Integrating Economics into Natural Resource Planning Involving Fish and Wildlife Habitat

By

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Report No. 84-1

Alaska Department of Fish & Game
Division of Habitat

Errata

P. 8, lines 5 and 6: " are elastic" should read "arc elasticity."

P. 10, fig. 1: "Quantity" should read "Quantity per Unit of Time."

P. 20, fig. 2: add item F. Estimated Effects of Alternatives.

P. 21, B.: "Development of Planning Criteria" should read "Identification of Planning Criteria."

P. 21, lines 22 and 23: "relations" should read "regulations."

P. 23, line 11: "Projects" should read "Projections."

P. 23, line 13: "Economic demographic" should read "Economic and demographic."

P. 26, H.: "Selection of Alternative" should read "Selection of Preferred Alternative."

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INTRODUCTION

Increased population and other developmental pressures on Alaska's resources are causing more and more concern with respect to their impacts on fish and wildlife habitats. Although some forms of habitat modification may enhance fish and wildlife productivity or social well-being through providing greater accessibility, there are many cases where the habitat's carrying capacities are likely to be diminished by land use changes. Optimal allocations require that adequate consideration be given to all the resources and potential uses involved. Since economics constitutes that body of knowledge concerned with the allocation of scarce resources to satisfy human wants, it is a discipline that should be fully utilized in the process of planning for the uses of natural resources. It should be emphasized that problems of allocation occur both within and outside the market mechanism[1] and that economics is thus not limited to monetary measures of value alone. Too often economic reasoning is greatly underutilized because planners consider economics to be synonymous with the study of money or money-related fields or limited to simplistic "theory of the firm"[2] concepts.

Resource allocations are influenced by social, political, and psychological considerations, as well as by economics. In fact, as one delves more deeply into the social sciences, the distinctions among these academically defined disciplines become more obscure. Thus, such concerns as social welfare or social well-being are apt to fall within the scope of several disciplines.

1 "Market mechanism" refers to the determination of price and the quantity produced and consumed through the forces of supply and demand.

2 "Theory of the firm," or microeconomics, deals with individual firms or single industries. In its simpler formulations, it is based on many dubious assumptions.

In order to make economics an effective component of natural resource planning, it must be fully integrated into the process and not merely appended as an afterthought. In all too many cases, economists become involved only after resource allocations are made and then are asked to justify these allocations on the basis of some narrow definition of efficiency. Since economic efficiency had not been an objective throughout the planning process, it could be achieved only by chance, and it is extremely unlikely that any resulting plan would approach the optimal in this respect. If economic efficiency is a worthy objective, it must be considered throughout the planning process. Furthermore, efficiency is only one aspect of economics.

Economic efficiency as traditionally measured, however, may not always be an appropriate criterion for effective resource allocation - that is, equity may also be an appropriate concern. Techniques such as benefit-cost analyses are often misapplied to situations where the maximization of the ratio between discounted benefits and costs over time[3] is not a legitimate objective. This is often the case in the public sector, where such considerations as economic stability, providing social and merit goods,[4] and income distribution have been given priority as the result of socio-political forces.

The function of this report is to provide a primer on the use of economics in natural resource planning, with special emphasis relating to fish and wildlife habitat. Initially, economics will be placed in the context of the planning process as it involves fish and wildlife habitat planning so that practitioners can more readily interpret economic measures and judge the appropriateness of specific analytical techniques. Although there will be some discussion of specific approaches and analytical techniques, it is not the intent to provide a "Cookbook" or mandate the use of any particular methods. The intent is merely to discuss some techniques of economic analysis and place them in the context of the overall planning process.

3 Maximizing the ratio between discounted benefits and costs over time is not even an effective efficiency measure. Efficiency is best measured in terms of net benefits - i.e., maximizing the difference between discounted benefits and costs.

4 "Social goods" are public wants that are not satisfied through the market allocation process because their enjoyment cannot be made subject to payment of a designated price. "Merit goods" represent public wants that can be allocated through the market but are considered so meritorious that they are provided through the public budget over and above that which would have been provided through the market.

First, some general concepts of economics will be examined so that the reader can gain a better understanding of how specific approaches fit into an overall economic analysis. For instance, one should understand the implications of consumer's surplus in order to understand some techniques, such as the "travel cost method," for evaluating recreation.

Next, there will be a brief review of the economics of the public sector. As previously mentioned, there has been a large body of knowledge developed on this subject, and it is extremely relevant to the management of fish and wildlife. Unfortunately, much of this knowledge has yet to be widely applied to natural resource planning in Alaska.

Before specific techniques are addressed, it is essential that economics be examined in the context of natural resource planning, with special emphasis on fish and wildlife. The understanding derived therefrom is necessary in order for one to be able to judge the appropriateness of specific techniques to satisfy the needs of various phases of the planning process.

With the basis for a better understanding of how economics fits into the planning process having been provided, some specific techniques will receive a cursory examination, emphasizing what is being measured, its implications for the overall planning effort, and the strengths and weaknesses of each technique. The need for reliable data on underlying physical and biological interrelationships will also be stressed. Means of dealing with data shortcomings and uncertainties will be discussed as well.

It should be understood that the interrelationships between mankind and the earth's natural resources are so complex in many instances as to be incomprehensible to the human mind. As a result, attempts are made to explain complex situations through the use of simplified models. Although such models can be extremely useful planning tools, their limitations within the context of the overall planning effort must be realized. Rather than looking for "the

answer," we must realistically consider a range of probable outcomes and identify which are critical to the decision-making process.

It is understood that the users of this report will bring to it varying backgrounds in economics. Since there is neither sufficient time nor space to convey the fundamentals of economics in detail herein, a list of recommended additional readings has been prepared. The list is designed to assist both those who desire to gain a better understanding of the elements of economics and those who may wish to obtain additional information on some of the techniques discussed. The reference section pertains to sources used in the preparation of the report, but a more complete and partially annotated bibliography on economic evaluation of fish and wildlife has been prepared by McLean (1984).

I. BASIC CONCEPTS

Although this primer is not intended to delve deeply into microeconomic theory, a basic understanding of the market allocation mechanism (supply and demand) and the role of the public sector is essential to the application of economics to planning issues related to fish and wildlife habitat. In reality, the United States has a mixed economy, with both private (market) and public (government) sectors. The interrelationships between these two sectors can be a major consideration in fish and wildlife habitat planning.

A. Market Economy

In terms of the allocation process the market is not a physical place but a medium in which the forces of supply and demand interact. Neither supply nor demand refer to set physical quantities but to functional relationships. Even in highly competitive markets the equilibrium price resulting from the intersection of supply and demand curves and observed prices may diverge in the short run because of imperfect knowledge in the market. Thus, real prices will tend to move toward the equilibrium position over time through higgling between buyers and sellers, but the two may actually converge only during periods of long-run stability. As a result, short-run price variations are apt to exist for homogeneous products, even at the same location.

In competitive markets, prices for homogeneous goods and services tend to vary by location. The price received for a commodity at the place of production is reduced by the cost of transporting it to the place where it is sold. By the same token, the cost of transportation for consumers to reach a resource, as is generally the case in the recreational use of fish and wildlife, tends to reduce the market value of that resource. Thus, the more distant a resource is from the users, the lower its market value will tend to be because

of the transportation costs of bringing the resource to the people or the people to the resource. Bear in mind, this discussion pertains to a situation in which the resources in question are perfect substitutes for one another.

Although pricing of homogeneous products may appear complicated, the situation becomes conceptually more complex when differentiated goods and services are considered. Whereas one king salmon steak may be considered a nearly perfect substitute for another of equal quality, this is seldom the case for recreational fishing opportunities. In the latter case, a fishing opportunity in one geographic setting may differ significantly from a similar opportunity in another. Even if such differentiation exists only in the mind of the user, it can be an important factor in consumer preference. If one fishing opportunity is not a perfect substitute for another, many of the traditional precepts associated with market behavior for homogeneous products are no longer valid. The situation is made even more complicated because recreational opportunities appear to consist of packages of differentiated services rather than a single service.

1. Demand. In elementary economics textbooks, demand is generally treated as a function of price under some usually unexplained ceteris paribus (all else remaining the same) conditions. Unfortunately, a lack of understanding of these conditions can lead to serious misinterpretations. In a more realistic sense, demand can be expressed by the equation

$$Q = F(X_1, X_2 \cdots\cdots\cdots X_n)$$

where Q is the quantity demanded and X_1 to X_n represent independent variables, which may include price but are not limited to it. Other factors influencing the quantity demanded

may be real consumer income, the prices of other goods and services, and the tastes and preferences of the consumers.

In the traditional textbook approach, all factors except X_1 (price of the commodity) are held constant, this being the ceteris paribus condition. In actuality, one could hold price constant and vary one of the other factors or permit all factors to vary, in which case demand would be expressed as a multidimensional surface rather than as a single line. For instance, when forecasting, it is often more convenient and more meaningful to hold price constant and establish the relationship between consumption and some of the other independent variables, such as population, income, or days of paid vacation.

In some resource management situations there may be insufficient information or need to empirically establish demand functions, but the demand side can still be considered in terms of the market price. If the producing unit is not of sufficient magnitude to influence the market, the price may be taken as a given that the firm must meet in order to sell its output. In other words, the demand function faced by the producing unit is perfectly elastic. For example, if the market price for Alaskan groundfish is $.08/lb, Alaskan firms must produce at that cost or lower if they are to be economically viable. Buyers have the option to procure their groundfish from other regions of the world at the established market price, adjusted to allow for transportation costs, so that there would be no reason for them to pay a higher price for the fish.

The term "elasticity of demand" refers to the responsiveness of the quantity demanded to a change in one of the independent variables determining demand. Thus, price elasticity of demand

measures the sensitivity of a demand response to a change in price. By definition, price elasticity of demand is the percentage change in the quantity demanded divided by the percentage change in price when the price change is small; there are complications when price changes are large (are elastic), but this situation will not be discussed here. In the case where demand is elastic (elasticity greater than 1.00), a small decrease in price results in a more than proportional increase in the quantity demanded so that total revenues for the industry increase. For example, a price reduction for canned pink salmon (elastic demand) would result in greater total revenues because the decrease in price is more than offset by the additional sales that would result. By -contrast, if the demand for a product is inelastic (elasticity -less than 1.00), a small decrease in price is accompanied by less than a proportional increase in the quantity demanded, and therefore total revenues decrease.

Several factors affect price elasticity. Availability of substitutes can obviously have a pronounced effect. If, for example, consumers have no decided preference for either canned tuna or canned salmon, a price increase in the latter would be apt to increase tuna consumption at the expense of salmon consumption. Of course, the price of the commodity relative to consumer income is also an important factor. In fact, income elasticity is considered a more relevant factor than price elasticity in some cases. The versatility of the product - that is, the number of uses to which it can be put, can also influence elasticity, more uses tending to reduce elasticity. Finally, the position of the commodity price on the demand curve (upper end or lower end) can also influence elasticity, this being a purely mathematical determinant.[5]

5 If the market price is toward the upper end of the demand curve, demand is more likely to be elastic than if it is located toward the lower end. This results purely from mathematical relationships, and its validity is dependent upon the shape of the demand curve. Obviously, the percentage change in price will tend to be small at the upper end of the demand curve, since the base is large; and the percentage change in quantity will tend to be large, since the quantity base is small. Thus, a large percentage change in quantity divided by a small percentage change in price reflects an elastic demand. The opposite situation is likely to prevail at the lower end of the demand curve.

With respect to substitution, "cross elasticity of demand" represents a measure of the extent to which goods and services are related to one another. For example, increased outputs of canned red salmon may result not only in lower prices for that product but may also cause a decrease in the price for canned pink salmon. Furthermore, lower red salmon prices may also cause a decrease in the price and consumption of canned tuna.

