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The Economics of Improved Estuarine Water Quality:

An NEP Manual for Measuring Benefits

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The Economics of Improved Estuarine Water Quality: An NEP Manual for Measuring Benefits is the result of a collaborative effort between the U.S. Environmental Protection Agency's (EPA) Office of Marine and Estuarine Protection (OMEP) and Office of Policy, Planning, and Evaluation (OPPE).

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EXECUTIVE SUMMARY

Section 320 of the Clean Water Act provides for the development of Comprehensive Conservation and Management Plans (CCMPs) for estuaries of National significance. To ensure the greatest return on resources spent, it is often necessary to document the economic benefits associated with alternative management strategies. This publication, The Economics of Improved Estuarine Water Quality: An NEP Manual for Measuring Benefits, is designed to assist estuary program managers and staff in determining the cost effectiveness of various pollution abatement options. The document explains the concept of economic benefits, then describes how pollution abatement projects can generate benefits.

Economic benefits are defined in this manual as the dollar value associated with changes in the use or potential use of a body of water. Willingness to pay, consumer surplus, and producer surplus are elements of the conceptual basis for measuring economic benefits. Pollution abatement projects generate economic benefits in stages--reducing effluents improves water quality, which changes the aquatic habitat. Recreationists, commercial fishermen, and homeowners, for example, then alter the way in which they use the body of water. The value associated with these changes represents the economic benefits of a pollution abatement project.

Benefits include user benefits and intrinsic benefits. User benefits are direct or indirect and affect industry, agriculture, the municipal water supply, commercial fishing, navigation, recreation, health, habitat, and aesthetics. These typically can be measured by using commonly available market prices, or can be inferred from market prices. Intrinsic benefits are those that are not directly related to the current use of water-related resources. They typically express to individuals the "psychic," subjective value of improved well-being. Intrinsic benefits can be personal or intergenerational, short term or long term.

To evaluate pollution abatement projects, a distinction must be made between primary and secondary benefits. Primary benefits are the direct impacts of the project. Secondary benefits are the indirect impacts. In some cases secondary benefits should be included in the evaluation; in other cases they should not. This manual suggests an approach to describing nonmonetizable benefits and provides recommendations to help to avoid double counting. Report and display features also are provided. Detailed procedures are given for defining and estimating recreational as well as commercial fishing benefits.

Recreational benefits covered include swimming, health, fishing, boating, and intrinsic benefits. The methods described to evaluate swimming benefits include the travel cost, contingent valuation survey, and participation/unit-day valuation methods. A cost-of-illness method is proposed to evaluate swimming-related health benefits. The demand estimation method for evaluating fishing benefits is described step by step, and a two-step procedure is given for evaluating benefits to boating. The commercial fishing benefits discussion focuses on commercial shellfishing, and four case studies are provided to assist in defining the benefits associated with reopening shellfish beds. Intrinsic benefits from reopening shellfish beds also can be estimated using methods such as the contingent valuation method (described in Chapter VI, Recreational Benefits).

Because there are numerous and subtle factors to consider when estimating the benefits of pollution abatement, this manual describes the types of analyses that can be made rather than dictating specific methodologies. To assist further in planning the best approach for measuring benefits, a list of technical publications that address industrial point-source effluent guidelines, limitations, and standards is provided at the end of this manual.

GLOSSARY

Bequest Value: An option value that reflects intergenerational concerns. (See Option Value.)

Common Property Resource: A resource such as air or water that is essentially free of charge or available to many users.

Consumer Surplus: The conventional dollar measure of the satisfaction that individuals derive from consuming a good or service, exclusive of what they pay for it.

Economic Base Analysis: A technique for estimating the secondary benefits from implementing a pollution abatement project by tracing the interindustry relationships and utilizing a single multiplier.

Economic Benefit: The dollar value associated with the incremental, beneficial changes in the use or potential use of the water body.

Existence Value: A measure of an individual's willingness to pay for knowing that the services of a resource exist, independent of any anticipated use by that person.

Individual's Demand Curve: A graphical representation of a person's desire for goods and services; the curve is used to determine an individual's maximum willingness to pay to consume specified goods or services.

Input/Output Analysis: A technique for estimating the secondary benefits from implementing a pollution abatement project by tracing the linkages between industries in a regional economy and utilizing several multipliers that result.

Intrinsic Benefits: All benefits associated with a resource that are not directly related to the use of that resource. (See Option Value and Existence Value.)

Net Benefits: A term used to denote benefits that either remain after, or are free from, costs and other charges that are assessed.

Nonmonetizable Benefits: Those benefits that cannot be valued monetarily or for which a dollar value cannot be easily assigned.

Option Value: A type of intrinsic benefit that quantifies the amount of money, beyond user values, that individuals are willing to pay to ensure access to a resource (or level of environmental quality).

Primary Benefits: Direct benefits of, or the increases in well-being resulting from, a pollution abatement project.

Producer Surplus: The measure of change in the well-being of a firm; that is, a measure of the excess of revenues over costs.

Secondary Benefits: Those benefits that are indirectly created by a pollution abatement project, either through the stimulative effects stemming from additional activities generated by the direct impacts of the project, or through the demand-induced effects of the expenditures required by the project.

User Benefits: Those benefits associated with the direct or indirect use of the resource.

Willingness to Pay: A measure of the maximum amount that an individual is willing to spend for each quantity of specified goods or services.

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Chapter I

Introduction

Section 320 of the Clean Water Act provides for the development of Comprehensive Conservation and Management Plans (CCMPs) for estuaries of National significance. To ensure the greatest return on resources spent, it is often necessary to document the economic benefits associated with alternative management strategies. The purpose of this manual is to assist estuary program managers and staff in identifying, estimating, and evaluating the economic benefits of water quality improvements created by various pollution abatement options. Estimating economic benefits helps to determine that a project's benefits are reasonably commensurate with the project's costs.

Benefit estimation cannot be approached mechanically. Each situation is unique, introducing new complexities that require judgment and versatility in determining how best to measure the various benefits. Furthermore, the availability of data is important in selecting and developing methods for estimating benefits. The availability of data both constrains and shapes the analysis. Therefore, estuary managers and project analysts are urged to gather and review all relevant information before proceeding with a site-specific approach. To aid in the preparation process, the U.S. Environmental Protection Agency (EPA) Industrial Technology Division (also known as the Effluent Guidelines Division) has compiled a list of technical publications that address industrial point-source effluent guidelines, limitations, and standards. The list, referred to as Exhibit A, is included at the end of this manual. Because there are numerous and often subtle factors to consider in benefits estimation, this manual does not dictate specific methodologies that must be used when estimating the benefits created by pollution abatement options; rather, the manual describes the types of analyses that EPA believes can serve as benchmarks.

This manual first explains the concept of economic benefits, briefly touching on willingness to pay, and consumer and producer surpluses. The document then describes how pollution abatement projects can generate benefits. Chapters follow on each of the kinds of benefits that could result. The section below outlines the general procedures for estimating the benefits from water pollution controls. This manual is intended to be a primer on benefits analysis. For a more comprehensive explanation of benefits estimation, see the Benefit-Cost Assessment Handbook for Water Programs (U.S. EPA, 1983).

Chapter II

Concept of Economic Benefits

The following discussion of economic benefits is conceptual in places. This section is intended to clarify the technical definition of the term benefits to facilitate understanding of the practical application of the benefits analysis, and to provide an overview of the typical context in which water quality problems exist (i.e., common property resources). Some familiarity with microeconomic principles is assumed. A more comprehensive explanation is given in the Benefit-Cost Assessment Handbook for Water Programs (U.S. EPA, 1983).

In other documents the term benefits has been used loosely to refer to outcomes such as the expected number of beach closings averted per season or the reduction in total phosphorous loadings in the water body. The term economic benefit, as it is used in this manual, is more specific. Here, the term refers to the dollar value associated with the incremental, beneficial changes in the use, or potential use, of the water body. The economic concepts used to measure these benefits are derived from economic theory, according to which individuals acquire satisfaction (or utility) by consuming goods and services.

A. The Context: Nonoptimal Use of a Common Property Resource

One of the fundamental problems in water quality economics is the "common property resource" issue. In some cases, typically when an air, water, or other resource use is essentially free of charge and/or available to many users, that resource will tend to be overused relative to some optimal level. To understand this phenomenon, it is necessary first to describe the basic concepts of demand curves (willingness to pay) and supply curves.

B. Willingness to Pay: Demand Curves and Consumer Surplus

An individual's demand curve, which is a reflection of a person's desire for goods and services, is an important conceptual guidepost for defining and measuring economic benefits. The typical demand curve, presented in Figure 1, shows the maximum amount that an individual would be willing to pay for each quantity of good X. The downward slope of the curve indicates that an individual is willing to buy more of X at lower prices than at higher prices. In Figure 1, it is assumed that all the other factors that might influence demand, such as income, the prices of related goods, etc., do not change. Thus, according to the demand curve, if the market price is P_0, the individual will purchase Q_0 of X and make a total expenditure equal to P_0AQ_00. Because the demand curve measures the individual's maximum willingness to pay for each level of consumption, the total willingness to pay for Q_0 can be derived as the total expenditures plus the triangle P_0P_iA.

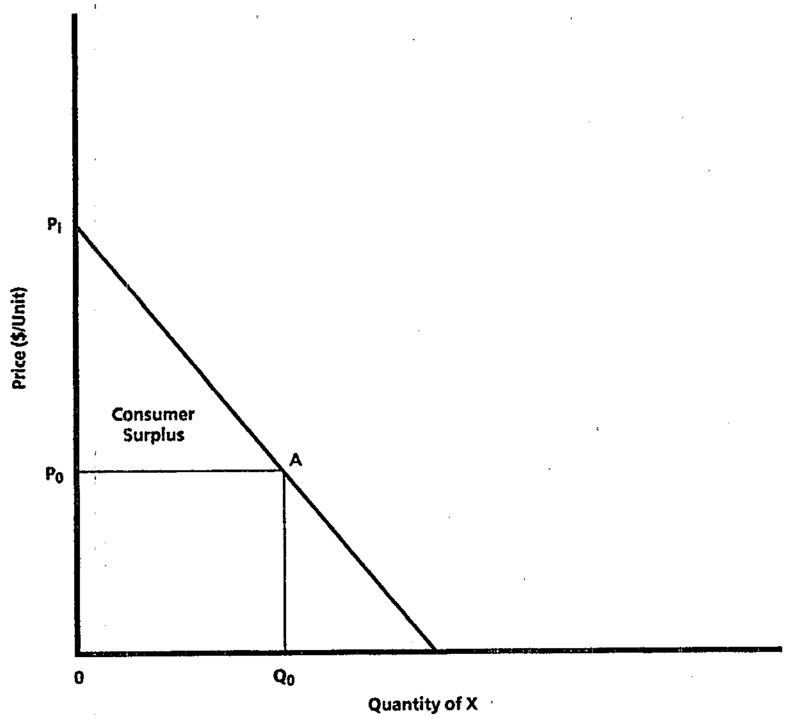

Figure 1. Demand Curve and the Consumer Surplus Welfare Measure

The difference between what individuals actually pay with a constant price per unit and the amount that they are willing to pay is defined as the consumer surplus--the conventional dollar measure of the satisfaction that individuals derive from consuming a good or service, exclusive of what they pay for it. For most activities that depend upon services related to the environment, the price is zero. For example, often no price is charged for admittance to public beaches. In such cases, economists develop demand curves based on surrogate prices (e.g., using travel costs). (See Section VI.A below.)

Although the area under the typical demand curve is not a theoretically ideal measure of a recreationist's consumer surplus, in most water-based recreational applications it provides a sufficiently close approximation to the ideal measure and is simpler to estimate (Willig, 1976). Comprehensive data, such as a recreationist's income level, distance from the person's house to the recreational site, and the frequency of trips taken to the recreational site, generally will not be available for rigorous empirical estimation of water pollution abatement benefits. A comprehensive individual-user telephone survey would be needed to gain this information; however, such a survey is expensive and time-consuming. Therefore, developing a more theoretically rigorous measure of individual consumer surplus without comprehensive data would probably add only a false sense of precision. Even measuring the area under a typical demand curve is difficult. It requires the ability to specify and estimate demand and supply curves. The difficulty arises because the data observed (i.e., prices and quantities) reflect only the intersection, or equilibrium point, of the two curves. Specifying these curves requires data on variables other than price and quantity to account for "shifts" in the curves. Even if the demand and supply curves can be successfully specified, the data available to estimate the equations are often highly correlated, resulting in poor parameter estimates. These are the problems faced when "hard" data are available, as in the private marketplace. The problems become much more severe when estimating the consumer surplus for public goods.

Despite having serious methodological problems, these methods are used to estimate water quality benefits and are relied upon by decision makers. For example, under Executive Order 12281, benefit estimates relying upon these techniques are commonly used in the Regulation Impact Analyses (RIA) that support guideline standards promulgated by EPA and approved by the Office of Management and Budget (OMB). The methods discussed below reflect these estimation problems, and offer suggestions on how best to deal with difficult situations. For those interested in pursuing more rigorous estimates, the Benefit-Cost Assessment Handbook for Water Programs (U.S. EPA, 1983) can be consulted.

How would estimates of individual consumer surplus be used in estimating the benefits of water quality improvement? As an example, one beneficial impact of water pollution controls might be a reduction in the number of days of beach closings due to excessive fecal coliform counts. Thus, estimates of a random sampling of recreationists' consumer surplus for each visit to the beach, properly expanded to represent the total number of recreationists likely to use the beach on any given day, would provide a dollar value of the economic benefits of improving water quality to increase the recreational use of that beach by one day.

C. Supply Curves and Producer Surplus

Analogous to the concept of consumer surplus, producer surplus is the measure of a change in the well-being of a firm (<u>firm</u> is used generically to mean any economically productive entity). In Figure 2, the producer surplus is the area above the original supply curve S_0 and below the price line P_0 faced by the firm or industry. The supply curve shows the relationship between the quantity of output that the firm is willing to supply and the price at which the firm can sell the output. The upward slope of the curve indicates that the firm is willing to sell more at higher prices than at lower prices, all else being equal. The area $0NUQ_0$ measures the costs to the firm of supplying Q_0 of the good, and the area $0P_0UQ_0$ measures the revenues generated by selling Q_0 of the good at the price P_0. Producer surplus is the area of the triangle NP_0U that measures the excess of revenues over costs.

Whether a firm is economically better off after water pollution controls have been implemented is sometimes difficult to determine, but examining the change in producer surplus will help. For example, controls may lead to the reopening of shellfish beds. If so, a polluting firm could see its marginal costs (or fixed costs) rise, resulting in lower quantities sold and economic losses. Moreover, if the shellfish industry is competitive, new firms will be established to supply the additional demand, or the price will drop to reflect lower costs, eliminating excess profits. Consumers will be better off in total, but producers will be neither better nor worse off economically. On the other hand, an increase in harvestable supply and possible decrease in processing costs could lead to a reduction in the firm's marginal costs of supplying shellfish. This scenario is depicted as the rightward shift in the supply curve from S_0 to S_1 in Figure 2. If there is no change in the price for a firm's or industry's output, then the change in producer surplus would be equal to the area UTMN. Unlike individual consumer surplus, which is measured in terms of utility or satisfaction, a change in producer surplus provides an exact measure of a change in a firm's welfare because it is measured directly in dollars.

