FORECASTING CHANGES IN SITE SPECIFIC RECREATION USE

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This paper reviews methods for forecasting recreation use at Bureau of Reclamation sites. The following general approaches are considered: time series analysis, extrapolation of use rates, use estimating models, carrying capacity approaches, market surveys, and informed judgement. No one method can adequately address all forecasting issues. The selection of approach depends on the planning question to be answered.

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September 1996

UNITED STATES DEPARTMENT OF THE INTERIOR ★ BUREAU OF RECLAMATION

BUREAU OF RECLAMATION MISSION STATEMENT

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.

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As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally-owned public lands and natural resources. This includes fostering wise use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. Administration.

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AUDIENCE

This paper is technical in nature. It is intended for use as a quick reference primarily by individuals interested in methods of forecasting changes in recreation use (i.e., economists, recreation planners). The executive summary provides an overview for those with a more casual interest in the subject.

EXECUTIVE SUMMARY

Recreation has become an important component of many Reclamation projects. Both water and land based recreational activities have contributed significantly to overall project benefits. Analysis of both current and future recreation use has become increasingly necessary within the context of Reclamation's planning process.

A distinction must be made between estimating recreation use and forecasting recreation use. For purposes of this paper, estimating recreation use involves gathering data on the current amount of use at an existing site. Forecasting use involves attempting to predict use levels into the future at either a new or existing site.

Forecasting the impact of Reclamation actions on recreation use is critical to both economics and recreation. Recreation analyses are important components of both the National Economic Development (NED) benefit-cost comparisons and the Regional Economic Development (RED) local impact analyses. Estimates and forecasts of use are necessary for recreation facilities/site planning, maintenance scheduling, visitor management, and operating cost/revenue evaluation.

The question is not whether to develop recreation forecasts, but how to develop the forecasts. As a result, the purpose of this paper is to review recreation use forecasting techniques in terms of their applicability to Reclamation sites.

Before one can begin selection of a recreation forecasting method, certain steps must be taken. First, one must decide on the most appropriate measure of recreation use, be it participation (number of visitors) or visitation (number of visits, days, etc.). The selection of the recreation use measure can have implications for the selection of a forecasting method.

After deciding on the recreation measure, one then must collect recreation use information—both current and historical use data can be invaluable. If use data are unavailable, and time and budgets permit, various approaches could be considered to estimate use at the site. The estimation approaches range from car counters, to entrance station or facility based head counts, to activity permit counts, to site sampling. Site sampling is the most complex approach and involves interviewing a subsample of site users. A well designed sampling approach can provide estimates of both participation and visitation. If use data are unavailable and time and budget constraints preclude recreation use estimation, forecasting options exist which do not require the availability of current or historical use information.

The forecasting approaches discussed in this paper have been categorized into data based and non-data based approaches. Data based approaches rely on the availability of detailed recreation use and recreator specific information for application of a wide range of often sophisticated mathematical and statistical forecasting procedures. The scope and quality of the input data can allow for the mathematical consideration of numerous relationships affecting recreation use. Non-data based approaches do not require the availability of current or historical use or recreator data. These approaches tend to be less complex than the data based approaches, although not always less accurate. One of the primary advantages of the data based approaches is that they often allow for statistical testing to validate the results. It is suggested that data based approach forecasts be tempered by expert judgement to further validate the results. The following table presents the various data based and non-data based forecasting methods discussed in this paper.

Table EX1. - Forecasting methods.

Data Based Approaches	Non-Data Based Approaches
A. Time Series Analysis	A. Carrying Capacity
B. Extrapolation of Use Rates	B. Market Survey
C. Site Specific Use Estimation Models	C. Informed Judgement
D. Regional Use Estimating Model	

Under the data based approaches, the **time series analyses** make use of both current and historical data to estimate trends or moving averages. These approaches are naive given they assume future growth follows historical growth patterns. As a result, these approaches are often limited to short term forecasting (less than 5 years).

Approaches based on **extrapolation of use rates** apply county specific visitation per capita estimates to forecast use. Population projections applied to these use rates provide forecasts of recreation use. This approach takes into consideration both distance from the site and population change.

The heart of the paper is the discussion of the **site specific use estimation models**. This section is the longest and most detailed in the paper. The section is subdivided into multiple site and single site use estimation modeling. Multiple site use estimating models allow for estimation of use across a series of interrelated sites within a geographic region. These models are especially adept at considering the influence of the important elements of site quality and site substitution within the forecast. Single site models can be used to develop forecasts for only one site; accounting for site quality and substitution is more difficult within these models.

The multiple site model section is further subdivided into individual and aggregate data models. Individual data models use information gathered from individual recreators and non-recreators. Data applied often include: 1) whether one participates at the site, 2) if so, how often in a given year, 3) distance to the site from home, etc. Aggregate data models use information which has been summed up to the site level. Data applied often include: 1) total site visitation broken down by county of origin, 2) distance to site from county population center, 3) socioeconomic characteristics by county, etc.

Individual data models are often analyzed in three stages - probability of participation, frequency of visitation, and site selection. The probability of participation model estimates the number of participants in a given recreational activity based on data from both participants and nonparticipants. The frequency of visitation model estimates the number of recreation trips taken annually by participants. The site selection model allocates the total number of trips across the various site options.

Aggregate data models can be used to estimate either number of participants or level of visitation. The popular zonal travel cost model is an aggregate data model used to estimate visitation.

The final data based approach discussed in the paper is the **regional use estimating model**. This model is comprised of two submodels—a trip generation model and a trip distribution (gravity) model. This aggregate data model first uses the trip generation submodel to forecast total recreation trips by activity within a geographic region. The trip distribution model is then used to allocate the trips between the various sites in the region. This approach is not emphasized in the paper because it tends to be less accurate than the site specific approaches.

Non-data based approaches do not involve use of mathematical or statistical modeling and consequently do not require extensive amounts of input data.

The **carrying capacity** approach restricts the growth in recreation use to the carrying capacity of the site. This is considered a non-data based approach because once the carrying capacity estimates have been developed, this approach does not require a significant quantity of input data. However, procedures used to actually develop the carrying capacity estimates can be complex.

Various carrying capacity measures exist: 1) facilities (capacity of boat ramps, swimming beaches, etc.), 2) resource or ecosystem (physical capacity of a reservoir or ecosystem), and 3) social (carrying capacity based on acceptable number of encounters, crowding). Carrying capacity approaches assume sufficient excess demand exists within the region to fully use the facilities or resources of the site. Because excess demand is a short term concept, long term forecasts are generally not developed using the carrying capacity approach.

Another non-data based short term forecasting approach involves the use of **market surveys**. These surveys sample within a given market area and ask about potential visitation patterns by activity for a fixed period of time, normally not beyond 1 year. Contingent behavior surveys, a site specific variant of the market survey, have developed in recent years to query site users about their potential visitation under varying conditions. These approaches are especially useful when attempting to forecast use under conditions dramatically different from those experienced in the past.

Informed judgement represents the last non-data based approach discussed in the paper. The approach involves tapping the expertise of knowledgeable individuals in the field. Involved procedures (e.g., Delphi techniques) can be used to develop a consensus from a group of experts. Expert judgement is often used in conjunction with another approach.

Given the wide range of possible recreation forecasting approaches, no one method is preferred in all situations. The most appropriate forecasting approach depends to some extent on the question being posed. See the conclusion for a discussion of linking forecasting approaches with planning questions.

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1.0 INTRODUCTION

Recreation has become an important component of many Reclamation projects. Both water based and associated land based recreation activities have contributed significantly to overall project benefits. Recreation analyses need to consider not only the traditional lake based activities of boating, swimming, and fishing, but also shoreline activities such as picnicking and camping, and in-stream activities such as anadromous fishing and rafting. Analyses of both the amount of recreation use and potential impacts on use have become an increasingly important part of Reclamation's planning process.

Accurate estimates and forecasts of the impact of Reclamation actions on recreation use have become critical to many planning studies. From an economics perspective, analyses of recreation are often important components of both National Economic Development (NED) benefit-cost comparisons and Regional Economic Development (RED) local impact analyses. From a recreation planning perspective, estimates and forecasts of use by activity are necessary for facilities/site planning and maintenance, visitor management, and operating cost/revenue estimation.

The question is not whether to develop recreation use forecasts, but how to develop the forecasts. As a result, the purpose of this paper is to review the multitude of forecasting techniques in terms of their applicability to forecast use at Reclamation sites.

The emphasis of this paper is on methods of forecasting site specific recreation use. Site specific forecasting as opposed to regional or national oriented forecasting is emphasized because Reclamation management activities generally influence use at the site level.[1]

This paper is divided into six sections: 1) Introduction, 2) Measures of Recreation Use, 3) Approaches to Estimating Recreation Use, 4) Approaches to Forecasting Recreation Use, 5) Conclusion, and 6) Bibliography. The fourth section, Approaches to Forecasting Recreation Use, is the heart of the paper. This section presents and critiques each of the forecasting methods.

[1] Many of the forecasting studies reviewed for this paper focus on the projection of regional or national participation or visitation. A regionally oriented model (e.g., one that estimates statewide visitation by activity) may be able to provide site specific estimates through use of a gravity model—a model which allocates visitation between sites based on distance and site quality. This trip allocation methodology is described but not emphasized in this paper. The combined regional and gravity model approach tends to be less effective at measuring site use as compared to the more site specific approaches.

2.0 MEASURES OF RECREATION USE

Because different recreation measures may be used to address different management objectives, no standard measure of recreation use has or will likely ever evolve. This section presents various measures of recreation use and how to convert between them (Walsh, 1986).

An individual's decision to recreate is often represented as a two step process: 1) deciding whether to participate, and 2) given one decides to participate, how often to visit over a given period of time. Therefore, a distinction must be made between the number of participants and their frequency of visitation. For our purposes, participation refers to the estimation of the number of users, whereas visitation refers to their frequency of use.

2.1 Participation

Number of users for a given period of time (e.g., users per year).

2.2 Time Based Visitation

- Recreation Day/Activity Day
- Recreation Visitor Day or Hour

2.2.1 Recreation Day/Activity Day

Recreation by one individual at a site for any portion of a 24-hour period. The approach is satisfactory for measuring the quantity of recreation in a single (or similar) activity, where the length of stay (hours per day) does not vary significantly between participants.

Problems:
1) Approach can result in double counting when measuring individual use for more than one activity during a single day.
2) Cannot compare estimates if length of stay (hours) varies significantly across users.
3) May not be a useful measure when applying the travel cost method because travel costs reflect a full trip and not a single day (unless the trip can be assumed to last only 1 day).[2]

2.2.2 Recreation Visitor Day (USDA Forest Service)

A recreation visitor day (RVD) represents 12 person hours of recreation. This activity could reflect 12 hours by 1 person, or 12 persons for 1 hour, or anywhere in between. The recreation can take place continuously or intermittently within the same 24-hour day or across time. This approach provides a good measure of recreational activity when individuals participate in greater than 1 activity per day for varying periods of time.

Problems:
1) Recreators perceive recreation as an occasion rather than a set period of time. From an economic valuation perspective, the amount of recreation use generally reflects the frequency of use as opposed to the duration of use. If 12 people visit a site for 1 hour, this would be counted as 12 recreation occasions and not one 12-hour RVD. Because recreation activities generally do not last 12 hours, the 12-hour RVDs may dramatically underestimate number of

[2] Travel cost method applies statistical approaches to estimate value per recreation trip as opposed to recreation day. A statistical model is estimated which predicts trips to a site as a function of travel costs and other variables. The basic premise is: as travel costs increase, trips tend to decrease, all else being equal.

recreation occasions. RVDs provide a good measure of facilities use for maintenance purposes, but not a good measure of the number of recreation occasions.

2) The same point applies to RVDs as to recreation days with regard to the application of travel cost model; travel costs reflect the entire trip and not a single day or hour of use.

2.3 Recreation Occasion Based Visitation: Recreation Visit or Trip

Recreation Visit (National Park Service): recreation by a single individual for any length of time. This measure is the same as a recreation trip when the individual visits only 1 recreation site during the visit. When the visits are of similar duration (single day or overnight/weekend), this measure provides the best use estimate for application of travel cost models.

Problems:
1) Measure becomes less effective when trips are of significantly different lengths of stay because value per visit is a function of length of stay. When comparing across sites or activities, this measure is often categorized by length of stay.
2) Problems also arise when individuals use more than 1 site on the same visit because travel costs must be apportioned between sites.[3]
3) Another problem arises when trips are taken for multiple purposes. For example, if an individual visits relatives and subsequently travels to a Reclamation reservoir to go fishing, then the travel costs associated with only the recreation purpose need to be identified. This task is often difficult.