Demand curves are temporary in nature; that is, they represent a relationship during a specific period in time. Therefore, the time during which a demand function is relevant depends on the degree of market stability. Both the shape and position of demand curves are likely to change over time. As a result of changes in the variables assumed to be held constant under the ceteris paribus condition, demand curves are likely to shift as time passes and conditions change. The difficulty of distinguishing movement along the same demand curve from shifts to new demand curves is responsible for the so-called "identification problem." Thus, empirically establishing demand curves for salmon sportfishing opportunities over a multiyear period is difficult because population growth and changes in other factors cause shifts to new demand curves rather than movement along the same curve.

"Derived demand" refers to "a demand on the part of producers that is derived from consumer demands for other goods and services" (Duerr 1960). Processors of canned red salmon may be directly responsive to consumer demand, but the situation faced by commercial fishermen is based on the demand of these processors for a primary input, the fish. Compared to the consumer demands from which they originate, derived demands tend to be more inelastic.

"Consumer's surplus" is another concept related to demand that deserves special mention because it is often used as a measure of social well-being, or social value, particularly in relationship to recreational activities such as hunting and fishing. Consumer's surplus is the net value between the total consumers are willing to pay and what they actually do pay for a good or service. In figure 1, DEF represents a market demand curve and SET a supply curve.[6] The forces of supply and demand are at equilibrium at E, where the market price is P and the quantity produced and consumed is Q. Total revenue received by the industry is represented by the rectangle OPEQ (i.e., the price multiplied by the quantity produced/consumed). The triangle PDE represents the amount that consumers are willing to pay for the commodity over and above what they actually do pay, this being the consumer's surplus. Triangle PES represents the amount that producers receive above the price at which they were willing to provide the commodity, this value being called "producer's surplus."

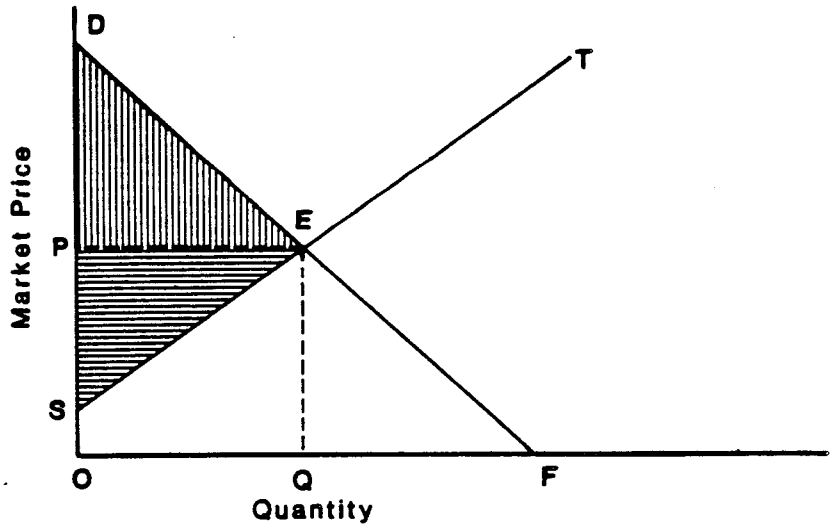

Figure 1. Hypothetical demand and supply curves illustrating consumer's surplus and producer's surplus.

6 The supply curve represents the functional relationship between the quantity supplied and the price.

Consumer's surplus alone or consumer's surplus plus producer's surplus are often used as measures of net social benefit. Estimates of consumer's surplus are frequently relied upon to evaluate fish and wildlife, especially where nonmarketed recreational uses are involved. Nonetheless, it should be noted that considerable controversy exists regarding consumer's surplus as a measure of net social benefits. The limitations of the consumer's surplus are well expressed by the renowned welfare economist, I.M.D. Little (1963):

> The great trouble with any consumer's surplus criterion is that one does not know, even after the event, whether the criterion was satisfied. In fact, the plain truth is that it does not yield us a criterion at all--or if it can be said to yield a criterion, then it is one which is open to anyone's interpretation within very wide limits.
>
> To the above objections we may add that we have in this chapter been supposing that individuals are all 'economic,' and never die; thus the great difficulties concerned with the application of the whole welfare system to the real world must be added to the particular difficulties associated with consumer's surplus. Even then, we have only been using the theory to estimate whether the 'gainers' could overcompensate the 'loosers,' ignoring the factor losses and rents (i.e., assuming that amounts and kinds of work are perfectly divisible), external economies and diseconomies, and the distribution of real income.
>
> Our conclusion is that consumer's surplus is a totally useless theoretical toy. . . .

Other economists have argued that consumer's surplus, at least from a practical standpoint, can provide a useful measure of social well-being (Willig 1976). Nevertheless, analysts and planners should bear in mind that consumer's surplus is an incomplete measure of social value. In summary, the following express the limitations of consumer's surplus as a measure of social well-being:

a) The consumer's surplus criterion theoretically operates only in a general equilibrium situation, which in turn exists only under conditions of pure competition. Human perceptions of fish and wildlife more closely approximate the monopolistic competition model; that is, they involve differentiated products or services. Under the latter situation, general equilibrium does not occur, if, indeed, it does occur ever in reality.

b) Externalities[7] are not captured within the context of traditional supply/demand relationships, but they are nevertheless important components of social well-being.

c) Empirical evidence on the shape and magnitude of demand curves is seldom available, with the consequence that the measure of consumer's surplus is most often based on rather arbitrary assumptions.

2. Supply. As in the case with demand, the supply function represents a complex relationship among several variables. The physical availability of a resource is only one factor. The overall cost of production, including transportation costs, must be taken into consideration when determining if a viable market supply exists - that is, a resource that can be extracted, processed, and transported to the marketplace at a competitive cost.

Under the traditional ceteris paribus conditions, the supply curve represents the horizontal summation of the supply curves of all the individual firms in an industry. The supply curve for an individual firm is that portion of their marginal cost curve that rises above the average cost curve. Under the static ceteris paribus situation, an increase or decrease in

7 A benefit or undesirable effect that occurs to an entity as a result of an action initiated by another entity over which the recipient entity has no control. For example, people living downstream from a pulp mill may suffer from pollution effects but have no control over the pulp mill's actions, nor does the pulp mill bear any of the associated loses or costs.

the physical resource implies a shift from one supply curve to another, rather than a movement along a given curve. This can be an important consideration when weighing the economic effects of a habitat alteration affecting fish or wildlife populations.

As with demand, the responsiveness of the quantity supplied to price changes is measured by elasticity. It is determined by dividing the percentage change in the quantity supplied by the percentage change in price.

Underlying the cost curves and, thus, the supply curves is the production function - the physical relationship between inputs of resources and outputs of goods and services per unit of time. By applying price information to these data on inputs and outputs, costs and revenues can be calculated for different levels of output. Without sound information on the basic physical interrelationships, the task becomes formidable, if not impossible. For example, attempting to determine the cost effectiveness of a project to increase moose populations through manipulation of habitat by means of prescribed burning would surely be futile if the effect of the treatment on the moose population cannot be quantified. Cost records might be maintained and imputed moose values developed, but they would serve little purpose if the basic data are not available on the biological-physical interrelationships anticipated.

Before concluding the discussion of the private sector, some shortcomings in the application of traditional microeconomic theory to real planning situations should be mentioned. The traditional price competition model assumes that both producer and consumer have a high degree of knowledge concerning the market, even to the extent that they can see into the future.

In reality, consumption and production decisions are made under a veil of risk and uncertainty. Rather than having the luxury to maximize "profits" or personal utilities, decision makers must consider the relative probabilities that will permit them to be net gainers (not necessarily maximum net gains) rather than net loosers. In fact, the traditional approach is not particularly informative regarding whether its "profit maximization" objective is a long-run or short-run consideration; the two can be in conflict.

B. Public Sector Economics

Although the western democracies are generally described as being capitalistic, they actually represent mixed economics with significant public sectors; that is, one-third or more of their economic activity occurs in the government sector. There are situations in which the market mechanism simply does not act as an effective allocator of resources (national defense) and other situations where social concerns outweigh the narrow definition of economic efficiency (public education). In such cases, the political process rather than the market provides the major allocative thrust, although efficiency may remain a consideration.

The roles of the public and private sectors of the economy are well described by Musgrave and Musgrave (1976).

> The market economy, provided certain conditions are met, serves to secure an efficient use of resources in providing for private goods. Consumers must bid for what they wish to buy, and they thus reveal their preferences to producers. Producers, in trying to maximize their profits, will produce what consumers want to buy and will do so at least cost. Competition will assure that the mix of goods produced corresponds to consumers' preferences. This view, of course, is a highly idealized picture of the market system. In reality, various difficulties arise. Markets may be imperfectly competitive, consumers may lack sufficient information, and so forth. For

these reasons, the market mechanism is not as ideal a provider of private goods as it might be. But even so, it does a fairly satisfactory job.

At the same time, the market cannot solve the entire economic problem. For one thing, it cannot function effectively if there are "externalities," by which we mean situations where consumption benefits cannot be limited and charged to a particular consumer and those where economic activity results in social costs which need not be paid for by the producer or the consumer who causes them. For another thing, the market can respond only to the effective demand of consumers as determined by the prevailing state of income distribution, but society still must judge whether this is the distribution it wants.

Although government may become involved in the operation of the market in several ways, only expenditure and revenue measures will be discussed here. Obviously, there is a wide range of government activities, including laws and regulations, that influence the private sector, but these are beyond the scope of this paper for the most part. The three functions of the public sector that will be discussed involve the allocation of certain goods and services, economic stability, and the distribution of income and wealth.

1. Allocation function. The allocation function occurs in situations where it is perceived that the market is an inadequate allocator of resources; that is, other allocative means are capable of providing a more socially optimal situation. In this context, public wants that are provided for outside of the market mechanism are divided into "social goods" and "merit goods."

   If social goods are to be provided at all, the public sector must provide them. Social wants are satisfied by goods and services that can be consumed by all, regardless of their willingness to pay. The market cannot effectively allocate such services because those who do not pay are not excluded

from the benefits. Because anyone can receive these benefits, there is no incentive for individuals to make payments.

In the case of wild salmon spawning and rearing habitat, the owners of critical spawning and rearing areas generally do not have control or property rights to the fish. On the other hand, commercial fishermen who are usually completely disassociated from the freshwater spawning habitat of salmon benefit from the harvest of these fish at a later stage in their life cycle. Since fishermen have no property rights associated with the fish prior to harvest, the incentive for individual fishermen to protect critical habitat areas is not commensurate with the benefits they receive; that is, each fisherman may reap the benefits whether or not he makes individual sacrifices to maintain or increase salmon production. This is an example of a social good, in that there is no individual incentive to protect or enhance a resource. However, commercial fishermen can act together through the political process to assure desired salmon habitat protection.

In contrast to social goods, merit goods can be allocated through the market mechanism, but these goods and services are considered socially beneficial to the extent that they are provided through the public budget over and above that which would be provided through the pricing system. Public education is an example, but many forms of outdoor recreation, including sportfishing and hunting opportunities, appear to have been given this status through the political process.

Sportfishing for king salmon might be allocated through the market, although the cost of enforcement would be prohibitive in much of Alaska. In contrast to the situation in sparsely populated Alaska, the sportfishing opportunities for Atlantic

salmon in Europe and some drainages in New Brunswick are allocated through the pricing system within the limits of publicly imposed regulations. The point is that sportfishing, hunting, and many other forms of outdoor recreational services can be allocated through the market mechanism, but our society has decided that participation in such activities should not be determined by one's financial well-being alone. Thus, there are public policies that in effect subsidize participation in many forms of outdoor recreational activities, including sportfishing and hunting.

