Appropriate and Inappropriate Economic Analysis for Allocation Decisions

The Case of Alaska Halibut

by

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Executive Summary

The North Pacific Fishery Management Council currently is considering whether to directly limit the total amount of halibut caught by the recreational charter boat fishery. While quotas apply to the commercial harvest of halibut, the harvest by the charter fishery is not controlled by a quota. Since catch limits for the commercial sector are set after the harvests of sport fishers (including guided charters) are deducted, there is concern that growth of the charter industry could result in "a de facto allocation of the halibut resource away from the commercial long-line fisheries".

The Council's Halibut Guideline Harvest Level Committee is examining four alternatives to the status quo that would set limits on the catch of halibut by the recreational charter boat sector. Under the four alternatives to the status quo, the total allowable catch would be split between commercial and guided sport sectors (after deducting other halibut removals). Each of the four alternatives has implications for the allocation of halibut harvests between commercial and charter fisheries, and the changes in harvest that would occur given halibut biomass fluctuations.

Policy changes affecting the allocation of halibut harvest rights among user groups will have real economic consequences, and these consequences are likely to differ among users and communities. Deliberations by the NPFMC regarding the ultimate allocation of harvests must be informed by information concerning expected economic consequences of allocation decisions on affected groups and communities. However, there is often confusion among resource managers regarding the appropriate use of economic information for decision making. Misuse of economic data and specious "economic" arguments are common in debates over fisheries allocation policies. Many resource managers fail to distinguish between measures of economic activity and measures of economic benefits.

This paper describes the information that must be considered in an appropriate economic analysis of halibut allocation policies, and distinguishes appropriate from inappropriate uses of economic information.

Economic Benefits and Impacts

One of the principal objectives of the Magnuson-Stevens Act is to maximize the economic benefits of fish used for food and recreation. In the cases of preventing overfishing and rebuilding overfished stocks, the Act directs Councils to minimize, to the extent practicable, economic impacts on fishing communities. Accordingly, an important consideration in the allocation of fish harvests between the commercial and charter sectors is the economic benefits that are generated by harvest activity in each sector, and the economic impacts of changes in halibut fishery management policy.

Economic impacts consist of 'real' and 'apparent' economic impacts. Real economic impacts are the *net economic benefits* gained or lost as a result of an action (e.g., change in fishery management policy). Apparent economic impacts are changes in economic activity for which there is no change in net economic benefits. As explained in detail herein, changes in net economic benefits have real economic consequences for the region. In contrast, changes in economic activity may or may not have actual economic consequences.

Many arguments used by fisheries user groups are placed under the general umbrella of economic impacts, even though they are often incorrect or incomplete. For example, estimates of aggregate economic activity are often improperly substituted for, or interpreted as, estimates of net economic benefits. Unfortunately, such misleading arguments can lead to policies that actually reduce the total economic value that residents derive from publicly-owned fish stocks.

Net economic benefits associated with halibut allocation policies are defined as the difference between total economic benefit and total economic cost. In a fishery management context, economic benefit reflects the total value that a region (or nation) derives from the use of a fishery resource. Contrary to common belief, net economic benefits are not necessarily linked to money payments to or from any group. Although money payments may reflect some aspects of economic value, net economic benefits cannot be measured through simple transfers of money. Rather, the measurement of true net economic benefits requires a set of tools and guidelines known as Benefit Cost Analysis (BCA).

Some analyses attempt to include secondary, or support industries (i.e., restaurants, bait shops, hotels, fish processing plants) as recipients of net economic benefits. However, as discussed below, gains to these secondary industries are generally offset by nearly identical losses elsewhere. Accordingly, estimation of net benefits to secondary or support industries generally involves double counting of benefits already measured elsewhere, and is therefore avoided. As a general rule, the appropriate measure of economic net benefits includes only the primary effects of a policy change.

From an economic perspective, the halibut allocation that produces the largest possible sum of net economic benefits represents the most productive or optimal use of the halibut harvest. However, it does not follow from this statement that the group with the largest total net benefits from the current halibut allocation should be given 100% of the allocation. One must consider changes in total net economic benefits to all groups resulting from successive incremental changes in allocation. If the total net economic gain from an incremental shift in allocation outweighs the total net losses, then the incremental shift increases total net benefits.

Net Benefits Derived by Recreational Anglers

Economic value is defined in terms of the amount that an individual would be willing to pay to receive a fisheries product, rather than spending that same amount of money on other goods and services. The difference between the amount that a person is willing to pay to obtain a particular product and the amount that is actually paid is the net economic benefit obtained by the individual. For example, assume that a sport angler would be willing to pay $1000 for a particular halibut charter fishing trip, based on his income and preferences. However, the actual trip only costs $750. As a result, the angler receives $250 in consumer surplus — equal to his total willingness to pay of $1000 minus the amount that he actually pays, $750. This $250 represents the net economic benefit generated by the fishing trip, and received by the angler.

For many resource managers, “real” money expenditure represents a more “concrete” measure of economic gain. However, the actual transfer of money alone is meaningless as a measure of economic value. In the above example, the angler pays $750 for the fishing trip — the same $750 represents a gain to the provider of charter services. This pure financial transfer provides no gain in economic benefit, because the same $750 gained by one group is lost by another.

The appropriate indicator of the net benefits of charter fishing to anglers is based on the net worth of the product to anglers. More specifically, the net benefit of a fishing trip to an angler is the difference between his or her willingness to pay for the fishing trip, minus the amount that is actually paid.

Net Benefits to Charter Vessel Operators

Operators of charter vessels incur costs that include money actually paid to others (e.g., money paid for boat fuel, wages, moorings, etc.) and opportunity costs of other resources used in charter fishing. In return, charter operators are paid revenues by sport fishermen for each trip. The sum of total revenues minus total resource costs is the appropriate measure of net economic benefits received by charter operators. The net economic benefits are not equal to the total revenues earned by charter operators, and are not exactly equal to net profits.

Net Benefits to Commercial Fishers

Although commercial halibut fishermen and charter vessel operators work in different industries and supply different products, associated net economic benefits are measured in the same manner. That is, net economic benefits in the commercial fishery are equal to the total ex-vessel revenues associated with the sale of halibut products minus the total resource costs related to fishing. This appropriate measure of net economic benefits in the commercial halibut fishery accounts for the difference between total economic benefits and total economic costs. As noted above, this estimate of net benefits is not equal to total expenditures or profits in the commercial fishing industry.

Net Benefits to Workers in the Commercial or Charter Industry

Economic impact analysis often presents estimates of the number of jobs that will be lost or gained under various policy scenarios. A common assumption is that job creation is an economic benefit. However, while the creation of jobs may be desirable from a variety of perspectives, it does not in general represent a real economic benefit. Under relatively narrow conditions, a small portion of the income associated with new jobs may be considered an economic benefit. *As a general rule, however, neither jobs nor the income associated with new jobs are considered economic benefits*.

There are only two instances in which the creation of new jobs represents a legitimate economic benefit to workers: 1) if the new jobs are taken by current residents who were previously unemployed or under-employed; or 2) if the new jobs result in an increase in wages within the particular industrial sector.

A significant implication of this is that benefit-cost analysis values jobs more highly in communities where jobs are scarce, relative to eligible workers. In communities where jobs are already plentiful, new jobs will likely be taken by new in-migrants, resulting in negligible net economic benefits to the region.

Input-Output Analysis

Input-output models (I-O) provide a snapshot of the financial linkages among sectors in a regional economy. In simple terms, I-O tracks monetary payments as they move through a regional economy — measuring the transfer of money from one group (sector) to another. Often described as "economic impact analysis," I-O seeks to estimate changes in gross output, income, and/or employment resulting from exogenous changes, including changes in government fisheries policy. For example, the commercial software package IMPLAN allows I-O analysis of changes to a broad range of sectors in regions across the United States, and may be supplemented with data to allow analysis of the "economic impact" of fisheries policy.

Despite its common use in assessing aggregate economic impacts of fisheries policy decisions, *I-O is not a substitute for benefit-cost analysis, and does not provide an estimate of the net economic benefits of policy changes*. The principal reason that I-O is not an appropriate tool for fisheries allocation decisions is that it does not measure economic benefits. Although this limitation is well-known by experienced I-O practitioners, it is often ignored by interested parties who may wish to use I-O results to argue for specific policy alternatives.

I-O analysis measures economic transfers — the shift of money from one group to another — the overall benefit of which, in general, is zero. I-O does have legitimate uses in the analysis of policy options. However, the measurement of net economic benefits, efficiency, or community well-being is not one of these legitimate uses.

Common Myths Regarding the Use of Economics Information in Fisheries Allocation

Myth 1: The harvest allocation that produces the most income or revenue is preferred from an economic standpoint.
Fact 1: The economic value of revenue or gross income cannot be ascertained without information concerning opportunity costs, or alternative uses of productive assets.

Myth 2: Since consumer surplus doesn't involve the transfer of "real" money, it does not represent a real economic value and should not be used in fishery allocation decisions.
Fact 2: The true consumer value of a fishery product is the difference between the "worth" of that product to a user (what he would be willing to pay to obtain it) and the amount of money that is actually paid.

Myth 3: The activity that involves the most dockside expenditures must have the highest economic value, and should be given the higher allocation.
Fact 3: This argument suffers the same problems as the "revenue" argument discussed above. Revenues and expenditures are simply the flip side of the same monetary transfer — the net value of which is zero. Economic value and financial transfers are not identical, and financial transfers cannot be interpreted as a measure of well-being.

Myth 4: The sector with the highest total value for fish harvests should be granted 100% of the allocation.
Fact 4: The allocation decision must be viewed from a marginal perspective. The decision maker must consider whether a marginal (i.e., additional) shift in allocation from one sector to another will increase or decrease total net benefits. Because the marginal value of fish allocation (i.e., the value of the last fish allocated) will differ depending on the total allocation to each sector, regulators must consider the net economic effects of successive small changes in allocation. Regulators must balance, at the margin, the value of harvest allocation gained by one sector with the value of harvest lost by another sector.

Myth 5: The allocation that produces the most jobs is best, especially in small rural communities.
Fact 5: The value of a job depends on many factors. At one extreme, if the economy is in full employment and wages do not change, the economic value of a job to existing residents is zero, because the new workers must be imported from outside the region. In contrast, if many workers are unemployed, the value of jobs to those workers may be substantial. One cannot simply add up the number of jobs created and use this sum as a proxy for the gain economic benefits.

