Forecasting Fishing and Hunting License Revenue

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EXECUTIVE SUMMARY

The Department of Fish and Wildlife (DFW) contracted with the Washington State Institute for Public Policy (Institute) to develop models and procedures to forecast revenue from the sale of hunting and fishing licenses. This report describes (1) current impediments to developing detailed revenue forecast models, (2) short-term strategies for forecasting license revenues, and (3) suggestions for improving forecast methodology as more information becomes available.

Current Impediments to Revenue Forecasting

Three major obstacles currently exist to developing forecasts:

- Recent changes in how licenses are sold;
- Changes in license structure; and
- Limited data.

Combined with the complexity of modeling the purchasing decisions of hunters and fishers, these issues present serious problems at this time.

Short-Term Strategies for Revenue Forecasts

Given these obstacles to developing comprehensive forecasting models, the Institute recommends the following short-term approach to developing license revenue forecasts:

- Limit forecasts to total hunting revenue and total fishing revenue;
- Use simple time-trend forecasting models; and
- If necessary, allocate total hunting revenue and total fishing revenue forecasts to specific licenses based on recent sales data.

Recommended Improvements

Over time, more data will become available on sales of hunting and fishing licenses. These additional data will provide opportunities to expand and improve upon the short-term models. The potential improvements are fairly modest and incremental in the near future and more dramatic and far-reaching in the longer-term.

- **Near-term improvements**
  - ✓ Re-estimate time-trend models annually to improve forecasts; and
  - ✓ Re-examine the impact of the new license structure and the Washington Interactive Licensing Database (WILD) system to improve forecast models.

- **Longer-term improvements**
  - ✓ Use of data collected from WILD system will improve forecasts; and
  - ✓ Continue to examine relevant behavioral and economic factors that may be used in future forecast models.

I. INTRODUCTION

The Department of Fish and Wildlife (DFW) contracted with the Washington State Institute for Public Policy (Institute) to develop models and procedures to forecast department revenue from the sale of hunting and fishing licenses.[1] If possible, the models would also be used to estimate the impact of policy changes—such as fee increases—on total revenue. This report addresses the following:

- Current impediments to developing detailed revenue forecast models;
- Short-term strategies for forecasting license revenues; and
- Suggestions for improving forecast methodology as more information becomes available.

In developing any forecasting procedure, the goal is to identify one or more factors that have a consistent relationship to the item of interest. Statistical techniques (regression and various statistical tests) are then used to validate and quantify that relationship. In the present case, these techniques will indicate the expected impact of changes in economic-, hunting-, and fishing-related measures on the sales of hunting and fishing licenses. The resulting model(s) will, under certain circumstances, provide a forecast of future values of the item of interest.

To clarify the following discussion of model development, we will introduce two statistical terms. The item we wish to forecast is referred to as the *dependent variable*. Examples of dependent variables include total annual hunting license revenue or number of saltwater fishing licenses sold per year. One or more measures of economic or other activity, referred to as *explanatory variables*, are used to explain changes in the dependent variable. Explanatory variables might include changes in state population or the previous year's catch of steelhead.

Ideally, data with minimal measurement errors that are available for an extended period of time are used to develop the forecasting model. Other characteristics concerning the statistical properties of the data are also important. To the extent that the data to be used in developing the forecasting model are less than ideal, options in developing models may be limited, and subsequent forecasts may be subject to greater error than desired. For the immediate future, the problem faced in forecasting hunting and fishing license revenue is that the data available for developing forecasting models are insufficient in a number of respects.

This report will discuss the limitations of the data available in developing revenue forecasting models (Section II), recommended models given the data limitations (Section III), and suggestions for developing more useful and accurate models in the future (Section IV).

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[1] In this report, *licenses* include tags, permits, and any other hunting- or fishing-related fees collected by DFW.

II. Limitations of Hunting and Fishing License Data

Currently, three major obstacles to developing license revenue forecasts exist: (1) recent changes in how licenses are sold, (2) changes in license structure, and (3) limited data. Combined with the complexity of modeling the purchasing decisions of hunters and fishers, these issues present serious problems at this time.

