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Volume IV

Evaluating Changes in the Quality of the Recreation Experience

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This is the fourth in a series of manuals designed to provide recreation evaluation procedures to further implement the "Principles and Guidelines" of the U.S. Water Resources Council. The emphasis of the first three volumes of this series was, primarily, on the evaluation of providing new or additional facility developments. This manual emphasizes the evaluation of qualitative differences in the recreation experience. The primary purpose of this manual is to describe procedures and methodologies for valuating changes in recreation use values that result from management decisions impacting on recreation facilities and services and on the related natural resource base.

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NATIONAL ECONOMIC DEVELOPMENT PROCEDURES MANUAL - RECREATION

VOLUME IV

EVALUATING CHANGES IN THE QUALITY OF THE RECREATION EXPERIENCE

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PREFACE

The work reported herein was conducted as part of the National Economic Development (NED) Procedures Manual Work Unit within the U.S. Army Corps of Engineers (COE) Planning Methodologies Research Program. Mr. William Hansen of the COE Water Resources Support Center (WRSC), Institute for Water Resources (IWR), manages this Work Unit under the general supervision of Mr. Michael Krouse, Chief of the Research Division; Mr. Kyle Schilling, Director of IWR; and Mr. Kenneth Murdock, Director of WRSC. Mr. Robert Daniel (CECW-PD) is the Technical Monitor for Headquarters, COE.

Dr. Daniel D. Badger, Emeritus Professor, Department of Agricultural Economics, Oklahoma State University, co-authored this report while serving under terms of an Intergovernmental Personnel Act Agreement between IWR and the Oklahoma Water Resources Board.

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CHAPTER I

INTRODUCTION

PURPOSE

This is the fourth in a series of manuals designed to provide recreation evaluation procedures to further implement the "Principles and Guidelines" (P&G) of the U.S. Water Resources Council (1983). The emphasis of the first three manuals in this series (Vincent, et al., 1986; Moser and Dunning, 1986; and Hansen et al., 1990) was, primarily, on the evaluation of providing new or additional recreation facility developments. This manual (Volume IV) emphasizes the evaluation of qualitative differences in the recreation experience. The first three volumes focused more on quantity issues (valuing changes in supply), while this volume focuses more on how changes in the quality of resource attributes affect the demand for, and the value of, the recreation experience (valuing shifts in demand).[1]

The primary purpose of this manual is to describe procedures and methodologies for valuating changes in recreation use values that result from management decisions impacting on recreation facilities and services and the related natural resource base.

BACKGROUND

As described in the P&G, National Economic Development (NED) benefits arise when a Federal investment in water resources increases the Nation's

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[1]Volume I (section on region models) and Volume II (Contingent Value Models) did discuss evaluating qualitative factors, but with lesser emphasis than this manual will provide.

output of goods and services or reduces the cost of producing these goods and services. These benefits are measured as the dollar value of the increased output or the dollar value of the reduction in costs. The adverse economic effects are the NED costs which arise because resources are diverted for the project that would have value in alternative uses. These costs are measured as the dollar value of the resources in their next best alternative use.

Although the P&G was primarily developed for planning new projects, NED benefits and costs are also relevant in the valuation of management decisions at existing projects. Activities, such as controlling water releases at dams, managing fish and wildlife habitat programs, providing ranger patrols, and mowing of road shoulders, impact the facilities, services, and/or natural resource base that contribute to the recreation experience. Improved valuation of the impacts of such actions could provide for a more efficient and effective allocation of limited resources. For recreation, this valuation is hindered, not only by an absence of market prices, but sometimes also by an imprecise linkage between the management action and its impact on the recreation experience.

For example, an illustration of the generalized linkages between a potential reallocation of water and resulting impacts on water quality, fish habitat and recreationists is presented in Figure 1. A change in the allocation of water (or storage space) between project outputs (uses) could affect the reservoir operating criteria, leading to a change in the flow regime. Changes in water release schedules could result in changes in water quality and in the aquatic habitat. Over a period of time, biological changes in the fishery resource (e.g., in the size or number of fish) may occur. For many recreation users, the fishery resource is an important attribute that affects their recreation experience. The impacts on the fishery resource would, therefore, ultimately be reflected in a change in recreation user behavior and in economic value.

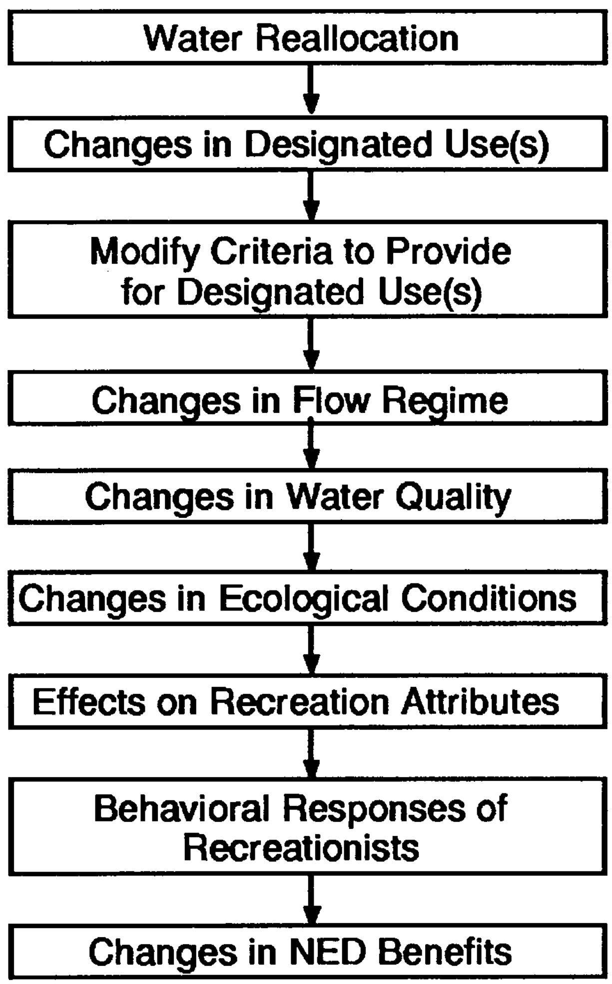

Figure 1. Interrelationships of Reallocation of Water and Resulting Biological and Economic Effects

The economic evaluation of such actions as depicted in Figure 1 requires not only being able to identify the general cause and effect relationships, but also the marginal changes in user behavior and value that ultimately occur. For example, assume a management action is going to improve (or degrade) water quality or aquatic habitat in an area, resulting in an increase (decrease) in the fishery resource. Some previous studies have valuated such actions based on an "average value per fish." That is, the total recreational value for those fishing under existing conditions is first estimated and that value is divided by the number of fish currently caught. The resulting average value per fish is multiplied by the changes in fishery resource or catch, to determine the benefits (positive or negative) of the management action. Such a procedure violates two basic concepts: (1) it assumes the total value of the recreation experience is entirely dependent on the fish caught; and (2) it ignores the principle of diminishing marginal returns.