Myth 6: Benefit cost analysis cannot consider the distribution of benefits — and therefore ignores potentially devastating economic effects on small rural fishing communities.
Fact 6: Although BCA practitioners often ignore the distribution of economic benefits to simplify the analysis, an appropriately conducted BCA *can account* for the distribution of benefits among regions and different effected groups.

Myth 7: Although benefit cost analysis provides more exact measures of net economic benefits, the use of I-O as a substitute is acceptable where it may be conducted at lower cost.
Fact 7: I-O is promoted as a quick, inexpensive substitute for BCA — perhaps

not equivalent but acceptable if the data for a BCA is questionable or not readily available. However, despite its potential ease of use, *I-O is not a substitute for BCA*. Policies based solely on the results of I-O can actually reduce the total economic value that residents derive from halibut stocks. I-O analyses will often show *positive* income and employment effects of major disasters such as oil spills. Moreover, the ease of use of I-O by untrained individuals often leads to misinterpretations and misuses of I-O results, as detailed above.

Myth 8: Because benefit cost analysis is case-specific and subject to uncertainty, input-output analysis provides more reliable and accurate results, particularly when generated by standardized programs such as IMPLAN.
Fact 8: Both BCA and I-O are subject to potential uncertainties and biases. However, the uncertainties and potential biases of I-O are often obscured by the use of pre-packaged computer software such as IMPLAN. Like all analysis, the accuracy of the end results of an I-O model will depend on the accuracy of model parameters. IMPLAN is based on national average production coefficients and other parameters that may not apply equally to all regions and all situations. Accordingly, I-O will not necessarily provide more accurate or reliable results than BCA.

Myth 9: An appropriate measure of net economic benefits should include impacts on secondary industries such as restaurants, motels, retail shops, and similar businesses.
Fact 9: It is *not appropriate* to count secondary effects as *net economic benefits*. Secondary effects of fisheries policy changes are almost always offset by nearly equal and opposite gains or losses elsewhere in the economy. Policy makers may wish to consider implications for the regional distribution of income associated with these secondary effects. However, such impacts have no quantifiable relationship to net economic benefits.

Myth 10: Non-market valuation methods such as contingent valuation do not provide appropriate measures of net economic benefits, because they are not based on actual market transactions.
Fact 10: Non-market valuation methods such as contingent valuation provide appropriate measures of net economic benefits. The appropriateness of contingent valuation estimates for informing government policy has been formally supported by an NOAA Blue Ribbon Panel of Experts. Like all forms of empirical analysis, non-market analysis must be carried out according to stringent research standards, or the resulting benefit estimates will be subject to considerable bias. When conducted according to proper standards, contingent valuation and other forms of non-market analysis can provide appropriate measures of net economic benefits or losses.

Guidelines for Policy Analysis

The following guidelines should be followed when using economic data to assess halibut allocation options.

1) Input-Output (I-O) analysis should not be used as a substitute for benefit cost analysis (BCA). Net economic benefits are the appropriate indicator of the economic consequences of a fisheries allocation policy—these benefits are measured only by benefit cost analysis.

2) When combining the results of BCA and I-O to inform policy, the net economic benefit estimates generated by BCA should be given greater emphasis, compared to the economic activity estimates of I-O. When choosing the appropriate economic tool to assess economic consequences of halibut allocation policies (or any fisheries policy), BCA should be selected over I-O.

3) Where possible, benefit cost analysis should include new research *specific* to the halibut allocation decision in the Gulf of Alaska. Benefit estimates "transferred" from studies conducted in other regions, or for other fisheries, will often misrepresent the net economic benefits associated with halibut allocations in the Gulf of Alaska.

4) Benefit cost analysis should be conducted according to careful professional standards to avoid bias and misuse, and should be conducted by experts familiar with the specific BCA methods in question. Presentation of results should make clear the limitations associated with the data and methodologies applied.

5) Where possible, sensitivity analysis should be conducted as part of a BCA, to illustrate the range of potential outcomes for net economic benefits to different groups.

6) Presentation of BCA results should be accompanied by explicit discussions of the groups to which benefit estimates apply. Where BCA results are aggregated over all stakeholder groups, this aggregation should be made explicit.

7) Information concerning economic benefits (from BCA) is meaningful in its own right, without reference to I-O results. However, economic activity estimates (from I-O) can be misleading without reference to appropriate measures of net economic benefits.

8) If policy-makers wish to consider the results of I-O, these results must be interpreted properly within an economic framework. Specifically, it should be made clear that I-O results do not have quantifiable implications for net economic benefits or regional well-being.

9) If policy-makers wish to consider the results of I-O, pre-packaged routines such as IMPLAN should be tailored to the specific conditions of the region, by an expert familiar with the appropriate use and interpretation of I-O results.

10) Any presentation of I-O results should be supplemented with a discussion of real economic benefits. Specifically, the discussion should make clear the distinction between I-O results and measures of real economic benefits, to avoid the common confusion between measures of economic activity and economic benefit.

11) Presentation of job creation estimates from I-O should be supplemented with discussions of the local employment context, and information concerning the estimated number of jobs that will be taken by previously unemployed workers.

12) Any discussion of I-O "multiplier" effects should include an explicit discussion regarding the assumptions implicit in the underlying analysis. Researchers must ensure that multipliers are used and interpreted properly. Finally, distinction should be made between the measures of economic activity measured by multipliers and measures of net economic benefits which are *not* related in any measurable way to I-O multipliers.

13) The net economic benefits of changes in halibut allocation should be assessed on a marginal basis. To identify the allocation that offers the greatest net economic benefits, researchers must assess the costs and benefits associated with sequential marginal changes in halibut allocation.

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I. Introduction

The Alaska Halibut Fishery is the largest single fishery for which the United States has applied Individual Fishing Quota (IFQ) management (Knapp 1997; Iudicello 1999). However, while vessel class-and area-specific halibut IFQ's are required for commercial harvest, the harvest of the charter (sport) fishery is not governed within the IFQ system. Rather, the harvest of the charter fishery has historically been regulated through individual "bag-limits" for licensed resident and non-resident sport fishers (North Pacific Fishery Management Council (NPFMC) et al. 1998). As the catch limits for the commercial long-line industry are set after the harvests of sport fishers (including guided charters) and unintentional by-catch are deducted, the increased growth of the charter industry could result in "a de facto allocation of the halibut resource away from the commercial long-line fisheries" (NPFMC and the University of Alaska's Institute for Social and Economic Research (ISER) 1997, p. 1-1). This pattern has become of increasing concern to stakeholders in the halibut fishery, as the charter fishery has undergone significant expansion since the early 1990's (e.g., NPFMC et al. 1998; NPFMC and ISER 1997).

Estimates of the NPFMC and ISER (1997) estimate that the guided charter industry accounted for 9% of the combined guided sector/commercial sector harvest; given no regulatory change, this share could increase to 14% by 2008 given current total allowable catch projections and conservative assumptions regarding sector growth. Aside from aggregate effects on the commercial and charter industries, such a re-allocation would likely have significant regional impacts, as the commercial and charter industries have an uneven presence in many Alaska communities. Since 1993, the NPFMC has discussed the ongoing expansion within the charter industry, and resulting depletion of, and conflict over, localized halibut stocks (NPFMC et al. 1998).

The Halibut Allocation Issue

As described by the North Pacific Fishery Management Council's (1998) "Problem Statement" concerning the halibut allocation issue, the existing situation threatens "…the Council's ability to maintain the stability, economic viability, and diversity of the halibut industry, the quality of the recreational experience, the access of subsistence users, and the socioeconomic well-being of the coastal communities dependent on the halibut resource." The Council has noted the following specific areas of concern: 1) localized depletion of halibut in several areas, related to pressure from charter operations, lodges, and outfitters; 2) overcrowding of productive grounds and declining catches for historic sport and subsistence fishermen; 3) the *de facto* open ended reallocation of halibut harvest from the commercial fishery to the charter industry; 4) impacts on community stability as traditional sport, subsistence, and commercial fishermen are displaced by charter operators, lodges, and outfitters, including conflicts between user groups; 5) limited information concerning the socioeconomic composition of the current charter industry; and 6) the need for reliable catch data (NPFMC et al. 1998).

Decisions regarding commercial-charter allocation of the substantial[1] halibut harvest will influence a large number of fishery participants. As of 1998, there were 500 known IFQ share holders in "smaller" Gulf of Alaska communities (Alaska Commercial Fisheries Entry Commission 1999a) and 2,110 quota share holders in "larger" Gulf of Alaska communities (Alaska Commercial Fisheries Entry Commission 1999b).[2] These two groups represented a harvest of nearly 32 million IFQ equivalent pounds in 1998 (Alaska Commercial Fisheries Entry Commission 1999a, b). Supplementing the commercial quota share holders, there are over 2,000 charter vessels licensed by the International Pacific Halibut Commission (NPFMC et al. 1998), for which non-IFQ bag-limits apply to individual sport fishers. The harvest of these charter vessels may be estimated from 1998 log book data[3]; however, Alaska Division of Fish & Game staff have recommended that this data be verified over a three-year period to assure accuracy (NPFMC et al. 1998). Finally, in addition to those who fish from charter operations, "non-commercial" users of the resource include numerous traditional (non-charter) sport fishers and subsistence users (NPFMC et al. 1998).

Policies affecting the allocation of halibut harvest rights among user groups will have significant and real economic consequences, and these consequences are likely to differ among regions and types of communities. Deliberations regarding the ultimate allocation of scarce harvests should be informed by information concerning the expected economic consequences of allocation decisions on effected groups and regions. However, within the resource management community, there is often confusion regarding the appropriate interpretation and use of economic information as an aid to policy making (Steinback 1999; Edwards 1991; Grigalunas and Congar 1995). Accordingly, misuse of economic data and specious "economic" arguments are common in debates over appropriate fisheries allocation policies. Contributing to the misuse of purportedly "economic" arguments is a fundamental misunderstanding of appropriate means to compare the net economic benefits of competing fishery allocations (Edwards 1991). In addition, many resource managers fail to distinguish between aggregate measures of economic activity and net measures of economic benefits (Steinback 1999; Edwards 1991).

