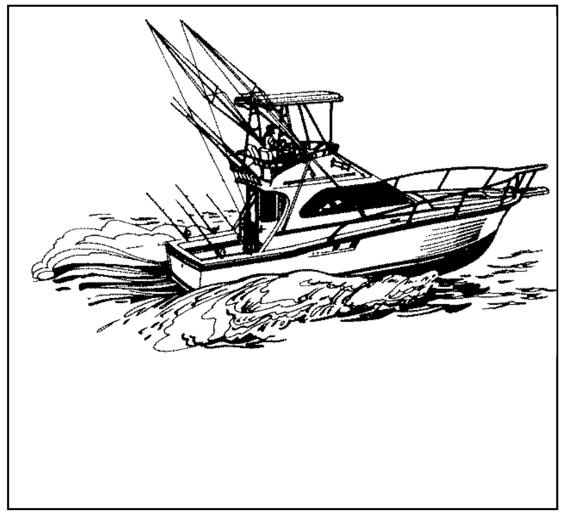
# Lake Ontario Sportfishing: Trends, Analysis, and Outlook



**June 2009**

**HDRU Series No 09-3**

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## AKNOWLEDGMENTS

We thank Tom Eckert and staff from the New York State Department of Environmental Conservation's Cape Vincent Fisheries Station for providing one of the datasets used in the analysis, and Shaun Keeler, Jana Lantry, and Steve LaPan for insights and information needed to do the model forecasting.

Funding for this study was provided under project R/FHD-11 funded under award NA070AR4170010 from the National Sea Grant College Program of the U.S. Department of Commerce's National Oceanic and Atmospheric Administration, to the Research Foundation of the State University of New York on behalf of New York Sea Grant. The statements, findings, conclusions, views, and recommendations are those of the authors and do not necessarily reflect the views of any of those organizations.

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# INTRODUCTION

Lake Ontario is New York's largest sport fishery, both in terms of angler days and expenditures. In 2007, angler effort on Lake Ontario (including embayments) exceeded 1.5 million angler days, and expenditures of Lake Ontario anglers in counties bordering the lake topped $54 million (Connelly and Brown 2009). Lake Ontario's sport fisheries are diverse. Its salmonine fisheries have been important to anglers and an important economic generator to local communities since their introduction around 1970, resulting in the first salmon runs in the Salmon River and other tributaries in 1973 (Brown and Connelly 1991, Brown 1976). In addition, warmwater fishing for bass is important, especially in the Eastern Basin of the lake, and accounted for approximately 21% of all angler days lake-wide in 2007 (Connelly and Brown 2009). The lake also has a significant yellow perch fishery.

## History of Lake Ontario Sportfishing

The stocking of salmonines since 1970 and their survival, growth, and availability for harvest have undergone periodic change as the Lake Ontario ecosystem has contended with many stressors and other agents of change over the past 30 to 40 years. These include phosphorous controls, implemented in Canada in 1970 and New York in 1972, which resulted in declines in algal abundance and epilimnetic zooplankton production and a shift in pelagic primary productivity toward smaller organisms (Mills et al. 2005). Sea lamprey, (*Petromyzon marinus*), which wiped out initial stockings of salmon in 1968, were brought under control, allowing the survival of stocked salmonines.

The alewife (*Alosa pseudoharengus*), which existed in perceived nuisance populations prior to 1970, became a pivotal food fish for salmonines; their expanded populations allowed for larger annual stockings of salmonines through the 1970s and much of the 1980s. However, zooplankton, the major food sources for alewives, declined in production through the 1980s due to a combination of predation and nutrient loss. Alewife abundance also declined, by 42% from the early 1980s to the early 1990s (O'Gorman et al. 2000). As a result of this trend, New York State and the Province of Ontario agreed on a maximum stocking of 8 million salmonines annually in the mid-1980s (Kerr and Le Tendre 1991), and stockings were further reduced to 4.5 million annually in 1993.

Other factors affecting sport fishing included increased populations of double-crested cormorants and their depredation of fish in the latter 1970s through their peak year on Little Gallloo Island in 1996, and the introduction of zebra mussels and other mussels (*Dreissena* spp.), which led to increased water clarity and caused changes in where bass and other species sought habitat. Several other exotics, including round goby (*Neogobius melanostomus*) were introduced in the latter 1990s.

The first fall salmon runs in the Salmon River (primarily) in 1973 signaled the start of a salmonine fishery that in the 1980s attained lake-wide importance to sport anglers—in near-shore areas in the spring, in the open lake in the summer, and in estuaries and tributaries in the fall, with steelhead fishing extending into winter. A substantial number of stakeholders developed around the fishery—anglers, charter captains, sporting goods stores, bait and tackle shops, guides, other recreation service sectors (lodging facilities, restaurants, groceries, convenience stores), local governments, and law enforcement agencies at both the state and local levels.

The number of charter fishing businesses using Lake Ontario increased from 33 in 1975 to 450 in 1985 (Dawson 1991). The number of charter fishing trips increased by 87% from 1985 to 1990 and exceeded 20,000 trips in 1990. Charter fishing trips comprised almost 10% of all open water fishing boat trips in 1990. The number of charter captains peaked somewhere in the early to mid 1990s, and declined substantially afterward. By 2002, an estimated 198 businesses were still operating (Lichtkoppler and Kuehn 2003).

Another factor reflecting the success of the fisheries has been the frequent fishing derbies. The Empire States Lake Ontario (ESLO) derby has been held annually since 1978. Fishing-related expenditures of derby entrants rose from $483,000 in 1978 to $6.0 million in 1988 (Brown et al. 1991). In later years the impact of the derby declined as fishing declined generally, but the estimated expenditures of ESLO derby entrants in 2007 were still substantial at $2.8 million (ESLO 2008).

Several studies over the years have documented various aspects of the economic development and impact on Lake Ontario communities that have been largely attributable to the growth in the fisheries since 1970 and their partial decline in the 1990s. At the peak of the fisheries, at least $100 million in angler expenditures accrued to communities on or near the lake (Connelly et al. 1990a). This number was derived from the 1988 statewide angler survey, which documented expenditures of $87.5 million related to fishing in the open lake and bays, $9.5 million by Salmon River anglers, $2.6 million by Lower Niagara River anglers, and additional expenditures occurred from anglers fishing other tributaries. At the local level, Brown and Connelly (1991) demonstrated the positive benefits of the fishery on Salmon River communities, even though the local county (Oswego) had no sales tax.

A series of specific changes in the size of hooks allowed for snagging and the eventual change in regulations that made snagging illegal, starting in 1995, represented a major policy shift that generated considerable debate. Snagging had initially been permitted on the biological basis that the spawning salmon would die anyway and thus techniques that increased harvest efficiency were proper. But concerns about the ethics of snagging, combined with a wide variety of human behavioral problems local communities faced from crowds of snaggers, led to the change in policy. An investigation of the likely impacts of a policy outlawing snagging and other forms of foulhooking on Salmon River angling showed that most anglers opposed the proposed policy change and that a reduction of up to 25% of angler days and resulting economic impact could be expected (Connelly et al. 1990b). The likely compensatory increase in anglers who had not fished for salmon previously because they opposed the type of fishing environment caused by snagging was believed to be small. Thus, the elimination of snagging may have been one of a number of factors that led to the decline in salmon fishing after 1990.

Contaminants are among the factors that may have depressed the demand for salmon fishing in Lake Ontario both as the fishery was developing and up to the present time. The discovery of PCBs and mirex in Lake Ontario salmon, trout, and some other species led to a ban on possession of salmon and trout in 1976-77 and salmon and trout stocking were temporarily discontinued in 1977 (Brown et al. 1991). Later, stocking and fishing for these species continued but health advisories were issued. For many years these advisories for many waters, including Lake Ontario, have stated that women of childbearing age, infants, and children should eat no fish and that others should eat no more than one meal per week.