Although fish catch may be important, many fishermen participate in other activities (e.g., camping or picnicking) during their fishing trips and other factors (e.g., relaxation, being with friends, and enjoying the natural environment) also may contribute to their overall experience. The total economic value of that experience is a function of all factors, not just the number of fish caught. In addition, the concept of diminishing marginal returns infers that the value per unit of a good to the consumer or user declines as more and more units are consumed or used (or, in this example, fish caught). Average values based on the total fish catch under existing conditions will almost always overestimate the marginal value of changes in fish catch that might result from management actions.

SCOPE

Step by step procedures for valuation techniques, such as the Travel Cost Method (TCM) and the Contingent Value Method (CVM), are documented in the first three volumes of this series. This manual, therefore, does not present the basic methodologies that have been developed for measuring recreation benefits. This manual illustrates how these methodologies can be used to value changes in the quality of the recreation experience.

This manual is limited in scope to addressing use-related values. Much of the recent research literature on recreation, particularly CVM studies, is addressing the measurement of such non-use values as option and existence values. There is still concern and controversy, however, on when these values are particularly relevant and of the ability of existing techniques to separate ideological content from the value measures. This manual is, therefore, limited to the measurement of use-related values.

Finally, this manual is limited to the measurement of NED benefits and does not address the issue of economic impacts. The economic impact of recreation and related tourism expenditures is often of importance to local sponsors and their constituents. Such impacts are not, however, considered in the estimation of NED benefits and costs, and are, therefore, beyond the scope of this manual.

INTENDED AUDIENCE

This manual has been written primarily for use by Corps of Engineers economists, biologists, outdoor recreation and environmental specialists, and other planners. Distribution to non-Federal sponsors and to others involved in providing and/or evaluating outdoor recreation opportunities is encouraged.

ORGANIZATION OF MANUAL

Chapter II presents the conceptual background for the manual. It provides a general discussion of NED benefits. It explores demand curve analysis and the causes of shifts, either positive or negative, in the demand curve for selected recreation and environmental attributes or activities. Finally, the chapter addresses alternative techniques for measuring impacts of demand curve shifts, such as regional travel cost and contingent value models.

Chapter III provides further amplification of the CVM and TCM approaches. It gives examples of studies that may be useful as guides in valuating management actions that impact on the quality of the recreation experience.

CHAPTER II

CONCEPTUAL BACKGROUND

As cited in the Principles and Guidelines (U.S. Water Resources Council, 1983):

> Benefits arising from recreation opportunities created by a project are measured in terms of willingness to pay. Benefits for projects (or project features) that increase supply are measured as the willingness to pay for each increment of supply. Benefits for projects (or project features) that alter willingness to pay (e.g., through quality changes) are measured as the difference between the without- and with-project willingness to pay.

and,

> Many proposed projects subject to NED benefit-cost analysis involve both recreation gains and recreation losses. For example, stream and land-based recreation may be lost because of the project, or recreation may be transferred to the proposed site from a more distant site. Net recreation benefits are the value of the gains minus the value of the losses; benefits may be positive or negative.

The basic principle for evaluating NED benefits is to use the concepts developed from the economics of private goods as an analogy for valuing the outputs of Federal water resource projects. Basic principles of economics predict that private markets accurately determine the value of goods to society. The economic model of markets is based on the behavior of producers and consumers in the voluntary exchange of private goods and services. Consumers influence the market through the purchase and consumption of goods and services that provide them with utility or satisfaction. It is assumed that consumers make purchases in markets based on their individual valuations of the goods and services. The external representation of this value is called demand, which describes the relationship between the quantity of a good or service that individuals wish to buy and the factors that influence their decisions.

DEMAND CURVE

The demand for a good or service can be represented by a demand curve. A demand curve shows the relationship between the amount of a good or service people are willing and able to purchase and the price of that good or service. The typical demand curve obeys the Law of Demand, which postulates that reductions (increases) in the price of the good or service will result in increases (decreases) in the quantity purchased or consumed. As such, the demand curve slopes downward, to the right. For example, the demand curve in Figure 2 indicates that at a price of $10, none (0) of this particular good (in this case recreation days) would be purchased or consumed by users. The price would simply be too high for consumers to purchase any of the product. If the price is lowered to $5; however, 50 units would then be purchased or consumed. In Corps recreation studies, the quantity of the good is typically measured in recreation days of use.

The Law of Demand only holds, however, if all the other determinants of demand, such as income, the quality of the good and the prices of other goods, remain constant. Changes in these other determinants will shift the demand curve, outward or inward, depending on whether or not the resultant change increases or decreases demand, respectively. For example, increases in real income or population shift the demand curve for most goods or services outward, to the right. For the same price, more units of the good or service would be purchased or consumed. The introduction of substitutes or a reduction in the price of substitute goods or services will shift the demand curve inward, to the left. For the same price, fewer units of the good or service would now be purchased or consumed.

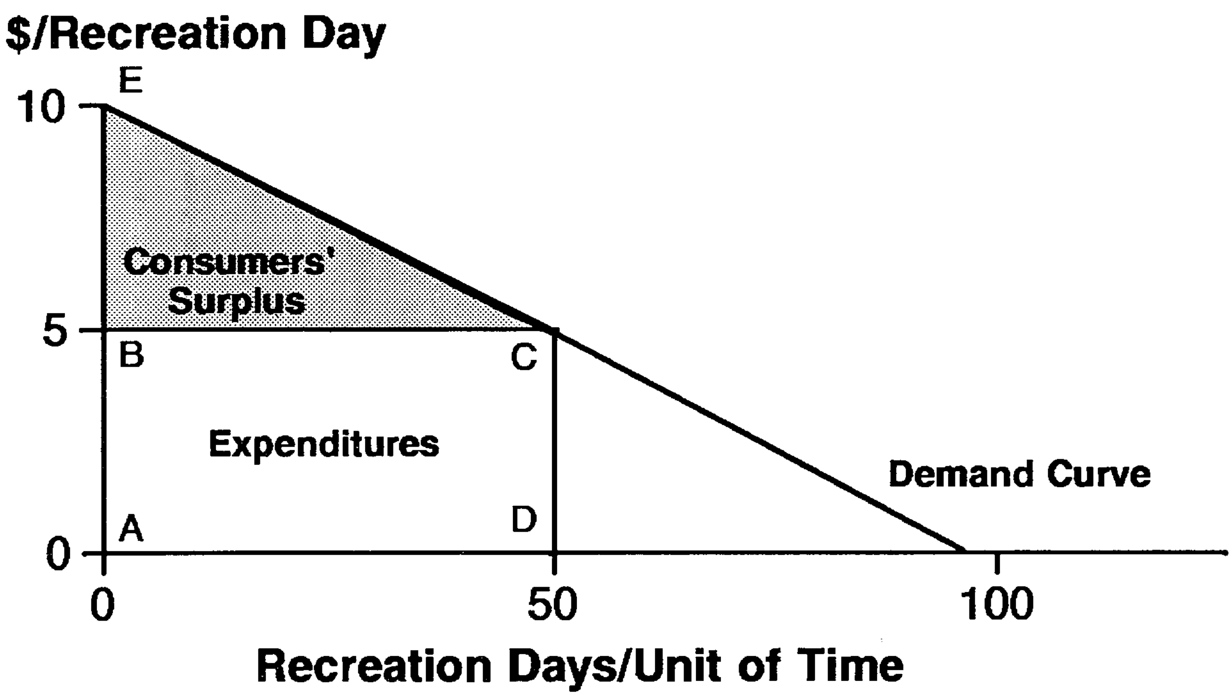

Figure 2. Demand Curve and Consumers' Surplus Example

The demand curve also can be used to describe the total value of the good or service to consumers. As described more fully below and under certain assumptions, the area under a market demand curve is a good approximation of the total value of the good or service. If consumers (recreationists) must pay to obtain the good or service, the difference between the value to consumers of the quantity they consume, and the money they must pay to obtain the good or service, is called consumers' surplus.

