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Application of the Regional Recreation Demand Model (RRDM) to Clearwater Lake, Little Rock District: Benefit Estimates and Visit Forecasts

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Purpose

The RRDM was developed by the Natural Resources Research Program to evaluate recreation use and economic benefits associated with changes in reservoir operation or construction of new projects (Ward and others, in press). Of primary interest to the U.S. Army Corps of Engineers are the effects of water-level changes on recreation use and economic benefits.

This technical note analyzes the effects of proposed water-level changes at Clearwater Lake, Missouri. The RRDM is used to estimate recreation use and economic benefits associated with four proposed increases in water levels. The data collection is described, and the data sources are identified. Updating and calibration of the models is outlined, and per-user and total economic benefits are calculated. Finally, several management scenarios (that is, water-level changes) are analyzed.

Data Collection

Assembling new site data to be analyzed by the RRDM involves many steps. This section reports on the sources used to collect a complete data set for Clearwater Lake, located in southeast Missouri.

The first step in database assembly was to develop a market area county list. The RRDM uses a one-way market area of 175 miles for campers and 125 miles for day-users. Observations are on a county level, with the largest city in each county used as the common origin point for all visitors in that county. Using the computer program PCMiler® (ALK Associates, Princeton, NJ), along with a national map, one can determine that the camping market area for Clearwater Lake includes counties within the states of Missouri, Tennessee, Arkansas, Illinois, and Kentucky.

Using a map with county divisions, a circle with a 175-mile radius was drawn. This circle is larger than the true market area since actual road distances are not considered. Then, the names of all counties within this circle were recorded. About 130 counties fall within this approximate market area.

It was then necessary to identify the largest city within each of these counties. The Bureau of the Census[1] publishes a summary report of characteristics for each state. These reports list the population of major cities and towns within each county. The city or town with the largest population is considered to be the travel origin point for that county.

Travelers are assumed to visit the nearest recreation area on Clearwater Lake. Since PCMiler requires a town name as the input to mileage estimation, a two-step procedure is necessary. First, visitors are assumed to pass through one of three nearby towns on their way to Clearwater Lake. The towns considered are Piedmont, Garwood, and Ellington. Then, the distance and travel time from each of these towns to the nearest recreation area on Clearwater is estimated. The possible destination areas on Clearwater Lake were assumed to be Webb Creek or the River Road-Piedmont Park (RR-PP) area. The Bluff View area was not considered since the mileage between the town of Piedmont and this area was about the same as the distance to the RR-PP area.

For each possible origin county, the distance (and travel time) to each of the three destination cities was calculated using PCMiler. Then, an amount of distance and travel time was added to account for travel to the recreation area. For example, consider the destination town of Piedmont. Travel from Piedmont to the RR-PP area is about 6 miles, which is assumed to take about 0.2 hr. Finally, the minimum travel distance (and associated travel time) from each county to a recreation area on Clearwater Lake was determined. Counties within 175 miles (one way) are included in the camping data set, and counties within 125 miles comprise the day-use data. A total of 89 counties are in the Clearwater camping market area and 40 counties are in the day-use market area. The full 89 observation data set is used as a starting point for all analysis, and a Statistical Analysis System (SAS Institute 1985) computer program is used to sort it into the smaller day-use data set when needed.

Once the length of the data set is determined, the next step is to fill in several types of data. These include county-level demographic data and site characteristics. The demographic information is obtained from two sources, the USA Counties CD-ROM and the Bureau of the Census Summary Tape File 3 CD-ROM (U.S. Department of Commerce). The USACounties data can be easily downloaded into spreadsheets or ASCII format. The Census data must be downloaded using separate DBase® (Ashton-Tate Company) computer programs. Thus, USACounties is the more useful for assembling data for RRDM, unless one is familiar with DBase programs.