2.4 Conversion Methods

The following simple formulas are used to convert between the various visitation measures:

1. RVDs to Recreation Days:

   $(\mathit{RVD}\text{s} \times 12) \div \mathit{average\ hours\ per\ day}$

2. Recreation Days to RVDs:

   $(\mathit{Recreation\ days} \times \mathit{average\ hours\ per\ day}) \div 12$

3. Recreation Visits (Trips) to Recreation Days:

   $\mathit{Visits} \times \mathit{average\ days\ per\ trip}$

4. Recreation Days to Recreation Visits (Trips):

   $\mathit{Recreation\ days} \div \mathit{average\ days\ per\ visit}$

5. Recreation Visits (Trips) to RVDs:

   $(\mathit{Visits} \times \mathit{average\ days\ per\ visit} \times \mathit{average\ hours\ per\ day}) \div 12$

[3] Various apportionment options exist, including allocating costs based on length of stay at each site (see Mendelson et al., 1992).

6. RVDs to Recreation Visits (Trips):

   $[(RVDs \times 12) \div average\ hours\ per\ day] \div average\ days\ per\ visit$

7. Visitation to Number of Participants:

   To convert from total visitation to number of participants, the analyst must know the average number of trips, days, etc. per participant per length of time (e.g., year). Total visitation could be divided by average visitation per participant per year to estimate the number of participants per year.

   Visits per year ÷ average visits per participant per year

3.0 APPROACHES TO ESTIMATING RECREATION USE

A distinction should be made between estimating and forecasting recreation use. Estimating recreation use involves determining current levels of use. Forecasting recreation use involves determining future levels of use, often based on changing management conditions. Although the primary purpose of this paper is a presentation of the various methods of forecasting recreation use, a brief discussion of the methods of use estimation is presented below.

Estimation approaches include car counters, entrance station vehicle and person counts, facility based head counts, use permits/fees, and sampling. The first four methods generally attempt to provide a census of users, although not necessarily by recreational activity. Sampling involves gathering data from a subsample of participants and aggregating this information into site totals.

3.1 Car Counters

Car counters are perhaps the most widely applied recreation use estimation method. This approach uses trip wires located at major access routes into and out of the site. Car count data are used to approximate the number of vehicles on-site. This information, combined with data on the average number of persons per vehicle, provides an estimate of total site visitation. Unless counters are placed at single activity access points, this approach generally provides no data on visitation by activity. Because the same individuals can be counted each time they visit the site, car counters estimate visitation and not number of participants.

The advantage of car counters is that they are inexpensive and easy to use. They involve minor maintenance and monitoring costs, and can record visitation 24 hours a day. For certain sites, when located properly, car counters can provide a reasonably accurate estimate of total visitation.

The car counter method also has its disadvantages. Should users exit and re-enter the site several times during the same visit, car count data would overstate visitation. Car count data are most accurate when a site has only one access point. With multiple access points, and especially when a major transit route crosses the site, the likelihood of vehicles passing through without using the site increases. Recreation use would be overestimated to the extent that passersby are included in the counts.

3.2 Entrance Station Vehicle and Person Counts

Entrance station vehicle and occupancy counts provide another method of estimating visitation. With this method, the entrance station attendant records information on both number of vehicles and persons per vehicle.

Should these data be considered a census of total visitation, the accuracy of the approach would depend on both the frequency the entrance station is staffed and the amount of use during the unmanned periods. For example, should the entrance station only be staffed on weekends, the accuracy of the overall visitation figures would be suspect, especially if a significant amount of use occurs on weekdays. In reality, entrance stations are often only staffed during peak use periods. Visitation estimates from such data should therefore be considered a lower bound.

Conceptually, entrance station data could also be evaluated as a sample. Ideally, entrance station data would be collected during both high and low use periods by season to provide estimates of visitation per day (weekday, weekend, holiday). The data could then be aggregated into estimates of total visitation.

Unmanned, mechanical, gated entrance stations provide another source of visitation information (and fees). The advantage of these systems is their constant recording; missing vehicles is not a problem. The disadvantage is the inability to record the number of vehicle occupants. Because the number of occupants per vehicle is fairly constant, this shortcoming is not a major obstacle to estimating visitation. These gated stations obtain similar data, enjoy similar advantages, and suffer similar disadvantages as car counters, although at a higher cost. The major advantage over car counters is in fee collection.

Another unmanned option is to use a fee collection station. Such stations provide users with site information while simultaneously collecting entrance fees. Because these stations are ungated, they tend to be fairly inexpensive. However, in addition to the initial placement costs, costs of payment monitoring must also be considered. These stations normally do not include trip wires, so visitation estimates are based on the number of paying customers. Payment monitoring becomes very important to ensure compliance and reasonably accurate visitation estimates. To the extent that some users may get away with not paying the fee, this approach could understate total visitation. In addition to providing for fee collection and visitation estimation, this system can be used to gather user data (e.g., primary activity, length of stay, zip code of origin, etc.) as part of the payment procedure.

3.3 Facility Based Head Counts

Head counts at specific facilities is another approach to estimating use. Like the car count and entrance station data, this method does not require personal interaction (surveys, permits, fee collection) between park personnel and the general public.

Head counts at specific facilities (swimming beaches, picnic areas, lake surface, etc.) provide the advantage of estimating amount of use by activity. Counts are generally made at different times of the day, and where necessary, from different vantage points.

The primary disadvantage of this approach is the potential for double counting of individuals. Because counts are made at various times during the day, double counting could occur for individuals whose length of stay at the same facility extends across two or more recording periods. When the facility is large (e.g., entire lake surface of many of Reclamation's reservoirs), head counts are often made from different locations. This procedure creates the potential for double counting as people move from one location to another within the same activity (e.g., boating). Double counting could also occur where individuals participate in more than one activity during the same visit (boating, fishing, and swimming activities could be counted separately). Recent attempts to address the double counting problem have made use of videotape procedures where enlarged pictures have been used to follow individuals across time and place.

3.4 Use Permits/Fees

Some recreational activities at certain sites require use permits/fees (e.g., developed camping, back-country camping, hiking, skiing, rafting). Fee receipts and permits often record size of party; which allows estimation of total visitation for that activity.

This approach has advantages over the car and entrance station counts because it is activity specific. Unfortunately, this information is normally only gathered for a limited number of activities at a given site. Therefore, this approach provides reasonably accurate but incomplete recreational use information by activity. Even if permit/fee data were obtained for all activities at a particular site, aggregation of visitation across activities would overstate total visitation to the extent that people participate in multiple activities on the same visit.

3.5 Sampling

Sampling involves interviewing a subsample of the total number of users. Activity specific estimates can be developed from the sample. A properly designed sampling approach can result in reasonably accurate estimates of both participation and visitation.

A critical part of the sampling approach is the sampling strategy and corresponding aggregation method. A sampling strategy needs to consider variation in recreation use during the year (seasonality), during the week (weekend, weekday, holiday), during the day (morning, afternoon, evening), and across locations (activity access points, participation areas, etc.). To aggregate up to total visitation or visitation by activity, a statistically valid aggregation approach must be devised. Therefore, both the sampling strategy and the aggregation approach should be developed with the help of a knowledgeable statistician.

2) Historical population estimates by county
3) Population projections by county over the forecast period

- Advantages:

1) Ease
2) Analytical time
3) Some explanatory power (population, distance, demographic factors)
4) Rates can be transferred to other similar sites
5) Short term (fixed rates) and long term (variable rates) forecasts

Disadvantages:

1) Requires forecast of population and demographic factors
2) Typically assumes the relationship between population, demographic factors, and visitation remains constant over time

4.1.2.1 Population Forecasts

The most basic use rate extrapolation approach is to forecast recreation use to grow with the regional population. In essence, this approach involves applying the current overall site visitation rate (total visitation divided by total market area population) to the growth in regional population. The accuracy of the approach depends on the geographic distribution of the site's market area. The more highly concentrated the user population about the site, the better the forecast. As a result, this approach normally limits the regional population to the county within which the site is located or perhaps adjacent counties.

Should the user population come primarily from the same county as the site, obtaining usage rates for neighboring counties may not be necessary. Conversely, should the user population stem from numerous counties, the limited regional population base assumption normally associated with this approach would fail to consider the impact of those more distant counties. Should the regional population be expanded to include the entire user population, this approach would still prove inadequate because it fails to consider the "gravity concept," where use tapers off with distance. With multiple counties in the user region, overall recreation use forecasts may be over- or understated given the variation in use between counties.

The approach is exclusively a forecasting tool. Current estimates of recreation use must be available for use as the forecast starting point. This approach is therefore only appropriate for existing sites with available use estimates.

- Data Needs:

1) Current estimates of recreation use
2) Appropriate population forecasts

- Advantages:

1) Ease
2) Analytical time
3) Long and short term forecasts

- Disadvantages:

1) One explanatory variable (population)
2) Requires forecast of population

3) Assumes the relationship between population and visitation remains constant over time
4) Fails to consider gravity concept
5) Only for existing sites with current use estimates

4.1.3 Site Specific Use Estimating Models

Use estimating models apply statistical regression techniques in an attempt to explain variation in recreation use at a given site or series of sites. These models can be used to forecast recreation use as a function of the various explanatory variables.[6] Because this approach uses multiple explanatory variables, it is preferred over trend extrapolation (no explanatory variables) and usage rates (typically one to two explanatory variables). Explanatory variables often include demographic and socioeconomic characteristics of the user market areas, availability of substitute opportunities (sites, activities, species), travel distance, and site quality factors.

Forecasts of recreation use can be developed by applying the model's regression coefficients[7] to updated estimates of the explanatory variables. Information on the explanatory variables must be forecasted over the study period and multiplied by the appropriate regression coefficients to forecast use. If the explanatory variable forecasts are based on simple historic trends, this approach becomes essentially equivalent to an elaborate trend analysis (Hof, 1979). Recreation forecasts become only as good as the explanatory variable projections, which may be just as difficult to project as the overall recreation measure.

The approach assumes that the regression coefficients estimated from the model also reflect the future relationship between use and the explanatory variables. In addition, the assumption is made that the number of explanatory variables does not change over time. Most models also assume a fixed relationship between recreation use and facilities—as use increases so will the supply of facilities. This assumption is unrealistic because it fails to account for carrying capacities of the sites. The accuracy of the overall forecast therefore becomes a function of the model's assumptions, coefficients, and explanatory variable forecasts.

- Advantages of Modeling in General:

  1) Accounts for more explanatory variables than any other approach, statistically based
  2) Can be transferred to other sites
  3) Allows long or short term forecasts

- Disadvantages of Modeling in General:

  1) More complicated than other approaches, requires more time, data, and technical expertise
  2) Requires forecasts for all explanatory variables
  3) Assumes the relationship between all explanatory variables and visitation remains constant over time
  4) Assumes the explanatory variables included in the model will adequately explain recreation use over time

A use estimating model could apply time series data (data collected over time), cross-sectional data (data collected across individuals or sites for a given time period), or a combination of both. The important requirement is to provide variation in both the dependent and independent variables. One would expect to see variation over time with time series data. Variation may or may not be observed with cross-sectional data. A variable like fish catch at a given site could vary considerably across individuals during the same time period. Conversely, a variable like reservoir size or water quality may not vary over a given period. However, variation

[6] Explanatory or independent variables are used in the statistical model to explain variation in the dependent variable (visitation).

[7] Regression coefficients are an output of the statistical estimation process. These coefficients show, in numerical terms, the relationship between each explanatory variable and the dependent variable.

in size of reservoir could be obtained with cross-sectional data by pooling data across sites. Cooper and Loomis (1990) suggest pooling cross-section and time series data to maximize variation and to account for parameter variation over time.

Use estimating models can be either single site or multiple site. Single site models allow for use estimation at only one site; whereas multiple site models allow for use estimation at multiple sites across a specified region. Table 4.2 illustrates the various multiple and single site modeling options presented in this paper.

Table 4.2. - Use estimating model options.

Multiple Site Models	
Individual Data Models	Aggregate Data Models
1. Individual Choice:	1. Total Participation
a. Probability of Participation	2. Total Visitation
b. Frequency of Visitation	3. Varying Parameter
c. Site Selection	4. System of Demand Equations
	5. Urban Daily Visitation
Single Site Models	
Individual Data Models	Aggregate Data Models
1. Individual Choice:	1. Total Participation
a. Probability of Participation	2. Total Visitation
b. Frequency of Visitation	3. Urban Daily Visitation

4.1.3.1 Multiple Site Models

Multiple site use estimating models apply data from a series of recreation sites. Such data often provide sufficient variation to allow for inclusion of both site quality and substitution variables within the model.