Again referring to Figure 2, if the price of the good or service is $5 per unit, consumers are willing to purchase 50 units in a given time period. The total value to the consumers of these 50 units is the area under the demand curve between a quantity of 0 and 50 units. The amount they must pay, or their expenditures, (area ABCD) is $5 per unit X 50 units = $250. The difference between what they are willing to pay and what they actually have to pay is the consumers surplus' (area BEC). In this example[2], the consumers' surplus is ($5 per unit X 50 units)/2 = $125. The total amount of $375 ($250 + $125) is the maximum amount consumers are willing to pay rather than go without <u>50 units</u> of this particular good or service.

The marginal value for the 50th unit, in this example, is $5. If the price is higher than $5 per unit, fewer units would be purchased; if the price is lower than $5, more units would be purchased. The average <u>total</u> willingness to pay for 50 units, however, is $7.50 per unit ($375 ÷ 50 units), and the average consumers' surplus is $2.50 per unit ($125 ÷ 50). The consumers' surplus for the 50th or marginal unit is zero. The $5 price (cost) is exactly equal to the value of the final unit consumed or taken.

When the quality of an environmental amenity, of the resource base, or of the facilities or services provided is improved, it will serve as an attractant to the recreation population. In essence, such an <u>improvement</u> will shift the demand curve to the right, as shown in Figure 3 with the shift of D_1

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[2]In this simplified example where the demand curve is a straight line, the consumers' surplus can be estimated using the formula for the area of a right triangle, 1/2 (base x height).

to D_2. Improvements in the quality of the good or service will cause consumers to desire more of that good or service at the same price. This holds for a recreation day at a particular site or facility the same way it holds for cars or microwave ovens. If restrooms are improved, attractive landscaping is added, a gravel access road is paved, additional boat ramps are added, increased water discharges clear up an algae problem, or fishing habitat is improved, both current and potential recreationists soon find out about these improvements. Some current recreationists will use that particular site or facility more often, and others who had not previously used the site or facility will begin using it.

Again referring to Figure 3, and assuming the cost per recreation day stays the same as in the previous example ($5), the recreationists will now take or consume (demand) 75 recreation days in a given time period rather than the 50 units previously taken. The amount paid, or the expenditure, is now $375. It includes the expenditure of $250 for the first 50 recreation days (area ABCD) plus 25 X $5 or $125 (area DCFG) for the additional 25 recreation days that would now be taken.

The area under the demand curve designated as consumers' surplus (area BHF) also has increased. It is now ($7.50 [12.50 - 5.00] per recreation day X 75 recreation days)/2 = $281.25; an increase of $156.25. Again, the total consumers' surplus of $281.25 represents the additional amount recreationists would be willing to pay rather than forego the opportunity to use the particular recreation area (site or facility) <u>75 recreation days per unit of time</u>. Of the $156.25 increase in consumers' surplus in this example, ($2.50 per recreation day X 25 recreation days)/2 or $31.25 (area CKF) results from the consumers' surplus associated with the 25 additional recreation days taken. The remaining $125 (area CEHK) results from an increase in the consumers' surplus associated with the first 50 recreation days of use previously taken.

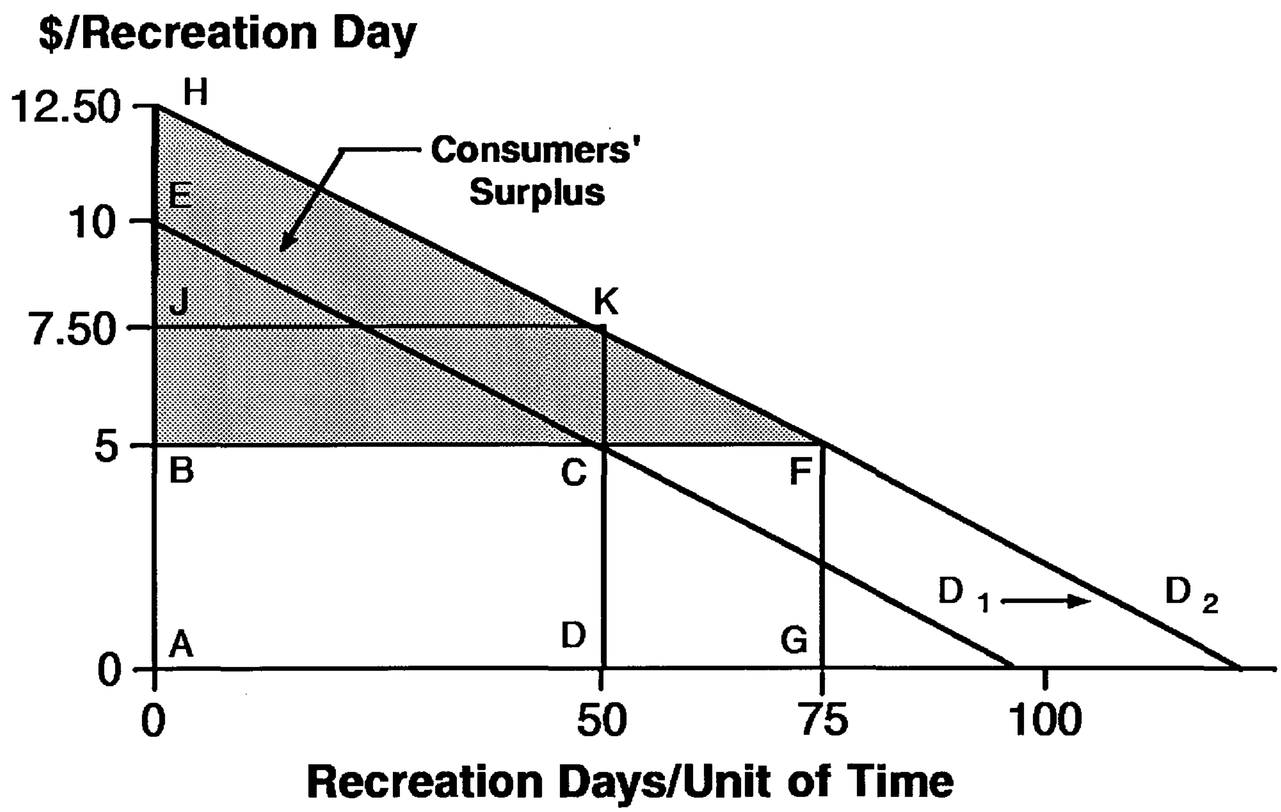

Figure 3. Shift in Demand Curve Due to Improvement in Quality

Benefit/cost analysis can be used to determine whether or not the improvement in quality is economically justified. In the above example, the change in consumers' surplus of $156.25 is the appropriate benefit measure to include in such an analysis.[3] This should be compared to the cost of the improvement, as well as any additional capital or operation and maintenance costs that would be required to support the increase in use. If benefits and costs continue over time, they would need to be projected and appropriately discounted.[4]

There may be occasions when the quality of the recreation experience declines. This could result from such factors as vandalism, inadvertent pollution, deterioration in facilities because of a decrease in operation and maintenance funds, an operational change in use of the water, or a drought affecting water levels.

