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

PROGRESS REPORT: STATEWIDE MODELS

by

Tommy L. Brown

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Outdoor Recreation 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:10-11

PROJECT TITLE: Public Attitudes Toward Wildlife and Its Accessibility

STUDY NUMBER AND TITLE: VI - Provision of Planning and Human Dimensions Research Design Assistance to the Bureau of Wildlife

JOB NUMBER AND TITLE: VI-4 - Addressing the Human Dimensions Research Needs of Species Management Planning

JOB OBJECTIVE: To describe the distribution of key human population strata across a series of basic management units derived from ecologically defined zones of the state.

To construct a 3-5 year projection of demand as expressed by sporting license sales.

To help Bureau staff define the human dimensions data needs that should be identified in species management plans and, for data needs identified by those plans, to design or assist in the design and analysis of studies (conducted by Project 146-R- staff or Bureau staff) to meet those needs.

JOB DURATION: 1 April 1984-30 June 1986

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Progress Report: Statewide Models

Introduction

A major problem facing Fish and Wildlife administrators is the development of budget projections, particularly from the income side. License sales, a key component of income, vary from year to year. Although variation has come to be expected, the reasons for the variation and the general longer term trend are not well understood.

Having had some previous experience in the development of license sales models in the early 1970s, the Cornell Outdoor Recreation Research Unit offered to develop a series of explanatory/predictive models that DEC staff might use to understand factors associated with changes in sales and resulting revenues from major license types. The first series of models developed from statewide data are reported herein. Future models will be developed for substate data.

Methods

The data base for the models developed in this report is annual, longitudinal data on license sales (the dependent variables) and socio-demographic and resource-related independent variables. The data base generally spans the years 1962-1984.

New York has changed its license structure in several ways over the past 2 decades. One of the requirements of a longitudinal data base is comparable

10. Dummy variables representing events occurring over only a portion of the 1962-1984 period (described in later sections).

Several other potentially relevant predictors were examined: fall enrollment in college, a meat price index, and a gasoline price index. However, these variables were too highly intercorrelated with some of the population variables (the latter judged to be more basic predictors) for both to be used in regression models.

In addition to developing models to explain license sales, revenue models were also examined for each of the 4 major license types. However, we found that revenue is best projected from the license cost coefficient in models explaining sales.

Interpretation Precautions

A number of factors affect the magnitude and interpretation of the regression coefficient for any given predictor. The most important factor is the specification of the model. We don't know the precise identity of all the factors affecting the sales of any given license type. If we did know, we likely would not have good measures of each factor. To the degree that we are either including irrelevant factors (which appear statistically significant either because they are chance correlations or are correlated with other relevant factors) or that we are omitting relevant factors, our regression coefficients will be biased. There is no good or simple test for determining the amount of bias.

The degree of intercorrelation among variables supposedly has little impact on the regression coefficient (assuming the intercorrelation is not perfect), but intercorrelation does effect the estimated standard error of

data over the time period studied. Thus, after examining license sales data, certain assumptions were made and certain license types were combined or reallocated, as described in our Status Report of 2 April 1985. In brief, 4 major resident license types were created:

1. Small Game. Small game plus small game/big game combination licenses.
2. Big Game. Big game plus small game/big game combination plus sportsman's licenses.
3. Combination Hunting-Fishing. Hunting-fishing plus sportsman's licenses.
4. Fishing. Regular fishing plus 3-day license.

For each of these 4 license types, multiple regression analysis was used to develop explanatory models. The primary independent variables used were:

1. State population of age 14-64. Also subgroups of ages 14-17, 18-44, and 45-64.
2. Total employment. Also subgroups agricultural and nonagricultural employment.
3. Total unemployment.
4. Real per capita income (adjusted for inflation).
5. License cost. Where license types were combined, weighted per license cost was calculated.
6. Total interstate highway miles.
7. Acres of harvested cropland (total).
8. Adult male deer harvested, lagged 1 year (i.e., previous year's harvest).
9. Total deer management permits issued.

the variable (typically increasing it). Other more technical aspects such as autocorrelation can also affect the coefficients. There is a test for autocorrelation, but there is a range for which the test is indeterminate.

Thus, the choice of the best model, and the interpretation of models involve a great deal of judgment. For a particular type of license, as many as 3 alternative models were found that have an r^2 of .92 or higher, relatively low standard errors, and each independent variable being statistically significant at the .05 level (which should not be viewed as a requirement). Yet the coefficients of a key variable such as license cost may vary substantially.

The first, and most general level of interpretation of a multiple regression model is to indicate the relevant predictor variables and the direction of association (positive or negative). This is the easiest interpretation to make, but it can not be guaranteed to be error-free because we have an insufficient theoretical base to know each of the relevant variables.