Another problem common to decision making within the government sector but often absent in the private sector has to do with the handling of externalities. "Externalities," sometimes called "external economics" and "diseconomics" or "spillover effects," denote the impacts of actions by some decision-making unit on the activities of others (McKean 1958). These impacts are not apt to be directly felt by the first group, which was responsible for bringing about the action. When these impacts are of the type that affect the quantities produced by other firms, they are called "technological spillovers." The other type of spillover, pecuniary, is occasioned by shifts in prices. Differences in concern in the public and private sectors about externalities are expressed well by Knetsch et al. (n.d.):

> In both the private sector and the public sector, decision-makers who strive to develop good policy for their organizations evaluate uses of funds to insure that the expected returns exceed the costs. While the basic notion of benefit and cost evaluation is similar for both the private and public sectors, there is one basic difference. When decision-makers in the private sector, say in a private business, evaluate the benefits of investing in a new production facility and compare those benefits with associated costs, they are concerned only with the gains and losses which <u>accrue</u> to their firm. Because any other

gains and losses which may accrue to outside parties do not show up in the revenues and costs of their firm, they are typically ignored in private investment evaluation. On the other hand, a responsible decision-maker in the public sector cannot adopt so restricted a view. He must conceive of his investment project in a more comprehensive way so that all of the costs and gains associated with the undertaking are accounted for in the investment decision whether or not all appear as receipt of, or disbursements by, his particular agency. Indeed, it is just because market-governed private organizations cannot charge for third-party costs that the public sector must undertake so many resource development activities.

2. Distribution function. In the operation of a democratic society, there are times when it is perceived to be socially desirable for government to become involved in the distribution of income and wealth. The factors that determine distributional patterns are laws on inheritance, availability of educational opportunities, social mobility, distribution of innate talents, and the structure of markets. The mechanism to facilitate distributional changes by the public sector are tax and transfer policies. Although conflicts are inevitable, it is considered desirable to make distributive adjustments in such a manner as to minimize the effects on the efficient operation of the market.

With respect to fish and wildlife, the State of Alaska is involved in the distribution of benefits in a number of ways. Rather than relying on a free market allocation in commercial salmon harvesting (at least up to a biological limit necessary to protect the resource), the state administers a limited entry permit system that restricts the number of fishermen and controls the areas in which they fish.

Another example of the state's involvement in the distribution of benefits is its handling of some big game hunting opportunities. In specific geographic areas where the state deems it

necessary to closely control harvests, it administers a program of drawing permit hunts. Hunters can take a chance that they will be selected to receive a special permit by paying a token fee (usually $5.00) and submitting an application, with winners being selected through a lottery system. An alternative would be to auction off these limited hunting opportunities, thus relying on the free market system. Although such an approach would surely receive considerable political opposition, an auction would likely provide a higher income to the state for the use of the resource, although limiting participation to those willing and able to pay a high price.

3. Stabilization function. An uncontrolled free economy is subject to rather violent fluctuations in prices and employment. The stabilization function is concerned with maintaining stable resource use and value of money. Therefore, public policies are directed at a stabilizing function, even though it can be in conflict with other objectives.

   Long-run stabilization is certainly a concern of the State of Alaska in the management of its fish and wildlife resources. Quotas are set on the harvest of many species of fish and wildlife, although short-run revenues could be increased by permitting greater harvests. Emergency closures are often involved when the long-run stability of the resource appears threatened. Here again it would be difficult to provide such protection through the market system, but the public sector can effectively operate to perform this function.

II. ECONOMICS IN THE NATURAL RESOURCE PLANNING PROCESS

Because economics deals with the allocation of scarce resources to satisfy human wants, it should play a major role in natural resource planning involving fish and wildlife habitat. If economic concerns are to be adequately addressed, they must be engaged throughout the process and not treated as mere adjuncts. There is clearly a role for economics in each phase of the typical natural resource planning process in which the Department of Fish and Game is likely to become involved in inter-agency efforts (fig. 2). Although it is convenient to examine each of these phases independently, it should be emphasized that planning is an interactive process.

A. Identification of Public Issues, Management Concerns, and Resource Use Opportunities
B. Identification of Planning Criteria (Decision and Process)
C. Data/Information Collection and Analysis
D. Analysis of the Management Situation
E. Formulation of Alternatives
G. Evaluation of Alternatives
H. Selection of Preferred Alternative
I. Plan Approval and Implementation
J. Monitoring and Evaluation

Figure 2. Typical natural resource planning process.

A. Identification of Public Issues

The initial step in most natural resource planning processes involves the identification and development of a preliminary understanding of the nature, complexity, and magnitude of the problems to be addresses. Areas of public concern are identified and interpreted to the extent possible. Public agency concerns and responsibilities are taken into account - that is, to what extent can the agencies cope with the issues that have been identified? In order to analyze issues effectively, consideration must be given to such factors as human-resource interactions and conflicts in resource use. From the supply side, an understanding of the resources available to satisfy human wants - that is, the opportunities that are available - is needed. The desirability of an interdisciplinary approach from the outset is clear. Many issues are apt to be economic in nature and must be adequately defined at this stage so that the following phases of the planning process can be effectively completed. For example, income and employment impacts of a proposed action might be identified as a major issue, but decisions must still be made regarding the appropriate measures and the reliability of the estimates that are required.

B. Development of Planning Criteria

In the second step, planning criteria relative to the issues and concerns are identified. Criteria may be based on laws and relations, professional standards, and by agreement within the planning team. They represent standards of judgement upon which decisions are to be made. Many criteria are apt to involve economic considerations, or the allocation of resources.

C. Data Information Collection and Analysis

Once issues have been identified and planning criteria developed, plans for the collection of appropriate data are made. Existing sources of information are examined and primary data collection conducted when necessary and feasible within temporal and budgetary constraints. Information collection is a prelude to the analysis of the management situation and other phases of the planning process.

An important component of the analysis involves the estimation and interpretation of demand and supply situations as they relate to resource allocation. Costs of producing various goods and services are compared with the prices offered in the available markets. To the extent possible, costs of production from alternative locations are examined, including consideration for the effects of the costs to consumers of traveling long distances to and within Alaska to use these resources.

Although much effort is usally put forth to inventory physical resources, little effort is expended to determine what portion of the physical supply constitutes a viable market supply. Estimates of production costs are needed for specific goods and services, including transportation costs. Estimates of the latter should consider both the costs to move products to appropriate markets and the costs to move consumers to the resources, as is the case with many fish and wildlife uses.

To effectively allocate resources, reliable information is needed on the demand for various goods and services related to fish and wildlife. Although many of the traditional concepts of demand do not readily lend themselves to the quantification of nonmarketed goods and services, the inclusion of public wants into a broader

definition of demand is essential in order to identify the ends toward which resource management should be directed. The demand for natural resources can be divided into a number of categories: sportfishing, commercial fishing, hunting, and nonconsumptive uses. The effects of changing socioeconomic conditions, as indicated by the projections, will form the basis for estimating future demands of fish-and wildlife-related goods and services.

Since planning deals with the future, hindsight alone has limited application. Projections of selected socioeconomic characteristics for specific future time frames can provide valuable input to the planning process. Projects are conditional futures and should not be confused with predictions. The underlying assumptions of any set of projections should be clearly specified. Economic demographic parameters projected by other agencies, such as population, personal income, employment, and employment earnings, can be related to pressures on the natural resource base. On the basis of the analysis provided by the assessment of the current situation, addressed above, changes in these parameters can be related to their effects on community structure and function as well as on demand for fish- and wildlife-related goods and services. Several sets of projections of alternative future situations can be useful in providing a basis to assess the effects such changes might have on policy and also decisions. The results are addressed in terms of the interrelationships between socioeconomic conditions and fish and wildlife resources.

D. Analysis of the Management Situation

In this stage of the process, an interdisciplinary effort is needed to sythesize the available information in an effort to develop an understanding of resource capability to resolve previously identified issues within the limitations set by institutional contraints

and budgetary realities. Due to the complexity of "real world" situations, abstract models are often employed to facilitate a better understanding of the overall situation. For example, the U.S. Forest Service (USFS) usually develops a linear programming model during this stage to help simplify the complex interrelationships that must be considered in forest planning. In this stage of the planning effort, it is important that there be a firm understanding of the socioeconomic situation. For appropriate geographic areas, information on socioeconomic parameters must be analyzed and their contributions toward realizing social well-being objectives understood. The major resource-based industries of the region are identified, with those related to fish and wildlife examined in detail so that the interdependencies between resources and the human population are clearly understood. To the extent possible, distributional aspects and community interrelationships are examined.

The determination of the most effective means of satisfying the demands or public wants previously identified should be a major consideration. Several techniques of economic analysis can be applied to the planning process to determine the cost effectiveness of managerial options, even in cases where these options involve nonquantifiable outputs. Imaginatively applied sensitivity analysis can be a useful tool for situations in which the level or quantification is weak.

E. Formulation of Alternatives

All of the information developed in the preceding phases is brought to bear in the formulation of alternatives. This phase is concerned with the development of alternative plans to satisfy previously identified issues and management concerns to the extent feasible within the limits of the management opportunities. Since the essence of economics concerns itself with the allocation of scarce

resources to satisfy competing demands, the formulation of alternative strategies is an area in which economics expertise can make one of its greatest contributions to the planning process. Additional analyses may be conducted to ensure that such objectives as cost effectiveness or social well-being are given sufficient consideration in the process. If such concerns are ignored in the formulation phase, it can be only by chance that associated criteria will be satisfied.

F. Estimated Effects of Alternatives

Analyses are conducted to determine the probable impacts of each alternative being considered. Displays such as charts, graphs, etc., can be used to show socioeconomic impacts at various levels - national, regional, and local, for example. Distribution as well as total effects can be assessed. Although monetary values are often relied upon, other measures of social well-being can also be discussed and quantified to the extent possible. Reliable data on the physical and biological effects of alternative resource allocations are usually essential to the assessment of socioeconomic impacts.

G. Evaluations of Alternatives

The principal function of this phase of the planning process is to measure the effectiveness of each alternative with respect to the planning criteria previously identified. Because of the iterative nature of planning, the alternative formulation and evaluation phases tend to become indistinguishable in practice. The relationship between the formulation and evaluation phases is discussed by Jameson, Moore, and Case:

> In general, the formulation of alternative steps of the planning process is concerned with devising ways of satisfying social demands, policy requirements and administrative

priorities. The evaluation step is a formal assessment of how well the alternatives accomplish these tasks, especially with regard to policy requirements and administrative priorities. However, the distinction between these two steps of the planning process is thin. It may be more realistic to recognize that formulation and evaluation activities are performed together and that planning teams go through several rounds of formulating and evaluating alternatives.

These iterations help identify conflicting policy requirements and permit further exploration of other solutions. In the intermediate stages of formulation and evaluation, conflicting objectives may be resolved through technical solutions. Where no technical solutions are possible, such conflicts can be resolved by adjusting either the objectives themselves or the amount of organizational assets expended to secure the objectives.

H. Selection of Alternative

Although the final selection is a managerial function, the interdisciplinary team generally has the responsibility to recommend a course of action. There again, it is imperative that economics as well as other relevant areas of expertise be fully involved in the selection process. The interdisciplinary team provides the mechanism by which various areas of expertise are integrated into a cohesive effort to select the alternative that most closely meets the previously defined criteria. Uncertainty regarding future events must be considered in terms of both shifting human wants and the ability of the resource base to satisfy them.

