RESERVOIR RECREATION USE ESTIMATION MODELING WITH WATER LEVEL FLUCTUATION

July 2001

U.S. Department of the Interior
Bureau of Reclamation

REPORT DOCUMENTATION PAGE	Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave Blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	July 2001	Final

4. TITLE AND SUBTITLE

Reservoir Recreation Use Estimation Modeling With Water Level Fluctuation

5. FUNDING NUMBERS

U. S. Bureau of Reclamation, Solomon River Environmental Assessment Study

6. AUTHOR(S)

Jonathan Platt

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Bureau of Reclamation
Technical Service Center
Economics Group (D-8270)
Denver CO 80225-007

8. PERFORMING ORGANIZATION REPORT NUMBER

EC-2001-02

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Bureau of Reclamation
Policy Analysis Office
Denver CO 80225

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

DIBR

11. SUPPLEMENTARY NOTES

n/a

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Available from the National Technical Information Service,
Operations Division, 5285 Port Royal Road. Springfield, Virginia 22161
(703) 487-4650

12b. DISTRIBUTION CODE

13. ABSTRACT ***(Maximum 200 words)***

This paper presents the results of a series of use estimation models developed to address recreation visitation impacts from fluctuating water levels at two Kansas reservoirs.

14. SUBJECT TERMS

15. NUMBER OF PAGES

51 pages

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UL	UL	UL	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18
298-102

Technical Memorandum Number EC-2001-02

RESERVOIR USE ESTIMATION MODELING WITH WATER LEVEL FLUCTUATION

by

Jonathan Platt

Economics Group
Technical Service Center
Bureau of Reclamation
Denver, Colorado

July 2001

UNITED STATES DEPARTMENT OF INTERIOR BUREAU OF RECLAMATION

ACKNOWLEDGMENTS

This research was conducted under fiscal year 2001 U. S. Bureau of Reclamation Solomon River Environmental Assessment funding. The author would like to thank Earl Ekstrand of the Reclamation's Denver Economics Group for his helpful comments and suggestions.

TABLE OF CONTENTS

1.0 INTRODUCTION

Over the past 25 years, the U. S. Bureau of Reclamation (Reclamation) has gradually evolved from a dam building agency to a water management agency. Instead of focusing almost exclusively on the development of new water supplies, Reclamation's current program attempts to efficiently allocate presently available water resources among competing users. Reallocating water away from historic uses implies re-operation of Reclamation's reservoirs. Reservoir re-operations are often pursued to manage instream flow volumes, control water temperatures, mobilize sediment, etc. to improve environmental conditions for fish and wildlife. Regardless of the objective, reservoir re-operation results in fluctuating water levels compared to historic conditions. One of the primary effects of reservoir fluctuation is the impact upon recreation. As a result, impacts to recreation are often an important consideration in Reclamation planning studies.

Impacts on recreation can be evaluated in different ways with perhaps the most universal measure being the change in recreation use or visitation. Developing estimates of the impacts of the various proposed alternatives on recreation use and ultimately economic value and regional economic activity are standard practice in most planning studies. From an economics perspective, estimating changes in recreation use is the first step. Subsequent effort must be devoted to: 1) assigning economic value to the various impacted activities via some sort of benefits transfer approach, or 2) obtaining recreation expenditure information by activity for estimation of regional economic impacts. From an operational perspective, information on recreation visitation by activity can be used by recreation managers to project potential safety concerns, identify facility requirements, and schedule facility maintenance.

A wide range of approaches exist for estimating recreation use including market surveys, use estimating models, time series forecasting, population based participation rates, facility availability, and carrying capacity (see Platt 2000, 1996 for discussions of the various approaches). The market survey and use estimating model approaches allow the analyst the greatest flexibility to focus on those visitation influencing factors which fall under the direct control of reservoir managers. While recreation surveys provide useful data, the requirement of federal agencies to adhere to strict Office of Management and Budget (OMB) approval requirements can make survey options time consuming and expensive. As a result, the use of existing recreation visitation, water level, and climatic data in the construction of statistically based use estimating models is often a practical option. The objective of this document is to present the results of a range of statistical use estimating models developed to measure the change in recreation use associated with fluctuating water levels at two Kansas reservoirs.

2.0 USE ESTIMATION MODELS

Use estimating models (UEM) apply multiple regression techniques to estimate statistical relationships between recreation visitation and a wide range of explanatory variables, including reservoir water levels. The statistical basis of this approach may remove some of the subjectivity inherent in many of the other visitation estimation approaches.

Model selection is often determined based on the type of data available. Hydrologic data on water levels is generally provided on a monthly basis implying use of a monthly oriented UEM. Unfortunately, visitation information is often only available on an annual basis. In cases where monthly visitation cannot be obtained, annual UEMs provide a less complicated, but potentially viable option to the monthly UEM. A difficulty with using either the annual or monthly orientation is that considerable water level fluctuation can occur within a given month or year. Even with the relatively short time frame of a monthly model, the use of average, beginning of month, or end of month water level data can create problems particularly when water levels fluctuate substantially across the month. Ideally, a daily model would be more appropriate since it avoids most of the within period fluctuation associated with both the annual and monthly models. The problem with the daily model lies in obtaining the necessary water level and visitation data on a daily basis to allow for model estimation and prediction.

Both monthly and annually oriented UEMs can be estimated using either total visitation across activities or visitation separated by recreational activity. Given it is possible that only certain activities would be impacted by water level fluctuations (e.g., water based activities such as boating, waterskiing, fishing, swimming), more appropriate model definition may involve targeting only the impacted activities. Using total visitation instead of visitation for only the impacted activities may lead to estimation problems due to the influence of non-impacted activities on the statistical relationships. However, if visitation by activity is unavailable, use of a total visitation model may be necessary.

The most obvious difficulty in estimating activity specific models is that visitation may not be broken down by activity. Categorizing visitation by activity is complicated by the possibility of multiple activity trips. Typically, estimates of visitation by activity are based on the trip's primary activity. While not perfect, this technique generally provides adequate estimates of visitation by activity.

It is often assumed that water based recreation activities would be impacted the most by a change in reservoir water level. However, the potential for impacts to land based activities should not be dismissed. Many land based activities may benefit from the scenic qualities associated with a reservoir, including adequate water levels. Consequently, as water levels drop and unsightly mud flats or reservoir rings develop, land based activities could also be adversely affected. Modeling the impact upon land based activities could be accomplished within the context of a total visitation model (includes both water and land based activities) or a separate land based activity model.

Annual Visitation Model:

Bowker et al. (1994) developed annual UEMs for Shasta and Trinity Lakes in northern California. While monthly water level data were available, modeling options were limited by the existence of only annual visitation data. As illustrated below, the authors applied a start of the recreation season water level variable (May or June) in conjunction with a seasonal drawdown variable (May/June minus September water levels) to predict the influence of water levels on annual visitation.

The following briefly presents the general model used by Bowker et al. (1994) in terms of structure (activity, site, year orientation), variable definitions, and expected signs for the explanatory variables (in parenthesis under each variable). Some elaboration is provided on the expected signs of the water level based site quality variables.

$$\text{Total Annual Visitation}_{jt} \text{ or Annual Visitation by Activity}_{ajt} = f(\underset{(+)}{\text{Water Level}_{jt}}, \underset{(-)}{\text{Drawdown}_{jt}}, \underset{(+)}{\text{Year}_t})$$

Activity: $a = 1,...,l$
Site: $j = 1,...,m$
Year: $t = 1,...,o$

where:

Dependent Variable: Total annual visitation at site *j* in year *t* or Total annual visitation at site *j* in year *t* in activity *a*

Explanatory Variables:

Water Level_{jt} = Beginning of recreation season average monthly water levels (May) at site *j* in year *t*. Considered to be somewhat of a measure of natural conditions. The expected sign on this variable was positive. Recreation seasons with higher starting water levels generally experienced greater annual visitation. Apparently, water levels within the dataset did not exceed optimal levels.

Drawdown_{jt} = Amount of drawdown between beginning of season water levels and September water levels at site *j* in year *t* as measured by the drop in feet of average monthly water levels between May and September. The expected sign on this variable was negative where the smaller the seasonal drawdown, the greater the total visitation.

Year_t = Annual time variable. For sites with rising visitation and market area populations, the sign on this variable would be positive.

2.2 **Monthly Visitation Model**

Data permitting, estimation of a monthly UEM may be preferable since it would take into consideration visitation and water level fluctuation not only across years, but across months within each year. An early monthly UEM estimated the influence of fluctuating water levels at Lake Texoma on the Oklahoma/Texas border (Badger 1972).

$\text{Monthly Visitation}_{jmt}$	=	f(Month_m,	Year_t,	Water Level_{jmt},	$\text{Water Quality}_{jmt}$,	Weather_{jmt},	School_{jmt},	Socio_{jmt})
or		(?)	(+)	(+)	(+)	(varies)	(-)	(+)
Monthly Visitation by Activity_{ajmt}								

Activity: $a = 1,...,l$
Month: $m = 1,...,p$
Year: $t = 1,...,o$
Site: $j = 1,...,m$

where:

Dependent Variable: Total visitation at site *j*, in month *m*, and year *t* or Total visitation in activity *a*, at site *j*, in month *m*, and year *t*

Explanatory Variables:

Month_m = Variable identifying individual months or groupings of months. The expected sign on this variable is unknown since it is likely that some months would be positive and others negative.