The second, and more difficult interpretation to make with confidence is that of the magnitude of the predictor or explanatory variable. Of particular attention in this report is that of the license fee coefficient. If a particular type of license sales is the dependent variable and license cost the related predictor variable, a coefficient of -10,000 is interpreted to mean that a one unit, or $1.00 increase in the license fee will result in 10,000 fewer licenses sold. It may be that if the magnitude of the coefficient is -10,000, the license fee could increase by $4.00 before total revenue is maximized. On the other hand, in this hypothetical example, if the magnitude of the license cost coefficient is -30,000, revenue is now at

its maximum level, and a license increase will decrease revenue. Thus, estimating the magnitude of the license cost coefficient is a key element of this analysis. The results section will indicate our best judgment of the level of this coefficient, and the relative confidence (judgmental as well as statistical) we have in it.

The third, and most difficult task related to the regression models is a prediction of license sales or revenue in the future. This is difficult not only because we have no sure knowledge of the validity of the model we have selected, but because the prediction also depends on the accuracy with which the independent variables can be predicted. Given an acceptable model, selected sensitivity analyses can be done in which some variables are held at certain levels and others (particularly ones in which DEC has potential control) are varied to determine the impact.

We feel that the best uses of the models developed in this report are (1) to develop an understanding of the underlying aggregate variables affecting changes in license sales and (2) to examine 3 to 5 year projections. In the absence of a major event such as a license fee increase, a new contaminant discovery in fish or wildlife, or a new license structure (e.g., the senior license), the number of licenses sold in year x may be as good a predictor of sales in year x+1 as anything developed through this type of modeling, simply because sales typically do not change dramatically from year to year. However, a more definite trend emerges over a longer period which can not be predicted if the factors affecting sales are not understood.

Despite these acknowledged precautions about the subjectivity of the models chosen and the careful interpretation of the results, we feel that the models provide considerable insight into factors associated with license

sales and associated revenues. We hope the substate work, now underway, provides additional and more specific insights into more localized factors affecting license sales.

RESULTS

Small Game License Sales

Adjusted small game license sales (in which a combination small game-big game license is counted as a small game as well as a big game license) were 266,350 in 1961-62, the earliest year of the data base (Table 1). Sales reached a high of 283,236 in 1967-68, then began a rather steady decline to a low of 154,760 in 1980-81. Sales then rose to 177,264 in 1982-83, but declined to 160,483 in 1983-84. Average sales over the 23-year period were 240,888, or 50% higher than the 1983 level.

The best explanatory model developed for small game license sales for the 1962-1983 period (with standard errors in parentheses) was:

$$\begin{aligned} SGLS = {} & \underset{(194{,}763)}{113{,}064} + \underset{(41.46)}{166.6}\ P45\text{-}64 - \underset{(22.87)}{83.17}\ NAg + \underset{(21.67)}{99.46}\ REAL \\ & - \underset{(4{,}020)}{8{,}046}\ \$\$ - \underset{(48.10)}{75.07}\ IM + \underset{(9{,}392)}{15{,}284}\ CL \end{aligned}$$

Where:

SGLS = Number of adjusted small game licenses sold;

P45-64 = 45-64 aged NY population (thousands);

NAg = Total nonagricultural employment in New York (thousands);

REAL = NY per capita income, adjusted for inflation;

$$ = License cost;

IM = Miles of interstate highway open in NY;

CL = Dummy variable indicating whether or not the combination small game/big game license was sold

This model has an r^2 of .969, and an adjusted r^2 (adjusted for degrees of freedom for variables in the model) of .957. The standard deviation of

Table 1. Adjusted Resident Small Game License Sales, 1962-1984.

Year	Resident Small Game Licenses	Combination Small Game-Big Game Licenses	Adjusted Small Game Licenses
1961-62	266,350		266,350
1962-63	277,886		277,886
1963-64	267,515		267,515
1964-65	275,036		275,036
1965-66	276,991		276,991
1966-67	281,517		281,517
1967-68	283,236		283,236
1968-69	277,187		277,187
1969-70	272,656		272,656
1970-71	277,977		277,977
1971-72	264,838		264,838
1972-73	253,558		253,558
1973-74	267,389		267,389
1974-75	270,155		270,155
1975-76	256,993		256,993
1976-77	239,159		239,159
1977-78	227,520		227,520
1978-79	180,011		180,011
1979-80	163,251		163,251
1980-81	154,760		154,760
1981-82	115,117	53,572	168,689
1982-83	97,581	79,683	177,264
1983-84	79,803	80,680	160,483

licenses from the regression line is 9,171. The mean difference between licenses actually sold and the model-estimated value for the 22 years from 1962-1983 was 6,211, ranging from a maximum of 14,964 in 1969 (a 5.8% error) to 799 in 1977 (a 0.3% error). The error in the model is not time-correlated; e.g., the mean error for the 6 most recent years of the model is similar to that for previous years.

Interpretation

A one unit change in any independent variable implies a one unit change in small game license sales, all other factors held constant, given the earlier precaution about possible biases in the model. We do not have research information about the effect of all of these variables on small game hunting, but we examined a large number of slightly different models, and feel that this is a very plausible model, and that the coefficients seem stable.