The sites included in the model are generally limited to those providing similar recreational activities. For example, a multi-site model for reservoir activities would not normally include downhill skiing sites. Economists justify this exclusion by assuming consumption of reservoir recreation is unaffected by downhill skiing opportunities (i.e., assumption of a weakly separable utility function). The result is that demand functions for reservoir recreation can be estimated without including all other goods and services competing for an individual's budget.[8]

The development of a multiple site model requires a definition of the study region. The region should be based on the geographic distribution of recreational opportunities and users rather than pre-established political boundaries.

[8] For Reclamation studies, in addition to ensuring that the sites provide similar recreational activities, we may also want to model similar sites based on type of site. For example, we may want to model reservoir, river, and ocean sites separately.

Defining the scope of the study region is often difficult. Should the region include a large multi-state area or only a small multi-county area? The answer depends on the size of the impacted area. Large scale studies, such as the re-operation of the Columbia River system, involve a huge area of impact and therefore require large multi-state models. Conversely, smaller scale studies such as the analysis of re-operation of the Red Bluff dam on the Sacramento River may only require a multi-county model. Statistical tests on individual parameters (Zeimer and Musser, 1979) or the overall equation (Kmenta, 1971) can be used to determine when removal of sites significantly reduces the explanatory power of the equation.

The size of the multi-site model may also impose certain advantages and disadvantages. For example, large scale models may be necessary to adequately incorporate substitution and site quality terms. However, an appropriately defined small scale model may provide more accurate visitation estimates at a particular site (Loomis et al., 1986).

4.1.3.1.1 Individual Versus Aggregate Data

Two basic types of data drive use estimating models—individual and aggregate. Individual data involve gathering specific visitation and explanatory variable information from individual recreators and perhaps non-recreators. Aggregate data reflect overall site visitation and variable information broken down by zone of origin.

Individual data are used in the estimation of a model known as the individual choice model. In this model, the decision to recreate involves a sequential, 3-step decision process: 1) whether or not to pursue the recreational activity (participation decision), 2) given one participates, how often to participate (frequency of visitation decision), and 3) given one participates, where to participate (site selection decision). These decisions often require separate equations—a probability of participation model to estimate number of participants, a frequency of visitation model to estimate amount of use per participant, and a site selection model to allocate the visitation to each site. Combining the results of these models provides an estimate of total visitation at each site.

The application of individual data creates some sampling issues which need to be considered in model estimation. The type of sample affects not only the model to be estimated but also the statistical estimation approach. Two basic types of samples are generally experienced in recreation—censored and truncated samples.

Data from a survey of the general population result in a censored sample because they provides information on both users (participants) and nonusers (non-participants). Censored samples occur when values of the dependent variable (e.g., trips) are bounded by zero. Given this data range, the ordinary least squares (OLS) assumption of a normally distributed error term about the regression line may not apply; therefore, statistical estimation using OLS may result in biased results. In practice, the degree of error depends on the mean and variation of visitation across the sample. The higher the average visitation and smaller the variation, the smaller the negative portion of the regression's error distribution and the less problematic would be the use of OLS. Looking at figure 4.1, the demand curve, D_0 (mean trips = 1), suffers more severely from censoring effects than does demand curve D_1 (mean trips = 5). When the negative portion of the error term distributions appear large, alternative procedures such as Tobit, Heckman, or Cragg can be used to adjust for the non-negativity characteristics within the visitation model. Without these adjustments, negative trips can be predicted.[9]

[9] The Tobit model uses information from both users and nonusers to ensure non-negativity. The model uses maximum likelihood estimation (MLE) as opposed to OLS. MLE attempts to estimate model parameters by maximizing the probability of observing sample values as opposed to minimizing the sum of the squared residuals about the regression line (OLS approach). By assuming the same factors explain both the participation and visitation decisions, the Tobit model accounts for both decisions in one step. The Heckman approach uses a two-step procedure where the participation decision is estimated using a Probit model (a 0,1 dependent variable model estimated with maximum likelihood). From the Probit model, an inverse Mills ratio is obtained, which is then used as an independent variable (inclusive value) in the frequency model. The frequency model can then be estimated with OLS procedures. This linked estimation procedure allows for different variables to be included in the two

Data from an on-site survey normally result in a truncated sample because they provide information only from site users. Truncated samples occur when values of the dependent variable are bounded by one. This truncating occurs in on-site samples because recreators have taken at least 1 trip at the sampled site. As with the censored sample corrections, the truncated sample also implies special econometric treatment (maximum likelihood truncated normal regressions). Note that censored data can be easily converted into truncated data by removing the nonusers (annual trips = 0) from the sample.

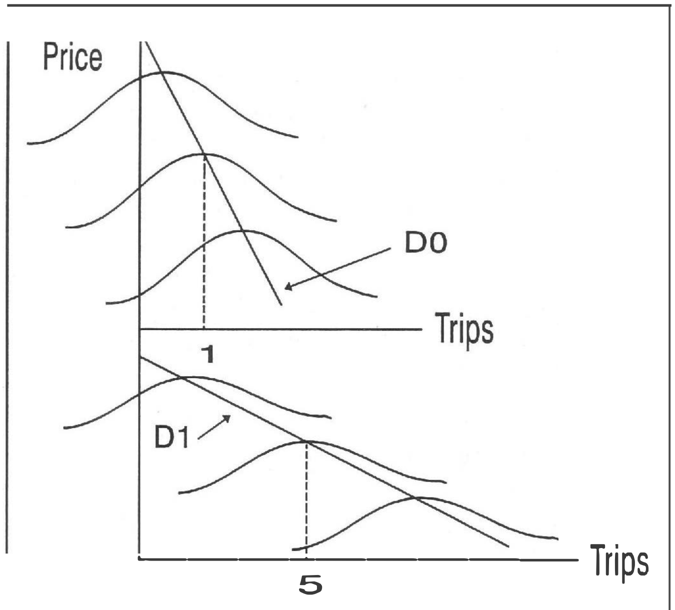

Figure 4.1. - Truncated error terms.

With an on-site data set, the participation decision cannot be modeled. The frequency decision could be estimated using a truncated normal procedure; however, an estimate of the number of users would still be required for aggregation.

If the on-site survey is conducted across several sites, the lower bound for trips would be zero at each site because the users would likely not visit all the sites in the region. In this case, the sample becomes censored with respect to the frequency of visitation decision. The overall participation decision (i.e., whether or not to become a water based recreator) still cannot be estimated because everyone in the sample is already a recreator. However, a conditional probability of participation at a given site can be estimated using multinomial logit or probit procedures[10] to reflect the probability of selecting the site given one is already a recreator (see site selection model). The frequency model would again require use of the Tobit, Heckman, or Cragg procedures given the censored data set.

Another characteristic of on-site samples is avidity bias. Avidity biased (or endogenously stratified) samples result when the probability of being sampled varies based on the number of annual trips. On-site samples suffer from this problem given the greater the number of annual trips an individual takes, the higher one's probability of being sampled. Avidity bias is normally corrected by using weighting techniques as opposed to statistical procedures. A general population survey of users only (e.g., one obtained from a list of license holders) or of users and nonusers would not suffer from avidity bias.

An issue of relatively recent interest relates to the integer nature of the individual's frequency decision. The participation and site selection decisions are yes/no in nature (0/1 dependent variables handled with logit/probit techniques) and result in probabilities ranging from 0 to 1. The individual's frequency of visitation decision requires that trips be estimated as an integer (individuals cannot take fractional trips). When summing over the sample, the visitation for the average individual is not integer constrained and fractional trips may legitimately result. To address the integer issue, count data models have evolved (see the count data modeling section under the individual's frequency of visitation model).

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decision steps. The Cragg approach uses a similar two-step procedure, except the frequency equation is conditional on a positive response in the participation equation (for further discussion, see Bockstael et al., 1990).

[10] Multinomial logit and probit are maximum likelihood procedures which are applied when the desired output of the model is a probability. The values of the dependent variable are restricted to 0 or 1, where 0 reflects nonparticipation and 1 reflects participation. The difference between the two methods relates to the cumulative density function used (logistic versus normal), however as sample sizes increase, the difference between the approaches becomes minimal.

Alternatively, visitation models could be developed using aggregate data (data collected by zone or county). Levels of visitation are estimated for each zone on a per capita basis. As a result, both the participation and frequency of visitation issues are handled simultaneously. Theoretically, the possibility of a zero lower bound in zonal visitation implies the need to account for non-negativity through use of the Tobit, Heckman, or Cragg procedures. In practice, OLS procedures are still widely used. Avidity bias and integer requirements associated with individual data do not normally apply to aggregate data.

Although aggregate data do have some ease of modeling advantages over individual data (i.e., often can apply less sophisticated approaches), researchers still prefer to use individual data when available. Individual data often allow for more modeling flexibility by providing considerable variation across the sample data. Aggregate data require use of zonal or county averages for distance and socioeconomic variables. The use of such averages can create problems, the most obvious of which is the failure to account for variation within the zones.

4.1.3.1.2 Individual Data Models

The following list describes the subscripts used in model presentation throughout this section:

	= individual
j	= site
$\sum j$	= summed across a series of sites
a	= activity

Combinations of subscripts are used as follows:

ia	= individual i in activity a
ij	= individual i at site j
iaj	= individual i in activity a at site j
ia or *iaj*	= individual i in activity a <u>or</u> individual i in activity a at site j

Individual Choice Model: The individual choice model is designed to use either two or three modeling components: 1) the two-component model analyzes participation and frequency of visitation decisions, or 2) the three-component model analyzes participation, frequency of visitation, and site selection decisions.

- Data Needs: defined via the discussion of the variables.

- Advantages of the individual choice model:

  1) Provides a defined model of individual choice
  2) Uses individual data as opposed to zonal data

- Disadvantages of the individual choice model:

  1) Requires multiple equations
  2) Requires sophisticated econometrics
  3) Requires a detailed data set, normally obtained via general population and on-site surveys

4.1.3.1.2.1 Individual's Probability of Participation Model

This model uses cross-sectional and sometimes time series data to estimate an average individual's probability of participation in a given recreational activity or in a given activity at a given site. The average probability of participation is multiplied by the population estimate across the sampled market area to calculate number of participants. Projections of probabilities of participation, based on changing site quality characteristics, can be used along with population projections to forecast participation.

The cross-sectional model uses variation across sites and individuals for estimation. The model calculates site participation with values for the explanatory variables relevant to each study site. The time series model may use information from the study site exclusively. To provide the necessary variation in the quality variable, participation information is gathered across individuals over time.

This approach requires a survey of the general population, where survey respondents include both participants and nonparticipants.[11]

$$\textit{Probability of Participation}_{ia\ or\ iaj} = \beta_0 + \beta_1\ TC_{ij} + \beta_2\ SQ_{ij\ or\ j} + \beta_3\ SUB_{ij} + \beta_4\ SOC_i + \beta_5\ COE_{iaj}$$

Individual $= 1,\dots,n$
Site j $= 1,\dots,m$
Activity a $= 1,\dots,o$

where:

Dependent variable	=	0 if nonparticipant, 1 if participant (statistical estimation via limited dependent variable model—e.g., logit, probit)

Independent variables:

travel cost (*TC*)	=	out-of-pocket costs of travel and time costs of travel for individual *i* to site *j*
site quality (*SQ*)	=	site characteristics, possibly including catch rates, water quality, water quantity and flow, etc. for individual *i* at site *j*. • catch rates should vary across individuals at same site in a given year • water quality/quantity information may not vary across individuals at the same site, but could vary across time or between sites
substitutes (*SUB*)	=	gather same information as for site quality plus distance from residence to all regional sites or to the closest substitute site
socioeconomics (*SOC*)	=	characteristics such as income/education, age, ethnic background, family size/number of children, vacation home ownership, etc. for individual *i*
cost of equipment (*COE*)	=	cost of recreational equipment and licenses/permits needed to participate in the activity for individual *i* at site *j*

When defining the model by activity and site, the site subscript pertains to the focus site. When the model relates only to the activity, site information may still be important, but requires definition. Normally, the site information in this case is based on the closest site or average site across the region.

An extension of this model suggests the use of a simultaneous system of participation models across different recreational activities (Caswell and McConnell, 1980; Hay and McConnell, 1984). Those authors suggest that the models should be estimated simultaneously to account for interrelated participation behavior across activities (e.g., an individual who boats has an increased probability of fishing).

[11] Should the objective be to model the number of recreators at a site which has been degraded, one would need to sample only at the study site because the reduced site quality would presumably only affect current users. Conversely, at an improved site, one could sample at substitute sites under the assumption that recreators of those sites may be willing to increase their use of the study site after the quality has been improved (Ribaudo and Epp, 1984). This method fails to consider the possibility that the site improvement may attract previous non-participants to the activity (normally an infrequent occurrence).