This paper describes the socioeconomic elements that should be considered in an appropriate economic analysis of halibut allocation policies, and seeks to distinguish appropriate from inappropriate uses of economic information. The paper also discusses the errors implicit in common economic myths used to justify particular allocation choices. Finally, the paper outlines some of the empirical methods that may be used to measure appropriate economic benefits and costs. Theoretical discussions are kept to a minimum in order to focus on the implications and potential policy uses of the results, and to ensure that the text is accessible to non-economists.

Throughout the paper, the presentation focuses on the appropriate versus inappropriate use and interpretations of economic models and data for fishery allocation decisions. The following sections illustrate legitimate uses of economic indicators and model results, and contrast these to inappropriate uses common in public relations campaigns and the public media. Specifically, the paper compares and contrasts various measures of net economic benefit generated through Benefit Cost Analysis (BCA) with measures of aggregate economic or financial activity generated through Input-Output (I-O) Analysis or other types of "economic impact" analysis. Although often confused by resource managers, each approach characterizes a different aspect of economic effect(s). Each approach has appropriate uses and misuses. This paper illustrates that benefit cost analysis provides the measures of net economic benefit appropriate to ensure the most productive use of the halibut resource, from an economic perspective. Input-output analysis, while providing valid information regarding changes in gross output, income, and employment, *is not a substitute for benefit-cost analysis, and does not provide an estimate of the net economic benefits of policy changes.* Input output analysis may be used to *supplement* an appropriate benefit cost analysis (BCA), providing information on financial flows, the regional distribution of employment and income, and impacts on secondary industrial sectors not addressed by a properly conducted BCA. However, input-output and other forms of economic impact analysis do not measure net economic benefits or the well-being of society, and hence cannot be used to determine the "best" or most productive economic use of the halibut resource.

The remainder of this introduction is devoted to a brief discussion of the policy alternatives being considered by the North Pacific Fishery Management Council. Section II of the paper then presents the fundamentals of benefit cost analysis and the appropriate use of economic data. This includes a discussion of the limitations of benefit cost analysis and the use of regional vs. national measures of benefits and costs, as well as discussion of empirical methods used to measure net economic benefits. Section III discusses input-output analysis and other forms of "economic impact" analysis, and illustrates reasons why, in general, these methods are inappropriate for assessment of economic benefits and costs. Section IV discusses various common myths used to promote specific fisheries policy decisions. Finally, Section V presents final implications and conclusions.

Management alternatives considered for the allocation of halibut harvests

As described in the January 12, 1999 minutes of the Halibut Guideline Harvest Level (GHL) Committee, the following GHL alternatives are under consideration:

Alternative 1. Status quo. Do not develop regulations to implement a halibut GHL.

Under this alternative, local area management plans (LAMP's) will be developed to manage the harvest of guided sport anglers. These LAMP's may include line limits on boats; annual angler limits; vessel trip limits; super-exclusive registration of charter vessels; moratorium; and/or a sport vessel only area.

Alternative 2. Convert the GHL to an allocation.

Under this alternative, the guided sport fishery would be allocated 12.76% of the combined commercial and guided sport halibut quota in area 2C, and 15.61% in area 3A. The guided sport fishery would close when that sector reached its allocation.

Alternative 3. Convert the GHL to an allocation range.

Under this alternative, the allocation range "will have an upper and lower limit and would be a fixed amount expressed in numbers of halibut." The allocation range would be set by IPHC for Areas 2C and 3A. If the guided sport halibut harvest exceeds the upper limit of the range in a year, the guided sport fishery would be restricted to reduce the harvest back within the allocation range using various specified management actions.

Alternative 4. Under a GHL, apply a range of management measures listed below to curtail catch rates of guided anglers once a GHL is attained.

Under this alternative, the GHL functions as a cap. Specified management measures would be applied up to two years after attainment of the GHL.

Alternative 5. Area-wide moratorium only.

The specific criteria for the moratorium are detailed in the Committee minutes.

Additional details of each alternative are provided by NPFMC (1998). Each of the alternatives has implications for the allocation of halibut harvests between commercial and charter fisheries, the management measures that would be used to obtain the desired allocation, and the changes in harvest that would occur given halibut biomass fluctuations. However, unlike the current status quo, each of the "cap" alternatives proposed would result in the IPHC projecting halibut removals from "bycatch, subsistence, deadloss, and unguided sport fisheries, with the remainder being split, at some percentage, between commercial fisheries and guided sport fisheries." (NPFMC and ISER 1997, p. 6-1).

This paper does not address the case-by-case economic consequences of various management measures that might be used to maintain a charter GHL or specific allocation (e.g., line limits, trip limits, area closures, etc.). The consequences of various management measures is covered in detail by the fisheries literature (Anderson 1986; Iudicello et al. 1999; National Research Council 1999). Rather, this paper focuses on economic analysis of the consequences of the resulting allocation between commercial and charter sectors. Although the ultimate economic analysis of these consequences will depend on the specific characteristics of the management alternative chosen, appropriate economic analysis of halibut allocation will be grounded in the same fundamental models and principles. The following section illustrates and describes these fundamental concepts.

II. Economic Benefits and Economic Impacts

One of the principal objectives of the re-authorized Magnuson Fishery Conservation and Management Act (the Magnuson-Stevens Act) is to maximize the economic benefit of fish used for food and recreation.[4] In the cases of preventing overfishing and rebuilding overfished stocks, the Act directs Councils to minimize, to the extent practicable, economic impacts on fishing communities.[5] Accordingly, an important consideration in the allocation of fish harvests between the commercial and charter sectors is the economic benefits that are generated by harvest activity in each sector, and economic impacts of changes in halibut fishery management policy.

This section describes the proper interpretation and measurement of economic benefits and impacts as they are applied to fishery management decisions. Economic consequences consist of 'real' and 'apparent' economic consequences. Real economic consequences are the *net economic benefits* gained or lost as a result of an action (e.g., change in fishery management policy). Apparent economic consequences are changes in economic activity for which there is no necessary change in net economic benefits. As explained in detail below, changes in net economic benefits have real economic implications for the region, in that they affect the economic well-being of communities and regions. In contrast, changes in economic activity are apparent impacts only—they may or may not have real economic consequences for the region. Apparent economic consequences (such as changes in regional income) may appear to be legitimate "economic" indicators, but in fact have no quantifiable link to net economic benefits or real economic consequences.

Many arguments used by fisheries user groups are placed under the general umbrella of economic impacts, even though they are often "incomplete, distorted, or even incorrect" (Edwards 1990, p. 1). For example, estimates of aggregate (gross) economic activity are often improperly substituted for, or interpreted as, estimates of net economic benefits (Edwards 1991). Unfortunately, such misleading arguments can lead to policies that actually reduce the total economic value that residents derive from publicly owned fish stocks (Edwards 1990). The same is true whether one considers small regions such as fishing villages, or large economies such as that of the United States.

Net economic benefits associated with halibut allocation policies are defined as the difference between total economic benefit and total economic cost. Alternately, economic benefits reflect the overall well-being of society, from an economic perspective. In a fishery management context, economic benefit reflects the total value that a region (or nation) derives from the use of a fishery resource (Lipton et al. 1995). Contrary to common belief, net economic benefits are not necessarily linked to observable money payments to or from any group. Although money payments may reflect some aspects of economic value, net economic benefit cannot be measured through simple transfers of money. Rather, the measurement of true net economic benefits (or economic value) requires a set of tools and accompanying guidelines known as **Benefit Cost Analysis** (BCA) (Lipton et al. 1995; Boardman et al. 1996; Sassone and Schiffer 1978).

Within the context of halibut allocation policies, significant net economic benefits may be derived by five groups: 1) recreational halibut anglers; 2) halibut charter operators; 3) the commercial fishing industry; 4) purchasers of halibut products; and, in some cases, 5) workers in the charter or commercial fishery. Differences among the groups that derive net economic benefits are occasionally obscured by discussions that focus primarily on generic "consumer and producer surpluses" without emphasizing the different characteristics of user groups that may derive benefits. Some analyses also attempt to include secondary, or support industries (i.e., restaurants, bait shops, hotels, fish processing plants) as recipients of net economic benefits. However, as discussed below, gains to these secondary industries are generally offset by nearly identical losses elsewhere. Accordingly, estimation of net benefits to secondary or support industries generally involves double counting of benefits already measured elsewhere, and is therefore avoided (Boardman et al. 1996). As a general rule, appropriate benefit cost analysis focuses only on the primary effects of a fisheries policy change.

The total change in net economic benefits to society is the sum of changes in net economic benefits to each group mentioned above. From an economic perspective, the halibut allocation that produces the largest possible sum of net economic benefits represents the most productive or optimal use of the halibut resource (NPFMC and the Alaska Institute for Social and Economic Research 1997). However, it does not follow from this statement that the group with the largest total net benefits from the current halibut allocation should be given 100% allocation. As shown by Edwards (1991) and many others, one must consider the changes in total net economic benefits to all groups resulting from successive incremental (i.e., small) changes in allocation. If the total net economic gain from an incremental shift in allocation outweighs the total net losses (considering net economic gains and losses to all primary groups noted above), then the incremental shift results in a more productive use of the halibut resource from an economic perspective. If the total net economic gain is less than the total net economic losses, then the incremental shift results in a less productive use of the halibut resource, again from an economic perspective.

The Role of Benefit Cost Analysis in Measuring Net Economic Benefits

Benefit cost analysis (BCA) is the general method used by economists to measure net economic benefits received or lost by society, or by various population sub-groups. It is the sub-discipline of economics devoted to the measurement of social well-being. The primary practical purpose of BCA is to assist in decision making, by providing information on the gain or loss of net economic benefits. In simple terms, BCA is designed to help resource managers make decisions that increase the net social productivity of society's resources (Lipton et al. 1995; Boardman et al. 1996). Under the general umbrella of BCA is a set of methods used to measure economic benefits under a variety of conditions, and for a variety of groups. BCA also includes a number of rules and guidelines concerning the use of various measurement methods, and the aggregation of results from various methodologies.

Estimating net economic benefits involves careful development and application of studies using one or more market and non-market BCA methods (Lipton et al. 1995; Grigalunas et al. 1999).[6] These include market-based supply and demand methods, non-market recreation demand models, survey-based contingent valuation approaches, and others (Freeman 1993). The specific method(s) used to estimate economic benefits will depend upon the resource and derived service of interest. Although BCA methods were historically market-based, the increasing importance of benefit estimation has led to a large body of research concerning non-market valuation methods, as in many cases the environmental goods considered are not traded in traditional markets (Peterson and Randall 1993; Mitchell and Carson 1989; Freeman 1993; Carson et al. 1994;

Grigalunas and Conger 1995). Such non-market methods can be critical components of BCA, and are often the only economic means available to assess certain social costs and benefits of management actions.