We examined the effect of total population as well as that of age groups 14-17, 18-44, and 45-64 on small game license sales (SGLS). Relationships between the total population and SGLS were not significant. However, the 45-64 aged population was positively correlated with SGLS, and by itself explained 90.6% of the variance. The simple correlation between SGLS and P18-44 is highly negative ($r = -.844$) and also statistically significant, but is correlated with P45-64 to the extent that only one of these variables can be included in the model. The total number of small game licenses divided by the 18-44 year population has dropped from 0.066 in 1962 to 0.048 in 1983 (with a low of 0.041 in 1981).

Employment, but more specifically nonagricultural employment, is negatively correlated with SGLS. For the years included in the model, during which nonagricultural employment has ranged from 6.16 to 7.29 million, a decrease of about 83 small game licenses has been associated with each additional 1,000 employed in nonagricultural sectors. As the second variable added, it explains only an additional 1.4% of the variance, but is statistically significant at the 0.01 level.

Real per capita income is positively associated with SGLS to the degree that each added real dollar of per capita income is associated with an increase of about 99 small game licenses, all other variables held constant. Real per capita income has increased by 36.2% from 1962 to 1983. As the third variable in the model, this variable explained an additional 2.4% of the variance, and was statistically significant at the 0.01 level.

The license cost has a moderate impact on small game license sales. Each additional dollar of license cost is associated with a decline of 8,046 adjusted small game licenses (with a standard error of 4,020). The implications of this are discussed in the next section on revenue analysis. As the fourth variable to enter the model, this variable explains an incremental 1.2% of the variance in license sales, and is statistically significant at 0.01.

Econometricians and other recreation specialists have long realized that an important factor affecting demand is the availability of substitutes. For all that it has been studied, we don't know a great deal about substitutes for recreation activities. We tend to think of the activity most closely related to an activity (small game hunting, in this case) as the substitute. Thus we think of big game hunting, target shooting, or perhaps fishing. Yet,

for all those who buy a license one year but not the next, the activity "occupying" the time slot of hunting may have no relationship to hunting. It may be a competing activity such as work around the house, boating, or general travel.

In situations where a specific substitute activity can not be identified, a proxy variable that captures access to other opportunities is sometimes used. We have used miles of interstate highways as such a variable. As the fifth variable to enter the model, it is not significant at the 0.05 level, but we surmise this is because there is so little variance left to be explained. In the absence of any other included variable, interstate road miles is significant. The inclusion of interstate road miles increases both the actual r^2 (by 1.1%) and adjusted r^2, and it lowers the standard error.

Interstate road miles is negatively correlated with SGLS, suggesting that it does provide a measure of access to leisure opportunities that compete with small game hunting. Each completed mile of interstate highways has been associated with a decline of about 75 small game licenses. For the period of the model, interstate miles have almost doubled, from 768 in 1962 to 1,428 in 1982. In the absence of other factors, some of which are counterbalancing, this gain in interstate miles would be associated with the loss of 49,500 small game licenses, according to the model.

The last variable used in the model is a dummy variable for the small game/big game license, first sold in 1981-82. Even adjusting for combination licenses as we did, a larger number of small game licenses were sold in 1982-83 (also the first year of a price increase) than would be expected. We surmise this combination license was available nearly all of 1981-82, but not

the entire year, in that it did not make the literature that described the other licenses. This dummy variable also is not statistically significant at the 0.05 level, due to the number of variables in the model (it is significant if other variables are omitted), but it does improve the r^2 slightly (by 0.5%), and more importantly, it reduces the standard error of the model by 461 licenses.

Projected Sales and Revenues

Projections of some of the independent variables in the model are not available, so we have made our own (Table 2). Based on the projections in Table 2, we have then substituted the projections into the SGLS model, varying the license fee by $1.00 increments. The model estimates a loss of 8,046 adjusted small game licenses sold for each dollar that the fee is increased. Estimated sales and revenue generated for a schedule of possible fees is shown in Table 3.

Table 2. Projected Independent Variable Data Affecting Small Game License Sales, Excluding License Cost[1]

Variable	1983	1987	1990
Pop. 45-64	3,661,000	3,646,000	3,655,000
Nonag. Employment	7,285,000	7,500,000	7,650,000
Real Per Capita Income (1967 Dollars)	4,405	4,650	4,800
Interstate Miles	1,428	1,440	1,450
Presence of Small Game/ Big Game License	Yes	Yes	Yes

[1]Only population projections are available. The authors have projected other variables, based on recent trends and other relevant information.

Table 3 suggests that in license year 1982-83, the last year included in the model, revenue from SGLS would have been maximized at a fee of $6.00 higher than the current fee. A weighted $14.39 fee undoubtedly was not politically feasible, and would have resulted in the loss of over 48,000 small game licenses, but it would have increased revenues by $302,000.

Table 3. Projected Small Game License Sales and Revenues for 1983, 1987, and 1990.