By 2000-2001 marine trades businesses along the shore of eastern Lake Ontario were noting business declines and expressing concerns. Both fish populations and harvest appeared to be down substantially from previous years. Likely causes attributed by the marine trades sector included cormorant depredation on fish and also relocation of bass to better habitat cover due to increases in water clarity. The Lake Ontario Fisheries Coalition obtained state funds to examine tourism and fishing trends in recent years (prior to 2001). Some declines occurred in license sales for Jefferson and Oswego Counties, which closely mirrored statewide trends in license sales. Declines in fishing-related spending from 1986 to 2001 for the two-county area, in constant dollars, were estimated at $8.2 million, with a total economic impact, including indirect and induced effects, of $10.9 million (Brown et al. 2002).

**Sportfishing Trends and Previous Analysis**

The most detailed trend data on Lake Ontario fishing is DEC's annual estimate of open water fishing boat trips (Figure 1). These trips grew rapidly in the 1980s, peaked at around 220,000 in 1990, and declined sharply to less than 100,000 in 1996. Fishing boat trips remained at about this level in 2001, and then began an additional gradual decline.

By the late 1980s, concerns emerged and grew about the sustainability of Lake Ontario's salmon and trout fisheries at the levels at which they had evolved and the demands of some stakeholders that stockings should continue to increase. Siemer and Brown (1994) reviewed the motivational literature related to sportfishing as well as data showing that over 80% of the open water trips taken on the lake since 1985 had been for salmon and trout. Using investment theory (Maehr and Braskamp 1986), they hypothesized that highly invested anglers, including tournament anglers, snaggers (snagging was legal through 1994), and others would hold stronger motivations related to personal achievement than other anglers. A 1989 survey of a sample of boat anglers found results consistent with these hypotheses. Heavily invested anglers, including snaggers and tournament anglers, had significantly higher factor scores in the areas of challenge and accomplishment than other anglers. The results, which also included a strong novelty component, were called "particularly concerning," given a decision by DEC at that time to reduce stocking of coho and chinook salmon. The subsequent decline in fishing effort and accompanying economic impact, which the study results pointed to, occurred starting in 1991, as Figure 1 shows.

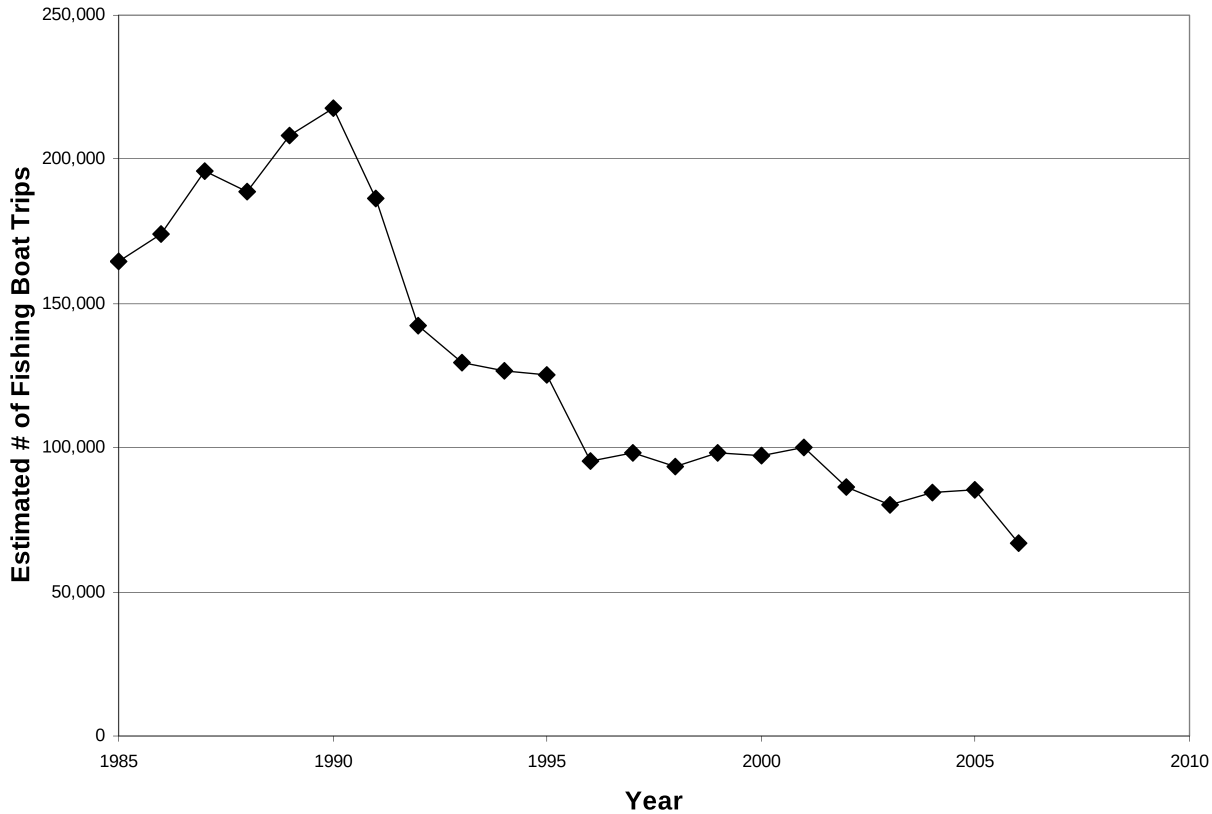


Figure 1. Annual estimate of open water fishing boat trips on Lake Ontario, 1985 to 2006.

## Study Purpose and Objectives

The overall purpose of this study was to synthesize previous data and knowledge to develop a better sense of factors associated with changing trends in fishing effort in Lake Ontario, to attempt to model changes in fishing longitudinally, and to use that information to develop short-term fishing forecasts. The specific objectives were:

1. To examine trends and likely causal factors related to changes in sportfishing demand in New York's Great Lakes waters over the past 30 years, by type of fishery and by major geographic subregions of these waters.

2. To develop quantitative models to explain the relative contribution of various biological and socioeconomic factors to changes in fishing participation on Lake Ontario.

3. To forecast changes in fishing participation for New York's Great Lakes waters over the next 3 to 5 years.

4. To estimate the economic impact associated with major changes in these fisheries historically, and with any changes forecasted from the results of Objective 3.

5. To examine the extent to which trends related to New York's Great Lakes fisheries are specific to the unique characteristics of these fisheries and their anglers versus a part of broader trends affecting New York State and the Great Lakes region.

# METHODS

An extensive literature review, summarized earlier in this report, was conducted of past human dimensions work and also of biological/ecological research pertaining to Lake Ontario fisheries. Longitudinal databases were updated with license sales information for New York and other Great Lakes states, and for counties within New York that border the Great Lakes. A longitudinal database of open boat fishing trips was obtained from the Cape Vincent Fisheries Station, New York State Department of Environmental Conservation (DEC). A database of socioeconomic factors that are available on an annual basis was developed. This included such items as the adult population of New York residents by broad age groupings, household income, cost of a New York fishing license, and dummy variables indicating the year of a license fee increase. Because of previous research indicating that a novelty factor was likely operating, a sequential time variable was also created.

A database of newspaper articles from the Syracuse Post Standard related to Lake Ontario was assembled from 1987 through 2006. The Post Standard covers both Eastern Lake Ontario and the central portion of the Lake, and had wide coverage of Lake Ontario sportfishing issues over this time period. Each article was coded as to issues dealt with in the article (snagging, cormorants, or viral hemorrhagic septicemia [VHS]) and whether the overall tone was positive, negative, or neutral (including balanced positive and negative) toward the impacts of these topics on fishing. The lack of available articles from earlier periods limited the usefulness of this database.

Multiple linear regression was used to examine factors explaining changes in fishing boat trips and license sales over time. Models were developed with significant factors and checked for collinearity. Three to five-year predictions were obtained for each of the significant variables to allow for forecasting of fishing boat trips and license sales using the models.