The economic analysis for Clearwater Lake is performed using two model options. First, the Little Rock models as presented in the RRDM report (Ward and others, in press) are used as the analysis base for Clearwater Lake. Then, the pooled models,

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[1] Publication "U.S. Counties" (various years), Economic and Statistical Administration, U.S. Department of Commerce, Washington, DC.

which combine data from the Little Rock, Nashville, and Sacramento Districts, are used (Ward and others, in press).

These models require the following demographic data:

- County population.
- Average county per-capita income.
- Average county wage rate.
- Percent under age 18 in each county.
- Percent minority racial composition of each county.
- Unemployment rate for each county.

Data were obtained from USACounties from the most recent year available. In most cases this is the 1990 census data, though population estimates are more recent. The demographic data were merged with the county list using SAS. The monetary variables were converted to 1980 dollars for conformity to the RRDM specification. Data on inflation are available from the Statistical Abstract of the United States, published by the Census Bureau.

Several site characteristics for Clearwater Lake are needed for the analysis. These variables include

- Surface acres of the lake at the recreation pool (1,630 acres).
- Number of parking spaces at the site (1,202).
- Number of camping sites (404).
- Number of boat launch lanes (17).
- Number of swimming beaches (3).
- Number of day-use picnic tables (86).
- Number of private boat docks (0).
- Number of full-service marinas (0).
- Capacity of the lake at the recreation pool (22,000 acre-ft).
- Average depth of the lake (13.5 ft).
- Number of game fish species (5).
- Number of shoreline miles (27).

Most of this information is available from the Natural Resources Management System (NRMS). Since some NRMS data are listed by recreation area, site data are obtained by summing over all areas at a site. The number of game fish species is obtained from site brochures (or site managers, if necessary). Average depth is capacity divided by the number of surface acres.

Other site characteristics require more effort. For the Little Rock District camping model, data on total dissolved solids (TDS) are required. However, Little Rock District personnel said that no data on TDS are available for Clearwater Lake, although data on TDS are available for two nearby Corps sites, Bull Shoals and Norfork Lakes. An average of readings from these lakes is 157 mg/L. This value was used for Clearwater Lake.

Water-level data are needed for the variables PCT_FULL (fullness of the lake) and CV (variability of lake levels), as detailed in the RRDM report (Ward and others, in press). Water data were obtained from Lee Schoonover of the Little Rock District for the years 1993 and 1994. Since 1994 was a flood year at Clearwater, 1993 was chosen as the base year. As described in the RRDM report, the water-level variable PCT_FULL needs to be weighted according to monthly visitation at a site. Using this procedure for Clearwater Lake, PCT_FULL is 100 during 1993. The value of the variable CV for 1993 was calculated as 1.62.

To calculate the travel cost variable, two more pieces of information are needed. The average number of people per vehicle for Little Rock District sites is given in the RRDM report as 2.77 (Ward and others, in press). The average variable operating cost for a motor vehicle is also needed. Operating cost averages are published annually by the American Automobile Manufacturers Association ("AAMA Motor Vehicle Facts and Figures"). Variable operating cost (gas, tires, and maintenance) for 1993 was 9.3 cents per mile. In 1980 dollars, the cost is converted to 5.8 cents per mile.

The variable OCEAN gives the one-way distance from each county to the nearest ocean or great lake recreation site as an indication of a large substitute site. The possible destination sites for counties in the market area were chosen to be Indiana Dunes State Park (on Lake Michigan), Biloxi, MS, and Galveston, TX. Using PCMiler, the distance from each county to these sites was estimated. The lowest distance was chosen for the value of OCEAN. The other substitute variable is SUB_INDEX, as described in the RRDM report. Since values of SUB_INDEX were available for each county in the Clearwater market area from the original RRDM data collection, values were simply merged. If this information had not been available, the average value from the RRDM report (14,673 for the Little Rock District) would have been used.

For the pooled models, climate data are also needed. The source used for climate data is *The Weather Handbook* (Conway and Liston 1974). The next section describes how the RRDM was applied to the Clearwater data to obtain benefit estimates.