Changes in How Licenses Are Sold

Hunting and fishing licenses are sold by dealers throughout Washington, as well as at Department of Fish and Wildlife (DFW) offices. Prior to March 1, 2001, over 600 dealers used a non-computerized system to sell licenses and report sales and receipts to DFW. Revenue from a month's license sales was due to DFW within the first two weeks of the following month.

With the implementation of the Washington Interactive Licensing Database (WILD) system, licenses are created and sold electronically, but by fewer dealers (about 500). It is anticipated that the WILD system will reduce the amount of time needed to purchase a license. Purchasers will be required to provide a social security number, which was not necessary under the non-computerized system. Revenue will also be transmitted electronically on a weekly basis so that DFW will receive the revenue from the current week's sales the following week.

It is unclear what differences, if any, implementation of the WILD system and the smaller number of dealers will have on sales of hunting and fishing licenses. Shorter waiting periods could have some positive impact on sales, while mandatory social security number reporting could reduce sales. The change in dealer sales reporting could affect revenue figures, although this should have a larger impact on monthly and quarterly rather than annual revenue patterns.

Change in License Structure

Currently, there are five types of fishing licenses and nine types of hunting licenses.[2] Many licenses are further subdivided into resident, non-resident, youth, senior citizen, and disabled veteran categories. Ideally, separate forecasting models for each license category would be developed.

However, a substantial change in the structure of licenses occurred in 1999. Licenses sold between 1989 and 1998 differ from those sold in 1999. This change in license structure is especially problematic because only one year of the data available for modeling purposes refers to the type of licenses we wish to forecast in the future.

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[2] This excludes tags for a second or third bear, cougar, turkey, or pheasant, as well as special raffles.

One way to address the lack of comparability of data from before and after 1999 is to attempt to redefine (crosswalk) the pre-1999 data *as if* the 1999 licensing categories had been in effect for the entire period. For example, prior to 1999, it was possible to buy a hunting license for cougar only. However, as of 1999 it is only possible to buy a license to hunt cougar in combination with a license to hunt (1) bear only, (2) bear and deer *or* elk, or (3) bear and deer *and* elk. If this licensing structure had been in effect prior to 1999, then all of those persons who purchased a cougar license would either have purchased one of the combination licenses or purchased no license at all.

By combining what we know about changes in licensing with revenue data, it is possible to convert 1989–1998 data into the license categories of 1999. Presumably, this crosswalk makes it possible to track the distribution of revenues from 1989–1998 as if the 1999 licensing structure were in place during those years. However, the process of redefining the 1989–1998 data may not accurately represent how license purchasers would have behaved if they had been presented with the license structure that came into effect in 1999.

In addition to the sweeping changes in licensing structure in 1999, a number of new license categories were introduced between 1989 and 1998.[3] Each change reduces the ability to produce accurate forecasts.

Data Availability

Annual sales data by type of license are available from 1989 through 1999. Although annual license revenue is not available, it can be estimated by multiplying the number of licenses sold by the corresponding annual fee. The data provide only 11 observations for statistical analysis and forecasting purposes. The limited number of observations present two technical problems: (1) difficulty in identifying relationships between license sales and explanatory variables, and (2) limitations on the number of explanatory variables that can be used in one model.

First, consider a model that attempts to explain total hunting license revenue by changes in the number of travel trailers and campers registered in Washington. This is a logical relationship to investigate, as hunters might reasonably be expected to use campers or travel trailers as part of a hunting trip.

During the 1989–1999 period, both total hunting license revenue (adjusted for inflation) and registrations of travel trailers and campers were generally declining. If a relationship between revenue and camper registrations is demonstrated statistically, it may indicate a feasible model to use in forecasting hunting license revenue. However, it is also possible that both revenue and registrations are declining between 1989 and 1999 for unrelated reasons. With a longer series of data covering more years, we are likely to observe more year-to-year increases and decreases in both revenue and registration. If the relationship

[3] Between 1989 and 1998, at least nine new license categories or fees were introduced: Puget Sound Enhancement, Warm Water Enhancement, Residential Senior Food Fish, Non-resident 1-Day Game Fish, Resident 1-Day Game Fish, Resident Senior Game Fish, Resident/Non-resident 3-day Food Fish, 3-Day Shell Fish, and Senior Shell Fish.

holds up over both increases and decreases in the two data series, it improves the likelihood that any statistically estimated relationship is real rather than coincidental.