I. Plan Approval and Implementation

Although this is strictly a managerial function, economists and other specialists provide consulting services in this phase. There is often a further opportunity to elaborate on salient findings developed in other phases of the process and to provide judgment on the sensitivity of factor changes to meeting objectives. While managers have the responsibility to make the final decision and

carry through the implementation, specialists such as economists should provide a consulting service.

J. Monitoring and Evaluation

In reality, planning occurs in situations dominated by uncertainty; knowledge is often limited regarding basic relationships between inputs and outputs. Human perception and demands are apt to change over time. As a result, there is often a divergence between anticipated and actual performances regarding planned actions. The monitoring function provides an opportunity to determine to what extent the plan that has been implemented is working toward meeting its objectives. As the result of this observation and evaluation, modifications can be made in the plan to reset it on the desired course or the course changed in deference to new-found information pertinent to the original objectives. Here again, an interdisciplinary approach is essential to ensure that a wide range of concerns are adequately addressed.

III. PROJECTION TECHNIQUES

While historical data are deemed sufficient for planning purposes in most disciplines, economists are frequently called upon to look into the future. Obviously, making inferences beyond the scope of the data that are not testable is not a precept of the scientific method as traditionally defined. Nonetheless, this does not suggest that inference itself or asking "what if" questions have no scientific basis. In fact, there is a major field in statistics called "forecasting" that deals with historical data in order to make projections into the future.

For planning purposes, it is important to understand the distinction between predictions and projections. Predictions are simply a statement of what one believes will happen; projections, on the other hand, are conditional statements of the future based on a number of assumptions that should be clearly specified. If any one of these underlying assumptions is violated, planners have the opportunity to assess the likely effects it will have on the future situation. For example, projections of a substantial increase in sportfishing activity in Southcentral Alaska might be contingent upon the assumption of a large increase in the Anchorage population. If it becomes apparent that this assumption is inaccurate, the projections can be readily adjusted to accommodate the altered situation. Although no one may be able to accurately and consistently predict the future, a rational approach to anticipating likely future conditions is essential to effectively manage natural resources.

One of the simplest projection techniques involves the extension of past trends into the future. The number of hunting licenses sold in Alaska can be plotted over time, for example, or a regression analysis[8] calculated and the results extrapolated to the desired target data. An approach of this kind, however, does not consider the underlying factors

8 Regression analysis estimates the extent to which a change in the value of one variable (the independent variable) tends to be accompanied by a change in the value of another variable (the dependent variable).

that contribute to hunting license sales, and it ignores some of the primary components of time-series[9] behavior. Although it might be desirable to project on the basis of secular trend,[10] it is sometimes difficult to isolate it from cyclical, seasonal, and irregular variations in time-series data.

A more sophisticated projection technique involves cross-sectional analysis. With this approach, the underlying factors responsible for variation in the parameter to be projected are identified and the relationships quantified so that changes in the independent variables can be used as the basis for extrapolation into the future. A strong relationship might exist, for example, between sportfishing activity in Alaska and such factors as state population, personal income, average days of paid vacation, the unemployment rate, gasoline prices, and fresh salmon prices. Multiple regression analysis (regression analysis that includes more than one independent variable) can be used to quantify the level of sportfishing activity that is explained by these independent variables. If the coefficient of determination[11] for this regression analysis is sufficiently high to give one confidence that these variables adequately explain variations in sportfishing activity, the estimating equation can be used as the projection model. By substituting socioeconomic projections developed by other agencies into the regression equation,[12] an estimate of sportfishing activity can be calculated for a given scenario of the future. One of the underlying assumptions of this approach is that the relationships between the dependent and independent variables will remain constant throughout the projection period.

9 Time series is a display of data showing the magnitude of some phenomenon at various points in time.

10 Secular trend is the smooth and regular movement of time services over a long period of time.

11 The coefficient of determination measures the proportion of the total variation in the dependent variable that can be explained by variation in the independent variable or variables.

12 The regression equation measures the degree of change in the dependent variable associated with changes in the independent variable or variables.

For the State of Alaska, the Institute of Social and Economic Research (ISER) of the University of Alaska operates the Man-In-The-Arctic (MAP) projection model, which is based on a number of complex socioeconomic interrelationships. As stated in Hull et al. (1983),

> the ISER MAP Economic Modeling System produces annual projections of a large variety of economic and demographic variables based upon user inputs representing the development of basic industry and state government fiscal behavior. The system consists of a number of computerized models; computer programs for model creation and utilization; parameter and variable files for model implementation; and data sets for creation and estimation of model variables and parameters.

The MAP model can be quite useful in fish and wildlife habitat planning in several respects. Projections of alternative futures can be the basis for estimating anticipated public wants or demands for fish and wildlife resources. The model also appears sufficiently flexible to accomodate development of subroutines that will allow projections and impact assessments of alternative management strategies related to the more commercially oriented aspects of fish and wildlife resources.

IV. EVALUATION TECHNIQUES

Since there are several measures of value, evaluating fish and wildlife habitat is an extremely complex issue. Value to whom? is often the key question. Values can be measured in terms of stimulation of the economy, satisfaction accruing to users, or enhancement of society in general. Some forms of value can be conceptually identified but defy quantification. Other values are quite readily measurable but difficult to define in terms of social well-being. Whatever measures of value are included in the planning process, comparisons should be made with caution and careful interpretation. Conceptually, a number of measures for estimating social value have been developed, but very often they lack sufficient quantification for practical application.

Abstract valuation models may provide stimulating classroom discussions or interesting journal articles, but they have not been particularly successful when applied to real natural resource planning problems. Sufficient data are often not available to quantify relationships that appear conceptually sound.

As with most resources, there are several aspects of value related to fish and wildlife, and each of these requires quite different interpretations and techniques to effectively measure them. The most readily available data, although not always the easiest to interpet or most relevant, pertain to direct commercial values. Even though direct commercial values involve marketed commodities, information is not readily available unless some data-collection system is instituted. Estimates of the value of commercial fishery products in Alaska, for example, are available because several agencies make a specific effort to collect the relevant information. On the other hand, estimates of the value of furbearer pelts is far more difficult to obtain, although these products also enter commerce, because no specific effort is made to

collect the relevant data. Even more difficult to obtain is information about products illegally marketed, such as ivory in some instances.

Besides the direct sales of fish and wildlife products, there is also induced commercial activity. People who hunt, fish, photograph, or merely observe fish and wildlife spend money for equipment, transportation, food and lodging, user fees, and the like. Another form of induced economic activity involves the secondary effects related to both direct and indirect commercial expenditures.

Individuals engaging in fish-and wildlife-related activities benefit in several ways from such participation. Where marketed goods and services are involved, it is often assumed that their value is reflected in the market price or, in a more complete sense, in the consumer's surplus, even though there is seldom sufficient information to measure the latter. Both sport and subsistence users of fish and wildlife benefit from the food value and other by-products derived, which substitute for commodities that would otherwise have to be purchased in the market. The fisherman who catches a salmon has secured food that otherwise would have to be bought or a substitute food purchased. Besides such tangible returns, there are more nebulous values accruing to both sport and subsistence users, such as improved physical and mental health. Although these kinds of value have been recognized to some extent, quantification to the level desired for application to planning situations is seldom available.

The primary concern of the public sector is with the values accruing to society as a result of human involvement with fish and wildlife. Social benefits may be in the form of increased productivity or more ideal behavior. As previously discussed, social wants most often tend to be expressed through social mores and accommodated through political action rather than through the market mechanism. One should not conclude, however, that social benefits and costs are always nebulous. Some are

quite readily measurable, such as reduced property values attributable to specific pollution damages or the cost required to eliminate or control pollution.

Other forms of social value tend to be especially difficult to measure and, for that matter, to interpret. The desire of individuals to retain the option to use a resource in the future ("option values"), although they plan no present consumption, is an example. Even if it were possible to emperically establish a demand curve for a given resource, option values probably would not be included because there would be no intent to utilize the resource at present. Some argue, however, that cost may be the reason a person plans no current consumption and that, were the price sufficiently reduced, individuals expressing option values would indeed participate.

Another complex and largely nonquantifiable concept that has been discussed at some length in the literature in recent years is "existence values." This term is applied to a situation where a value is placed on a resource because it exists, even though the individual is not likely to ever have any direct contact with it. The relationship between a large segment of society, particularly in the continental United States, and the timber wolf provides a good example of existence values. Many people place a high value on the preservation of this species even though they are extremely unlikely to ever encounter a wolf. Although it may be difficult to measure existence values in monetary terms, the fact that such values exist is amply manifested through political action.

A. Marketable Goods and Services

Even with marketable goods and services such as commercial salmon products, there is some disagreement regarding the proper measures of value. The market price multiplied by the quantity produced gives the total market value, which is a measure of economic

stimulation but not necessarily of social value. Some maintain that the consumer's surplus is the only appropriate measure of social value (a critical concern in public-sector planning), but this measure is also incomplete for the reasons previously cited (the exclusion of externalities). Furthermore, the lack of sufficient data often precludes the measurement of either consumer's surplus or producers surplus in real planning situations.

In practice, the appropriate measures of value are often dictated by circumstances. Business leaders and elected officials may be interested in direct expenditures and secondary economic stimulation related to specific activities in their communities. Very often the number of jobs stimulated by fish-and wildlife-related activities are a primary concern. Even if limited concern is directed toward evaluating the satisfactions enjoyed by participants in hunting or sportfishing or the benefits accrued to society as a result, interest may be focussed on related expenditures and the number of jobs created. Although these measures do not actually evaluate the resource, the associated expenditures are often a major concern and cannot be ignored in the real sociopolitical world.

There are also situations where price data may not be available for a given resource, but where market values, if not social values, may be imputed.

1. Market comparison method. As the name implies, the market comparison method uses the known value of specific goods or services to estimate the value of comparable goods or services. The method appears straightforward and simple, but it requires considerable skill to apply, particularly in cases involving imperfect substitutes. The market comparison method has been used quite effectively to establish land values based on comparable lands for taxation and legal purposes. Since

reliance must usually be put on historical data, market comparisons are best used during periods of long-run price stability. There are several limitations of this method that should be noted. For one, it is strictly a measure of market value and does not attempt to measure social value. Here again, a primary concern of the public sector is not being addressed. Another weakness of the market comparison method is that the marginal value of a resource use to the consumer is apt to fall below the market price at some point as consumption increases. For instance, a person may be willing to pay from $5.00 to $10.00 per pound for fresh king salmon steaks once a month, but the same person is unlikely to pay that price for several hundred pounds of salmon during a month. Thus, the retail market price of salmon, used as a yardstick of comparison, may lead to an overestimation of the value of the flesh of sport-caught salmon. It should be emphasized, moreover, that the package of differentiated services that constitutes a pleasurable salmon fishing trip is not being measured by the market value of salmon flesh. Nevertheless, there is a value for salmon as a food derived from fishing, and this value should be taken into account, although it does not reflect the total value associated with either sport or subsistence fishing.

Application of the market comparison method is even more difficult when it is used to evaluate approximate substitutes, such as using beef prices to impute moose values. Depending on the tastes of those involved, moose may be preferred over beef or vice versa. In either case, the use of unadjusted beef prices to evaluate moose meat can be quite misleading. Besides the differences in consumer preferences, which should be reflected in the relative values, there is the problem of diminishing marginal utility because the consumer is inundated

with a good as a substitute for another commodity he would likely purchase more sparingly during a given time period.

Judgement must also be used in the selection of the appropriate market outlets from which the comparisons are to be made. Not all market outlets are available to each consumer, but salmon prices, for instance, are apt to vary significantly among wholesalers, retailers, or commercial fishermen at the dock. Prices also tend to vary from locality to locality. People living in isolated fishing villages can often purchase salmon at lower costs than are prevalent at retail outlets in Anchorage. On the other hand, the situation is likely to be reversed when evaluating moose on the basis of beef prices; that is, beef would be relatively less expensive in Anchorage than in most isolated villages.