Benefit Estimates

Using the RRDM involves applying the estimated coefficients to a new data set. This produces a prediction of day-use and camping visitation and benefits. As described in the RRDM report (Ward and others, in press), the visit predictions should be calibrated to the project in question. The visit predictions from the RRDM model will likely differ from actual visitation at the site. There are several reasons for this. First, some random error is expected in all recreation demand models. Second, the models are in logarithmic form. Conversion to nonlogarithmic visit predictions will normally produce a downward bias. Finally, recreation behavior at a site that was not included in the RRDM analysis may differ from that at studied sites.

To calibrate the models, a multiplicative factor is used to adjust the predicted visits to equal the actual, or observed (reported), visits. This adjustment does not affect the per-user benefits estimated by the models. So, multiplying actual visitation by the per-user benefits produced by the models will give an estimate of the total recreation benefits provided by the project.

Visitation estimates for Clearwater Lake were provided by Diane Batson of the Little Rock District. The actual number of day-use visitors at Clearwater in 1993 was 1,088,100, and camping visitation was 74,100. By applying the Little Rock District models to the 1993 Clearwater data, the unadjusted visit predictions are 128,300 for day-users and 23,400 for campers. Multiplying the day-use model by (1,088,100 ÷ 128,300), or 8.481, calibrates the model to correctly predict 1993 day-use visits. The calibration for the camping model is (74,100 ÷ 23,400), or 3.167. These calibration factors also account for counties outside the market areas. The calibrated models are used to predict how visitation would be impacted by various management options.

Once the models are calibrated, benefits can be calculated. The formulas given in the RRDM report are used to calculate benefits. The integration formulas require the maximum travel cost in the sample to be determined. Maximum travel cost values are $33.28 for the day-use sample and $43.04 for the camping sample (in 1980 dollars). Using the benefit calculation formulas, an average day-user benefit of $1.55 is produced ($2.47 in 1993 dollars). The average camper consumer surplus (economic benefit) is $7.39 ($11.79 in 1993 dollars). The total day-use consumer surplus provided by Clearwater Lake in 1993 (in 1993 dollars) is estimated as $2,687,600. The camping surplus is calculated as $873,200. The total benefits generated by Clearwater Lake in 1993 are estimated as $3,560,800. This benefit estimate is more than the annual benefits provided by Blue Mountain and Nimrod Lakes but less than the other six sites in the Little Rock District included in the RRDM analysis.

The three District pooled models were also applied to Clearwater Lake. In 1993 dollars, the average Clearwater day-user consumer surplus is estimated as $12.93. This value is about 10 percent higher than the day-user benefit using the Little Rock District model. For campers, the average per-user benefit is $2.09, which is about 15 percent less than the surplus from the Little Rock camping model. The total benefits using the pooled models are $958,100 for campers and $2,274,100 for day-users. The total benefit, $3,232,200, is about 9 percent less than total benefits estimated with the Little Rock District models.

The benefit estimates are close because of the similarity of the coefficients on travel cost in the models. That is, the coefficient or number (x) that the value of the travel cost or price is mathematically raised to (y^x or Travel Cost^x) is similar for the pooled and the Little Rock models. Results from the RRDM report indicate that transferred models perform best in the Little Rock District, since estimated price elasticities in the Little Rock District are in between those for the Nashville and Sacramento Districts. (Elasticity expresses the relationship or percent change in demand (or visitation) resulting from a change in price (travel cost).)

Applications

Two types of management applications are considered for Clearwater Lake. First, the recreational impact of increasing the lake size is explored. Second, use projections are made for the year 2000 using census forecasts.

The existing recreation pool size of the lake is 1,630 surface acres. Four larger lake sizes are considered:

- 2,730 acres (elevation 508 ft).
- 3,330 acres (elevation 514 ft).
- 3,850 acres (elevation 519 ft).
- 4,900 acres (elevation 529 ft).