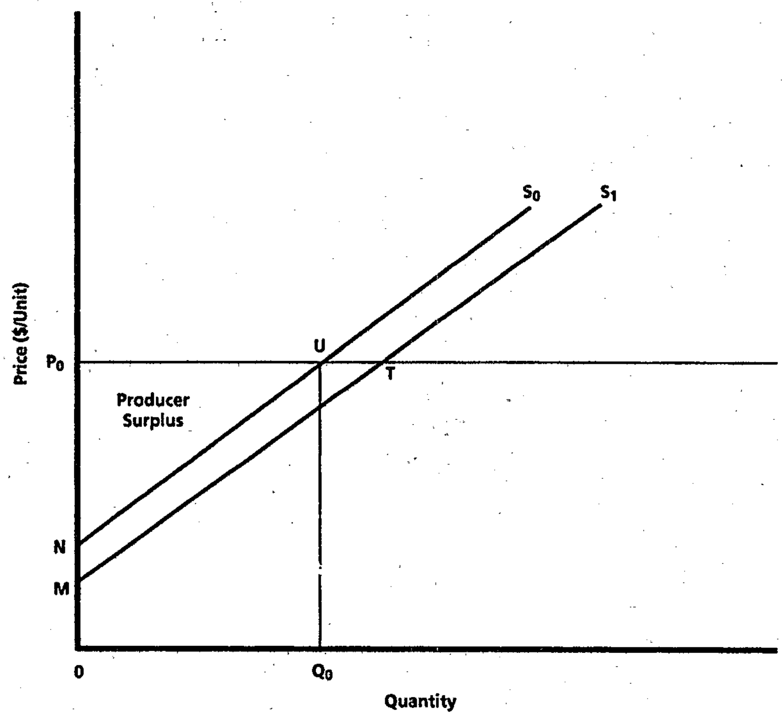

Figure 2. Supply Curve and Producer Surplus

The change in consumer and producer surplus provides the conceptual basis for measuring economic benefits. Before these concepts can be applied, however, it is necessary to understand the nonoptimal use of common property resources, the process by which water pollution controls produce economic benefits, and the different kinds of benefits that may be considered.

D. How Common Property Resources May Not Be Optimally Used

As mentioned in Section II.A, the availability of common property resources can result in their nonoptimal use. This section describes how nonoptimal use may arise, and presents an overall framework for the need for water quality protection and hence for estimating the overall costs and benefits for water quality protection programs and projects.

Figure 3 presents a basic model used to equate social costs with social benefits and represents a summation of net benefits for both consumers and producers, given the common property resource.

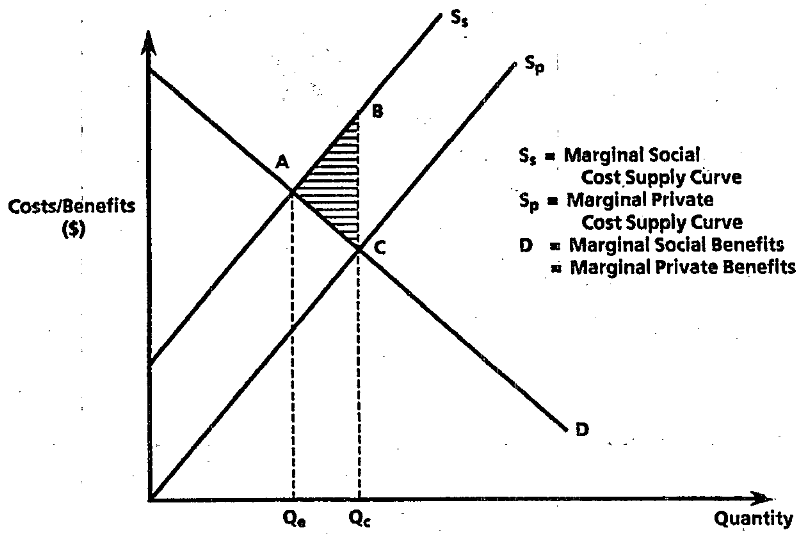

Figure 3. Nonoptimal Use of Common Property Resources

The optimum level of output is that at which the marginal social cost equals the marginal social benefit, yielding output Q_e. However, the unregulated competitive market provides output Q_c instead. The increased welfare associated with producing Q_e is given by the area ABC. The reduction in total social cost from the change is the area under the marginal social cost curve, ABQ_cQ_e. The loss of social benefit equals the area under the marginal social benefit (demand) curve, ACQ_cQ_e. The difference between the two, area ABC, represents the net welfare improvement from the reduced output of market goods and the increased level of environmental goods (water quality enhancement).

The preceding example illustrates the common problem of overuse of a common property resource. For example, estuarine waterways may become polluted because of agricultural runoff (i.e., nonpoint sources) or industrial discharges (i.e., point sources). Policy prescriptions, such as requirements for agricultural Best Management Practices (BMPs) or industrial pretreatment regulations, are intended, in effect, to equate the marginal private cost supply curve (S_p) in Figure 3 with the marginal social cost curve (S_s).

In reality, it is extremely rare that S_p or S_s in Figure 3 either are ever known or can truly be estimated at reasonable cost. However, it is usually possible to discover if a proposed water quality protection program or project will result in an overall improvement in social welfare. In other words, it is possible to determine if a reduction in the size of the "social welfare loss triangle," area ABC in Figure 3, will occur.

At its essence, benefit-cost analysis of improvements to estuarine water quality is intended to achieve precisely a determination of the size of the change in the social welfare loss triangle. If the benefits of such improvements outweigh their costs, then the program is desirable.

The remainder of this manual focuses on methods to predict and estimate the economic benefits of estuarine water quality improvements. In many cases, the analyst must be aware that some costs are often required to achieve those benefits. For example, industrial users may benefit from cleaner process water for cooling, etc., but pretreatment regulations, or required changes in agricultural practices to achieve those benefits in a watershed, may be costly.

While these costs are recognized, the focus of this manual is on <u>benefits</u> estimation. Occasionally, the term <u>net benefits</u> is used to denote benefits <u>net</u> of costs; but, in general, cost estimating as discussed in this manual is more straightforward. The following section provides examples of sources for cost estimation for wastewater treatment facilities, but other costs, such as of government regulation programs and agricultural practice changes, are not explicitly covered.

Chapter III

How Pollution Abatement Projects Can Generate Economic Benefits

Economic benefits of water pollution controls are produced in distinct stages. As Figure 4 illustrates, reducing the quantities of effluent being discharged into a water body improves the various parameters or measures of water quality, which in turn can lead to changes in the aquatic habitat in the impacted area. Once the economic agents directly affected by the water body (e.g., recreationists, commercial fishermen, and homeowners) perceive these changes, they may alter how they use the water body. The measured value associated with these changes in use or potential use represents the economic benefits that the project generates.

The first link in this chain--the relationships among the various water pollution controls and the qualitative and quantitative reductions in effluents--is technical and in many ways noneconomic. One aspect of this link that is economic in nature, however, is the cost of constructing, upgrading, operating, and maintaining various water pollution controls such as municipal wastewater facilities. Although cost data may not be directly applicable to optimal reductions in effluents (i.e., there are ancillary equipment and related costs that do not impact effluent levels), the data nonetheless should be considered and the relationship between money spent and expected outcome closely examined.

Several publications are available that address these issues. Construction Costs for Municipal Wastewater Treatment Plants: 1973-1978 (U.S. EPA, 1980) examines cost information collection, analysis, and estimation techniques, and includes examples to illustrate various costing procedures. For instance, examples include estimating the total project cost for a new 2.0 million gallons per day (mgd) activated sludge secondary treatment plant in Columbia, Missouri; estimating the cost of enlarging an existing advanced secondary treatment plant in Billings, Montana, from 4.0 to 5.5 mgd; and estimating the cost of enlarging or upgrading an existing 2.0-mgd primary treatment plant in Gainesville, Florida, to a 5.0-mgd advanced wastewater treatment plant. The examples are accompanied by appropriate graphs and calculations to guide the reader through the estimation process.

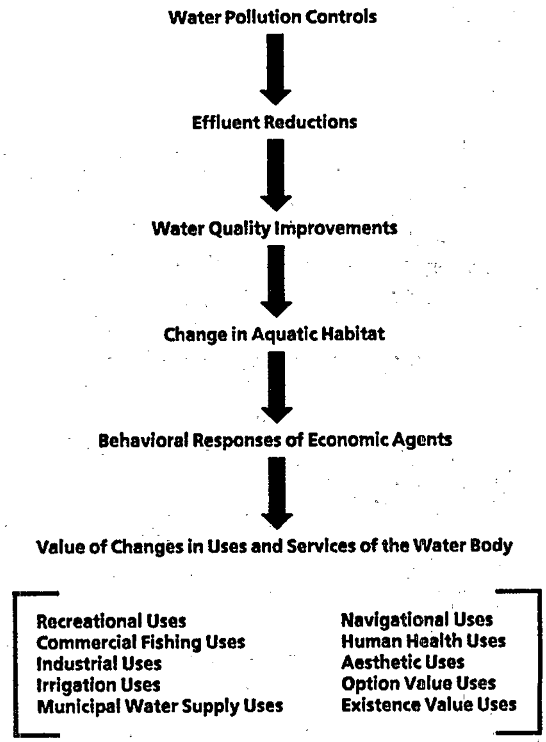

Figure 4. Causal Relationships and Economic Benefits

Similarly, Construction Costs for Municipal Wastewater Conveyance Systems: 1973-1979 (U.S. EPA, 1981) examines the costs of constructing gravity collection sewers, interceptors, pumping stations, and the associated force mains necessary to collect and transport wastewater to a treatment facility. This report, which is based on analysis of 777 collection systems, provides detailed analysis of various cost estimating procedures and includes examples. Two examples address estimating the total project cost to construct 5,000 ft of 30-in. sewer in Louisville, Kentucky, and estimating the total project cost for a wastewater collection system to serve a population of 2,500 people in Mankato, Minnesota.

Yet another document that examines the economic aspects of this first link in the chain is Operation and Maintenance Costs for Municipal Wastewater Facilities (U.S. EPA, 1981). This document summarizes operation and maintenance data for more than 900 treatment plants and almost 500 conveyance systems throughout 41 of the 48 contiguous states. Included is information on administrative costs, sludge-handling costs, and staffing. In addition, examples are provided that illustrate estimation procedures in these key areas, such as estimating administrative costs for a secondary wastewater treatment facility with a design flow of 5.0 mgd, and estimating total operation and maintenance costs for a new treatment plant with a design flow of 2.75 mgd. The estuary manager or analyst may also wish to consult "Cost-Effective Operation and Maintenance: Six Cities Save Over One Million Dollars" (U.S. EPA, 1986), another reference for analyzing effective wastewater treatment options.

The second link in the chain--the relationship between effluent reductions and changes in water quality--is noneconomic in nature, as it involves a variety of physical and biochemical processes and relationships.[1] Because these physical and biochemical processes, which take place once pollution has occurred, are predominantly noneconomic in nature, they are not covered in this manual. However, it is critical that the economist or analyst gain a reasonably clear understanding of the relevant physical and biochemical processes.

The third link in the chain involves translating the predicted changes in water quality parameters, such as dissolved oxygen, suspended solids, or fecal coliforms, into quantified physical effects on habitats, such as changes in fish habitats or reductions in the number of beach closings. This link represents the interrelationships between the noneconomic (i.e., physical and biochemical) and the economic stages of the production of benefits. In some circumstances, the analysis cannot proceed beyond this link because the effects that induced changes in water quality have on marine aquatic habitats are not well understood. For example, some pollution is intermittent (caused by rainstorms) so that the resulting water quality problems are transient and may result in only a short-term adverse effect. However, in other cases intermittent problems can have cumulative, long-term effects, possibly resulting in direct consumer loss of benefits (e.g., shellfish beds may be closed for an extended period or swimmers may have a lingering fear of the water long after the beach has been reopened). Predicting water use benefits that would result from controlling intermittent sources of pollution is difficult. In this situation, the impacts of controls should be described qualitatively. A qualitative analysis may identify other factors that should be considered and will aid in the decision-making process. (See Section V.C for further discussion.)

The link between water quality improvement and change in aquatic habitat has been examined in Habitat Requirements for Chesapeake Bay Living Resources (Chesapeake Bay Program, 1988). To document the present water quality of Chesapeake Bay and refine strategies for reducing or preventing further increases in nutrient enrichment and contamination by toxic metals and organic compounds, Bay Program personnel developed a resource-based

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1 These processes and relationships come into play once decreased or increased effluents enter the environment. However, it is clear that polluters' decisions to change pollution practices are often closely related to economic (typically profit and loss) considerations.

approach for defining habitat objectives. After studying major trophic relationships and energy paths in the bay, then establishing zones based on water depth and salinity, representative and target species could be identified and profiled. These species serve as indicators of Chesapeake Bay's ecological condition. Related habitat matrices were developed for the target species and provide information such as the sensitivity of a particular species to toxic substances. The Habitat Requirements document can be used to develop resource-based water quality standards. The document details the steps involved and presents species-specific data.

It should be emphasized that habitat benefits themselves often foster other improvements and have value beyond that determined by the analyst when establishing links in the causal relationships to arrive at economic benefits from improved water quality. This document focuses on benefits to water users and nonusers of improved water quality, which may include not only better fisheries (a point addressed later) but improved wetland quality, which in turn can readily result in healthier flora and fauna, greater estuarine species diversity, etc. In turn, this can lead to higher-valued consumptive and nonconsumptive recreation, and even commercial values. In many cases, the value of protection and restoration of habitat can also be estimated, using the techniques described in this report.

A related document, but one that examines the other side of the relationship--in this case, the need to improve water quality by altering the pollutant (i.e., phosphorous) level--is the Handbook: Retrofitting POTWs for Phosphorous Removal in the Chesapeake Bay Drainage Basin (U.S. EPA, 1987). The handbook presents general engineering considerations for retrofitting wastewater treatment facilities, performance and cost data from selected plants, process design synopses, and chemical and safety concerns. Also included are a comparison of biological phosphorus removal processes, a discussion of the effects of combined phosphorus and nitrogen control on the engineering requirements, estimated cost graphs for retrofitting plants, and an examination of numerous other factors in phosphorus removal. Several case studies in the Chesapeake Bay and Great Lakes Drainage Basins are described as well.

Similarly, the Design Manual: Phosphorus Removal (U.S. EPA, 1987) explores several phosphorus removal strategies and processes, and provides detailed case histories or various applications of the technology. For example, using the Phostrip (biological) process at a wastewater treatment plant (15-mgd design capacity) in Little Patuxent, Maryland, resulted in an average total phosphorus removal efficiency of 94%; using chemical addition systems at treatment plants in Elizabethtown, Pennsylvania, and Little Hunting Creek, Virginia, resulted in estimated chemical sludge production levels from phosphorus removal of 30% to 44%; and adding iron as waste pickle liquor (approximately 5 mg/L) at the Back River Wastewater

Treatment Plant in Baltimore, Maryland, significantly improved sludge handling operations, boosting average daily sludge production of dry solids from 69 to 88 tons and wet solids from 390 to 456 tons for an increase of 29% and 17%, respectively. It is advisable to consult these and other documents when examining the link between improvements in water quality and changes in aquatic ecological habitats.