Year_t = Variable identifying individual years, reflects a trend variable. For sites with growing visitation, the sign on this variable would be positive.

Water Level_{jmt} = Monthly water levels (average, end of month, monthly range) by site and year. The expected sign for the average or EOM water level variable would typically be positive, where higher water levels are associated with higher use.

$\text{Water Quality}_{jmt}$ = Monthly average water quality by site and year. The expected sign for this variable would be positive, implying increased water quality is associated with increased visitation. Water quality can also be influenced by water levels, with improved quality typically associated with higher water levels.

Weather_{jmt} = Monthly average temperature, total monthly precipitation, etc. by site and year. Depending on the weather measure, the sign for these variables can be positive or negative.

$School_{mt}$ = Binary variable indicating whether school is in session by month and year (out=0, in=1). More visitation typically occurs when school is out.

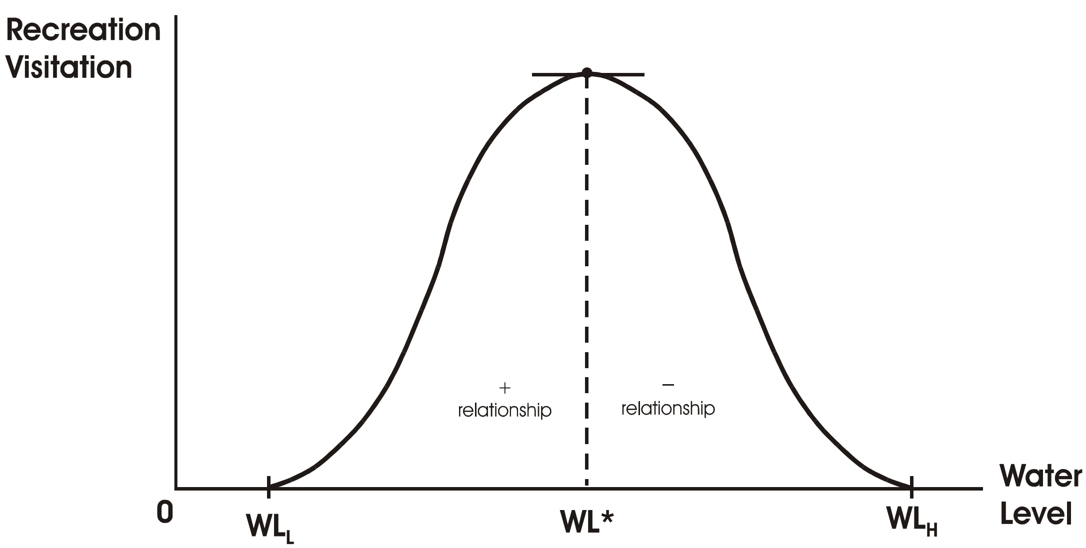
$Socio_{mt}$ = Population, income and other socioeconomic variables for market area, by month and year. Typically, a positive relationship exists between visitation and most socioeconomic variables.

The annual and monthly visitation UEMs are estimated based on existing historic visitation and water level data. These approaches work well until one attempts to evaluate an alternative where water level fluctuation is beyond the historic range. Using a model to project effects beyond the range of the underlying data is normally inadvisable. An option to expand the range of data used within these models is to conduct contingent behavior surveys. Contingent behavior questions involve setting up a scenario (e.g., a change in water levels) and asking recreators how they would react in terms of their visitation behavior. Some controversy exists as to whether or not recreators can provide reasonable responses to water level changes beyond their range of experience (Boyle et al., 1993). At this point, the literature seem to suggest that well presented scenarios even beyond the range of a recreator's experience may still provide useful information. As noted in the introduction, the problem with any survey approach relates to time and cost issues.

3.0 RELATIONSHIP OF WATER LEVEL TO RECREATION

The recreation economic literature has generally identified a positive relationship between water levels and recreation use. In other words, as water levels increase or decrease, so has recreation use. However, the literature also suggests that this positive relationship may only hold within a certain range of water levels. Typically, the overall relationship between water levels and recreation use has been characterized as bell-shaped (see Figure 1). The tails of the bell-shaped distribution end at the low and high end water level thresholds (WL_L and WL_H). High and low end water level thresholds represent the points where visitation goes to zero as severe problems associated with safety, access, water quality, and site attractiveness arise. Between the low and high end water level thresholds exists an acceptable range of water levels for pursuing the specified recreation activity. The bell-shaped relationship arises within the acceptable range of water levels.[1] As water levels increase beyond the low end threshold, visitation also increases (i.e., the positive portion of the curve). At some point, visitation peaks, reflecting the optimal water level for that activity (WL*). Water level increases beyond the optimum reduce visitation until the high end water level threshold is reached and visitation goes to zero (i.e., the negative portion of the curve).

Figure 1: Visitation to Water Level Relationship



While the bell-shaped relationship theoretically holds for both water based activities and land based water influenced activities, the actual thresholds and optimal water levels may vary considerably between activities at each reservoir as well as between reservoirs. Therefore, it is often desirable to estimate impacts separately for each activity and reservoir. Given the water

[1] The bell shaped relationship is assumed here primarily for ease of presentation. It is likely that the relationship is less symmetric, being skewed in one direction or the other.

level relationship is less direct for land based activities as compared to water based activities, the impacts of fluctuating water levels may be more pronounced for water based activities.

Despite that fact that most of the literature suggests a relationship between reservoir water levels and recreation use, it should be noted that this was not always the case. In some instances, studies found no significant relationship. It is possible that for certain activities, access may be the dominant issue. If all water levels within the acceptable range provided sufficient access, no water level to visitation relationship would materialize since each water level would be equally satisfactory. Alternatively, it could simply be that certain activities hypothesized to vary with water levels may in actuality be completely unrelated to water levels. Therefore, it should be acknowledged that difficulty in finding a relationship between recreation use and water levels may simply be due to the lack of such relationship for a particular activity, site, or range of water levels.

4.0 APPLICATION AND STATISTICAL RESULTS

The approaches discussed previously were applied in a recreation analysis of two Reclamation reservoirs on the Solomon River in northern Kansas. Agricultural water delivery contracts from both Kirwin and Webster reservoirs were being renewed. Various water delivery options were being considered which could affect water levels at the two reservoirs. As a result, a methodology needed to be developed which would evaluate the potential impact of fluctuating water levels on recreation use. The following discussion presents the step by step process conducted in developing the analysis. Separate sections are devoted to the analyses developed using both monthly and yearly data. Given this document also acts as a technical appendix for the Solomon River recreation analysis, all the selected models are presented.

4.1 Monthly Recreation Modeling:

Step 1: Data Gathering

Recreation managers at both sites were contacted regarding the availability of visitation information by activity. In both cases, monthly visitation information by activity was obtained. At Kirwin reservoir, the monthly visitation data were only available from October 1993 to September 2000. At Webster reservoir, a more extensive set of data were available running from January 1980 to December 2000. Obviously, the quality of the models described in this paper are only as good as the underlying data. Since we had no input into the collection of the visitation data, we make no assertions as to its accuracy.

In addition to the monthly detail, the visitation data were also available by activity. Information on the following activities were provided at each site:

> 1) Kirwin: Swimming and boating combined, camping and picnicking combined, warm water fishing, wildlife observation (primarily bird watching), and waterfowl hunting.
>
> 2) Webster: Camping, swimming, boating and waterskiing combined, picnicking, warm water fishing, wildlife observation (primarily bird watching), and waterfowl hunting.

Given the visitation data were more or less separated by activity, separate models were developed for each activity. If data were combined across all activities, similar types of models could still be tested. However, since not all recreation activities may be affected by fluctuating water levels, a model using data combined across activities may be more difficult to estimate.

Historic end of month (EOM) water level data and total monthly precipitation data were obtained from Reclamation's McCook, NE office for both reservoirs.

Average monthly air temperature data were downloaded from the internet site of the National Oceanic and Atmospheric Administration's High Plains Regional Climatic Center, Lincoln NE.

Step 2: Theoretical Model Development

Given monthly visitation data were available by activity, attempts were made to construct monthly use estimating models by activity. Based on the existing literature, the following model was attempted:

$$\text{Monthly Visitation}_{ajm} = f(\underset{(?)}{\text{Year}}, \underset{(+)}{\text{WL}}, \underset{(-)}{\text{WL}^2}, \underset{(-)}{\text{Precipitation}}, \underset{(+)}{\text{Temperature}}, \underset{(?)}{\text{Monthly Dummy Variables}})$$

where:

Activity:	$a = 1,...,l$
Site:	$j = 1,...,m$
Month:	$m = 1,...,n$

Dependent Variable: Total visitation in activity *a*, at site *j*, in month *m*

Explanatory Variables:

Year =	Year of monthly data. This variable was intended to reflect a trend variable, used in lieu of socioeconomic variables. Expected sign: unknown. One might expect population and income to potentially affect recreation use. Populations in the adjacent counties of these reservoirs have been fairly stable or even declining in recent years. Conversely, income levels have been gradually rising. The combined effect leads to an unknown sign for this variable.
WL =	EOM water levels measured in terms of feet above mean sea level (other water level measures could be used such as surface area, content). Expected sign: Positive.
WL^2 =	EOM water levels squared (quadratic model provides expected bell-shaped function). Expected sign: Negative (the positive, negative signs on the WL and WL^2 variables result in the bell-shaped function).
Precipitation =	Total monthly precipitation in inches. Expected sign: Negative, but may be positive for some activities (e.g., fishing).
Temperature =	Average monthly air temperature. Expected sign: Positive (the warmer the air temperature, the greater the reservoir use).

