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THE DEMAND FOR MAINE RESIDENT HUNTING AND FISHING LICENSES

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The Maine Department of Inland Fisheries and Wildlife is currently in the throes of a budgetary crisis. Negotiated employee salary increases and the general inflationary trend of the 1970's have resulted in significant increases in operating costs. The Department, like many of its counterpart agencies in other states, is funded primarily from dedicated revenues collected from the sale of hunting and fishing licenses. Since there are no built-in adjustments for inflation in license fees, as there are in sales taxes or even income taxes, Department revenues have not kept pace with costs. As a result, the Department is projecting a budget deficit of around one million dollars for FY 1980-81.

Several alternatives have been suggested to alleviate the crisis. These include an excise tax on fishing and hunting equipment sold within the State, transferring money from the State general fund, higher resident and/or non-resident license fees, and cutting programs to enable the Department to continue to rely solely on current funding sources. These alternatives have been the subject of considerable debate in the Maine legislature and among the citizens of the State.

The methods most frequently suggested to increase Department revenues is to increase the prices for resident and/or non-resident hunting and fishing licenses. Perhaps the easiest "political" solution is to increase non-resident hunting and fishing license fees. Obviously, non-resident sportsmen are not directly represented in the Maine legislature; hence, the "political fallout" from such an increase would be minimal. In fact, such a decision may be politically popular among resident sportsmen since it would probably reduce the number of non-resident hunters and fishermen. However, fewer non-resident sportsmen translates into fewer imported dollars for the Maine tourist-oriented economy. An earlier study (Faunce) found that non-residents spent an average of \$384 per trip to hunt in Maine. Part of these expenses were incurred outside of Maine but the economic impact of non-resident hunting expenditures in Maine is still substantial.

Furthermore, existing evidence suggests that increasing non-resident license fees may worsen the financial situation of the Department. A study of the demand for non-resident hunting licenses (Lutz) found that the demand curve is elastic for prices greater than \$55. Since the 1979 fee level of \$62.50 is slightly above this price, further increases in license fees may result in a decrease in revenue from non-resident hunting licenses. This finding is supported indirectly by another study (Faunce). Data from a survey of non-resident hunters in Maine in 1978 indicates that even small increases in the costs associated with hunting in Maine would result in a significant decrease in non-resident hunting activities. Hence, higher non-resident license fees may result in greater than proportional decreases in the quantity of non-resident licenses sold.

An increase in resident license fees, like most other fee or tax increases, is unpopular from a political viewpoint. However, the study by Faunce indicates that resident hunters are not as sensitive as non-residents to higher costs. This may indicate that the price

elasticity of demand for resident licenses is inelastic in the current price range.

The purpose of this paper is to present more information on this topic by estimating the demand for resident hunting, fishing and combination (both hunting and fishing) licenses in Maine through the use of time series data. The objectives of the paper are to estimate the demand for each of the three types of licenses, calculate their respective elasticities and, finally project the quantity of licenses sold and the total revenue generated from the sale of resident licenses for 1979 and 1980. We believe this type of information is useful for policy purposes. Officials in the Department of Inland Fisheries and Wildlife and other policy makers can use this information to evaluate the impact of some of the alternatives that have been mentioned to solve the fiscal problems of the Department.

MODEL SPECIFICATION AND DATA

Several techniques have been developed to estimate the demand for recreational activities and the value of recreational resources (Clawson and Knetsch, Langford and Cocheba, McConnell, Bishop and Heberlein). However, these techniques are not well-suited for estimating the demand for licenses. Cross-sectional demand analysis is not possible either, since the price of a license is uniform and constant for a given period of time. A contingent valuation approach could be used, but it requires the collection of primary data. In addition, the results are subject to respondent bias (Bishop and Heberlein). Respondent bias could be large in a study such as this because of the emotional nature of the topic. Therefore, a time series approach seems appropriate and the basic data required for the analysis are available from secondary sources.