The Little Rock District models are used to estimate visitation for each lake level. Baseline visitation is calibrated for 1993 levels. The value of SUR_ACRES is then successively changed from 1,630 acres to each higher value. The value of all other facility variables is assumed constant. This may necessitate moving some facilities that would be flooded by higher water levels. The cost of such actions is not considered here.

Table 1 presents the results of this analysis. Camping visitation is predicted to increase by a higher percentage than day-use visitation as a result of higher lake levels. Increasing lake size to 3,300 acres (about double the present recreation pool acreage) would increase total recreation benefits by about 11 percent. Increasing lake acreage by a factor of 3 would increase recreation benefits by about 18 percent. These values do not include any wildlife or aesthetic benefits that could be attributed to a larger lake.

Table 1.
Impact of Different Water Levels, Clearwater Lake Using 1993 Visitation as Baseline

	Surface Acres of Lake (Elevation in Parentheses)			
Impact	2,730 (508)	3,330 (514)	3,850 (519)	4,900 (529)
Additional day-use visitors	61,700 (+5.7%)	86,400 (+ 7.9%)	104,800 (+9.6%)	135,900 (+12.5%)
Additional camping visitors	11,500 (+15.5%)	16,400 (+22.1%)	20,200 (+27.3%)	26,800 (+36.2%)
Additional day-use benefit	$152,400	$213,400	$258,900	$335,700
Additional camping benefit	$135,600	$193,400	$238,200	$316,000
Total recreation benefit	$288,000 (+8.1%)	$406,800 (+11.4%)	$497,000 (+14.0%)	$651,700 (+18.3%)
Average value per acre-foot of water	$ 9.69	$ 8.50	$ 5.67	$ 6.01

Note: All dollar values are expressed as 1993 dollars.

The final row in Table 1 presents the average value per acre-foot of water over the relevant range. The dollar values are converted into per acre-foot values using the area-capacity table for Clearwater Lake. At 1,630 acres, the lake contains 21,920 acre-ft of water. Raising the lake level to 2,730 acres adds 29,710 acre-ft. The average value of water over the range from 1,630 surface acres to 2,730 acres is $9.69 (288,000 ÷ 29,710). At 3,330 surface acres the lake contains 69,770 acre-ft, an addition of 47,850 acre-ft over baseline. The average value per acre-foot is $8.50 (406,800 ÷ 47,850). As Table 1

illustrates, the dollar value per acre-foot of water generally declines as the lake level is further increased.

An interesting question is whether increasing lake size would create excess demand for facilities. Consider the example of camping sites. According to the NRMS data set, Clearwater Lake presently has 404 camp sites. Julia Smethurst of the Little Rock District has indicated that campsite use is 70 percent during the 3 summer months and is at carrying capacity during summer weekends. Assume that the average size of a camping group is three people and the average length of stay is 2.43 days (Jackson and Rogers 1990). Total camper carrying capacity for a 90-day summer period is

$$\{[(90 \div 2.43) * 3] * 404\} = 45{,}000 \text{ camper visitors}$$

If camping demand during the summer period is 70 percent of carrying capacity, then about 32,000 campers actually visit Clearwater Lake during a 90-day summer period. A total of about 13,000 more campers could be accommodated during the summer months.

Total camping visitation in 1993 is estimated to be 74,100. So, about 43 percent of annual camping use occurs during a 3-month summer period. Consider an increase in lake size to 4,900 surface acres. The RRDM predicts 26,800 additional camping visitors annually. Assume that 43 percent of these new visitors (11,500 visitors) come during the summer months. Note that existing camping demand allows for a maximum of 13,000 additional camping visitors. So, increasing lake size to 4,900 acres would increase summer usage of camp sites to about 97 percent of carrying capacity. From this analysis, it seems that additional campsites would help ease summer congestion if lake size were increased to 4,900 acres, especially during the weekends.