4.1.3.1.2.2 Individual's Frequency of Visitation Model

The individual frequency of visitation model is designed to estimate trips per participant for a particular site or across a series of sites within a region. Therefore, this model can be defined by site or region. The model must be linked with a probability of participation model to estimate total visitation.

The individual visitation model is normally designed with trips per participant at the study site as the dependent variable. Other specifications often pool data across sites so the dependent variable becomes either the sum of visits across all sites, the number of visits to the typical site, or the number of visits separated by site (Kling, 1986).

Data for this model are gathered from participants, normally from an on-site survey. A number of econometric/statistical corrections within the modeling process may be appropriate (i.e., integer, truncation, and avidity bias corrections) because of the nature of the dependent variable and the application of on-site sample data.

$$Trips/Participant_{ij \text{ or } \Sigma j} = \beta_0 + \beta_1\, TC_{ij} + \beta_2\, SQ_{ij \text{ or } j} + \beta_3\, SUB_{ij \text{ or } j} + \beta_4\, SOC_i$$

Individual $i = 1,...,n$
Site $j = 1,...,m$

where:

Dependent variable	number of annual trips to site or across sites within the region per participant (trips ≥ 1, truncated estimation model: truncated normal, Heckman, or Cragg)

Independent variables:

travel cost (*TC*)	=	out-of-pocket costs of travel and time costs of travel for individual *i* to site *j*
site quality (*SQ*)	=	site characteristics, possibly including catch rates, water quality, water quantity and flow, etc. for individual *i* at site *j* (catch rates will vary by individual at the same site, other characteristics such as water quality would not vary by individual at the same site, need variation over time or across sites)
substitutes (*SUB*)	=	site characteristics and distance to other sites in the region
socioeconomics (*SOC*)	=	characteristics such as income, age for individual *i*

When the model is designed to estimate visitation at multiple sites across a region, the site subscript can refer to the closest site, the average site, the favorite site, or some other designation.

Count Data Model:

An individual's number of trips per site or across all sites are constrained to non-negative integers (i.e., 0,1,2...). Use of the censored or truncated normal distributions (Tobit or Truncated models) precludes estimation of a negative number of trips but not fractional trips. Improvements in the accuracy of the trip estimates often result from further constraining the trip frequency model's output to non-negative integers.

Count data models are trip frequency models which restrict trip estimates to non-negative integers. The Poisson distribution is a popular non-negative integer distribution which assumes equality of the mean and variance. Should this mean-variance equality assumption prove invalid (e.g., if variance exceeds the mean, called overdispersion), a negative binomial distribution may be appropriate. Overdispersion can result in biased and inconsistent estimators. Tests for overdispersion are fairly simple and could be routinely applied (Gomez and Ozuna, 1993).

ε_{ik} = the unobservable, random utility component from visiting all other sites k

The most common approach to estimating these site selection probabilities involves use of a multinomial logit (MNL) model estimated using maximum likelihood techniques. The probabilities can be expressed using the following formula for individual i to site j. The numerator reflects the utility associated with site j and the denominator the utility for all other sites:

$$Probability_{ij} = \frac{\exp^{B_0 + B_1TC_{ij} + B_2SQ_{ij\ or\ j}}}{\sum_{k=1}^{j} \exp^{B_0 + B_1TC_{ij} + B_2SQ_{ij\ or\ j}}}$$

Individual $i = 1,...,n$
Site $j = 1,...,m$

exp = exponential function, base e(see footnote below)[12]

where:

Dependent variable = 0 if nonparticipant, 1 if participant (statistical estimation via limited dependent variable model—multinomial logit)

Independent variables:

travel cost (*TC*) out-of-pocket costs of travel and time costs of travel for individual i to site j
site quality (*SQ*) = site characteristics, possibly including catch rates, water quality, water quantity and flow, etc. for individual i at site j (catch rates will vary by individual at the same site, other characteristics such as water quality would not vary by individual at the same site, need variation over time or sites)

Individual socioeconomic characteristics are not included in the model. For a given individual, socioeconomic characteristics do not vary and therefore do not aid in the explanation of an individual's site choice. However, socioeconomic characteristics are often used to segment the data so separate models can be estimated for distinct population groups (Stynes and Peterson, 1984). Also note that a specific site substitution variable is not included in the model. The model accounts for substitution by comparing the desirability between sites as represented by the denominator of the equation.

A recent extension of this model incorporates prior trips to the various sites as an explanatory variable. A prior trips variable with a positive sign indicates habit forming behavior. A prior trips variable with a negative sign indicates variety seeking behavior. This dynamic aspect has been shown to improve the predictive power of the model, an ongoing problem with recreation demand models (Adamowicz, 1994). However, inclusion of the prior trips variable creates some econometric and specification problems which are difficult to remedy (McConnell et al., 1990). Habit forming behavior can also be modeled using such variables as the number of years using the site and equipment purchases (e.g., boats).

Because variables included in the probability function include both travel costs and site quality, two variables used to help define site substitution, these models have proven especially attractive when attempting to estimate complicated substitution effects.

[12] e is a nonrepeating irrational number (2.718...) which reflects a frequently occurring exponential growth value.

An assumption of the MNL model is that the error terms are independently and identically distributed (McFadden, 1973). A feature of assuming independence of the error terms is called the independence of irrelevant alternatives (IIA) property.

The IIA property means the ratio of choice probabilities between pairs of sites is independent of the existence or attributes of other sites. Alternatively stated—choices between two sites are made without considering other sites. This statement implies that the probability ratios remain constant when new sites are added to the choice set. The advantage of this property is that new choice alternatives can be added without re-estimating the model (Stynes and Peterson, 1984). The disadvantage is that it fails to allow for dependency between sites (Peterson et al., 1983). When adding another site to the choice set, this property results in the new site drawing proportionally from all other sites.[13] This property may be overly restrictive resulting in illogical behavioral choices.

To avoid this property, nested multinomial logit models have been applied. The nested model uses a decision tree format where certain choices are conditioned on previous choices (e.g., assume one first chooses reservoir recreation over river recreation, the second decision becomes a conditional choice between reservoir sites exclusively). As a result, only similar types of sites are affected by the addition of a new site, as opposed to proportionally drawing from all possible sites. Although the lower level decision is conditioned upon the upper level decision, the upper decision is made in anticipation of the utility associated with lower level options.

```
                                                          Decision
                                                            Level
                    Water Based       Land Based
                    Activities        Activities.......     .. 1

       Lake/Reservoir   River    Ocean...................... 2

 Site 1   2   3   4   5..................................... 3
```

Figure 4.2. - Illustration of decision levels.

The various levels of the overall decision process, as illustrated on figure 4.2, are modeled sequentially, often linked using inclusive values (see Jones and Stokes Associates, 1987; Milon, 1988). Inclusive values are explanatory variables which incorporate information and anticipated utility from the lower level choice options directly into the upper level decision model. For example, when modeling the choice between site type (reservoir, river, ocean), inclusive values incorporate information from the various site selection options associated with each site type.

The nested multinomial logit model provides for a more complete accounting of the range of substitution and site quality effects, while simultaneously allowing for an individual's nonparticipation at certain sites (i.e., corner solutions). The nested model, although an improvement, still suffers from decision process questions (what is the sequence of decisions, how should the tree be structured), estimation difficulties, and choice occasion estimation requirements.

[13] Proportional redistribution can be problematic as illustrated by the classic red bus-blue bus problem from the transportation literature. Assume individuals have the option to commute to work by auto, bus, or train. Say we paint half of the buses blue to differentiate them from their original red color. We would expect only the bus users to redistribute between the two color buses. The IIA property would imply a reallocation of trips from all modes, not just the bus mode.

- Advantages of site selection model:

    1) Provides a good format for handling substitution
    2) Consistent with economic theory (utility theoretic)
    3) Handles both corner (zero trips to site) and interior solutions (positive trips to site)

- Disadvantages of site selection model:

    1) Very data intensive
    2) Requires sophisticated econometrics
    3) Assumes independent trip occasions
    4) Requires surveys of individuals behavior

4.1.3.1.3 Aggregate Data Models

4.1.3.1.3.1 Aggregate Total Participation Model

The aggregate model uses grouped participation information by activity and site, separated by a site's market area origin zones, to estimate the average participation by zone. Multiplying these zonal per capita participation rates by the zonal populations provide estimates of the total number of recreators by activity at the study site. This approach is an extension of the extrapolation of participation rate approach, the difference being the participation rates are actually modeled. This approach allows one to forecast changes in participation rates based on changes in the explanatory variables.

$$\textit{Participants/Population}_{iaj} = \beta_0 + \beta_1\, TC_{ij} + \beta_2\, SQ_j + \beta_3\, SOC_i + \beta_4\, COE_{aj}$$

Zone		$= 1,\ldots,n$
Site	j	$= 1,\ldots,m$
Activity	a	$= 1,\ldots,o$

where:

Dependent variable	=	number of participants in activity a at site j from zone i

Independent variables:

travel cost (TC)	=	average out-of-pocket costs of travel and time from zone i to site j
site quality (SQ)	=	site characteristics, possibly including average catch rates, water quality, water quantity and flow, etc. at site j (because site quality will not vary for each zone at a given site, data are required across sites or time to provide the necessary variation)
substitutes (SUB)	=	gather same information as for site quality plus distance from zone to the closest substitute site
socioeconomics (SOC)	=	characteristics such as income, age, ethnic background, etc. for zone i
cost of equipment (COE)	=	average cost of recreational equipment and licenses/permits needed to participate in the activity a at site j (variation across sites or time)

- Advantages:

    1) Simplicity
    2) OLS estimation
    3) Surveys not required to gather data, makes use of readily available visitation records

- Disadvantages:

  1) Uses aggregated data (excludes individual characteristics)
  2) Provides only participation and not visitation information

4.1.3.1.3.2 Aggregate Total Visitation Model

Model estimates trips by site.

The aggregate total visitation model represents the traditional zonal travel cost model (ZTCM). The ZTCM is developed in two stages: 1) estimate the per capita demand curve, and 2) calculate the site demand curve from the per capita curve. Because the second stage site demand curve is used to calculate recreation benefits[14], our focus from the perspective of visitation estimation will be on the first stage curve.

To estimate the per capita demand curve, data are gathered on visitation by zone (zip code, county, concentric ring/group of counties, state) to each site within the specified region. These data represent the dependent variable in the model. Data are also gathered on quality by site and various other factors by zone (distance or travel cost, substitute sites, and socio-economic factors). By incorporating data across all sites in the region, this single equation model can be used to estimate visitation at any of the sites. The model may be set up as follows:

$$Trips/Population_{ij} = \beta_0 + \beta_1\, TC_{ij} + \beta_2\, SQ_j + \beta_3\, SUB_{ij} + \beta_4\, SOC_i$$

Zone $i = 1,\ldots,n$
Site $j = 1,\ldots,m$

where:

Dependent variable	=	number of trips or trips per capita to site by zone each year (researchers often use natural log of trips per capita to avoid predicting negative trips and to reduce problems of unequal variance [heteroscedasticity])

Independent variables:

travel cost (*TC*)	=	out-of-pocket costs of travel and time costs of travel from zone i to site j
site quality (*SQ*)	=	site characteristics, possibly including catch rates, water quality, water quantity and flow, etc. for site j (variation created by pooling sites or gathering time series data).
substitutes (*SUB*)	=	site characteristics and distance to other sites in the region (site and zone specific)
socioeconomics (*SOC*)		population characteristics such as income and age for zone i

Forecasts are developed by projecting values for each of the per capita demand curve's explanatory variables and multiplying those values by the model's coefficients to estimate trips per capita for that year. Projected zonal populations for those same years are multiplied by the appropriate trips per capita to estimate trips per zone. Aggregating across zones provides an estimate of the total trips to the site for that year.

[14] In the second stage (site demand curve), the coefficients from the per capita curve are used to estimate each zone's demand for trips to the focus site with increasing distance. Data gathered on visitation to the site across all zones reflect current demand based on current travel costs. This visitation figure reflects one point on the site demand curve. The rest of the curve is mapped out by calculating visitation by zone as prices are increased until visitation from all zones goes to zero (choke price). The area under the site demand curve represents recreation benefits (i.e., consumer surplus).

Instead of requiring two separate models as in the individual choice model, the ZTCM simultaneously includes both probability of participation and frequency of participation components by using trips per capita as the dependent variable. The trips per capita from zone i to site j can be expressed as follows:

$$\frac{Trips_{ij}}{Population_{ij}} = \frac{Number\ Trips_{ij}}{Number\ Recreators_{ij}} \times \frac{Number\ Recreators_{ij}}{Population_{ij}}$$

$$\text{(Trips per Capita)} = \text{(Frequency of Participation)} \times \text{(Probability of Participation)}$$

Finally, despite the aggregation problems associated with using data based on zonal averages, the traditional ZTCM handles the sampling biases of censoring, truncation, and endogenous stratification/avidity bias rather well (Hellerstein, 1992). However, integer estimation is still attractive even when using aggregated data. Based on the work by Hellerstein, count data models using both the Poisson and Negative Binomial approaches outperformed the ZTCM OLS models.