The market comparison method can be a useful planning tool in some situations, but it must be applied with careful and consistent judgement. Although the method has its inadequacies, it may be the only available means of valuation. In sum, the market comparison method can provide some useful insights relative to market values for unpriced goods and services but does not provide any estimates of social values, which are a primary concern of the public sector.

2. Residual method. The residual method is another conceptually simple technique that can sometimes be useful in evaluating resources. The method is best adopted to situations where the market price for a finished product is established and all the input costs are known except for that of the resource being evaluated. Quite simply, the residual method can be expressed as $R = M - C$, where R is the residual value of a resource, M is the market price of the final product, and C is the known manufacturing and distribution costs.

The residual method is often used by public resource agencies to set prices for some outputs. It is this method, for example, that foresters most frequently use to set minimum prices for stumpage in public timber sales.

There are several limitations to the residual method that should be taken into consideration. Here again, an attempt is made to measure market values only, and no consideration is given to social values. Since calculations of residual values usually depend on historical data, they may misrepresent the value of a resource based upon current market conditions. In imperfectly competitive markets, the residual value may represent the maximum that an average firm will pay for a resource. Since production efficiency is apt to vary from firm to firm, the actual sales price of a resource may vary significantly from the residual calculations.

B. Nonmarketed Goods and Services

The limitations of consumer's surplus alone as a measure of social value have been previously discussed. Nevertheless, there have been some rather ingenious attempts to evaluate fish and wildlife resources in terms of this incomplete measure of social value. Although consumer's surplus is less than a perfect measure, it can be an effective planning tool if carefully interpreted - that is, so long as its inherent limitations are realized and taken into consideration during the planning process. Two general approaches have most frequently been used to evaluate fish and wildlife, the direct consumer surplus approach and the travel cost method. Opportunity costs are sometimes used to evaluate nonmarketed goods and services. This approach, however, is seldom well adopted to determining consumer's surplus or other measures of social well-being.

1. Direct consumer's surplus approach. In this approach, estimates of consumer's surplus are based upon the direct

questioning of participants or potential participants. Most questions are designed to solicit information on the monetary value that an individual places on participation in a given activity. From this information, a demand schedule can be determined under the ceteris paribus conditions and, if some form of cost estimates is available, the consumer's surplus calculated. The response to a question on the willingness to pay, for example, identifies a point on the price-demand curve, and a sufficient number of responses provides the basis for estimating the downward sloping demand curve. The area under this demand curve includes both consumer's surplus and consumer's expenditure. Questions may also be stated in a manner to obtain direct consumer's surplus responses - for example, how much additional money would you be willing to pay to participate in a given activity? In this case, it is not necessary to construct demand curves because direct measures of consumer's surplus are obtained.

Rather than asking questions on what an individual will pay for the use of a resource, one can ask what is the maximum an individual will accept to forego the use of a resource. The results can be used in an analogous way to construct an offer curve and calculate the total value under the curve and also the consumer's surplus, depending on the availability of supporting information. Here again, the questions may be designed to solicit direct estimates of consumer's surplus.

Intuitively, it might be presumed that estimates of willingness to pay and willingness to sell would not vary significantly, but practice has shown otherwise. Willingness-to-sell values tend to be substantially higher than willingness-to-pay estimates. Of course, it should be recognized that hypothetical questions are usually being asked and that they may solicit hypothetical answers. In either the buying or selling case, the respondent is not usually called upon to go through an

actual budgeting exercise and become involved in the real exchange of currency, as is the case with market sales and purchases. However, several studies have been conducted where the actual exchange of money occurred, and disparities between the willingness to buy and willingness to sell were still observed. A possible explanation of this disparity is suggested by Gordon and Knetsch (1979):

> In part the survey reactions may be accounted for by possible strategies to attain maximum advantage on the part of respondents. However, this could probably, in principle, be eliminated with better measurements. It also may be the case that people view dollars differently depending on whether they are a potential receipt or a payment. Payments deducted from wages are viewed with less concern by most people than cash payments of equal size, and potential deductions from taxable income are probably scrutinized with greater care by those facing payment than by those anticipating a refund. Perhaps our observations are akin to these, calling for some sort of recognition of discontinuity or irreversibility in our view of income and utility relationships.
>
> It may also be that we can expect to find variation in the responses due to the commonly observed aversion to risks. People might on average understate their willingness to pay, hedging against actual payment, and on average overstate their compensation demands to better assure that their loss is covered.

Since the direct consumer's surplus approach requires a sampling of the relevant population, it is likely to be fairly expensive and time-consuming. Not only is the sampling design critical but so also is the structure, design, and wording of the questionnaire or interview schedule. Particular care must be taken not to ask questions in a manner that will solicit biased answers or make the respondents feel they are involved in some form of gamesmanship.

2. Travel cost method. In its simplest form, the travel cost method involves an estimate of the consumer's surplus implied by behavioral patterns of users regarding their travel

expenditures to reach a given site and the perceived value for the use of that site. The individual who incurs the highest travel cost to reach a site is assumed to be the marginal user; that is, the travel expenditures completely offset the value of being at the site so that there is no consumer's surplus for that individual. All other users, however, have lower travel costs, and, assuming they all have the same payoff, the difference between the costs of reaching the site by the marginal users and all other users represents the consumer's surplus. Thus, the travel cost method is based on the premise that the aggregate consumer's surplus represents the social value of the site - at least to the extent that consumer's surplus measures social value.

The assumptions underlying the application of the travel cost method are specified by Snider and Worrell (1979):

(a) All users obtain the same total benefit, and this is equal to the travel cost of the marginal (most distant) user.

(b) The consumer's surplus of the marginal user is zero.

(c) Travel cost is a reliable proxy for price. This, in turn, rests on an assumption that the disutility of overcoming distance derives from monetary costs alone.

(d) People in all distance zones would consume the same quantities of the activity at given monetary costs. That is, the demand curves for all distance zones have the same slope.

In order to overcome the limitations imposed by these assumptions, several modifications of the travel cost method have been developed. Additional variables considered in some of the modified models include travel time, user characteristics, site-quality characteristics, user fees, population of market area, and quality characteristics of the experiences available at both the primary site and its alternatives.

Regarding the appropriate variables to include in a project-oriented travel cost model, Dwyer (1980) concludes:

> The model should include those factors that are expected to explain use, particularly the experience attributes likely to be influenced by management options. Estimates of the parameters are based on observed trips from various origins (i) to an area (j). The wide range of costs and substitutes facing individuals at different distances from an area, as well as varying populations at each origin provide considerable information about the influence of the quality characteristics, Q_j, which is often influenced by wildlife management options, it is preferable to estimate the model jointly for a number of areas that have different levels of Q. The model can be used to estimate visitation expected under new or modified conditions, provided that estimates of the relevant variables are available.

As for application of the travel cost method to fish and wildlife habitat evaluation, there is another serious limitation that should be taken into consideration. Most often, the site being evaluated does not include the entire range of habitat requirements necessary to sustain the fish or wildlife populations being evaluated. There is often inadequate information to determine the contribution that a particular site makes toward the overall habitat requirements necessary to support a population of a given fish and wildlife species. If the area under consideration contains only part of the production unit, an understanding of its contribution to the whole system is necessary for meaningful evaluation. Furthermore, it is not only the fish or wildlife that contribute to the value of the site but also human expectations of the opportunities at that site. In most instances, the contribution that other areas make toward the consumer's surplus that appears to be manifested at a specific site must be taken into account, because only a portion of the total fish and wildlife habitat requirements are likely to be located at that site.

3. Opportunity cost approach. An opportunity cost represents the value foregone when one resource use is chosen over another. Where several opportunities are sacrificed, the alternative with the next highest value to the course of action chosen represents the opportunity cost. Although it is often convenient to express opportunity costs in monetary terms, it is not essential. It might be appropriate, for example, to express the opportunity cost of a logging operation in terms of the acreage of wilderness sacrificed.

Opportunity costs can provide useful insights for planning as long as their interpretation is kept within the context of their limitations. For example, a logging plan in an unroaded area might be developed strictly on the basis of "economic efficiency" and then be altered to maintain a sport fishery for salmon. The difference in monetary value between the "efficient solution" (highest net market returns) and the modified approach is an opportunity cost. In such a plan, 100 foot corridors might be retained along all streams to protect salmon spawning and rearing areas. Leaving such corridors of trees would quite likely reduce total timber revenues and increase roading costs per unit of output. The difference in net revenues that results from these alternative approaches is the opportunity cost incurred to protect the salmon resource. It should be noted that the opportunity cost represents a minimal value of the salmon-producing habitat, since it only represents one level where salmon protection was given priority over timber revenues. Even if the entire logging plan were scrapped in deference to salmon production the net revenues foregone would represent only a minimal value of the salmon resource in the judgement of the managing agency. In other words, there is no information regarding the total net value of timber that would be necessary to reverse the decision.

There are other limitations to the opportunity cost approach that should also be mentioned. It generally measures losses in terms of gross revenues or even net revenues, but it seldom is designed to weigh social values. As a method of evaluation, the opportunity cost approach can also be easily misinterpreted. The opportunities foregone to protect two salmon streams, for example, may be represented by grossly different sums of money, but there is no inference that the stream associated with the higher opportunity cost is more valuable than the other. All that is indicated is that each stream has a certain value in terms of opportunities foregone, but neither has been extended to its maximum limitation, so there is no basis for comparison. Obviously, there is no way to determine the maximum value of a resource by use of the opportunity cost approach, because alternative uses are being weighed, not the selected use.

V. ALLOCATION MODELS

The efficient allocation of resources, including land, is often the objective upon which planning efforts are focused. In many cases, fish and wildlife habitat managers become involved in planning efforts involving several agencies, some of which represent interests that are in conflict with others. There are also occasions when decisions must be made regarding conflicts in resource allocation that favor some species of fish and wildlife over others. Numerous techniques have been developed that can provide valuable assistance in determining the most effective means to allocate scarce resources to satisfy human wants. For the most part, these techniques have been applied to more readily quantified resources than to fish and wildlife. Nevertheless, their application can have substantial implications for fish and wildlife habitat planning. Only two such techniques will be discussed here, linear programming and game theory. The former has had rather wide application to natural resource planning, and the latter offers a means to consider allocative strategies under the more realistic conditions of risk and uncertainty.

A. Linear Programming

Linear programming is a mathematical technique that has been successfully applied to many resource allocation problems, although it has been used sparingly with respect to fish and wildlife. In linear programming, an objective function[13] is minimized or maximized, subject to a number of constraints. The objective function and each of the constraints must be expressed in the form of simultaneous linear equations.

Objective functions vary considerably from case to case. Maximizing net revenues, or "profits," may be a legitimate goal for a private

13 In linear programming, the function whose value is to be maximized or minimized, often profits or costs.

business firm but would usually not be consistent with the overall goals of the public sector. In the latter case, maximizing outputs with a budget constraint or minimizing the cost to implement a politically established program are more likely objectives. In either case, linear programming can be a useful tool in determining an optimal solution. With respect to natural resource planning, linear programming can be used to determine the optimal use of resources to achieve a desired end.

As with any planning tool, linear programming should be applied with consideration of its limitations. For fish and wildlife habitat planning, the technique often requires a level of quantification not readily available. In some situations, the underlying assumptions of linearity (all relationships are linear) may also be a serious limitation. Nonetheless, the most obvious shortcoming of the technique for most planning purposes is its static nature and large data requirements. Recent extensions of the technique have made it more readily adaptable to situations where risk and uncertainty must be considered.

