DEVELOPMENT OF EXPLANATORY AND PREDICTIVE MODELS FOR HUNTING AND FISHING LICENSE SALES AND REVENUE TRENDS IN NEW YORK

Progress Report No. 6

by

Nancy A. Connelly and Tommy L. Brown

Series No. 91-8

June 1991
DEVELOPMENT OF EXPLANATORY AND PREDICTIVE MODELS FOR HUNTING AND FISHING LICENSE SALES AND REVENUE TRENDS IN NEW YORK

by

Nancy A. Connelly and Tommy L. Brown

June 1991
HUMAN DIMENSIONS RESEARCH UNIT PUBLICATIONS SERIES

This publication is part of a series of reports resulting from investigations dealing with public issues in the management of wildlife, fish, and other natural resources. The Human Dimensions Research Unit (HDRU) in the Department of Natural Resources at Cornell University is a nationally-recognized leader in the study of the economic and social values of wildlife, fish, and other natural resources and the application of such information in management planning and policy. A list of HDRU publications may be obtained by writing to the Human Dimensions Research Unit, Department of Natural Resources, Fernow Hall, Cornell University, Ithaca, NY 14853.
PROJECT TITLE: Public Attitudes Toward Wildlife and Its Accessibility

STUDY NUMBER AND TITLE: I - Wildlife Management Situation Analysis and Demand Projection

JOB NUMBER AND TITLE: I-1 - Anticipating the Nature and Demographics of Wildlife Demand

JOB OBJECTIVES: To analyze the relationships between New York State population, user demographic trends, demand for wildlife-related recreation, and license sales performance.

To assist in wildlife program evaluation and planning by predicting trends in resource use and revenue levels associated with such use.

JOB DURATION: 1 July 1989 - 30 June 1992
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>TABLE OF CONTENTS</td>
<td>i</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>ii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>ii</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>RESULTS</td>
<td>2</td>
</tr>
<tr>
<td>Small Game License Sales</td>
<td>2</td>
</tr>
<tr>
<td>Big Game License Sales</td>
<td>5</td>
</tr>
<tr>
<td>Resident Fishing License Sales</td>
<td>8</td>
</tr>
<tr>
<td>Nonresident Fishing License Sales</td>
<td>10</td>
</tr>
<tr>
<td>SUMMARY</td>
<td>13</td>
</tr>
<tr>
<td>LITERATURE CITED</td>
<td>15</td>
</tr>
</tbody>
</table>
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Projections for big game license sales and predictor variables for 1993 and 1995</td>
<td>7</td>
</tr>
</tbody>
</table>

LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adjusted small game license sales, 1962-1990</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Adjusted big game license sales, 1962-1990</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Adjusted resident fishing license sales, 1962-1990</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>Adjusted nonresident fishing license sales, 1962-1990</td>
<td>11</td>
</tr>
</tbody>
</table>
INTRODUCTION

This is the sixth in a series of reports that have dealt with factors affecting hunting and fishing license sales in New York, and the revenue implications of those changing factors. This report utilizes data from the state longitudinal data base for the years 1962-1990. Models from this data base have been reported previously in 1985, 1986, 1988, 1989 and 1990 progress reports (Brown 1985, Brown and Connelly 1986, Brown and Connelly 1988, Connelly and Brown 1989, Connelly and Brown 1990). These models investigate 4 types of licenses -- resident small game hunting, resident big game hunting, resident fishing, and nonresident fishing. Each model is structured to include all licensees who could have participated in that activity. The following license types comprise these license groupings:

1. **Resident Small Game.** Small game + small game/big game + small game/fishing + sportsman's licenses.

2. **Resident Big Game.** Big game + small game/big game + sportsman's licenses.

3. **Resident Fishing.** Fishing + 3-day fishing + small game/fishing + sportsman's licenses.

4. **Nonresident Fishing.** Nonresident fishing + 5-day nonresident fishing. When combined as indicated above, these 4 types of licenses are referred to as adjusted small game, big game, resident fishing, and nonresident fishing licenses.

This report presents 4 updated (including data through 1990) state-level longitudinal models. Each model was reexamined in detail and we concluded that each continued to best explain license sales over time.
Demographic data had to be estimated for 1990 and in some cases for 1989. The regression models were constructed using the minitab statistical package (Ryan, Jr. et al. 1982).