Once changes in aquatic habitats have been recognized by users or potential users of the water body, these individuals or firms will alter how they use the resource. Changes in the pattern of uses and services associated with the resource represent the economic benefits that result from implementing successful estuarine pollution controls. The last stage of the analysis is to determine the dollar value associated with changes in uses and services of the affected water body. Before reviewing the methodologies for valuing these benefits, it is appropriate to identify all of the uses or services of the water body that may be affected by the improvement in water quality. These uses and services are identified in the next section.

Chapter IV

Benefit Categories

The sources of benefits from the changes in the uses and services of the water body are categorized in Figure 5. The economic benefits created by water quality improvements can be grouped into two broad categories--user benefits and intrinsic benefits. User benefits are those benefits associated with the use of the resource; these benefits are divided into direct uses and indirect uses of water. Intrinsic benefits are all benefits associated with a resource that are not directly related to the use of that resource; these benefits are also divided into two subcategories, option value and existence value. All of the subcategories are then divided further to delineate specific economic beneficiaries. Each of these categories is discussed below.

A. User Benefits

1. Net Benefits to Industrial Users of Water

Industrial water uses are usually classified as boiler feed, cooling water, and process water. Boiler feed is water that is boiled in thermal electric plants to make steam for space heating and for use in industrial processes. Since intolerable quantities of salts are normally present in water sources used as boiler feed, the water generally is treated before use regardless of the concentration of pollutants. The implication is that the benefits from water pollution controls would be slight insofar as water is used for boiler feed since treatment is required regardless of the pollutant levels.

Cooling water is used to cool heated surfaces. Quantitatively, by far the most important use of cooling water is in electric generating plants. Quality requirements for cooling water are not nearly as stringent as for boiler feed. Still, cooling water is sometimes treated before use to prevent scale and slime formations, and cooling towers must undergo a "blowdown" process periodically to remove these formations. Thus, water pollution controls might reduce the costs of treatment and the frequency of blowdown. Also, pollution controls might reduce the use of toxic cleaning agents that are discharged in effluents; this would benefit users downstream as well.

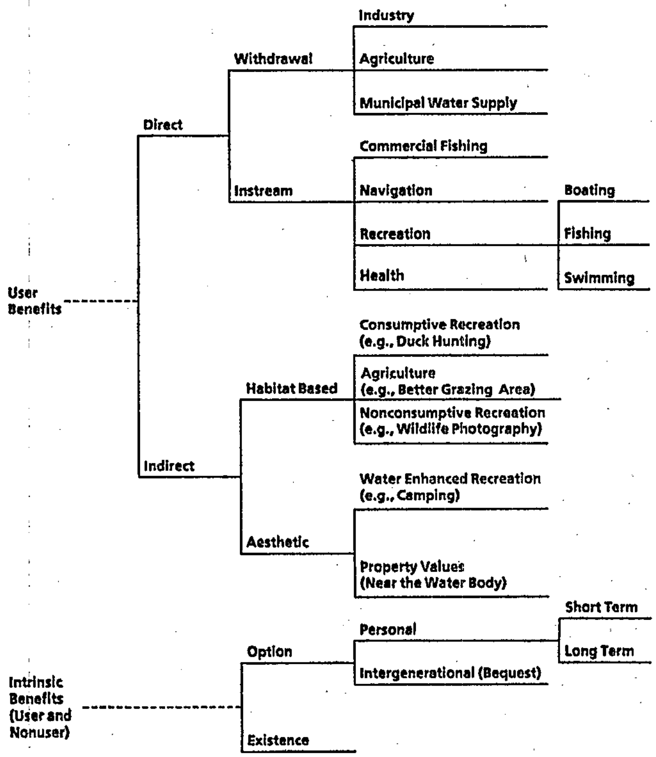

Figure 5. Sources of Benefits of Water Pollution Control

Process water is water used in a wide variety of industrial processes. Many of these are once-through uses in which withdrawn water is used to transfer wastes to the water body. Water quality is relatively unimportant in most of these uses. The implication again is that water pollution controls would result in little or no economic benefits for process-water uses.

Some studies have estimated the cost savings of treating withdrawn water if the water quality were to be improved. Estimating a firm's producer surplus from a water quality improvement has been much less sophisticated than estimating consumer surplus. The primary focus has been on estimating the cost savings associated with the change in water quality. The estimates are derived largely from engineering cost estimates (Eliassen and Rowland, 1962; Greeley and Hansen, 1969). Past estimates of industrial withdrawal benefits have been very small, since industrial water treatment costs are not more than 0.1% to 1.0% of production costs. Furthermore, many firms respond to deterioration in water quality by changing to new processes that can accommodate low-quality water, instead of treating water before using it. If this change occurs, estimates of reduced treatment costs are inappropriate and would overestimate the benefits of improved water quality.

The benefits analysis must also take into account recent trends in increasing water reuse and recycling in industrial processes. In some cases, water quality improvements may reduce industrial costs; in particular, more reuse and recycling may be possible or treatment expenses before reuse may be reduced. However, there may be no benefit to industries that reuse and recycle water if their water quality requirements are low. Thus, the analyst must gain a clear understanding of the industrial processes affected.

Before benefits can be estimated, the case must be made that firms' costs would, in fact, be affected by water pollution controls. As implied above, such instances are likely to be rare.

Industrial users may, however, be subject to additional costs from water quality regulations. For example, pretreatment at the industrial site may be required before discharge into sewer systems or waterways; this may mean adapting a new technology and incurring the costs. These costs must be included as offsets to the benefits estimates. Tax savings to the user from any tax credits, however, should not be included because the public pays these costs through reduced tax income.

2. *Net Benefits to Agricultural Users of Water*

Although it is unlikely that brackish estuarine water will be diverted for irrigation purposes, agricultural uses of water are a concern to estuary program managers. The impacts that these uses have on the estuary should not be overlooked. In many estuaries, diversion of freshwater for agricultural uses has resulted in longer residence times of toxicants in the estuary. As the water level in the estuary is reduced, the salinity concentration increases. More incoming water is then needed to reduce the toxicant and salinity levels. Wetlands also can be adversely impacted by freshwater diversion. The benefits of freshwater use must therefore be weighed against associated habitat degradation costs.

One significant issue pertinent to such locales as Washington, California, and Hawaii is saltwater intrusion from an imbalance of groundwater pumping at sea level with saltwater permeating through the soil or Ghyben-Herzburg floatation lenses. The more brackish the water is in estuaries contiguous with irrigated agricultural wells, the more likely the longevity of water supply will be affected, since the salt concentrations will distort the separation of freshwater and saltwater. Hence, there is a direct benefit to agricultural water supply from estuarine water quality enhancement.

3. *Net Benefits to Municipal Users of Water*

It is unlikely that marine or estuarine water will be diverted for drinking water purposes. However, municipal water supply uses should be considered in the cost-benefit analysis of water quality improvements. Freshwater diversions for municipal uses can result in longer residence times of toxicants in the estuary and may adversely impact wetlands as well. Pollutants in surface water runoff may also find their way into a municipal water supply. Therefore, municipal water uses in and around the estuary, and the impact that associated freshwater diversions have on the resource base, should be considered fully.

4. *Net Benefits to Commercial Fishing*

Water pollution can affect the productivity of commercial fisheries in several ways. Conventional pollutants and toxic substances can affect the biological productivity of estuarine areas, seriously damaging the food chain that supports commercially valuable species. Pollutants can also directly reduce, eliminate, or make unfit for consumption populations of finfish and shellfish species. Within some estuaries, local stocks of sport fish have declined and other commercially important species have been taken off the market because of toxic substance contamination. Shellfish beds also have been closed to commercial harvesting as a result of water pollution. Pollution abatement may result in the partial or complete restoration of these resources. Estimation of the economic benefits associated with protection and restoration of fishery resources is discussed in a later section of this manual.

5. *Net Benefits to Navigation*

The presence of corrosive substances in the water can shorten the lives of, and otherwise damage, vessels and structures such as wharves and pilings (Tihanski, 1973). Water pollution controls may therefore create navigational benefits.

6. *Net Benefits to Recreation*

Many past studies indicate that the recreational benefits resulting from water quality improvements are the most quantitatively significant. Water-based recreational activities that can be affected by water pollution include swimming, sportfishing, hunting of waterfowl, bird-watching, wildlife photography, boating, sailing, and water skiing. For water pollution control projects, recreational benefits are likely to be created by the value of an increase in daily (seasonal or annual) usage (if it is not already utilized to its capacity) because of perceived improvements in the recreational attractiveness and/or safety of the water body. Estimation of recreational benefits is discussed in a later section of this manual.

7. Net Health Benefits

Health benefits may be associated with many of the previously mentioned uses of a water body, in particular water-based recreation and the consumption of contaminated finfish and shellfish. Theoretically, the health benefits that might result from water pollution controls would equal the sum of the affected individual's willingness to pay for the reduction in the risk of contracting illnesses (such as infectious hepatitis, diarrhea, fever, and gastroenteritis in the case of water recreation). This willingness to pay is thought to depend on three principal characteristics of the illness: (1) the degree of pain and discomfort, (2) the extent of cosmetic losses in personal appearance, and (3) the extent of time that the person is sick. A quantitative economic assessment of swimming-related health benefits associated with fecal coliform reductions is discussed in a later section of this manual.

8. Habitat-Based Benefits

Habitat-based benefits are those benefits that are the result of an impact on the ecosystem. The benefits are divided into two subcategories, consumptive and nonconsumptive recreation. For example, improvements to water quality could support the aquatic ecosystem by providing food, cover, and other needed elements for the survival and propagation of various species. This, in turn, could lead to increased duck hunting (consumptive recreation) and increased wildlife photography (nonconsumptive recreation).

Habitat-based benefits can be quite complex because of the close, and two-way, ecological connection between habitat and water quality. Water quality degradation may decrease habitat quality, for example, by weakening the ecological integrity of riparian zones. A reverse causal link may then be initiated, in which reduced natural filtering and cleansing functions of riparian zones may not only reduce, for instance, the value of wetlands for flood production, but may also further degrade water quality. Clearly, the economic analyst must understand these two-way processes, perhaps by working closely with biologists and chemists, and must also consider these seemingly indirect but often very important benefits.

9. Benefits to Aesthetics

The term aesthetics refers to other ways in which the quality of the water body affects the well-being or utility of those who live and work around it. Odor, unsightly shore deposits, and large accumulations of scum, foam, surface slicks, or other visible pollutants can adversely affect, among other factors, residential property values on or near the shoreline. In extreme cases, such as the washing ashore of medical wastes, direct recreational use of the water is also impacted and can result in beach closings or other mitigating measures. However, because aesthetic effects often are not associated with direct use of the water, they pose severe measurement and valuation problems. Nonetheless, to the extent that they involve utility gains and, hence, willingness to pay, they are every bit as real in an economic sense as direct recreational use. [For more discussion of the property value impact benefit model, see the Benefit-Cost Assessment Handbook for Water Programs (U.S. EPA, 1983).]

B. Intrinsic Benefits

Intrinsic benefits include all benefits associated with a resource that are not directly related to the current use of that resource. Briefly, intrinsic benefits can be categorized as the sum of option (bequest) value and existence value.

Intrinsic benefits are difficult to measure correctly, but to the extent that they involve willingness to pay, they are every bit as real in an economic sense as direct recreational use. The best method to estimate intrinsic benefits is by using contingent valuation surveys, as discussed later in this manual. Intrinsic benefits can be significant. In recent studies of the benefits of water quality improvements, intrinsic benefits have typically amounted to approximately 50% of recreational user benefits (Fisher and Raucher, 1982; Mitchell and Carson, 1981; Walsh et al., 1978).

1. Option Value

Option value is defined as the amount of money, beyond user values, that individuals are willing to pay to ensure access to the resource (or a level of environmental quality) in the future, when there is uncertainty in resource availability and/or individual use (demand), regardless of whether the individual is a current user. Option benefits reflect the value of reducing uncertainties and avoiding irreversibilities. When option values reflect intergenerational concerns, they are referred to as bequest values. Bequest values are defined as the willingness to pay for the satisfaction associated with endowing future generations with the resource.

Although these calculated benefits are useful analytical tools, their utility and accuracy are enhanced when they are subjected to a societal discount rate. Such a rate and procedure adjusts future dollar measures of benefits for society's true value of money plus the implicit tradeoff between consumption and investment. For example, to invest in water quality today means not investing in some other alternative or foregoing consumption today. If no discount rate is applied when using the estimation methods, the resulting benefits estimates will be significantly overstated.

2. *Existence Value*

Existence value is defined as an individual's willingness to pay for knowing that the services of the resource exist, independent of any anticipated use by the recreationist. For example, people may have a stewardship motive for wanting to ensure the continued existence of whales regardless of whether they ever plan on going whale-watching. People may also value for philosophical, ethical, or religious reasons knowing that healthy ecosystems will continue to exist. A. M. Freeman (1981) presents an approach to defining and measuring existence values.

Chapter V

General Procedures for Evaluating Benefits

This discussion of the general procedures for evaluating benefits includes the appropriate framework to be used, the distinction between primary and secondary benefits, an explanation of unmeasurable benefits, how to deal with uncertainty, and the appropriate report and display procedures to be used.

A. Benefit Framework

The incremental economic benefits generated by a proposed pollution abatement project are evaluated by comparing the situation with the project to that without it. The annual value of the uses, potential uses, and services of the water body with the proposed project, minus the annual value of the uses and services of the water body without the proposed project, represents the incremental annual economic benefits created by the pollution controls.

B. Primary and Secondary Benefits

The distinction between primary and secondary benefits is important since the analysis should include only certain benefits. Typically, primary benefits are taken to be the direct impacts of, or the increases in well-being resulting from, the proposed project. Secondary benefits are defined as those benefits indirectly created by the project, either through the stimulative effects stemming from additional activities generated by the direct impacts of the project, or through the demand-inducing effects of the expenditures (inputs) required by the project.

For example, an investment in a pollution abatement project could reduce the number of beach closings per season and lead to increased recreational use of that beach. The willingness to pay for the additional recreational enjoyment at that beach is a measure of a primary benefit of the project. Further, because of the increased recreational use of the beach, the demand for the services of nearby restaurants and hotels may increase, leading to the hiring of more cooks, groundskeepers, and other service personnel. This increase in employment represents a secondary effect stemming from additional activities generated by the direct impacts of the project. Wages paid to the laborers who were hired to construct the pollution control facilities would also represent a secondary benefit, in this case induced by the expenditures required by the project.