Economic impact analysis was used to show the extent to which anglers' expenditures contribute to the economies of communities in counties bordering Lake Ontario. Data from the recently completed statewide angler survey were used to estimate angler expenditures, and the economic impact of those expenditures was estimated using a computerized Input-Output economic model called IMpact Analysis for PLANing (IMPLAN) (MIG Inc., 2000). Using the forecasts from the regression models, estimates of economic impact under various scenarios were developed.

# RESULTS

## Declines in Lake Ontario Fishing: Local, Regional, or National Phenomenon?

It is natural that stakeholders look for local reasons when declines occur in fishing. Reduced stocking of salmonines, decreased productivity in the lake, and "negative" publicity by the media are among the reasons often given for decreased fishing in Lake Ontario. Indeed, local and regional factors, which will be examined later, may be at work. However, broader societal factors operating at a U.S. regional or national level, which may be far less visible to stakeholders, may also be operating, and will be examined first in this analysis.

Figure 2 compares fishing license sales nationally versus in the Great Lakes states from the early 1960s through 2005 and Figure 3 compares fishing license sales statewide in New York with those in counties bordering New York's Great Lakes (Lake Ontario and Lake Erie). License sales from the 1960s to the present are strongly correlated between (1) counties bordering New York's Great Lakes, (2) statewide in New York, (3) across all Great Lakes states, and (4) nationally. The Pearson correlation coefficient between license sales in New York counties and national sales over this period of time is 0.851. Similarly, the correlation between fishing license sales in New York and all of the Great Lakes states is 0.842. The correlation between sales nationally and in the Great Lakes states is 0.920, and the correlation between statewide sales in New York and in counties bordering New York's Great Lakes is 0.926. Given that sales trends across the four levels of license sales are non-linear and that the shapes of the graphs are similar, it is very likely that similar forces are operating at all levels.

Trend data are also available from DEC's open water fishery surveys for Lake Ontario and Lake Erie. Fishing effort for Lake Ontario peaked in 1990 and has trended downward since (Figure 1). The fishing effort curve for Lake Erie, using a measure of angler hours, is very similar to Lake Ontario except that peak effort occurred a year earlier for Lake Erie, in 1989.

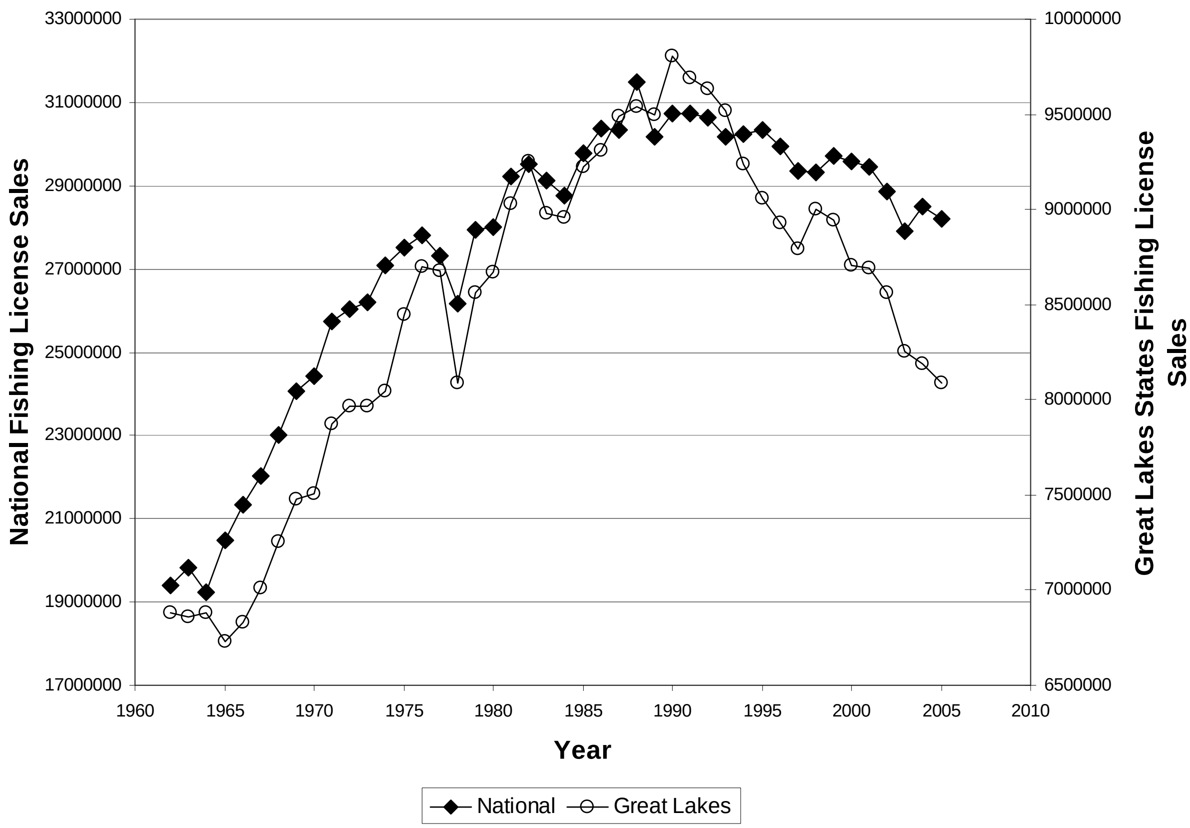


Figure 2. The number of fishing licenses sold nationally and in Great Lakes states between 1962 and 2005.

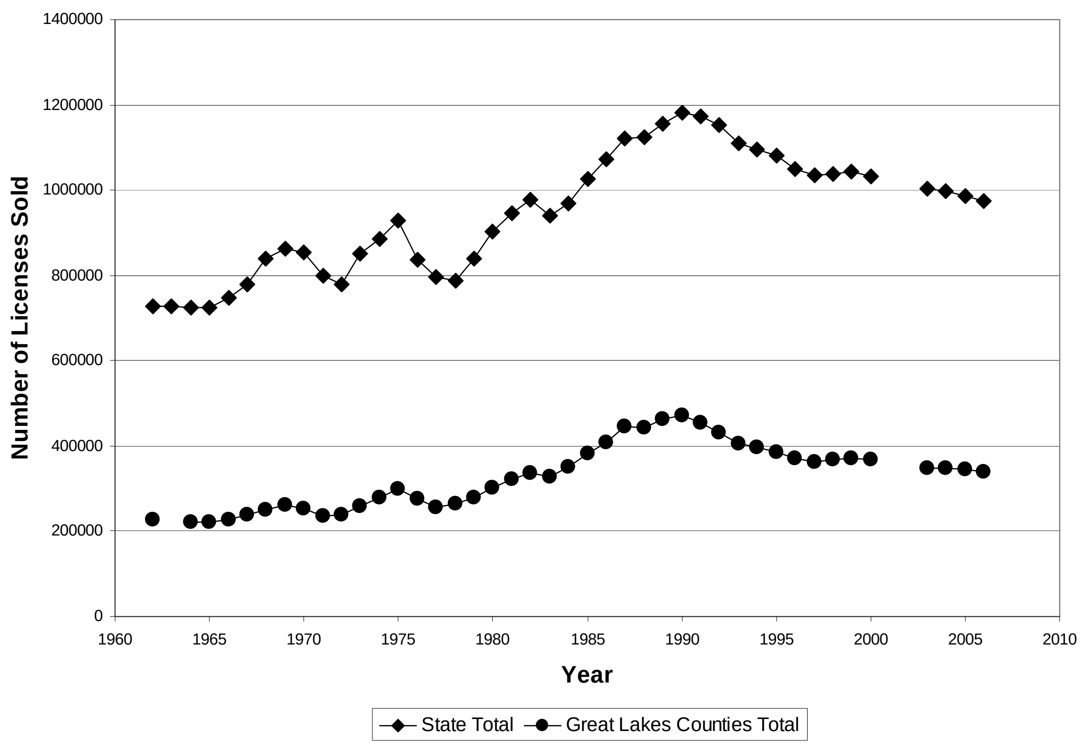


Figure 3. Number of fishing licenses sold in New York State and in New York Counties bordering the Great Lakes, 1962 to 2006.