Monthly Dummy Variables = A series of qualitative or dummy variables for each month of the recreation season for each activity. To avoid estimation problems, the number of qualitative variables is set at one less than the full number of months associated with each season. Expected sign: unknown since certain months may be positive but others negative.

Step 3: Data Manipulation:

A. Dependent Variable:

With monthly visitation data separated by activity, the seasonal nature of the activities became apparent. Months where no visitation typically occurred were discarded in developing datasets for each activity. Had these months not been discarded, a series of zero visitation data points would have been associated with historic monthly water levels thereby making statistical estimation difficult. The following months were used for each recreation activity at each reservoir:

1) Kirwin:

A) Swimming and boating: May to September

B) Camping and picnicking: May to September

C) Warm water fishing: April to September

D) Wildlife observation: January to December (entire year)

E) Waterfowl hunting: September to January

2) Webster:

A) Camping: May to September

B) Swimming: May to September

C) Boating and waterskiing: May to September

D) Picnicking: May to September

E) Warm water fishing: March to October

F) Wildlife observation: January to December (entire year)

G) Waterfowl hunting: September to January

B. Explanatory Variables:

1. Water Level: Models were tested using both EOM and beginning of month (BOM) water levels. EOM and BOM water level data was squared and used in the regressions to test for the anticipated bell-shaped function.

Step 4: Statistical Estimation

Ordinary least squares (OLS) multiple regression models were estimated using the LIMDEP statistical package (Greene, 1998).

A. Modeling Preparation:

Prior to attempting the statistical modeling, a significant amount of work was pursued to efficiently use LIMDEP. A series of batch files were developed to run the myriad of regressions for each site and recreation activity. A separate batch file was developed for most recreation activities at each reservoir. In addition, a series of read files were developed to read in the data and construct the logged variables. See Appendix A for an example of the read and batch files for monthly warm water fishing models at Webster Reservoir.

B. Modeling:

The statistical estimation process started by estimating the above described model using OLS regressions with three functional forms: 1) linear, 2) quadratic, and 3) semi-log (logged dependent variable only). The linear model was run as a base case. The quadratic model was run to test for the hypothesized bell-shaped function, and the semi-log model was estimated to prevent the possibility of negative visitation predictions. A few observations with zero dependent variable values had to be removed to allow for estimation of semi-log models.

Since there was no particular logic to selecting one over the other, models were estimated using both end of month (EOM) and beginning of month (BOM) water levels. As it turned out, there was not much difference between the EOM versus BOM models.

Reviewing the Durbin-Watson statistic results of the initial regressions, it was not surprising to discover that the monthly time series based regressions showed autocorrelation effects. Autocorrelation implies observations are related across time. Such correlation violates assumptions of OLS estimation. In virtually all models, the Durbin-Watson statistic proved either inconclusive or conclusively that autocorrelation existed (for only one model did the *d* statistic indicate a lack of autocorrelation). LIMDEP includes a generalized difference procedure (AR1 term) which estimates the coefficient of autocovariance (ρ) based on the

Durbin-Watson statistic. Including the correction into the estimation process adequately adjusted for the autocorrelation problem.

We also looked at the potential for multicollinearity by reviewing explanatory variable correlation matrices obtained using the "DSTAT" command. Multicollinearity refers to the potential correlation or relationship between explanatory variables. The presence of multicollinearity can be a problem since it may result in high standard errors, thereby adversely affecting the significance of the explanatory variables. Despite the possible estimation difficulties, the existence of multicollinearity may not necessarily result in severe problems. If a model is to be used purely for purposes of forecasting, as is the case in this application, multicollinearity may not create substantial problems (Gujarati, 1988). Multicollinearity showed up to some extent in the monthly models, particularly between the "year" and the "water level" variables (correlations exceeded .7), but variable significance was not problem. Note that multicollinearity creates problems only for linear relationships among the explanatory variables. Multicollinearity doesn't rule out nonlinear relationships, therefore use of the water level and water level squared variables didn't create problems. Given multicollinearity wasn't excessive (used correlation of .8 as a threshold), and given the promising statistical results of the models, no particular effort was put into correcting for multicollinearity.

Step 5: Model Selection

A. Model Selection Criteria: For each recreation activity, the following criteria were used to select the "best" model:

1) Significant Water Level Variable: Since water levels were the primary factor under control of reservoir managers, it was critical to have a significant water level variable within the model. Fortunately, many of the different models resulted in significant water level variables. Significance was assumed at the 90% confidence level or higher (P[|Z|>z] column at .10 or lower).

2) Quadratic Water Level Term: Based on existing literature, it is generally hypothesized that the relationship between water level and recreation visitation would be bell-shaped. The quadratic function with a positive water level variable and a negative water level squared variable results in such a function.

3) Number of Significant Variables: In addition to the water level variables, the number of other significant variables influenced model selection.

4) Expected Signs: Based on the literature, including the models presented in section 2.0, the positive/negative direction of the expected relationship for each explanatory variable was assigned (see theoretical model in step 2 above). Given these assumed relationships, statistically significant variables for each of the models were evaluated in terms of expected signs.

While in many cases the results seem counterintuitive at first glance, it should be noted that odd results can sometimes be explained with further digging. Fishing in particular can be especially difficult because visitation is a function of both water access and catch rates (for most other activities, access may be the primary issue). The relationship between fishing access and water levels may be relatively straightforward, but the relationship between water levels and catch rates can be cloudy. In the short run, as water levels decline, fish may become more concentrated such that catch rates increase. Conversely, as water levels decline, water quality problems may also become more concentrated, leading to increased fish mortality. In the long run, a positive relationship between water levels and fish population is generally expected to hold. As a result, the water level to catch rate relationship is difficult to discern and can lead to seemingly odd statistical results especially when viewed in combination with the access issue. Time and budget constraints precluded all but very superficial investigation of these and other issues related to seemingly incorrect variable signs. Ideally, further consideration could be given to such factors as: 1) the range of water levels found in the underlying data, 2) the unique physical characteristics of the site (e.g., are especially good fish habitats created under high or low water conditions due to physical conditions), 3) the interrelationship between recreational activities at the site (e.g., if a competing activity is impacted more severely, even under declining conditions, visitation for a given activity could actually increase; crowding effects could dampen visitation as water conditions improve), etc.

5) Coefficient of Determination (Adjusted R^2): A commonly used measure of the goodness of fit of the estimated function to the underlying data.

6) Prediction Accuracy (R^2): To evaluate prediction accuracy, explanatory variable data from each observation was plugged into the estimated function to predict visitation for that observation (LIMDEP's "keep=" command). The predicted visits (or natural log of visits) were then regressed on the actual visits (or actual log of visits). The adjusted R^2 from that regression was used as a measure of prediction accuracy.

B. Model Selections: Based on a comparison of models using the above criteria, the following models for each activity at each reservoir were selected as "best":

1. Kirwin Reservoir:

a. *Swimming and Boating*:

Dependent Variable: Visits

Model is usable across the following Water Level Range: 1724.6' to 1737.0'

Explanatory Variables: # of Observations: 35

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	-110604487.3	55020643.	-2.010	.0444	
YEAR	129.7211310	75.882840	1.709	.0874	1996.5000
EOMWL	127042.1902	63490.850	2.001	.0454	1729.9097
EOMWLSQ	-36.56472700	18.326962	-1.995	.0460	2992591.7
PRECIP	-85.38207761	62.173429	-1.373	.1697	3.2200000
TEMP	-17.78641422	55.233446	-.322	.7474	69.837000
MAY	-1158.989003	552.63407	-2.097	.0360	.20000000
JUNE	-586.6153956	751.39038	-.781	.4350	.20000000
JULY	312.8907311	860.83495	.363	.7163	.20000000
AUG	586.0704798	677.59704	.865	.3871	.20000000

Adjusted R^2: .300
Prediction R^2: .515

Unanticipated Signs: The TEMP variable shows a negative sign. We weren't overly concerned since the variable proved insignificant.

b. *Camping and Picnicking*:

Dependent Variable: Natural Log of Visits (Note: The analyst will need to take the antilog of predicted values to estimate predicted visits)

Model is usable across the following Water Level Range: 1724.6' to 1737.0'

Explanatory Variables: # of Observations: 35

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	-81094.17501	37015.895	-2.191	.0285	
YEAR	.4518204993E-02	.85615933E-01	.053	.9579	1997.0000
EOMWL	93.61522654	42.748305	2.190	.0285	1729.4834
EOMWLSQ	-.2701811320E-01	.12353662E-01	-2.187	.0287	2991118.6
PRECIP	.5309614689E-03	.60520258E-01	.009	.9930	2.9782857
MAY	.8487023606	.53009715	1.601	.1094	.20000000
JUNE	.8163213033	.51084881	1.598	.1100	.20000000
JULY	1.154349811	.39392543	2.930	.0034	.20000000
AUG	.2426437965	.33889486	.716	.4740	.20000000

Adjusted R^2: .494
Prediction R^2: .613

c. *Warm Water Fishing*:

Dependent Variable: Visits

Model is usable across the following Water Level Range: 1724.6' to 1737.0'