For market goods, such as commercially harvested fish, market prices and quantities can be used to estimate net benefits to fishers and fish consumers. Such estimation methods are based on well-known supply and demand models of market behavior (Wessells and Anderson 1992). Some non-market goods and services, such recreational fishing, also require outlays (e.g., for gasoline, time to travel to a site, and payments to charter operators) which may be used to estimate demand and the derived net economic benefit. In the case of charter fishing, people "reveal" derived economic benefits by their actions — by their purchases and how they use their time and scarce resources to obtain recreational fishing experiences. Hence, net benefits often can be estimated for recreational activity using travel cost and participation data. Other types of resources may generate passive benefits (i.e., benefits that involve no observable activity).[7] In such cases, market data cannot be used to estimate net benefits. Instead, surveys using stated preference methods must be employed. For example, the contingent valuation method (CVM) is a stated valuation approach in which researchers use carefully developed surveys to estimate values that people hold for well-defined changes in the quantity or quality of an environmental resource and/or its services (Johnston and Asche 1998). Although each of these methods has unique estimation capacity and potential for error, they are all legitimate and appropriate means to measure particular aspects of net economic value within a benefit cost analysis.

BCA recognizes that different stakeholder groups are likely to derive different types of benefits as a result of halibut allocation policies, and is designed to address tradeoffs among the net economic benefits received by different groups. These net benefits will depend not only on the gross allocation, but also on the regulatory measures used to obtain the desired allocation. Moreover, net economic benefits will depend on the future state of certain parameters — information which may be unavailable at the current time. Accordingly, a BCA will often assess the role of risk and uncertainty in determining the net economic benefits received by any one group. In many cases, uncertainties will involve greater potential economic consequences (gains or losses) to some groups than to others. For example, a program that provided a fixed tonnage harvest allocation to the charter industry would subject the commercial industry to relatively greater risk associated with stock fluctuations, as the commercial fishery would absorb reductions or increases in the total allowable catch (Minutes of the NPFMC Scientific and Statistical Committee, Feb. 1-2, 1999). Such effects are legitimate considerations in a BCA.

Appropriate methods used to assess net economic benefits will differ depending on the source of the net benefit, and the group receiving that benefit. Lipton et al. (1995) provide an excellent summary of appropriate techniques for BCA applied to fisheries and coastal issues, and illustrate case studies applied to fishery management. Many of the issues introduced in this document are described in greater detail by this well-presented work (Lipton et al. 1995). In addition, some of the appropriate methodologies for measuring net economic benefits are illustrated and/or described by the report of the NPFMC and the Alaska ISER (1997). In addition, Berman et al. (1997) present a relatively comprehensive BCA study of commercial-sport allocation decisions in the Kenai River salmon fishery, including estimates of net economic benefits to commercial owner/operators, sport anglers, and commercial crew. The types of values derived by the five primary groups (i.e., sport anglers, commercial fishers, charter operators, fishery laborers, and halibut consumers), and the measurement of these values are discussed below.

Net Benefits Derived by Recreational Anglers

Perhaps the most common misperception concerning the economic value of charter fishing to anglers is that it is equal to the amount of money that the angler pays for the fishing trip. However, in general, economic value is not what a consumer pays for a product. To illustrate the fallacy of this assumption, imagine that a recreational angler is given a free halibut fishing trip. Although no money changes hands (the angler pays $0), the average person clearly would value this gift — and this represents a legitimate economic value (Edwards 1991). Indeed, if the angler were instead asked to pay some monetary amount (e.g., $200) for the halibut fishing trip, the economic value received by that angler would actually decrease, because the angler receives the same fishing trip but is now $200 poorer. This example illustrates that there is no particular relationship between the amount that a person actually pays for a product, and the economic value he or she derives from that product.

Economic value is defined in terms of the amount that an individual would be willing to pay to receive a fisheries product, rather than spending that same amount of money on other goods and services. The difference between the amount that a person is willing to pay to obtain a particular product and the amount that is actually paid is defined as consumer surplus, and represents the net economic benefit obtained by the individual.[8] For example, assume that a sport angler would be willing to pay $1000 for a particular halibut charter fishing trip, based on his income and preferences. However, the actual trip only costs $750. As a result, the angler receives $250 in consumer surplus — equal to his total willingness to pay of $1000 minus the amount that he actually pays, $750. This $250 represents the net economic benefit generated by the fishing trip, and received by the angler. Although the actual estimation of consumer surplus given data on recreational fishing behavior is somewhat more complex (Freeman 1993), it is based on the same fundamental concepts.

As noted by Edwards (1990; 1991), the concept of consumer surplus often invokes skepticism on the part of fishery managers, because it is not linked to a measurable transfer of money. For many resource managers, "real" money expenditure represents a more "concrete" measure of economic gain. However, as illustrated above, the actual transfer of money alone is meaningless as a measure of economic value. In the above example, the angler pays $750 for the fishing trip — the $750 thus represents a loss of wealth to this angler. In contrast, the same $750 represents a gain of wealth to the provider of charter services. This pure financial transfer provides no gain in economic benefit, because the same $750 gained by one group is lost by another. To illustrate another, more obvious example, imagine two people passing a $20 bill back and forth between them. No matter how many times the $20 is passed back and forth, no economic benefits are created — the same $20 is simply transferred back and forth. This illustrates the simple fact that a pure transfer of money is not a measure of net economic benefits.

The appropriate indicator of the net benefits of charter fishing to anglers is based on the net worth (or value) of the product to those anglers. More specifically, the net benefit of a fishing trip to an angler is the difference between his or her willingness to pay for the fishing trip, minus the amount that is actually paid. In technical terms, the net benefit derived from recreational fishing is the "maximum net willingness to pay over and above recreation costs" (Hushak 1987, p. 442). The average willingness to pay for charter halibut fishing trips may be estimated from actual market purchases of fishing trips at different total trip prices, as described by Edwards (1990), Hushak (1987), Grigalunas and Congar (1995), and many others.[9] Such "recreation demand" models are common and well-developed in the economics literature (e.g., Bockstael et al. 1987; 1988; Bell et al. 1982; Freeman 1993; Larson 1993; Kahn 1998). For an example of the estimation of net benefits to Alaska sport anglers, see Berman et al.'s (1997) analysis of the Kenai River salmon fishery.

As noted by the NPFMC and ISER (1997), it may be appropriate to omit some of the total measure of consumer surplus from charter fishing from the estimate of net economic benefits. This is because a measurable proportion of the angler benefits related to charter fishing are received by non-residents of the United States (e.g., Canadian residents) — and a BCA focused on benefits to the U.S. (and its residents) should exclude that portion of consumer surplus derived by non-U.S. residents. It is also important to note that certain allocation measures may provide greater net benefits or profits to charter vessel operators, while actually reducing net benefits derived by guided halibut anglers. That is, the net economic benefits of charter customers (anglers) and charter operators will not necessarily react in the same manner to allocation measures.

Net Benefits to Charter Vessel Operators

Operators of charter vessels incur incremental resource costs as a result of conducting each additional charter trip. These costs may include money actually paid to others (e.g., money paid for boat fuel, wages, moorings, etc.) and opportunity costs of other resources used in charter fishing (Lipton et al. 1995; Edwards 1990).[10] In return, charter operators are paid revenues by sport fishermen for each trip. The sum of total revenues minus total resource costs is referred to as producer surplus, and is the appropriate measure of net economic benefits received by charter operators. Note that these net economic benefits are not equal to the total revenues earned by charter operators, and are not exactly equal to net profits.[11]

For example, assume that a charter vessel operates in the halibut fishery for 100 days. During this time, the vessel takes in $100,000 in revenues from sport anglers. Further assume that total resource costs incurred include $50,000 paid to others for labor and supplies, and $10,000 in **opportunity costs**, representing the potential net benefits of the highest value alternative use of the owner's time and fixed capital resources (Sutinen 1980; Gwartney and Stroup 1997). The resulting *net economic benefits* received by the charter operation are therefore equal to $100,000 - $50,000 - $10,000 = $40,000. This represents the net gain of the charter operator, accounting for total economic costs and total revenues. It is important to notice that this net benefit is *not* equal to revenues ($100,000), nor is it equal to profits as an accountant might measure them ($100,000 - $50,000 = $50,000).

To illustrate why accounting profits are not the appropriate measure of net economic benefit, consider a second simple example. Assume that a charter vessel operates in the halibut fishery, and earns $25,000 in accounting profits. However, assume that if the same charter operator were to operate in the salmon fishery, his net economic benefits would be $30,000. Even though the operator is earning positive profits in the halibut fishery, he is actually losing money relative to what he could be earning in the salmon fishery. The charter operator's economic resources are not being put to the most productive use, and this is reflected in a *negative* producer surplus equal to ($25,000 - $30,000) = -$5,000. The simple measure of accounting profit in the halibut fishery fails to account for the net losses that the charter operator incurs by foregoing the valuable opportunity to fish in the salmon fishery.

In sum, although raw revenue and profit data may be used to help estimate the net economic benefits associated with charter operation, appropriate calculation of net benefits requires one to account for total resource costs, including opportunity costs (Sutinen 1980; Edwards 1990). It is not possible to state that larger gains in raw income are preferable (from an economic perspective) to smaller gains income—because income shifts alone do not incorporate changes in total resource costs. Changes in income do not represent changes in net economic benefits.

Although it may be difficult to observe some aspects of resource cost (such as unobservable aspects of opportunity cost), it is possible to estimate total resource costs using the estimated *supply curve* for halibut charter fishing, as described by Edwards (1990) and Hushak (1987). Empirical estimation of total resource costs in Alaska fisheries (including unobservable aspects of opportunity cost) are illustrated by Berman et al. (1997) and Boyce (1993). Although both analyses address opportunity costs in the commercial fishery, similar methodologies may be applied to charter owner/operators. Bioeconomic models of marine recreational fishing are provided by McConnell and Sutinen (1979) among many others. Hushak (1987) also discusses practical issues and complications involved in estimation of such supply relationships. Lipton et al. (1995) illustrate the calculation of producer surplus with and without prior estimates of the supply curve, with an application to the Chesapeake Bay striped bass fishery. Naïve estimates of "economic benefit" based solely on revenues or profits will generally overestimate the actual net economic benefits associated with charter operations.