Year	Weighted Fee	Licenses Sold	Revenue (000's)
1983	$ 8.39[1]	169,515	$1,442
	9.39	161,468	1,516
	10.39	153,421	1,594
	11.39	145,374	1,656
	12.39	137,328	1,701
	13.39	129,282	1,731
	14.39	121,236	1,744
	15.39	113,190	1,742
1987	$ 8.39[1]	172,751	$1,449
	9.39	164,705	1,547
	10.39	156,659	1,620
	11.39	148,613	1,693
	12.39	140,567	1,742
	13.39	132,521	1,774
	14.39	124,475	1,791
	15.39	116,429	1,792
	16.39	108,203	1,773
1990	$ 8.39[1]	175,943	$1,476
	9.39	167,897	1,577
	10.39	159,851	1,661
	11.39	151,805	1,729
	12.39	143,759	1,781
	13.39	135,713	1,817
	14.39	127,667	1,837
	15.39	119,621	1,841
	16.39	111,575	1,829

[1]1983 weighted small game license fee.

The projected socioeconomic factors would increase the revenue-maximizing fee (to the nearest dollar) from $14.39 in 1983 to $15.39 in 1987 and 1990.

Discussion

The best confirming evidence that small game license sales have not reached their revenue-producing maximum is to examine sales and revenue surounding the last price increase. The weighted fee increased from $6.21 in 1981-82 to $8.39 in 1982-83. Despite the price increase, sales increased from 168,689 to 177,264. Sales then dropped to 160,483 in 1983-84, a loss of 8,206 from 1981-82, but gross revenue from 1983-84 sales @ $8.37 was $1.346 million, compared to only $861,000 in 1981-82.

Although small game license fees can be increased to improve revenues, the long-term decline in small game license fees is troublesome. The hunter training course registration data, which is a barometer of new hunting recruits, mirrors this situation. Firearms registrations declined from 58,254 in 1981 to 42,252 in 1984. The added 4 hours training required in 1985 may further dampen registrations.

Thus, while our best projections provide some justification for a price increase, small game hunting opportunities should receive increased visibility. Otherwise, the declining influences could have compounding effects not picked up in the projection model.

Big Game License Sales

Adjusted big game license sales (BGLS), in which the combination small game/big game license and the sportsman's license is also counted as a big

game license, steadily increased from a low of 421,707 in 1961-62, to a high of 698,501 in 1981-82. Sales dropped the last 2 years to 688,658 in 1982-83, and to 665,936 in 1983-84 (Table 4).

The best explanatory model for BGLS is:

$$\begin{aligned} BGLS = & -329{,}494 + 86.53\ P18\text{-}44 + 6.2203\ BH\text{-}1 - 1.1996\ P \\ & (168{,}216)\quad (36.71)\qquad\quad (0.9064)\qquad (0.2299) \\ & -18{,}586\ \$\$ + 149.37\ IM + 65{,}136\ CL \\ & (7{,}284)\qquad (57.13)\qquad (28{,}354) \end{aligned}$$

Where:

BGLS = Big game license sales;

P18-44 = NY 18 to 44 aged population;

BH-1 = Adult bucks harvested the previous year;

P = Number of deer management permits issued during the current year;

$$ = Weighted license fee

IM = Miles of interstate highway

CL = Dummy variable indicating whether a combination small game/big game license was offered for sale

This model has an r^2 of .971, and an adjusted r^2 of .960. Its standard error is 17,112 licenses. The mean prediction error is 10,826 licenses, or 1.9% of the mean of 573,138 licenses sold during the 23-year period. The largest prediction error was 33,757 licenses in 1970-71 (5.8% error), and the smallest was 96 licenses in 1973-74 (0.02% error). The model has no significant autocorrelation (knowing the prediction in a given year does not help in predicting the following year), but the average error over the last 4 years (1980-81 through 1983-84), 3,838 licenses, is well below the mean error of 10,826 for the entire 23 years.

Interpretation

The broad 14-64 aged population was not significantly associated with BGLS, nor were the younger 14-17, or older 45-64 aged segments. However, the 18-44 year segment was positively associated with BGLS (statistically significant at the 0.05 level). This segment has steadily increased from 6.059 million in 1962 to an estimated 7.472 million in 1984.

Table 4. Adjusted Resident Big Game License Sales, 1962-1984.

Year	Resident Big Game Sales	Combination Big Game/Small Game Sales	Sportsman's License Sales	Adjusted Big Game Totals
1961-62	421,707			421,707
1962-63	449,979			449,979
1963-64	463,697			463,697
1964-65	466,850			466,850
1965-66	484,384			484,384
1966-67	501,821			501,821
1967-68	522,956			522,956
1968-69	538,873			538,873
1969-70	571,126			571,126
1970-71	586,865			586,865
1971-72	509,893			509,893
1972-73	510,137			510,137
1973-74	591,374			591,374
1974-75	632,549			632,549
1975-76	648,516			648,516
1976-77	649,225			649,225
1977-78	636,327			636,327
1978-79	437,835		192,641	630,476
1979-80	409,860		232,723	642,583
1980-81	406,116		263,630	669,746
1981-82	360,637	53,572	284,292	698,501
1982-83	353,419	79,683	255,556	688,658
1983-84	336,958	80,680	248,298	665,936

The number of adult bucks harvested the previous year is very strongly associated with BGLS (statistically significant at the 0.001 level). The coefficient suggests that each buck harvested the previous year is associated with the sale of 6.22 big game licenses the following year.