Explanatory Variables: # of Observations: 41

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	-1844870.930	728475.66	-2.533	.0113	
YEAR	225.9421393	238.77971	.946	.3440	1996.6111
BOMWL	803.8800329	240.79422	3.338	.0008	1730.3933
PRECIP	168.6686020	89.414397	1.886	.0592	3.0211111
TEMP	88.64199534	79.977138	1.108	.2677	65.815000
APR	-404.3891475	1404.7004	-.288	.7734	.19444444
MAY	4421.527117	973.30729	4.543	.0000	.16666667
JUNE	2628.746782	1273.4061	2.064	.0390	.16666667
JULY	919.5602539	1486.3566	.619	.5361	.16666667
AUG	-2173.097937	1079.9797	-2.012	.0442	.13888889

Adjusted R^2: .827
Prediction R^2: .865

d. *Wildlife Observation*:

Dependent Variable: Visits

Model is usable across the following Water Level Range: 1724.6' to 1737.0'

Explanatory Variables: # of Observations: 83

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	-217821648.9	.11493324E+09	-1.895	.0581	
YEAR	56.75379089	191.30746	.297	.7667	1996.7590
EOMWL	251581.7156	132717.53	1.896	.0580	1729.7555
EOMWLSQ	-72.68058158	38.337262	-1.896	.0580	2992058.5
PRECIP	54.16374717	175.32078	.309	.7574	1.9334940
JAN	-168.1827921	1439.8008	-.117	.9070	.72289157E-01
FEB	240.8412306	1386.4828	.174	.8621	.84337349E-01
MAR	1623.348625	1401.5616	1.158	.2468	.84337349E-01
APR	3127.025161	1440.2163	2.171	.0299	.84337349E-01
MAY	7402.704951	1540.6500	4.805	.0000	.84337349E-01
JUNE	4178.415978	1439.8228	2.902	.0037	.84337349E-01
JULY	3523.714794	1474.6967	2.389	.0169	.84337349E-01
AUG	2395.425561	1478.2462	1.620	.1051	.84337349E-01
SEP	2616.006945	1483.6215	1.763	.0779	.84337349E-01
OCT	2097.526603	1370.9396	1.530	.1260	.84337349E-01
NOV	-78.67460009	1382.3293	-.057	.9546	.84337349E-01

Adjusted R^2: .379
Prediction R^2: .493

e. *Waterfowl Hunting*:

Dependent Variable: Visits

Model is usable across the following Water Level Range: 1724.6' to 1734.9'

Explanatory Variables: # of Observations: 31

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	462109.5532	159347.00	2.900	.0037	
YEAR	-91.75442652	46.420263	-1.977	.0481	1996.4516
EOMWL	-159.9614562	45.191793	-3.540	.0004	1729.2626
PRECIP	108.6506222	75.281053	1.443	.1489	1.0100000
SEP	-2576.426347	283.72777	-9.081	.0000	.16129032
OCT	-2335.499675	256.78396	-9.095	.0000	.19354839
NOV	-508.9704386	250.21936	-2.034	.0419	.22580645
DEC	174.0833245	245.89728	.708	.4790	.22580645

Adjusted R^2: .867
Prediction R^2: .898

Unanticipated Signs: The sign on the water level variable came in negative, implying that hunting activity dropped as water levels increased during the 1994 to 2000 time period. This relationship did not hold for Webster Reservoir across the longer 1980 to 2000 time period. Recreation personnel at the site suggest that this result may be due to the high water levels associated with the 1994-2000 period. If water levels get too high, the amount of hunting and nesting area can be adversely impacted. Interestingly, this negative relationship did not hold for any of the other recreation activities at Kirwin for the 1994 to 2000 time period.

2. Webster Reservoir:

a. *Camping*:

Dependent Variable: Visits

Model is usable across the following Water Level Range: 1859.2' to 1906.8'

Explanatory Variables: # of Observations: 105

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	354822.7751	173482.52	2.045	.0408	
YEAR	-296.3978817	109.87287	-2.698	.0070	1989.5000
BOMWL	126.7400128	46.706119	2.714	.0067	1877.6407
PRECIP	32.70044294	70.770531	.462	.6440	3.2207000
TEMP	6.944888693	61.254679	.113	.9097	71.201900
MAY	4074.446294	550.01173	7.408	.0000	.20000000
JUNE	1168.073708	641.13705	1.822	.0685	.20000000
JULY	3085.336261	920.61365	3.351	.0008	.20000000
AUG	380.8691822	737.86084	.516	.6057	.20000000

Adjusted R^2: .438
Prediction R^2: .474

b. *Swimming*:

Dependent Variable: Natural Log of Visits (Note: The analyst will need to take the antilog of predicted values to estimate predicted visits)

Model is usable across the following Water Level Range: 1859.2' to 1906.8'

Explanatory Variables: # of Observations: 105

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	-3759.311241	1795.0042	-2.094	.0362	
YEAR	-.5732598252E-01	.28392320E-01	-2.019	.0435	1990.0000
EOMWL	4.097087466	1.9079447	2.147	.0318	1878.0247
EOMWLSQ	-.1081492417E-02	.50719490E-03	-2.132	.0330	3527141.0
PRECIP	.4501403316E-02	.17294803E-01	.260	.7947	3.1548571
MAY	.6594524545	.11425951	5.772	.0000	.20000000
JUNE	1.132850417	.13084576	8.658	.0000	.20000000
JULY	1.542211071	.13179640	11.701	.0000	.20000000
AUG	.9473763819	.10688358	8.864	.0000	.20000000

Adjusted R^2: .542
Prediction R^2: .553

c. *Boating and Waterskiing*:

Dependent Variable: Visits

Model is usable across the following Water Level Range: 1859.2' to 1906.8'

Explanatory Variables: # of Observations: 105

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	-5146552.085	2982036.3	-1.726	.0844	
YEAR	-35.78905901	49.040505	-.730	.4655	1990.0000
EOMWL	5508.238560	3169.9544	1.738	.0823	1878.0247
EOMWLSQ	-1.453118055	.84263057	-1.725	.0846	3527141.0
PRECIP	-23.64260068	28.560392	-.828	.4078	3.1548571
MAY	847.8021483	188.89729	4.488	.0000	.20000000
JUNE	734.4946316	216.36550	3.395	.0007	.20000000
JULY	1573.479461	217.60418	7.231	.0000	.20000000
AUG	313.2592337	176.22141	1.778	.0755	.20000000

Adjusted R^2: .356
Prediction R^2: .380

d. *Picnicking*:

Dependent Variable: Visits

Model is usable across the following Water Level Range: 1859.2' to 1906.8'

Explanatory Variables: # of Observations: 105

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	-3115075.887	1338278.7	-2.328	.0199	
YEAR	-24.74983097	22.528746	-1.099	.2719	1990.0000
EOMWL	3353.505998	1422.6853	2.357	.0184	1878.0247
EOMWLSQ	-.8882077813	.37816244	-2.349	.0188	3527141.0
PRECIP	8.029640983	12.775827	.629	.5297	3.1548571
MAY	-233.3972152	84.564392	-2.760	.0058	.20000000
JUNE	396.3904697	96.862897	4.092	.0000	.20000000
JULY	826.8044319	97.327972	8.495	.0000	.20000000
AUG	143.4596040	78.757344	1.822	.0685	.20000000

Adjusted R^2: .452
Prediction R^2: .457

e. *Warm Water Fishing*:

Dependent Variable: Visits

Model is usable across the following Water Level Range: 1859.0' to 1906.8'

Explanatory Variables: # of Observations: 168

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	-36762946.49	13432311.	-2.737	.0062	
YEAR	-273.8889553	179.23775	-1.528	.1265	1990.0000
EOMWL	39569.52696	14283.125	2.770	.0056	1877.7470
EOMWLSQ	-10.49048999	3.7969786	-2.763	.0057	3526097.2
PRECIP	-76.40858263	112.94956	-.676	.4987	2.6613095
MAR	3166.588131	801.00385	3.953	.0001	.12500000
APR	3083.055004	1018.6277	3.027	.0025	.12500000
MAY	13613.15019	1147.6526	11.862	.0000	.12500000
JUNE	9605.154207	1157.3502	8.299	.0000	.12500000
JULY	13429.00363	1137.9147	11.801	.0000	.12500000
AUG	6756.056857	1016.0461	6.649	.0000	.12500000
SEP	4814.871100	774.62268	6.216	.0000	.12500000

Adjusted R^2: .567
Prediction R^2: .577

f. *Wildlife Observation*:

Dependent Variable: Natural Log of Visits (Note: The analyst will need to take the antilog of predicted values to estimate predicted visits)

Model is usable across the following Water Level Range: 1858.8' to 1906.8'

Explanatory Variables: # of Observations: 252

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	-5126.354997	1762.4121	-2.909	.0036	
YEAR	-.4608436702E-01	.22522774E-01	-2.046	.0407	1990.0000
EOMWL	5.529904484	1.8746757	2.950	.0032	1877.3169
EOMWLSQ	-.1463349982E-02	.49841533E-03	-2.936	.0033	3524484.8
PRECIP	.2876909508E-02	.13462844E-01	.214	.8308	2.0393254
JAN	.4327437941	.10232904	4.229	.0000	.83333333E-01
FEB	.7639609739	.13153589	5.808	.0000	.83333333E-01
MAR	2.779239347	.14957801	18.581	.0000	.83333333E-01
APR	2.775397396	.16112947	17.225	.0000	.83333333E-01
MAY	3.703280630	.17069896	21.695	.0000	.83333333E-01
JUNE	3.440207178	.17005124	20.230	.0000	.83333333E-01
JULY	3.732954422	.17017754	21.936	.0000	.83333333E-01
AUG	3.216138944	.16207447	19.844	.0000	.83333333E-01
SEP	2.929993185	.14807000	19.788	.0000	.83333333E-01
OCT	1.938027154	.13007982	14.899	.0000	.83333333E-01
NOV	.5397293507	.99376891E-01	5.431	.0000	.83333333E-01