The second limitation imposed by the small number of observations (data points) relates to how many variables can be used in a single forecasting model. This is a mathematical limitation. To estimate a statistical model (to merely "do the math"), it is necessary to have at least one more data point than the number of explanatory variables used in the model. However, to obtain useful forecasts, it is desirable to have considerably more observations than explanatory variables. Because we have 11 observations, up to 10 explanatory variables could theoretically be used to develop forecast models. In practice, however, a much smaller number of explanatory variables is desirable.

Summarizing the Impact of Data Limitations

The limitations discussed above suggest a cautious short-term modeling approach that does not attempt to infer more information from the data than it actually contains. The example of cougar hunting can be used to further explain this issue.

To estimate the license sales for any one of the current licenses that include the right to hunt cougar, it is necessary to take into account the sales of all other licenses that include cougar. In turn, the sales of these other licenses are affected not only by factors related to cougar hunting but also to factors that impact bear, deer, and elk hunting. Statistical techniques exist that enable the modeling of cougar license sales accounting for such interactions. However, they require the use of additional explanatory variables related to bear, deer, and elk hunting, as well as cougar hunting.

Given the limited number of data points available at this time, the potential to accurately estimate such an equation is greatly reduced. This is compounded by the fact that only one year of data reflects actual license purchases under the new structure of licenses. To re-create data from years prior to 1999, as if the 1999 licensing structure had been in place, requires an assumption that the relationship of cougar, bear, elk, and deer licenses would have been the same each year in the past as it was in 1999. Because of the interrelationship of cougar, bear, elk, and deer hunting created by the new license structure, this assumption is the equivalent of holding all the factors that affect big game hunting constant (at least in a relative sense). This would seem to be a questionable assumption, especially since 1999 is the first year of sales under the new license structure, and hunter behavior may not have fully adapted to the existence of the various combination licenses.

These issues argue for a relatively simple approach to modeling license sales and revenue in the immediate future. Therefore, we recommend limiting modeling efforts to year-ahead forecasts of total fishing license revenue and total hunting license revenue using a limited number of explanatory variables. The following section describes these recommendations in more detail.

III. Suggested Year-Ahead Forecasting Methods

Limit Forecasts to Total Hunting and Fishing Revenues

The change in license structure and the limited number of observations argue against forecasts for each license category under the new license structure. A practical short-term approach is to combine license categories into total fishing license revenue and total hunting license revenue and model those two broad categories separately. Although this implicitly assumes that total hunting and total fishing revenues would be the same even across different licensing arrangements, it is a safer assumption than that needed to artificially recreate historical data based on the 1999 license structure. In addition, we can statistically control for overall differences in revenue attributable to the 1999 changes more credibly than for individual licenses.

To calculate total hunting and fishing revenue over the 1989–1999 period, we did the following:

(1) Grouped all obvious hunting licenses into one time series and all obvious fishing licenses into another;

(2) Split revenue from combined hunting and fishing licenses sold from 1989 through 1998 between hunting and fishing based on the fraction of 1999 total license revenue attributable to hunting (about 44 percent) and fishing (about 56 percent);

(3) Used the same ratios to split revenue from the remaining revenue sources—duplicate licenses, conservation licenses, and access stewardship decals—between hunting and fishing; and

(4) Excluded revenue from migratory waterfowl and collector duck stamps (a relatively minor revenue source) from the calculation of hunting and fishing revenues.

Table 1 provides a detailed list of which licenses are assigned to hunting and fishing categories.