The number of party permits sold is very strongly associated with BGLS (significant at the 0.01 level), and the coefficient is negative. An examination of consecutive-year change in permits sold versus licenses sold shows that in 11 cases, the direction of change was the same, and in 11 cases, the direction of change was opposite. There is no particular temporal pattern to this effect, except to note that in 5 of the last 6 2-year periods, the direction of change has agreed. In other variations of the model presented here, the permits variable was consistently highly

The cost of the big game license was negatively associated with sales, and significant at the 0.05 level. The coefficient suggests that each dollar of price increase is associated with a drop of 18,586 licenses. The implications of this on revenue are discussed in the following section.

Interstate road miles is significantly associated with BGLS at the 0.05 level, but unlike small game sales, where the sign of the coefficient was negative, it is positively associated with BGLS. This suggests that more travel is associated with big game hunting, and that the interstate system has facilitated that travel.

As with small game licenses, a dummy variable indicating whether the small game/big game combination license was sold aids in the explanation of the model. The sign of the big game coefficient is also positive.

In the order that the independent variables were entered into the model, the 18-44 aged population explained 83.0% of the variance. Incremental

amounts explained by the addition of other variables were 2.9% by adult bucks harvested the previous year, 7.7% by total permits issued, 1.6% by the license cost, 0.9% by interstate highway miles, and 1.0% by the dummy combination license variable. When entered in a different order, however, variables 2 through 6 will each explain a larger proportion of the variance (as was true for variables in the small game model). Thus, the proportion of additional variance explained should not be interpreted as an index of importance for the independent variables.

Projected Sales and Revenues

Before one can predict BGLS for 1987 and 1990 (as was done for small game licenses), projections would have to be derived for the buck harvest in 1986 and 1989, and for the total number of permits issues in 1987 and 1990. We do not have those projections, but will supply projections of the other variables so that DEC staff can supply various harvest/permit/license fee scenarios and use the model to project BGLS and revenues.

The 18-44 year New York population, estimated at 7,362,000 in 1983, is projected to rise to 7,722,000 in 1987, and to 7,821,000 in 1990. We project interstate miles, estimated at 1,430 in 1983, is projected to be 1,440 in 1987 and 1,450 in 1990. The big game/small game combination license is expected to continue, and thus that dummy variable will continue to carry the coefficient of "1".

The revenue impacts of increasing the big game license fee, independent of changes in any other resource or demographic characteristics, is shown in Table 5. The model and resulting data show that the big game license fee is far below the revenue-maximizing fee of about $22.19. Furthermore, unless

there is a substantial change in the harvest or permits issued, the projected increase in 18-44 population would drive the revenue maximizing point slightly higher than Table 4 shows for 1987 and 1990.

Table 5. Projected Big Game License Sales and Revenues in 1984, for a Schedule of Possible Fees.

Weighted Big Game Fee	Projected License Sales	Projected Revenues (000's)
$ 8.19*	665,936	$5,454
10.19	628,764	6,407
12.19	591,592	7,211
14.19	554,420	7,867
16.19	517,248	8,374
18.19	480,076	8,733
20.19	442,904	8,942
22.19	405,732	9,003
23.19	387,146	8,978

*Current weighted fee.

Discussion

Political factors must be considered, as well as the long-term implications of having substantially fewer big game licenses sold, if the fee were to be substantially raised. These implications include maintaining an adequate deer harvest (Could this be done through additional permits?). They also include the question of whether some people would be driven out of hunting who have sufficient commitment to the activity that they would initiate others into the activity if they continued. These factors probably argue against a fee increase to the revenue maximizing point. However, we see little to suggest that a big game license fee of as much as $15.00, if it were politically feasible, would have major undesirable impacts.

Combination Small Game/Fishing License Sales

The small game/fishing license has been sold historically, and has been an important license, although it declined substantially in importance with the introduction of the sportsman's license in 1978-79. Because of concern that the influence of variables affecting combination licenses might differ from those affecting single license buyers, small game/fishing combination licenses were analyzed as a separate entity (other combination licenses have been implemented too recently to analyze them in this way). In this analysis, adjusted combination small game/fishing licenses are the sum of the combination license and the sportsman's license. If desired, a subsequent analysis could be made in which all major resident licenses are grouped into 3 categories: small game, big game, and fishing.

Adjusted combination small game/fishing licenses, during the period studied, have fluctuated from rougly 210,000 in the early 1960s to in excess of 250,000 in 1970-71. License sales dropped substantially to 214,716 in 1975-76, and further, to 188,334 in 1977-78. They recovered to 246,690 in 1978-79, and rose to an all-time high of 309,898 in 1981-82, then decreased in the last 2 years to 269,891 in 1983-84 (Table 6).