Adjusted R^2: .845
Prediction R^2: .846

g. <u>Waterfowl Hunting</u>:

Dependent Variable: Visits

Model is usable across the following Water Level Range: 1859.0' to 1904.0'

Explanatory Variables: # of Observations: 103

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	-1011415.704	449053.51	-2.252	.0243	
YEAR	1.819496700	3.7507778	.485	.6276	1989.8738
BOMWL	1069.497924	477.77735	2.238	.0252	1876.2126
BOMWLSQ	-.2837019399	.12711667	-2.232	.0256	3520344.5
PRECIP	9.960642442	10.994168	.906	.3649	1.1297087
SEP	60.06128442	35.604996	1.687	.0916	.18446602
OCT	-23.56863577	36.180272	-.651	.5148	.20388350
NOV	225.7731180	36.244286	6.229	.0000	.20388350
DEC	132.4411020	32.149938	4.119	.0000	.20388350

Adjusted R^2: .437
Prediction R^2: .479

Step 6. Monthly Visitation Prediction

To use a monthly model, one would need to multiply the expected values for each of the explanatory variables by their respective coefficients and sum the result. The monthly dummy variables allow for monthly visitation estimation. In the Solomon River application, hydrologists provided data on forecasted monthly water levels for each alternative. The year of the prediction was set to current (2001), so the only missing information related to the precipitation and temperature variables. Without any information as to these variables, average precipitation and temperature for the particular month in question was used in the monthly visitation prediction for each alternative.

As an illustration, the following presents visitation predictions developed using the Kirwin and Webster reservoir wildlife observation models. Data from the first observation in each dataset (October 1993 for Kirwin, January 1980 for Webster) was entered into each model.

1) Kirwin Wildlife Observation Model:

Dependent Variable: Visits

Explanatory Variables:

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	-217821648.9	.11493324E+09	-1.895	.0581	
YEAR	56.75379089	191.30746	.297	.7667	1996.7590
EOMWL	251581.7156	132717.53	1.896	.0580	1729.7555
EOMWLSQ	-72.68058158	38.337262	-1.896	.0580	2992058.5
PRECIP	54.16374717	175.32078	.309	.7574	1.9334940
JAN	-168.1827921	1439.8008	-.117	.9070	.72289157E-01
FEB	240.8412306	1386.4828	.174	.8621	.84337349E-01
MAR	1623.348625	1401.5616	1.158	.2468	.84337349E-01
APR	3127.025161	1440.2163	2.171	.0299	.84337349E-01
MAY	7402.704951	1540.6500	4.805	.0000	.84337349E-01
JUNE	4178.415978	1439.8228	2.902	.0037	.84337349E-01
JULY	3523.714794	1474.6967	2.389	.0169	.84337349E-01
AUG	2395.425561	1478.2462	1.620	.1051	.84337349E-01
SEP	2616.006945	1483.6215	1.763	.0779	.84337349E-01
OCT	2097.526603	1370.9396	1.530	.1260	.84337349E-01
NOV	-78.67460009	1382.3293	-.057	.9546	.84337349E-01

Adjusted R^2: .379
Prediction R^2: .493

Variables:	October 1993 Data:	Data Sources for Predictions:
CONSTANT =	1	(By definition)
YEAR =	1993	(Set by study managers)
EOMWL =	1734.21	(Provided by hydrologists)
$EOMWL^2$ =	3,007,484.32	(Analyst must calculate squared water level.)
PRECIP =	1.38	(Average precipitation for target month. Obtained from regional climate center.)
JAN =	0	(0 or 1 depending on which month is being estimated)
FEB =	0	(“ ”)
MAR =	0	(“ ”)
APR =	0	(“ ”)
MAY =	0	(“ ”)
JUNE =	0	(“ ”)
JULY =	0	(“ ”)
AUG =	0	(“ ”)
SEP =	0	(“ ”)
OCT =	1	(“ ”)
NOV =	0	(“ ”)

Note: With these monthly dummy variables, distinct visitation estimates can be developed for each month of the year. Since wildlife observation is pursued year-round, it doesn't really have an off-season characterized by zero visitation. For all other activities, visitation occurs only across a particular sequence of months. To estimate visitation for each month, simply change the location of the 1 to the month of interest. For December, enter zeros for all months.

Model Prediction: 3451
Actual Visits: 3878

2) Webster Wildlife Observation Model:

Dependent Variable: Natural Log of Visits (need to take the antilog of predicted values)

Explanatory Variables:

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	-5126.354997	1762.4121	-2.909	.0036	
YEAR	-.4608436702E-01	.22522774E-01	-2.046	.0407	1990.0000
EOMWL	5.529904484	1.8746757	2.950	.0032	1877.3169
EOMWLSQ	-.1463349982E-02	.49841533E-03	-2.936	.0033	3524484.8
PRECIP	.2876909508E-02	.13462844E-01	.214	.8308	2.0393254
JAN	.4327437941	.10232904	4.229	.0000	.83333333E-01
FEB	.7639609739	.13153589	5.808	.0000	.83333333E-01
MAR	2.779239347	.14957801	18.581	.0000	.83333333E-01
APR	2.775397396	.16112947	17.225	.0000	.83333333E-01
MAY	3.703280630	.17069896	21.695	.0000	.83333333E-01
JUNE	3.440207178	.17005124	20.230	.0000	.83333333E-01
JULY	3.732954422	.17017754	21.936	.0000	.83333333E-01
AUG	3.216138944	.16207447	19.844	.0000	.83333333E-01
SEP	2.929993185	.14807000	19.788	.0000	.83333333E-01
OCT	1.938027154	.13007982	14.899	.0000	.83333333E-01
NOV	.5397293507	.99376891E-01	5.431	.0000	.83333333E-01

Adjusted R^2: .845
Prediction R^2: .846

Variables:	January 1980 Data:	Data Sources for Prediction: (same as above)
CONSTANT =	1	
YEAR =	1980	
EOMWL =	1871.81	
$EOMWL^2$ =	3,503,672.68	
PRECIP =	0.75	
JAN =	1	
FEB =	0	
MAR =	0	
APR =	0	
MAY =	0	
JUNE =	0	
JULY =	0	
AUG =	0	
SEP =	0	
OCT =	0	
NOV =	0	

Model Prediction: 784 (Note: since this model predicts the natural log of visits, the antilog of the prediction must be taken)

Actual Visits: 710

All models reflect an abstraction of reality and therefore involve a certain degree of error, this implies that model prediction will never exactly match with actual events. Perhaps the best way to use a model is not so much for predicting expected levels of visitation, but for predicting changes in expected visitation between two or more alternative sets of conditions. The greater the predictive accuracy of the model, the more confidence one could place on the predictions.

It should be noted that the predictions can be very sensitive to the number of decimal places used in the calculation. This is especially true when a quadratic model is used due to the size of the squared value (i.e., rounding or truncating off several decimal places may sound minor, but when multiplied by a value in the millions can make a noticeable difference). Bottomline, the most precise calculations result when all the decimal places are used. However, if the primary purpose of the model's application is to predict visitation differences between alternatives, as opposed to visitation levels for each alternative, consistent use of the same degree of rounding is all that is required.

As indicated previously, care must be used to apply the models only to situations within the range of underlying data. As the number of observations used to develop the models decrease, the likelihood of experiencing data limitation problems increases (although even with a large number of observations, data range problems can arise). This proved to be the case for the Kirwin models. Water levels for the alternatives under consideration fell well below those used to estimate the models. As a result, the models could not be used to estimate visitation at Kirwin.

4.2 Yearly Recreation Modeling:

Step 1: Data Gathering

Since visitation data may not always be available by month, we also attempted statistical modeling using yearly data obtained from recreation managers at each site.

Step 2: Theoretical Model Development

Option 1: Quadratic Model

$$\text{Yearly Visitation}_{ajy} = f\,(\underset{(?)}{\text{Year}},\ \underset{(+)}{\text{Average WL}},\ \underset{(-)}{\text{Average WL}^2},\ \underset{(-)}{\text{Precipitation}})$$

where:

Activity:	a = 1,...,l
Site:	j =1,...,m
Year:	y = 1,...,n

Dependent Variable: Total visitation in activity *a*, at site *j*, in year *y*

Explanatory Variables:

Year = Year of data. This variable is intended to reflect a trend variable, used in lieu of socioeconomic variables. Expected sign: unknown. One might expect population and income to potentially affect recreation use. Populations in the adjacent counties of these reservoirs have been fairly stable or even declining in recent years. Conversely, income levels have been gradually rising. The combined effect leads to an unknown sign for this variable.

Average WL = Average of the end of month water levels across the recreation season. Expected sign: Positive.

Average WL^2 = Average of the end of month water levels across the recreation season squared (quadratic model provides expected bell-shaped function). Expected sign: Negative (the positive, negative signs on the WL and WL^2 variables creates the bell-shaped function).

Precipitation = Total seasonal precipitation. Expected sign: Negative, but may be positive for some activities (e.g., fishing).