Although traditionally this model uses cross-sectional aggregated data, it can also be estimated with time series data. Time series data have the advantage of potentially providing variation in the site quality variable without pooling data across sites. Loomis and Cooper (1990) warn that site quality coefficients within a pooled site model may vary significantly from those based on a single site time series model. Loomis and Cooper preferred the single site time series model and strongly suggested using lagged quality variables to test for habit forming behavior.

- Advantages:

  1) Single equation
  2) Accounts for both participation and frequency decisions
  3) Estimated using OLS/WLS procedures
  4) Less data intensive than individual model
  5) Data are often available from visitor records without use of a survey

- Disadvantages:

  1) Individual characteristics lost in zonal aggregates
  2) Weighting may be necessary with zones of unequal populations
  3) Greater probability of multicollinearity in grouped data— travel time variables are sometimes discarded, leading to potential omitted variable biases (combined travel cost and travel time variables have been conceived)
  4) Inadequate handling of multiple site and purpose trips (bias correction procedures are described in Haspel and Johnson, 1982)
  5) Cannot handle urban sites (lack of variation in travel cost)
  6) Model may be statistically difficult to estimate if the number of visitation origin zones is low in relation to the number of explanatory variables (low degrees of freedom)

4.1.3.1.3.3 Varying Parameter Model

The varying parameter model (Vaughan and Russell, 1982) represents an extension of the original multiple site travel cost model. Each site's quality variables affect both the intercept and slope of the demand equation. With one equation, a unique demand curve can be developed for each site.

$$Trips/Population_{ij} = \beta_0 + \beta_1\ (\beta_0 \times SQ_j) + \beta_2\ TC_{ij} + \beta_3\ (TC_{ij} \times SQ_j) + \beta_4\ SOC_i + \beta_5\ (SOC_i \times SQ_j) + \ldots$$

Zone $i = 1,...,n$
Site $j = 1,...,m$

where:

Dependent variable		number of trips to site by zone each year

Independent variables:

travel cost (TC)	=	out-of-pocket costs of travel and time costs of travel from zone i to site j
site quality (SQ)	=	site characteristics, possibly including catch rates, water quality, water quantity and flow, etc. for site j (variation created by pooling sites or gathering time series data).
socioeconomics (SOC)	=	population characteristics such as income and age for zone i

The above specification reflects the full interaction model where site quality affects all model parameters (intercept shifter and line pivot). An alternative specification of the model assumes that site quality acts mainly as an intercept shifter and ignores the pivoting effect of the other interactive terms (Loomis et al., 1986).

The model collapses into the above expression and can be estimated as a single equation using pooled site data. Conversely, the estimation is often developed in two steps: 1) regress trips by site onto site prices and income (one regression per site), and 2) regress the own-price coefficients from the first round of regressions on the quality characteristics of the sites. The first model has to account for the censored nature of the sample (Tobit model); the second model requires a generalized (weighted) least squares estimation to account for the fact that parameter estimates are used instead of the true parameters (Bockstael et. al, 1988).

Number of site visits is estimated as a function of own site characteristics but not other site characteristics (Kling, 1987). As a result, regardless of the estimation procedure, the model does not appear to handle substitution.

- Advantages:

  1) Incorporates site quality in a useful way
  2) Less data intensive than system of demand equations and discrete choice modeling approaches

- Disadvantages:

  1) Requires observations across time at each site or across sites
  2) Visitation and site quality variables must be consistently measured and collected at sites in the model.
  3) Substitution effects are not incorporated.

4.1.3.1.3.4 System of Demand Equations

A demand equation is estimated for each of the sites in the region. The equation for each site includes not only an own-price term but also cross-price terms from each of the sites in the region. The model can be estimated using Zellner's seemingly unrelated regression model or King's seemingly unrelated Poisson model (for more discussion of estimation approaches, see Ozuna and Gomez, 1994).

$$V_{i1}/P_i = \beta_{01} + \underbrace{\beta_{11}\, TC_{i1}}_{\text{(own price site 1)}} + \beta_{21}\, SOC_i + \underbrace{\beta_{31}\, TC_{i2} + \ldots + \beta_{j-1,1}\, TC_{ij}}_{\text{(cross price sites 2-}j\text{.......)}}$$

$$+ \underbrace{\beta_{1j}\, TC_{i1}}_{\text{(cross price site 1)}} + \beta_{2j}\, SOC_i + \underbrace{\beta_{3j}\, TC_{i2}}_{\text{(cross price... sites 2-(}j\text{-1))}} + \ldots + \underbrace{\beta_{j-1,j}\, TC_{ij}}_{\text{(own price site }j\text{)}}$$

Zone $i = 1,...,n$
Site $j = 1,...,m$

where:

Dependent variable = number of trips to site by zone each year

Independent variables:

travel cost (*TC*) = out-of-pocket costs of travel and time costs of travel from zone *i* to site *j*
socioeconomics (*SOC*) = population characteristics such as income and age for zone *i*

Of particular interest when developing estimates of recreation use as a result of a Reclamation action is the impact on substitutes (sites, activities, species, etc.). Accounting for substitution is important in developing an impact analysis because substitution of recreation use from one site or activity to another may offset loses or gains at the study site.

This model accounts for substitution with all the cross price terms. However, the substitution effect is measured purely in terms of travel distance; no consideration is given to site quality effects. Site quality normally cannot be incorporated unless time series data are available because quality would not vary across zones for the same year at the same site. As a result, this model is difficult to apply when changes in site quality are driving the change in use.

An early application of this model (Burt and Brewer, 1971) suggests modeling sites grouped by similar categories (homogeneous sites). For example, the authors focused on water based sites. The sites were further separated by size, with a model developed for each site size, using the other sized sites as substitutes.

- Advantages:

  1) Handles site substitution well

- Disadvantages:

  1) Data intensive
  2) Does not handle site quality effects well
  3) Complex modeling

4.1.3.1.3.5 Urban Daily Visitation Model

Models which attempt to address visitation to urban sites generally do not include travel costs as an explanatory variable because such costs do not vary greatly across site users. Daily visitation models have evolved to address urban visitation. Such models aggregate daily use to estimate annual visitation. Variables which are used to explain variation in daily use over time include population within the area, weather, day of the week, and season (Dwyer, 1988). Such models can include site characteristics across multiple sites to allow for site substitution.

$$Daily\ Use_{jt} = \beta_0 + \beta_1\ POP_{jt} + \beta_2\ TEMP_{jt} + \beta_3\ DAY + \beta_4\ MONTH + \beta_5\ SQ_{jt} + \beta_6\ SUBS_{jt}$$

Site $j = 1,...,n$
Year $t = 1,...,m$

where:

Dependent variable		=	number of people visiting site each day each year

Independent variables:

population	(*POP*)	=	population by site within access area
temperature	(*TEMP*)	=	weather conditions by site
day of week	(*DAY*)	=	day of week
month	(*MONTH*)	=	month (reflects seasonality)
site quality	(*SQ*)	=	site quality characteristics
substitution	(*SUBS*)	=	site quality characteristics of other sites within access area

- Advantages of the urban daily visitation model:

  1) Provides a method for estimating use at an urban site
  2) Uses readily available aggregate data

- Disadvantages of the urban daily visitation model:

  1) Does not include travel cost variable; therefore, cannot be used to value recreation use
  2) Not appropriate for sites outside an urban setting

4.1.3.2 Single Site Models

Single site models apply data from one site for model estimation. Defining the impacts on or from other regional sites may be more difficult within this model. Variation in site quality characteristics may be missing unless time series data are available or characteristics vary across individuals. Should site quality and substitution variables be included, many authors believe the single site model can be quite practical and useful (Loomis et al., 1986).

Normally, multiple site models are preferred except in cases where the study site is unique or provides different recreational activities compared to other sites in the region.

The single site models will involve many of the same types of models as found under the multiple site section with some exceptions. For individual data, the individual choice model could again be used except the site selection component would not be necessary. With aggregate data, the varying parameter and system of demand equation models would not be relevant because the focus is on a single site.

$$Trips/Population_{i1} = \beta_0 + \beta_1\, TC_{i1} + \beta_2\, SQ_{i \text{ or } t} + \beta_3\, SUB_{ij} + \beta_4\, SOC_i$$

i = individual or zone
j = site
t = time

where:

Dependent variable	=	visitation per individual or zone to study site

Independent variables:

travel cost (*TC*)	=	out-of-pocket cost of recreation access to the study site: cost of travel to the site, time cost of travel, lodging costs in transit, and site activity access costs; onsite costs: lodging, meals, opportunity cost of on-site time are normally excluded from cost because it does not reflect access cost

site quality (*SQ*)	=	relevant study site characteristics influencing recreation use. The characteristics depend on the activity to be modeled—fish catch rates, reservoir size, water flow (rivers), water quality measures, number of facilities, etc. Site quality measure has to vary across individuals or over time at the site.
substitutes (*SUB*)	=	distance and quality measures to substitute sites in the region, other recreational activities at the study site and other regional sites, catch/bag rates for other fish and game species at the study site and other regional sites
socioeconomics (*SOC*)	=	income, age, sex

- Advantages of single site models:

  1) Fairly simple modeling
  2) Less data intensive than multiple site modeling approaches
  3) May provide a more accurate forecast for the specific site than a multiple site model

- Disadvantages of single site models:

  1) Models only one site, can only transfer to limited range of similar sites
  2) May be difficult to include site quality because of lack of variation
  3) Cannot be used to estimate the impact of a change in quality at the study site on visitation at other sites in the region, does not provide a clear picture of substitution effects within the region.

4.1.4 Regional Use Estimating Model—Trip Generation and Distribution

Although the primary emphasis of this paper is on site oriented estimation methods, this section briefly discusses how regional oriented models can be used to develop site specific visitation estimates. When site specific visitation data are unavailable, an alternative would be to use regional visitation data from a trip generation model in conjunction with a gravity or trip distribution model. A major assumption with this approach is that the regional visitation information from the trip generation model could be separated by zone (county). The gravity/trip distribution model then distributes the zonal visitation across the various sites. The model functions in a similar capacity as the site selection decision within the individual choice model. The regional visitation/gravity model approach is generally less effective at predicting site visitation than the approaches based on site specific data collections.

4.1.4.1 Trip Generation Model

Trip generation models estimate aggregated recreational activity (participation or visitation) across all sites within a given region. Such models are often based on a combination of cross-section and time series data. Recreational activity must be estimated by origin (e.g., state or county) to apply the trip distribution model presented below. These models do not employ site oriented variables to explain recreation activity because they are not site specific. These models tend to use more demographically oriented explanatory variables such as population, age, sex, and income along with general estimates of recreation supply (e.g., miles of coastline, acres of park land) and participation costs (e.g., license fees, equipment costs). These models often use explanatory variable information from prior years to introduce a dynamic, lead/lag element into the forecast.

An example of a regional trip generation approach (Loomis and Ditton, 1988) uses socioeconomic factors in conjunction with population to forecast regional visitation. Participation rates (site visitation divided by user population) were calculated separately by age, race, and sex cohort (e.g., white males in the 16 to 24 age group). These rates were then applied to projected changes in population within each cohort over time.

4.1.4.2 Trip Distribution (Gravity) Model

The gravity model's basic form (Cesario, 1969) can be shown as:

$$v_{ij} = N_i \, [\{A_j \div (D_{ij} \times \varepsilon_{vd})\} \div \{\sum A_m \div (D_{im} \times \varepsilon_{vd})\}]$$

where:

Dependent variable	=	visits from origin i to site j

Independent variables:

total trips (N_i)	=	total recreational trips to all sites from origin i
site quality (A_j)	=	attractiveness of site j
travel distance (D_{ij})	=	distance from origin i to site j
elasticity (ε_{vd})	=	elasticity of visits with respect to distance
substitute quality (A_m)	=	attractiveness of site m
substitute distance (D_{im})	=	distance from origin i to site m

The term $[\{A_j \div (D_{ij} \times \varepsilon_{vd})\} \div \{\sum A_m \div (D_{im} \times \varepsilon_{vd})\}]$ reflects the attractiveness distance ratio for site j divided by the ratio for all other sites m. This term provides a visitation percentage for site j. As the $\{A_j \div (D_{ij} \times \varepsilon_{vd})\}$ term increases across sites, the percentage of trips expected to site j also increases. The sum of the visitation percentages across sites adds to 1.