## Models and Forecasts of Fishing License Sales and Fishing Effort

### Model of Statewide License Sales

For longitudinal models of statewide fishing license sales in New York, we used data from 1967 to 2006, minus 2001 and 2002, which were unavailable from DEC. Independent variables that were considered for inclusion in the model:

1. Weight of trout and salmon stocked statewide, lagged by 3 years
2. New York State population aged 18-64
3. New York State population aged 18-44
4. Number of interstate highway miles in New York, which had been statistically significant in some previous license sales modeling efforts
5. Cost of a New York resident fishing license
6. Dummy variable indicating the year of a license fee increase
7. Dummy variable counting the number of years since a license fee increase
8. Dummy variable squaring the number of years since a license fee increase
9. Time (1967-2006)

The best regression model found from these data, in terms of explained variance in license sales was:

Statewide fishing license sales (resident and nonresident) = -461,809 (Constant)
+176 New York State population aged 18-44 (standardized Beta = .676, sign. = .001)
+ 10,014 Dummy variable counting the number of years since a license fee increase (standardized Beta = .237, sign. = .001)
+ 0.167 Weight of trout and salmon stocked statewide lagged by 3 years (standardized Beta = .285, sign. = .019)

This model has an adjusted $r^2$ of 0.847, and has no problems related to collinearity.
It is similar to models developed previously for resident and nonresident fishing license sales (Connelly and Brown 1991). The variable that contributed most to the explanation of fishing license sales was the number of people living in New York State in the 18-44 age group. As the population increased, so did the number of fishing licenses sold. The second variable in the model was a dummy variable representing the number of years since a license fee increase. We have found that in the year of a fee increase the number of licenses sold decreases sharply, but then rebounds over several years. This dummy variable mirrors that pattern. The third variable in the model is a biological variable representing the availability of stocked trout and salmon. The variable, which measures the weight of the fish stocked, was lagged by three years so that it is associated with the time frame when anglers would be most likely to catch those fish. As would be expected, the model suggests that as more fish are stocked, the number of licenses sold increases.

### Forecast of Statewide Fishing License Sales

Inputting data provided by DEC and Bureau of Census into our model, we forecasted license sales five years into the future. Figure 4 shows the actual license sales and those predicted by the model. The sudden drop in predicted license sales occurs in the year of a fee increase. DEC is uncertain as to the year in which that will take place but believes it will occur sometime in the next five years. We chose a year for illustrative purposes in our model.

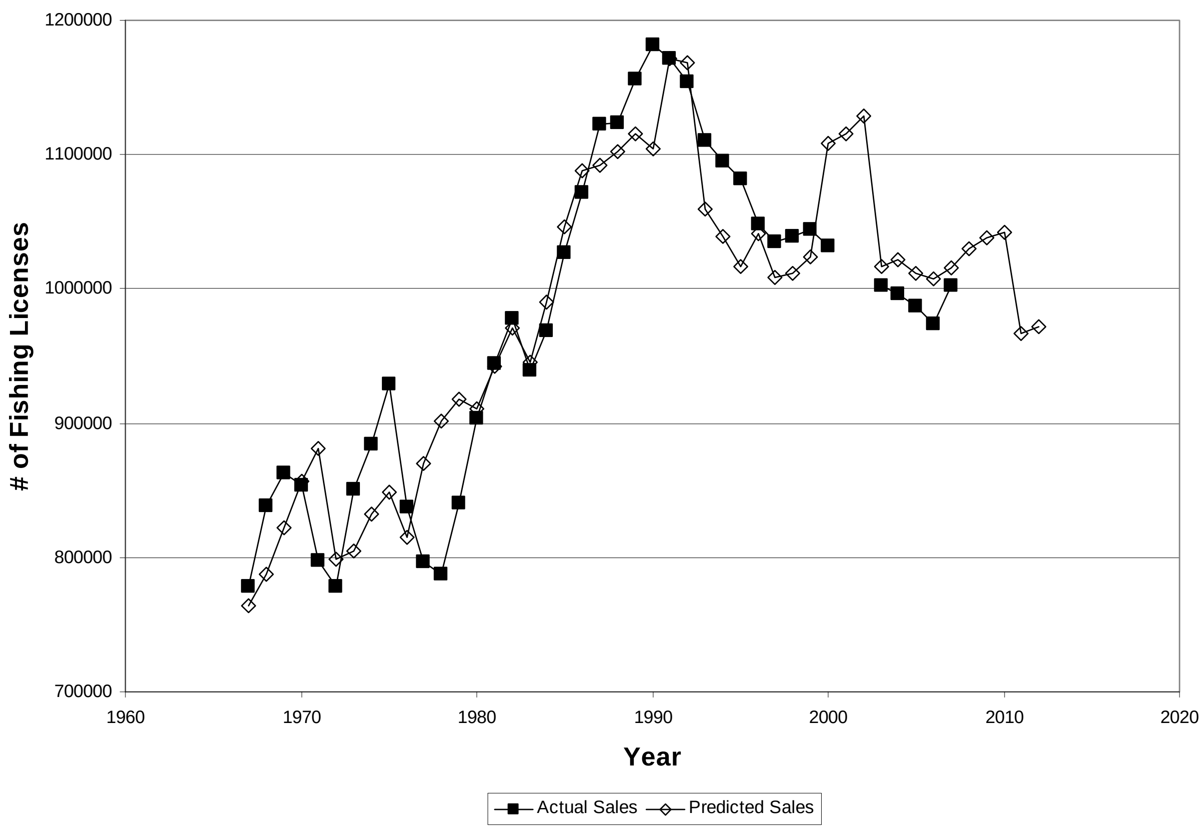


Figure 4. Actual fishing license sales in New York and those predicted by our model.

### Model of License Sales in Counties Bordering New York's Great Lakes

We also modeled fishing license sales (resident plus nonresident) for the ten counties bordering Lake Ontario, Lake Erie, and the Niagara and St. Lawrence Rivers. In addition to examining possible independent variables noted above for the statewide model, we tried dummy variables indicating two significant situations in Great Lakes fishing: the years when health advisories were issued and the years when snagging was allowed.

The best regression model found was:

Fishing license sales=

-446,530 (Constant)

+ 94 New York State population aged 18-44 (standardized Beta = .627, sign. = .001)

+ 0.120 Weight of salmon stocked statewide lagged by 3 years (standardized Beta = .357, sign. = .002)

+ 4,596 Dummy variable counting the number of years since a license fee increase (standardized Beta = .190, sign. = .004)

The model has an adjusted $r^2$ of 0.877. It is very similar to the statewide model, with the same three significant variables. This is not surprising because Figure 3 shows almost the same pattern in license sales statewide compared to Great Lakes counties. The years when snagging was allowed was not significantly correlated with license sales. The years when health advisories were issued was significantly correlated with license sales, but with the wrong sign to be a possible causal agent. This correlation simply reflects that the presence of contaminants was known and health advisories were issued during the years of major growth of the salmonine fisheries.

Further breakdown of license sales in the Great Lakes counties into resident and nonresident sales reveals very different patterns for each (Figure 5). The overall increase and subsequent decline in license sales in Great Lakes counties in the 1980s and 90s appears to be due primarily to nonresident license sales. One could conclude that the growth and subsequent economic impact in the region was due primarily to people coming from out of state to fish. Figure 6 shows license sales by county, with the peak increases more prominent in certain counties. In 1990, the proportion of non-resident licenses sold was highest in Orleans (71%) and Oswego (70%) counties.