Table 1A

Licenses Assigned to "Total Hunting" Category

LICENSE/TAG	PERIOD
Cougar (resident, non-resident)	1989-98
Damage Bear (resident, non-resident)	1998
Deer (resident, non-resident)	1989-98
Deer Raffle Ticket	1997-98
Elk (resident, non-resident)	1989-98
Elk Raffle Ticket	1997-98
Eastern WA Pheasant Enhancement	1997-98
Eastern WA Upland Game Bird	1989-98
Goat Tag (resident, non-resident)	1989-98
Hunt (resident, non-resident)	1989-98
Hound Stamp	1989-98
Moose Raffle Ticket	1997-98
Moose Tag (resident, non-resident)	1989-98
Partnership Elk Application	1989-98
Single Deer/Elk Application	1989-98
Sheep Raffle Ticket	1997-98
Sheep Tag (resident, non-resident)	1989-98
Turkey (resident, non-resident)	1989-98
Western WA Upland Bird 2-day	1992-98
Western WA Upland Bird Annual	1989-98
Western WA Upland Bird (youth)	1993-98
Hunt and Game Fish (resident); *assign 44% of revenue to hunting*	1989-98
Duplicate Licenses; *assign 44% of revenue to hunting*	1989-99
Conservation License; *assign 44% of revenue to hunting*	1989-98
Access Stewardship Decal (first, second); *assign 44% of revenue to hunting*	1999
Deer + Elk + Bear + Cougar (resident, non-resident, youth, disabled veteran)	1999
Deer + Elk (resident, non-resident, youth, disabled veteran)	1999
Deer OR Elk + Bear + Cougar (resident, non-resident, youth, disabled veteran)	1999
Deer OR Elk (resident, non-resident, youth, disabled veteran)	1999
Bear + Cougar (resident, non-resident, youth, disabled veteran)	1999
Bear - Second (resident, non-resident, youth, disabled veteran)	1999
Cougar - Second (resident, non-resident, youth, disabled veteran)	1999
Goat OR Sheep OR Moose (resident, non-resident, youth)	1999
Small Game w/ Big Game Lic. (resident, non-resident, youth, disabled veteran)	1999
Small Game 3-day	1999
Small Game Only (resident, non-resident, youth, disabled veteran)	1999
Turkey - Second (resident, non-resident, youth, disabled veteran)	1999
Turkey - Third (resident, non-resident, youth, disabled veteran)	1999
Western WA Pheasant w/ Small Game (resident, non-resident, youth)	1999
Western WA Pheasant w/ Small Game 3-day	1999
Deer Raffle	1999
Elk Raffle	1999
Moose Raffle	1999
Sheep Raffle	1999
Big Game Permit App. (resident, non-resident, youth)	1999

Table 1B

Licenses Assigned to "Total Fishing" Category

LICENSE/TAG	PERIOD
Food Fish 3-day (resident, non-resident)	1989-98
Food Fish Stamp 3-day (resident, non-resident)	1995-98
Food Fish (resident, non-resident)	1989-98
Resident Food Fish (senior)	1995-98
Game Fish 1-day (non-resident)	1995-98
Game Fish 3-day (non-resident)	1989-98
Game Fish (non-resident youth)	1995-98
Game Fish (resident, non-resident)	1989-98
Game Fish 1-day (resident)	1995-98
Game Fish 3-day (resident)	1989-98
Game Fish (resident senior)	1991-98
Puget Sound Enhancement	1994-98
Puget Sound Enhancement 3-day	1998
Shellfish 3-day	1994-98
Shellfish (resident, non-resident)	1989-98
Shellfish (senior)	1994-98
Steelhead	1989-98
Steelhead (youth)	1990-98
Warmwater Enhancement	1997-98
Hunt and Game Fish (resident); *assign 56% of revenue to fishing*	1989-98
Duplicate Licenses; *assign 56% of revenue to fishing*	1989-99
Conservation License; *assign 56% of revenue to fishing*	1989-98
Access Stewardship Decal (first, second); *assign 56% of revenue to fishing*	1999
Combination - FW/SW/SF (resident, non-resident, youth, disabled veteran)	1999
Saltwater (resident, non-resident, senior)	1999
Freshwater (resident, non-resident, senior)	1999
Fresh/Saltwater 2-day	1999
Shellfish (resident, non-resident, senior)	1999
Shellfish & Seaweed 2-day	1999

Modeling and Forecasting Total Hunting License Revenue

Although limiting the analysis to total hunting or total fishing revenue avoids some of the issues previously discussed, the problems associated with the small number of data points remain:

- In developing a model to forecast total hunting license revenue, we are limited to a small number of explanatory variables.
- We are unable to determine if an estimated relationship between a particular explanatory variable and the dependent variable of total hunting license revenue will hold over time.