Figure 4 illustrates the effect of such a degradation in quality. In Figure 4, the demand curve shifts to the left (from D_1 to D_2), signifying that recreationists will consume fewer recreation days of that resource (site or facility) at the same cost as considered previously. At a price (cost) of $5 per recreation day, only 25 recreation days will now be taken, compared to 50 days prior to the loss in quality of the recreation experience. The aggregate cost (expenditure) to the recreationists will be 25 X $5 or $125 (area ABFG), which is a decrease from the $250 of area ABCD. Similarly, the consumers' surplus will be reduced to $31.25, area BHF or ($2.50 [$7.50 - $5.00] X 25)/2, which is less than the $125 of area BEC.

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[3]This assumes that none of the $5.00 in expenditures is for entrance or user fees.

[4]A detailed discussion of discounting procedures is beyond the scope of this manual. The interested reader is referred to Chapter XI of the NED Procedures Manual - Urban Flood Damage (Davis, et al., 1988).

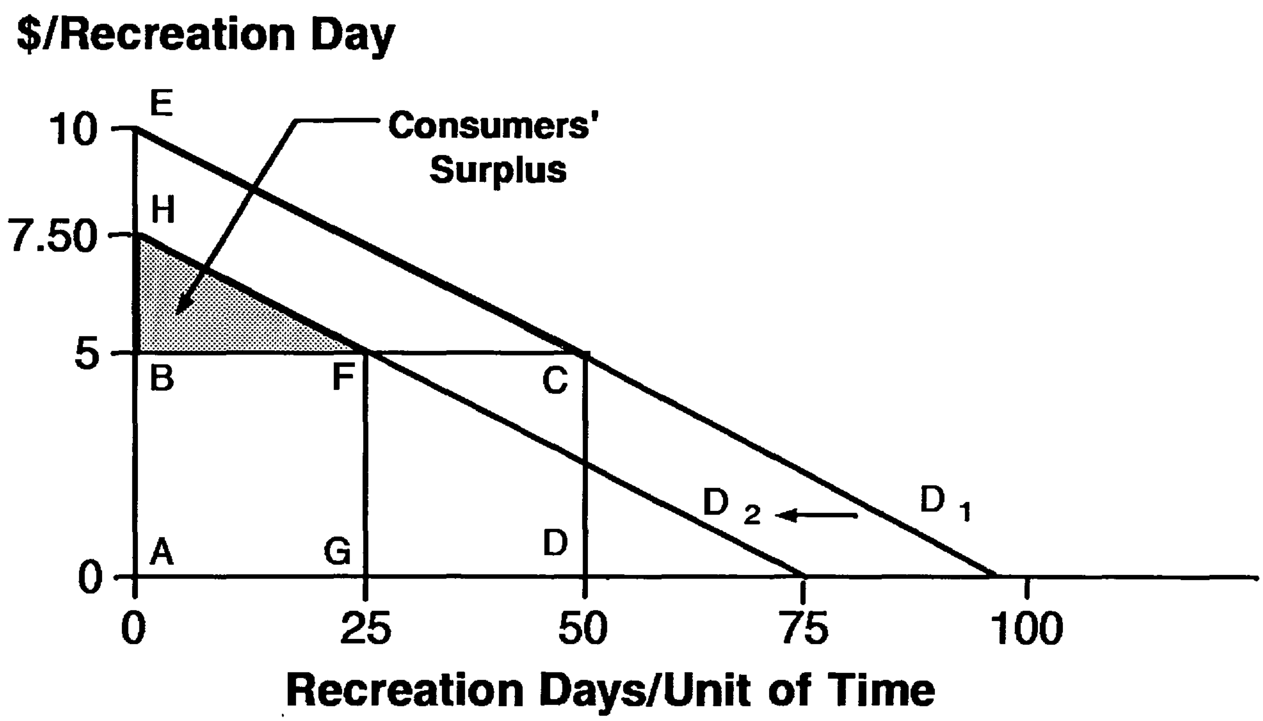

Figure 4. Shift in Demand Curve Due to Decrease in Quality

The previous discussion has illustrated, conceptually, how demand curves can be used to measure the NED benefits (changes in consumers' surplus) associated with qualitative changes in the recreation experience. Both the Travel Cost and the Contingent Value Methods can be used to empirically incorporate demand shifters into use and value estimation models. The general procedures for incorporating such measures are briefly described below; several actual applications from the literature are summarized in Chapter III.

GENERAL APPLICATION

In its most simplified form, the price-quantity (demand) relationship can be expressed as:

$$Q = f(P) \qquad (1)$$

Equation 1 states that the quantity demanded (Q) is a function of the price or cost (P). Such a relationship was graphically illustrated in Figure 2 and can be used to measure changes in consumers' surplus resulting from changes in the quantity of a good or service provided. However, to measure changes in consumers' surplus resulting from qualitative changes in the good or service, such as illustrated in Figure 3, a more comprehensive formulation of the demand relationship is needed. Such a formulation can be expressed as:

$$Q = f(P, D_m, A_n, S_o) \qquad (2)$$

Equation 2 states that the quantity demanded (Q) is not only a function of price (P), but also a function of: a vector of m socio-demographic variables (D), such as population, income, and education; a vector of n site attributes (A), which could include natural resource related variables, such as water quality, fish catch, and wildlife observed, and/or facilities or services provided, such as boat ramps, campgrounds, and ranger patrols; and a vector of o measures of the price and quality of substitute opportunities (S). The non-price variables (i.e., the D's, A's, and S's in equation 2) are demand "shifters," since they shift the price/quantity relationship to the right or left, depending on whether or not they have a positive or negative impact, respectively, on the demand for a particular good or service.

Conceptually, the amount and type of variables, or demand shifters, that can be included in a demand function are unlimited. Data limitations and resource constraints will, however, pragmatically limit the types and numbers of variables that can be included. Both the Travel Cost and the Contingent Value Methods can be used to estimate, or "quantify," the general relationship described in equation 2.

TRAVEL COST METHOD

The Travel Cost Method (TCM) is fully described in Volume I of the NED Procedures Manual - Recreation (Vincent, et al., 1986). It uses the variable travel cost individuals incur to visit a site as a proxy for price to determine net willingness to pay. Observations of use at existing sites are used to derive the price/quantity relationship. As such, there must be sufficient variation in the prices (travel distances) faced by different individuals to statistically estimate the relationship. Similarly, if shifters are to be introduced into the demand relationship to account for differences in the quality of the recreation experience, there must be sufficient variation in the qualitative measure faced by different individuals to statistically estimate the effect on the price/quantity relationship. For the TCM, this will typically require the availability or development of either a cross-sectional or longitudinal data base.

