

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

PROGRESS REPORT NO. 3

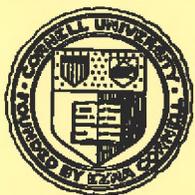
by

Tommy L. Brown and Nancy A. Connelly

July 1988



Series No. 88-6



**Human Dimensions Research Unit
Department of Natural Resources
New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University, Ithaca, N. Y.**



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STATE: NEW YORK

PROJECT NO.: W-146-R:13

PROJECT TITLE: Public Attitudes Toward Wildlife and Its Accessibility

STUDY NUMBER AND TITLE: I - Deriving Social Indices of Public Attitudes
Toward Wildlife Populations and Their Use

JOB NUMBER AND TITLE: I-11 - Monitoring Trends in Human Population
Characteristics of Importance to Wildlife Program
Planning

JOB OBJECTIVES: To analyze the relationships between New York State population
and user demographic trends 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 1986 - 30 June 1989

EXECUTIVE SUMMARY

This is the third of a series of progress reports on efforts to explain and predict hunting and fishing license sales and revenues in New York. Previous reports of the same title were issued in October, 1986 and August, 1985.

Three data bases were originally developed under this effort: (1) a statewide longitudinal (time series) data base from 1962 up through the most current year for which data are available (1986 for the current report); (2) a combined county-level data base for all counties over the years 1962 and following, and (3) a 1980 county-level cross-sectional data base. This report deals entirely with updates of the statewide data base. The county-level data bases have been used as a means of assessing counties where small game participation (i.e. license sales) have been less than would be expected, given the demographic characteristics of each county (Job VII-10). As the DEC Management Systems Unit takes further shape and hunting demand and supply is documented and managed on the basis of ecozones and major human population centers (Job I-12 is contributing to this effort), it is anticipated that further development and use will be made of the county-level data sets.

In work accomplished under Progress Report 3, modifications have been made to the data bases used previously. The hunting/fishing combination data base used previously to correspond to combination license sales of this type has been replaced by 3 longitudinal data bases for resident small game hunting, big game hunting, and fishing. Updated models for each of these data bases are presented. We also examined these data bases to determine if they are helpful to understanding the impact of 3-day resident fishing licenses and senior citizens licenses on overall revenues. Unfortunately, any revenues lost from the availability of these special licenses is such a small proportion of total revenue that the models are not sensitive to that level of impact. Finally, models were examined with an eye to a possible

restructuring of license sales that simplify the number of license options now available.

Good projections of all of the independent variables used in the models are not available, but the expected short-term trend (over the next 5 to 10 years) in combination with the size of the coefficient of each relevant variable permits us to make a directional projection and to provide some information on the price-sensitivity of each license type. The models suggest a likely decrease over the next few years in each of the major resident licenses - small game, big game, and fishing. Any decline in fishing would be primarily related to age structure. The 18 to 44 year population of New York, which has been important to hunting and fishing, has peaked, and is projected to decline through 1995. Price increases in fishing licenses would reduce the total number of license buyers somewhat, but revenues would increase for any price increase that would likely be politically feasible.

The recent and projected declines in hunting license sales are attributable to additional factors interacting with the age structure of the population. Increasing urbanization, declines in access and some types of habitat (e.g., pheasant), and changing values (not all of these variables will fit into any one model) are affecting hunting participation to the degree that price increases would reduce the number of licensed hunters more sharply than licensed anglers. For anything beyond a small increase in hunting licenses, revenues would likely decline. Therefore, these factors should be strongly considered when setting proposed new license fee structures and amounts.

It is recommended that this job be continued at least through 1988-89, as scheduled.

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INTRODUCTION

This is the third of what is anticipated to be a series of reports dealing with factors affecting hunting and fishing licenses sales in New York, and the revenue implications of those changing factors. This report utilizes data from the state-level longitudinal data base for the years 1962-1986. Models from this data base have been reported before in the 1985 and 1986 progress reports (Brown 1985, Brown and Connelly 1986). There were 3 models for 3 types of resident hunting licenses - small game, big game, and small game/fishing combination. For comparative purposes DEC requested that the small game/fishing combination license sale model be eliminated and those licenses be included in both the small game model and the fishing model. Thus the new small game model would account for all licensees who could have hunted small game. Similarly, the new fishing model would account for all licensees who could have fished, regardless of the other activities they might have participated in. The categorization of big game licenses remained unchanged from previous reports. The following license types comprise these new resident groupings:

1. Small Game. Small game + small game/big game + small game/fishing + sportsman's licenses
2. Big Game. Big game + small game/big game + sportsman's licenses.
3. Fishing. Fishing + 3-day fishing + small game/fishing + sportsman's licenses.