Performing the same analysis with a lake size of 3,300 acres, a total of about 7,000 new summer camping visitors would be predicted. This would increase summer usage to about 87 percent of carrying capacity. Additional campsites may also be warranted at this lake level. The input of an onsite resource manager could affirm the validity of the analysis. For example, a manager may be aware of the need for additional facilities. If excess demand exists for any facilities, an increase in lake size would only place further demands on these facilities.

One additional point should be mentioned. The coefficient on the size of lake in the Little Rock District model was estimated from a cross section of eight lakes in the District. Holding the facility levels constant, visitation tends to be higher at larger lakes. The validity of the model to predict the impact of adjusting the size of a single lake has not been established. The numbers presented in Table 1 still represent reasonable estimates with the available models and data.

The other simulation considered here is a forecast of visitation at Clearwater. Two factors are important in making such a forecast. First, the impact of changing demographics (such as increasing population) can be directly estimated using the RRDM since these are independent variables in the models. However, the RRDM does not account for trends in recreation demand. The RRDM is based on the public's visitation behavior during the visitor study years, 1983-1986. If overall visitation changes over time, then model forecasts may be inaccurate, especially if forecasts are

made far into the future. Recreation demand models that cover longer periods of time would provide insight into long-term demand trends.

Two forecast strategies are explored. First, the Little Rock RRDMs are used to forecast visitation for the years 2000, 2010, and 2020 based on population projections published by the Bureau of the Census (Campbell 1992). Using this report, demographic projections are made for the variables POPULATION, MINOR, and UNDER_18. Variables are updated based on projections for the state of Missouri since Clearwater is located in Missouri. County-level projections are not available in the census reports.

Using the Little Rock RRDMs, the visit projections are presented in Table 2. The problem with using the RRDMs for long-term visit forecasts is that the RRDM is based on cross-sectional data which do not account for any time trends, as explained above. Thus, overall trends in water-based recreation are not taken into consideration. The RRDM forecasts should be accurate if recreation behavior remains constant. Large shifts in recreation demand may limit the ability of the RRDM to produce accurate forecasts.

Table 2. Visitation Projections Using RRDM - Clearwater Lake

Year	Day-Use Visits	Camping Visits	Total Visits	Time Series Model[1]
2000	1,148,000	76,000	1,224,000	1,153,000
2010	1,240,000	80,000	1,320,000	1,502,000
2020	1,345,000	84,000	1,429,000	1,936,000

[1]See Figure 1 and text for a description of this model.

A time series analysis was attempted as another approach to long-term forecasting. Data were available on total visitation at Clearwater Lake from 1976 to the present from Diane Batson of the Little Rock District. The explanatory variables are Missouri population and a time trend variable (the year). The estimated model is presented in Figure 1. The R-square of the time series model is 0.44. The low t-statistics shown under the model in Figure 1 are likely the result of the high collinearity between Missouri population and year. Still, the average prediction of the model over the years 1976 to 1994 is in error by only 9 percent. The larger prediction errors may be caused by fluctuations in water levels, which are not included in the model. The time series model assumes that recreation trends over the past 20 years will continue. Obviously, any future unexpected trends are difficult to predict.

Figure 1 shows forecasts for 1995 through 2000, as well as for 2010 and 2020. These forecasts assume average water conditions at the lake. The last column in Table 2 compares the time series model predictions with those of the Little Rock RRDMs. The forecasts are similar (within 15 percent) for 2000 and 2010; however, the time series model prediction for 2020 is about 1.4 times the forecast using the RRDM.