Traditional economic theory is useful for specifying the demand for resident hunting, fishing and combination licenses. The quantity of licenses sold is hypothesized to be a function of the license price (in real dollars), real income per capita and population. In addition, an expected hunting success variable is included in the hunting and combination license equations. It is hypothesized that the number of hunting and combination licenses sold is positively related to expected hunting success. It is assumed that hunters base their expectations regarding hunting success for the current year on the basis of success in the previous three years. A weighted summation process is used to calculate expected hunting success, such that success in the most recent year is weighted more heavily than success in the previous year, etc. The ratio of deer killed per licensed resident hunter is used as a measure of hunting success.¹ That is, the expected hunting success for year t is defined as:

$$HS_t = \sum_{i=1}^3 W^i \frac{DK_{t-1}}{Q_{L,t-1}}$$

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¹Deer hunting accounted for 70 percent of all hunting activities by Maine residents in 1978 (Faunce).

where HS_t = the calculated hunting success variable for year t ;
 DK = the quantity of deer killed in Maine in year $t-i$;
 Q_L = the quantity of resident combination and hunting licenses sold in Maine in year $t-i$;
 W^i = the weight applied to the ratio of deer killed to the number of licensed resident hunters.

The weighting factor (W) is constrained such that:

$$\sum_{i=1}^3 W^i = 1.0$$

Therefore, $W = .544$ when $i = 1$.

The hypothesized equations for the three types of licenses are:

$$Q_H = f(RP_H, RY/CAP, POP, HS)$$

$$Q_F = f(RP_F, RY/CAP, POP)$$

$$Q_C = f(RP_C, RY/CAP, POP, HS)$$

where:

Q = quantity of hunting (Q_H), fishing (Q_F) and combination (Q_C) licenses sold in a given year;

RP = the real price of hunting (RP_H), fishing (RP_F) and combination (RP_C) licenses in a given year;

RY/CAP = real income per capita for Maine residents in a given year;

POP = population of the State in a given year;

HS = expected hunting success variable based on the weighted actual success rate in the three preceeding years.

Theoretically, the price of the combination license should be included in the demand equations for hunting and fishing licenses since the combination license is a substitute for the other two. In addition, the price of hunting and fishing licenses should be included in the demand model for combination licenses for the same reason. This is not done, however, because of the almost perfect correlation between the prices of the different licenses. Price changes for all resident licenses occurred in the same year and the percent change in prices was of comparable magnitude for the three licenses.

All of the data used to estimate the three demand equations are available from secondary sources. The Maine Department of Inland Fisheries and Wildlife maintains the license price, quantity sold and deer kill data. Population and income data are available from Census reports. The time period used in the analysis is 1953-1978.

RESULTS

Several functional and structural forms of the demand equations were estimated by OLS to determine the appropriate form for the equations. Various factors were considered to determine the "best" form. Since one of the major reasons for estimating the equations is to estimate the price elasticity of demand for the licenses, the estimated coefficients and their respective standard errors are important considerations. Furthermore, since the equations are to be used to forecast the quantity of licenses sold in 1979 and 1980, measures of goodness-of-fit and the standard error of the regression equation are also important. For the purposes of this paper, the sum of the squared residuals between the actual quantities and the estimated quantities of licenses sold was used as a measure of goodness-of-fit for each form of the equations.

The initial equations were estimated by OLS. However, a Durban-Watson test indicated that the disturbance terms were autocorrelated. The equations were estimated again, using the Cochrane-Orcutt method to correct for the autocorrelation

(K_{menta}). The linear form of the corrected equations were chosen as the most appropriate functional form and are presented here:

$$\begin{aligned} \hat{Q}_H &= 163300 - 457520 RP_H - 1666.2 RY/CAP - .00724 POP \\ (t) \quad (3.87) \quad (-1.95) \quad (2.47) \quad (-.13) \\ R^2 &= .88 \quad d = 2.02 \quad d.f. = 22 \end{aligned}$$

$$\begin{aligned} \hat{Q}_F &= 94117 - 651170 RP_F - 238.0 RY/CAP + .0303 POP \\ (t) \quad (1.93) \quad (-4.44) \quad (-.33) \quad (.48) \\ R^2 &= .81 \quad d = 1.84 \quad d.f. = 22 \end{aligned}$$

$$\begin{aligned} \hat{Q}_C &= -114300 - 303970 RP_C + 1423.5 RY/CAP + .1490 POP \\ (t) \quad (-3.53) \quad (-4.85) \quad (3.07) \quad (3.71) \\ R^2 &= .98 \quad d = 1.35 \quad d.f. = 22 \end{aligned}$$

Several interesting points about the estimated equations should be noted. First, the hunting success variable has been deleted from the hunting and combination license equations. Contrary to our hypothesis, the variable did not explain any of the variation in the quantity of licenses sold. This contradicts the casual observations of Department personnel. However, the result is consistent with information obtained in the 1978 survey of Maine hunters. Only about 20 percent of the resident hunters indicated that bagging a deer was a major reason for hunting. Other factors, such as a change in the daily routine, being close to nature and companionship with other hunters were the most frequently mentioned reasons for hunting. Clearly, these factors are unrelated to hunting success.