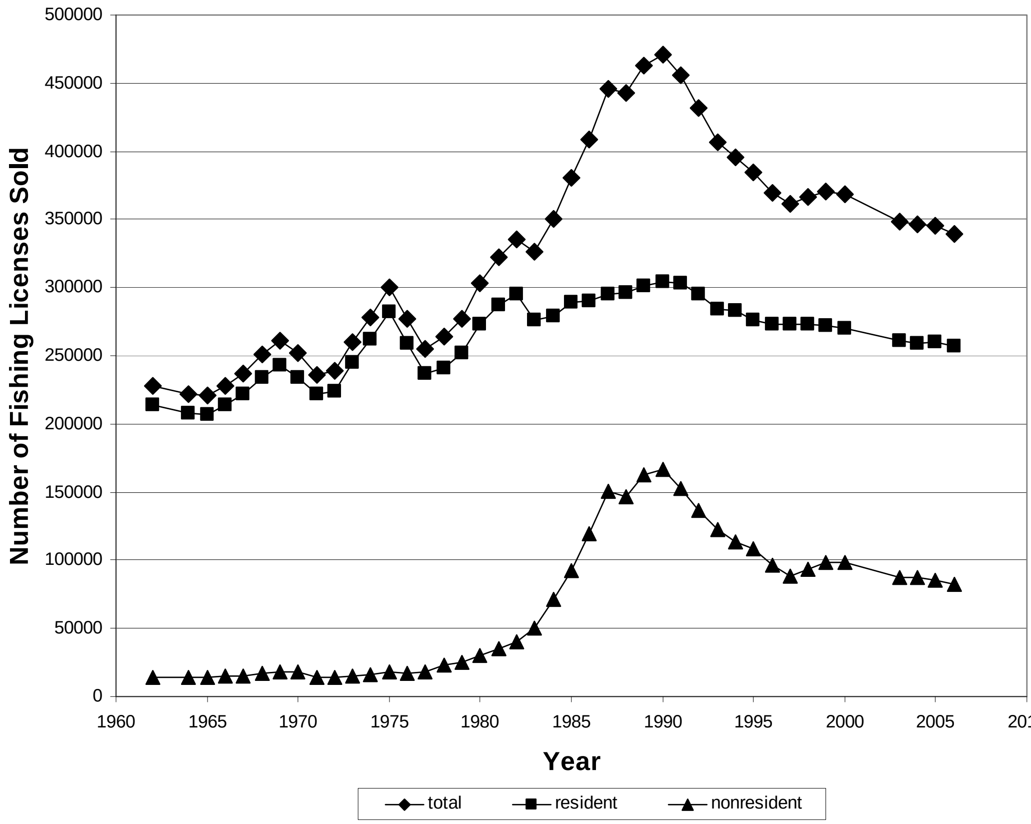


Figure 5. Resident, nonresident, and total number of fishing licenses sold in counties bordering New York's Great Lakes, 1962 to 2006.

### Model of Fishing Boat Trips on Lake Ontario

Data for modeling fishing boat trips on the open lake between 1985 and 2006 included independent variables used in the license sales models plus several variables obtained from the census of boat anglers:

1. Average number of trout and salmon caught per boat trip
2. Average number of trout and salmon harvested per boat trip
3. Average number of bass caught per boat trip
4. Average number of bass harvested per boat trip
5. Percent of trips for trout and salmon where no trout or salmon were caught
6. Percent of trips for bass where no bass were caught

Other variables examined included number of trout and salmon stocked in Lake Ontario and the Upper St. Lawrence River, a dummy variable indicating when round gobies (an invasive species) were discovered, price of a gallon of gas, water level on Lake Ontario on September 1, and media variables lagged one year. (The media variables tested in the model were limited to 1987-2006 because of the availability of the newspaper database.)

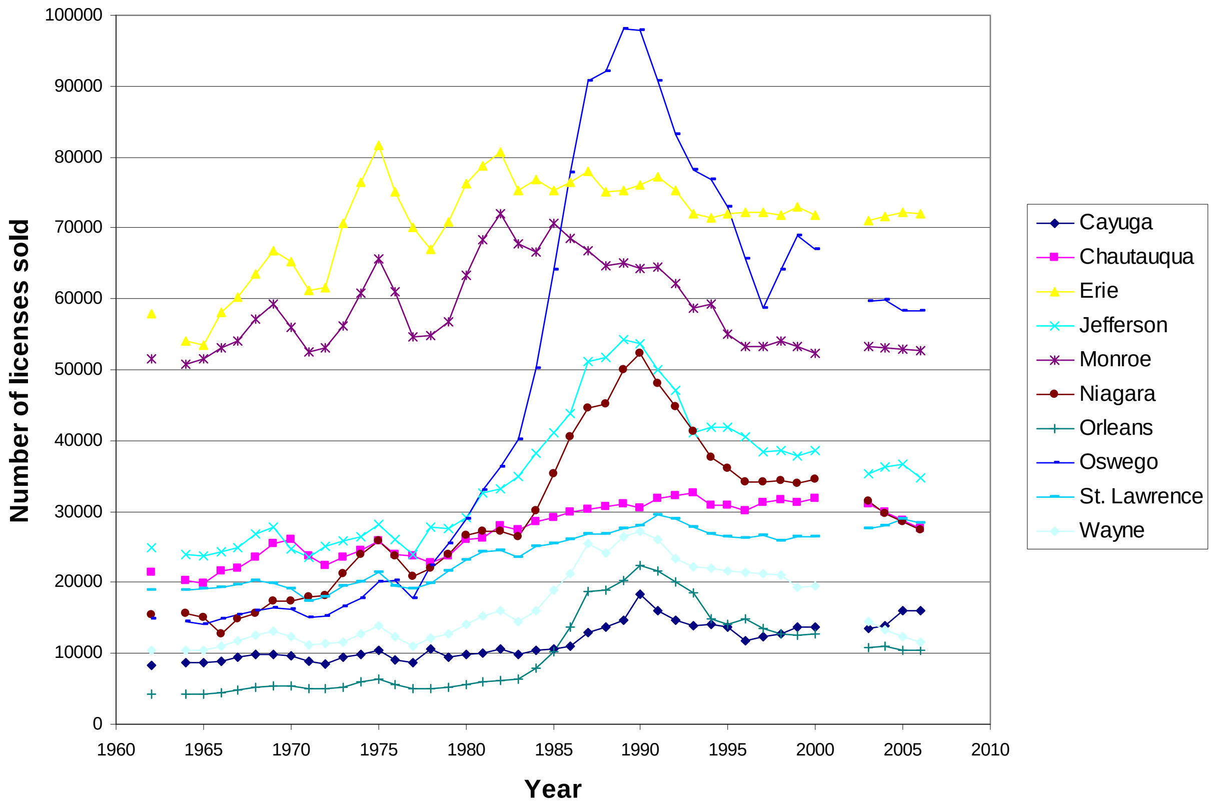


Figure 6. Fishing license sales for counties bordering New York's Great Lakes, 1962 to 2006.

After considering all of these possible explanatory variables, the best regression model developed was:

Fishing boat trips on Lake Ontario=
7,869,374 (Constant)
- 3,928 Time (standardized Beta = -.539, sign. = .002)
+ 15.7 Number of salmon stocked (standardized Beta = .356, sign. = .023)
+ 16,030 Average # of bass harvested per boat trip (standardized Beta = .173, sign. = .074)

The model has an adjusted $r^2$ of 0.852. There were no problems with collinearity. In this model, Time may be acting as a surrogate for two interacting phenomena: the novelty of Great Lakes salmonid fishing specifically, which appears to be gradually declining, and the declining interest in fishing and outdoor recreation seen nationally. The time variable is highly correlated with license cost but contributes the most to the explanation of fishing boat trips. The number of salmon stocked in Lake Ontario is positively correlated with all boat trips (Figure 7). The number of bass harvested, positively correlated with the number of trips, is significant at .074 but was retained in the model because it is close to 0.05 significance. We would expect the effects of bass harvest to play a smaller role than effects related to harvest of trout and salmon.