Option 2: Water Level Change Model:

$\text{Yearly Visitation}_{ajy}$ = f (Year, Beginning or End of Season WL, WL Change, Precipitation)
(?) (+) (-) (-)

where:

Activity: a = 1,...,l
Site: j =1,...,m
Year: y = 1,...,n

Dependent Variable: Total visitation in activity *a*, at site *j*, in year *y*

Explanatory Variables:

Year =	Year of data. This variable is intended to reflect a trend variable, used in lieu of socioeconomic variables. Expected sign: unknown (see above).
Beginning or End of Season WL =	End of month water levels at either the beginning or end of the recreation season. Expected sign: Positive (typically, the higher the start/end of season water level the better).
WL Change =	Change in end of month water levels across the recreation season. Expected sign: Negative (typically, the less variation water levels across the recreation season the better).
Precipitation =	Total seasonal precipitation. Expected sign: Negative, but may be positive for some activities (e.g., fishing).

Step 3: Statistical Estimation

Ordinary least squares multiple regression models were again estimated using the LIMDEP statistical package (Greene, 1998).

A. Modeling Preparation:

A significant amount of work was pursued to efficiently use LIMDEP. A series of read and batch files were developed to read the data, construct the variables, and run the myriad of regressions for each site and recreation activity. See Appendix A for an example of the read and batch files for monthly warm water fishing models at Webster Reservoir.

B. Modeling:

As with the monthly modeling effort, the statistical estimation process for the yearly models started by estimating the above described quadratic and water level change models using OLS regressions with three functional forms: 1) linear, 2) quadratic, and 3) semi-log (logged dependent variable only). The linear model was run as a base case. The quadratic model was run to test for the hypothesized bell-shaped function, and the semi-log model was estimated to prevent the possibility of negative visitation predictions.

Since there was no particular logic to selecting one over the other, the yearly models were estimated using both end of month (EOM) and beginning of month (BOM) water levels. As it turned out, there was not much difference between the EOM versus BOM models.

Reviewing the Durbin-Watson statistic results of the initial regressions, it was not surprising to discover that the yearly time series based regressions showed autocorrelation effects. Actually, in all models, the Durbin-Watson statistic proved inconclusive. With an inconclusive test, the standard procedure is to make the appropriate corrections based on the assumption that autocorrelation exists. Including the autocorrelation correction described previously in the estimation process adequately adjusted for the autocorrelation problem.

Step 4: Model Selection

A. Model Selection Criteria: The yearly models where chosen based on the same model selection criteria as discussed in the monthly modeling section.

B. Model Selections: Based on a comparison using the previously mentioned criteria, the following yearly models for each activity at each reservoir were selected as “best”. Despite having only seven observations for Kirwin reservoir, the results are presented since this lack of data may not be an unusual situation. Potentially useful models were estimated for Kirwin, but given the low number of observations, the results should be viewed with some skepticism. For Webster, data were available back to 1980. It is possible that some of the significant, but unanticipated signs on the variables in these models may be the result of too few observations.

1. Kirwin Reservoir:

a. <u>*Swimming and Boating*</u>:

Dependent Variable: Visits

Model is usable across the following Water Level Range: 1724.6 to 1729.9

Explanatory Variables: # of Observations = 7

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	-9817759.549	3724837.0	-2.636	.0084	
YEAR	1434.758563	551.72859	2.600	.0093	1997.0000
SEPBOMWL	4012.318010	1543.6231	2.599	.0093	1727.8414
BOMWLCHG	-5327.235445	1328.1202	-4.011	.0001	-2.8942857
PRECIP	657.8657379	158.15265	4.160	.0000	14.891429

Adjusted R^2: .637
Prediction R^2: .846

Unanticipated Signs: The precipitation variable came in positive.

b. *Camping and Picnicking*:

Dependent Variable: Natural Log of Visits

(Note: The analyst will need to take the antilog of predicted values to estimate predicted visits)

Model is usable across the following Water Level Range: 1726.9 to 1730.5

Explanatory Variables: # of Observations = 7

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	130243.9012	43840.892	2.971	.0030	
YEAR	-.2192588205	.10867604	-2.018	.0436	1997.0000
AVGEOMWL	-149.7946073	50.276837	-2.979	.0029	1729.4829
AEOMWLSQ	.4321780320E-01	.14466864E-01	2.987	.0028	2991115.2
PRECIP	.4686713373E-01	.50848033E-01	.922	.3567	14.891429

Adjusted R2: .694
Prediction R^2: .897

Unanticipated Signs: Note that the signs are opposite of expectations on the average water level (AVGEOMWL) and water level squared (AEOMWLSQ) terms. This implies a U-shaped water level to visitation relationship as opposed to a bell-shaped relationship.

c. *Warm Water Fishing*:

Dependent Variable: Natural Log of Visits

(Note: The analyst will need to take the antilog of predicted values to estimate predicted visits)

Model is usable across the following Water Level Range: 1724.6 to 1729.9

Explanatory Variables: # of Observations = 7

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	-1173.603870	264.25876	-4.441	.0000	
YEAR	.1725709520	.39799566E-01	4.336	.0000	1997.0000
SEPBOMWL	.4843724772	.10886653	4.449	.0000	1727.8414
BOMWLCHG	-.5457274707	.73982535E-01	-7.376	.0000	-2.4728571
PRECIP	.5390522420E-01	.13857021E-01	3.890	.0001	17.177143

Adjusted R^2: .858
Prediction R^2: .937

d. *Wildlife Observation*:

Dependent Variable: Natural Log of Visits

(Note: The analyst will need to take the antilog of predicted values to estimate predicted visits)

Model is usable across the following Water Level Range: 1724.1 to 1730.5

Explanatory Variables: # of Observations = 7

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	-832.5381836	263.85206	-3.155	.0016	
YEAR	.1987058876	.69696363E-01	2.851	.0044	1997.0000
DECEOMWL	.2579348639	.79235364E-01	3.255	.0011	1728.3386
EOMWLCHG	-.1630472664	.75097879E-01	-2.171	.0299	-1.6128571
PRECIP	.2090152881E-01	.30173054E-01	.693	.4885	22.534286

Adjusted R^2: .481
Prediction R^2: .813

e. *Waterfowl Hunting*:

No statistically significant models were found.

2. Webster Reservoir:

a. *Camping*:

Dependent Variable: Natural Log of Visits

(Note: The analyst will need to take the antilog of predicted values to estimate predicted visits)

Model is usable across the following Water Level Range: 1859.1 to 1904.0

Explanatory Variables: # of Observations = 21

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	83.32196218	76.692516	1.086	.2773	
YEAR	-.8602525434E-01	.43622889E-01	-1.972	.0486	1990.0000
SEPEOMWL	.5197873704E-01	.16058610E-01	3.237	.0012	1876.7162
EOMWLCHG	-.3185802699E-01	.16395898E-01	-1.943	.0520	-2.9180952
PRECIP	.2260148094E-01	.16509457E-01	1.369	.1710	15.774286

Adjusted R^2: .310
Prediction R^2: .351

b. *Swimming*:

Dependent Variable: Natural Log of Visits

(Note: The analyst will need to take the antilog of predicted values to estimate predicted visits)

Model is usable across the following Water Level Range: 1859.1 to 1904.0

Explanatory Variables: # of Observations = 21

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	72.39058260	78.662860	.920	.3574	
YEAR	-.7515108242E-01	.43786907E-01	-1.716	.0861	1990.0000
SEPEOMWL	.4574398348E-01	.15049508E-01	3.040	.0024	1876.7162
EOMWLCHG	-.3636774977E-01	.15259041E-01	-2.383	.0172	-2.9180952
PRECIP	.2328753492E-01	.15235047E-01	1.529	.1264	15.774286

Adjusted R^2: .334
Prediction R^2: .360

c. *Boating and Waterskiing*:

Dependent Variable: Natural Log of Visits

(Note: The analyst will need to take the antilog of predicted values to estimate predicted visits)

Model is usable across the following Water Level Range: 1859.1 to 1904.0

Explanatory Variables: # of Observations = 21

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	78.68526295	87.079762	.904	.3662	
YEAR	-.1083586314	.52203741E-01	-2.076	.0379	1990.0000
SEPEOMWL	.7762072306E-01	.21697920E-01	3.577	.0003	1876.7162
EOMWLCHG	-.5010832912E-01	.22630830E-01	-2.214	.0268	-2.9180952
PRECIP	.1233253900E-01	.23361788E-01	.528	.5976	15.774286

Adjusted R^2: .384
Prediction R^2: .452

d. *Picnicking*:

Dependent Variable: Natural Log of Visits

(Note: The analyst will need to take the antilog of predicted values to estimate predicted visits)

Model is usable across the following Water Level Range: 1859.1 to 1904.0

Explanatory Variables: # of Observations = 21

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	79.70121008	73.932275	1.078	.2810	
YEAR	-.8783801640E-01	.42179736E-01	-2.082	.0373	1990.0000
SEPEOMWL	.5494822482E-01	.15659655E-01	3.509	.0004	1876.7162
EOMWLCHG	-.3921663758E-01	.16005257E-01	-2.450	.0143	-2.9180952
PRECIP	.2110131535E-01	.16136331E-01	1.308	.1910	15.774286

Adjusted R^2: .385
Prediction R^2: .425

e. *Warm Water Fishing*:

Dependent Variable: Natural Log of Visits

(Note: The analyst will need to take the antilog of predicted values to estimate predicted visits)