The best model that we could develop for the combination small game and fishing licenses, given a very limited amount of fisheries data, is:

$$\begin{aligned} SGFC = {} & \underset{(165{,}822)}{957{,}918} - \underset{(39.59)}{194.56}\ P45\text{-}64 + \underset{(14.43)}{91.67}\ REAL - \underset{(1{,}866)}{12{,}436}\ \$\$ \\ & - \underset{(8{,}949)}{32{,}304}\ CONT + \underset{(10{,}685)}{43{,}749}\ SPORT - \underset{(47.83)}{172.44}\ P14\text{-}17 \end{aligned}$$

Where:

SGFC = Small game/fishing combination licenses

P45-64 = NY population 45-64 years of age

REAL = Per capita income, adjusted for inflation

CONT = Dummy variable indicating presence of contaminants in Lake Ontario waters

P14-17 = NY population 14-17 years of age

Table 6. Adjusted Resident Small Game Hunting and Fishing Combination License Sales, 1962-1984.

Year	Resident Hunt and Fishing Licenses	Sportsman's Licenses	Adjusted Small Game/Fishing Licenses
1961-62	211,344		211,344
1962-63	212,826		212,826
1963-64	206,917		206,917
1964-65	210,268		210,268
1965-66	213,931		213,931
1966-67	223,997		223,997
1967-68	232,318		232,318
1968-69	246,980		246,980
1969-70	252,829		252,829
1970-71	251,305		251,305
1971-72	223,581		223,581
1972-73	220,220		220,220
1973-74	242,925		242,925
1974-75	247,045		247,045
1975-76	214,716		214,716
1976-77	195,644		195,644
1977-78	188,334		188,334
1978-79	54,049	192,641	246,690
1979-80	37,947	232,723	270,670
1980-81	34,303	263,630	297,933
1981-82	25,606	284,292	309,898
1982-83	25,404	255,556	280,960
1983-84	21,593	248,298	269,891

This model has an r^2 of .946, or .926 when adjusted for degrees of freedom. The standard deviation of licenses sold around the regression line is 8,735.

The mean annual error is 6,222 licenses, and ranges from a high of 11,765 in 1972, to a low of 445 in 1973.

Interpretation

The first explanatory variable in the equation, the 45-64 age population, is negatively correlated with sales when other factors are controlled for statistically. This population segment peaked at 4.174 million in 1968, and has declined since, to an estimated 3.648 million in 1984. It has almost reached its trough; it is projected to reach 3.646 million in 1987 and then to rise slightly to 3.655 million in 1990. This variable explained 44.1% of the variance in SGFC licenses and was statistically significant at the 0.01 level.

The second variable to enter the model, real per capita income, is positively associated with SGFC license sales, is also statistically significant at the 0.01 level, and explains an additional 28.9% of the variance.

Believing that adjusted SGFC license sales, which includes sportsman's licenses, may have been aided by the visibility of the new license as well as the discounted price (which is taken into account in the weighted license fee), a dummy variable was created for the years in which this license has been sold (since 1978-79). This dummy variable was statistically significant at 0.01, explained an additional 3.6% of the variance, and according to the model has been associated with an average gain of 43,749 licenses, other factors held constant.

The third variable to enter the equation, the weighted license fee, explained an additional 11.5% of the variance and was significant at the 0.01

level. It is negatively correlated with sales, as we would expect, and has a coefficient of 12,436. The implications of this coefficient on revenue are explained in the next section.

The only fisheries data available to us is total miles of public stream access. This variable steadily increases in much the same way as the 18-44 population and real income, and thus has not been a helpful explanatory variable. The only obvious option at this point was to create dummy variables where we felt they were justified by logic and by examination of residuals from the data. The fourth variable to enter the equation is such a variable, a dummy variable that attempts to represent the publicly visible contaminant problems in fisheries that the state has faced since 1976. Such a dummy variable was significant at 0.01, explained an additional 4.4% of the variance, and had the expected negative correlation, with a coefficient suggesting an average contaminant-related cost of 32,304 licenses.

It should be indicated that the 18-44 year population is highly correlated with SGFC license sales, and that this correlation is positive. However, the variable is so highly correlated with the 45-64 year population (although the correlation is negative) and with real income that its separate effect can not be shown in this model.

The last variable to enter the equation, the 14-17 age population, explained only an additional 2.1% of the variance, but was also statistically significant at the 0.01 level. This variable is also negatively correlated with sales when other variables are controlled for. This population segment peaked in 1973 at 1.358 million, and is expected to continue to decline through 1990. The 16-17 aged population is probably the relevant population

to SGFC licenses, but better projections were available for the wider 14-17 age span, and there appears to be little difference in the trend of the slightly different age segments.

Projected Sales and Revenues

Omitting the license price, our projections of other independent variables is shown in Table 7. These projections are then used to develop the projections of license sales and revenues shown in Table 8. In 1984, revenue would have been maximized at a weighted fee of 19.31, $4.00 above the current fee. However, the revenue peak is so flat that only $9,000 in revenue would have been gained from the last $1.00 of increase. By 1987, when it may be feasible politically to expect a price increase to be approved, the maximum revenue figure would be @ $20.81, or $5.00 higher than the current fee. Although little is gained from the last 50 cents of the fee, license increases occur only every 5 years or so, and by 1990, the revenue maximizing figure will have increased by another dollar.