All coefficients (except the intercept) in the hunting equation are negative in sign. The real price and real income per capita coefficients are both significant at the 95 percent confidence level. The negative sign and statistical significance of the real income per capita is easy to explain empirically, since the quantity of hunting licenses sold steadily declined and real income per capita steadily increased during the period of analysis. However, one should exercise caution in interpreting the meaning of the negative coefficient. For example, we do not believe that one should conclude that hunting is an inferior activity because the model estimated here is not properly designed to test that hypothesis.²

Another possible explanation for the negative coefficient on income is that a hunting license is an inferior good. That is, as real income per capita increases, sportsmen may substitute a combination license for the "inferior" hunting license. The raw data tends to support this hypothesis in that the quantity of hunting licenses sold decreased and the quantity of combination licenses sold increased as real income per capita increased. Again, however, one should exercise caution. Earlier it was noted that the price of combination licenses should be included in the hunting license equation, but was not because of the multicollinearity between

²Inferences concerning the normal or inferior nature of the activity should be based on the quantity of activity days "consumed" rather than on the number of residents who are licensed to hunt. Furthermore, one must consider the total number of hunting and combination licenses sold before one can speculate about the nature of hunting. Even though the number of hunting licenses declined steadily from 124 to 81 per 1,000 population, the total number of resident licensed hunters (hunting and combination license holders) only declined from 159 to 152 between 1953 and 1978. Hence, although hunting may be an inferior activity, we are not ready to proclaim that finding on the basis of the results of this study.

hunting and combination prices. However, the price of a combination license declined slightly relative to the price of a hunting license. Hence, the substitution of combination licenses for hunting licenses observed during the period may be due to changes in the price ratio rather than changes in the level of real income per capita.

Finally, the significance of the negative coefficient on real income per capita may be due to specification bias in the model. Clearly, there are many excluded variables that influence the demand for hunting licenses. For example, a change in social attitudes about hunting could be an important factor. Failure to include variables of this nature may have resulted in an inflated estimate of the significance of real income per capita in the hunting equation.

The real price of fishing licenses is the only statistically significant variable in the fishing equation. The coefficient on real income is negative in sign, but insignificant. The coefficient on population is positive but also insignificant. In contrast, all coefficients in the combination license equation are statistically significant at the 95 percent level. Both real income per capita and population have positive coefficients in the latter equation.

The Durban-Watson statistic for the combination license equation is relatively low, even after correcting for first order autocorrelation. This suggests that second order (or higher) autocorrelation still exists. However, since the calculated statistic of 1.35 lies in the inconclusive range for the Durban-Watson test, additional correction procedures were not utilized.

In order to obtain an indication of the quality of projected license sales, the three equations were used to estimate the actual quantities sold during the period of analysis. A comparison of actual and estimated quantities is reported in Table 1. In general, the equations provide adequate estimates of the actual quantities. The largest difference (+16.2%) occurred for the hunting equation in 1971. This was caused by a sharp decline in the actual quantity of hunting licenses sold during that year. In total, there are only 5 years in which the actual quantity of licenses sold do not fall within the 95 percent confidence interval for the estimated quantities. The average percent difference between actual and estimated quantities for the hunting, fishing and combination license equations are 3.2, 3.3 and 2.7 percent, respectively.

The price elasticity of demand for each of the three equations are reported in Table 2. Two sets of elasticities are presented: one set is based on the mean values for prices and quantities (E_{pm}) and the other is based on 1978 prices and quantities (E_{p78}). Both sets illustrate the highly inelastic nature of all three demand curves at the selected price-quantity combinations.