Multiplying the site percentages from the trip distribution model by total zonal visitation from the trip generation model provides an estimate of the zonal visitation to each site. Aggregating the visitation to each site across the zones provides an estimate of total visitation by site. In practice, these models have been used primarily for prediction of use rates (Kling, 1986).

- Advantages:

  1) Plausible option when site specific data are not available.

- Disadvantages:

  1) Less accurate in forecasting site use as compared to site oriented methods
  2) Regional visitation estimates must be separated by zone
  3) Requires two equations

4.2 Non-Data Based Approaches

4.2.1 Carrying Capacity

Carrying capacity of a site is normally measured in one of two ways—based on facilities (e.g., boat ramps, swimming beaches) or based on the resource (e.g., physical capacity of the lake or ecological capacity of an ecosystem). These capacity measures can be further adjusted to reflect human interaction. Social carrying capacity establishes a level of use to provide an acceptable number of encounters. Should crowding be pervasive, allowable use could be controlled (reservations, lotteries, etc.) to reduce user contact.

Because facilities vary over time in response to recreation demand, unless the forecast is short term or the growth in facilities is known (e.g., available facilities expansion plan), a facilities based approach may understate long term use. Conversely, carrying capacity based on the resource may make more sense for longer-term forecasts given the lack of variation in the level of resource. Even physical measures can vary over time because of drought, changing water commitments, etc. Therefore, carrying capacity approaches should be used primarily for short term and perhaps intermediate term forecasts.[15] The appropriate caveats should be included when variation in facilities or physical measures are possible.

A critical element when applying a carrying capacity approach is the actual carrying capacity estimate. A carrying capacity based forecast is only as accurate as the carrying capacity estimates. Therefore, considerable time and effort should go into developing the carrying capacity estimates used in the analysis.[16]

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[15] A traditional simplistic approach for estimating recreation impacts from changing reservoir water elevations uses data on facilities and resource carrying capacity.

This approach is not a true forecasting approach but is more of an impact estimation method. However, the approach can be used to forecast changes in recreation use caused by changing water elevations given an existing baseline forecast. Therefore, this approach aids in developing "with project" forecasts for comparison to baseline "without project" forecasts.

The approach considers the accessibility of various recreation facilities (e.g., boat ramps) as reservoir water elevation varies. The approach requires existing information as to the total amount of recreation use by activity and access point. As water levels decline (increase) and facilities become unusable (usable), estimates are made as to the decline (increase) in recreation use.

For example, if a reservoir provides 100,000 visitor days of boating activity equally distributed across 3 access points and 1 of those access points is lost for the entire recreation season, one might claim that 1/3 of the boating activity would be lost. Further review would suggest that recreators may be able to use another access point instead of foregoing their activity. The carrying capacity of the remaining facilities provides information as to the upper bound of potential facility substitution. Resource carrying capacity (e.g., carrying capacity of the reservoir water surface) provides another upper bound estimate useful as a validity check.

[16] A U.S. Army Corps of Engineers (COE) recreation use manual (Vincent et al., 1986) suggests two steps to calculate annual site carrying capacities:

Step 1: Calculate recreation design day load: number of visitors supportable by project resources/facilities for the design day:

$$\begin{array}{c} \textit{Design} \\ \textit{Day} \\ \textit{Load} \end{array} = \begin{array}{c} \textit{Instantaneous} \\ \textit{Capacity} \\ \textit{per Unit} \end{array} \times \begin{array}{c} \textit{Daily} \\ \textit{Turnover} \\ \textit{Rate} \end{array} \times \begin{array}{c} \textit{Number} \\ \textit{of Units} \\ \ \end{array}$$

Step 2: Convert design day load estimates to annual use estimates: the design day is normally based on the average weekend use during the peak season:

$$\begin{array}{c} \textit{Annual} \\ \textit{Use} \\ \ \\ \ \end{array} = \begin{array}{c} \textit{Design} \\ \textit{Day} \\ \textit{Load} \\ \ \end{array} \times \begin{array}{l} \textit{Number of} \\ \textit{Weekend Days} \\ \textit{in Peak Season} \\ \ \end{array} \quad \begin{array}{l} \textit{Proportion of} \\ \textit{Peak Season Use} \\ \textit{Expected on} \\ \textit{Weekends} \end{array} \quad \begin{array}{l} \textit{Proportion of} \\ \textit{Annual Use} \\ \textit{Expected in} \\ \textit{Peak Season} \end{array}$$

The basic premise behind use of the carrying capacity approach is excess demand.[17] Should it be possible to prove that sufficient excess demand exists in the study region to absorb the additional carrying capacity provided by the project, it becomes logical to simply assume recreation use at carrying capacity (assumes recreation use in excess of capacity is either restricted, not possible, or cannot be maintained long term). The forecast of recreation use for the entire region would be assumed equal to the carrying capacity of all the sites. As demand continues to increase and new site locations become harder to find (and fund), use of this technique will increase. This approach is especially relevant for urban sites where recreation demand often greatly exceeds the supply of recreational facilities (Walsh, 1986).

Assuming we are evaluating the development of a new site, the first step required to apply the carrying capacity approach is to determine the carrying capacity of regional sites. This step requires determining the extent of the resource and planned facilities. Developing instantaneous carrying capacity figures (e.g., people at one time [POAT] used by USFS) for the resource and the facilities provides estimates of the upper bound on recreation use at each site. This upper bound must take into consideration seasonal use patterns (i.e., unused swimming capacity in January at cold weather sites should not imply use is not at capacity). Should facilities/resources or seasonal use patterns change over time, capacity figures will vary, otherwise forecasts would remain steady over time.

The second step involves comparing current estimates of recreation use at each of the sites to their carrying capacities to determine if excess capacity exists at any of the sites. Should excess capacity exist for an activity planned for at the study site, the carrying capacity concept would not be applicable. The carrying capacity approach assumes all the sites in the region are being used at capacity, implying excess demand.

Should all the sites in the region be at capacity, a final step is required involving the estimation of regional demand by recreation activity. Regional demand data may be available from state parks and recreation departments or in the statewide comprehensive outdoor recreation plans (SCORPs). Alternatively, regional recreation demand could be estimated via the survey approach discussed later.

Comparison of total regional demand to the carrying capacity of all regional sites provides an estimate of the excess demand within the region. Comparing the carrying capacity of the new site to the estimates of regional excess demand indicates whether the level of excess demand is sufficient to assume the new site will be used at capacity.

The difficulty stems from the need to show sufficient excess demand in the region across the entire study period. Should the number of sites and/or facilities at those sites change during the study period, the impact must be evaluated in terms of excess demand.

- Data Needs:

    1) Carrying capacities (instantaneous)—available from agency site development and facility standards
    2) Daily turnover—available from agency site development and facility standards
    3) Number of units
    4) Number of design days during the peak season
    5) Appropriate proportions for design days during the peak season and peak season to annual use

[17] All of the "data based approaches" discussed in this paper in essence assume zero excess demand. Those approaches generally assume that regional recreation facilities will grow with demand so as to avoid excess demand in the long term. With excess demand nonexistent, differences between demand and consumption/use disappear. Given the reasonableness of the zero excess demand assumption in the long-term, carrying capacity forecasts based on the premise of excess demand should be limited primarily to short-term forecasts.

- Advantages:

  1) Simplicity
  2) Forecasts unnecessary once excess demand has been determined

- Disadvantages:

  1) No explanatory power
  2) Limited applicability
  3) Assumes no shifts in recreation patterns and preferences over time
  4) May require substantial amount of data gathering from each site and for the overall region
  5) Does not estimate site specific demand
  6) Primarily for small projects with limited market areas
  7) Not appropriate for long term forecasts

4.2.2 Market Survey

Another approach, generally used for short-run forecasting, is to directly ask people within the site's geographic market area about their intended recreational activity. Questions are normally quite broad, encompassing all recreational activities. Posing these broad based questions about recreation use for a period of time beyond a year or two becomes problematic because situations tend to change. As a result, survey responses as to anticipated general recreation behavior often differ from actual behavior as the forecast period increases.

These surveys tend to be fairly accurate in describing participation and levels of visitation within an activity, but accuracy may not hold for participation at the site level. People can often provide useful information on their overall number of visits, but may not be able to provide information by site. Therefore, the approach may be more useful for market forecasts as opposed to site specific forecasts. As the number of alternative sites increases, the accuracy of anticipated use estimates at specific sites tends to decrease (the more choices, the harder it is to allocate anticipated visitation).

Sociologists have been successful in identifying personal characteristics which affect choice of recreation site or activity (age, sex, and education may explain certain recreational decisions). Knowing these characteristics for the regional population over time may provide some insights into recreation use. Market surveys can provide current information as to the socioeconomic/demographic characteristics of the market area. Gathering this information allows one to consider some of the use estimating model approaches described above.

- Advantages:

  1) Simplicity
  2) Accurate in the short-run

- Disadvantages:

  1) Short-run forecasts only
  2) Requires survey sampling
  3) Little explanatory power

4.2.2.1 Contingent Behavior Survey

A condensed version of the market survey approach associated with a specific activity and/or site uses a contingent behavior survey. Although the broad market surveys are often considered inaccurate at the site level, these contingent behavior surveys have been successfully used in recent years to gauge recreator reaction to site management (e.g., changes in reservoir water level and instream flows). These contingent behavior surveys are often directed at current site users; these recreators have a good understanding of the characteristics of the site and how they might react should those characteristics vary. As a result, these surveys are considered more accurate for site level estimation than the broad general market surveys.

The contingent valuation method (CVM) provides the framework for the recent expansion of contingent behavior surveys. CVM is a federally accepted approach to estimating recreation benefits. The approach relies on a survey of the affected public. Individuals are directly asked how much they would be willing to pay for changes at the study site. The contingent behavior approach likewise uses surveys of the affected public. The primary difference is that contingent behavior questions focus on how an individual's recreation use would change as a result of the proposal. As with CVM surveys, proper care must go into describing the proposal, the baseline, and any important underlying assumptions.

The contingent behavior approach may be particularly appropriate when the more data intensive approaches falter. A primary advantage of the contingent behavior approach is that questions about virtually any change in site management can be explored. This characteristic allows for analysis of changes in management outside the range of historical data. Contingent behavior results have recently been combined with historical data to develop travel cost models (Narayanan, 1986).

Contingent behavior approaches are not without faults. Individuals are asked to forecast how their recreation use would change as a result of a proposed project or change in site management. Some respondents can provide fairly accurate indications; others can only speculate how they might react. The uncertainty issue has lead some researchers to include accuracy check questions within the survey in an attempt to determine how confident the respondents feel about the accuracy of their answers. Several other biases may creep into the survey results, many of which can be adequately avoided or corrected through questionnaire design, survey type (mail, telephone, in-person), sample selection, and survey implementation (pretesting, reminder notices and follow-up mailings, nonresponse surveys).

Depending on the population sampled, contingent behavior questions could be used to estimate either visitors or visitation. A survey of the general population (sample includes both nonrecreators and recreators) could be used to estimate the impact of a project or policy on the number of recreators as well as visitation. Contingent behavior questions could focus on both the decision to participate and the frequency of visitation. For example: "If this new site was developed, would you use it? If so, how many times a year would you go?" Conversely, an on-site survey of recreators would generally be limited to estimating visitation because the decision to recreate has already been made.[18] Assuming an estimate of the number of recreators is available, information regarding changing recreator use from the on-site survey could be used to evaluate visitation.

Another aspect to the contingent behavior survey is that questions could be posed to evaluate impacts on other sites. After determining how an individual would react to the development of a new site, questions could be asked about the use of other sites. For example: "Would you reduce use at any other site as a result of increased use at this site? If so, at which site and by how much? In addition to site substitution, other forms of substitution (recreation activity, time, species, etc.) could also be addressed.

[18] With recreator estimates available, on-site surveys could be used to estimate reductions in recreators as a result of a management action (e.g., lowering lake elevations). An on-site survey could not be used to evaluate an increase in recreators because current nonrecreators are not contacted.

- Advantages:

    1) Flexibility, theoretically can handle any question
    2) Estimate both visitors and visitation

- Disadvantages:

    1) Cost
    2) Time consuming (e.g., survey will likely require Office of Management and Budget [OMB] approval)
    3) Expertise required

4.2.3 Informed Judgement

This approach taps the judgement of recreational experts. Although subjective, this approach can prove useful when important causal factors have not been considered in previous analyses. Experts can temper the results of quantitative techniques. Because quantitative models are an abstraction of reality, adjusting model results is often important because models cannot hope to include all relevant explanatory variables associated with future recreation use. Many forecasters routinely ask recreation experts to review their forecasts to avoid errors not obvious to the forecaster. Of course, the usefulness of this approach depends directly on the knowledge of the "experts." The experience and insights of the panel of experts may prove more useful than even the most sophisticated statistical forecasting model. Despite their complexity and sophistication, quantitative models have not always proven to be more accurate than professional judgement.