Once combined as indicated above these 3 types of licenses are referred to as adjusted small game, big game, and fishing licenses.

This report will present 3 new, updated, state-level models for adjusted small game, big game, and fishing license sales. Two other models which illustrate the impact of special license types on revenue will also be reported. The impact of the

senior license on current and future revenue will be examined, as well as the impact of 3-day fishing license sales on fishing revenue.

RESULTS

Small Game License Sales

Adjusted small game license sales rose steadily from 1962, peaked in 1971, and have since declined in a somewhat cyclical pattern (Fig. 1). Sales in 1986 were over 100,000 less than in 1971.

Because of the high correlations between independent variables, no one small game license sale model can encompass all relevant factors. Thus 2 models were developed; one that represents what we believe to be the effect of population size on small game license sales and the other to represent the effect of license cost. Because all relevant factors are not in the same model, the coefficients for the variables in each model are biased. To get an idea of the amount of bias, coefficients of variables used in both models can be compared. The more similar the coefficients, the less bias we would expect in the models.

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

$$\text{SGLS} = 445,196 - 46.26 (\text{P14-64-Mean}) - 0.083 (\text{P14-64-Mean})^2 + 3,792.9 \text{PI}$$

(15,873) (24.32) (0.061) (992.8)

Where:

SGLS= Adjusted 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);

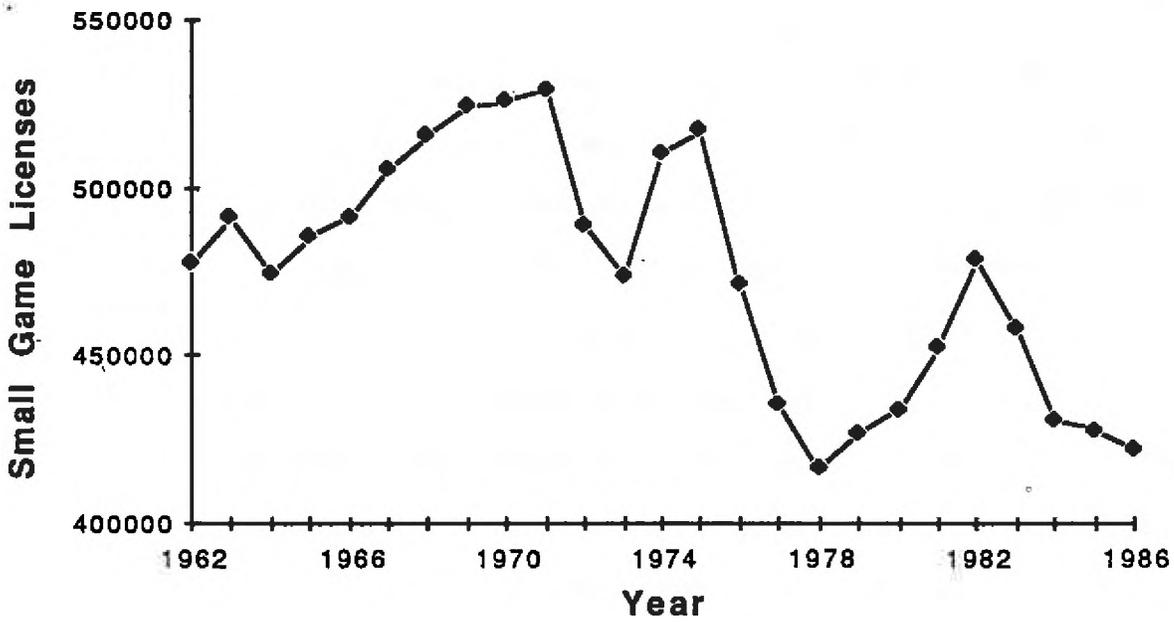


Figure 1. Adjusted Small Game License Sales, 1962-1986.

PI = Index of the pheasant population in central and western NY (known to DEC as: Pheasant/observer index).