RESULTS

Small Game License Sales

Adjusted small game license sales appear to have stabilized in the past 4 or 5 years after dropping by about 12% from 1982-1986 (Fig. 1). The long-term trend has been a decline of approximately 110,000 licenses since the peak year of 1971.

Figure 1. Adjusted small game license sales, 1962-1990.
Two small game models were developed and presented in past progress reports because no single model was able to encompass all relevant factors (due to high correlations between the independent variables of license cost and population). After updating the database for 1990 and exploring other possible models, these same 2 models continue to provide the best explanatory power for variation in license sales. They are presented here with their updated coefficients.

The best explanatory model including population size for small game license sales (with standard deviations in parentheses) was:

\[
SGLS = 443,036 - 60.35 (P14-64 - Mean) - 0.093 (P14-64 - Mean)^2 + 3,783 PI \\
(13,632) (25.35) (0.054) \\
(917)
\]

where:

- \(SGLS\) = Adjusted resident small game license sales;
- \((P14-64 - Mean)\) = NY 14-64 age population minus mean of NY 14-64 age population (thousands);
- \((P14-64 - Mean)^2\) = \((NY 14-64 age population minus mean of NY 14-64 age population)^2\) (thousands);
- \(PI\) = Index of the pheasant population in central and western NY (the "pheasant/observer index").

This model has an adjusted \(r^2\) of .774 and a standard deviation of 18,108 licenses.

The second small game license sale model describes the effect of license cost on sales. The best explanatory model including license cost for small game license sales (with standard deviations in parentheses) was:

\[
SGLS = 480,888 - 8,325 SS + 222.1 LCyc^2 + 2,758 PI \\
(22,835) (2,829) (137.1) (1,012)
\]

where:

- \(SGLS\) = Adjusted resident small game license sales;
$\$ = Weighted license fee;

LCyc$^2 = (License cycle which rises each year by 1 until a fee increase, which resets it to 0)^2$;

PI = Index of the pheasant population in central and western NY (the "pheasant/observer index").

This model has an adjusted $r^2$ of .801 and a standard deviation of 17,021 licenses.

Both models show an improvement in $r^2$ and a similar standard deviation as compared with models reported in the last progress report. Each year for the past 4 years alternative models have been tried. These 2 models continue to have the best explanatory power of all models that were examined. Furthermore, their coefficients have been stable over time. As updated data has been added annually, the coefficients have changed only slightly. Therefore, the general conclusions of the last progress report still hold and are reiterated here for the reader's convenience.

Because the pheasant index is expected to remain constant over the next 10 years and the 14-64 aged population will continue a very gradual increase into 1995 (<1%), the first model, which has no license fee variable, predicts a constant level of small game license sales. Since no fee increase was instituted last year, actual license sales remained constant as the model predicted. However, fee increases, which seem likely in the coming year, would result in a projected decline of 8,325 licenses for each dollar of increased fees. For example, the model predicts that a $2 increase in license fees in 1992-93 would result in 27,700, or 6% fewer licenses sold in that year than in 1990. The license cycle variable would predict a continuing cyclical pattern over time which exerts a positive influence on license sales after the year of a fee increase. So continuing with our example, license sales would rebound slightly in 1993-94 by roughly 200 and in 1994-95 by 900 from 1992-93.
Although a fee increase reduces the number of licenses sold, the total revenue generated increases up to a point. A $2 increase in fees in 1992-93 (this fee increase amount is used only for illustration purposes, but is one of the amounts currently being considered by the state legislature), would be associated with a predicted increase in revenues of 17% over 1990 levels.

**Big Game License Sales**

Unlike small game license sales which seem to be leveling off after several years of decline, big game license sales are continuing a slow rate of decline after peaking in 1982 (Fig. 2).