Although linear programming has not been used directly in fish and wildlife habitat planning in Alaska, the preservation of some habitat has been accomplished, at least temporarily, in the Susitna Basin as the result of the application of this technique. A linear programming model was used by the Economic Research Service to consider the optimal allocation of lands for commercial forestry and agriculture in the Talkeetna drainage (Fuglestad and O'Neill 1984). Because of the uncertainty about prices in Alaska for timber and certain agricultural products, the study utilized considerable sensitivity analysis to demonstrate that neither forestry nor agriculture were economically viable land use alternatives in much of the Susitna Basin. As a result, the Alaska Department of Natural Resources retained considerable quantities of land in a wild state

that had been previously considered for agricultural development. Even though the value of fish and wildlife habitat was not even included in the model because of the paucity of data, the results of the study indicated that the public would be better off in terms of the economic efficiency criterion if they did not invest in road construction and other developmental activities to enhance agriculture in much of the area.

B. Game Theory

Game theory is a mathematical technique that permits the selection of an optimal strategy when facing an opponent having his own strategies. Although, game theory has not had wide application in fish and wildlife habitat planning in Alaska or elsewhere, it deserves mention because its conceptual content provides a basis for approaching allocation problems involving imperfect knowledge. Decision theory, an extension of game theory, is potentially more useful for natural resource planning because it deals with decision making under conditions of uncertainty, an unknown opponent; this contrasts with game theory, where one is dealing with a specific opponent who has definite counterstrategies for each strategy that might be advanced. Decision theory is sometimes referred to as a game against nature - that is, nature is the opponent.

The principle advantage of the game theory approach (including decision theory) is that it provides a means to consider risk and uncertainty in the planning process. It provides a basis for making allocative decisions in situations where outcomes are not certain and, thus, more realistically simulates the conditions under which natural resource managers must operate. Simplistic maximization or minimization objectives lose their meaning when outcomes are uncertain.

Basic to game theory and decision theory is the development of a "payoff matrix," which illustrates the anticipated payoffs for various arrays of strategies. As a result, the selection of the appropriate strategy becomes somewhat subjective, based upon both economic and psychological considerations. Several decision rules[14] have been developed in an attempt to explain managerial behavior, but there is little empirical evidence to suggest that any of these has received widespread use.

14 In game theory, or decision theory, a rule that tells a participant (player) how to choose among the strategies that are available to him.

VI. SYSTEMS ANALYSIS

There are a number of approaches that fit under the general heading of systems analysis. Four of the most commonly used analytical techniques in natural resource planning are benefit-cost analysis, the internal rate of return, present net worth, and cost-effectiveness analysis. With each of these techniques, there is considerable disagreement as to which benefits and costs should be included in the analysis. Some maintain that all effects of a given project, both tangible and intangible, should be considered in judging the feasibility of a proposed action. They claim that estimated or derived values can provide an appropriate substitute for market values in many cases. At the other extreme are those who argue that only primary effects are worthy of consideration.

The types of analyses discussed in this section are similar in one respect: they all involve benefits and costs that occur during different time periods. The value of money is not constant over time. People are willing to pay interest to satisfy present wants rather than forego consumption to a future time period. On the other hand, money is placed in financial institutions or otherwise invested with the objective of increasing its future value. For example, $100 available today will be worth more than that amount one year hence. By contrast, $100 promised a year from now is worth less than $100 today.

Relative to the time preference for money, Christiansen (1979) states:

> Investing in stream protection entails a cost over and above the amount of the initial outlay. This cost is the cost of capital, usually expressed as annual interest. It may be an explicit cost arising out of a need to borrow the funds and to pay explicit interest on the loan. Or it may be an opportunity cost in the form of implicit interest, arising out of the fact that although the firm does not need to borrow, it has other opportunities for the use of its funds, opportunities that it must forgo if it carries out the stream-protection measures. In the first case, the firm's cost of capital is its borrowing rate of interest. In the second case, the cost is the earning rate of the forgone investment opportunities. Whatever its origin, if such a cost exists, it may be used to guide the firm in making investment decisions. There are five

investment-criterion models that use such a guiding rate of return: (1) discounted net worth, (2) compounded net worth, (3) equal annual equivalent, (4) internal rate of return, and (5) benefit-cost ratio.

Discounting is the process by which the monetary value of future benefits and costs are brought backward to the present at compound interest. The basic discounting formula is

$$V_p = \frac{Vn}{(1 + i)^n}$$

where Vp is the present value, Vn is the end value, i is the rate of interest (discount rate), and n is the number of years that the end value is discounted. Obviously, the present value is less with higher discount rates and longer time periods. It should also be noted that this involves an exponential relationship rather than a linear relationship. As a result, discount rates and the timing of flows of benefits and costs are primary determinants of project feasibility.

A. Benefit-Cost Analysis

Conceptually, benefit-cost analysis is a rather straightforward approach that involves the discounting of streams of benefits and costs expressed in monetary terms to a designated base period, usually the present. In the abstract world of economic theory, benefit-cost analysis can provide an infallible guide to project selection. However, decisions are not made in the abstract, and as one must deal with the realities of natural resource planning, the limitations of the technique become obvious. There is a fundamental problem of deciding the appropriate benefits and costs to include in an analysis. Quantification for many benefits and costs is lacking. Since both costs and returns are apt to occur over different time periods and with varying degrees of certainty, appropriate interest and discount rates, as well as risk allowances, must be selected in order to reduce all values to a common demoninator. Projections into the future, with all their uncertainties, are also essential

inputs. Another problem to be considered concerns the appropriate geographic area to which a cost-benefit analysis should apply. Finally, there is not even an effective criterion for choosing among alternative projects without becoming involved in a great deal of subjectivity.

In order to facilitate a clearer understanding of the methodology, benefit-cost analysts have developed several definitions pertinent to the field:

(1) Primary, or direct, benefits represent the value of goods and services that result directly from the purpose for which a project was undertaken and the associated costs incurred.

(2) Net primary benefits are the total of the primary benefits minus the costs.

(3) Secondary, or indirect, benefits are the values over and above the immediate product or services generated by the project but realized as a result of activities stemming from or induced by that project.

(4) Tangible benefits are those that can be measured in monetary terms; whereas intangible benefits cannot.

(5) Direct, or primary, costs are the value of the goods and services needed for the establishment, maintenance, and operation of the project and to make the immediate products of the project available for use or sale.

(6) Indirect, or secondary, costs are the costs of further processing and any other costs (above direct costs) stemming from or induced by the project

(Ciracy-Wantrup 1955)

There is considerable controversy regarding the kinds of effects that should be included in a benefit-cost analysis. Ideally, all effects of a given project, both tangible and intangible, should be considered in judging project feasibility. However, the quantification of these effects often prohibits their effective inclusion in the decision-making process.

As previously discussed, externalities should be considered when planning within the public sector. From a practical standpoint, selection of externalities worthy of consideration and elimination of those too trivial to warrant attention is a subjective task. For those effects considered worthy of inclusion in an analysis, the task remains of devising effective means of evaluation.

The evaluation of benefits and costs, including externalities, is one of the most challenging aspects of benefit-cost analysis. Estimating costs is not usually as difficult as estimating benefits, inasmuch as markets exist for many factors of production. However, estimating the opportunity cost of tax-raised funds is a complex problem that is far from being resolved. Where multiproduct ventures are under consideration, there is an allocation problem at still another level. Interdependences among projects also make it difficult to effectively isolate the benefits and costs of a given action. Such cases are sometimes resolved by measuring the effects with and without each project and isolating the extra costs and gains attributable to each one. However, care must be taken to give full consideration to interactions in such cases. The evaluation of social benefits represents another source of difficulty.

It is necessary to discount both benefits and costs to the same base period in order to judge the acceptability of projects and to make meaningful comparisons among them. The determination of appropriate interest rates, discount rates, and risk allowances is a prerequisite to the conversion of anticipated benefits and costs into a common basis in terms of time and degree of certainty. Thus arises

the problem of deciding which interest rates to use: the marginal internal rate of return, the market rate of interest, the government interest rate, or some subjective rate. It may be assumed that the appropriate rate of interest should reflect society's rate of time preference, but converting this concept into a tangible measure is another matter.

One should be cognizant of the possible economic changes that might be induced by public resource development. Shifts in the supply and demand schedules for the immediate products of the project may result from changes in technology and preferences brought about by the public investment. Including such shifts in benefit-cost analysis, however, leads the analyst into the uncertain world of the future.

Regional or area considerations often enter public investment decisions, especially on the state and local levels. On the national level, such matters are often ignored because the desirability of transfers involving regions, industrial or occupational groups, and among individuals is a separate issue in public policy. Quite properly, state and local governments must consider the net benefits that accrue to their taxing districts in order to justify the financing of public projects.

Perhaps the most fundamental difficulty facing practioners of benefit-cost analysis is the selection of effective criteria. Although a benefit-cost ratio of 1.00 or greater indicates the economic feasibility of taking an action, it is not an effective ranking technique. In regard to public projects, the ordering of preferences based entirely upon the ratio of benefits to costs is conceptually incorrect. Similar to the case of the entrepreneur of classical economic theory, the level of output should be at the point where net revenues are maximized, which is not usually at the point where the ratio of revenues to costs is at its maximum. In

other words, net benefits cannot be expected to be at a peak where the benefit-cost ratio is at a maximum. McKean (1958) states:

> Similarly, the most significant test in public investment, wherever measurable benefits and costs are important, is surely not the ratio of gross benefits to total costs. The only thing revealed by the ratio is whether or not some net return can be expected. It provides little basis for doing what governmental agencies must usually do, that is, judge the relative merits of projects whose ratios are greater or less than unity. If the conventional benefit-cost ratio is used for this purpose, a project that has gross returns and operating cost will be at a relative disadvantage, whatever its potential contribution to net worth.

It is apparent that no readily available and universally applicable approach to ranking projects is available. Perceptive judgement, based on familiarity with the overall situation and an understanding of the criteria, involved, can help identify the most salient factors that should be considered in a given analysis. The systems into which alternative actions can best be fitted and that hence will provide estimates of the level of optimization should be selected through an interdisciplinary approach. Suboptimization (optimizing for a subproblem rather than the ultimate objective) must also be guarded against if criteria vary from one level of management to another.

B. Internal Rate of Return

Although it is necessary to select an appropriate discount rate in order to determine the benefit-cost ratio, another approach is to set the current net worth equal to zero; that is, set the benefit-cost ration at 1.0, and calculate the rate of interest necessary to meet this condition. The internal rate of return is the rate of discount that makes the present value of benefits exactly equal to the present value of costs (Mishan 1976).

The internal rate of return can be a useful planning tool, but it also has shortcomings that should be taken into consideration. One difficulty with this measure is that the solution is not necessarily unique; that is, there may be two or more rates that have a current net worth of zero. Even if the calculations yield a unique solution, it is still a matter of judgement regarding the extent to which the internal rate of return reflects society's rate of time preference and thus justifies investment in the proposed action. Furthermore, all the conceptual and quantitative shortcomings discussed for benefit-cost analysis pertain to the internal rate of return because the same values over time are used in the calculations.

With these limitations in mind, Gansner and Larsen (1969) reach the following conclusion:

> Forest economists and others who use internal rate of return to rank the financial desirability of alternative investments in timber production must use this economic tool with care. If a particular investment yields a unique internal rate of return, the internal rate of return value is a sound index for determining whether or not the investment is worth undertaking. But when the problem is to choose between mutually exclusive productive investment alternatives, the internal rates of return to these options will not rank them consistently with their present values. A choice cannot be made without knowing the appropriate discounting rate. Given this discounting rate, the options should be ranked in terms of their present values.