For these reasons, the models discussed should be considered a temporary, short-term solution to forecasting license revenue. The resulting forecasts should also be examined for consistency relative to available qualitative information and collective opinions of DFW staff.

A variety of models using explanatory variables that might reasonably be related to hunting were tested. These models can be categorized as either forecasting models or as policy analysis models. While the distinction between the two is not always clear, it is a reasonable way to categorize models when we are limited to a very small number of explanatory variables.

For forecasting models, forecasted values of the explanatory variables must be readily obtainable. Therefore, forecasting models use explanatory variables such as population growth or changes in employment, for which accepted forecasts are available.

Policy analysis models use potentially interesting explanatory variables such as length of season. These types of models are useful in developing the impact of policy or other changes on revenue estimates. For example, by using “high,” “average,” and “low” values for the length of the elk season, it is possible to estimate the percentage impact in revenue associated with an unusually long or short elk season. Once the actual hunting season is set, the policy analysis model estimates can be used to judge if revenue forecasts developed using other means are reasonable.

Ideally, a forecast would include both policy analysis and forecasting variables. Unfortunately, as noted above, the small number of observations currently available raises concerns about whether estimated relationships between explanatory variables and hunting license revenues can be expected to hold up over time. The small number of observations also limits the number of explanatory variables that can be used in a single model.

One way to address these issues is to use a model based only on time-related variables rather than using economic or hunting-related explanatory variables. This approach is possible using available data and provides straightforward forecasts. However, this approach is not very helpful for answering “what if” questions (e.g., how will license revenue change if deer seasons are lengthened) or in identifying changing trends in the purchase of licenses.

Table 2 provides information on both the forecasting and policy analysis models examined. For example, model H1 relates inflation-adjusted hunting license revenue to the percentage of Washington's population living in unincorporated areas (i.e., areas which are not cities or towns) and a "dummy" variable to account for the change in license structure that occurred in 1999. The parameter estimate of 431,198 for the percentage of Washington's population living in unincorporated areas indicates that for every 1 percent increase (decrease) in the state's population living in rural areas, hunting license revenue would be expected to increase (decrease) by $431,198. See Appendix A for other models examined.

Because the forecasts provide total hunting license revenue, it may be desirable to allocate the forecast total to each of the various individual licenses under the new license structure. The allocation can be based on actual recent sales data by type of license. For example, if recent WILD data indicate that deer and elk licenses for state residents account for 45 percent of all hunting revenues, then 45 percent of total hunting license revenue forecast for a future year will be assumed to come from resident deer and elk licenses. As more data become available through the WILD system, it will be possible to modify allocation percentages for license types to reflect changing trends in the types of licenses sold. This approach makes good use of the relatively limited amount of data currently available in a way that avoids the problems related to the change in license structure.

Table 2

Total (Inflation-Adjusted) Hunting License Revenue Models

FORECASTING MODELS	EXPLANATORY VARIABLES	PARAMETER ESTIMATE	STANDARD ERROR	P VALUE
(Model H1)	Intercept	14,268,857	674,141	0.00
	TIME	(337,350)	108,648	0.01
	YR99	919,412	1,195,125	0.46
	Adj. R^2	0.458		
(Model H2)	Intercept	(7,731,990)	5,834,990	0.22
	%UNINCORP	431,198	124,736	0.01
	YR99	1,032,112	1,127,559	0.39
	Adj. R^2	0.521		
POLICY ANALYSIS MODELS				
(Model H3)	Intercept	7,370,582	1,615,967	0.00
	DEERLAG	81	67	0.26
	ELKLAG	190	362	0.62
	Adj. R^2	0.437		
(Model H4)	Intercept	(1,729,841)	4,307,786	0.70
	DEERDAYS	26,535	7,002	0.01
	ELKDAYS	82,368	40,481	0.08
	Adj. R^2	0.580		