The highly inelastic demand curves clearly have significant policy implications. They indicate that the Department of Inland Fisheries and Wildlife could generate a substantial amount of additional revenue by increasing the price of each type of license. The magnitude of the possible price increases is illustrated by the 1978 revenue maximizing prices, which are also reported in Table 2. The Department could charge \$18–\$22 for hunting and fishing licenses and as much as \$30 for a combination license without

Table 1.
Actual Versus Estimated Quantities of Hunting, Fishing and Combination Licenses
Sold for the Period 1953-1978

Year	Hunting			Fishing			Combination		
	Actual Quantity Sold (Q_H)	Estimated Quantity Sold ($\hat{Q}_H$)	Percent Difference	Actual Quantity Sold (Q_F)	Estimated Quantity Sold ($\hat{Q}_F$)	Percent Difference	Actual Quantity Sold (Q_C)	Estimated Quantity Sold ($\hat{Q}_C$)	Percent Difference
1953	112,328	114,310	+ 1.8	92,383	99,061	+7.2	31,725	30,016	-5.4
54	113,656	114,280	+ 0.5	97,954	94,278	-3.8	32,589	32,808	+0.7
55	108,815	111,450	+ 2.4	99,599	91,961	-7.7	34,277	35,551	+3.7
56	108,689	107,260	- 1.3	96,991	95,897	-1.1	35,331	33,374	-5.5
57	112,372	108,510	- 3.4	102,980	97,806	-5.0	36,739	37,125	+1.1
58	110,740	109,230	- 1.4	105,989	102,240	-3.5	38,581	37,568	-2.6
59	109,298	108,330	- 0.9	104,549	104,520	- .03	39,945	40,781	+2.1
1960	113,650	107,810	- 5.1	107,570	103,650	-3.6	41,697	42,262	+1.4
61	103,061	109,320	+ 6.1	107,295	106,080	-1.1	41,881	42,282	+1.0
62	106,674	106,940	+ 0.3	107,146	105,700	-1.4	41,971	43,749	+4.2
63	102,871	406,970	+ 4.0	103,430	105,560	+4.7	42,090	43,801	+4.1
64	106,909	104,440	- 2.3	103,048	102,600	-4.4	44,126	45,338	+2.7
65	102,987	103,270	+ 2.7	100,785	102,360	+1.6	47,359	47,394	+0.1
66	101,286	96,952	- 4.3	89,548	94,143	+5.1	45,433	45,372	-0.1
67	99,993	97,366	- 2.6	89,233	90,966	+1.9	46,012	47,118	+2.4
68	99,919	96,187	- 3.7	92,236	90,959	-1.4	47,895	48,797	+1.9
69	94,030	94,566	+ 0.6	89,327	92,207	+3.2	47,923	49,352	+3.0
1970	99,120	93,821	- 5.4	96,432	91,511	-5.1	50,879	50,706	-0.3
71	81,721	94,970	+16.2	95,770	97,618	+1.9	52,068	55,066	+5.8
72	78,422	82,063	+ 4.6	85,685	83,921	-2.1	49,789	49,735	-0.1
73	79,827	81,914	+ 2.6	91,028	87,314	-4.1	59,715	55,394	-7.2
74	82,931	84,493	+ 1.9	92,133	93,516	+1.5	66,370	63,630	-4.1
75	86,513	87,706	+ 1.4	91,647	94,598	+3.2	72,174	68,105	-5.6
76	83,325	82,879	- 0.5	89,946	89,449	- .06	72,973	73,126	+0.2
77	86,872	84,034	- 3.3	88,856	92,182	+3.7	72,902	75,742	+3.9
78	87,911	84,588	- 3.8	91,454	91,605	+1.7	76,295	75,983	-0.4

decreasing total revenue. The actual price of the licenses in 1978 was \$7.50 for hunting and fishing licenses and \$12.50 for combination licenses. Hence, the Department could have doubled their prices above the 1978 level and still be on the inelastic portion of the demand curves.³

FORECASTS FOR 1979 AND 1980

The estimated equations were used to forecast the quantity of hunting, fishing and combination license sales for 1979 and 1980.

³If the Department had charged \$15 for hunting and fishing licenses and \$25 for a combination license in 1978, the revenue generated from the sale of the resident licenses would have been \$3.43 million. This is 49 percent greater than the actual revenue of \$2.30 million collected in 1978 through the sale of resident licenses. Once again, however, these results must be interpreted with caution because the prices mentioned above are well above the range of the price data used to estimate the equations.