Model is usable across the following Water Level Range: 1859.4 to 1895.5

Explanatory Variables: # of Observations = 21

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	105.0712537	69.825053	1.505	.1324	
YEAR	-.1009090741	.44287582E-01	-2.278	.0227	1990.0000
MARBOMWL	.5663734954E-01	.19631007E-01	2.885	.0039	1876.3838
BOMWLCHG	.2948626691E-01	.17717825E-01	1.664	.0961	.33238095
PRECIP	.2839609189E-01	.25002872E-01	1.136	.2561	21.290476

Adjusted R^2: .353
Prediction R^2: .404

Unanticipated Signs: Note that the beginning of month water level change variable (BOMWLCHG) came in positive.

f. *Wildlife Observation*: (2 models presented)

1. Water Level Change Model:

Dependent Variable: Natural Log of Visits

(Note: The analyst will need to take the antilog of predicted values to estimate predicted visits)

Model is usable across the following Water Level Range: 1859.2 to 1897.2

Explanatory Variables: # of Observations = 21

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	97.03984575	75.490390	1.285	.1986	
YEAR	-.9213875283E-01	.47509759E-01	-1.939	.0525	1990.0000
JANBOMWL	.5183181698E-01	.20777746E-01	2.495	.0126	1875.9271
BOMWLCHG	.4050087577E-01	.20619593E-01	1.964	.0495	.78619048
PRECIP	.9683730572E-02	.30041298E-01	.322	.7472	24.481905

Adjusted R^2: .275
Prediction R^2: .323

Unanticipated Signs: Note that the beginning of month water level change variable (BOMWLCHG) came in positive.

2. Quadratic Model:

Dependent Variable: Natural Log of Visits

(Note: The analyst will need to take the antilog of predicted values to estimate predicted visits)

Model is usable across the following Water Level Range: 1861.0 to 1895.7

Explanatory Variables: # of Observations = 21

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	-9015.696637	5363.0158	-1.681	.0927	
YEAR	-.6431249856E-01	.46883444E-01	-1.372	.1701	1990.0000
AVGBOMWL	9.703109080	5.6713454	1.711	.0871	1877.2576
ABOMWLSQ	-.2571002390E-02	.15117500E-02	-1.701	.0890	3524243.0
PRECIP	.1840084880E-01	.15718065E-01	1.171	.2417	24.481905

Adjusted R^2: .390
Prediction R^2: .454

g. *Waterfowl Hunting*:

No statistically significant models were found.

Step 5. Yearly Visitation Prediction

To use a yearly model, one would need to multiply the expected annual values for each of the explanatory variables by their respective coefficients and sum the result. In the Solomon River application, hydrologists provided data on forecasted monthly water levels for each alternative. This data would have to be converted into seasonal water level changes (EOMWLCHG and BOMWLCHG variables) and seasonal average water levels (AVGBOMWL and AVGEOMWL variables) based on the various months in the season for each recreation activity. The year of the prediction would need to be determined. The only missing information would pertain to the precipitation and temperature variables. Without any information as to these variables, average precipitation and temperature for the particular months in each recreation season could be used in the annual visitation prediction for each alternative.

As an illustration, the following presents visitation predictions developed using the Kirwin and Webster reservoir wildlife observation models. Data from the first observation in each dataset (1994 for Kirwin, 1980 for Webster) was entered into each model. For Webster, we show the results of the quadratic (bell-shaped) model only.

1) Kirwin Wildlife Observation Model:

Dependent Variable: Natural Log of Visits

Explanatory Variables:

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	-832.5381836	263.85206	-3.155	.0016	
YEAR	.1987058876	.69696363E-01	2.851	.0044	1997.0000
DECEOMWL	.2579348639	.79235364E-01	3.255	.0011	1728.3386
EOMWLCHG	-.1630472664	.75097879E-01	-2.171	.0299	-1.6128571
PRECIP	.2090152881E-01	.30173054E-01	.693	.4885	22.534286

Adjusted R^2: .481
Prediction R^2: .813

Variables:	1994 Data:	Data Sources for Predictions:
CONSTANT =	1	(By definition)
YEAR =	1994	(Determined by study managers)
DECEOMWL =	1729.1	(Provided by hydrologists)
EOMWLCHG =	-4.32	(End of season EOM water level minus beginning of season EOM water level must be calculated by analyst.)
PRECIP =	20.31	(Sum of monthly precipitation across recreation season. Data obtained from regional climate center.)

Model Prediction: 49,286 (Note: since this model predicts the natural log of visits, the antilog of the prediction must be taken)

Actual Visits: 46,555

2) Webster Wildlife Observation Model (Quadratic Model):

Dependent Variable: Natural Log of Visits

Explanatory Variables:

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	-9015.696637	5363.0158	-1.681	.0927	
YEAR	-.6431249856E-01	.46883444E-01	-1.372	.1701	1990.0000
AVGBOMWL	9.703109080	5.6713454	1.711	.0871	1877.2576
ABOMWLSQ	-.2571002390E-02	.15117500E-02	-1.701	.0890	3524243.0
PRECIP	.1840084880E-01	.15718065E-01	1.171	.2417	24.481905

Adjusted R^2: .390

Prediction R^2: .454

Variables:	1980 Data:	Data Sources for Predictions:
CONSTANT =	1	(By definition)
YEAR =	1980	(Determined by study managers)
AVGBOMWL =	1869.83	(Provided by hydrologists)
ABOMWLSQ =	3,496,264.23	(Water level squared must be calculated by analyst)
PRECIP =	16.66	(Sum of monthly precipitation across recreation season. Data obtained from regional climate center.)

Model Prediction: 101,919 (Note: since this model predicts the natural log of visits, the antilog of the prediction must be taken)

Actual Visits: 117,694

5.0 CONCLUSIONS

The basic conclusion of this paper is that if sufficient visitation data exists, it may be worth attempting to statistically estimate a relationship between reservoir (or river) water levels and recreation use. While data on visitor origin is often unavailable, implying travel cost models could not be estimated, visitation data may be available which would allow for use estimation modeling.

The recreation visitation models developed for this analysis were estimated as part of the Solomon River environmental process. Historic visitation data was obtained for both Kirwin and Webster reservoirs by activity and month. Combining the visitation data with information on historic water levels, temperature, and precipitation, allowed for estimation of both monthly and yearly recreation use estimation models by activity. While more emphasis is placed on the monthly models given the greater number of observations, the yearly models also proved promising. Significant statistical relationships surfaced even with the Kirwin yearly models where only seven observations were available.

It is interesting to note that one of the driving forces behind this modeling effort was the need to address water level impacts on land based activities (e.g., camping, picnicking, wildlife observation). Water based activities (e.g., swimming, boating, boat fishing) can often be addressed using alternative methods including information on the availability of water access facilities such as boat ramps. Land based activities may be related to water levels, but their facilities are typically not restricted by fluctuating water levels. As a result, use estimation modeling is one of the few approaches capable of estimating impacts to land based activities. Based on the visitation data provided for Kirwin and Webster reservoirs, there does appear to be a significant relationship between land based activities and reservoir water levels.

6.0 REFERENCES

Badger, D. 1972. "Recreation study and assessment of pool elevation effect on recreation visitation at Lake Texoma." Report prepared for: U.S. Army Corps of Engineers, Tulsa District.

Bowker, J., H. Cordell, L. Hawks, D. English. 1994. "An economic assessment of alternative water-level management for Shasta and Trinity Lakes." USDA Forest Service, Southeastern Forest Experiment Station, Outdoor Recreation and Wilderness Group, Athens, GA.

Boyle, K., M. Welsh, and R. Bishop. 1993. "The role of question order and response experience in contingent-valuation studies." *Journal of Environmental Economics and Management* 25:S-80 to S-99.

Greene, W. 1998. LIMDEP, Version 7.0. Econometric Software, Plainview, NY.

Gujarati, D. 1988. Basic Econometrics. McGraw-Hill Book Company, New York.

Platt, J. 2000. "Impact of Fluctuating Reservoir Elevation on Recreation Use and Value." Technical Memorandum #: EC-2000-02, U. S. Bureau of Reclamation, Technical Service Center, Economics Group, Denver CO.

Platt, J. 1996. "Forecasting Changes in Site Specific Recreation Use." Technical Memorandum #: EC-96-14, U. S. Bureau of Reclamation, Technical Service Center, Economics Group, Denver CO.