The increased price of gasoline in recent years may be partially responsible for decreases in boat trips, particularly for nonresidents and others who live some distance from Lake Ontario. However, this variable is inversely correlated with the number of salmon stocked, and we can not ascertain the relative separate effects of these two variables.

Meaningful correlations were not found between number of media articles and boat fishing trips. It appears from the analysis that more articles with a negative bent were written during years when there were more boat trips. This is understandable in terms of concerns about crowding and services, but even when the media articles were lagged one year, similar results occurred. Thus, it is not apparent that negative media articles played much of a role in suppressing fishing on Lake Ontario.

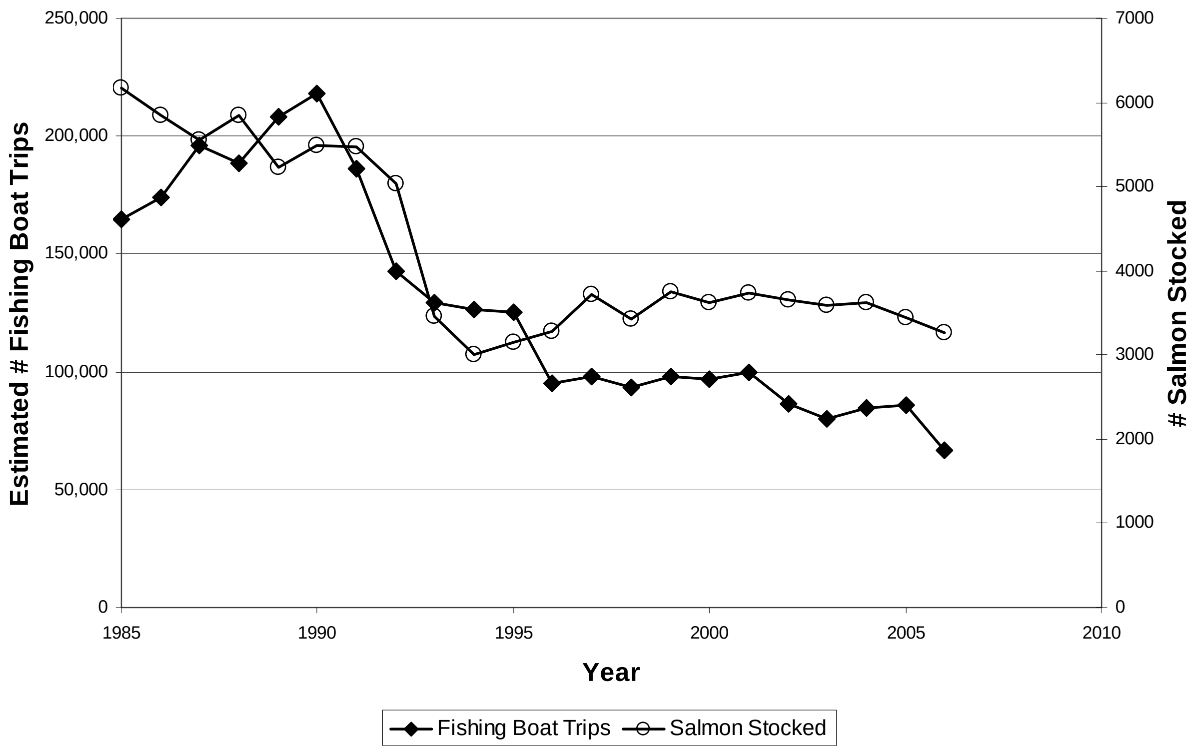


Figure 7. Estimated number of fishing boat trips taken on Lake Ontario compared with the number of salmon stocked in the Lake between 1985 and 2006.

### Forecast of Fishing Boat Trips on Lake Ontario

After consulting with DEC on future stocking plans and predictions for bass harvest, fishing boat trips were forecasted for the next five years after the end of the database in 2006 (Figure 8). The small drop in projected trips for 2008 is due to the known, but unusual decline in stocking levels for that year. The model predicts a decline in fishing trips of 32% in the ensuing five years. Different assumptions about bass harvest could be made that would show some variation in the forecast, but those effects would be relatively minor because the contribution of bass harvest to the overall prediction in the model is small.

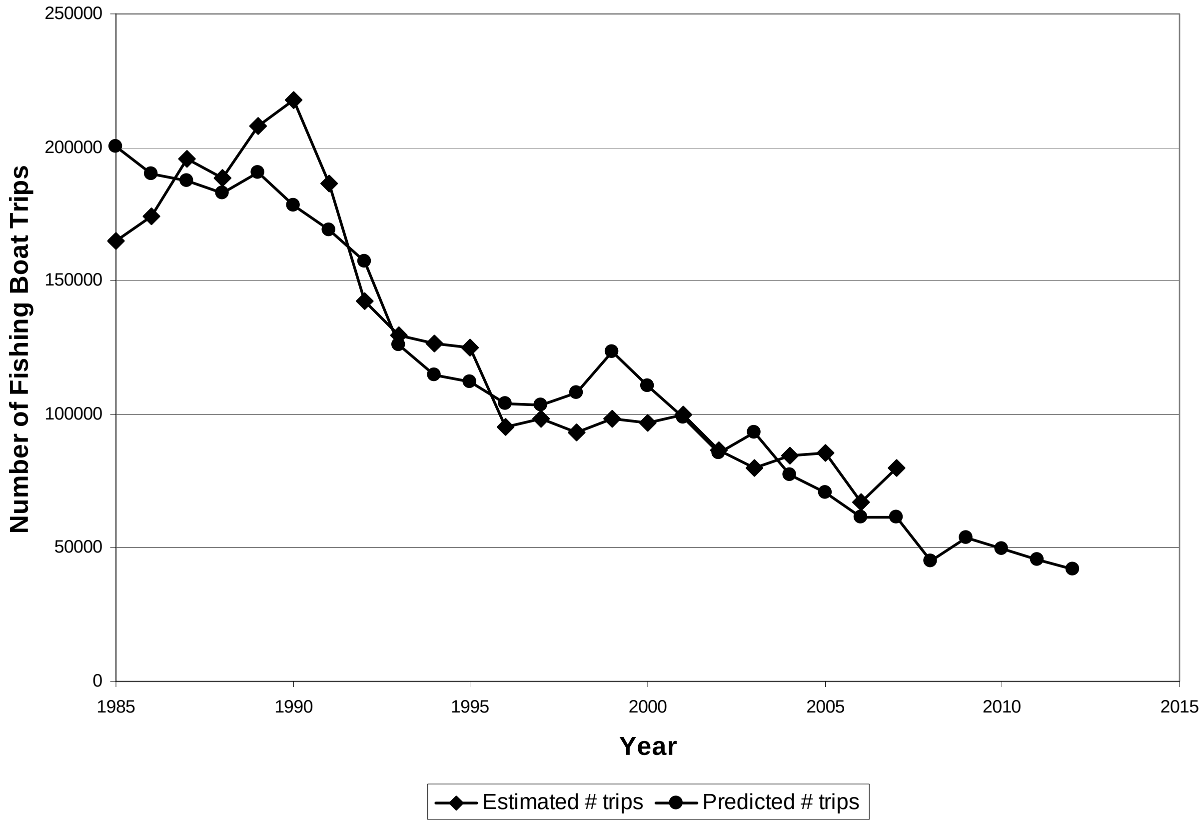


Figure 8. Estimated number of fishing boat trips taken on Lake Ontario compared with the number predicted by multiple regression analysis.

## Estimating Economic Impact of Angling on Lake Ontario and Forecasts Based on the Fishing Boat Trips Model

### Angler Expenditures

In 2007, a statewide survey was conducted of anglers fishing New York State waters (Connelly and Brown 2009). The mail questionnaire asked anglers to record their fishing locations within the state and how often they fished each location, the species they were targeting, and their expenditures at the site and en route. Of the 20,775 respondents to the survey, 1,490 indicated that they fished Lake Ontario (including embayments) in 2007. Expanding the data from this sample, it was estimated that anglers spent 1.5 million days fishing Lake Ontario in 2007. The mean expenditures of $35 per day at the fishing site and $17 en route to the fishing site expand to total expenditures in 2007 by all anglers of $54 million at the fishing site and $26 million en route.