This model has an adjusted r^2 of .706 and a standard deviation of 19,590 licenses. The variable most highly correlated with small game license sales was the pheasant population index (.83). This variable is important as one of very few available resource variables, but it reflects only 1 species' population size in a portion of New York State. It can not have as strong an influence as a causal factor in small game licenses sales statewide as the regression model suggests, but we do believe that the pheasant decline has had a significant effect on small game license sales. Dave Austin, Bureau of Wildlife, predicts that because there are no anticipated gains or losses in habitat that the index will remain relatively constant over the next 10 years.

The population variable represents the age group (14-64) most likely to be participating in small game hunting. Having this age group in the model is valuable when trying to make projections of license sale trends. Population is logically not linear in its association with license sales. Up to some population level, the more people, the more hunters to draw from, so we would expect a positive correlation between the 2 variables. At some population level, however, we would expect an inflection point beyond which on balance more people mean less huntable acreage, increased urban orientation, and possibly other factors that would cause a negative correlation with license sales. Indications suggest that we have passed that point of inflection in New York.

Because population and license sales are not believed to be linearly correlated, we have introduced a polynomial, population squared as well as the linear form of population. Any positive variable and its square are so highly correlated, however, that some transformation is needed to reduce this intercorrelation. One of the most straightforward transformations is to subtract the mean of the variable from each case

(Pedhazur 1982). Thus, our population model uses the linear and squared functions of the 14-64 year population minus the mean of this variable. Because the 14-64 age population will continue a very gradual increase into 1995, license sales are predicted to decline by approximately 2% using the above model.

The second small game license sale model reported here 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:

$$\text{SGLS} = 474,495 - 6,902 \text{ \$\$} + 309.4 \text{ LCyc}^2 + 2,652 \text{ PI}$$

(24,636) (3,227) (159.5) (1,066)

Where:

SGLS= Adjusted small game license sales;

\$\$ = License fee;

LCyc² = (License cycle variable which rises each year by 1 until a fee increase, which resets it to 0);

PI = Index of the pheasant population in central and western NY (known to DEC as: Pheasant/observer index).

This model has an adjusted r^2 of .756 and a standard error of 17,859 licenses. As would be expected, the license fee is negatively correlated with license sales. For every increase of \$1 in the fee a corresponding decrease of 6,900 licenses sold can be expected.

The license cycle variable also reflects fee increases. Each year there is no fee increase the value of the variable increases by 1 and is then squared. The squaring function shows the positive exponential effect on licenses sales for the number of years since an increase. This variable helps to explain the cyclical nature of the past 10-15 years' sales.

The pheasant index was also significant in this model, allowing us to compare coefficients between models. The coefficient in this model was 2,652, compared to

3,793 in the population model. The difference between the 2 numbers implies some bias in the other coefficients in the models. But the fact that there is not an order of magnitude difference between them suggests that the bias is not large.

Since the pheasant index is expected to remain constant over the next 10 years and fee increases seem likely, projections from this model would also suggest declining small game license sales. The cyclical pattern of sales seen in the past 10-15 years would also be expected to continue, but with an overall declining trend.

Big Game License Sales

Sales of resident big game licenses peaked in 1982 and have since declined (Fig. 2). The categorization of licenses has been unchanged since previous reports, but additional data acquisition has led us to revise our earlier model. The new variables can be used for future prediction whereas some of the ones dropped could not. For the license sale years 1961-62 through 1985-86, the best explanatory model for adjusted big game license sales, with standard deviation in parentheses was:

$$\begin{aligned} \text{BGLS} = & 531,347 + 114.71 \text{ REAL} - 130.96 \text{ NAg} + 177.81 \text{ IM} - 9,215 \text{ $$} + \\ & (151,764) \quad (40.06) \quad (37.64) \quad (81.45) \quad (4,530) \\ & 2.10 \text{ BH}^{-1} + 0.39 \text{ LS}^{-1} - 27,785 \text{ INC} \\ & (0.50) \quad (0.17) \quad (14,290) \end{aligned}$$

where:

- BGLS = Adjusted 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 NY;
- \$\$ = Weighted license fee;
- BH⁻¹ = Adult bucks harvested the previous year;
- LS⁻¹ = Big game license sales the previous year;