Table 7. Projected Independent Variable Data Affecting Combination Small Game and Fishing License Sales, Excluding License Cost.

Variable	1984	1987	1990
Population 45-64	3,728,000	3,646,000	3,655,000
Population 14-17	1,106,000	1,024,000	890,000
Real Per Capita Income	4,450	4,650	4,800
Sportsman's License	Yes	Yes	Yes
Contaminants	Yes	Yes	Yes

Table 8. Projected Combination Small Game/Fishing License Sales and Revenues for 1984, 1987, and 1990.

Year	Weighted Fee	Licenses Sold	Revenue (000's)
1984	15.81*	280,191	$4,430
	16.81	267,755	4,501
	17.81	255,319	4,547
	18.31	249,101	4,561
	18.81	242,883	4,569
	19.31	236,665	4,570
	19.81	230,447	4,565
1987	15.81	312,927	4,947
	17.81	288,055	5,130
	19.81	263,183	5,214
	20.81	250,747	5,218
	21.81	238,311	5,198
1990	15.81	348,033	5,502
	17.81	323,161	5,755
	19.81	298,289	5,909
	21.81	273,417	5,963
	22.31	267,199	5,961
	22.81	260,981	5,953

Discussion

We have a concern with models involving fishing license sales that the models developed may contain biases due to the lack of omitted relevant variables. The only fisheries resource variable that we have a measure of is miles of stream access. We have no stocking measures, and no measures that provide an indicator of contaminants or angler perceptions thereof. We believe that the coefficients associated with license fees are reasonable measures, but we caution that we are less confident of the license sales projections. The dummy variables for the sportsman's license and contaminants could conceivably be measuring something else, and there is no assurance that the effect will remain constant through 1990.

Combination licenses dropped from 309,898 in 1981-82 to 280,960 in 1982-83, and to 269,891 in 1983-84. The projection model predicted a drop from 311,395 in 1981-82, to to 269,619 in 1982-83, followed by an increase to 280,191 in 1983-84. At this point we can't say whether this is random error in the model, or whether unmeasured factors are at work. If 1984-85 combination sales increase from 1983-84, this will be an indication that the model is still reliable. If not, this will indicate the presence of influences not being measured in the model.

Resident Fishing Licenses

In this analysis of resident fishing licenses we have combined the annual and the 3-day resident license, the latter sold since 1981-82. The weighted license fee used reflects this combination.

Adjusted resident fishing license sales have averaged 527,998 over the 23-year period, ranging from a low of 462,082 in 1964-65 to a high of 617,128 in 1974-75 (Table 9). Sales dropped from the 1974-75 high to 524,970 in 1978-79, rebounded to 571,651 in 1981-82, then dropped in 1983-84 to 522,524, the lowest level since 1970-71.

The best model that we could develop from the available data was:

$$\text{FLS} = \underset{(276{,}580)}{748{,}715} + \underset{(17.97)}{85.69}\ \text{REAL} + \underset{(14{,}132)}{60{,}745}\ \text{USAL} - \underset{(64.22)}{129.83}\ \text{P45-64} - \underset{(6{,}300)}{12{,}079}\ \$\$$$

Where:

FLS = Adjusted resident fishing license sales;

REAL = Per capita income in 1967 dollars, adjusted for inflation;

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

P45-64 = NY 45-64 age population

$$ = license cost

This model has an r^2 of .779, or .730 when adjusted for degrees of freedom. The standard deviation of predicted data around the regression line is 22,102. The mean prediction error is 15,003 licenses or 2.8% of the mean number sold. The error ranges from a minimum of 130 licenses in 1967-68 to a maximum of 43,890 in 1970-71. The error is not correlated with respect to time.

Table 9. Adjusted Resident Fishing License Sales, 1962-1984.

Year	Annual Licenses	3-Day Licenses	Adjusted Fishing Licenses
1961-62	467,350		467,350
1962-63	466,285		466,285
1963-64	469,106		469,106
1964-65	462,082		462,082
1965-66	478,008		478,008
1966-67	495,223		495,223
1967-68	541,181		541,181
1968-69	546,201		546,201
1969-70	529,679		529,679
1970-71	492,849		492,849
1971-72	502,858		502,858
1972-73	572,220		572,220
1973-74	581,372		581,372
1974-75	671,128		671,128
1975-76	567,776		567,776
1976-77	542,141		542,141
1977-78	533,473		533,473
1978-79	524,970		524,970
1979-80	554,726		554,726
1980-81	558,946		558,946
1981-82	564,730	6,921	571,651
1982-83	526,823	19,394	546,217
1983-84	493,444	29,080	522,524

Interpretation

Real per capita income explained the greatest amount of the variance of any variable, 38.8%, and is positively correlated with license sales. It is statistically significant at 0.01. Real per capita income has steadily increased from $3,234 in 1961 to $4,450 in 1984, although it has temporarily declined in recession years such as 1970, 1974-77, and 1979-80. It has steadily increased since 1982, probably due largely to stable oil supplies and prices that have kept inflation under control. There are no long-range real income projections, but the immediate future seems positive for increased real income.