<u>Cross-sectional data.</u> Most travel cost studies that have included measures of the quality of the recreation experience have used cross-sectional data sources, that is, visitation data collected from several different recreation sites or areas over a similar time period. The sites or areas must exhibit significant differences in the measures of quality being valuated.

For example, as described in Appendix C of Volume I (Vincent, et al., 1986), a TCM was previously developed for lake recreation in the Corps Sacramento District. For this model, the size of the lake in surface acres during the normal recreation season was included as a measure of lake attractiveness. Visitation data were available for seven different Corps lakes with varying pool sizes. Multiple linear regression then was used statistically to separate the effect of pool size on visits (and value) from the effects of other variables. In the Sacramento model these other variables were population, price (measured in terms of travel distance) and a measure of the availability of substitute opportunities.

Longitudinal data. In some cases, TCM studies can take advantage of longitudinal or time series data. In such applications, visitation data are collected at the same recreation site or area over a period of time, during which a change (improvement or degradation) of a particular factor affecting the quality of the recreation experience is made. By comparing behavioral patterns before and after the change, the effect of the qualitative factor on both recreation use and value can be statistically measured.

Whether using cross-sectional or longitudinal data, the TCM is based on observations of actual behavior. Although this is considered as an advantage by some over the "contingent" questioning of the CVM, it does have some limitations. An important limitation is that the types of variables and ranges of values that can be tested statistically are limited to conditions that presently exist or have previously occurred, and for which origin-destination visitation data are available. For example, the normal recreation pools for the seven lakes in the Sacramento model ranged in size from 570 to 6,520 acres. This model could be used to evaluate other lakes in the area with pool sizes within this range with a high level of confidence. However, as with any such model, if it is applied to lakes outside this range, for example to valuate a lake with a pool size of 12,000 acres, there is less confidence in the results. Another limitation is that the TCM generally cannot be used to evaluate conditions, facilities or services not previously existing or provided. Documentation of visitor behavior under such conditions would simply not be available for model estimation.

CONTINGENT VALUE METHOD

The Contingent Value Method (CVM) estimates changes in NED benefits based on the willingness to pay and the level of participation by individual recreationists. This price/quantity consumed relationship is determined by directly asking individual recreationists (either through a mail questionnaire, telephone or personal interview) questions that indicate their willingness to pay for specific recreation opportunities.

As with the TCM, the CVM can be used in both cross-sectional and longitudinal studies. A CVM survey can be designed to elicit behavioral and/or valuation responses under varying qualitative conditions at many different sites or at the same site before and after a qualitative change. In addition, through the use of hypothetical scenarios, the CVM can elicit possible behavioral reactions and valuation information on potential changes in resource conditions, facilities or services not previously existing or provided.

The CVM consists of designing and using hypothetical markets to identify the value of recreational amenities, just as actual markets would if they existed. Three basic steps are involved: (1) the analyst establishes a detailed hypothetical market; (2) the analyst communicates that hypothetical market to the respondent and permits the respondent to "use" the hypothetical market to establish prices or values which reflect the respondent's individual valuation of the goods, services and amenities "bought" or "sold"; and, (3) the analyst treats the values reported by the respondent as individual values for goods, contingent upon the existence of the hypothetical market, and treats them, along with the data contained in the market description (step 1), as basic data for estimation of the aggregate value of the goods, services, and amenities.

The CVM specifically differs from the TCM in that, rather than being based on actual demonstrated behavior of users, it is based on their hypothetical, contingent behavior. The CVM is predicated on the assumptions that: (1) consumers can assign an accurate value to recreation experiences, and (2) this valuation can be directly elicited from them in response to a hypothetical scenario in a questionnaire. Successful application of the CVM requires a high degree of skill and precision in the development, pretesting, and administration of survey instruments to minimize the opportunity for biased or invalid response and to maximize the consistency and repeatability of results.

Some of the advantages of the CVM method are: (1) it obtains direct estimates of consumers' surplus and therefore is not dependent on historical use statistics or other types of historical data; (2) it is particularly useful for valuating small changes in quality and differences in management strategies; (3) it can be used to evaluate sites that may be one of several destinations visited on a single trip; and, (4) it can be used for sites or activities with insufficient variation in travel distance for using the travel cost method.

Specifically, CVM techniques can be used to obtain economic information from respondents (recreationists) on the actual dollar values they are willing to pay for improvement (or to prevent degradation) in the quality of the recreation experience. One of the keys, however, to a successful CVM application is being able to describe the impacts of management actions on the recreation experience in terms that can be perceived and understood by respondents.

Some management actions may be directly quantifiable and easily described to potentially impacted users. Examples include changes in the number or types of facilities such as campsites, boat ramps or beach areas. For other management actions, however, the impact may not be as explicit. For example, describing water quality improvements by percentage increases in dissolved oxygen or improved fisheries by an increase in stream flows in cubic feet per second would probably not be very meaningful to most recreationists. What is probably perceived by most recreationists is, for example, the additional opportunities (activities) provided by an improvement in water quality or an increase in the size or number of fish caught because of the improvements in the fishery. In the next chapter, specific examples are provided as to how such qualitative variables are defined and measured.

CHAPTER III

EXAMPLE APPLICATIONS

This chapter presents some studies which incorporate measures of quality into the value estimation models. They provide examples of how the recreationist's willingness to pay for improvements in the quality of the resource or environmental attribute can be measured. Selected studies using both the TCM and CVM approaches are discussed. The primary emphasis of this chapter is to highlight the approach used, rather than to emphasize the results or findings of the studies presented.

TRAVEL COST METHOD

EFFECTS OF TIMBER HARVESTING ON FISHERY

Loomis (1989) used a bioeconomic approach to analyze the change in value of recreational and commercial fisheries due to sedimentation from timber harvesting and road building in two national forests. The case study sites were the Siuslaw National Forest near Corvallis, Oregon, and the Porcupine-Hyalite Wilderness Study Area in Montana. Hydrologic models were linked with fisheries models to predict the change in catchable fish populations due to watershed disturbances from road building and timber harvesting. A travel cost model was then used to estimate the change in NED benefits that would result from alternative management actions that would impact the fish populations.