Although the judgement of recreation experts can be invaluable in tempering the results of a forecast, judgement alone is often inadequate to actually develop a forecast. As a result, this approach is normally used in conjunction with one of the other forecasting methods. Although conceptually the approach could be used in a stand alone fashion, in practice, it is traditionally used to evaluate a previously developed forecast.

Perhaps the best know informed judgement method is the Delphi technique. This approach normally involves several rounds of visitation estimates by a group of experts. After reviewing existing information, the experts develop and then share their estimates and rationale. This procedure normally provides the necessary feedback to allow for a convergence of group opinion into a consensus. The exchange of information is conducted via a series of questionnaires as opposed to face to face interactions. This process encourages individual input and helps eliminate problems associated with direct confrontation and group pressure (Moeller and Shafer, 1983).

- Advantages:

    1) Simplicity
    2) Incorporates professional judgement of experts
    3) Often used to refine forecasts from one of the other approaches
    4) Especially useful for long term forecasts where too many factors are impacted to depend on quantitative models

- Disadvantages:

    1) Subjective

5.0 CONCLUSION—SELECTING A FORECASTING APPROACH

5.1 Linking Forecast Method with Planning Question

Given this exhaustive discussion of the various methods of forecasting recreation use, we need to address what methods are preferred in answering which questions. No one method is preferred to answer all planning questions. In their demand modeling paper, Loomis et al. (1986) address the appropriate model for each of the following questions: 1) impacts of building a new site, 2) impacts of a change in quality at a current site, 3) forecasting the amount of use at a current site, and 4) forecasting of the amount of use when travel cost models are inappropriate. We address each of these questions given the full range of forecasting methods.

QUESTION 1: Impacts from a New Site

Estimation of use at a new site is often complicated by lack of data. As a result, time series approaches which depend on the availability of historical data would not be appropriate. The similar site or the carrying capacity methods have traditionally been applied. The similar site method applies use rates or use estimating models from similar sites to forecast use at the new site (see appendix A for a discussion of the similar site method). Alternatively, if it can be demonstrated that sufficient excess demand exists within the region, the site could be assumed to be used at capacity.

Market surveys could also be conducted asking residents of a new site's potential market area if they would visit the new site and if so, how often. However, these general surveys tend to be more accurate in measuring overall visitation by activity and not necessarily visitation at a particular site. Site specific contingent behavior surveys provide another survey option. However, the success of contingent behavior surveys is partially attributable to the targeting of site users. Because a new site has yet to develop a user population, this approach may also prove difficult to apply.

Exclusive use of the opinions of recreation experts, the stand alone informed judgement approach, is also a possibility. However, it is probably unreasonable to expect a group of recreation experts to accurately evaluate the effects on site substitution created by development of the new site.

QUESTION 2: Impacts from a Change in Quality at a Current Site

To evaluate changes in quality at a site (e.g., reservoir water elevation, river instream flow, water quality, fish and wildlife populations), one of the use estimation modeling options is normally used because these models often include site quality as an explanatory variable. Application of time series based trends or historic use rates are generally inappropriate because they normally focus purely on the amount of use without addressing causality (low to moderate explanatory power). Carrying capacity analyses, with the exception of the carrying capacity facility accessibility approach, also do not address causality and fail to account for quality changes.

Regarding the range of modeling options, we obviously have to focus on those models which can effectively incorporate site quality. This requirement implies that the system of equations approach would be not useful to address this question.

Depending on the length of the forecast, market survey or perhaps more appropriately, contingent behavior survey approaches may also be considered. Stand alone informed judgement approaches are always an option should time and budget constraints preclude use of other approaches.

QUESTION 3: Forecasting the Amount of Use at a Current Site

Assuming data availability, all of the approaches could be applied to forecast use at a current site. However, certain options may have advantages over others. Trend analysis, use rates, carrying capacity, and informed judgement approaches may have cost and time advantages over the modeling and survey approaches. When comparing modeling approaches, single site models may have both accuracy and cost advantages over the more complex multiple site models when dealing with this question (Loomis et al., 1986).

QUESTION 4: Forecasting Use when Travel Cost Models are Inappropriate

The popular travel cost model has difficulty under certain conditions: 1) when trips involve multiple sites or purposes, 2) when the range of the historic data is insufficient to address the question being posed, 3) when insufficient variation exists in the travel cost variable (e.g., at urban sites).

In cases one and two, contingent behavior surveys have been conducted to gather the necessary data to answer the question directly or to supplement existing travel cost data for estimation of the model.

In the case of forecasting use at urban sites, the lack of significant variation in travel distance and therefore cost, basically eliminates application of the travel cost model. All the multiple site, single site, and regional modeling options (with the exception of the urban daily visitation model) would also be eliminated because they also require variation in travel cost. The time series, extrapolation of use rates, carrying capacity, market survey, and informed judgement approaches would be applicable.

5.2 General Advantages and Disadvantages of Each Approach

To provide more general aid in the decision of selecting a forecasting approach, table 5.1 presents a relative ranking of the approaches in terms of what were deemed to be eight of the most important evaluative factors. The factors were selected based on a review of the advantages and disadvantages of each approach and include the following: cost, complexity, data needs, forecast duration, explanatory power, model transferability between sites, ability to address site substitution and quality, and ability to measure urban use.

Cost reflects the amount of budget and time required for each approach. Complexity refers to the required level of mathematic, statistical, or economic technical expertise. Data needs represent how data intensive or input data hungry the approach is likely to be. Forecast duration reflects the appropriate length of the forecast period ("S/T - L/T" indicates the approach can be used to forecast use ranging from short term to long term). Explanatory power refers to degree to which causal factors explaining variation in recreation use are addressed. The potential for transferability between sites reflects whether an approach developed for one site may be applied to forecast use at another site. The substitution and site quality factor indicates if site substitution and site quality impacts can be reasonably included within the approach. The urban use factor indicates whether the approach can be applied to forecast use at urban sites.

Table 5.1 shows that, generally speaking, the low cost approaches are often less complex, less data intensive, involve shorter forecast durations, provide less explanatory power, lack transferability, may not address substitution and site quality, but may be used to measure use at urban sites. Conversely, the higher cost approaches tend to be more complex, more data intensive, allow for longer forecast durations, provide greater explanatory power, are more readily transferable, can handle substitution and quality, but are not appropriate for measuring use at urban sites.

The selection of approach depends to some degree on the level of detail required in the analysis. In the case of an appraisal level screening study where time and budget are limited, one of the lower cost and lower complexity approaches may suffice. For detailed planning documents with significant recreational impacts, one of the more intensive forecasting approaches may be warranted.

Table 5.1. - Major advantages and disadvantages by forecasting approach.

Forecasting Approach:	Cost[19]	Complexity	Data Needs	Forecast[20] Duration	Explanatory Power	Transfer Model?	Substitution & Quality?	Urban Use?
				I. Data Based Approaches:				
A. **Time Series**	$$	Moderate	Moderate	S/T	Low	No	No	Yes
B. **Use Rates**	$	Low	Moderate	S/T - L/T	Moderate	Yes	No	Yes
C. **Multiple Site Models** (1-6):								
1. Individual Choice	$$$	High	High	S/T - L/T	High	Yes	Yes	No
2. Aggregate Participation	$$	Moderate	Moderate	S/T - L/T	High	Yes	Yes	No
3. Aggregate Visitation	$$	Moderate	Moderate	S/T - L/T	High	Yes	Yes	No
4. Varying Parameter	$$$	High	High	S/T - L/T	High	Yes	Yes-Quality	No
5. System of Equations	$$$	High	High	S/T - L/T	High	Yes	Yes-Subst.	No
6. Urban Visitation	$$	Moderate	Moderate	S/T - L/T	High	Yes	Yes	Yes
D. **Single Site**	$$	Moderate	Moderate	S/T - L/T	Moderate/High	Yes?	Yes?	No
E. **Regional Modeling**	$$$	High	High	S/T - L/T	High	No	Yes?	No
				II. Non-Data Based Approaches:				
A. **Carrying Capacity**	$	Low	Low - Moderate	S/T	Low	No	No	Yes
B. **Market Survey**	$$$	Moderate	Low	S/T	Low	No	Yes	Yes
C. **Informed Judgement**	$	Low	Low	S/T - L/T	Low	No	Yes?	Yes

[19] High Cost = $$$, Moderate Cost = $$, Low Cost = $

[20] S/T = Short Term (< 5 years), L/T = Long Term (+ 10 years)

6.0 BIBLIOGRAPHY:

A code describing the general topic of the paper has been entered to the left of each bibliography citation. The list of descriptors is as follows...

Paper Descriptions:

AGE	= Ratio Method Using Age Cohorts
CA	= Cluster Analysis
CB	= Contingent Behavior Survey
CC	= Carrying Capacity Approach
CD	= Count Data Models
DC	= Discrete Choice, Allocation, Share, Site Selection Model
GRAV	= Gravity Model
HPF	= Household Production Function
ITCM	= Individual Travel Cost Model
MDT	= Multiple Destination Trip Model
NZTCM	= Nonlinear Zonal TCM & Gravity Model
OSM	= On-site Time Model
PROB	= Probability of Participation - Single Equation
SIM	= Simulation Modeling
SOEP	= System of Equations - Probability of Participation
SOEV	= System of Equations - Visitation
SSM	= Similar Site Method
T-CC	= Theory - Carrying Capacity
T-CONG	= Theory - Congestion
T-EC	= Theory - Econometrics & Modeling
T-G	= Theory - General Forecasting
T-HFB	= Theory - Habit Forming Behavior
T-REC	= Theory - General Recreation
T-REG	= Theory - Regional Modeling
T-TA	= Theory - Trend Analysis
T-TCM	= Theory - Travel Cost Modeling
T-VAR	= Theory - Variable Selection
TSM	= Time Series Model
UM	= Urban Visitation Model
VP	= Varying Parameter Model
ZTCM	= Zonal Travel Cost Model

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ITCM Allen, P. G., T. H. Stevens, and S. A. Barrett. 1981. "The effects of variable omission on the travel cost technique." *Land Economics* 57(May):173-180.

MDT Baxter, M. J. and G. Ewing. 1981. "Models of recreational trip distribution." *Regional Studies* 15:327-344.

OSM Bell, F. and V. Leeworthy. 1990. Recreational demand by tourists for saltwater beach days." *Journal of Environmental Economics and Management* 18:189-205.

ZTCM Bergstrom, J. and H. K. Cordell. 1991. "An analysis of the demand for and value of outdoor recreation in the United States." *Journal of Leisure Research* 23(1):67-86.

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SOEP Caswell, M. and K. McConnell. 1980. "Simultaneous estimation of jointly dependent recreation participation function." *Journal of Environmental Economics and Management* 7:65-76.

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NZTCM, GRAV Cesario, F. 1975. "A combined trip generation and distribution model." *Transportation Science* 9:211-223.

T-VAR Cesario, F. 1975. "A new method for analyzing outdoor recreation trip data." *Journal of Leisure Research* 7:200-215.

SIM Cesario, F. 1975. "A simulation approach to outdoor recreation planning." *Journal of Leisure Research* 7(1):38-52.

ZTCM Cesario, F. and J. Knetsch. 1976. "A recreation site demand and benefit estimation model." *Regional Studies* 10(1):97-104.

ZTCM Cheung, H. 1972. "A day-use park visitation model." *Journal of Leisure Research* 4(2):139-156.

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T-EC, CD Creel, M. and J. Loomis. 1990. "Theoretical and empirical advantages of truncated count data estimators for analysis of deer hunting in California." *American Journal of Agricultural Economics* 72:434-41.

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T-G Cummings, L. and J. Busser. 1994. "Forecasting in recreation and park management: Need, substance, and reasonableness." *Journal of Park and Recreation Administration* 12(1):35-50.

T-CONG Deyak, T. and V. K. Smith. 1978. "Congestion and participation in outdoor recreation: A household production function approach." *Journal of Environmental Economics and Management* 5:63-80.

ITCM, CD, SIM Dobbs, I. 1993. "Individual travel cost method: Estimation and benefit assessment with a discrete and possibly grouped dependent variable." *American Journal of Agricultural Economics* 75(1):84-94.

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UM Dwyer, J. 1988. "Predicting daily use of urban forest recreation sites." *Landscape and Urban Planning* 15(1/2):127-138.