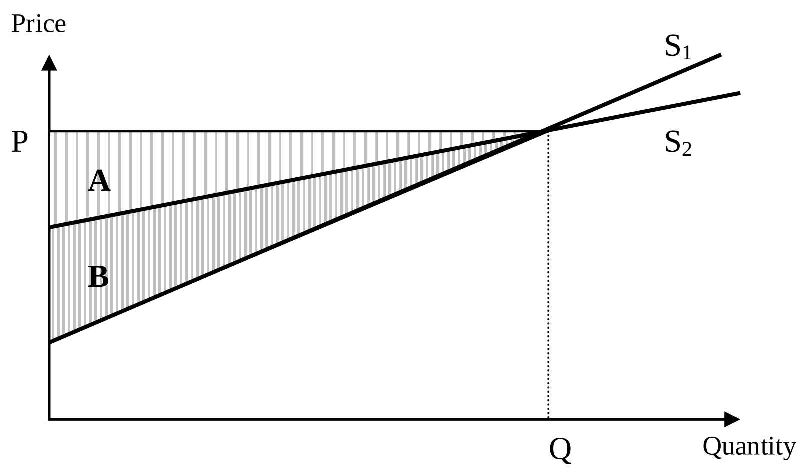
Net Benefits to Commercial Fishers

Although commercial halibut fishermen and charter vessel operators work in different industries and supply different products (fish vs. sport fishing services), associated net economic benefits are measured in the same fundamental manner. That is, net economic benefits in the commercial fishery are equal to the total ex-vessel revenues associated with the sale of halibut products minus the total resource costs related to fishing. As above, where it may be difficult to observe some aspects of resource cost (such as unobservable aspects of opportunity cost), it is possible to estimate total resource costs using the estimated ex-vessel supply curve for halibut, as described by Edwards (1990), Iudicello et al. (1999), Kahn (1998) and many others. Simply put, the supply curve is estimated using statistical analysis of historical price and quantity patterns in the halibut fishery — it forecasts the quantity of halibut that fishermen will supply, on average, at any given market price. Using information embedded in the supply curve, it is possible to mathematically calculate incremental and total resource costs. Subtracting these estimated resource costs from total ex-vessel revenues provides an estimate of producer surplus in the commercial halibut fishery. This producer surplus estimate is the appropriate monetary measure of net economic benefits in the commercial halibut fishery, as it accounts for the difference between total economic costs and total economic benefits. A variety of sources discuss the incorporation of producer surplus into fisheries bioeconomic models, and the associated calculation of net economic benefits to commercial fishers (Kahn 1998).[12] As noted above, this producer surplus estimate is not equal to total expenditures or profits in the commercial fishing industry.

The quantity supplied by commercial fishers may be either highly responsive to changes in ex-vessel price (elastic), highly unresponsive to price changes (inelastic) or moderately responsive to such changes. All else being equal, the responsiveness of the quantity supplied (the *price elasticity of supply*) to changes in ex-vessel price will influence the net economic benefits received by commercial fishers, and the impact of allocation policies on these benefits. In general, greater elasticities of supply (greater responsiveness to price on the part of fishers) will tend to result in lower net economic benefits to commercial fishers. Lower supply elasticity (lower responsiveness to price on the part of fishers) will tend to lead to higher net economic benefits to commercial fishers. An appropriately estimated supply curve will account for changes in the responsiveness of commercial effort and catch to changes in ex-vessel price, and the impact of the IFQ system on this responsiveness. In general, steeper supply curves reflect inelastic supply; flatter supply curves reflect more elastic supply.

To illustrate this result graphically, Figure 1 shows two supply curves with different supply elasticities. Supply curve S_1 is less elastic than S_2, as indicated by its relatively steeper slope. That is, S_1 is less responsive to changes in price than S_2. As shown the diagram, the magnitude of producers surplus is affected by the price elasticity. Producers surplus is the area below the price and above the supply curve. For supply curve S_1, the amount of producers surplus is given by the sum of areas A and B. For the more elastic supply curve S_2, the amount of producers surplus is only area A. In general, for a common price and quantity, a more elastic supply curve has less producers surplus than if it were less elastic. These results carry over into assessments of producers surplus changes resulting from fishery allocation policies, with greater supply elasticity, in general, leading to larger changes in producer surplus.

Figure 1. Supply Curves and Producer Surplus: The Effect of Elasticity



In addition to the price elasticity of supply, one of the key determinants of the change in net economic benefits to commercial fishers resulting from shifts in halibut allocation is the price *elasticity of demand* for halibut products by consumers (NPFMC and ISER 1997). Simply put, the elasticity of demand indicates the relative decrease (increase) in the quantity of halibut purchased by consumers caused by in increase (decrease) in market price. All else being equal, if the demand for halibut is highly price-elastic (quantity purchased is very price-sensitive), then changes in net benefits to the commercial fishing industry resulting from allocation changes will tend to be larger. This is because market price will be relatively insensitive to changes in quantities of halibut provided by the industry. Hence, large decreases (increases) in quantity will not be offset by large increases (decreases) in price, holding other factors constant. The opposite will hold true if the demand for halibut is price-inelastic. Accordingly, an appropriate forecasting of the impacts of halibut allocation policies on commercial fishers will likely require information regarding the behavior of the consumers of halibut products. It is important, however, that these elasticity estimates are based on reliable estimates of consumer behavior. Preliminary elasticity estimates or those based on invalid or misleading assumptions can lead to substantial biases in the estimates of net economic benefits to commercial fishers.

A simplified assessment of the change in producer surplus in the Alaska halibut fishery (resulting from halibut allocation changes) is provided by NPFMC and ISER (1997). However, based on the many assumptions and simplifications implicit in their model, they indicate that "the projections contain a great deal of uncertainty, and should be used in an ordinal sense rather than in an absolute sense," and that "comparisons of the magnitude of changes in net economic benefits accruing to the commercial fishery with the magnitude of estimates of changes in net economic benefits accruing to the guided fishery should be undertaken with care." (p. 6-21). Despite this uncertainty, their analysis does provide an indication of many issues that must be addressed when measuring producer surplus for commercial fisheries. However, given the limitations in the NPFMC and ISER (1997) analysis, their results should be treated with caution. Based on the caveats appropriately noted by NPFMC and ISER (1997), policy decisions should not be made based solely on these estimates, until the results can be verified or "ground-truthed" using additional data from the halibut fishery. Note that these cautionary remarks apply solely to the analysis of NPFMC and ISER (1997), and do not indicate limitations applicable to all appropriate estimates of producer surplus. More complex (and empirically appropriate) estimates of producer surplus in Alaska commercial salmon fisheries, accounting for both revenues and total resource costs, are provided by Berman et al. (1995) and Boyce (1993).

Occasionally, researchers may attempt to add net benefits to fish processors along with benefits to commercial vessel owner/operators. However, in general, this is not appropriate. Given a competitive processing industry, changes in net economic benefits to processors will be captured by measurements of producer and consumer surplus in the primary market. That is, if one measures changes in consumer surplus (to fish purchasers) and producer surplus (to vessel owner/operators) associated with commercial halibut allocation policies, any net benefits to competitive processing plants will be embedded in these benefit estimates (Just et al. 1982). Accordingly, adding processors' net benefits to total benefit estimates will likely result in double counting of the same aspects of net economic benefit—an inappropriate use of BCA methodology.

Net Benefits to Workers in the Commercial or Charter Industry

Economic impact analysis (see Section III following) often presents estimates of the number of jobs that will be lost or gained under various policy scenarios. A relatively common assumption is that such job creation is an economic benefit. However, while the creation of local jobs may be desirable from a variety of perspectives, it does not in general represent a real economic benefit to society. Under relatively narrow conditions, a small portion of the income associated with new jobs may be considered an economic benefit. *However, as a general rule, neither jobs nor the income associated with new jobs are considered economic benefits*. This is true in all industrial sectors, including the fisheries sector.

The justification for this statement is as follows. Suppose that a mate on a halibut charter vessel is paid $30,000 for his labor services. The charter vessel owner receives benefits from the use of that labor — and, those benefits to the owner are part of the *producer surplus* that is already measured for that vessel owner (see above). The mate also receives a benefit as a result of his employment — because he receives money in exchange for his time. Now suppose that a new job is created on *another* fishing vessel as a result of an increase in the charter halibut allocation, that pays the same salary ($30,000) and has the same working conditions. Obviously, if the mate were to change jobs (moves from his old job the new job) he would receive no added economic benefit because *the salaries are the same*. He would receive no more compensation for his time than he did in the original job. If the new fisheries job were taken by an individual who moves in from outside the region to take the new job, no economic benefits are provided to current residents of the region. This is because any economic benefits associated with the new job are taken by new in-migrants.[13] [14]

Following from the logic presented above, there are only two instances in which the creation of new jobs represents a legitimate economic benefit to workers: 1) if the new jobs are taken by current residents who were previously unemployed or under-employed; or 2) if the new jobs result in an increase in wages within the particular industrial sector (McConnell and Brue 1992). If jobs are taken by previously unemployed workers, then most[15] of the new earned wages are considered net economic benefits to the newly employed workers. If wages increase in the sector, then *only the amount of the net wage increase* represents a net economic benefit to workers, and then only in the case where the wage increase is not met by equal economy-wide price inflation.[16] It follows from the previous statements that job creation in communities with high unemployment will provide net economic benefits, as long as the new jobs are taken by previously unemployed individuals. However, job creation in economies that are close to full-employment will generally result in negligible or zero net benefits. A significant implication of this distinction is that benefit-cost analysis values jobs more highly in communities where jobs are more scarce, relative to eligible workers. In communities where jobs are already plentiful, new jobs will likely be taken by new in-migrants, resulting in negligible net economic benefits to the region.

An additional source of net benefits associated with fishing labor may include non-monetary aspects of job satisfaction, as described by Berman et al. (1995). To the extent that job satisfaction differs significantly between commercial fishing and alternate employment opportunities, changes in job satisfaction can represent legitimate economic benefits. One example of an estimation methodology for these benefits is presented by Berman et al. (1995). However, with regard to such net economic benefits, it is important to note that labor economists often assume that job satisfaction does not differ among jobs, unless reliable data indicates otherwise.