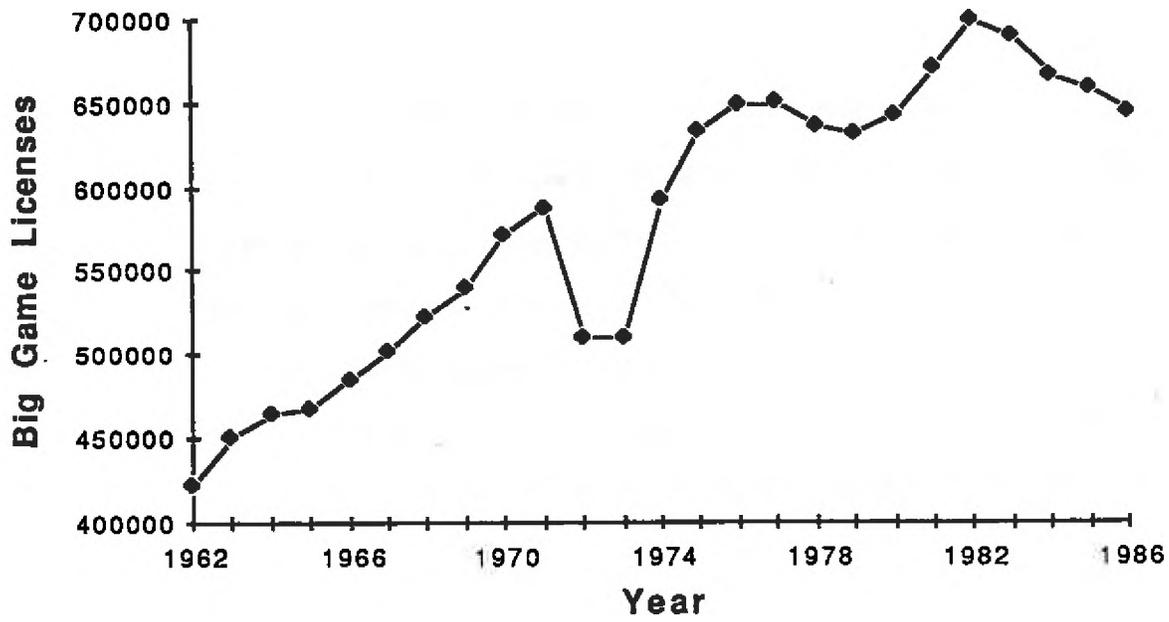


Figure 2. Adjusted Big Game License Sales, 1962-1986.

INC = Dummy variable indicating the year of a license fee increase.

This model has an adjusted r^2 of .957 and a standard deviation of 17,630 licenses. The regression model indicates that other relevant variables held constant, big game license sales are positively correlated with real income, interstate highway miles, the previous year's buck harvest, and the previous year's sales. Variables that are negatively correlated with license sales are nonagricultural employment and license cost. Population variables were tried in the model building process, but were not good predictors given other variables in the model. Nonagricultural employment certainly includes a population effect. Its negative sign may at first appear troublesome, because it implies that as employment increases (and presumably population size increases) the number of licenses sold will decrease. However, the negative sign is more likely reflecting decreased free time to hunt, increased urbanization, and less agricultural land. So nonagricultural employment is affected by population size, but these other factors have an overriding influence which leads to a negative correlation with big game license sales.

The relationship between license sales and interstate highway miles was positive, suggesting that travel is associated with big game hunting and that the interstate system has helped facilitate that travel. The highway system may facilitate access by urbanites to nearby resource areas.

The number of adult bucks harvested the previous year is very strongly associated with big game license sales. The coefficient suggests that each buck harvested the previous year is associated with the sale of 2.10 big game licenses the following year.

License sales are negatively associated with cost increases, but the relationship is nonlinear. A combination of 2 variables, license cost and a dummy variable indicating the years of license cost increases, are best at explaining the effect of cost

on license sales. The model indicates that an increase of one dollar in the license fee will result in a decline in license sales of 9,215 and in the year of the price increase, an additional decline of 27,785 licenses can be expected.

Increasing the license fee would reduce sales, but would increase revenue. The fee would have to be increased more than double its current rate before the revenue-maximizing point would be reached. Undoubtedly this is well beyond the point that would be politically feasible or advantageous for deer population management.

Projections of big game license sales using variables in the model depend entirely on our ability to predict future trends for individual variables. Based on the projections shown in Table 1, the model suggests a decline in license sales for 1990 and 1995. Since real income and interstate road miles can be expected to rise slightly over the projected time period, nonagricultural employment and license fee increases (projected at similar levels to past increases) would contribute most to the projected decline.