Should the economic value associated with these secondary benefits be added to the economic value of the primary benefits in determining the total benefits of the project? The answer to this question depends on the employment conditions in the economy. With relatively "full" employment, there is generally no basis for claiming the existence of any secondary benefits. This is not to deny that hotel or restaurant hirings may increase. The point is that in a full-employment economy, where there are essentially no idle resources, such hiring represents a transfer and not a net gain--it requires that some other activity be theoretically foregone or reduced. Thus, under full-employment conditions there is no presumption that the secondary benefit adds to aggregate national welfare, and therefore there is no basis for including secondary effects in the benefit calculation. Even in a less-than-full-employment economy, some resources that would be utilized to meet the increase in economic activity created by the pollution abatement project would be transferred from other productive uses and would therefore represent a transfer.

If, however, there is significant unemployment in those sectors of the labor market from which resources would be drawn, then the real social costs of their use may be close to zero. Hence, addition of secondary benefits to primary benefits is warranted. It should be noted that full employment does not imply a 0% unemployment rate. Economic full employment recognizes that a certain proportion of the labor force will be either switching jobs or just entering the labor market. For the rules and procedures governing benefit evaluation under conditions of unemployed or underemployed labor resources, see Section 713.1201 of "NED Benefit Evaluation Procedure: Unemployed or Underemployed Labor Resources" in the Procedures for Evaluation of National Economic Development Benefits and Costs in Water Resources Planning (1979) by the U.S. Water Resources Council. If economic conditions warrant including secondary benefits, then consult A Methodological Approach to an Economic Analysis of the Beneficial Outcomes of Water Quality Improvements from Sewage Treatment Plant Upgrading and Combined Sewer Overflow Controls (U.S. EPA, 1985) for an example of how to estimate these benefits.

There are two primary techniques for estimating secondary benefits: input/output and economic base analyses. Input/output analysis is the more detailed technique because it traces the linkages between industries in a regional economy. For example, increased fisheries or agricultural production may mean additional purchases of agricultural equipment and supplies from retailers and wholesalers, thereby increasing income in those sectors. In turn, retailers and wholesalers may then purchase additional business services. As the additional purchases circulate through the economy, "multiplier" effects are realized so that the secondary benefits can be widely spread to other industries. One input/output model structure, IMPLAN, created by the U.S. Forest Service, is commonly used and can be developed inexpensively for any area of the United States. For a description of input/output analysis, see Isard (1960). Another source is the U.S. Water Research Council (1977).

Economic base analysis is a simpler version of the input/output analysis. While it also recognizes interindustry relationships, those relationships are summarized in a single multiplier. More detail on the economic base analysis is provided in Isard (1960).

C. Nonmonetizable Benefits

Given the available data and empirical methods, certain benefits cannot be valued monetarily. Nonmonetizable impacts should be described in the most explicit terms possible, preferably in quantitative (though nonmonetary) units. Consider, for instance, a recurring odor or surface scum problem. A dollar value cannot be easily assigned to these impacts. However, the distance (i.e., pervasiveness) and frequency of the problem can be stated quantitatively. Perhaps the odor is evident within a 300-ft radius of a sewer outlet and is most noticeable on weekends, or perhaps the scum extends 1/4 mile along the shoreline and is evident the first week of every month. Such indicators at least provide comparative information on the magnitude of the impact, even though the monetary value of the impact may not be expressed in monetary units. For example, the ecological benefits of pollution abatement projects on wetlands is not well understood, so it is difficult to monetize these benefits. Nonetheless, a description of the current condition and possible beneficial outcomes that may result from the project can be very helpful to managers and decision makers in considering strengths and weaknesses of alternative management options.

D. Double-Counting of Benefits

A major difficulty in estimating benefits is that benefit categories and estimation methods are sometimes related in awkward and overlapping ways. One technique may measure the joint benefits of more than one category, or it may not capture all the benefits accruing to that category. This introduces the possibility of double-counting some of the benefits of water pollution control and not fully counting others. For example, improved water quality may result in both increased recreational fishing and boating activity. Separate methods are used to estimate the increased fishing participation and the increased boating participation. However, some of the increased boating activity is primarily for the purpose of fishing. Double-counting of fishing benefits would result if no adjustment were made.

One way to avoid or reduce the possibility of double-counting is by gathering anecdotal data about boating usage. Marina operators have a good sense of who their customers are and what recreational habits they have. Talking with marina staff will yield anecdotal information on the split between boating and fishing. These data can then be used to estimate various benefits more accurately.

E. How to Deal with Uncertainty

As stated earlier, each situation that requires benefit estimation is unique: different types of data and different assumptions will be required. Moreover, each situation and selected methodology will have its own level of uncertainty. If extreme uncertainty exists, no single method will yield reliable results. Instead, consider using more than one model and correlating the information.

The estuary manager or analyst should establish an upper and lower bound of uncertainty (rather than a single number that yields a false sense of precision) to define a range of accuracy. To establish upper and lower bounds, examine all available historical data, develop reasonable assumptions, and identify linkages between water quality improvements and possible outcomes. [Refer to Figure 4 as an example of linkages and to A Methodological Approach to an Economic Analysis of the Beneficial Outcomes of Water Quality Improvements from Sewage Treatment Plant Upgrading and Combined Sewer Overflow Controls (U.S. EPA, 1985) for a case study of how to deal with uncertainty.] The intent is to determine trends that will help to establish upper and lower bounds. As a change in water quality affects one of the linkages, the degree of uncertainty in each subsequent stage is also affected. Quantifying the degree of uncertainty to within an acceptable range will make the results more reliable and usable.

It is important to recognize explicitly the source of uncertainty. To convey the significance of uncertainty, it is necessary to relate the concept of uncertainty with actual benefits identified, and specify the source of the uncertainty. For example, regarding public health, uncertainty refers to the margin of error in measuring the magnitude of health effects. The two sources of the margin of error are (1) the complexity of environmental impacts to an ecosystem encountered by beneficial users, and (2) the lack of evidence and research properly relating dose/response data with willingness to pay scales for avoiding illness and mortality through enhanced water quality.

F. Report and Display Procedures

In writing a report, the following information should be reported for each benefit category and for each type of effluent treatment being considered:

(1) Justification that benefits will result for the treatment option under consideration (i.e., water quality and other analyses indicate that under current conditions there is significant use impairment)

(2) Description of the site, its estimated capacity for recreationists, fish harvests, or other monetizable uses, and a list of available substitute sites and their proximity

(3) Description of the benefit estimation method used, assumptions made, data sources used, and general procedures followed in the analysis

(4) Discussion of potential biases (e.g., double-counting or underreporting of data in the literature)

(5) An annual estimate of primary benefits

(6) The rationale for reporting upper and lower bounds for a category's benefits

(7) Justification for and value of any secondary benefits

(8) Any nonmonetizable benefits for the category with upper and lower estimates of the magnitude of the non-monetizable effects, if possible.

A benefit summary statement for all categories should also be prepared. The suggested format for the summary statement is presented in Figure 6.

	Lower Bound	Upper Bound	Source of Uncertainty
I. Primary Benefits			
A. Recreation			
1. Swimming			
2. Boating			
3. Fishing			
B. Commercial Fishing			
1. Shellfish			
2. Finfish			
Subtotal			
II. Other Monetizable Benefits			
A. Other Recreation			
B. Other Commercial Fishing			
C. Industrial			
D. Agricultural			
E. Municipal			
F. Navigational			
G. Aesthetic			
H. Intrinsic			
I. Other			
Subtotal			
III. Total Monetizable Primary Project Benefits			X
IV. Nonmonetizable Primary Project Benefits (List)			X
V. Secondary Benefits			
A. Recreation			
B. Commercial Fishing			
Subtotal			

Figure 6. Value of Benefits Summary Statement

Chapter VI

Recreational Benefits

A. Defining Recreational Benefits

One outcome of severe water pollution can be fecal coliform counts exceeding the 200 most probable number (MPN) per 100 mL national health limit, thereby closing affected beaches for some time afterwards. For a pollution abatement project, quantifiable recreational swimming benefits include, but are not limited to, (1) the value of the increase in the number of days per season available for recreation owing to a reduction in the number of seasonal beach closings, (2) the value of the increase in daily beach usage (if it is not already utilized to capacity), and (3) the value of the increased, daily recreational enjoyment owing to perceived improvements in the recreational attractiveness and/or safety of the beach.

Figure 7 represents an individual recreationist's consumer surplus for the increased and improved recreational opportunities at the beach. The individual's demand curve without the pollution abatement project is represented by the demand curve D_0, which indicates that the individual takes T_0 number of day-trips to the beach during the year. The area AB0 under the curve represents the individual's consumer surplus for T_0 day-trips. Pollution controls will most likely reduce the presence of oil, grease, floatable debris, fecal coliform bacteria, and suspended solids. These water quality variables do not represent an exhaustive list of parameters that may be affected; however, the first three variables can easily be detected by a swimmer (Feenberg and Mills, 1980), and excessive fecal coliform counts, while not easily detectable by a swimmer, lead to beach closings.

By reducing the number of beach closings and the presence of these highly visible pollutants, water pollution controls will most likely result in perceived improvements in the recreational attractiveness and/or safety of the beach. (Temporary closings of beaches or posted warnings about beach use after storms may be perceived as an indication that an area is unsafe for swimming at all times.

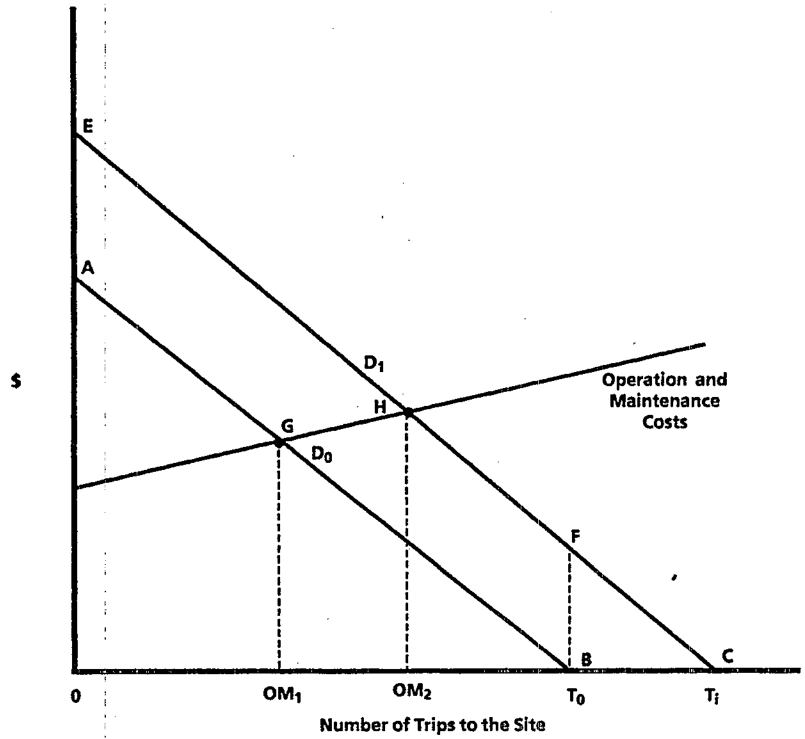

Figure 7. Individual Consumer Surplus for Beach Recreation

Depending upon the number of closings per season, the public may avoid certain beaches, regardless of their appearance or proximity.)

As shown in Figure 7, these perceived improvements[1] would lead to a shift outward of the individual's demand curve to D_1. As a result of the project, the increased recreational enjoyment at the beach for the original T_0 number of day-trips taken by the recreationist is represented by the area ABFE. The perceived improvements also will lead to an increased number of visits to the site by the individual (assuming that the site is not currently being utilized to capacity), which is represented by the area BCF. The value of the benefits to the recreationist for the increased enjoyment from current beach use as well as the increase in beach use is the total area between the

1 Realize that, for a single individual, the shape of the curve as hypothesized may be very different from the added value received from better water quality. The user may value an added day at the beach higher if it occurs on a holiday rather than on a nonholiday. Added days at the beach may have less value than existing days (diminishing marginal returns). Also, improved water quality–since it improves the water year around–may not really produce added days at the beach for a single individual because days available are dictated by nonwater-quality factors (e.g., vacation days).

two demand curves ABCE. As described below, this area should be estimated for each recreationist in a randomly drawn sample and weighted in such a manner that the total number of original day-trips in the sample is expanded to equal the total number of visits currently made to the site during the season. The sum of these weighted areas represents the aggregate, annual consumer surplus for the improved recreational attractiveness and safety of the beach.

A pollution control project that reduces or eliminates the number of beach closings also increases the number (supply) of days when the beach is open for recreation. The value of an additional recreational day can also be determined by the demand curve D_1 in Figure 7. The average consumer surplus for each day-trip to the beach is the area under the individual's demand curve divided by the number of day-trips taken, area $E0C/T_i$. The average consumer surplus per day-trip for a randomly selected sample of recreationists at the beach can be calculated by first computing the average consumer surplus per day-trip for each recreationist in the sample, and then computing the average consumer surplus per trip for the entire sample.

An estimate of the dollar value of the number of daily beach closings avoided by pollution controls is equal to

average sample consumer surplus per day-trip to the beach with the project (dollars spent per individual visit)	×	estimated average daily attendance at the beach with the project (number of individuals per day)	×	number of daily beach closings expected to be avoided owing to combined sewer overflow (CSO) controls (number of days).

One caveat to the above description is that increased beach visitation may incur some costs in the form of maintenance, such as refuse collection and servicing of restroom facilities. Thus, a slight refinement to the estimation approach in Figure 7 should be considered, when appropriate. If operation and maintenance costs are as shown in Figure 7, increased beach use benefits would be offset by increased operating and maintenance costs, area $GHOM_1OM_2$.

This dollar figure represents the value for the increased supply of recreational days available at the beach and the increased consumer surplus per trip. In addition, it assumes that the demand curves can be measured either because the beach access is allowed for a fee (so that market data can be used to measure the curves), or because, if beach access is free, the demand curves can be measured by other techniques. The figure omits the potential increase in daily use that may also result from water quality improvements. As shown in the next section, certain methods can capture all of these benefits, whereas others capture only a portion.

B. Estimating Recreational Benefits

In the previous sections, water quality benefits have been addressed primarily from a theoretical perspective. In this section, actual estimation techniques that could be used will be examined. Since in the real world, time, resources, and available data constitute very real constraints that shape and limit the analysis, where possible, several estimation techniques that vary in sophistication will be discussed. In this manual, only the most salient features of these methods will be highlighted. For more detail, consult the Benefit-Cost Assessment Handbook for Water Programs (U.S. EPA, 1983).

1. Swimming Benefits

a. Travel Cost Method

As Figure 7 indicates, the key to calculating individual consumer surplus is estimating the individual's demand curve for beach recreation. Ordinary demand curves are normally estimated by using price and quantity-demanded data. However, because most beaches are public goods, no prices are charged for recreational services offered. Fortunately, the transportation and time costs involved often constitute a major portion of the costs of engaging in recreation at a beach. These travel costs provide surrogate prices so that the demand can be estimated.

The essence of the travel cost method is that the combination of the number of day-trips to a site and the round-trip travel cost for each recreationist traces out a demand relationship since the geographical location of the recreationist's residence exerts a kind of experimental control, forcing the more distant consumers to bear heavier travel and related costs; and those who face higher travel costs usually will visit the site less frequently than those who live closer, all else being equal. This permits empirical estimation of the demand for a recreation site's availability.