Net Benefits to Seafood Consumers

In most cases, the primary consumers of halibut are not located in the region in which the fish are caught. Hence, the economic value derived from the consumption of fresh and frozen halibut is primarily enjoyed by national rather than regional households. For this reason, resource managers interested primarily in regional net economic benefits may wish to give less weight to the consumer benefits of halibut consumption. In other cases, portions of consumer surplus may be ignored entirely within an appropriate BCA, such as in the case where a proportion of halibut consumers are not U.S. residents (NPFMC and ISER 1997). Nevertheless, subject to issues concerning the residency of halibut consumers, benefits received by the consumers of halibut products represent a legitimate source of economic benefit associated with the halibut fishery.

As described above for recreational anglers, the basis of net economic benefits associated with halibut purchases is on the net worth (or value) of the specific product to individuals, as measured by their willingness to pay. More specifically, the net benefit of a halibut to an individual is the difference between his or her willingness to pay for the fish, minus the amount that is actually paid. As before, the amount actually paid for the halibut is not a measure of net economic benefit. Edwards (1990; 1991) describes these concepts in greater detail, with specific focus on fish purchases and net economic benefits.

Restating the concept of economic benefit as applied to seafood consumers, economic benefit is defined in terms of the amount that an individual would be willing to pay to receive a fisheries product, rather than spending that same amount of money on other goods and services. The difference between the amount that a person is willing to pay to obtain a particular product and the amount that is actually paid is defined as consumer surplus, and represents the net economic benefit obtained by the individual. For example, assume that an individual would be willing to pay $100 for a 20 lb. halibut, based on his income and preferences. (Note, even if the individual were given the halibut as a free gift, it would still be worth $100 to him, because the value of the fish is based on his income and internal preferences.) However, the market price of the halibut is $80. As a result, the individual would receives $20 in consumer surplus (or net economic benefits) from the purchase of the halibut — the fish is worth $100 to him, but he only has to pay $80. As noted above in the case of consumer surplus for recreational anglers, the actual estimation of consumer surplus for halibut consumers is more complex than suggested by the simple mathematics of this example. However, it is based on the same fundamental economic concepts.

The average willingness to pay for halibut products, and resulting consumer surplus, may be estimated from market data — observations of actual market purchases at different prices. This estimation is based on long-accepted and relatively non-controversial market supply and demand methods of benefit-cost analysis (Sasson and Schaffer 1978; Boardman et al. 1996). Wessells and Anderson (1992) provide a summary of these methods as applied to the seafood industry. NPFMC and ISER (1997) present a preliminary illustration of consumer surplus changes resulting from halibut allocation changes. As noted above, these estimates are preliminary and based on a great many simplifying assumptions. However, although consumer surplus may be calculated from observations of market purchase behavior for halibut, as shown by NPFMC and ISER (1997), it cannot be approximated by total expenditures on fish products.

As discussed above with regard to the commercial halibut industry, the impacts on consumer surplus derived by halibut consumers will depend on the price-elasticity of demand for halibut. As noted above, price-elasticity reflects the responsiveness of quantity purchased to changes in relative price. All else being equal, if the demand for halibut is highly price-elastic (highly responsive to price), then consumer surplus changes resulting from changes in available halibut quantity will likely be minimal. If demand for halibut is price-inelastic, then consumer surplus changes will likely be more substantial. Additional discussion regarding consumer surplus and price-elasticity in the halibut industry are provided by NPFMC and ISER (1997). However, note that elasticity estimates provided by NPFMC and ISER (1997) are preliminary and subject to the caveats noted above (see "Benefits to Commercial Fishers" above). Accordingly, these elasticity estimates should be verified with additional data prior to their use in actual allocation decisions.

Fishery Applications of Benefit Cost Analysis Methodologies

The methodologies and techniques noted above have all been applied to the measurement of net economic benefits associated with commercial and/or recreational fisheries. The economics literature provides guidelines and numerous examples—many with direct policy applications (Lipton et al. 1995). *Given appropriate data*, experienced practitioners of BCA can often estimate or approximate net economic benefits to various stakeholders with only a moderate commitment of time and resources. However, where appropriate data is not collected or readily available, many BCA methodologies can require a substantial commitment of time and manpower. Where assumptions or approximations are used to compensate for a lack of appropriate data, the realism of the assumptions or approximations will be reflected in BCA results—non-realistic assumptions can often lead to substantial biases in net benefit estimates.

The use of *market data* for estimation of net economic benefits to commercial fishers and consumers of fishery products is well established in the literature, as summarized by Wessells and Anderson (1992), Iudicello (1999), and many others. Market estimates of producer surplus in Alaska commercial salmon fisheries are provided by Berman et al. (1995) and Boyce (1993). However, the literature concerning non-market valuation methods, particularly as applied to the recreation demand of sport anglers (and the derived net benefits of charter operators), is less familiar to many policy makers. For this reason, this section illustrates some recent applications of non-market methodologies to recreational fisheries.

In general, non-market studies of recreational fishing fall into two broad categories: 1) revealed preference research dominated by studies based on the travel cost methodology (TCM), and 2) stated preference research dominated by studies based on the contingent valuation or contingent choice methodology (CVM). Both TCM and CVM are officially sanctioned for measuring net economic benefits for federally funded outdoor recreation investments, including investments that impact recreational fisheries (Ward and Loomis 1986). Ward and Loomis (1986) provide an excellent general summary of TCM as applied to the estimation of recreation demand. A similar summary of CVM is provided by Mitchell and Carson (1989) and Cummings et al. (1986). Lipton et al. (1995) provide an excellent description of the use of economic valuation and benefit cost methodologies in fisheries management and other environmental areas, designed for use by coastal policy makers.

Fisheries applications of both TCM and CVM are common. For example, Morey et al. (1991), Morey et al. (1993), and Opaluch et al. (1999) illustrate TCM approaches to modeling net economic benefits associated with recreational sport fishing. The 1991 study estimates angler demand for trips to various fishing sites along the Pacific coast, along with associated net economic benefits. This study accounts for substitution among fishing sites, the characteristics of sport anglers, and the type of fishing considered (e.g., shore vs. boat). These results are used to estimate the net economic benefits (or change in total economic value) that would result from either elimination or enhancement of sport salmon fishing at various Oregon fishing sites. The 1993 study assesses participation and site choice for Atlantic salmon sport fishing, using a nested-logit travel cost model. Again, this methodology is used to estimate the net economic benefits or losses associated with policy changes affecting the salmon fishery at various sites. It accounts for substitution among sites, and the impact of the quality of fishing and catch rate on the choice of fishing vs. other forms of recreation (Morey at al. 1993). Opaluch et al.'s (1999) study estimates the change in overall recreational fishing trips and associated net benefits that would result from changes in expected catch in the Peconic Estuary of Long Island, NY—as might be expected given a change in bag limits. Again, these results account for substitution among different types of water-based recreation.

Travel cost studies have also been conducted to assess net economic benefits to anglers in Alaska fisheries. For example, Jones and Stokes Associates (1987) use discrete choice travel cost models to assess the demand for recreational fishing in South-Central Alaska. This detailed model addresses a wide range of factors in modeling recreational angler behavior and net economic benefits from fishing, including the choice of fish species, the choice of location, the characteristics of various fishing sites, and the characteristics of anglers. Berman et al. (1997) apply a similar nested random utility model to estimate the benefits to sport anglers of changes in the commercial/sport allocation of Kenai River salmon.

The above noted studies provide examples of a large number of fisheries applications of TCM. Differences between the various approaches are in part a result of differences in data availability and model assumptions. The appropriate type of model in any given situation will depend on the availability of specific types of data, and the observable behavior of sport anglers. The principal result here is that travel cost applications to recreational fishing are common and well developed, and similar methodologies may be applied to sport halibut fishing in the Gulf of Alaska.

Applications of CVM to fisheries issues are likewise common and well-developed in the literature. For example, Boyle et al. (1992) estimate the value of salmon sport-fishing trips to the Penobscot River, Maine. Maharaj (1995) presents both TCM and CVM estimates of net economic benefits resulting from various policy changes to the New England sport salmon fishery. Adamowicz et al. (1994) combines TCM and CVM into a single revealed-stated preference model, and uses this approach to evaluate benefits from a variety of water-based recreational activities, including recreational fishing in Alberta, Canada. Like TCM, CVM can account for substitute recreational sites and characteristics of recreational anglers, and provides appropriate measures of net economic benefits. However, unlike TCM, CVM is able to assess net economic benefits in cases where data on actual angler behavior are limited or absent.

However, as CVM studies are based on hypothetical scenarios presented in surveys, they must be conducted according to stringent standards to avoid bias, a discussed by Arrow et al. (1993).

Although applications of non-market valuation methodologies to fisheries policy issues are common, there are few applications that explicitly address fishery allocation issues. These include Berman et al.'s (1997) BCA study of net economic benefits associated with the commercial-sport allocation of Kenai River salmon, and Schuhmann and Easley's forthcoming analysis of commercial-recreational allocation in the North Carolina red drum fishery. NPFMC and ISER (1997) provide preliminary BCA estimates for the halibut fishery, yet these results are preliminary and subject to a number of important caveats, as noted above.

Limitations of Benefit Cost Analysis

As discussed above, benefit cost analysis is the appropriate means to assess net economic benefits from a fisheries allocation policy. However, actual quantification of net economic benefits associated with various halibut allocation policies may in some cases pose empirical (and some conceptual) challenges. Moreover, like all forms of empirical research, the quality of the end-results of benefit cost analysis (BCA) depends on the quality of the data and analysis methods. This section discusses some important limitations of benefit cost analysis, and identifies characteristics that may be used to identify unreliable or invalid BCA analysis.

Distribution and Equity Implications of BCA

Benefit cost analysis is capable of assessing net benefits and costs for different groups affected by fisheries policy decisions, and the distribution of benefits and costs within an affected group. However, in practice, researchers typically estimate the average benefit received by a "representative" group member, where the representative member represents an heterogeneous population. For example, a typical BCA might estimate the "average" producer surplus gain or loss to an "average" commercial fishermen, without considering the differences in impact between fishermen operating out of small rural communities and those operating out of urban centers. However, given the uneven distribution of fisheries policy benefits, aggregate net benefit measures may be considered inadequate (Swallow et al. 1994; Zeckhauser 1981). Policy-makers often wish to consider both the total benefits of a policy and the distribution of benefits across regions, population groups, and perhaps even sub-groups within particular industries. Simply put, this includes information concerning who will receive benefits from a particular policy, and where those individuals are located (Zeckhauser 1981). However, despite conclusions that information on policy implications for alternative segments of the population may be useful to policy makers (Krutilla 1981; Just et al. 1982), and that the probability of policy adoption may depends critically on the distribution of benefits across the relevant population, economists often overlook distribution and equity aspects of program evaluation, focusing instead on aggregate benefit estimates (Zeckhauser 1981).