To measure the economic impact of fishing to local communities, a typical convention of restricting the analysis to include only expenditures made by anglers living outside those communities was followed. Approximately one-sixth of the U.S. portion of Lake Ontario's fishing effort can be attributed to anglers who live outside New York State, and just over half (52.2%) can be attributed to anglers who fished Lake Ontario from a county other than the one they lived in. These anglers who were bringing new money into each Lake Ontario county were considered "tourists" and only their data was included in the economic impact analysis discussed below. Anglers living in counties bordering Lake Ontario were considered tourists only for trips in which they traveled to another county bordering the lake to fish. At-location expenditures for tourist-related fishing averaged $53 per day and totaled $43 million for 2007. This represents approximately 80% of all the expenditures made at the fishing site.

**Economic Impact**

Economic impact analysis was used to show the extent to which anglers' expenditures contribute to the economies of communities in counties bordering Lake Ontario. The overall contribution of fishing to the local economy extends beyond the anglers' direct purchases listed above because the businesses that sell goods and services to anglers are in turn stimulated to use additional labor and purchase additional materials to produce their own products and services. Thus, each "tourist" angler purchase starts a chain reaction of spending and re-spending that has a cumulative impact on the level of sales, jobs, and other economic components of the local economy.

However, the extent of the stimulus provided by new economic activity is limited. A portion of the expenditures immediately leaves the local economy and thus makes no meaningful additional contribution. For example, the portion of the cost of a gallon of fuel that a local marina or service station pays to an out-of-state fuel supplier is substantial and adds to the local economy. Similarly, much of the cost of a restaurant meal goes to pay out-of-state growers and food processors. Such expenditures exemplify the most important kind of "leakage" from an economy and must be accounted for at each stage of the spending and re-spending cycle.

To estimate the economic impact of recreational fishing on communities bordering Lake Ontario, a computerized Input-Output economic model called IMpact Analysis for PLANing (IMPLAN) was used (MIG Inc. 2000). The model requires estimates of the direct expenditures made by anglers broken down by economic sector (Table 1). These estimates are provided at the county level and represent expenditures made by anglers living outside each county. The statewide angler survey did not collect data by economic sector, so total expenditures were apportioned using data from a recent boater survey on Lake Ontario (Connelly et al. 2005). Expenditures were highest in Oswego and Jefferson Counties, where well-known salmon and bass fisheries exist. The Western Basin (Niagara, Orleans, and Monroe Counties) attracts a more local clientele and thus, "tourist" expenditures were not as high.

Results of the IMPLAN analysis can be expressed as dollar output (expenditures) or jobs created (Table 2). The impacts are typically separated into direct effects, indirect effects, induced effects, and total effects. The direct effects are the initial angler expenditures discussed previously in Table 1.

**Table 1. Expenditures associated with fishing Lake Ontario made by "tourist" anglers (i.e., those not living in the county where they fished), by economic sector.**

| Counties Bordering Lake Ontario | Economic Sectors | | | | | | | Total | Avg/day |
|---|---|---|---|---|---|---|---|---|---|
| | Marinas | Restaurants | Grocery Stores | Lodging | Entertainment Businesses | Gas Stations | Other Retail Stores | | |
| Niagara | 446,855 | 555,157 | 231,767 | 329,672 | 53,285 | 594,579 | 323,824 | 2,535,139 | 35.25 |
| Orleans | 956,450 | 770,189 | 342,696 | 289,186 | 51,463 | 538,314 | 386,264 | 3,334,561 | 62.56 |
| Monroe | 366,577 | 295,189 | 131,345 | 110,836 | 19,724 | 206,319 | 148,043 | 1,278,033 | 30.81 |
| Wayne | 2,299,129 | 1,851,393 | 823,778 | 695,151 | 123,707 | 1,294,007 | 928,508 | 8,015,674 | 43.32 |
| Cayuga | 221,434 | 265,107 | 115,736 | 36,319 | 19,119 | 223,991 | 94,252 | 975,958 | 26.90 |
| Oswego | 3,738,487 | 4,475,820 | 1,953,988 | 613,185 | 322,786 | 3,781,669 | 1,591,259 | 16,477,194 | 65.70 |
| Jefferson | 2,912,947 | 2,460,019 | 1,102,602 | 281,457 | 183,767 | 2,172,413 | 1,210,540 | 10,323,746 | 59.82 |

The indirect effect represents the impact of the additional business spending that is created as these businesses sell more output and in turn must purchase additional inputs. This can be illustrated as the first round of re-spending by marinas, restaurants, etc. as they spend some fraction of their revenues from anglers on purchases of additional supplies of goods and services within the local community. Table 2 shows a total indirect impact of over $9 million across the seven Lake Ontario Counties, with the indirect impact highest in Oswego and Jefferson counties.

The induced effect represents the additional economic activity associated with the income of workers and business owners that is typically spent on household consumer goods purchased from businesses in the local community. The induced impacts ($8 million in total) were a little less than the indirect impacts, but still exceeded $2 million each in Oswego and Jefferson counties (Table 2).

**Table 2. Output and employment impacts of angler expenditures associated with fishing on Lake Ontario, by county (2007 dollars).**

| | Dollar Output | | | |
|---|---|---|---|---|
| Counties Bordering Lake Ontario | Direct | Indirect | Induced | Total |
| Niagara | 2,535,139 | 542,315 | 535,258 | 3,612,712 |
| Orleans | 3,334,561 | 537,932 | 465,029 | 4,337,522 |
| Monroe | 1,278,033 | 487,189 | 409,071 | 2,174,293 |
| Wayne | 8,015,674 | 1,794,395 | 1,217,359 | 11,027,428 |
| Cayuga | 975,958 | 198,290 | 206,836 | 1,381,084 |
| Oswego | 16,477,194 | 2,841,938 | 2,649,320 | 21,968,452 |
| Jefferson | 10,323,746 | 2,948,712 | 2,463,604 | 15,736,062 |
| Total | 42,940,305 | 9,350,771 | 7,946,477 | 60,237,553 |
| | | | | |
| | Employment | | | |
| | Direct | Indirect | Induced | Total |
| Niagara | 43.7 | 5.1 | 6.7 | 55.5 |
| Orleans | 69.8 | 7.2 | 5.2 | 82.2 |
| Monroe | 22.3 | 3.8 | 3.6 | 29.7 |
| Wayne | 162.6 | 17.7 | 13.3 | 193.6 |
| Cayuga | 19.1 | 2.3 | 2.3 | 23.7 |
| Oswego | 333.4 | 28.6 | 28.8 | 390.8 |
| Jefferson | 199.3 | 31.0 | 26.4 | 256.7 |
| Total | 850.2 | 95.7 | 86.3 | 1,032.2 |

The total effect is the sum of the direct, indirect, and induced effects. This represents the total economic impact attributable to recreational fishing on Lake Ontario. Our estimate for the total effect lake-wide is $60 million in 2007 (Table 2). The total impact was greatest in Oswego County ($22 million) and least in Cayuga County ($1.4 million), which has very little shoreline on Lake Ontario.

Employment impacts are measured by the effects of tourist spending on jobs. Not all tourism-related jobs are 40-hour per week jobs; some are part-time (less than 40 hours). However, the impact estimates shown in Table 2 convert the mix of full and part-time labor that is typical for each business sector (e.g., lodging, gas stations) to full-time, 40-hour per week equivalent jobs. Employment impacts also can be segmented by direct, indirect, induced, and total effects (Table 2). The total number of full-time job equivalents attributable to recreational tourist fishing on Lake Ontario in 2007 was just over 1,000. Most of the jobs were a result of direct expenditures (850). Indirect and induced effects resulted in almost 100 jobs each area wide. The number of jobs attributable to recreational fishing was highest in Oswego County (391).