T-REC Dwyer, J., J. R. Kelly, and M. D. Bowes. 1977. "Improved procedures for valuation of the contribution of recreation to National Economic Development." Water Resources Center Research Report No. 128, University of Illinois Urbana-Champaign, Champaign-Urbana, IL.

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T-EC Ewing, G. 1983. "Forecasting recreation trip distribution behavior." In *Recreation Planning and Management*, eds. S. Lieber and D. Fesenmaiser, Venture Publishing, Inc., State College, PA, pp. 120-140.

T-EC, DC Feenburg, D. and E. Mills. 1980. *Measuring the Benefits of Water Pollution Abatement*. Academic Press, New York.

T-EC Fletcher J., W. Adamowicz, and T. Graham-Tomasi. 1990. "The travel cost model of recreation demand: theoretical and empirical issues." *Leisure Sciences* 12:119-147.

UM Gillespie, G. and D. Brewer. 1968. "Effects of nonprice variables upon participation in water-oriented outdoor recreation." *American Journal of Agricultural Economics* 50(1):82-90.

T-EC Gomez, I. and T. Ozuna Jr. 1993. "Testing for overdispersion in truncated count data recreation demand functions." *Journal of Environmental Management* 37(2):117-125.

ITCM Gum, R. and W. Martin. 1975. "Problems and Solutions in Estimating the Demand for and Value of Rural Outdoor Recreation." *American Journal of Agricultural Economics* 57(Nov):558-566.

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T-G Kalter, R. J. and L. Gosse. 1970. "Recreation demand functions and the identification problem." *Journal of Leisure Research*, 2(1):43-53.

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T-EC Kmenta, J. 1971. *Elements of Econometrics.*" MacMillan Co., New York.

ZTCM Knetsch, J., R. Brown, and W. Hansen. 1976. "Estimating expected use and value of recreation sites." In *Planning for Tourism Development: Quantitative Approaches*, eds. C. Gearing, W. Swart, and T. Var, Praeger Press, New York.

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T-TCM — Mendelson, R., J. Hof, G. Peterson, and R. Johnson. 1992. "Measuring the Values of Multiple Destination Trips." *American Journal of Agricultural Economics* 74(4):926-33.

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SOEV Ozuna Jr., T. and I. Gomez. 1994. "Estimating a system of recreation demand functions using seemingly unrelated Poisson regression approach." *Review of Economics and Statistics* 76(2):356-360.

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PROB ITCM Rockel, M. and M. J. Kealy. 1991. "The value of nonconsumptive wildlife recreation in the United States." *Land Economics* 67(4):422-34.

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T-EC Shaw, D. 1988. "On-site samples' regression: problems of non-negative integers, truncation, and endogenous stratification." *Journal of Econometrics* 37:211-223.

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T-EC PROB Smith, V. K. and V. Munley. 1978. "The relative performance of various estimators of recreation participation equations." *Journal of Leisure Research* 10(3):165-176.

ZTCM Sorg, C. and L. Nelson. 1986. "Net economic value of elk hunting in Idaho." USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Report No. RM-12, Ft. Collins, CO.

AGE Sport Fishing Institute. 1988. "Economic activity associated with marine recreational fishing in 1985: Volume III—Future participation in marine recreational fishing." prepared for National Marine Fisheries Service, Washington, D.C.

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T-EC Stynes, D. 1983. "An introduction to recreation forecasting" and "Time series and structural models for forecasting recreation participation." In *Recreation Planning and Management*, eds. S. Lieber and D. Fesenmaiser, Venture Publishing, Inc., State College, PA, pp. 87-95, 105-119.

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ZTCM T-EC Sutherland, R. 1982. "A regional approach to estimating recreation benefits of improved water quality." *Journal of Environmental Economics and Management* 9(3):229-247.

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PROB — Walsh, R., D. Harpman, K. John, J. McKean, and L. LeCroy. 1987. "Wildlife and fish use assessment: Long-run forecasts of participation in fishing, hunting, and nonconsumptive wildlife recreation." Colorado Water Resources Research Institute Technical Report No. 50, Ft. Collins, CO.

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ZTCM ITCM T-EC — Ward, F. and J. Loomis. 1986. "The travel cost demand model as an environmental policy tool: a review literature." *Western Journal of Agricultural Economics* 11(2):164-178.

T-G T-REC — Water Resources Council. 1983. "Economic and environmental principles and guidelines for water and related land resources implementation studies." U. S. Government Printing Office, Washington, D.C.

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T-CC — West, P. 1981. "On-site social surveys and the determination of social carrying capacity in wildlife recreation management." USDA Forest Service, North Central Forest Experiment Station research note NC-264, St. Paul, MN, 4 pp.

TSM PROB T-TA — West, Patrick C. 1977. "A status group dynamics approach to predicting participation rates in regional recreation demand studies." *Land Economics* 53(2):196-211.

ZTCM — Wetzstein, M., R. Green, and G. Elsner. 1982. "Estimation of wilderness use functions for California: An analysis of covariance approach." *Journal of Leisure Research* 14(1):16-26.

ZTCM TSM DC — Wilkinson, P. 1973. "The use of models in predicting the consumption of outdoor recreation." *Journal of Leisure Research* 5:34-48.

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T-EC — Zeimer, R. and W. Musser. 1979. "Population-specific recreation demand models and the consequences of pooling sample data." *Western Journal of Agricultural Economics* 4(1):121-128.

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APPENDIX

Forecasting Use at New Sites

Forecasting use at new sites is more complicated than at existing sites because of the lack of use data for the new site. The forecasting approaches used at the new site include those discussed above. The primary difference for application of any of the "data based approaches" involves use of the similar site method. The carrying capacity and market survey approaches are also appropriate for a new site.

Similar Site Method: (Data Based Approaches)

The similar site method involves selecting a comparable site or group of sites from a list of existing sites based on the characteristics of both sites and user populations. Characteristics for comparison include: project type, size, facilities, quality, operations, market area socioeconomic characteristics, number and location of substitute sites, etc. Once a similar site(s) is chosen, visitation data from that site can be applied to forecast use at the new site. The basic assumption is that use patterns would be similar between the existing and new site given similar site and population characteristics.

Matching sites exactly is rare because of the large number of comparison factors, therefore direct application of use estimates from the existing site to the new site would be unrealistic. The similar site approach attempts to apply existing per capita use rates or use estimation models to forecast use at the new site. Explanatory variable estimates for the new sites are used with the per capita use rates or use estimation models to forecast use. This approach, therefore, is essentially a "use transfer" concept akin to the "benefit transfer" concept often used to derive economic values.[21]

The following list reflects an abridged version of the steps involved in applying the similar site approach as shown in Vincent et al. (1986):

Step 1: Evaluate characteristics of proposed project—reservoir area, reservoir fluctuations, accessibility, alternative recreation opportunities, recreation facilities, activity limitations, activity potential
Step 2: Select similar project(s)—based on a comparison of the characteristics noted in step 1
Step 3: Evaluate similar site's market area—develop per capita visitation rates by distance zone
Step 4: Select or construct per capita use curve for similar site—obtained by plotting zonal per capita use rates against zonal distance
Step 5: Modify similar site's per capita use curve to reflect proposed project—adjustments should be made based upon differences in the project characteristics noted in step 1
Step 6: Estimate proposed project market area population—based on similar site's market area
Step 7: Calculate annual use—Apply per capita use curves to proposed project's market area population, sum across zones to calculate total use

- Advantages:

  1) Provides explanatory power
  2) Statistically based
  3) Short or long run forecasting

- Disadvantages:

  1) Difficult to find good matches
  2) May be subjective
  3) Gravity model accounts for only population and distance factors
  4) Requires a bank of existing sites with use data

[21] Benefit transfer involves application of an existing travel cost or contingent valuation model from another site or similar recreation activity for use in estimation of an economic value for the study site and activity.

Example: Application of Similar Site Method using a Multiple Site Zonal Travel Cost Model

After reviewing the characteristics of the proposed site, the next step is to find a similar site which has already been modeled. Model selection is based on various factors including geographic proximity/market area, site resources, recreational activities, model type, model date, and model accuracy.

The following multiple site zonal travel cost model was proposed as an example to illustrate how to estimate the impact of a new fishing site using the similar site method (Loomis and Brown, 1984).

$\ln TRIPS_{ij}/POP_i = \beta_0 + \beta_1\ TRAVEL\ COST_{ij} + \beta_2\ FISH_j + \beta_3 \ln SUBS_i$

i = origin, j = site, and ln = natural log

where:

TRIPS	=	trips to site *j* from origin *i*
POP	=	population from origin *i*
TRAVEL COST	=	travel and time costs from origin *i* to site *j*
FISH	=	total fish harvest at site *j*
SUBS	=	substitute site index for origin *i* (fish harvest at each site/travel cost from each origin to each site)

Original Data used to Develop Multiple Site Model: The data are purely hypothetical and are used for illustrative purposes only.

Observation No.	Trips	Population	Trips/Pop.	Ln Trips/Pop.	Travel Cost	Fish	Ln Subs	Subs
1 - Site 1	50	100	0.5	-0.69315	10	200	1.609438	5
2 - Site 1	20	200	0.1	-2.30259	50	200	1.098612	3
3 - Site 1	25	500	0.05	-2.99573	100	200	0.788457	2.2
4 - Site 1	24	800	0.03	-3.50656	150	200	0.336472	1.4
5 - Site 2	15	100	0.15	-1.89712	20	100	2.995732	20
6 - Site 2	25	500	0.05	-2.99573	40	100	1.609438	5
7 - Site 2	8	800	0.01	-4.60518	70	100	0.262364	1.3
8 - Site 2	5	1000	0.005	-5.29832	100	100	1.609438	5
9 - Site 3	20	500	0.04	-3.21888	30	50	1.609438	5
10 - Site 3	14	800	0.0175	-4.04556	80	50	0.336472	1.4
11 - Site 3	10	1000	0.01	-4.60517	110	50	0	1
12 - Site 3	5	5000	0.001	-6.90776	150	50	1.609438	5

Regression Output: Ordinary Least Squares Estimation

			Travel Cost	Fish	Ln Subs
Constant	-3.07088	X Coefficient(s)	-0.02594	0.013601	-0.11969
Std Err of Y Est	0.701467	Std Err of Coef.	0.005228	0.003272	0.290445
R Squared	0.868612	t-Statistic	-4.9613	4.156289	-0.41208

Trip Estimation for Original 3 Sites: Comparing Actual to Estimated

Estimated versus actual trips can be made for each zone/observation or at the overall site level. The numbers in parenthesis to the right of the estimated and actual trip columns reflect the total estimated and actual trips for sites 1, 2, and 3.

Observation No.	Ln Estimated Trips/Pop.	Estimated Trips/Pop.	Population	Estimated Trips	Actual Trips
1 - Site 1	-0.80272	0.448109	100	44.81092	50
2 - Site 1	-1.77907	0.168796	200	33.75912	20
3 - Site 1	-3.0388	0.047892	500	23.94606	25
4 - Site 1	-4.28157	0.013821	800	11.05679 (113.6)	24 (119)
5 - Site 2	-2.58809	0.075164	100	7.516374	15
6 - Site 2	-2.94091	0.052818	500	26.4088	25
7 - Site 2	-3.5578	0.028501	800	22.80114	8
8 - Site 2	-4.49714	0.011141	1000	11.1408 (68.7)	5 (53)
9 - Site 3	-3.36158	0.03468	500	17.34025	20
10 - Site 3	-4.50608	0.011042	800	8.833316	14
11 - Site 3	-5.24393	0.005279	1000	5.279491	10
12 - Site 3	-6.47404	0.001543	5000	7.714913 (39.1)	5 (49)

Analysis: New Site

After the appropriate model has been selected, one then needs to determine which counties (origin zones) are expected to visit the new site. An algebraic analysis of the multiple site model can provide assistance in this effort. Solving for the distance at which trips go to zero (or reasonable proximity, say .0001) can provide an estimate of the potential market area.

For each of the counties within the market area, the travel cost must be estimated based on approximate travel distance and travel time. Potential fish populations and harvest rates need to be obtained from the biologists. Finally, the substitute index needs to be developed for each of the origin zones expected to visit the site. All this information is then used along with the multiple site travel cost model's coefficients to predict visitation at the new site.

County No.	Population	TC	Fish	Ln Subs	Subs	Ln Estimated Trips/Pop.	Estimated Trips/Pop.	New Site Estimated Trips
13	100	30	175	2.995732	20	-1.8274	0.160831	16.08312
14	500	40	175	1.609438	5	-1.92085	0.146482	73.241
15	800	100	175	0.262364	1.3	-3.31586	0.036303	29.04231
16	5000	125	175	1.609438	5	-4.12551	0.016155	80.77611
								199.1425