It is important to note that this limitation, as stated, is not a limitation inherent to BCA — rather, it is a result of the common use of BCA methods. That is, economists often choose to ignore distributional issues, because such considerations can complicate empirical analyses. Despite this tendency, available BCA tools allow economists to assess the distribution of benefits across relevant population groups and sub-groups — given such information, resource managers may qualitatively consider these distinct sets of net benefits when making policy choices. The advantage of such an approach to BCA is that it makes explicit the distribution of benefits among affected groups. The primary disadvantage is that it may in some cases obscure the total net impact on social well-being.

Another potential complication of the use of BCA to address benefit distribution, or to assess benefits for specific regions, is that it raises often difficult questions which must be addressed by resource managers. For example, if a BCA is to address only certain regions or groups, managers must decide which regions or groups will be given standing. For example, in a BCA addressing net economic benefits of halibut allocation to Alaska communities, should net benefits to new in-migrants be included? Second, managers must decide whether benefits to different groups will be given equal distributional weight. Although economists generally give equal weight to net benefits received by all groups with standing, policy makers may wish to emphasize benefits received by specific groups (e.g., those in less developed rural communities). Although such choices will affect the outcome of a benefit cost analysis, they cannot be made on economic criteria alone. Accordingly, the results of a BCA will, to a certain degree, depend on *a priori* choices which determine the role of benefit distribution in the analysis (Boardman et al. 1996).

Regional Versus National Scope

Benefit cost analysis may assess net economic benefits over any chosen geographical region, whether that region is a community, a state, or an entire nation. However, the ultimate results of a BCA will likely depend on *a priori* choices regarding the geographical region over which net economic benefits will be assessed. For example, most consumers of halibut do not reside in communities in which the halibut is harvested. Accordingly, a purely regional BCA will not account for benefits and costs to those who purchase halibut products. In contrast, a larger-scale BCA may assess benefits nation- or world-wide, including consumers of halibut who do not live in Alaska communities. However, such a large-scale analysis may tend to obscure benefits or costs to a small geographical region, such as an Alaska fishing community. Although BCA has the flexibility to address net economic benefits given a wide degree of constraints on geographical region, resource managers must be aware of the implications of such constraints for BCA results. Moreover, specific types of regional constraints on a BCA may greatly complicate analyses, or result in much more formidable data requirements.

Secondary Effects in BCA

In general, benefit cost analysis does not consider secondary effects. For example, an increase in the halibut allocation for charter operators will likely generate increased economic activity and income for those industries that provide inputs or support services to the charter sector, or otherwise benefit from increased charter business (e.g., bait and tackle shops, hotels, restaurants). Appropriate BCA only considers direct impacts (e.g., net economic benefits to charter operators) and does not consider secondary effects on other industries. Although this practice often generates skepticism on the part of resource managers, it is based on observable patterns in which secondary effects are almost always offset by nearly equal and opposite effects elsewhere.

Individuals will often substitute one form of recreation for another. For example, if they do not spend time charter fishing, they may spend more time hunting, camping, or hiking. Accordingly, if an increase in charter fishing in one Alaska community results in anglers spending more money in that community's hotels, restaurants, and other establishments, that increase is almost always offset by losses in revenues at another community's hotels, restaurants, and establishments. This is because the individual has substituted time spent in the charter fishing community with time that would otherwise be spent at a community with alternate recreational opportunities (e.g., hunting or fishing for other species). Hence, the financial gain to one area's secondary businesses is generally offset by financial losses elsewhere. When one properly accounts for all secondary effects in both communities, the net economic benefit of this shift is, in general, very close to zero (Edwards 1990). Given such patterns, which are ubiquitous throughout the economy, appropriately conducted BCA does not consider secondary effects. Indeed, if secondary effects were included, the result would be an upward bias, or overestimate of changes in net economic benefits (Boardman et al. 1996).

Occasionally, anglers may choose substitute activities in regions not covered by an appropriate BCA. For example, if prevented from halibut fishing in Alaska, some anglers may travel to British Columbia to fish. In this case, some of the offsetting gains will be realized in another country—and their measurement may not be appropriate in a national scale BCA. In such cases, some of the secondary impacts may represent legitimate changes in net economic benefits, as the offsetting impacts occur in areas not covered by the BCA. *However, the existence of such situations must be established by comprehensive studies of angler behavior that provide data on substitute sites chosen by halibut anglers.* Such data on substitute sites and prices are required for appropriate models of sport-fishing demand by anglers (Morey et al. 1991; 1993; Ward and Loomis 1986). In the absence of reliable data demonstrating the rate at which anglers will visit substitute sites *outside* of the region of interest (i.e., the United States), the general assumption is that offsetting impacts will occur *within* the region of interest, and net secondary effects are accordingly assumed to be zero. That is, unless reliable data demonstrate that secondary effects are not offset within the region in which a BCA is conducted, the default assumption is that these secondary effects are negligible (Boardman et al. 1996).

Although it is appropriate, in economic terms, to ignore secondary effects in BCA, regional policy makers may wish to assess these effects in as much as they impact aggregate economic activity in a specific region. Such analysis may be conducted with the aid of Input-Output models, as discussed in Section III, and may be an important consideration when regional economic growth or activity is valued by policy makers. However, it is important to note that such measurements of secondary impact may not be interpreted as indicators of net economic benefit. Rather, they are measures of aggregate economic activity. These and other details of "economic impact analysis" are also discussed in Section III.

Measurement Issues in BCA

Simple errors in BCA may arise for many reasons (Boardman et al. 1996). One of the most common sources of errors is the result of inaccurate data — errors in observation, recording, or interpretation of events. For example, the Alaska Division of Fish & Game staff have recommended that 1998 charter log book data be verified over a three-year period to assure accuracy (NPFMC et al. 1998), suggesting that measurement errors may be suspected. Similar measurement errors may occur in the assessment of commercial harvest, standing biomass levels, or other relevant data. Clearly, measurement errors will carry over into final BCA results, leading to potential bias. An additional set of potential errors may occur in forecasting future events or trends. For example, assessments of producer and consumer surplus for halibut products depends on an accurate estimate of prices (both ex-vessel and consumer), as they will exist at the time of the policy change. Accordingly, if future prices shift unexpectedly, prior surplus estimates may not provide accurate estimates of net economic benefits. Yet another source of potential error may be generated by inappropriate behavioral or model assumptions made by researchers.

In the case of analysis of the net economic benefits of halibut allocation policies, a variety of uncertainties exist. These include uncertainty surrounding many critical parameters including biomass, future exploitation rates, by-catch rates, harvests of subsistence and unguided sport fishers, harvest efficiency (catch per unit effort), harvest costs, ex-vessel price elasticity, and the growth of the guided sport fishery (NPFMC and ISER 1997). In most cases, researchers trained in BCA can account for such uncertainty when estimating net economic benefits. For example, sensitivity analysis (Boardman et al. 1996) presents BCA results under a wide range of potential outcomes for critical parameters, allowing resource managers to view net benefit estimates under different future scenarios. Still other types of analysis may be used to forecast future trends in key parameters (e.g., ex-vessel prices), based on past patterns of change (e.g., J.L. Anderson Associates 1999). Finally, detailed models of charter and commercial fleet behavior responses to allocation mechanisms would provide information that could be used to reduce the variance (i.e., uncertainty) of net benefit estimates.

An additional set of potential measurement errors relates to specific non-market valuation methods, such as the contingent valuation method (Mitchell and Carson 1989) and the travel cost method (Freeman 1993). Each of the non-market valuation methods is covered by a large and growing literature, and each involves its own set of potential biases (Kahn 1998; Freeman 1993; Peterson and Randall 1984). Although discussion of the potential errors associated with each of the existing non-market methodologies is beyond the scope of this paper, resource managers must be aware that improperly conducted non-market valuation assessments can result in biased benefit estimates. Accordingly, non-market research must be conducted according to stringent quality standards and guidelines, such as those presented by Arrow et al. (1993) for contingent valuation analysis.

In summary, BCA is capable of generating valid and accurate benefit estimates and/or approximations, but is also subject to measurement errors and other biases. The validity and accuracy of BCA results depends on the quality of the underlying analyses and the data used by those analyses.

Intrinsic and Other "Non-Economic" Values

Assessment of net economic benefits using economic value provides an anthropocentric view of policy impacts. When valuation is used to estimate damages, resources are assumed to have value only insofar as they provide services that are directly or indirectly valued by people. Some individuals may find such assessments incomplete or misleading, in that they fail to consider "intrinsic values," or values apart from those held by people. Moreover, BCA tools are often poorly equipped to deal with moral, cultural, and similar issues. For example, it may be empirically difficult (though not theoretically impossible) to measure the "net economic benefit" associated with the culture of a viable fishing community, or a historical native subsistence fishery. In addition, legitimate economic effects may cause social impacts that are difficult to assess using benefit cost analysis. For example, the collapse of a commercial fishery in a rural village and the accompanying large-scale unemployment might lead to increased local rates of alcoholism or other social problems. Where such concerns are relevant, BCA may provide an incomplete assessment of the many factors relevant to management. Accordingly, managers should consider BCA the appropriate tool for measurement of net economic benefits, but only one of many tools relevant to ultimate policy decisions.

III. Input-Output Analysis: Income Based Measures of Economic Impact

Input-output models (I-O) provide a snapshot of the financial linkages among sectors in a regional economy. In simple terms, I-O tracks monetary payments as they move through a regional economy — measuring the transfer of money from one group (sector) to another. Often described as "economic impact analysis," I-O seeks to estimate changes in gross output, income, and/or employment resulting from exogenous changes, including changes in government fisheries policy (Lipton et al. 1995; Hushak 1987; NPFMC and ISER 1997). For example, the commercial software package IMPLAN allows I-O analysis of changes to a broad range of sectors in regions across the United States, and may be supplemented with data to allow analysis of the "economic impact" of policies applied to different fisheries sectors (Steinback 1999). Although the following section focuses on I-O analysis, similar findings apply to other methodologies that may be loosely described as "economic impact" models.