This approach insures that the investment yielding the highest level of present worth will be chosen.

C. Current Net Worth

Current net worth is the most straightforward approach for examining discounted benefits and costs and is often considered the most useful measure. It provides a clear measure of net benefits or net costs, though it is subject to the same quantification problems and arbitrariness regarding the selection of the appropriate discount rate as benefit-cost analysis. Current net worth is simply the difference between the stream of benefits and costs (expressed in monetary terms) discounted to the present time frame. It is also referred to as "net present value" and "discounted cash flow."

The calculation of current net worth can provide a useful planning tool, providing there are sufficient data available regarding the salient factors involved and discount rates reflective of the social rate of time preference are applied. Even with dubious information regarding these two concerns, the use of sensitivity analysis in the calculation of net current worth can provide useful insights for planning activities. Very often, the lack of reliable information on the complex physical-biological interrelationships relating to fish and wildlife habitat modifications makes application of any of the systems analysis techniques particularly difficult.

For a given project, McKean (1958) suggests that analysts should provide decision makers with calculations of present net worth (the present value of the receipt stream minus the present value of the cost stream) for a range of discount rates. This, of course, passes on the responsibility of choosing the proper interest rate to another level of policy makers. In the face of uncertainty, the possible results of a course of action become even more imprecise. When the uncertainties inherent to a given project are included in the analysis, the outcome can best be examined in terms of a

distribution of probable outcomes rather than as a single solution. Once again, sensitivity analysis can be used to aid decision makers in taking uncertainty into account.

D. Cost Effectiveness Analysis

Cost effectiveness analysis is concerned with completing an action in the most economically efficient manner. Public decisions are often made to take specific actions even though the benefits may not be readily quantifiable, but accomplishing the task at least cost is still a viable concern. Where costs are incurred over a period of of time, it is necessary to reduce them to a common time period, usually the present, for the sake of convenience. In these cases, selection of an appropriate discount rate is again a critical factor.

VII. IMPACT ANALYSIS

In general, any change in the status quo of the economy brought about by a specific action constitutes an economic impact. In fish and wildlife habitat planning, sound information on the basic physical and biological effects of a proposed action are a requisite of economic impact analysis. If information is not available on the anticipated population changes in the species concerned, it is very difficult, if not impossible, to assess the economic impact of a particular action. For instance, it might be suspected that a placer mining operation will have a negative effect on salmon productivity in a specific stream, but it will be necessary to know the timing and magnitude of such losses in order to assess the economic effects.

Goldsmith (1981) gives a good explanation of economic impact:

> More specifically, we can then define the economic impact of a project as the differences in the economy between two alternatives: one in which the project occurs and the other in the absence of the project. Two important points concerning this definition are as follows:
>
> 1. At least one of these alternatives is hypothetical. It is impossible to experience and measure the economy both with and without the project at the same point in time. This makes measurement of the size of the impacts imprecise and subject to substantial error and disagreement.
>
> 2. Economic impact analysis does not compare a before-and-after situation. Because economic change occurs continuously, an analysis which compares the economy before and after the project would include some changes which could not be attributable to the project itself but which would be the result of other factors such as the underlying economic growth of the economy.
>
> Economic impact is a special type of economic change that is specifically and casually related to a particular economic development. Viewed in this way, the word impact should carry no pejorative connotations but should be viewed as neutral, just as change is a neutral word. Impacts of a development may be good or bad, according to the particular situation and the individual making the evaluation.

The kinds of measures in which economic impact is usually expressed do not relate well to consumer's surplus or the more complete measures of social value. Impact is often expressed in terms of gross regional product, the monetary value of all goods and services produced in the study area. Although conceptually a good measure of economic activity, data limitations tend to make estimates of gross regional product imprecise. Where accurate estimates are feasible, however, it is the most complete measure of economic activity available.

Economic impacts are often measured in terms of changes in personal income, the sum of all payments made to individuals in the study area. In Alaska, personal income is dominated by wages and salaries. Ideally, personal income impacts should include income from all sources, but such information is often lacking, particularly in Alaska.

Another measure of economic impact considered especially important in political circles is employment. Because of the sharp seasonal fluctuations that occur in Alaska, employment is best expressed in man-years if comparisons are to be made. Reliable data are available for most industries in Alaska, although obtaining detailed information is sometimes precluded by the regulations pertaining to confidentiality when three of fewer hiring firms are involved.

Economic impacts include both primary (direct) and secondary (induced) effects. In fact, some analysts divide secondary effects into several subcategories. The economic activity directly related to an action constitutes primary effects. However, any significant action or project is likely to affect the economy through secondary or induced economic effects in addition to the primary effects. A salmon aquaculture project, for example, may cause a particular fish-processing firm or group of firms (an industry) to expand output. The additional production will require more inputs and thus increase the quantity demanded from firms producing such inputs, and they in turn will create an increase in the derived demand for the goods and services needed for their own production. The suppliers, in turn, purchase more inputs to meet the

expanded demand for their outputs and so on down the line, creating a ripple effect throughout the affected economy. As a result, the general economic impact is greater than that experienced by the specific industries primarily involved.

For relatively small changes in a regional economy, it is generally assumed that prices will remain constant. However, a particular action could cause shifts in either or both the supply and demand functions. In such a case, price is likely to change and thus should be considered in the impact assessment.

A. Input-Output Analysis

Although having some conceptual shortcomings, input-output analysis has been widely applied to natural resource planning as a means to assess the economic impacts of proposed actions. Essentially, it is a systematic mathematical technique used to empirically analyze the interdependence of the producing and consuming sectors of the economy for a designated geographic area. Input-output analysis is strictly a supply-side approach in which demand analysis, in the the traditional sense, is not even a consideration (Baumol 1961).

Basic to input-output analysis is the transactions matrix, which portrays the flow of goods and services expressed in monetary units among the sectors of the economy for a designated period of time, usually one year. The sales of a given industry to each of the other industies are given along each row of the matrix. Included in this row are also the sales to the final consumer, which is termed "final demand." This term has a special meaning in input-output analysis and should not be confused with traditional demand analysis. Down each column of the matrix, the monetary value of all purchases by the industrial sector designated for that column is given (Jones 1978).

By the use of mathematical manipulations, the impacts of proposed actions can be estimated and economic multipliers determined. Three measures of multiplier effects are most commonly used: 1) gross output or sales, usually referred to as final demand multipliers; 2) household income, referred to as income multipliers; and 3) employment, usually referred to as employment multipliers (Palmer et al. 1978).

An important consideration in the calculation of input-output multipliers is the handling of households. Type I multipliers consider household consumption expenditures (direct sales to local households) as being exogenous to the model - that is, they are considered only as final demand. With Type II multipliers, local household consumption expenditures are treated as endogenous to the model - that is, they are treated as being another industry. Households sell labor, rent property, provide financing, and perform services for which they receive wages, salaries, interest, and dividends; and their purchases of locally produced goods and services are considered to be parallel with those emanating from other local industrial sectors. This procedure allows one to take into account the induced effects of new rounds of local household consumption expenditures on the local economy.

The advantages of using Type II multipliers is expressed well by Palmer et al. (1978):

> There are sound economic arguments for treating local households as an industry in an I-O analysis. When output changes in response to a change in final demand, we know that household income increases by definition. New household income in turn is very likely to result in new household consumption expenditures. New consumption expenditures generate repercussions of their own on the local economy. The Type II multiplier is used to estimate the magnitude of those repercussions on an industry-by-industry basis.

As with any modeling effort, the limitations of input-output analysis should be considered when applying the results to real planning

efforts. Even if one were to accept the general equilibrium assumption, the static nature of an input-output model must be taken into consideration. An input-output model may be looked upon as a still photograph taken for one instant in the sequence of time. As a result, its time horizon may be quite short, particularly in regions with rapidly changing economic conditions, such as Alaska. Underlying input-output analysis is an implicit assumption that all inputs are employed in rigidly fixed proportions that do not change over time. There are also underlying assumptions regarding constant returns to scale, that each sector produces only one product and that there is an unlimited supply of capital. As previously mentioned, input-output analysis deals strictly with supply, demand not even being a consideration, so market limitations do not enter into consideration.

Besides its conceptual shortcomings, data limitations can also be a serious problem in input-output analysis. Securing adequate empirical information to adequately portray a transactions matrix is likely to be extremely expensive if primary data are used. Although some shortcuts have been used effectively to develop input-output models in the continental United States, the application of these results to Alaska is restricted by the state's more primitive economic structure. As with most analyses designed to estimate economic conditions, input-output analysis should be applied with caution based upon a thorough understanding of its strengths and weaknesses.

Summary and Conclusions

Because economics is that body of knowledge that deals with the allocation of scarce resources to satisfy human wants, it should be a major consideration in natural resource planning involving fish and wildlife habitat. To make a meaningful contribution, economics expertise must be integrated into the overall planning process and not treated as an adjunct. Interdisciplinary planning teams provide an excellent opportunity for economists and other specialists to integrate their special areas of knowledge into cohesive planning efforts designed to satisfy a wide range of public wants.

In many cases, the market mechanism can be relied upon as an effective allocator of limited resources among competing demands. Under ideal circumstances, the forces of supply and demand interact to set prices and the quantities that are both produced and consumed. However, there are situations where the market is deemed an inadequate allocator, particularly with respect to some components of social well-being. In such instances, government (at various levels) becomes involved in the allocative process. In the case of noncommercial uses of fish and wildlife, public involvement in the allocative process has long been accepted.

Although the United States is most often referred to as a nation that relies primarily on the market to allocate resources, it actually has a mixed economy, with a sizable public sector. There are three major functions of the public sector: allocation, distribution, and stabilization.

The allocative function operates in situations where it is perceived that the market is performing inadequately as an allocator of resources and that adjustments must therefore be made to achieve social optimality. Public wants that are provided for outside of the market are divided into "social goods" or "merit goods." Because social goods may be enjoyed by anyone, regardless of

willingness to pay, they do not lend themselves to a market allocation. On the other hand, although merit goods can be allocated through the market, they are considered socially desirable to the extent that they are provided through the public budget over and above the quantities that would be allocated through the market. There are numerous instances where the public sector is deeply involved in the allocation of fish and wildlife in Alaska.

The public sector is also concerned with the distribution of income or wealth and the stabilization of the economy. Thus, public actions should be evaluated in terms of such objectives, rather than assuming that some narrowly defined "economic efficiency" criterion is universally applicable. If the maximization of net monetary returns is not the objective of a proposed action, it is obviously inappropriate to use that criterion to judge its success or failure.

Throughout the planning process, there is a need for economic perspectives, data, analyses, and interpretation. Merely inserting cold, hard, inflexible figures into the process at various stages has limited utility. There must be an understanding of what the figures mean in terms of socioeconomic objectives, the level of confidence at which they can be accepted, the basic underlying interrelationships, and the sensitivity of outcomes to factor changes.

At the outset of a planning effort, an understanding of the current socioeconomic situation is usually desirable. This understanding not only provides a basis for assessing the demands made on natural resources but also defines the base from which impacts can be measured. It is also desirable to visualize the effects that alternative future conditions are likely to have on natural resources, including fish and wildlife habitat. Projections can be a useful tool for making such assessments. For planning purposes, projections have a special meaning - that is, they are conditional statements of the future based on specified sets of assumptions. If some of these assumed

situations do not materialize, planners have the opportunity to assess the effects on the projected outcomes.

The evaluation of fish and wildlife resources represents an extremely complex issue. Even where these resources are marketed, there is disagreement regarding the appropriate measures of value - that is, the question often arises, value to whom? Political and business leaders are often concerned with the economic impact that can be attributed to activities related to the use of fish and wildlife, whether these uses be commercial or nonmarketed. Where economic impact is a concern, information on the expenditures associated with certain pursuits (sportfishing) or the value of harvest (commercial fishing) are legitimate measures. Secondary effects on employment and income can be calculated through the use of such analytical techniques as input-output models.