Dependent variable, all models: total hunting license revenue, 1989–1999.
TIME = 1 if the year is 1989, 2 in 1990, and so on up to 11 in 1999.
YR99 = 1 if the year is 1999, zero otherwise.
%UNINCORP = percentage of Washington population living in an unincorporated area.
DEERLAG = the number of deer harvested in the previous year.
ELKLAG = the number of elk harvested in the previous year.
DEERDAYS = the sum of days for all deer seasons in the year.
ELKDAYS = the sum of days for all elk seasons in the year.

Modeling and Forecasting Total Fishing License Revenue

A similar approach to the one described for hunting license revenue can also be used to forecast fishing license revenue. Table 3 provides information on the fishing revenue models examined. Note that Table 3 contains only one policy analysis model. Due to reporting lags for variables (such as salmon harvest) and lack of data on items that may impact fishing license sales (such as the catch on opening day of the freshwater fishing season) we have had difficulty collecting "policy" variables that are helpful for forecasting purposes.

It is also important to note that, while the hunting models are based on inflation-adjusted license revenue, the fishing models in Table 3 reflect unadjusted fishing license revenue. Models using inflation-adjusted fishing license revenue performed very poorly. The inability to identify reasonable models based on inflation-adjusted revenue is a further indicator of the problems associated with a small number of data points.

Total fishing revenue would be forecast using one of the models in Table 3, with allocations to individual fishing licenses based on actual sales in 1999 and from WILD. See Appendix A for other models that were considered as well as an examination of previous attempts to model fishing and hunting license revenue.

Table 3
Total Fishing License Revenue Models

FORECASTING MODELS	Explanatory Variables	PARAMETER ESTIMATE	STANDARD ERROR	P VALUE
(Model F1)	Intercept	12,324,489	654,762	0.00
	TIME	400,530	105,525	0.01
	YR99	(2,336,723)	1,160,770	0.08
	Adj. R^2	0.554		
(Model F2)	Intercept	13,435,010	1,354,280	0.00
	TIME	266,855	118,678	0.05
	LAG_EMPGR	(166,722)	275,172	0.56
	Adj. R^2	0.358		
(Model F3)	Intercept	33,975,945	7,370,965	0.00
	%UNINCORP	(416,282)	157,571	0.03
	YR99	(2,033,849)	1,424,372	0.19
	Adj. R^2	0.332		
POLICY ANALYSIS MODELS				
(Model F4)	Intercept	11,717,610	2,427,926	0.00
	TIME	331,592	138,686	0.04
	LAG_STEELHD	7.79	17.43	0.67
	Adj. R^2	0.345		

Dependent variable, all models: total fishing license revenue, 1989–1999.
TIME = 1 if the year is 1989, 2 in 1990, and so on up to 11 in 1999.
YR99 = 1 if the year is 1999, zero otherwise.
%UNINCORP = percent of Washington population living in an unincorporated area.
LAG_EMPGR = percentage growth in non-agricultural employment in Washington in the previous year.
LAG_STEELHD = Washington steelhead catch from the previous year.

Forecast Recommendations

Given the data limitations described above, it is recommended for the near-term that annual hunting license and annual fishing license revenue forecasts use the simple aggregate models with a time trend and a dummy variable for the 1999 change in license structure—models H1 and F1. An allocation model based on the most recent actual license sales could be used to convert overall forecasts to forecasts of more detailed license categories.

By using a model that explains license revenue based strictly on the passage of time, changes to purchasing behavior that reflect an unusual event will not be reflected by the model. For example, if hunters were aware of weather conditions likely to produce an above-average deer harvest, we would expect that information to boost license sales. However, since the time-trend model provides an estimate based on average conditions over the 1989–1999 period, it would likely understate license sales in this situation.