The second variable to enter the equation, the dummy variable representing the opening of Great Lakes salmonid fishing and the growth period before the ban of 1976, explained an additional 22.7% of the variance of the model, and is statistically significant at 0.01. The coefficient suggests that in these 3 years, the events captured by the dummy variable resulted in an average sales increase of 60,475 resident licenses, all other factors held constant.

The 45-64 year population segment explained an additional 14.6% of the variance in adjusted fishing license sales, and is statistically significant at 0.05. This variable is negatively correlated with sales, as it was with small game/fishing combination sales. Again, the 18-44 year segment is positively correlated with sales, but intercorrelation with other independent variables prohibits its use in the model.

The last variable to enter the model, the weighted license cost, explained an additional 2.3% of the variance. The statistical significance is just outside the 0.05 level, but we believe it presents an accurate

reflection of the role of the license fee, and it further reduces the standard error. Revenue projections based on the coefficient of -12,079 are discussed in the following section.

Projected Sales and Revenues

Projections for the independent variables in the fishing license sales model are shown in Table 10. The implications on revenue, starting at the current weighted fee of $9.17, are shown in Table 11.

Table 10. Projected Independent Variable Data Affecting Adjusted Resident Fishing License Sales, Excluding License Cost

Variable	1984	1987	1990
Real Per Capita Income	4,450	4,650	4,800
Great Lakes Dummy Var.	No	No	No
Population 45-64	3,728,000	3,646,000	3,655,000

The projection model indicates that fishing license fees are far below the point of maximum revenue generation. As with any normal economic good or service, increasing the price will lower the demand. However, the license fee is the least important variable in the model. A license fee increase should definitely increase revenues.

Discussion

The earlier comments about the lack of fisheries resource data and some longitudinal measure of public visibility of contaminants applies to the resident fishing model as well as to the combination small game/fishing license model. The dummy variable used in the combination license model,

giving the value of "1" to years since the discovery of Great Lakes contaminants, was less effective in explaining variance than the one indicating the early salmonid years.

Table 11. Projected Adjusted Resident Fishing License Sales and Revenues for 1984, 1987, and 1990.

Year	Weighted Fee	Licenses Sold	Revenue (000's)
1984	9.17	545,662	$5,004
	11.17	521,504	5,825
	13.17	497,346	6,550
	15.17	473,188	7,128
	17.17	449,030	7,709
	19.17	424,872	8,145
	21.17	400,714	8,483
	23.17	376,556	8,725
	25.17	352,398	8,870
	27.17	328,240	8,918
	28.17	316,161	9,906
1987	9.17	563,049	5,163
	15.17	490,575	7,442
	20.17	430,180	8,677
	25.17	369,785	9,307
	28.17	333,548	9,396
	29.17	321,469	9,377
1990	9.17	574,734	5,270
	15.17	502,260	7,619
	20.17	441,865	8,912
	25.17	381,470	9,602
	28.17	345,233	9,725
	29.17	333,154	9,718

It is difficult to feel confident in this model as a license sale predictive model because we have so little data and also not as much angler behavioral knowledge as wildlife knowledge. We do feel that we can say with confidence that revenue related to resident fishing license sales can only be positively impacted by any license fee increase that is politically feasible.

Implications and Recommendations

The primary use of this analysis has been (1) to develop a better understanding of some of the larger or macro demographic and resource factors affecting license sales, and (2) to develop relationships between license costs and sales such that the sensitivity of license sales and revenues to license costs can be estimated.

It is believed that the analyses presented have achieved those goals with some degree of success. At least 2 precautions seem warranted, however. First, there are other factors influencing participation and license sales that we don't have longitudinal measures of. Hunter training registrations are down significantly in recent years. This could be a result of demographic factors, of resource factors (although probably not big game-related), of less visibility of the courses, or of less visibility or promotion of hunting generally. We don't know the reasons, and therefore we don't know to what degree our models captures those reasons. We are doubtful that all important factors have been captured because we believe that a continued decline in registrations has to eventually translate into sales losses.

The second precaution is that the implications of the models toward revenues generated do not consider the political feasibility of license fee increases. The model should be interpreted to mean, given that fees were successfully raised to a given level, exclusive of any major negative publicity (e.g., endorsement of a one-year boycott by a major conservation organization), a corresponding number of licenses would likely be sold. Note that the model says nothing about political, equity, biological, or other

considerations of adopting license fees at or near the point of maximum revenue generation; it simply tries to identify the maximum revenue points.

Further analyses will be undertaken at the substate level in attempt to determine the role of regional influences (that are not statewide in scope) on license sales. We hope to report on these analyses by the end of calender 1985.

It is strongly recommended that the Division support the maintenance and updating of this statewide data base. We would estimate a cost of about $2,000 per year, and would recommend that the work simply continue to be a part of the consulting portion of our work for DEC.