However, the travel cost method does have limitations. Travel expenses may or may not represent a large portion of recreational expenses, depending on whether the site visit requires a lengthy trip (e.g., sites near large urban areas may be inexpensive to reach). Furthermore, many recreational visits have multiple purposes, such as boating and swimming. If the water quality improvement is expected to affect one of several potential recreational activities, appropriate allowances must be made to net out the portions of travel expenses from the benefits estimation. For a more detailed discussion of the travel cost method, consult the Benefit-Cost Assessment Handbook for Water Programs (U.S. EPA, 1983). Also, see Loomis (1988) for variations of this method.

Since the travel cost equation is based on actual recreational visits, it is one of the most reliable techniques for estimating consumer surplus. It also captures all of the potential user benefits; however, it does not capture existence or option values. While travel cost studies are quite data-intensive, such studies are common dissertation topics. Local universities should be consulted as a possible source of such studies.

The final issue concerns properly specifying the travel cost equation to be estimated. The EPA publication A Methodological Approach to an Economic Analysis of the Beneficial Outcomes of Water Quality Improvements from Sewage Treatment Plant Upgrading and Combined Sewer Overflow Controls (U.S. EPA, 1985) provides substantial discussion on the most appropriate specification and estimation technique.

b. Contingent Valuation Survey Method

An alternative method for determining the appropriate willingness to pay for water pollution controls is the contingent valuation survey method. This method differs from the travel cost method in that it attempts to gather information on an individual's valuation of nonmarket goods directly by "creating" a hypothetical market through a survey questionnaire. One advantage this approach has over the travel cost approach is that the survey questionnaire can be designed to elicit not only the respondent's willingness to pay for discrete changes in water quality, but also his/her option and existence values as well. This survey approach involves asking individuals what they are willing to pay for specifically defined changes in environmental conditions such as a change in water quality. An example of this approach is Mitchell and Carson's Willingness to Pay for National Freshwater Quality Improvements (1984), which is available from EPA. The strength of this document is that it presents national data with a breakdown by region. To apply the findings of a strictly regional study to other parts of the country would yield inaccurate results because of varying geographic and demographic factors. This study, however, is national in scope and therefore a recommended resource.

Conducting a contingent valuation study that will result in defensible results is difficult. The key features of the market framework to assign dollar values are (1) the proposed means of payment, (2) the value elicitation procedure, and (3) the description of the resource being preserved. A useful example of how the surveyed group of individuals could perceive the water quality enhancement as a means of payment would be through their water bill or, in the case of renters, as a rent increase that incorporates utilities' enhancements. Regarding the value elicitation procedure, a voter referendum format of conducting the survey (Loomis et al., 1989) is a credible means that does not appear like a solicitation for charitable contributions. This method was used successfully with Proposition 70 of the State of California in 1987, for a bond issue allowing the purchase of habitat and open space. However, procedures to elicit valuation must be chosen carefully and will vary widely depending on whether telephone, mail, or face-to-face interview techniques are used.

The technical expertise required to design the survey, elicit responses, and derive the willingness to pay estimates is considerable. In addition to using Mitchell and Carson's national study (noted above), regional programs may have recent, local studies available that have a more appropriate estuarine focus. In the absence of such local studies, support for surveys of this kind might be a high priority for estuary protection programs in which recreational and related benefits are major concerns.

c. Participation/Unit-Day Valuation Method

The participation/unit-day valuation method relies on previously estimated values of individual consumer surplus for an average day's recreation. By applying these values to estimated daily use of a beach, the dollar value for an increase in the supply of recreational beach days available can be approximated. The advantages of this method are its simplicity and minimal data requirements. The disadvantage is that it cannot be used to estimate the aggregate, annual consumer surplus for the increased attractiveness and safety of the beach. Consequently, this method could lead to an underestimation of total, recreational swimming benefits.

This method has two distinct stages. The first stage involves the use of regional participation studies to estimate current beach attendance and to project the increase in beach use that would likely result from water quality improvements. The analyst must be concerned with several important issues. First, he/she must examine historical data and provide strong evidence of swimming use impairment under current water quality conditions. Assuming that any water quality improvement will lead to increased participation is inadequate. Second, the analyst should demonstrate that the beach is currently not being used at capacity. To project increases in swimming participation at beaches that are already congested is not credible. For further discussion of this subject, see <u>A Methodological Approach to an Economic Analysis of the Beneficial Outcomes of Water Quality Improvements from Sewage Treatment Plant Upgrading and Combined Sewer Overflow Controls</u> (U.S. EPA, 1985).

The second stage involves the valuation of the increased participation. Generally, the literature suggests that a $5.00 to $11.00 range per visit is reasonable. [Again, see Appendix B in <u>A Methodological Approach to an Economic Analysis of the Beneficial</u>

Outcomes of Water Quality Improvements from Sewage Treatment Plant Upgrading and Combined Sewer Overflow Controls (U.S. EPA, 1985).] This method is by no means exhaustive. The analyst should consult the Benefit-Cost Assessment Handbook for Water Programs (U.S. EPA, 1983) for discussion of other methods that may be used.

2. *Swimming-Related Health Benefits*

There are numerous potential health benefits associated with water pollution abatement projects–health effects associated with withdrawal uses such as drinking water or irrigation, health effects associated with pathogenic and/or toxic contamination of shellfish, and health effects associated with water contact. In this section, only swimming-related health effects associated with pathogens are discussed because this is an area where adequate data and dose/response information most often exist. People who swim in water that is polluted with certain bacteria have a high incidence of gastroenteritis.

The method proposed here to estimate swimming-related health effects (1) defines the population at risk, (2) applies a dose/response relationship to determine the likely incidence of gastroenteritis under current water quality conditions (without the pollution abatement project) and under the water quality's improved condition (with the pollution abatement project), and (3) values the reduction in swimming-related illnesses.

In determining population at risk, the analyst needs to consider not only the average daily number of visitors to the beach, but also air and water temperature data to determine the proportion of people at the beach who actually swim. For an example of how population at risk can be estimated, see Chapter 7 and Appendix C of A Methodological Approach to an Economic Analysis of the Beneficial Outcomes of Water Quality Improvements from Sewage Treatment Plant Upgrading and Combined Sewer Overflow Controls (U.S. EPA, 1985).

It has been demonstrated that Enterococci bacteria are a good indicator of the aquatic behavior of the viruses responsible for swimming-related illnesses. While Cabelli et al. (1980, 1982) have developed a dose/response relationship between Enterococci density and the number of cases of gastrointestinal symptoms per 1000 swimmers, typically only fecal coliform (and/or total coliform) density counts at beaches are available because State, local, and Federal public health standards are based on these bacteria. A statistical relationship between the more available indicator, fecal coliforms, and the more appropriate indicator, Enterococci, is provided in the aforementioned study.

The final stage is determining the value of the number of gastroenteritis cases that would probably be avoided as a result of the water quality improvement. Then to quantify the economic benefit, a cost-of-illness approach is used that depends on average wage rates and the number of work days lost due to the illness. Again, the aforementioned study provides more discussion on this subject.

3. Recreational Fishing Benefits

The method described here is taken in part from the National Marine Fisheries Service Guidelines on Economic Valuation of Marine Recreational Fishing (Huppert, 1983). This method is intended to demonstrate how a model would predict increases in recreational fishing, given a water quality improvement that would enhance a fishery habitat and lead to an increase in the sustainable stock of recreational finfish. This section describes procedures to assign a dollar value that is equivalent to the amount that recreationists would be willing to pay for increased estuarine angling.

It is important to note the limitations inherent in the scope of this discussion. First, the procedures recommended here seek to develop dollar values that represent the value to participants of the increased and/or enhanced recreational fishing, not the income generated in associated support industries. The increase in recreational fishing is considered a primary benefit, whereas the economic impact of the recreational expenditures on a regional economy would most likely be a secondary benefit (see Section V.B). Second, this procedure does not capture nonuser benefits associated with enhanced recreational fishing.

Occasionally, gross angler expenditures are incorrectly taken as a measure of the economic value of recreational fishing. While expenditures are prima facie evidence that recreationists place value on fishing and the underlying natural resources, the total quantity of such expenditures made on recreational trips is not a useful estimate of that value. There are two reasons for this. First, many of the expenditures made for equipment, food, transportation, and lodging during a fishing-related trip are not specifically attributable to fishing. Recreational trips often are multipurpose in nature, and total expenditures are not a fair indicator of costs incurred specifically for fishing. Second, and most important, to treat expenditures as a measure of value involves a simple logical fallacy. Expenditures represent costs of fishing. With falling fuel prices, for example, we might find striped bass fishermen spending less per fishing trip in 1986 than in 1981. Should we take this as evidence that striped bass fishing has fallen in value? No. Expenditures represent a cost that detracts from the net economic value of the recreational experience. It is this net economic value that we seek to measure.

a. Criteria for an Acceptable Evaluation Procedure

An acceptable evaluation procedure has the following characteristics:

(1) The procedure should provide a reasonable explanation of the physical relationships among the controls implemented, the water quality improvements that result, the impact on estuarine fish stocks, and the change in recreational fishing demand associated with the change in fish supply.

(2) Evaluation should be based upon a recreational demand model for the particular fishery being affected or a similar fishery in a different "study area."

(3) Estimates of demand should account for the socioeconomic characteristics of the market area populations, qualitative characteristics of the recreational resources under study, and the availability of alternative recreational sites.

(4) Willingness to pay projections over time should be based upon projected changes in the underlying determinants of demand (e.g., personal tastes and preferences, income, availability of substitutes, etc.).

b. Demand Estimation Method

To analyze the demand for various fishing activities, it is useful to treat the recreationist's decision as a sequence of three choices. First (Stage I), the person chooses whether to fish in an estuary. Second (Stage II), the person selects the types of fishing (surf, beach, small boat, partyboat, pier, scuba, etc.) to participate in. Third (Stage III), the person must choose his/her preferred level of participation (i.e., how many trips of each type to make). Each stage of this decision process may be influenced by a variety of economic and environmental factors. Prominent among these factors are the individual's socioeconomic circumstances, the costs of participation, the physical characteristics of the type of fishing as well as the fishing site, and the chances of angling success.

Prevalence of estuary fishing in the population at large represents the Stage I decision made by individuals. Thus, lower estuary fishing participation rates (i.e., estuarine anglers per 1,000 population) in inland areas relative to coastal areas reflect individual choices based upon the cost of estuary fishing to them, the costs and attractiveness of other alternative recreational opportunities (e.g., freshwater fishing), as well as family income levels and other factors. Similarly, the proportion of different types of estuary fishing trips presumably reflects choices based upon relative costs and relative attractiveness of the alternatives. Number of trips taken per year per angler is an empirical measure of the final choice stage.

Statistical analysis of recreational data can proceed by examining the probability P of being fisherman P_i, the conditional probability of engaging in fishing type i given that one is a fisherman, and the number of fishing trips per year by fishermen engaging in type i, T_i. The relationship is presented as

$$\text{Trips-per-year}_i = \text{Population} \times P \times P_i \times T_i.$$

The change in activity days generated by an improvement in water quality is estimated as follows: increases in the amount of each type of fishing available causes changes in (1) the probability P of participating in fishing, (2) the conditional probabilities of choosing each of the types of fishing in the designated area P_{ij}, and (3) the number of days per year spent fishing for each type i, T_i.

While use of a participation model (e.g., Vaughan and Russell, 1981, 1982) may seem appropriate and could be utilized in some cases, determining what fishery types one would use in estuaries and therefore in a participation model can be difficult. Many estuarine fish are widely distributed species. Being unable to characterize segments of estuaries or entire estuaries in terms of the types of recreational fisheries supported could prevent a participation model from being easily and directly applied to such an analysis. Moreover, while a participation model may provide the increased demand for recreational fishing in terms of an increase in the number of fishing days by type, such a model will not provide an economic value of the recreationist's willingness to pay for the additional trips and/or enhanced "quality."

Perhaps a more suitable approach in this case would be to use travel cost models or contingent valuation surveys to determine the appropriate economic values for a fishing day. Variations of the Clawson-Knetsch travel cost technique, for example, have been used to estimate recreational benefits indirectly in a number of cases. (For related information, see Knetsch, 1974.) Studies of the Boston Harbor area and a segment of Pennsylvania's Monongahela River have utilized travel cost models successfully to examine various use classifications including fishing and boating. Conclusions of the Boston Harbor study indicate that water quality improvements resulting from combined sewage treatment plant and combined sewer overflow controls could yield \$12 to \$15 million in fishing and boating benefits. The Monongahela River study also yielded favorable travel cost data–the model predicted a value of \$83 per year per user household if a decrease in water quality is avoided–and also offers a discriminating comparison of the travel cost and contingent evaluation approaches. For more information on these case studies consult A Methodological Approach to an Economic Analysis of the Beneficial Outcomes of Water Quality Improvements from Sewage Treatment Plant Upgrading and Combined Sewer Overflow Controls (U.S. EPA, 1985) and A Comparison of Alternative Approaches for Estimating Recreation and Related Benefits of Water Quality Improvement (U.S. EPA, 1983), respectively. Table 1 provides a summary of selected studies (freshwater and marine) and Table 2 provides the results from a recent study on the Pacific Coast that calculates average expected willingness to pay per trip by mode.

c. Evaluation Procedures

To determine the economic benefit from a proposed action affecting marine recreational fishing, it is necessary to follow a four-step process. The following paragraphs explain each step in detail. The amount of effort devoted to each step may vary from one application to another, depending upon the nature of the proposed action, the difficulty of establishing the physical linkage between the action and the recreational experience, and the sensitivity of the evaluation to the formulation of the demand model. In every case, however, the procedure seeks to determine the condition of the fishery without the action, the probable effect of the action on the fishery, and the effect that the action has on the demand for recreational fishing. The economic benefit is then viewed as the net change in economic activity occurring in the defined fishery as a result of the proposed action.

Step 1. Define the Affected Fishery. Changes in recreational activity owing to proposed actions will typically be concentrated in some geographical or "market" area. The impacts should be related to (1) actual and potential recreationists drawn from identified locations, and (2) a particular set of fishing locations, species, stocks, and/or modes of fishing. A description of the subject fisheries and an inventory of biological resources involved should be included in this first step. Also needed is a definition of particularly important fishing sites, a description of alternative (competing) recreational fishing sites available and their characteristics, and an explanation of any significant constraints to estuarine access, if any. Reference to historical evidence regarding changes in the volume of recreational activities (e.g., fishing days by mode of fishing) over time is encouraged.