For the travel cost model, Loomis pooled cross-sectional data from several sites to estimate a recreation demand equation explicitly incorporating fish catch as a shifter (quality) variable. The data were collected from a survey of licensed fishermen and included information needed, not only to estimate the number of trips by area of origin typically included in a travel cost model, but also the total number of fish caught by the anglers. These latter data could be used to statistically estimate the effect of "fish catch" on the visitation rate for various sites from the cross-sectional data pool. The general form of the model used was:

$$\mathrm{Ln}(T_{ij}/POP_i) = B_0 - B_1(\mathrm{LnDIST}_{ij}) + B_2(\mathrm{LnFISH}_j) - B_3(\mathrm{LnSUBS}_{ik}) + B_4(\mathrm{LnINC}_i) \quad (3)$$

where: T_{ij} = trips from origin i to site j; i=1,...n; j=1,...m;

POP_i = population of origin i;

$DIST_{ij}$ = round-trip travel cost from origin i to site j;

$FISH_j$ = total fish catch at site j by all anglers;

$SUBS_{ij}$ = substitute index reflecting the relative price, quality and quantity of potential substitute sites for individuals in i for site j;

INC_i = average income of anglers from origin i;

B's = coefficients to be estimated; and

Ln = natural logarithm

The model was estimated using the double logarithmic form so as to impose the theoretically desirable condition of diminishing marginal impacts of fish catch on the visitation rate and, therefore, on the value per fish. The derived equation predicted a less than one to one proportional relationship between the number of fish caught and the number of trips taken. For example, for the Siuslaw case study, Loomis reported that, generally, a 10 percent increase in the number of catchable salmon resulted in an estimated 4-5 percent increase in the number of trips taken.

Recreational sport fishing benefits were first derived for existing conditions from the travel cost model for each site using the appropriate average fish catch data from the angler survey. To derive the sport fishing benefits under alternative management strategies (in this case levels of timber harvesting ranging from the natural condition of no logging to clearcutting), the effects of such strategies on the fish catch needed to be estimated. Loomis worked with National Forest Service planning teams to estimate the effects of alternative timber harvesting levels on sediment levels, stream temperatures, and other fishery habitat conditions, and the resultant impacts on catchable fish populations.

The estimated proportionate changes in catchable populations then were used to estimate new average fish catch measures for each of the management alternatives. By substituting the appropriate new fish catch measures for those occurring under existing conditions, estimates of the recreational sport fishing benefits associated with each alternative could be derived from the travel cost model.

The NED sport fishing benefits associated with each of the alternatives could then be estimated and comparisons made between alternatives. Those alternatives that improved the fishery habitat conditions, and thus the estimated average fish catch, shifted the resource demand curve to the right resulting in an increase in sport fishing benefits. Those alternatives that further degraded the habitat, resulting in a lower estimated fish catch shifted the resource demand curve to the left and resulted in lower NED sport fishing benefits. As noted by Loomis, net gains or losses in NED timber harvesting benefits also must be considered to fully evaluate the alternative management strategies.

In the Siuslaw National Forest, clearcutting on 87,000 acres would result in an estimated loss of around 84,000 salmon and 24,000 steelhead trout over the 30-year study period. Compared to natural (existing) conditions, an estimated economic loss of $2 million would accrue to recreational and commercial anglers from the clearcutting alternative. For the Porcupine-Hyalite Wilderness Study Area in Montana, the results indicated a $3.5 million loss in the value of trout fishing over a 50-year period from timber harvesting in the Gallatin and Yellowstone River Drainages.

Several improvements in this bioeconomic methodology are possible. The accuracy of the bioeconomic analysis can be improved if the fisheries models are more precise. Fisheries biologists currently are revising the fish-habitat models that Loomis relied upon for his study. Such revisions will lead to more accurate estimates of the losses to fisheries associated with increases in sedimentation.

EFFECTS OF CHANGES IN INSTREAM FLOW ON FISHERY

Maintaining adequate river flows for recreational fisheries is a major challenge for Federal and state water managers, in view of competing demands for water. Loomis and Cooper (1990) analyzed the economic benefits of changes in instream flow to fisheries on the North Fork of the Feather River in California. The recreationists' benefits were measured using a TCM demand equation. The level of fish catch was included as a quality variable, which was in turn a function of the stream flow. In other words, instream flow is an input to producing fishing quality.

River flow influences both the amount of water (such as wetted perimeter and depth of pools) and quality of habitat (such as water temperature). If fishing quality is measured as the total fish catch over a time period, it may be a function of both stream flow and the number of fishing trips to a site. A two equation system was estimated: (1) a trip demand and, (2) a quasi-supply or production function for fish catch. For the recreational site, the following generalized simultaneous system was specified:

$$TRIPS_{it}/POP_{it} = f(TRVCOST_{it}, INC_{it}, FISHCATCH_t, SUBS_i) + u_{it}, \quad (4)$$

$$FISHCATCH_t = f(FLOW_t, TRIPS_{it}/POP_{it}) + v_{it} \quad (5)$$

where:

$TRVCOST_{it}$ = transportation and time cost of traveling from origin i to the specified site in year t; i=1....n; t=1.....T;

INC_{it} = average household income in origin i in year t;

$FISHCATCH_t$ = river quality variable at time t;

$SUBS_i$ = price of substitute fishing site available to origin i;

u_{it} and v_{it} = random disturbance terms; and,

$FLOW_t$ = cubic feet per second (cfs) of flow in $year_t$.

Data for the study were collected using a short on-site survey of fishermen along six sections of the North Fork of the Feather River during 1981-1985. Information collected included the anglers' county of origin and creel data, including the number of fish kept.

Creel and origin-of-angler data, were available for each of the six river sections for each of the five years of study. The more typical cross-sectional analysis of multi-site differences could have been conducted with these area-of-origin data. However, flow data were only available for one river section, and the objective of the study was to determine the benefits of instream flow. Empirical estimates were presented, therefore, only for the river section (section 3, Rock Creek Dam to the Rock Creek power house) for which both stream flow and survey data were available. The five years of time-series data for river section 3 made it possible to estimate a single-site demand equation, incorporating river flow as a site quality variable.

For this study Loomis and Cooper used a nonlinear functional form to estimate the generalized demand and fishing quality equations (4) and (5) above. The areas of origin (i) were the 57 California counties from which visitation originated during the study period. The time periods (t) were the years 1981-1985. The travel cost was measured as a function of round trip distance to river section 3 from each area of origin, variable vehicle expenses such as fuel and repair costs per mile, the average number of passengers per automobile, and the opportunity cost of travel time in terms of a fraction of the wage rate. The income measure was the average household income in county i, in time t. Total fish kept in year t was the measure of fishing quality. Loomis and Cooper chose to model fishing quality as total number of fish kept, rather than catch per angler day. They believe, and other fishing research has shown (Sorg et al. 1985:5), that number of fish kept may be a better approximation of how anglers form their perception of a river's fishing quality.

The initial consumers' surplus (net economic benefits to anglers in river section 3) in 1981 was $108,465 for 4,721 angler trips, or a consumers' surplus per trip of $23.00. The average observed rate of flow was 101 cfs in

1981. Increasing the flow by 20 cfs increased the annual consumers' surplus by $1,458 to $109,923, or a marginal change for each 1 cfs of $72.90. Increasing the flow by 100 cfs increased the annual consumer surplus' by $5,672 to $114,137, or a marginal change for each 1 cfs of $56.72. Finally, increasing the flow by 200 cfs increased the annual consumer surplus' by $9,140 to $117,605, or a marginal change for each 1 cfs of $45.70. Anglers were willing to pay more for the initial increases in flow, but less for each increment as flow increases. The study also indicated a statistically significant relationship between flow and catch.