Fishing License Sales

Fishing license sales display a very cyclical pattern, but with a net increase from 1965-1986 (Fig. 3). This pattern is closely tied with years of cost increases (1971, 1976, and 1983), and is accounted for in the fishing license model with a license cycle variable.

For the license sale years 1961-62 through 1985-86, the best long-term explanatory model (with standard deviations in parentheses) was:

$$\text{FLS} = 203,513 + 76.70 \text{ P18-44} + 8,801 \text{ LCyc} + 93,926 \text{ USAL} + 41,183 \text{ STGL}$$

$$(152,991) \quad (23.33) \quad (2,358) \quad (19,970) \quad (24,590)$$

Table 1. Projections for variables in the big game license sale model and the resultant predicted license sales.

<u>Variables</u>	<u>Current</u>	<u>Projected</u>		
	<u>1986</u>	<u>1987</u>	<u>1990</u>	<u>1995</u>
REAL	4525	4525	4530	4530
NAg	7800	7900	8200	8300
IM	1510	1515	1517	1520
\$\$	8.20	8.22	10.20	13.20
BH ⁻¹	80,732	90,719	100,000	100,000
LS ⁻¹	657,653	644,168	660,000	660,000
INC	0	0	0	0
Predicted License Sales	646,887	650,230	619,266	579,058

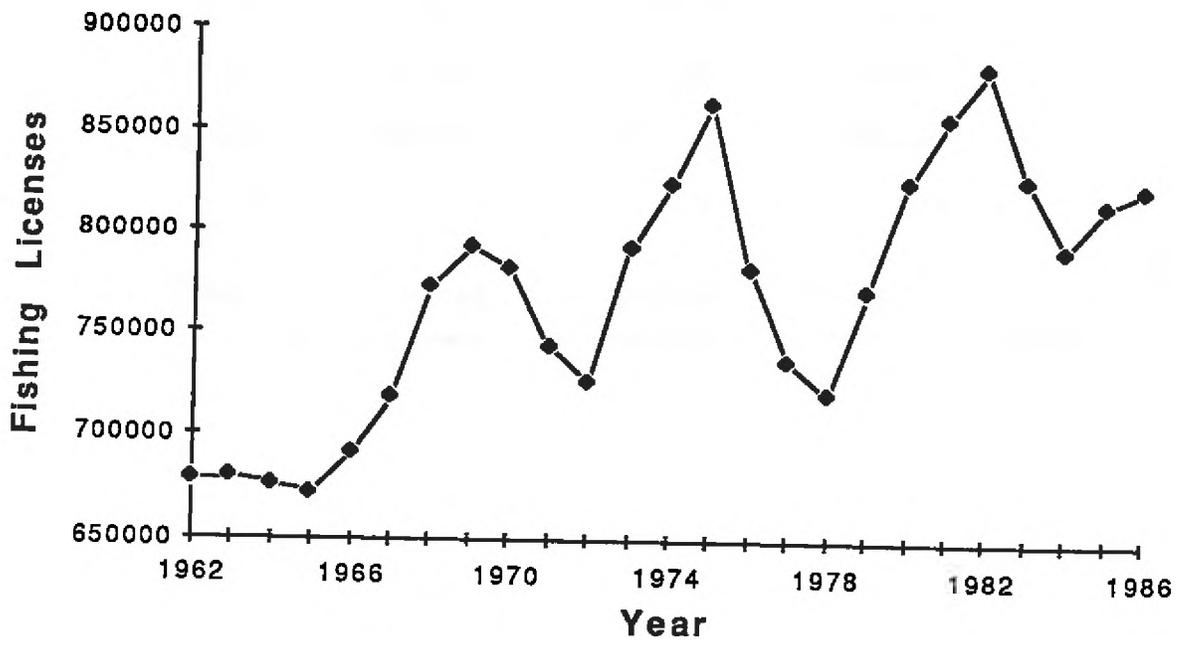


Figure 3. Adjusted Fishing License Sales, 1962-1986.

Where:

- FLS = Adjusted resident fishing license sales;
- P18-44 = NY 18-44 age population (thousands);
- LCyc= License cycle variable which rises each year by 1 until a fee increase which resets it to 0;
- USAL = Dummy variable representing the years 1973-75 when the Great Lakes salmonid fisheries opened, and before the discovery of contaminants;
- STGL = Dummy variable representing the years 1980-86 when full stocking of salmonids resumed in the Great Lakes.