Step 2. Determine How Physical Conditions Affect Recreational Quality and Quantity. Fishery management and development actions often cause physical changes that are not directly experienced by marine recreational fishermen. Many of these physical changes will directly or indirectly impact important characteristics or quality factors. For example, the average size, species composition, or number of fish available within a region may be altered. The effect of these on fishing characteristics important to

Table 1. Synthesis of Economic Estimates from Selected Recreational Fishing Studies[a]

Study	Fishing Season	Location and Activity	Method	Value of Travel Time	Consumer's Surplus per Day (1981$)[b]	Consumer's Surplus per fish (1981$)[b]
Brown et al. (1983)	1977	Oregon Steelhead	TC-zonal TC-micro-data	None[c]	$44[d]	
Ziemer et al. (1980)	1971	Georgia Warm Water	TC-micro-data	None[c]	$59[e]	
Vaughan & Russell (1982)	1979	Nationwide Fee Fishing Trout Sites	TC-zonal	BEA Average	$30 (trout) $ 7 (catfish)	$49 (trout) $34 (catfish)
King & Walka (1980)	1980	Arizona	TC-micro-data	None	$10	
Weithman & Haas (1982)	1979	Missouri Coldwater	TC-zonal	.35 of average wage	$20	

Table 1. (Continued)

Study	Fishing Season	Location and Activity	Method	Value of Travel Time	Consumer's Surplus per Day (1981$)[b]	Consumer's Surplus per fish (1981$)[b]
Huppert & Thomson (1984)	1979-80	California Marine Fishing from Partyboats	TC-zonal	1/3 of wage 2/3 of wage	$13 $20	
Miller (1984)	180	Selected States	TC-micro-data	1/3 of wage	$20-$42	
Samples & Bishop (1983)	1978	Lake Michigan Trout and Salmon	TC-zonal equation TC-zonal multi-equation	50% of wage	-- --	$ .46 $ 9.40
Menz & Mullen (1982)	1976	Adirondack	TC-zonal TC-multiequation	?	$23-38 (without substitution) $17-$30 (with substitution)	
Brown et al. (1980)	1977	Oregon Ocean Salmon Freshwater Salmon Steelhead Washington Ocean Salmon	TC-zonal TC-zonal	Average wage rate	 -$78 -$25 -$36 -$75	

Table 1. (Continued)

Study	Fishing Season	Location and Activity	Method	Value of Travel Time	Consumer's Surplus per Day (1981$)[b]	Consumer's Surplus per fish (1981$)[b]
Crutchfield & Schelle (1978)	1978	Washington Ocean Salmon	CVM-WTP	--	$25	
			CVM-WTA	--	$56-104[h]	
SMS Research (1983)	1983	Hawaii Ocean Fishing	CVM-WTP	--	$ 9-$85[g]	
			CVM-WTA	--	$178-$628[g]	
Donnelly et al. (1983)	1982	Idaho Steelhead	TC-single equation zonal CVM-WTP	$2.67/hour	$13.5[i]	--
					$28[j]	--
					$19[i]	$ 6.35[i]
					$48[j]	--

Notes: TC: travel cost method; CVM: contingent valuation method; WTP: willingness to pay; WTA: willingness to accept; ?: not reported.

a. Table from Rowe (1985).
b. Per angler unless otherwise noted. Values typically are based upon trips targeting this species.
c. Distance included as separate explanatory variable.
d. Value for trips rather than days.
e. Day value per household.
f. Value reported in personal correspondence.
g. Lower values for $1 starting bid. Higher values for $800 starting bid.
h. Willingness-to-accept range due to different cutoffs of maximum values accepted in analysis.
i. Based upon average 5.5-hour recreation day of sample respondents.
j. Based upon 12-hour recreation day, as used in Forest Service management plans.

Table 2 Average Expected Net Willingness to Pay per Trips by Mode in 1981 (1981$)

Site	Beach and Bank[a]	Man Made[a]	Party Boat[a]	Private Boat[a]	All Modes[b]
California	$31.00	$25.40	$11.80	$23.10	$23.10
Oregon	$39.00	$35.50	$ 3.70	$10.10	$53.00
Washington	$53.00	$26.90	$ 6.00	$20.50	$45.90

a. Calculated for the elimination of the mode at all sites in the states.
b. Calculated for the elimination of all site/model alternatives with a 1% or greater probability of being visited and calculated separately for each county of origin.

Source: Valuing Marine Recreational Fishing on the Pacific Coast, Robert Rowe, National Marine Fisheries Service, Southwest Fisheries Center, LJ-85-18C, June 1985.

anglers (i.e., catch rates) should be assessed. That is, linkages between objective conditions in the biological realm and perceived recreational "quality" need to be established.

A change in catch per angler day is one useful measure of recreational quality. Other measures developed should be justified by reference to source data, existing published studies, etc. Quantitative relationships among the important physical conditions (such as fish stock size) and recreational quality components (such as angler catch rate) may be derived from statistical models for the subject fishery or from studies of other very similar fisheries. Or a hypothesized relationship may be developed from accepted theory with specific adaptation to the subject fishery.

As an example of the latter approach, suppose that population biologists determine that the angler catch rates are proportional to fish stock abundance. A particular fishery project is expected to increase the stock by 10%. The observable consequence for the angler would be a 10% increase in catch per day of fishing. If fishing participation rates and frequency of fishing trips is a function of catch rates, then increases in catch rates could lead to more fishermen fishing more often.

Step 3. Estimate Baseline Recreational Activity and Value of Recreational Fishing. This step attempts to establish a base condition from which the proposed action will cause changes. The base condition may or may not be equivalent to the current conditions. If there has been some recent shift in the physical or economic setting, or a trend can be reliably extrapolated, the base condition could be established by predicting the near future. For example, if fish stocks have been declining over time, then the base case, which represents the condition of the fishery if no action is taken, could reflect the continued decline of that fishery. If the fishery has historically declined but is currently stable, then the current condition of the fishery would represent the base case. Whatever procedure is used, this base condition must include (1) an estimate of the number and types or recreational fishing trips that will take place in the subject fishery without the project, and (2) the net economic value (willingness to pay) aggregated for the whole fishery. Both components may be derived from a comprehensive model of demand for recreational fishing. Or, the two components might be developed from separate, but consistent empirical models.

(1) Estimating Volume of Recreational Activity. If no changes from current socioeconomic, institutional, and environmental conditions are expected to take place in the absence of the proposed action, the estimated level of recreational fishing may be equal to current (or recent historical) levels. This is the simplest approach. Current levels of recreational fishing may be derived from a model that accounts for differing recreational participation rates across travel distance zones and socioeconomic strata. Given per capita participation (e.g., fishing trips per year per angler) by residence zone and socioeconomic strata of anglers, future participation can be extrapolated based on population growth and other trends. To implement an extrapolation such as this requires extensive survey information revealing the geographic distribution and socioeconomic characteristics of marine recreational fishermen. Data collected for a travel cost study may provide the necessary information. A more sophisticated analysis may account for the effects of anticipated trends in recreational fishing conditions or fishing quality. For example, an established trend in fish availability, ocean access, or cost of participation (e.g., increasing cost of travel) may be expected to have an important influence on future participation in fishing, independent of general demographic trends. To account for these kinds of effects in the base condition requires a quantitative model linking recreational participation to the qualities or the characteristics that are expected to become trends.

Such a linkage may be developed as part of a recreational fishing demand model, wherein the changing characteristics are represented as "shift" variables in the demand curve. Travel cost demand studies may introduce these shift variables when multiple sites are surveyed and fishing characteristics vary among sites.

(2) Estimating the Value of the Recreational Fishery. To estimate the value of the fishery, a dollar value must be assigned to the number of fishing trips associated with the base condition. The basic notion of economic value is the willingness to pay. The recommended procedure is to estimate value per recreational fishing day or trip based upon a per capita recreational demand equation.

Step 4. Estimate Changes in Recreational Activity and Economic Value. This step should be a simple matter of combining results from Step 2 (concerning mechanisms by which proposed actions affect recreational fishing) with those of Step 3 (developing the economic model of recreational demand that incorporates the relevant shift variables). Per capita participation (demand) in the subject fishery will rise or fall, and the value per day or trip may change due to the proposed action. The relative size and importance of these two components will vary markedly from case to case.

An example is the case of improved fish availability in a specific fishery. The analysis in Step 4 would first indicate the level of participation (demand) and willingness to pay per angler as of the baseline condition. The results of Step 2 would be used to determine the magnitude of the impact of the project on recreational fishing via the shifter variable (i.e., the change in catch rates). The shifter variable would be used to "shift" the base case level of demand outwards to the new level of demand, and then the per trip willingness to pay value would be applied to the new aggregate number of fishing trips to determine the new economic value of the fishery. The difference between the aggregate baseline value of the fishery and the new (as a result of the project) aggregate value of the fishery represents the economic benefits of the project for recreational fishing. In Figure 7, the baseline condition would be represented by the demand curve D_0. The "with the water-quality project" condition would be represented by the demand curve D_1. The change in recreational value per angler is estimated by the area between the two demand curves.

The proposed project or regulatory action may cause a complex change in fishing qualities, such as when availability of some species is affected by the stock of another species. For example, a project might increase the amount of reef-related fishing while decreasing the opportunities for or aesthetic quality of troll fishing. In these cases, the analyst must estimate the negative effects as well as the positive effects. This may require that demand models be developed for more than one fishery.

d. Data Availability

Current Sources. Three major surveys have been conducted in recent years that obtained economic recreational fishing data on a national scale: (1) the ongoing NMFS Marine Recreational Fishery Statistics Survey (MRFSS), (2) the 1981 NMFS Socioeconomic Survey (S/E Survey), and (3) the 1985 U.S. Fish and Wildlife Service's National Survey of Fishing and Hunting (NSFH).

Both the MRFSS and S/E Survey are based on a combination of intercept (i.e., face-to-face interviews in the field) and telephone surveys. The MRFSS is structured so that detailed information on the catch, species, fishing mode, and location is collected at the fishing site through intercept interviews. A separate telephone survey, which canvasses the general population in coastal areas, collects data pertaining to level of fishing activity by mode of fishing and residence location. During 1979, 1980, and 1986, the economic data on distance traveled were collected during the intercept surveys. During 1981, the S/E Survey utilized both intercept and telephone follow-ups. That is, an angler contacted at the fishing site was also telephoned later with additional questions concerning expenditures, satisfaction level, disposition of catch, employment status, and income.

Major differences between the NSFH survey and the NMFS surveys are as follows:

(1) The NSFH surveys occur at 5-year intervals rather than annually.

(2) The NSFH canvasses the U.S. population by telephone and conducts personal interviews with a subsample to obtain statistically reliable results at the State level. The MRFSS canvasses the population only in a coastal strip and collects detailed species information by on-site intercept. MRFSS uses ratio estimators to generate data on noncoastal and out-of-state trips and catch.

(3) The NSFH asks anglers to recall the previous year's experience, whereas the MRFSS is conducted at 2-month intervals.

None of the data from these surveys is ideal for economic evaluation, but they should provide a first line of attack for specific recreational evaluation studies. At the very least, the general nationwide data can provide the analyst with an appreciation for the total numbers likely to be involved in marine fishing, broken down by region and mode of fishing. For some widespread fisheries, the MRFSS plus S/E Survey may provide sufficient coverage and sample size to conduct an economic evaluation. In other cases, examining available data will help to develop a more in-depth local survey.

Another approach that might provide valuable information on the abundance of the fishery resource is to conduct a time-series analysis of young juvenile (also known as prerecruit) species using one or more abundance indices and environmental parameters (Austin et al., 1986). Abundance indices examine the size and distribution of various species.

This approach has been undertaken for a number of finfish species. Results can be singularly informative or can be used to supplement other economic data sources, yielding data of perhaps even greater importance.

Future Sources. The Strategic Assessment Branch (SAB) in the Ocean Assessments Division, Office of Oceanography and Marine Assessment, National Oceanic and Atmospheric Administration (NOAA), has initiated a long-term effort to build a comprehensive national database and assessment capability for the nation's coastal and ocean resources. Components of this national marine resource assessment program include (1) a National Estuarine Inventory Data Atlas: Physical and Hydrologic Characteristics of 92 Estuaries, (2) a National Coastal Wetlands Data Base, (3) a National Shellfish Register of Classified Estuarine Waters, (4) Shoreline Characterization, (5) National and Regional Marine Resources Data Atlas, (6) a National Coastal Pollution Discharge Inventory, and (7) an Economic Survey of Outdoor Marine Recreation in the USA. At this time SAB's efforts are focused primarily on the data acquisition and processing stages. While several of these are ongoing projects, certain components of the databases have been completed and are available to the public.

Further information on NMFS surveys is available from Dr. Mark Holliday, NMFS F/S21, Room 8313, 1335 East-West Highway, Silver Spring, Maryland 20910. For more information on the NSFH, contact Dr. M. J. Hay, U.S. Fish and Wildlife Service, Room 2556, Department of Interior, 18th and C Street, N.W., Washington, DC 20240. For more information on the SAB effort contact Dan Basta, Strategic Assessment Branch, Ocean Assessments Division, Office of Oceanography and Marine Assessment, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Rockville, Maryland 20852.

The Economic Studies Branch of EPA, in conjunction with NMFS, will have available by fall 1990 a study on the demand for marine recreational fishing for the East Coast from New York to Florida. For more information about this study, write to Mark Holliday at the above address or to Mary Jo Kealy, U.S. Environmental Protection Agency, PM-220, 401 M Street, S.W., Washington DC 20460.

4. Recreational Boating Benefits

The method described here for predicting recreational boating benefits is a two-stage procedure: (1) estimating the change in recreational boating participation and (2) determining the value of that change.

Changes in participation due to water quality improvements can in theory result from (1) increased ownership of boats, (2) increased intensity of use by boat owners, (3) increased rentals of boats, and (4) increased intensity of use by renters. A study by Vaughan and Russell (U.S. EPA, 1985) indicates that increases in boat ownership and increases in rental use owing to water quality improvements are negligible. Therefore, the most likely source of increased boating participation is increased use by boat owners.

Even the increase in boat owners' intensity of use is arguably small. Boat owners face not only a constraint on leisure time, which other recreationists face, but also (1) weather constraints (windy days can impede water skiing, calm days impede sailing; rain impedes both), and (2) availability of marinas, moorings, and access ramps. Furthermore, 44% of the boaters in the U.S. Coast Guard survey (1979) reported using their boats more than 50% of the time for fishing, and this increase in boating participation would be covered under the recreational fishing benefits. Finally, unlike swimming, boating is not limited to specific locations. The boater can often avoid poor local water quality conditions by cruising a short distance. Nevertheless, if a case can be made that current water quality degradation is the <u>binding</u> constraint, then local and regional recreational surveys could be used to estimate an increase in participation. Given the usual amount of uncertainty, a range of increased boating days should be provided with the lower bound of that range often being zero.

The range of increased boating days can be valued using a lower-bound user day value of $18.00 and an upper-bound value of $41.00, based on 1982 dollar values [see Appendix B in <u>A Methodological Approach to an Economic Analysis of the Beneficial Outcomes of Water Quality Improvements from Sewage Treatment Plant Upgrading and Combined Sewer Overflow Controls</u> (U.S. EPA, 1985)].

5. *Intrinsic Benefits*

Intrinsic benefits, as defined earlier in this manual, are all benefits associated with a resource that are not directly related to the current use of that resource. Intrinsic benefits can be categorized as the sum of option (bequest) value and existence value (see Section IV.B). Although these nonuser benefits are not directly observable, they are as real and economically important as the more easily measured user benefits.