![Graph of Big Game Licenses, 1962-1990.](image)
The big game sales model reported in the previous 2 progress reports continued to be the best of several explanatory models examined. For the license sale years 1962-1989, the best explanatory model for adjusted big game sales (with standard deviations in parentheses) was:

$$BGLS = 578.430 + 53.69 \text{ REAL} - 118.48 \text{ NAg} + 248.32 \text{ IM} - 15.057 \text{ $$} + 1.36 \text{ BH}^{-1} + 0.55 \text{ LS}^{-1} - 19.847 \text{ INC}$$

where:

- BGLS = Adjusted resident big game license sales;
- REAL = NY per capita income, adjusted for inflation;
- NAg = Total nonagricultural employment in New York (thousands);
- IM = Miles of interstate highway open in New York;
- $$=$$ = Weighted license fee;
- BH$^{-1}$ = Adult bucks harvested the previous year;
- LS$^{-1}$ = Big game license sales the previous year;
- INC = Dummy variable indicating the year of a license fee increase.

The model has an adjusted $r^2$ of .943 and a standard deviation of 19,067 licenses. The independent variables had similar coefficients to the models reported previously, attesting to the stability of the models as new data is added.

Projections of big game license sales into the 1990's depends on our ability to predict future trends for the 7 independent variables. We have refined our projections of independent variables from past reports based on the more recent stable trends in certain predictive variables such as income and nonagricultural employment. For projection purposes, we estimate that the
first possible year in which the results of a license fee increase would be
evident is 1993. We have projected license sales in 1993 and on into 1995
with no additional fee increase to show how sales would rebound after a fee
increase in 1992-93. Table 1 shows an estimated loss of almost 10% from 1990
predicted license sales to 1993 projected license sales. This is due
primarily to the implementation of a $2 increase in license fees in 1992-93
(this fee increase amount is used only for illustration purposes, but is one
of the amounts currently being considered by the state legislature). However,
the projected loss of license sales in the model is also partly associated
with the long-term increasing trend in nonagricultural employment, which is
negatively correlated with license sales. We believe this variable acts as an
index of increasing urbanization.

| Variables      | Current     | Projected  |
| REAL          | 5,600 | 5,700 | 5,900 | 6,100 |
| NAg           | 8,234 | 8,284 | 8,434 | 8,534 |
| IM            | 1,500 | 1,500 | 1,510 | 1,520 |
| $$            | 8.17  | 8.15  | 10.20 | 10.20 |
| BH\(^{-1}\)    | 92,987 | 99,589 | 100,000 | 100,000 |
| LS\(^{-1}\)    | 627,380 | 624,195 | 620,000 | 620,000 |
| INC           | 0     | 0     | 1     | 0     |
| Predicted License Sales | 624,515 | 631,489 | 574,476 | 595,696 |
At a $2.00 increase, adjusted big game license revenues would increase in 1993 by approximately 14% because gains from the fee increase outweigh losses from reduced license sales. The revenue maximizing point (i.e. the point at which increasing cost no longer results in increasing revenue) of $20 is much higher than the current fee for a big game license, but is probably not politically feasible. Estimates for 1995 show a rebound in license sales after the fee increase of 1993, but not back to 1990 levels because of the long-term trends discussed above (Table 1). This cyclical pattern would be expected to continue into the future, assuming periodic license fee increases.

Resident Fishing License Sales

Adjusted resident fishing license sales have increased over the past few years and have shown a fairly consistent cyclical pattern over the past 29 years related primarily to license fee increases (Fig. 3).

Figure 3. Adjusted resident fishing license sales, 1962-1990.
The best long-term explanatory model (with standard deviations in parentheses) was:

\[
FLS = -154,975 + 149.0 \text{ P18-44} - 21,548 \text{ $$} + 5,091 \text{ LCyc} + 51,787 \text{ GLSAL}
\]

\[(265,765) \quad (48.0) \quad (10,384) \quad (2,338) \quad (18,419)\]

where:

- \(FLS\) = Adjusted resident fishing license sales;
- \(P18-44\) = NY 18-44 age population (thousands);
- \(\text{$$}\) = Weighted license fee;
- \(\text{LCyc}\) = License cycle variable which rises each year by 1 until a fee increase, which resets it to 0;
- \(\text{GLSAL}\) = Dummy variable representing the years 1973-75, 1981-1990 when stocked salmonids were being caught in the Great Lakes.

This model has an adjusted \(r^2\) of .795 and a standard deviation of 30,292 licenses. The independent variables had similar coefficients to the model reported last year, attesting to the stability of the model as new data is added.