This model has an adjusted r^2 of .774 and a standard deviation of 29,796 licenses. It is different from previously reported fishing license sale models because it is now based on all resident licenses that allow fishing. The cyclical pattern had not been as evident with the earlier data sets. The license cycle variable in this model is a surrogate for license cost, which is too highly correlated (.94) with population to permit both in the model.

The 2 dummy variables are associated with fishing along the Great Lakes. They are helpful in explaining license sales to the extent that the events they measure had a large impact on license sales. As pseudo-resource variables they leave a lot to be desired because they do not measure changes within the event (e.g. the effect of stocking on catch was not perceived as soon as stocking began) and they represent only a part of the New York State fishery resource.

The 18-44 age population segment was positively associated with fishing license sales. It was also highly correlated with per capita income and interstate highway miles, thus preventing them from being included in the model even though they seemed applicable. Unlike small game license sales, there is no indication that a

population level has been reached that would cause its relationship to fishing license sales to be nonlinear.

For long-term projection of fishing license sales the major influencing factor is the 18-44 age population segment. That population segment is currently at its peak and is expected to decline through 1995. Thus the model would predict a slight general decline (3 to 4%) in sales from 1986-1995, with a continued cyclical pattern due to anticipated fee increases.

Impact of 3-Day Fishing License Sales on Fishing Revenue

Revenue from fishing license sales is affected by the relatively recent addition of a 3-Day fishing license category. Time series data from fishing license sales were examined to determine whether a model could be developed that would indicate the effect of the 3-day license on total fishing revenues. This was done by creating a fishing revenue model in which the presence of the 3-day fishing license was a separate independent dummy variable. The best explanatory model (with standard deviations in parentheses) was:

$$\begin{aligned}
 \text{FR} = & -1,943,220 + 409,957 \text{ \$\$} + 456.9 \text{ P18-44} + 597,451 \text{ USAL} \\
 & (1,583,642) \quad (52,650) \quad (191.6) \quad (164,207) \\
 & + 332,498 \text{ INC} - 399,444 \text{ F3-Day} \\
 & (182,678) \quad (201,242)
 \end{aligned}$$

Where:

- FR = Fishing revenue, adjusted to '86 constant dollars;
- \$\$ = Full price license fee, adjusted to '86 constant dollars;
- P18-44 = NY 18-44 age population (thousands);
- USAL = Dummy variable representing the years 1973-75 when the Great Lakes salmonid fisheries opened, and before the discovery of contaminants;
- INC = Dummy variable indicating the year of a license fee increase;

F3-Day = Dummy variable indicating the years when 3-day fishing licenses were sold.

This model has an adjusted r^2 of .822 and a standard deviation of \$253,413. Each of the independent variables has the anticipated positive or negative sign. However, the coefficient of the 3-day fishing license (399,444) is not statistically significant, and its value is too large to be realistic. If all 3-day license holders in 1986 had bought full price licenses, revenue would have increased by only \$200,652. This maximum loss represents only about 3% of total fisheries revenues from resident license sales.

These longitudinal models are not that sensitive, and can not be used successfully to examine changes of this magnitude.

Impact of Senior License Sales on Revenue

A similar type of analysis can be done to measure the effect of senior license sales on revenue. Revenue for this model is defined as all revenue from the sale of licenses for which a senior license purchase could be substituted. This includes all licenses which allow a New York resident to hunt small game, big game, or to fish for the season. Projections of future effects are also important because we know that the number of people age 65-69, who are eligible to buy the senior license, will be increasing at least until 1990. By 1995 it is projected that the number of people in that age group will be starting to decline.

A similar strategy was used as with the 3-day resident fishing model, namely to develop a revenue model in which the presence of the senior license was one of several explanatory variables. The best explanatory model (with standard deviations in parentheses) was:

$$REV = 24,855,840 + 894,130 \text{ \$/\$} + 2,553.7 (\text{TOTPOP-Mean}) - 6.27 (\text{TOTPOP-Mean})^2 - 5,124 \text{ NAg} + 4,544 \text{ REAL} - 472,188 \text{ SRLic}$$

$$(5,998,073) \quad (131,101) \quad (485.3) \quad (2.39) \\ (1,226) \quad (1,027) \quad (800,478)$$

Where:

REV = Revenue generated from all related license sales, adjusted to '86 constant dollars;

\\$/\\$ = Weighted full price license fee, adjusted to '86 constant dollars;

(TOTPOP-Mean) = Total NY population - mean of total NY population (thousands);

(TOTPOP-Mean)² = (Total NY population - mean of total NY population)² (thousands);

NAg = Nonagricultural employment in New York (thousands);

REAL = Per capita income in 1967 constant dollars;

SRLic = Dummy variable indicating the years when the senior license was sold.