As noted by Loomis and Cooper (1990):

> To the extent that anglers represent most of the river's users and fishing quality is their dominant concern regarding stream-flow, fish stocking might be a viable mitigation option to offset below natural flows. Our simple bioeconomic model provides the information on the productivity of instream flow in producing fish and how anglers value additional fish caught.

This is not to say that instream flow is the only variable affecting fish populations or fishing quality, or that fish catch is the only variable affecting the quality of the recreational experience. The study does illustrate, however, how the interrelationships between management actions (flows), environmental effects (fish populations), and user behavior (recreational values) can be considered in a simplified valuation framework.

CONTINGENT VALUE METHOD

VALUATING QUALITATIVE DIFFERENCES IN ELK HUNTING IN MONTANA

Park, et al., (1991) report on evaluating the benefits for elk hunting in Montana under three different conditions: (1) an elk hunting trip under existing conditions; (2) an elk hunting trip where the chance of getting a trophy elk would be twice as good as under existing conditions; and, (3) an elk hunting trip where the hunter would see half as many other hunters as under existing conditions.

As noted by the authors, elk hunting in Montana is considered both a prized big game hunting experience and an increasingly scarce one. The state is known for providing a "wilderness" type experience, where hunts can take place in remote settings with few encounters with other hunters. Loss of habitat, through timber harvesting and other such activities, results in fewer opportunities to harvest a trophy elk (defined as one having antlers with six or more points), and to participate in a wilderness hunting experience. Information on the value to hunters of improving their opportunity to bag a trophy elk or to participate in a wilderness hunting experience could assist in valuating alternative timber harvesting and habitat management programs.

Data were collected from a sample of all resident and non-resident hunters with the appropriate Montana big game hunting license and elk tags for the fall 1986 season. Survey administration was based on the Total Design Method developed by Dillman (1978). This included an initial questionnaire in booklet form mailed to the sampled hunters. This was followed first by a postcard reminder, and then a replacement survey to remaining non-respondents. The response rate was 73% after adjusting for non-deliverable questionnaires.

For the contingent value portion of the questionnaire, each respondent was asked a series of three questions concerning willingness to pay for different hunting experiences. The dollar amount was phrased as an increase in "$X" in trip costs. The dichotomous choice or referendum format was used. With this format, respondents were asked whether or not (yes or no) they would still make a trip under the described conditions (scenario) if they had to pay $X more in trip costs than their current actual costs. The $X amount was varied among respondents.

The first contingent value question concerned their most recent trip. It provided an estimate of the benefit (additional willingness to pay) for hunting trips taken under existing conditions. The second scenario described an improvement in the chance of bagging a trophy elk. Respondents were asked whether they would still have made their last trip if everything else had been the same, except that their chance of getting a 6-point or better bull elk would be double AND their trip costs would be $X more than their current actual costs. The final scenario concerned encounters with other hunters. Respondents were again asked whether or not they would still have made their last trip if everything else had been the same, except that they would see half as many hunters as they actually did AND their trip costs would be $X more than their current actual costs. As with the first scenario, the $X amounts were also varied among respondents for the second and third questions.

In their analysis, the authors include a discussion of the comparison of functional forms (linear versus logarithmic) and of a normalization procedure which are beyond the scope of this manual. For illustrative purposes, only their findings from the analysis of the logarithmic functional form are presented here. The specification for the logarithmic logit[5] model used in their analysis was:

$$YPAY = \alpha_0 + \beta_1 \ln(BID) + \beta_2 \ln(INC) + \beta_3 \ln(ELK) \qquad (6)$$

where:

YPAY = hunter's yes/no response (YES = 1; NO = 0) to the willingness to pay question;

BID = increase in trip costs the hunter is asked to pay for the alternative hunting condition;

INC = income of the elk hunter

ELK = number of elk seen on the most recent hunting trip.

Maximum-likelihood estimates of the above model were derived for each of the three levels of hunting experience. The estimates were of the amount they would be willing to pay above their actual costs. The mean willingness to pay results were \$126 for current conditions, \$179 for doubling the chance of getting a trophy elk, and \$141 for reduced crowding conditions (fewer contacts with other hunters). With the logarithmic model, the authors reported the mean willingness to pay for getting a trophy elk, based on 95 percent confidence intervals, was significantly higher than both the mean willingness to pay for existing and reduced crowding conditions. Although the mean willingness to pay for reduced crowding was higher than that for existing

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[5]Logit is a special form of regression analysis that can be used when the dependent variable is measured in discrete (for example, yes = 1; no = 0), rather than continuous, terms. In this application the logit model estimates the probability of receiving a yes answer to various hypothesized increases in trip costs (willingness to pay). The area under the resulting logit curve is a cumulative probability function and is used to estimate the maximum likelihood willingness to pay. For those readers familiar with flood damage analysis, the logit curve is similar to the flood damage/frequency curve; and the maximum likelihood estimate is similar to expected annual flood damage.

conditions, the difference was not significant, again based on a 95 percent confidence interval.

The results of the elk hunting analysis relate a change in user values to a change in the recreation experience (in this case a change in crowding or harvest). To valuate a specific management action (e.g., a change in timber harvest practices) requires an estimate of how the management action would impact environmental factors (e.g., available habitat, hunting area, or size of elk herds), and ultimately those quality factors of the recreation experience included in the analysis.

VALUING WETLAND RECREATION BENEFITS

The continued loss of wetland areas to agriculture, development, and other activities is an issue of increasing concern. In a study for the Corps New Orleans District, Stoll, et al., (1989) state that considerable research has been devoted to identifying and quantifying major wetland functions, such as support of commercial fish and shellfish stocks, waste assimilation, and flood control. The support of outdoor recreation, however, is a wetland function that has received limited economic research attention.

The authors note, that to be useful for applied benefit-cost analysis, economic values must be linked to specific variables over which natural resource management agencies have control. They state the fundamental question of interest as: "How does a project induced change in wetland characteristics impact the net benefits derived from wetland-based recreation?"

The study was conducted in a large wetland area along the coast of Louisiana during the 1985-1987 period. Wetlands in this area are heavily used for varied recreational activities including: waterfowl hunting, saltwater fishing, freshwater fishing, recreational shrimping, and recreational crabbing. According to the authors, biological studies have shown that wetlands acreage is directly related to waterfowl, fish, and shellfish populations. Any loss of wetlands in the area is expected to directly impact bag or catch and, therefore, the recreation experience. The economic benefits of wetlands preservation are partially represented by the recreationist's willingness to pay for higher levels of bag or catch than would otherwise occur.

Data for the study were collected from a two-stage sampling process. To estimate annual use of the marsh, an intensive on-site interview was conducted at 80 access points. As part of this initial survey, respondents were asked if they were willing to be surveyed by mail at a later date. Approximately 95% of those interviewed agreed to participate in the later survey.

The subsequent mail survey included the contingent valuation scenarios and questions. Respondents were asked to value alternative wetlands protection programs using a series of referendum style questions (yes or no to a specific dollar amount). As described by Stoll, et al., (1989):

> Respondents were asked to assume that without the program, continued wetlands loss would eventually reduce their average bag/catch per day to zero. Thus, the "without" program scenario was a zero level of average bag or catch per day. The "with" program scenario was a positive level of bag/catch per day. In particular, respondents were asked to value three "with" program scenarios.