In the year of a fee increase, the model predicts a decline in license sales of 21,548 licenses for each dollar added to the cost plus the loss from the license cycle variable, which would be 5,091 times the number of years since the last fee increase. The year following an increase, 5,091 licenses would be gained from the license cycle variable. As an example, if a fee increase of $2 were implemented in 1992-93 (9 years after the last fee increase), the model would predict a decline of approximately 96,000 licenses in 1993. However, revenue would increase in 1993 by an estimated 10% over 1990 levels.

For longer-term projections, the major influencing factor is the 18-44 age population segment, which is expected to decline through 1995. The model
would predict a slight general decline (3 to 4%) in sales by 1995, independent of license fee increases.

**Nonresident Fishing License Sales**

Nonresident fishing license sales were examined in this report series for the first time last year because they represent a significant portion of total fishing licenses sold and we felt we had a sufficient data base to model sales at a reasonable level of accuracy. These nonresident sales were basically constant until 1981 when they began a sharp, steady rise (Fig. 4). We believe this increase in sales can be attributed primarily to the development of the Lake Ontario salmonid fishery.

For a model of nonresident license sales, a smaller number of variables is available to put in the model than for resident license sales. We currently have no population estimates or other socio-demographic variables because out-of-state anglers do not come from a specifically defined area. The only types of variables available at this time are resource and cost variables.
Figure 4. Adjusted nonresident fishing license sales, 1962-1990.

The best explanatory model (with standard deviations in parentheses) was:

\[
\text{NRFLS} = -63,317 + 0.20 \text{STOCKWT} + 48,933 \text{STGL} \\
(18,843) (0.03) (12,802)
\]

where:

NRFLS = Nonresident fishing license sales;

STOCKWT = Weight of stocked trout and salmon lagged 3 years;

STGL = Dummy variable representing the years 1981-1990 when stocked salmonids were being caught in the Great Lakes.
This model has an adjusted $r^2$ of .891 and a standard deviation of 22,556 licenses. This model continues to have the best explanatory power of all models examined even though the $r^2$ decreased slightly and the standard deviation increased slightly from last year's model.

Two variables were significant from the few we had to choose from. This small number of variables in the model limits its true predictive ability, especially in the event of notable changes in demographic variables. Furthermore, one variable in the model will likely remain constant in the future. The dummy variable representing the catch of stocked salmonids was important in explaining the sharp rise in license sales beginning in 1981, but since the stocking of salmonids is expected to continue indefinitely, this variable becomes a constant for future license sale predictions.

The variable in the model which does vary over time is the lagged weight of stocked trout and salmon. This variable was lagged by 3 years to correspond with license sales in the year most salmon were returning to spawn. The variable was highly correlated (0.91) with license sales. The ability of the model to predict license sales into the future is based primarily on this variable. Since the weight of stocked fish (e.g. the number of stocked fish) has leveled off in the last few years, the model predicts a leveling off in nonresident fishing license sales. It is likely that this stocking variable is so highly significant because it is an index of the harvest of Great Lakes salmonids. Should there be a crash in the Lake Ontario salmonid fishery, the model would not continue to be accurate. Ideally, we should have harvest rather than stocking data in the model, but harvest estimates are not available on an annual basis.
No cost-related variable was significant in the model. Therefore, we conclude that the current level of nonresident fees is not having a negative influence on license sales. Future fee increases may affect licenses sales if they are increased sufficiently. Unfortunately, we have no basis for estimating the level at which license sales would be affected by their price.

Revenue prospects from increased nonresident fees are good because nonresident fishing license sales appear to be less cost sensitive than resident license sales. Even though we can not predict at what point license sales will decline because of a fee increase, we can say that for any reasonable fee increase, even if license sales do decline, revenue should increase.

**SUMMARY**

The 3 statewide resident models presented herein predict declining license sales in the first half of the 1990's due to a combination of demographic factors and a probable license fee increase. A license fee increase can be thought of as causing a short-term decline in sales. Most often in the past this decline is negated within a few years. However, trends in demographic factors such as population or nonagricultural employment can provide an indication of longer term license sale trends. Both of these variables contribute to a predicted decline in license sales in the 1990's.

Our best guess for nonresident fishing license sales is that they will remain at a constant level based on the model which includes a stocking variable as the only variable which can vary in the future.

Estimates of revenues from hunting and fishing license sales show increases with increasing license fees because gains from fee increases outweigh losses from reduced license sales. For a $2 fee increase in each