This model has an adjusted r^2 of .878 and a standard deviation of \$624,122 (3.9% of '86 revenue). Its explanatory power is quite good, but like the 3-day resident fishing model, the special sales variable of interest, the senior license in this case, had a coefficient that is not statistically significant. The problem is similar in both cases: possible revenue loss from the special sales variable is too small a proportion of total revenue (about 3%) for the sensitivity of the model. The coefficient of 472,000 is approximately equal to the '86 loss of \$469,000 if all senior license holders had bought full price licenses. We emphasize, however, that the coefficient is not statistically significant. The fact that its value approaches a realistic (though extreme) value should be interpreted as happenstance.

This model was prepared to examine the impact of senior license sales on revenue, not to make projections of future revenue. The best projections of revenue would come from using the best small game, big game, and fishing license sale models presented previously in this report and multiplying projected numbers by an appropriate weighted license fee.

Effects of Simplifying New York's License Sales Structure on Sales and Revenue

Within the next year or two, it is anticipated that the Division of Fish and Wildlife will need a license fee increase to keep revenues consistent with increased costs. One proposal calls for a simplification of the number of types of licenses sold. Under this proposal, all combination licenses except the Sportsman's License would be eliminated. The new resident hunting license and the sportsman's license fee would make all new license buyers eligible for a party permit in the DMU of their choice if their name is drawn at no additional fee. A \$5.00 junior hunting license would be created for hunters 12-15 years of age. Longitudinal license sales models were used to estimate the effects of various price levels on license sales and revenues.

The hunting license model used combined all previous license sales to form resident hunting licenses, the independent variable. The model used, with standard deviations in parentheses, was:

$$\begin{aligned}
 \text{HSales} = & 369,651 - 59,085 \text{ \$ADJ} - 12,530 \text{ YRINC} + 181.02 \text{ REAL} + 3.565 \text{ BH}^{-1} \\
 & (169,417) (10,689) \quad (6,041) \quad (57.36) \quad (1.961) \\
 & +4,374 \text{ PHIND} \\
 & (4,147)
 \end{aligned}$$

Where:

H = Resident hunting license sales

\$ADJ = Adjusted license cost

YRINC = Year of license increase (Dummy Variable)

REAL = Real per capita income adjusted to 1967 constant dollars

BH⁻¹ = Buck harvest lagged 1 year

PHIND = Pheasant population index

This model had an adjusted r^2 of 0.767 and a standard deviation of 60,699 licenses.

The fishing model used to examine revenue effects of restructured licenses, with standard deviations in parentheses, was:

$$\text{FSales} = 367,044 - 13,186\$\$ + 107.44 \text{ REAL} + 95,964 \text{ STGL} + 65,942 \text{ USAL}$$

(87,487) (6,090) (25.70) (22,259) (20,433)

Where:

FSales = Adjusted resident fishing sales

\$\$ = Adjusted resident license fee

REAL = Real per capita income, adjusted to 1967 dollars

USAL = Dummy variable representing the years 1973-75 when the Great Lakes salmonid fisheries opened, and before the discovery of contaminants;

STGL = Dummy variable representing the years 1980-86 when full stocking of salmonids resumed in the Great Lakes.

Initially, these models were used to examine several alternative pricing scenarios. In that the models suggested that hunting participation (licenses purchased) was much more price sensitive than fishing, several alternative hunting license fee options were examined. Findings suggested that maximum revenues would be obtained by charging \$15 to \$16 for a resident hunting license and about \$29 for a resident sportsman's license. This assumes the new price structure alluded to above. For consistency in pricing, the resident fishing license was assumed to sell for approximately \$15.

Looking at the sportsman's license and partitioning the revenue due to hunting interest from that due to fishing interests, the models predict that the revenue component from fishing would still be increasing at a cost of \$30. However, the revenue component from hunting would decrease slightly above a price of \$28. Because hunting license sales have decreased in recent years even at stable prices, there is general concern about the decline in hunting interest, and the deer populations are sufficiently large in many parts of the state that it is difficult to keep them under control, these factors merit careful consideration in arriving at recommended fee increases.

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