Direct and Indirect Sales	NA	$39,000,000	$39,000,000

[1] NA indicates not applicable.

Conclusions

The data reported here indicate that Maine's Great Ponds are an extremely valuable economic resource as well as a stunning natural resource. If only one message comes out of this work it should be "Do not kill the goose that laid the golden egg." Maine's Great Ponds provide a valuable source of potable water, they contribute to the enjoyment of many Maine residents, they help relieve property tax burdens on local people in rural communities, and they support substantial economic activity. Protecting water quality and reducing user conflicts should be a priority of everyone who cares about Maine's Great Ponds.

Water quality protection preserves potable water sources and maintains desirable recreation experiences. The desirable recreation opportunities help to draw nonresidents to Maine who spend money in rural communities. This is an export industry that does not deplete a natural resource. While Maine people are sometimes reticent to accept people from away. Nonresident expenditures are a valuable source of economic activity that helps to support and maintain service businesses, such as convenience stores, in rural communities.

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Appendix

Coefficients to Adjust Monetary Data to July 1996 Dollars

Type of Use/Year Data Collected	Adjustment Period	Adjustment Coefficients[1]
Swimming/1989 Trip Expenditures	1989 Annual Average to July 1996	1.266
Swimming/1986 Net Economic Value	1986 Annual Average to July 1996	1.432
Swimming/1989 Net Economic Value Change From Reducing Eutrophication	1989 Annual Average to July 1996	1.266
Open Water Fishing/1994 Trip Expenditures and Net Economic Value	1994 Annual Average to July 1996	1.059
Ice Fishing/1994 Trip Expenditures and Net Economic Value	1994 Annual Average to July 1996	1.059
Fishing Equipment Expenditures/1989	1989 Annual Average to July 1996	1.266
Fishing/1989 Net Economic Value Change from Reducing Eutrophication	1989 Annual Average to July 1996	1.266
Motorized and Nonmotorized Boating/1989 Trip and Equipment Expenditures	1989 Annual Average to July 1996	1.266
Motorized and Nonmotorized Boating/1987 Net Economic Value	1987 Annual Average to July 1996	1.382

Motorized and Nonmotorized Boating/1978 Net Economic Value Change From Reducing Eutrophication	1978 Annual Average to July 1996	2.408
Waterfowl Hunting/1988 Expenditures and Net Economic Value	1989 Annual Average to July 1996	1.266
Public and Private Drinking Water/1995 Expenditures	1995 Annual Average to July 1996	1.030
Residential Public and Seasonal Private Drinking Water/1984 Net Economic Value	1984 Annual Average to July 1996	1.511
Attend and Visit Youth Camps/ 1995 Expenditures	1995 Annual Average to July 1996	1.030
Lake-Front Properties/ 1994	1994 Annual Average to July 1996	1.059

[1] The adjustment coefficients were calculated by dividing the historical consumer price index for July 1996 (the most recent one available) by the annual average consumer price index of the year in which the data was collected.