However, governmemt agencies are generally mandated to consider concerned with social values on a broader scale because they are supported by public funds. Particularly where nonmarketed goods and services are involved, considerable effort has been put forth to quantify consumer's surplus as a measure of social value. Although there is considerable controversy regarding the adequacy of consumer's surplus as a measure of social value, it does provide a measure (although incomplete) of the contribution of fish and wildlife resources. In practice, its major limitations are that externalities are not considered and that empirical evidence on the shape and magnitude of demand curves is often difficult to obtain.

Even in the absence of empirically established demand curves several techniques have been developed to estimate the consumer's surplus related to specific fish-and wildlife-related activities. Direct approaches that require interviews, such as "willingness to buy" and "willingness to sell," have received wide attention in the literature. An indirect approach, the travel cost method, has also had wide exposure. Thus far, these techniques have been less effective in actual planning situations.

Other evaluation techniques, such as market comparison, residual value, and opportunity costs, can be useful in appropriate situations, although they too have a number of conceptual shortcomings. Generally, these approaches do not attempt to measure social values.

Several economic models can be useful in determining optimal resource allocations under specific conditions. Linear programming is used frequently in natural resource planning, although it has not been particularly effective in dealing with fish and wildlife habitat planning problems, due primarily to quantification limitations. Although game theory has yet to receive widespread usage in natural resource planning, it (and decision theory) are appealing techniques because they are designed to deal with situations involving uncertainty.

Various techniques of systems analysis are frequently used in natural resource planning. Some of the more familiar approaches are benefit-cost analysis, the internal rate of return, current net worth, and cost effectiveness analysis. The successful application of these techniques to planning efforts involving fish and wildlife is often beset by inadequate valuation data. There is considerable controversy regarding the appropriate criteria to judge the acceptability of proposed actions, much less to rank them. Here again, it is essential that individuals have sufficient knowledge of such techniques in order to integrate them into the overall planning process.

Glossary

Amenity. Although generally anything that adds to one's satisfaction, the term has taken on a more specific meaning in natural resource planning - i.e., a good or service that is nonquantifiable, as opposed to commodities, which are quantifiable and lend themselves readily to evaluation.

Ceteris paribus. All else remaining the same.

Coefficient of determination. A number in the range from 0 to +1 that is a measure of the proportion of the total variation in the dependent variable that can be explained by variation in an independent variable.

Consumer's surplus. The difference between the price that a consumer pays for a good or a service and the amount that he would be willing to pay rather than be deprived of the good or service.

Contingency analysis. A procedure employed to cope with uncertainty with respect to major aspects of the environment assumed in an analysis. The procedure involves varying these assumptions and examining the results of the analysis in light of these changes.

Cross-elasticity of demand. The responsiveness of the quantity demanded for one product with respect to a price change for a substitutable or complementary product.

Decision rule. In game theory and decision theory, a rule that tells a participant (player) how to choose among the strategies available to him.

Decision theory. A body of knowledge and related mathematical techniques developed from the fields of statistics, mathematics, and logic designed to be of assistance in the making of decisions under conditions of uncertainty. Decision theory is quite similar to game theory in several respects, but a

major difference between the two is that in game theory the decision is being made vis-a-vis an opponent, whereas in decision theory the only opponent is nature with its related uncertainty.

Demand. The functional relationship between the quantity demanded and a number of independent variables. In practices, all of these independent variables except price are often assumed to be constant.

Derived demand. The demand by producers that is derived from consumer demands for other goods and services.

Diminishing marginal utility. The principle that as the level of consumption of a good is increased a point is reached where each additional unit consumed provides less utility (anticipated satisfaction) than did the preceding unit.

Discounting. The process of carrying an end value backward in time at compound interest.

Economic efficiency. That mix of alternative factors of production (resources, activities, programs, and so on) that results in maximum outputs, benefits, or utility for a given cost; alternatively, it represents the minimum cost for a specified level of output.

Economic impact. Any change in the status quo of the economy brought about by a specific action.

Economies of scale. Factors that reduce average production costs as the size of a plant increases. Economies of scale may be classified either as 1) internal, resulting from the increased size of an individual firm, or 2) external, resulting from the increased size of an industry as a whole.

Economics. That body of knowledge that deals with the allocation of scarce resources to satisfy human wants.

Elasticity. A measure of the responsiveness of the quantity demanded or supplied to changes in price or another variable.

Elasticity of demand. The responsiveness of the quantity demanded to a change in one of the independent variables, most often price in practice.

Elasticity of supply. The responsiveness of the quantity supplied to a change in price.

Endogenous variable. A variable the magnitude of which is dependent on and determined by the model being studied.

Exogenous variable. A variable that is wholly independent of the model being studied - that is, a variable determined by outside influences.

Expected value. The expected value of a strategy is determined by multiplying the value associated with each possible outcome by the probability that it will occur and then summing the products of these multiplications.

Externality. An economy or diseconomy - that is, a benefit or an undesirable effect that accrues to an entity as a result of an action initiated by another entity and over which the recipient entity has no control.

Free good. A good (or service) that is so abundant in relation to the demand for it that it can be obtained without paying money, without exchanging another good, or without self-exertion.

Function. A basic mathematical concept. A variable, y, is said to be a function of another, x, if a rule or relation exists whereby when a value is assigned to x, one or more values of y are determined. In this case, x would be the independent variable, and y would be the dependent variable. A dependent variable may be a function of more than one independent variable.

Game theory. A branch of mathematical analysis developed by von Neumann and Morgenstern to study tactical and decision-making problems in conflict situations. It is a mathematical process for selecting an optimum strategy in the face of an opponent who has a strategy of his own. Optimality may be defined by any of several criteria.

Linear programming. A deterministic model that assumes linear behavioral relationships and in which an optimal solution is sought (maximizing or minimizing) subject to one or more limiting constraints. Linear programming is used to determine the best or optimum use of resources to achieve a desired result when the limitations on available resources can be expressed by simultaneous linear equations. Every solution has a primal and a dual aspect - that is, a solution maximizing something (primal) and also one minimizing something (dual).

Marginal utility. The change in total utility due to a one-unit change in the quantity of a good or service consumed - for example, the additional satisfaction that a purchaser derives from buying an additional unit of a commodity or service.

Market mechanism. The determination of price and the quantity produced/consumed through the forces of supply and demand.

Merit goods. Public wants that could be allocated through the market mechanism but are considered so meritorious that they are provided through the public budget, over and above what is provided through the market and paid for by private buyers.

Microeconomics. That division of economics concerned with the income of a firm, the output of a firm or single industry, the price of a single commodity or service, the wage rate of an individual worker, or the wage bill of one firm or industry. In contrast, macroeconomics deals with aggregates such as total income, total output, total employment, the general price level, and the

general level of wages in the economy being examined, which is usually the national economy. Microeconomic analysis is often called "the theory of the firm" or "price theory."

Model. A representation of the relationships that define a situation under study. A model may be a set of mathematical equations, a computer program, or any other type of representation, ranging from verbal statements to physical objects. Models permit the relatively simple manipulation of variables to determine how a process, object, or concept would behave in different situations.

Monopolistic competition. A market situation characterized by many sellers of a particular kind of good or service but in which the output of each seller is to some degree differentiated from the good or service produced by every other seller.

Objective function. In liner programming, the function whose value is to be maximized or minimized (often profits or costs).

Opportunity cost. The measurable advantage foregone as a result of the rejection of the next best alternative use of resources. For example, the opportunity cost related to a decision to have the Government invest funds in an activity would be the benefits derived from those funds were they allowed to remain in the private sector of the economy.

Producer's surplus. The difference between the price at which a firm would be willing to produce a given quantity of a good or service and the price that the firm receives. Producer's surplus is also called "pure profits."

Pure competition. A market situation in which each buyer or seller of a homogeneous good or service is so small in relation to the entire market that the individual participant has no influence on the price of that good or service. Basic assumptions of the pure competitions model are that there are

many firms in the industry, homogeneous goods and services, freedom of entree to and exit from the market, and that independent decision making prevails (no collusion).

Pecuniary spillover. A spillover that is monetary rather than physical in nature and that causes a change in the monetary valuation of a physical input or output but does not change the relationship between physical inputs and physical outputs.

Regression analysis. Analysis undertaken to determine the extent to which a change in the value of one variable, the independent variable, tends to be accompanied by a change in the value of another variable, the dependent variable. Where only one independent variable is involved in the analysis, the technique is known as "simple regression analysis"; where two or more independent variables are involved the technique is called "multiple regression analysis."

Regression equation. Measures the degree of change in the dependent variable associated with changes in the independent variable or variables.

Scenario. A synopsis of a projected future situation.

Secular trend. The smooth and regular movement of time series over a long period of time.

Sensitivity analysis. A procedure employed to cope with uncertainty regarding the actual value of a parameter or parameters included in an analysis. The procedure is to vary the value of the parameter or parameters in question and examine the extent to which these changes affect the results of the analysis.

Simulation. An abstraction, or simplification, of a real-world situation. In its broadest sense, any model is a simulation, since it is designed to represent the most important features of some essential condition(s). Generally,

however, the term refers to a model being used to determine results under each of many specific sets of circumstances rather than to one being used to determine an optimal solution to a problem.

Social goods. Public wants that cannot be satisfied through the market mechanism because their enjoyment cannot be made subject to price payments.

Social opportunity cost discount rate. A discount rate used to measure the value to society of the next best alternative uses to which funds employed in a public investment project might otherwise have been put by taxpayers. In a perfectly competitive economy the cost of such funds would be represented by the market rate of interest.

Spillover. An economy or diseconomy for which no compensation is given (by the beneficiary) or received (by the looser). Spillover is sometimes synonymous with "externality" and with "external economy" or "external diseconomy."

Stochastic. A variable or process involving randomness. A variable is stochastic if the value it assumes is governed by chance and the values it may assume can be described by a probability distribution.

Subjective probability. A probability for which historical evidence is not available for decision making. The decision maker must therefore rely on his own estimation of the likelihood of various possible outcomes.

Suboptimization. Selection of the best alternative course of action pertaining to a subproblem - that is, to only part of the overall problem or objective.

Supply. The functional relationship between the quantity supplied and the price of the good or service.

Systems analysis. Systems analysis may be viewed as the search for and evaluation of alternatives that are relevant to defined objectives, based on judgement and, wherever useful, on quantitative methods, with the objective of presenting such evaluations to decision makers for their consideration. It emphasizes the system concept, under which any course of action designed to achieve an objective is viewed as a system requiring inputs and producing outputs. The inputs and outputs involved may take on any of a large variety of forms. In this sense, systems analysis encompasses both cost-benefit and cost-effectiveness analyses as well as other types of analysis that may be more limited in scope.

Technical coefficients. Coefficients obtained from an input-output analysis model, which show what fixed percentage input from each industry of the economy is required to produce a unit of output from a specific industry.

Technological spillover. A spillover that affects the relationship between physical outputs and physical inputs of some external entity that does not pay or receive payment for the spillover.

Time series. A display of data showing the magnitude of the same phenomenon at various points in time.

Uncertainty. In general, uncertainty and "risk" are used as synonymous terms. A distinction sometimes made between risk and uncertainty is that an event may be risky if a probability distribution can be ascertained. It is uncertainty if the probability of success or failure cannot be ascertained.

Utility. In economics, the real or fancied ability of a good or service to satisfy a human want.

Welfare economics. The study of the economic well-being of all persons as consumers and as producers, and possible ways in which that well-being may be improved.

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