To reduce the potential for forecasting errors, it will be important to obtain input from relevant parties (both inside DFW and elsewhere) concerning hunting-related or fishing-related factors that are at an above-average or below-average level. Based on this qualitative information, it may be desirable to adjust the model forecast up or down.

Forecast Example

To observe how these recommendations would be implemented, the following example shows how revenue from the sales of the combined bear and cougar license would be forecasted for the year 2000.

Step 1: Forecast total inflation-adjusted hunting license revenue using model H1.

First, all explanatory variables in H1 must be set to their year 2000 level. The time trend TIME is defined as 1 for 1989, 2 for 1990, etc. Therefore, for the year 2000, TIME is set to 12. The dummy variable YR99 is 1 for 1999 and zero for all other years, so it is set to zero. The intercept term does not change over time. Arithmetically, the year 2000 forecast is calculated as:

14,268,857 (intercept) - 337,350 x 12 (TIME parameter estimate multiplied by year 2000 value of TIME) + 919,412 x 0 (YR99 parameter estimate multiplied by year 2000 value of YR99)

14,268,857 – (335,350 x 12) – (919,412 x 0) = 10,220,657

Step 2: Increase for inflation between 1999 and 2000.

Model H1 is based on inflation-adjusted revenue. In other words, all revenues from 1989–1999 used to estimate the model were adjusted to equal their equivalent in 1999 dollars. To convert the forecast in step 1 to account for inflation between 1999 and 2000, the step 1 forecast is increased by 3.4 percent, to $10,568,159, based on the increase in the Consumer Price Index (CPI).

Step 3: Calculate the share of total hunting license revenue accounted for by bear and cougar licenses.

Using the most recent actual sales data, in this case 1999, we find that all (resident, non-resident, youth, disabled veteran) bear and cougar licenses accounted for 0.7 percent of all hunting license revenue. This gives a year 2000 forecast of:

.007 x $10,568,159 = $73,977.

IV. Potential Modifications to Forecasting Methods

Over time, more data will become available on sales of hunting and fishing licenses. These additional data will provide opportunities to expand and improve upon the models discussed in Section III. The potential improvements are fairly modest and incremental in the shorter-term and more dramatic and far-reaching in the longer-term.

Shorter-Term Improvements

As each additional year of sales and revenue data become available, the forecasting models for hunting and fishing should be updated. This will better estimate the parameter on the TIME variable, improving forecasts of how revenue changes over time. However, this will not address the potential forecasting errors associated with changes in other explanatory variables not included in the model (for example, the impact of weather on hunting). These types of models will require substantially more data and are discussed in the section on longer-term improvements.

Additional annual data will provide an opportunity to more accurately estimate the impact of the 1999 changes in licensing structure on revenue.[4] Additional data will also provide an opportunity to estimate the revenue impact, if any, of introducing the WILD system.

Longer-Term Improvements

Over time, more data will be available from the WILD system. These data will have a major advantage over the historic data used to develop the near-term models because they will all be collected under the new license structure. Even at an aggregate level, it is possible that the new structure has altered the total dollar value of license sales, so using the WILD data to develop forecasting models is likely to improve forecast accuracy.

The increase in data availability also creates an opportunity to model hunting and fishing license revenue with more meaningful explanatory variables rather than simply using a time trend. Initial investigations of more useful models similar to H2, H3, and H4 in Table 2 and F2, F3, and F4 in Table 3 could start in about five years. However, even models with as many as 15 observations would have to be interpreted with caution.

[4] By setting a dummy variable equal to 1 for all years after 1998, one could test the assumption that the change in the license structure has the same impact on revenue in each year after the change in licensing has occurred.

APPENDIX A: OTHER FORECASTING MODELS INVESTIGATED

In addition to those forecasting models for hunting and fishing license revenue discussed in the body of the report, several other models were investigated but were excluded from the body of the document because of weak results. For example, using inflation-adjusted fishing revenue as a dependent variable produced models with a very little explanatory power.

Table A-1 provides examples of alternative models unsuitable for forecasting purposes at this time. As additional data become available, re-visiting some of these models may be worthwhile.