Intrinsic benefits are difficult to measure and value. A contingent valuation approach is the most common technique used. Fisher and Raucher (1984) have demonstrated that intrinsic benefits can be inferred from user benefits. Evidence from their survey of existing studies indicates that intrinsic benefits are 40% to 60% of recreational-user benefits. Based on this study, as a rule of thumb, 50% of recreational benefits can be used as an estimate for intrinsic benefits, if finding a direct study is not possible. However, if rules of thumb such as this are used, a fairly wide band of uncertainty should be applied (see Figure 4).

Chapter VII

Commercial Fishing Benefits

Estuaries provide spawning and nursery habitats for commercially valuable fish. Water quality improvements can increase these commercial fish stocks, resulting in expansion of the fishing industry. The economic benefits associated with this expansion can be determined by comparing the commercial fishing market under current water quality conditions with the market that could develop if pollutant stresses were reduced or eliminated. One critical problem in estimating the commercial fishing benefits associated with finfish is that many species are migratory and spend only a portion of their lives in the estuary.

Regional fishery scientists involved in estuary programs should advise economic analysts of the degree to which finfish impact estimates can be developed for water quality improvements in each estuary. These scientists need to demonstrate how the pollution adversely impacts the reproductive cycle of the finfish species (i.e., recruitment failure). There are several potential impacts: mortality due to pollutant stress may lead to insufficient spawners; pollutant stress, which kills off macrophytes, and/or sedimentation may lead to the destruction of the spawning habitat; pollution may lead to a disruption of spawning behavior or avoidance of the spawning habitat altogether; or pollution may directly and indirectly disrupt the various tropic levels so that insufficient food is available, resulting in a reduction of adult spawning.

At this time, the relationship between the recruitment failure mechanism(s) and water pollution is not well understood. Consequently, associating a change in water quality with a change in maximum sustainable yield of fish stock is difficult. Therefore, this section focuses only on commercial shellfishing benefits.

A. Defining Benefits of Reopened Shellfish Beds

Shellfishing may be totally restricted by States in areas with pollutant levels exceeding health standards. This can result in major revenue losses for that State's shellfishing industry. In areas that border the closed beds, firms may be required to keep the harvested shellfish in depuration (decontamination) tanks for several days after harvesting, which increases production costs. Water pollution controls have resulted in the reopening of shellfish beds in a number of States. This section defines the economic benefits associated with reopening of shellfish beds in four different scenarios.

Case 1

If the shellfish industry serving the local market is such that no single firm can influence price, if the reopening of the shellfish beds affects only a small proportion of the firms serving the market, and if the increased harvest is small relative to the market for the product, then it can be safely assumed that product (i.e., shellfish) prices would remain fixed after the beds are reopened (see Figure 2). If the fishery is also being appropriately managed to maximize net economic yield (i.e., the fishery is regulated, and there is not free entry into it by other firms), then the economic benefits of water pollution controls for commercial shellfishing would be equal to the change in producer surplus (area MNUT in Figure 2).

Case 2

If some or all of these assumptions do not hold, defining and estimating economic benefits become more complicated. Case 2 is the example of an unregulated fishery. If the fishery is unregulated, the producer surplus accrues in the short run for the existing firms. However, their increased profits may attract additional firms to the resource, which ultimately reduces these excess profits to zero. In the absence of regulation of the resource (e.g., limits on fish catch or restricted access), water pollution controls would result in only transient primary benefits in the form of short-run producer surpluses. Such a short-run producer surplus, lasting only a year or two, is of little economic interest in evaluating a water quality project where the long-run impacts are considered economically relevant. In this situation, there would be no long-run producer surplus.

Case 3

Consider another situation where the yields from the reopened shellfish beds are large relative to the market, so that the increased yield depresses the market price. Assume also that the fishery is regulated so that access to the reopened beds is limited. This situation is portrayed in Figure 8. D_0 represents the long-run aggregate demand curve for shellfish. S_0 and S_1 represent the industry's long-run supply curves without the controls (i.e., the shellfish beds remain closed) and with the water pollution controls (i.e., the shellfish beds are reopened), respectively. Reopening the beds leads to an increased yield (Q_0 to Q_1). The increased quantity of shellfish harvested is sufficiently large to cause the price for shellfish to drop from P_0 to P_1. The pollution controls result in an increase

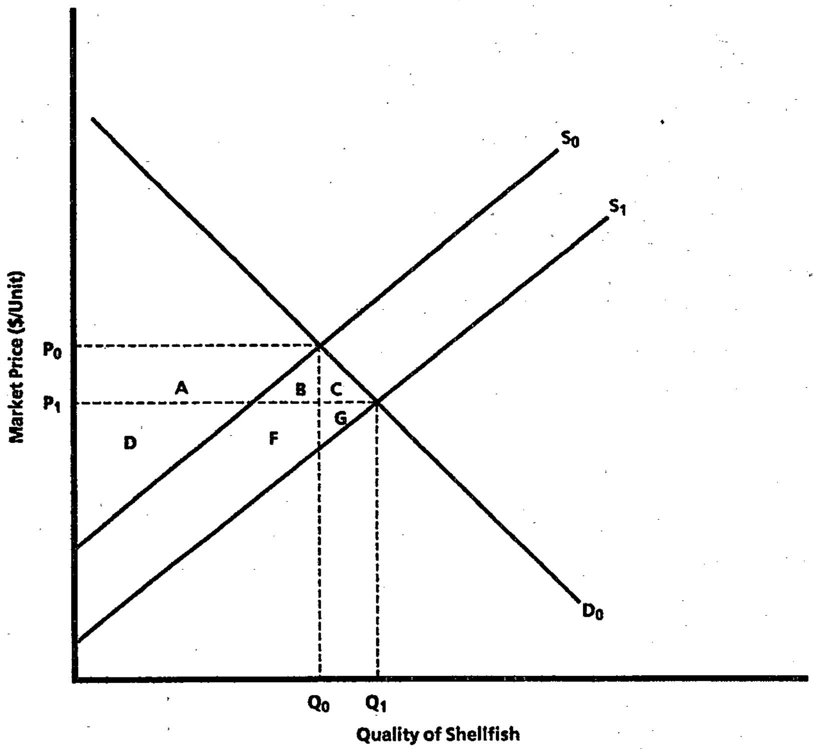

Figure 8. Demand and Supply Curves and Producer and Consumer Surplus for Case 3

in consumer surplus owing to the price reduction, which is equal in magnitude to the sum of the areas A + B + C. Before the beds are reopened, producer surplus is equal to the sum of the areas A + D. After the beds are reopened, the change in producer surplus is equal to F + G − A = ΔPS. ΔPS may be positive or negative, depending on the slope of the demand curve D_0. Indeed, both consumer and producer surpluses depend on the shape of the demand and supply curves.

Case 4

The last situation differs from Case 3 only in that the assumption of a regulated fishery is dropped. This situation is portrayed in Figure 9. Without regulation of the fishery, there is no long-run producer surplus as in Case 2. The reduction in the price of shellfish (as explained in Case 3), however, does result in consumer surplus benefits equal to the sum of the areas A + B (in Figure 9).

To summarize, Case 1 results in only producer surplus benefits; Case 2 results in no long-run benefits; Case 3 results in both producer and consumer surplus benefits; and Case 4 results in only consumer surplus benefits.

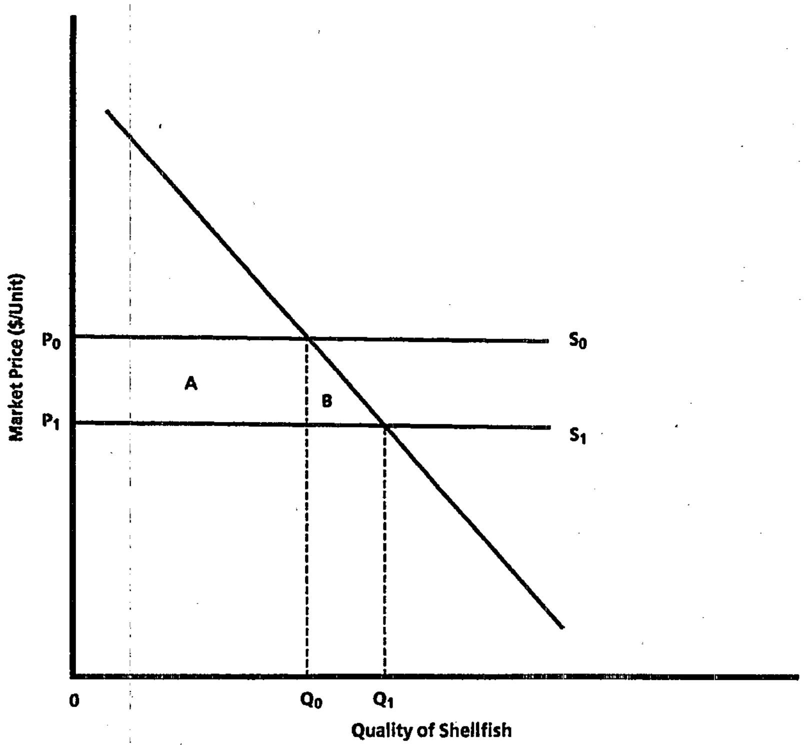

Figure 9. Demand and Supply Curves and Consumer Surplus for Case 4

B. Estimating Commercial Fishing Benefits

In some cases, pollution controls may not sufficiently reverse shellfish contamination and lead to the reopening of the beds. Consequently, any empirical estimate of these benefits must include adequate justification that the proposed controls would, in fact, lead to the reopening of the shellfish beds.

For Case 1, estimating the benefits is straightforward. The area MNUT in Figure 2 is equal to the market value of the increased yield, net of any changes in expenditures on other variable costs of production.

Cases 3 and 4 are more complicated. For either case, the industry supply and demand curves would have to be estimated empirically in order to value accurately those areas that represent the producer and/or consumer surplus benefits. (For additional information, consult Rorholm et al., 1965; Gulland, 1969; Altobello et al., 1977; McHugh and Mirchel, 1978; Wang et al., 1978; and Marchesseault and Russell, 1979.)

Chapter VIII

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Exhibit A

Publications Available Through EPA's Industrial Technology Division

Estuary managers and project analysts are urged to gather and review all relevant information before estimating the benefits of improving estuarine water quality. The following technical publications address industrial point source effluent guidelines, limitations, and standards. These publications can provide valuable information and are available through EPA's Industrial Technology Division, which is also known as the Effluent Guidelines Division.

Exhibit A Publications Available Through EPA's Industrial Technology Division

40 CFR Part Number	Industrial Point Source Category	Rulemaking Status	Title of Publication	EPA Document Number 440/1-(YEAR/ID Number)	Date of Publication	NTIS Accession Number
402	Cooling Water Intake Structures	Final	Best Technology Available for the Location Design Construction & Capacity of Cooling Water Intake Structures for Minimizing Adverse Environmental Impact	76/015-a	April 1976	PB 253573/AS
405	Dairy Product Processing	Final	Dairy Products Processing	74/021-a	May 1974	PB 238835/AS
406	Grain Mills	Final	Grain Processing	74/028-a	March 1974	PB 238316/AS
		Final	Animal Feed, Breakfast Cereal & Wheat Starch	74/039-a	December 1974	PB 240861/AS
		Supplemental	Corn Wet Milling	75/208-b	1975	–
407	Fruits & Vegetables - Canned & Preserved	Final	Apple, Citrus & Potato Processing	74/027-a	March 1974	PB 238649/AS
		Interim Final	Fruits, Vegetables & Specialties	75/046	October 1975	–
408	Seafood Processing - Canned & Preserved	Final	Catfish, Crab, Shrimp & Tuna	74/020-a	June 1974	PB 238614/AS
		Final	Fishmeal, Salmon, Bottom Fish, Sardine, Herring, Clam, Oyster, Scallop & Abalone	75/041-a	September 1975	PB 256840/AS
		Report	Report to Congress: Section 74 Seafood Processing Study - Executive Summary	80/020 Vol. I Vol. II Vol. III	September 1980	PB 81182362 PB 81182370 PB 8112388

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40 CFR Part Number	Industrial Point Source Category	Rulemaking Status	Title of Publication	EPA Document Number 440/1-(YEAR/ID Number)	Date of Publication	NTIS Accession Number
409	Sugar Processing	Final	Sugar Processing - Beet Sugar	74/002-b	January 1984	PB 238462/AS
		Final	Sugar Processing - Cane Sugar Refining	74/002-c	March 1984	PB 238147/AS
		Interim Final	Sugar Processing - Raw Cane Sugar Processing	75/044	February 1985	--
410	Textile Mills	Final	Textile Mills	82/022	September 1982	PB83-116871
411	Cement Manufacturing	Final	Cement Manufacturing	74/005-a	January 1974	PB 238610/AS
412	Feedlots	Final	Feedlots	74/004-a	January 1974	PB 238651/AS
413	Electroplating	Final	Metal Finishing	83/091	June 1983	PB84 115489
		Guidance	Guidance Manual for Electroplating and Metal Finishing Pretreatment Standards	84/091-g	February 1984	PB87 192597
		Final	Existing Source Pretreatment Standards for the Electroplating Point Source Category	79/003	August 1979	PB80 196488
414	Organic Chemicals	Final	Organic Chemicals and Plastics & Synthetic Fibers	87/009 Vol. I Vol. II	October 1987	PB88 171335

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40 CFR Part Number	Industrial Point Source Category	Rulemaking Status	Title of Publication	EPA Document Number 440/1-(YEAR/ID Number)	Date of Publication	NTIS Accession Number
415	Inorganic Chemicals Manufacturing	Final	Inorganic Chemicals Manufacturing Phase I	82/007	June 1982	PB82 265612
		Final	Inorganic Chemicals Manufacturing Phase II	84/007	August 1984	PB85 156446/ XAB
416	Plastics & Synthetic Fibers (Materials Mfg.)	Final	Organic Chemicals and Plastics & Synthetic Fibers	87/009 Vol. I Vol. II	October 1987	PB88 171335
417	Soap & Detergent Manufacturing	Final	Soap and Detergent Manufacturing	74/018-a	April 1984	PB288C13/AS
418	Fertilizer Manufacturing	Final	Fertilizer Manufacturing - Formulated Fertilizer Segment	75/042-a	1975	PB 24__63/AS
		Final	Fertilizer Manufacturing - Basic Fertilizer Chemicals	74/011-a	March 1974	PB 238652/AS
		Report	Summary Report - Phosphate Fertilizer Subcategory of the Fertilizer Point Source Category (40 CFR 418)		January 1982	–
419	Petroleum Refining	Final	Petroleum Refining	82/014	October 1984	PB83 172569