APPENDIX A: LIMDEP Batch Files

```
? LIMDEP Solomon Recreation Analysis Read File:  Monthly Fishing Models (Kirwin)
?
? Filename: d:\files\solomon\recreation\webster\LIMDEP\MnFishRd.txt
?
? Date: February 22, 2001
?
? Purpose: Read in Webster Reservoir Monthly Warm Water Fishing data.
? Create logged variables.
?
? Datafile: Lotus Spreadsheet d:\files\solomon\recreation\webster\LIMDEP\WMonFish.txt
?                              - # columns (variables) = 16
?                              - # rows = 168 observations, (no variable names)
?
Read;nobs=168;nvar=16;
Names=MONTH,YEAR,FISHING,BOMWL,BOMWLSQ,EOMWL,EOMWLSQ,PRECIP,TEM
P,MAR,APR,MAY,JUNE,JULY,AUG,SEP;
file=d:\files\solomon\recreation\webster\limdep\WMonFish.txt$
?
Create; LFISH=Log(FISHING)$
```

? **LIMDEP Solomon Recreation Analysis Batch File**: Monthly Fishing Models (Kirwin)
?
? Filename: d:\files\solomon\recreation\webster\LIMDEP\MnFishB3.txt
?
? Date: February 22, 2001
?
? Purpose: Develop Monthly Recreation Use Estimation Regression Models at Webster
? Reservoir for Warm Water Fishing. Using OLS and Tobit statistical estimation approaches
? initially with linear, quadratic, and semi-log function forms (also set up for double-log function
? form). Note that an autoregressive term (AR1) was added to each regression to adjust for
? autocorrelation evident in the initial regressions. Also includes correlation matrix (DSTAT)
? command and prediction regressions. Finally, the predicted values were saved (keep=
? command) and regressed on actual visitation to test the accuracy of the models.
?
? Dependent Variable = FISHING, LFISH
?
? Independent Variables = MONTH, YEAR, BOMWL, BOMWLSQ, EOMWL, EOMWLSQ,
? PRECIP, TEMP, MAR, APR, MAY, JUNE, JULY, AUG, SEP. *** Removed TEMP from
? regressions.
?
? Read file also set up to construct the following logged independent variables: LYEAR,
? LBOM, LBOMSQ, LEOM, LEOMSQ, LPRECIP, LTEMP.
?
? Datafile: Lotus Spreadsheet d:\files\solomon\recreation\webster\LIMDEP\WMonFish.lpj
? - # columns (variables) = 17 (24 with logged independent variables)
? - # rows = 168 observations (no variable names)
?

```
Load; file="d:\files\solomon\recreation\webster\LIMDEP\WMonFish.lpj"$
skip$
Namelist;NAME1=ONE,YEAR,BOMWL,PRECIP,MAR,APR,MAY,JUNE,JULY,AUG,
SEP$
Namelist;NAME2=ONE,YEAR,BOMWL,BOMWLSQ,PRECIP,MAR,APR,MAY,JUNE
,JULY,AUG,SEP$
Namelist;NAME3=ONE,YEAR,EOMWL,PRECIP,MAR,APR,MAY,JUNE,JULY,AUG,
SEP$
Namelist;NAME4=ONE,YEAR,EOMWL,EOMWLSQ,PRECIP,MAR,APR,MAY,JUNE
,JULY,AUG,SEP$
?
DSTAT;rhs=YEAR,BOMWL,BOMWLSQ,PRECIP,TEMP,MAR,APR,MAY,JUNE,JULY,AU
G,SEP,EOMWL,EOMWLSQ;output=2$
?
? OLS Regressions, Linear, Warm Water Fishing
REGRESS;lhs=FISHING;rhs=NAME1;AR1;keep=fhyhat1$
CREATE;fhdiff1=fishing-fhyhat1$
```

```
regress;lhs=FISHING;rhs=fhyhat1$
REGRESS;lhs=FISHING;rhs=NAME2;AR1;keep=fhyhat2$
CREATE;fhdiff2=fishing-fhyhat2$
regress;lhs=FISHING;rhs=fhyhat2$
REGRESS;lhs=FISHING;rhs=NAME3;AR1;keep=fhyhat3$
CREATE;fhdiff3=fishing-fhyhat3$
regress;lhs=FISHING;rhs=fhyhat3$
REGRESS;lhs=FISHING;rhs=NAME4;AR1;keep=fhyhat4$
CREATE;fhdiff4=fishing-fhyhat4$
regress;lhs=FISHING;rhs=fhyhat4$
?
? OLS Regressions, Semi-log (log-linear), Warm Water Fishing
REGRESS;lhs=LFISH;rhs=NAME1;AR1;keep=Lfhyhat1$
CREATE;Lfyhat11=exp(Lfhyhat1)$
CREATE;Lfhdiff1=fishing-Lfyhat11$
regress;lhs=FISHING;rhs=Lfyhat11$
REGRESS;lhs=LFISH;rhs=NAME2;AR1;keep=Lfhyhat2$
CREATE;Lfyhat22=exp(Lfhyhat2)$
CREATE;Lfhdiff2=fishing-Lfyhat22$
regress;lhs=FISHING;rhs=Lfyhat22$
REGRESS;lhs=LFISH;rhs=NAME3;AR1;keep=Lfhyhat3$
CREATE;Lfyhat33=exp(Lfhyhat3)$
CREATE;Lfhdiff3=fishing-Lfyhat33$
regress;lhs=FISHING;rhs=Lfyhat33$
REGRESS;lhs=LFISH;rhs=NAME4;AR1;keep=Lfhyhat4$
CREATE;Lfyhat44=exp(Lfhyhat4)$
CREATE;Lfhdiff4=fishing-Lfyhat44$
regress;lhs=FISHING;rhs=Lfyhat44$
?
```

```
? LIMDEP Solomon Recreation Analysis Read File:  Yearly Fishing Models (Kirwin)
?
? Filename: d:\files\solomon\recreation\webster\LIMDEP\YrFishRd.txt
?
? Date: February 22, 2001
?
? Purpose: Read in Webster Reservoir Yearly Warm Water Fishing data.
? Create logged variables.
?
? Datafile: Lotus Spreadsheet d:\files\solomon\recreation\webster\LIMDEP\WYrFish.txt
?                              - # columns (variables) = 13
?                              - # rows = 21 observations, (no variable names)
?
Read;nobs=21;nvar=13;
Names=YEAR,FISHING,MARBOMWL,OCTBOMWL,BOMWLCHG,AVGBOMWL,ABOM
WLSQ,MAREOMWL,OCTEOMWL,EOMWLCHG,AVGEOMWL,AEOMWLSQ,PRECIP;
file=d:\files\solomon\recreation\webster\limdep\WYrFish.txt$
?
Create; LFISH=Log(FISHING)$
```

? **LIMDEP Solomon Recreation Analysis Batch File**: Yearly Fishing Models (Kirwin)
?
? Filename: d:\files\solomon\recreation\webster\LIMDEP\YrFishB1.txt
?
? Date: February 22, 2001
?
? Purpose: Develop Yearly Recreation Use Estimation Regression Models at Webster Reservoir
? for warm water fishing. Using OLS and Tobit statistical estimation approaches initially with
? linear, quadratic, and semi-log function forms (also set up for double-log function form, need
to
? verify the logic). Note the correction for autocorrelation (AR1 term) discovered in prior
? regression runs.
?
? Dependent Variable = FISHING, LFISH
?
? Independent Variables = YEAR, MARBOMWL, OCTBOMWL, BOMWLCHG,
? AVGBOMWL, ABOMWLSQ, MAREOMWL, OCTEOMWL, EOMWLCHG, AVGEOMWL,
? AEOMWLSQ, PRECIP.
?
? Read file also set up to construct the following logged independent variables: LYEAR,
? LMARBOM, LOCTBOM, LBOMCHG, LAVGBOM, LABOMSQ, LMAREOM, LOCTEOM,
? LEOMCHG, LAVGEOM, LAEOMSQ, LPRECIP
?
? Datafile: Lotus Spreadsheet d:\files\solomon\recreation\webster\LIMDEP\WYrFish.lpj
? - # columns (variables) = 14 (26 with logged independent variables)
? - # rows = 21 observations (no variable names)
?
Load; file="d:\files\solomon\recreation\webster\LIMDEP\WYrFish.lpj"$
skip$
Namelist;NAME1=ONE,YEAR,MARBOMWL,BOMWLCHG,PRECIP$
Namelist;NAME2=ONE,YEAR,OCTBOMWL,BOMWLCHG,PRECIP$
Namelist;NAME3=ONE,YEAR,AVGBOMWL,ABOMWLSQ,PRECIP$
Namelist;NAME4=ONE,YEAR,MAREOMWL,EOMWLCHG,PRECIP$
Namelist;NAME5=ONE,YEAR,OCTEOMWL,EOMWLCHG,PRECIP$
Namelist;NAME6=ONE,YEAR,AVGEOMWL,AEOMWLSQ,PRECIP$
?
DSTAT;rhs=YEAR,MARBOMWL,OCTBOMWL,BOMWLCHG,AVGBOMWL,ABOMWLSQ
,MAREOMWL,OCTEOMWL,EOMWLCHG,AVGEOMWL,AEOMWLSQ,PRECIP;output=2$
?
? OLS Regressions, Linear, Warm Water Fishing
REGRESS;lhs=FISHING;rhs=NAME1;AR1$
REGRESS;lhs=FISHING;rhs=NAME2;AR1$
REGRESS;lhs=FISHING;rhs=NAME3;AR1$
REGRESS;lhs=FISHING;rhs=NAME4;AR1$

```
REGRESS;lhs=FISHING;rhs=NAME5;AR1$
REGRESS;lhs=FISHING;rhs=NAME6;AR1$
?
? OLS Regressions, Semi-log (log-linear), Warm Water Fishing
REGRESS;lhs=LFISH;rhs=NAME1;AR1$
REGRESS;lhs=LFISH;rhs=NAME2;AR1$
REGRESS;lhs=LFISH;rhs=NAME3;AR1$
REGRESS;lhs=LFISH;rhs=NAME4;AR1$
REGRESS;lhs=LFISH;rhs=NAME5;AR1$
REGRESS;lhs=LFISH;rhs=NAME6;AR1$
?
```

DEPARTMENT OF THE INTERIOR'S MISSION

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to tribes.

RECLAMATION'S MISSION

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.