Overall, both forecasts predict slight increases in visitation out to 2010 for Clearwater Lake under present conditions. The need for additional facilities to accommodate these visitors probably depends on the demand placed on present facilities. If present facility

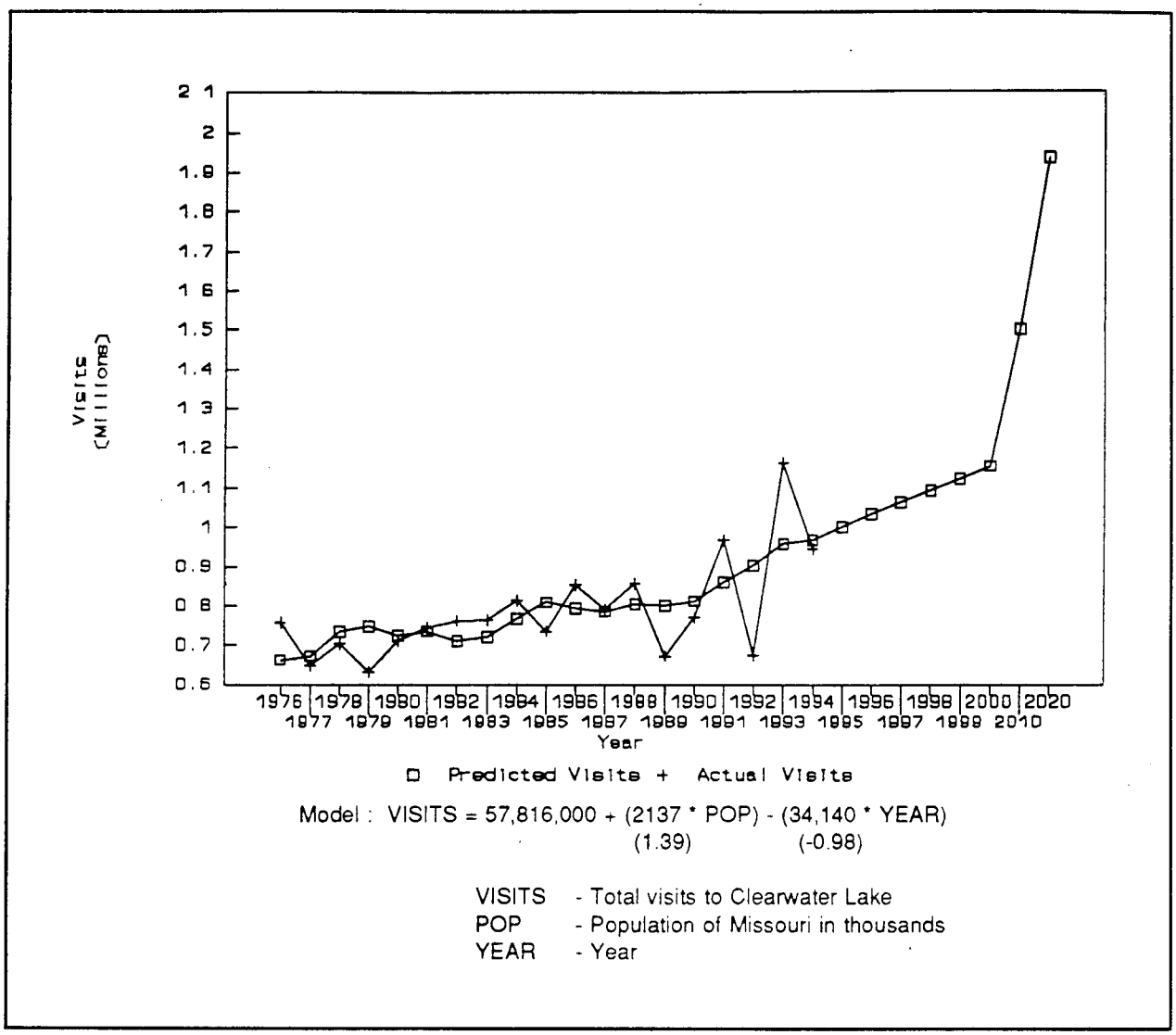

Figure 1. Predicted versus actual visits, Clearwater Lake

levels are sufficient to handle present visitors, then no new facilities may be needed. If the size of the lake is increased, additional facilities may be needed.

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Point of Contact

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