The results are reported in Table 3. The actual quantities sold are also presented for 1979. In terms of 1979, the hunting equation underestimated actual sales and the fishing equation overestimated actual sales. However, actual sales fall within the 95 percent confidence intervals for both equations. In contrast, actual sales of combination licenses lie just above the upper bound of the confidence interval for the forecasted quantity of combination license sales. This is due primarily to the small standard error of the combination license regression equation and the relatively narrow band included in the confidence interval.

The quantity data were also used to project Department revenues from the sale of licenses in 1979 and 1980. These projections are shown in Table 4. Forecasted revenue for 1979 is about \$52,000 less than actual revenue. The projected revenue for 1980 was obtained

Table 2.
Price Elasticities of Demand and the 1978 Revenue Maximizing Prices for
Maine Resident Hunting, Fishing and Combination Licenses

License Type	Price Elasticities at the Means (E_{pm}) ¹	1978 Price Elasticities (E_{p78}) ²	1978 Revenue Maximizing Prices ³
Hunting	-0.17	-0.19	\$22
Fishing	-0.25	-0.26	\$18
Combination	-0.40	-0.26	\$30

¹Calculated at the mean values of prices and quantities.

²Calculated at the 1978 values of prices and quantities.

³Calculation of revenue maximizing prices implicitly assumes that the relative prices

of the licenses do not change. This assumption has been violated but the prices are presented anyway to illustrate the difference between actual prices and the prices where $E_{p78} = -1.0$.

Table 3.
Forecasted Quantities of Maine Resident Hunting, Fishing and
Combination License Sales for 1979 and 1980

Type of License	Forecasted Quantity Sold $\hat{Q}$	95% Confidence Interval for $\hat{Q}$	Actual Q
Hunting (Q_H)			
1979	85,605	78,175-93,035	87,927
1980	83,632	76,201-91,062	—
Fishing (Q_F)			
1979	97,164	91,951-102,379	95,845
1980	94,369	89,156- 99,582	—
Combination (Q_C)			
1979	77,840	74,560-81,120	81,388
1980	75,128	71,848-78,408	—

Table 4.
Forecasted Revenue from the Sale of Maine Resident Hunting, Fishing,
and Combination Licenses for 1979 and 1980

Revenues	Year	
	1979	1980
Forecasted Revenue	\$2,343,768	\$2,930,621
95% Confidence Interval	\$2,207,945-\$2,479,605	\$2,756,384-\$3,104,850
Actual Revenue	\$2,395,640	—
Percent Difference	-2.1	—

by multiplying the forecasted quantities by their respective 1980 prices.⁴ The results indicate that 1980 revenues from the sale of resident licenses will be about \$2.9 million. This represents about \$535,000 or a 22 percent increase in revenues above the 1979 level. Based upon these results it seems certain that higher fees for resident licenses will generate additional revenue for the Department and should reduce the projected budget deficit for 1980.

CONCLUSIONS

The purpose of this paper was to estimate the demand for Maine resident hunting, fishing and combination licenses and determine if higher resident license fees is a feasible alternative to generate additional revenues for the Department of Inland Fisheries and Wildlife. The results indicate the demand for all three licenses is highly inelastic. Moreover, increases in resident license prices would generate substantial increases in revenue. The actual prices charged for each of the licenses are well below the prices associated with unitary elasticity. Therefore, policy makers have considerable flexibility in terms of increasing the price of resident licenses if it is determined that higher resident fees is the most appropriate way to raise revenue and alleviate the fiscal problems of the Department.

Even though the results indicate that higher license fees would result in a substantial increase in revenue, we are not advocating this action as a policy prescription. The fee level for resident (and non-resident) licenses is essentially a political decision. The alternatives and issues should be debated in the legislature and a decision should be reached through the political process. The

⁴The price schedule for 1980 is \$9.50 for both hunting and fishing licenses and \$16.50 for combination licenses.

results of this paper should be viewed as input into that decision process so that policy makers will have access to information concerning the economic impact and effectiveness of one of the alternatives being considered. Economic impact and feasibility information should be considered along with political viability and other factors.

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