### Economic Forecast Based on the Fishing Boat Trips Model

The model predicts a decline in fishing trips of 32% in the ensuing five years, which would be associated with a decline in direct expenditures of $17.3 million. However, only a portion of those expenditures would be by “tourist” anglers. If the assumption is made that the proportion of “tourist” anglers traveling to Lake Ontario remains constant, the direct, indirect, and induced effects of the loss in the predicted number of trips would be $19 million in 2007 dollars. This is equivalent to 330 jobs in the local communities.

## CONCLUSIONS AND RECOMMENDATIONS

Fishing trends in New York State and along Lake Ontario seem to be following national trends. Our statewide models, which are statistically good at explaining the trend over time, predict a gradual decline in the number of fishing licenses sold as the population ages. Altering this trend will likely be difficult because it involves increasing recruitment into fishing.

This research demonstrated the economic importance of recreational fishing to communities along Lake Ontario. In 2007, it was estimated that “tourist” anglers (those living outside the county bordering Lake Ontario where they fished) fished 811,416 days and spent $43 million in local communities. This translated into an economic impact of $60 million and 1,032 jobs.

The estimates derived from this study were of a similar magnitude to those from earlier surveys of boaters (many of whom fish from their boats [Connelly et al. 2004]). Connelly et al. (2004) estimated that boaters traveling from outside the area to boat on Lake Ontario spent an estimated $38 million in 2003. Those expenditures supported an estimated 760 jobs in the local communities. In another study of recreational boaters, an estimated $67 million was spent by those traveling to Lake Ontario and St. Lawrence River to boat in 2002 (Connelly et al. 2005). This accounted for about 1,000 local jobs.

We were not able to show quantitatively a relationship between the nature of articles in the media and fishing boat trips. Our data source was limited—articles from the Syracuse Post Standard between 1987 and 2006. Undoubtedly the broader media were instrumental in positively publicizing the fisheries during their growth phases. We were unable to show a relationship between publicity of problems related to the fisheries (e.g., contaminants, lowered stocking rates, invasive species) and declines in angler trips.

Based on the regression analysis, the forecast is for a decline in the number of fishing trips to Lake Ontario in the short-term (next five years). This was attributed primarily to the novelty of Great Lakes salmonid fishing continuing to wear off and the declining interest in fishing and outdoor recreation seen nationally. Depending on its length, the current recession could lower fishing participation even more or result in a shift in fishing-related tourism such that a greater proportion of trips are day trips. This would especially affect lodging establishments and restaurants.

Armed with this information, local communities can choose to be proactive and try to counteract the trend predicted by the model. For example, DEC biologists suggested that some anglers have adjusted their fishing techniques to catch more bass than round gobies (an invasive species). If other anglers were able to change and adopt these new techniques, harvest of bass could increase, perhaps reducing the predicted decline to 19% (instead of 32%). This would still result in a lower predicted loss of $11 million and 196 jobs, compared to $19 million and 330 jobs if no action were taken. Local communities could participate in educational programs to teach these new techniques to increase bass harvest. However it seems likely that other strategies directed at trout and salmon anglers will be needed, since they make up a large percentage of Lake Ontario anglers.

# LITERATURE CITED


Brown, T. L. 1976. The 1973-75 salmon runs: New York's Salmon River sport fishery, angler activity, and economic impact. New York Sea Grant Inst. Publ. NYSSGP-RS-76-025. 25 pp.

Brown, T. L. and Connelly, N. A. 1991. Impact of the Lake Ontario salmonid fisheries on Salmon River communities: a fiscal analysis. Human Dimensions Research Unit Series 91-9. Dept. of Natur. Resour., Cornell Univ. 14 pp.

Brown, T. L., N. A. Connelly and C. P. Dawson. 2002. Economic impacts of declines in the sport fisheries of eastern Lake Ontario. HDRU Series 02-01. Human Dimensions Research Unit, Cornell University.

Brown, T. L., B. A. Knuth and F. C. Menz. 1991. Lake Ontario's sport fisheries: socioeconomic research progress and needs. Canadian Journal of Fisheries and Aquatic Science 48(8):1595-1601.

Connelly, N. A., Bibeault, J.-F., Brown, J., and Brown, T. L. 2005. Estimating the economic impact of changing water levels on Lake Ontario and the St. Lawrence River for recreational boaters and associated businesses. Human Dimensions Research Unit Series No. 05-1. Dept. of Nat. Resour., Cornell Univ., Ithaca, N.Y.

Connelly, N. A., and T. L. Brown. 2009. New York statewide angler survey 2007, Report 1: Angler effort and expenditures. NYS Department of Environmental Conservation, Bureau of Fisheries. 109pp.

Connelly, N. A. and T. L. Brown. 1991. Development of explanatory and predictive models for hunting and fishing license sales and revenue trends in New York: Progress Report No. 5. HDRU Series 91-8. Dept. of Nat. Resour., Cornell Univ. 15 pp.

Connelly, N. A., Brown, T. L., and Kay, D. L. 2004. Recreational boating expenditures in 2003 in New York State and their economic impacts. New York Sea Grant Inst. Publ. NYSGI-S-04-001. Stony Brook: New York Sea Grant.

Connelly, N. A., T. L. Brown and B. A. Knuth. 1997. New York statewide angler survey 1996, report 1: angler effort and expenditures. NYS Dept. of Environ. Conserv., Albany, NY. 107 pp.

Connelly, N. A., T. L. Brown, and B. A. Knuth. 1990a. New York statewide angler survey 1988. NYS Department of Environmental Conservation, Division of Fish and Wildlife, Albany, NY.

Connelly, N. A., T. L. Brown and C. P. Dawson. 1990b. Evaluating the impact of proposed changes in snagging regulations on the Salmon River. New York State Department of Environmental Conservation, Division of Fish and Wildlife.

Dawson, C. P. 1991. A summary of the 1990 charter fishing industry along New York's Great Lakes coast. New York Sea Grant fact sheet.

ESLO. 2008. About ESLO. 2007 economic impact report. http://www.loc.org/resources/abouteslo.asp

Kerr, S. J. and G. C. Le Tendre. 1991. The state of the Lake Ontario fish community in 1989. Great Lakes Fishery Commission Special Publication 91-3.

Lichtkoppler, F. R. and D. Kuehn. 2003. New York's Great Lakes charter fishing industry in 2002. Ohio Sea Grant publication, The Ohio State University.

Maehr, M. L. and L. A. Braskamp. 1986. The motivation factor: a theory of personal investment. D. C. Heath Company, Lexington, MA.

MIG (Minnesota IMPLAN GROUP) Inc. 2000. IMPLAN Pro user's guide, analysis guide, data guide, version 2.0. Stillwater, MN.

Mills, E.L., J. M. Casselman, R. Dermott, J. D. Fitzsimons, J.D., G. Gal, K. T. Holeck, J. A., Hoyle, O.E., Johannsson, B. F., Lantry, J. C., Makarewicz, E.S. Millard, I. F. Munawar, M. Munawar, R. O'Gorman, R. W. Owens, L. G. Rudstarn, T. Schaner, and T. J. Stewart. 2005. A synthesis of ecological and fish community changes in Lake Ontario, 1970-2000. Great Lakes Fisheries Committee, Technical Report 67.

O'Gorman, R., J. H. Elrod, R. W. Owens, C. P Schneider, T. H. Eckert, and B. F. Lowry. 2000. Shifts in depth distriburions of alewives, rainbow smelt, and age-2 lake trout in southern Lake Ontario following establishment of dreissenids. Transactions of the American Fisheries Society 123:28-36.

Siemer, W. F. and T. L. Brown. 1994. Motivations and satisfactions of Lake Ontario boating salmonid anglers. J. Great Lakes Res. 20(2):457-470.