The three scenarios used were preserving bag or catch at current levels, at a decrease to 50% of current levels, and at a decrease to 25% of current levels.

The mail survey instrument was administered using Dillman's (1978) Total Design Method previously described. A total of 3,842 questionnaires were mailed. After adjusting for questionnaires returned because of bad addresses (163) and for blank questionnaires (29), the response rate was 55.2% (2,030).

A valuation model was estimated from the survey data and included the variables defined in Table 1. The general form of the model was similar to the previous elk hunting example (equation 6) except that many more explanatory variables were included. Once again, the model estimates the probability of a "YES" response to the CVM willingness to pay question. As described by the authors, mean willingness to pay for wetlands-based recreation was estimated by integrating[6] the resulting equation from zero to the maximum posted-price in the CVM survey. The integration results indicate an annual willingness to pay of $330 per recreationist to prevent wetlands loss. The authors interpret this value as the current annual value per user of wetlands-based recreation in the study area.

The researchers further indicate that with their estimated willingness to pay function (the valuation model), total value curves can be derived for recreational wetland use on an annual basis under varying bag/catch per day conditions. That is, changes in willingness to pay can be estimated based on changes in one or more of the bag or catch interaction variables defined in Table 1. They illustrate this procedure with a hypothetical example. Critical to such valuations is being able to predict the impact of physical alterations on the biological populations, and ultimately the change in the recreationist's bag or catch rate.

[6]A mathematical procedure for deriving the mean willingness to pay directly from the regional value estimating model.

Table 1. Definition of Variables Used in Valuation Model

Variable	Definition
OFFER	= natural logarithm (log) of posted-price
TDAYS	= natural log of annual waterfowl hunting, freshwater fishing, saltwater fishing, recreational shrimping, and recreational crabbing days
WHDUM	= indicator variable for waterfowl hunting participant (1 = YES; 0 = NO)
WHINT	= waterfowl bag interaction variable (product of natural log of waterfowl bag per day and WHDUM)
FFDUM	= indicator variable for freshwater fishing participant (1 = YES; 0 = NO)
FFINT	= freshwater fish catch interaction variable (product of natural log of average freshwater fish catch per day and FFDUM)
SFDUM	= indicator variable for saltwater fishing participant (1 = YES; 0 = NO)
SFINT	= saltwater fish catch interaction variable (product of natural log of average saltwater fish catch per day and SFDUM)
RSDUM	= indicator variable for recreational shrimping (1 = YES; 0 = NO)
RSINT	= recreational shrimp catch interaction variable (product of natural log of average recreational shrimp catch per day and RSDUM)
RCDUM	= indicator variable for recreational crabbing (1 = YES; 0 = NO)
RCINT	= recreational crab catch interaction variable (product of natural log of average recreational crab catch per day and RCDUM)
INCOME	= natural log of annual income
EQUINDEX	= aesthetics/environmental quality index
TYPE	= indicator variable for primary reason for hunting or fishing in wetland (1 = catch or bag fish and wildlife; 0 = other)
PERSPEND	= natural log of percentage of annual income spent on recreation
CLUBMEM	= indicator variable for membership in an outdoor club (1 = YES; 0 = NO)
CONGEST	= natural log of nonrecreational boats seen per mile per day
ACCESS	= natural log of time spent waiting at boat launch and traveling to site
PERYEAR	= natural log of percentage of lifetime spent recreating in the wetland study area

Source: Stoll, et al. (1989)

INTERDISCIPLINARY MODELS

The previous examples describe recent applications of the Travel Cost and Contingent Valuation Methods in estimating the value of qualitative changes in the recreation experience. They indicate how environmental impacts and impacts on recreation facilities or services can be quantified for at least one impacted population, recreation users. These studies have implicitly, if not explicitly, noted that valuating management actions requires an interdisciplinary effort to understand complex interrelationships between physical conditions, biological communities, and human perceptions and behaviors. Most valuation studies concentrate on modelling this latter human behavioral component. Few have attempted to operationalize the entire cause/effect relationship, for example, linking interrelated hydraulic, biologic, and behavioral models.

An exception is an on-going effort to develop an interdisciplinary planning model for water and fishery management in New Mexico. RIOFISH is a comprehensive simulation model incorporating and interfacing hydrologic, ecologic and economic modules (Cole, et al., 1990A, and Green-Hammond, et al., 1990). It was developed for 16 large reservoir fisheries of the Rio Grande and the Canadian, Pecos and San Juan Rivers. The effort is summarized by Cole, et al. (1990B) as:

> . . . the development of an interdisciplinary model that analyzes the effects of resource management decisions on New Mexico fishery production, yield, sportfishing effort, and economic benefit to anglers. The model recreates river flows and materials transported through reservoirs and their tailwaters from 1974 through 1987. Solar radiation, water temperature, phosphorus, nitrogen, suspended solids, and water exchange rates determine primary production. Organic loads from watershed sources, added to primary production, form a trophic base for sportfish forage. Fish production is partitioned into biomass and growth of each age class in sportfish and forage fish groups by differential

responses to food type, light, water-level fluctuation and predation. Fish biomass, with angler population distribution and site condition, contributes to determining angler effort and economic benefits. Model users can vary and analyze water level and quality, stocking, fishing regulations, site access, site facilities, and site entry fees.

As stated by the authors, the principal objectives for developing RIOFISH were: 1) simulate fisheries of major reservoirs and, to a lesser extent, connecting rivers in the main river basins of New Mexico; 2) estimate past fish yields, angler effort, and angler benefits; 3) simulate fish population structure, growth, and survivorship in river and reservoir habitats; 4) enable users to model economic impacts of changes in habitat conditions, stocking rates, harvest regulations, angler access, angler populations, and facilities as affected by potential management decisions; and, 5) make the group of models user friendly and operable on microcomputers.

Development of a simulation model like RIOFISH is a comprehensive interdisciplinary effort, requiring a large commitment of time and resources. The development of RIOFISH was initiated in 1980, and is presently considered at an ". . . advanced intermediate stage, ready to be structurally completed as a comprehensive statewide planning tool (Cole et al., 1990A)." Obviously, this level of effort is not possible for most Corps planning studies or operations decisions. It is, however, demonstrative of the type of interactive, multi-disciplinary analytical model that can be developed. Possibly even more importantly, it is illustrative of the types of physical, biological, and behavioral interactions that need to be considered in valuating alternative water resource management plans.

SUMMARY

As demonstrated by the examples described earlier, techniques are available to estimate the value of qualitative changes in recreational opportunities and experiences. Incorporating these measures into the valuation of alternative management actions, however, often still requires qualitative predictions of the actions' impacts on physical and biological conditions, and ultimately on recreation amenities that impact user behavior. The importance of clearly defining without- and with-project conditions and the potential interactions between physical, biological, and human activity can not be overstated. Management actions and resulting environmental impacts will often impact on recreational behavior in a manner that can be quantified. However, the precision of such estimates requires an interdisciplinary effort, providing outputs of engineering and biological studies in a usable format for input to the economic evaluations.

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