Table A-1
Other Hunting and Fishing License Revenue Models

FORECASTING MODELS	EXPLANATORY VARIABLES	PARAMETER ESTIMATE	STANDARD ERROR	P VALUE
HUNTING:				
(Model H-A1)	Intercept	(1,072,543)	3,498,798	0.77
	CAMPERLAG	291	75	0.00
	YR99	1,534,213	1,109,820	0.20
	Adj. R^2	0.584		
(Model H-A2)	Intercept	8,652,418	1,154,276	0.00
	FIRELAG	2374	704	0.01
	YR99	(985,633)	987,749	0.35
	Adj. R^2	0.507		
FISHING:				
(Model F-A1)	Intercept	(1,072,543)	3,498,798	0.77
	CAMPERLAG	291	75	0.00
	YR99	1,534,213	1,109,820	0.20
	Adj. R^2	0.584		
(Model F-A2)	Intercept	8,652,418	1,154,276	0.00
	FIRELAG	2374	704	0.01
	YR99	(985,633)	987,749	0.35
	Adj. R^2	0.507		

Dependent variable, all models: total inflation-adjusted hunting license revenue, 1989–1999.
TIME = 1 if the year is 1989, 2 in 1990, and so on up to 11 in 1999.
YR99 = 1 if the year is 1999, zero otherwise.
CAMPERLAG = registered camper vehicles, prior year.
FIRELAG = number of forest fires statewide, prior year.

Previous Attempts to Model Hunting and Fishing License Revenue

In October 1998, Richard Conway and Douglas Pedersen developed a revenue forecasting model[5] (referred to here as the "Conway model") for DFW. This constituted an important first effort towards assembling the data and institutional knowledge necessary to create a revenue forecasting process. However, the Conway model suffers from the same data limitations described in this report.

The Conway model estimated license sales for all major categories of hunting and fishing licenses and tags through 1998 using both statewide economic and demographic information (e.g., unemployment rates, state population) and variables specific to hunting and fishing (e.g., deer harvests, salmon harvests). Relevant fees were then applied to the forecasted license and tag sales to produce a revenue forecast.

As a test, the Conway model was used to "forecast" actual 1998 revenues. The forecast value exceeded the actual license revenue amount by 16 percent, a relatively large discrepancy. However, subsequent research by DFW staff indicates that the data available to Conway and Pedersen did contain some measurement errors. As a result, the Conway model forecast error for 1998 is actually less than 8 percent based on updated 1998 data.

While greater forecast accuracy is desirable, given the relatively short data series available to Conway and Pedersen and considering the errors subsequently identified in some of these data, the results are reasonable. The larger issue with using the Conway model relates to a point discussed in this report—changes to the structure of licenses and the manner in which they are sold. The Conway model was based on data through 1998, prior to the implementation of the 1999 license structure and the WILD system. Because the Conway model estimates license sales to arrive at a revenue forecast, Conway revenue forecasts are based on license categories that have been substantially altered or that no longer exist.

Although the Conway model can still be used to forecast total license revenue, such a forecast requires assumptions about the relationships between old and new license categories. For example, in the Conway model, the number of gamefish licenses sold depends on the sales of steelhead and foodfish tags. Thus, revenue forecasting with the Conway model requires that current sales of freshwater, saltwater, and combination fishing licenses be converted into hypothetical steelhead and foodfish tag sales that existed under the previous licensing scheme. Such a process will introduce additional data measurement errors into the forecasting process, resulting in less accurate forecasts.

The Conway model represents an important first step in organizing and verifying the information needed to establish a forecasting process. If changes had not been made to the structure of hunting and fishing licenses in 1999, the Conway model would have provided a reasonable source of revenue forecasts and a basis from which to enhance the forecasting process as new data became available. However, the Conway model no longer provides an accurate method for forecasting licensing revenues.

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[5] Richard S. Conway and Douglas H. Pedersen, "Washington Department of Fish and Wildlife Revenue Forecasting Model," Dick Conway and Associates, October 1998.