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40 CFR Part Number	Industrial Point Source Category	Rulemaking Status	Title of Publication	EPA Document Number 440/1-(YEAR/ID Number)	Date of Publication	NTIS Accession Number
420	Iron & Steel Manufacturing	Final	Iron and Steel Manufacturing Vol. I - General	82/024	May 1982	PB82 240425-a
			Vol. II - Coke Making, Sintering, Iron Making			PB82 240433-b
			Vol. III - Steel Making, Vacuum Degassing and Continuous Casting			PB82 240441-c
			Vol. IV - Hot Forming			PB82 240458-d
			Vol. V - Salt Bath Descaling, Acid Pickling			PB82 240466-e
			Vol. VI - Cold Forming, Alkaline Cleaning, Hot Coating			PB82 240474-f
		Guidance	Guidance Manual for Pretreatment Steel Manufacturing Point Source Category		September 1985	
421	Nonferrous Metals Manufacturing	Final	Dev. Doc. (Reference copy available in Public Record - EPA Headquarters)			
422	Phosphate Manufacturing	Final	Dev. Doc. Phosphorus Derived Chemicals Manufacturing	74/006-a	January 1974	PB241018/AS
		Final	Dev. Doc. Other Non-Fertilizer Phosphate Chemicals	75/043-a	June 1976	–
		Report	Summary Report - Phosphate Fertilizer Subcategory of the Fertilizer Point Source Category (40 CFR 418)	Contract # 68-1-4975	January 1982	

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40 CFR Part Number	Industrial Point Source Category	Rulemaking Status	Title of Publication	EPA Document Number 440/1-(YEAR/ID Number)	Date of Publication	NTIS Accession Number
423	Steam Electric Power Generating	Final	Steam Electric	82/029-b	November 1982	–
424	Ferroalloy	Final	Smelting and Slag Processing	74/008-a	1974	PB_38650/AS
		Interim Final	Calcium Carbide	75/038	February 1975	–
		Interim Final	Electrolytic Ferroalloys	75/038-a	February 1975	–
425	Leather Tanning	Supplement Final	Supplement Dev. Doc. - Leather Tanning and Finishing	88/016-s	February 1988	PB88 3541
		Guidance	Guidance Manual for Leather Tanning and Finishing Pretreatment Standards		September 1986	–
		Final	Leather Tanning & Finishing	82/016	November 1982	PB83 172593
426	Glass Manufacturing	Final	Insulation Fiberglass Segment	74/001-b	January 1974	PB238078/AS
		Final	Flat Glass Segment	74/001-c	January 1974	PB238907/0
		Interim Final	Pressed & Blown Glass Segment	75/034-a	August 1975	PB256854/AS

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40 CFR Part Number	Industrial Point Source Category	Rulemaking Status	Title of Publication	EPA Document Number 440/1-(YEAR/ID Number)	Date of Publication	NTIS Accession Number
427	Asbestos	Final	Building, Construction, and Paper Segment	74/017-a	February 1974	PB238320/AS
		Final	Textile, Friction Materials and Sealing Devices Segment	74/035-a	December 1974	PB240860/AS
428	Rubber Processing	Final	Tire and Synthetic Segment	74/013-a	February 1974	PB238609/AS
		Final	Fabricated & Reclaimed Rubber	74/030-a	December 1974	PB241916/AS
429	Timber Products Processing	Final	Timber Products	81/023	January 1981	PB81 227282
430	Pulp, Paper, & Paperboard	Final	BCT - Pulp and Paper	86/025	December 1986	PB87 172243/ AS
		Guidance	Guidance Manual for Pulp, Paper, and Paperboard & Builder's Paper and Board Mills		July 1984	–
		Final	Pulp, Paper, and Paperboard and the Builder's Paper and Board Mills	82/025	October 1982	PB83 163949
		Proposed	Control of Polychlorinated Biphenyls in the Deink Subcategory		1980	–
431	Builder's Paper and Paperboard Mills	Final	Pulp, Paper, and Paperboard and the Builder's Paper and Board Mills	82/025	October 1982	PB83 163949

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40 CFR Part Number	Industrial Point Source Category	Rulemaking Status	Title of Publication	EPA Document Number 440/1-(YEAR/ID Number)	Date of Publication	NTIS Accession Number
432	Meat Products Processing & Rendering	Final	Red Meat Processing	74/012-a	1974	PB238836/AS
		Final	Renderer Segment	74/031-d	January 1975	PB253572/2
		Supplement Reprint/ Final	Supplement to Development Document for the Renderer Segment of the Meat Products & Rendering	78/031-e	September 1978	–
		Supplement	Supplement to Development Document for Meat Products & Rendering - Renderer Segment	77/031-e	April 1977	–
433	Metal Finishing	Final	Metal Finishing	83/091	June 1983	PB84 115989
		Guidance	Guidance Manual for Electroplating and Metal Finishing Pretreatment	84/091-g	February 1984	PB87 192597
434	Coal Mining	Final	Coal Mining	82/057	October 1982	PB83 180422

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40 CFR Part Number	Industrial Point Source Category	Rulemaking Status	Title of Publication	EPA Document Number 440/1-(YEAR/ID Number)	Date of Publication	NTIS Accession Number
435	Oil & Gas Extraction	Proposed	Oil and Gas Extraction (Offshore)	85/055	July 1985	–
	Report to Congress - December 1987; Office of Solid Waste (382-4627)	Report	Assessment of Environmental Fact and Effects of Discharge from Offshore Oil and Gas Operations	4-85/0 2	August 1985 –	PB114964/AS
		Interim Final	Oil and Gas Extraction	76/055-a	September 1976	–
		Interim Final	Oil and Gas Extraction - Offshore	75/055	September 1975	–
436	Mineral Mining	Final	Mineral Mining and Processing	76/059-b	July 1979	PB80 110299
439	Pharmaceutical Manufacturing	Final	Pharmaceutical - BCT	86/084	December 1986	–
		Final	Pharmaceutical	83/084	September 1983	PB84 180066
440	Ore Mining and Dressing	Final	Placer Mining and Dressing - Gold Placer Mining Segment	88/061	May 1988	PB89 117790
		Final	Ore Mining and Dressing	82/061		
443	Paving & Roofing Materials (Tars & Asphalt)	Final	Tars and Asphalt	75/050		

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40 CFR Part Number	Industrial Point Source Category	Rulemaking Status	Title of Publication	EPA Document Number 440/1-(YEAR/ID Number)	Date of Publication	NTIS Accession Number
444	Auto & Other Laundries	Guidance	Guidance Document for Effluent Discharges from the Auto and Other Laundries Point Source Category		February 1982	–
446	Paint Formulating	Interim Final	Oil Base Solvent Wash Subcategories	75/049	1975	–
		Interim Final	Paint and Ink Formulating	75/050	February 1975	–
447	Ink Formulating	Interim Final	Oil Base Solvent Wash Subcategories	75/049	1975	–
448	Printing & Publishing	Guidance	Summary of Available Information on the Levels of Controls of Toxic Pollutants Dischargers in the Printing and Publishing Point Source Category	83/400	October 1983	–
452	Concrete Products	Guidance	Concrete Products	78/090	February 1978	–
454	Gum & Wood Chemicals Manufacturing	Interim Final	Gum and Wood Chemicals	76/060-b	April 1976	–
455	Pesticide Chemicals Manufacturing	Final	Pesticides - BPT Only	78/060-e	April 1978	PB285480
		Interim Final	Pesticides Chemicals Manufacturing	75/060-d	November 1976	–

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40 CFR Part Number	Industrial Point Source Category	Rulemaking Status	Title of Publication	EPA Document Number 440/1-(YEAR/ID Number)	Date of Publication	NTIS Accession Number
457	Explosives	Interim Final	Explosives Manufacturing	76/060-j	March 1976	–
458	Carbon Black	Interim Final	Carbon Black Manufacturing	76/060-h	April 1976	–
459	Photographic Manufacturing	Interim Final	Photographic Processing	76/060-l	June 1976	–
		Guidance	Guidance Document for the Control of Water Pollution in the Photographic Processing Industry	81/082-g	April 1981	PB82 177643
460	Hospitals	Interim Final	Hospitals	76/060-n	April 1976	
461	Battery Manufacturing	Final	Battery Manufacturing: Vol. I - Cadmium Subcategory - Calcium Subcategory - Leclanche Subcategory - Lithium Subcategory - Magnesium Subcategory - Zinc Subcategory	84/067	August 1984	PB121507

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40 CFR Part Number	Industrial Point Source Category	Rulemaking Status	Title of Publication	EPA Document Number 440/1-(YEAR/ID Number)	Date of Publication	NTIS Accession Number
461 (Cont.)	Battery Manufacturing (Continued)	Final	Battery Manufacturing: Vol. II - Lead Subcategory (erratta sheet p. 809)	84/067	August 1984	PB121507
		Guidance	Guidance Manual for Battery Manufacturing Pretreatment Standards		August 1987	–
463	Plastics Molding & Forming	Final	Plastics Molding and Forming	84/069	December 1984	PB84 186823
464	Metal Molding & Forming (Foundries)	Final	Metal Molding and Casting (Foundries)	85/070	October 1985	PB86 161452/ XAB
465	Coil Coating	Final	Coil Coating: Phase I	82/071	October 1982	PB83 205542
		Final	Coil Coating: Phase II - Canmaking	83/071	November 1983	PB84 198647
466	Porcelain Enameling	Final	Porcelain Enameling	82/072	November 1982	–
467	Aluminum Forming	Final	Aluminum Forming: Vol. I	84/073	June 1984	244425
		Final	Aluminum Forming: Vol. II	84/073	June 1984	PB 244433
468	Copper Forming	Final	Copper Forming	84/074	March 1984	PB84 192459

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40 CFR Part Number	Industrial Point Source Category	Rulemaking Status	Title of Publication	EPA Document Number 440/1-(YEAR/ID Number)	Date of Publication	NTIS Accession Number
469	Electrical & Electronic Components	Final	Electrical and Electronic Components: Phase I	83/075	March 1983	--
		Final	Electrical and Electronic Components: Phase II	84/075	February 1984	--
471	Nonferrous Metals Forming	Final	Nonferrous Metals Forming Vol. I Vol. II Vol. III	86/019	September 1986	 PB87 121760 PB87 121778 PB87 121786
472	Ethanol-for-Fuel	Guidance	Multimedia Technical Support Document: Ethanol-for-Fuel Industry	86/093	April 1986	PB86 177557/AS
		Guidance	Low BTU Gasifier Wastewater (1986)		July 1986	PB86 245438/AS
		Guidance	Low BTU Coal Gasification			
	Dioxin	Study	U.S. EPA/Paper Industry Cooperative Dioxin Screening Study	88/025	March 1988	--
	Domestic Sewage Study - Hazardous Wastes	Report	Report to Congress on the Discharge of Hazardous Wastes to Publicly Owned Treatment Works	530-SW-86-004	February 1986	PB86 184017/AS

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40 CFR Part Number	Industrial Point Source Category	Rulemaking Status	Title of Publication	EPA Document Number 440/1-(YEAR/ID Number)	Date of Publication	NTIS Accession Number
	Fate of Priority Pollutants in POTWs	Baseline Study Vol. I	Fate of Priority Pollutants in Publicly Owned Treatment Works: Vol. I	82/303 Vol. I	September 1982	PB83 122788
		Baseline Study Vol. II	Fate of Priority Pollutants in Publicly Owned Treatment Works: Vol. II	82/303 Vol. II	September 1982	PB83 122796
		Baseline Study 30 day Study	Fate of Priority Pollutants in Publicly Owned Treatment Works: 30 Day Study	82/302	July 1982	PB82 26330
		Baseline Study Pilot Study	Fate of Priority Pollutants in Publicly Owned Treatment Works: Pilot Study	79/300	1979	–
	Total Toxic Organics RCRA Information - POTW	Baseline Study Guidance	RCRA Information on Hazardous Wastes for Publicly Owned Treatment Works	OWEP	September 1985	–

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40 CFR Part Number	Industrial Point Source Category	Rulemaking Status	Title of Publication	EPA Document Number 440/1-(YEAR/ID Number)	Date of Publication	NTIS Accession Number
	Fate of 129 Priority Pollutants - Water Related	Baseline Study Vol. I	Water Related Environmental Fate of 129 Priority Pollutants - Introduction to Technical Background - Metals - Organics - Pesticides - Polychlorinated Biphenyls	4-79/029-a Vol. I	December 1979	PB80 204373
		Baseline Study Vol. II	Water Related Environmental Fate of 129 Priority Pollutants - Halogenated Aliphatic Hydrocarbons - Halogenated Aromatics - Phthalate Esters - Polycyclic Aromatic Hydrocarbons - Nitrosamines - Miscellaneous Compounds	4-79/029-a Vol. II	December 1979	PB80 204381
	Standard Inductive Classification Manual			OMB		PB87 100012
	Total Toxic Organics - Pretreatment Standards	Guidance	Guidance Manual for Implementing Total Toxic Organics (TTO) Pretreatment Standards	Permits	September 1975	--
	Combined Wastestream Formula	Guidance	Guidance Manual for the Use of Production Based Pretreatment Standards and the Combined Wastestream Formula	Permits	September 1985	--
	Paragraph 4(c) Program	Report	Paragraph 4(c) Program Summary Report		January 1984	--

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40 CFR Part Number	Industrial Point Source Category	Rulemaking Status	Title of Publication	EPA Document Number 440/1-(YEAR/ID Number)	Date of Publication	NTIS Accession Number
	Report to Congress: Limestone Discharge	Report	Report to Congress: The Effects of Discharger From Limestone Quarries on Water Quality and Aquatic Biomonitoring	82/059	June 1982	PB82 242207
	Sampling Procedures and Protocols	Methods	Sampling Procedures and Protocols for the National Sewage Sludge Survey		March 1988	–
	Analytical Methods	Methods	Sampling and Analysis Procedures for Screening of Industrial Effluent for Priority Pollutants		March 1977 revised April 1977	–
	EPA Methods 1634 and 1635	Methods	Method 1634 Volatile Organic Compounds in Municipal Wastewater Treatment Sludges by Isotope Dilution GC/MS; Method 1635 Semivolatile Organic Compounds in Municipal Wastewater Treatment Sludges by Isotope Dilution GC/MS		July 1988	–
	EPA Methods 1624 and 1625, Rev. C	Methods	Method 1624 Revision C: Volatile Organic Compounds by Isotope Dilution GC/MS Method 1625 Revision C: Semivolatile Organic Compounds by Isotope Dilution GC/MS		March 1988	–
	EPA Method 1618 Consolidate GC Method	Methods	Narrative on the Development and Validation of the "Consolidated GC Method for the Determination of ITD/RCRA Analytes Using Selective GC Detectors"		July 1986	–

Exhibit A (Continued)

40 CFR Part Number	Industrial Point Source Category	Rulemaking Status	Title of Publication	EPA Document Number 440/1-(YEAR/ID Number)	Date of Publication	NTIS Accession Number
	Isotope Dilution GC/MS - Organics	Methods	Analysis of Extractable Organic Pollutant Standards by Isotope Dilution GC/MS		July 1986	–
	Sewage Sludge Survey	Methods	Analytical Methods for the National Sewage Sludge Survey		March 1988	–
	List of Lists	Report	The 1988 List of Lists - List of ITD/RCRA Analytes			
		Report	The 1987 Industrial Technology Division List of Analytes		March 1987	–
		Report	Methods for Nonconventional Pesticides Chemical Analysis of Industrial and Municipal Wastewater	83/079-C		PB83 176636

Source: U.S. EPA, "Industrial Technology Division Technical Publications Availability Report," September 1988.

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