Economic impact and I-O analysis provide familiar measures of "economic" change resulting from fisheries policy, and have been applied to past fisheries policy issues (e.g., Andrews and Rossi 1986; Steinback 1999; Hushak 1987; Institute of Social and Economic Research 1996; NPFMC and ISER 1997). As noted by economists and I-O practitioners alike, I-O may be appropriately used as a tool in regional planning, and is often used by regional industries and governments to assess the impact of fishery regulations on the distribution of income and employment (Edwards 1990). However, despite its common use in assessing aggregate economic impacts of fisheries policy decisions, *I-O is not a substitute for benefit-cost analysis, and does not provide an estimate of the net economic benefits of policy changes* (Lipton et al. 1995; Jin and Hoagland 1998). I-O may be used in conjunction with a properly performed benefit-cost analysis to provide additional information regarding income distribution among industry sectors. In addition, I-O can be conducted in *partial* fulfillment of National Standard 8 of the amended Magnuson-Stevens Fishery and Conservation Management Act, which requires review of the regulatory impacts on fishing communities (Steinback 1999). However, I-O cannot be used in isolation to determine the most socially beneficial (or productive) allocation of any fishery stock. Moreover, the distribution of *income* among industry sectors (as forecast by I-O) does not have any particular quantitative link to the distribution of *net economic benefits* among sectors. As stated by NPFMC and ISER in their 1997 regulatory impact review of management alternatives for the guided sport halibut fishery: "Economic impacts differ from net benefits in that they measure the changes in the distribution of *economic activity* [emphasis added] between communities, and are not necessarily designed to find optimal solutions" (p. 6-9).

Insights Provided by I-O Models

In-depth coverage of the technical details and appropriate use of I-O is provided elsewhere (Miller and Blair 1985). This paper focuses on the question of its use as an economic tool to assess fishery allocation decisions. As noted above, I-O focuses on regional change in output, income, and employment, measured in terms of financial transfers to various sectors. For industries interested in forecasting the aggregate income or employment changes that will result from both direct and indirect effects of specific policy changes, I-O can provide useful insights. Likewise, I-O provides insights regarding the production of "new income," total economic activity, and economic growth resulting from fisheries policy changes (Hushak 1987). I-O can also provide insight regarding the self-sufficiency of an economy — measuring the extent to which changes in fishery harvest allocation will result in spending on imported inputs and outputs versus spending on local products. Finally, I-O may be used to supplement an appropriate benefit cost analysis (BCA), providing information on financial flows, the distribution of income, and impacts on secondary industrial sectors not addressed by a properly conducted BCA.[17] Indeed, some resource managers and economists encourage policy makers to review the results of both I-O and BCA, prior to making policy changes (NPFMC and ISER 1997).

However, despite the common tendency to associate income and financial transfers with net economic benefits, I-O analysis does not measure economic or net regional benefits, and does not measure the well-being of coastal communities or regions. Although the results of I-O are often inappropriately used as a substitute for the estimation of net economic benefits, these results are in fact measures of raw economic activity (Lipton et al. 1995; Hushak 1987). For this reason, I-O or economic impact analysis cannot be used to determine the allocation of fish stocks or other fisheries policy actions that would result in the greatest net economic benefits to national, state, or regional residents, and is an inappropriate tool for prescribing the "best" allocation of harvest rights from an economic perspective. Not surprisingly, the inappropriate use of I-O analysis as a surrogate for benefit-cost analysis, along with common mistakes in interpreting I-O results, can produce biased and misleading policy prescriptions. The inappropriate use of I-O is fostered by modern computer packages, which may allow analysts with minimal training to conduct regional I-O analysis at relatively low cost (Steinback 1999).

Elements and Assumptions of Input-Output Models

As noted above, a key distinction between the results of input-output analysis (I-O) and those of benefit cost analysis (BCA) is that I-O measures *aggregate economic activity* (i.e., dollar measures of the total flow of money between industry sectors), while BCA measures *net economic benefits* (i.e., total economic benefits minus total economic costs). To illustrate the difference between measures of economic activity and measures of net economic benefits, it is useful to understand the basic elements and assumptions of I-O analysis. This section briefly describes input-output, or economic impact analysis; discusses the appropriate uses of the information provided by these models; and describes limitations and misuses of I-O in the assessment of fisheries allocation policies.[18]

An I-O analysis is based on a "parsimonious accounting of financial links among industries, households, export markets, and, often, the public sector." (Edwards 1990, p. 10). Primary financial links between sectors are defined as **input** links or **output** links. Input links capture payments for resources or products that are intermediate in the production of a final product purchased by consumers. Output links represent financial payments for final products, generally from consumers to industries. Other types of linkages may capture taxes and other transfers involving the public sector. Industries within a given region are divided into somewhat homogeneous "sectors," where each sector has similar inputs and outputs. Based on survey or other data, links are specified among industry sectors and among consumers and industries. Distinction is made between households in a given region and those outside the region. A critical distinction is also made between payments for imported inputs and outputs, and payments to inputs and outputs produced within the region.

At the most fundamental level, results of I-O analysis are based on the tracking of monetary payments as they move through a regional economy. For example, production of a product by an industry sector (e.g., production of recreational fishing trips by charter boat operators) requires monetary payments to other (secondary) sectors to purchase inputs (e.g., bait and tackle, boat fuel). These secondary sectors then use those funds to hire labor, pay the owners of productive assets, purchase inputs from still other industries, etc. In this way, money is "recycled" through the economy, producing income for various sectors as is travels through the economy. A **transactions flow table** is used to record these linkages, and to track financial transfers. This table, along with derived multipliers, may be used to forecast the income changes for any industrial sector (or for the entire regional economy) that will be generated by exogenous changes to any other sector (Edwards 1990; Hushak 1987). However, note that the I-O analysis is determined solely by the flow of money. Accordingly, if an economic change does not result in money changing hands, it is not reflected in an I-O analysis.

Leakage from the regional economy occurs when money is spent on imports (or otherwise is paid to a sector that removes it from the local economy) or is saved by households. All else being equal, the greater number of times that a dollar earned by an industry sector is "recycled" before "leaking" from the regional economy, the greater is the income generation attributed to that dollar. Accordingly, I-O may also be interpreted as a measure of the self-sufficiency of a regional economy (Edwards 1990). For example, in a highly self-sufficient economy (i.e., one with few imports) an additional dollar earned by an industry sector will likely have a relatively large impact on regional income, because the dollar will change hands many times within the economy before being spent on imports (i.e., leaking from the economy). In a less self-sufficient, more "open" economy, the same dollar would most likely be forecast to have a lower impact on regional income. The estimated economic impact of a halibut allocation policy change will also "depend … on the definition of 'local'" (NPFMC and ISER 1997, p. 6-9). For example, if the local economy is defined on a very small scale (e.g., a small community such as Chignik), the estimated economic impact of any policy change will likely be small, as nearly all industrial and consumption inputs are imported from outside the local economy. However, if the local economy is defined over a larger scale (e.g., the Puget Sound region of Washington), estimated economic impacts of the same policy change will be much larger, as more industrial and consumption inputs will be purchased from local sources (NPFMC and ISER 1997).

Within an I-O analysis, effects of an exogenous fisheries policy change on income and production are defined in terms of three levels of effect: 1] direct effects; 2] indirect effects; and 3] induced effects (Edwards 1990). **Direct effects** of an increase in production of one sector (i.e., an increase in production that might be generated by an increase in the harvest allocation for a particular fisheries sector) reflect the direct purchase of inputs from other sectors within the economy. This initial increase in demand generates **indirect effects** as these secondary industries re-spend the resulting dollars for inputs into their production processes over several rounds of economic activity, effectively recycling the same dollars. **Induced effects** capture the secondary labor-consumption effects, as new income earned by labor and payments to the owners of capital and natural resources is spent on new products, again creating a feedback loop through which money again is recycled within the economy (Hushak 1987; Miller and Blair 1985). The following table is distilled from Steinback (1999), and illustrates the type of economic impact estimates generated by an I-O analysis.

Table 1. Summary of Total Economic Impacts Generated From Party and Charter Fishing in Maine. Source: Steinback (1999)

Category	Total Angler Expenditures	Direct Impact	Indirect Impact	Induced Impact	Total Impact
			Sales		
Nonresident	$1,117,336	$646,318	$227,280	$163,891	$1,037,489
Resident	$275,750	$143,860	$50,880	$29,819	$224,559
Total	$1,393,086	$790,178	$278,160	$193,710	$1,262,048
			Income		
Nonresident	$1,117,336	$194,516	$105,912	$92,713	$393,141
Resident	$275,750	$41,106	$22,948	$17,451	$81,505
Total	$1,393,086	$235,622	$128,860	$110,164	$474,646
			Jobs		
Nonresident	$1,117,336	31.1	3.8	3.7	38.6
Resident	$275,750	8.3	0.8	0.8	9.9
Total	$1,393,086	39.4	4.6	4.5	48.5

Interpreting the results of Table 1, a total of $1.39 million in total expenditures for party and residential fishing in Maine generated total regional sales of $1.26 million, total regional income of $474,646, and 48.5 "new" jobs. These results are also broken down into the impacts of expenditures by residents and non-residents, and into direct, indirect, and induced effects as explained above. If one accepts the assumptions of the underlying IMPLAN I-O analysis, these estimates indicate the aggregate economic activity that is generated by party and charter fishing in Maine (Steinback 1999), after all spending and re-spending of money by various sectors is complete.

Once the recycling of money is complete (i.e., the spending and respending of dollars resulting from a policy change), the overall income resulting from all rounds of spending may expressed by different types of output or income **multipliers** (Edwards 1990). The standard output multiplier reflects the "overall, or total effect of a change in final expenditures on regional production, divided by the initial, direct effect, where the total effect is the sum of the direct, indirect, and sometimes, induced effects" (Edwards 1990, p. 12). Various different types of multipliers exist, with different interpretations. For example, some multipliers are expressed in terms of regional incomes, while others are expressed in terms of regional employment. However, each is based on the fundamental idea of the "recycling" of dollars within a regional economy, and a financial accounting of the resulting transfers.

Limitations and Misuses of Input-Output Analysis

The principal reason that I-O is not an appropriate normative tool for fisheries allocation decisions is that it does not measure economic benefits. Although this limitation is well-known by experienced practitioners of I-O (Hushak 1987; Jin and Hoagland 1995), it is often ignored by interested parties who may wish to use I-O results to argue for specific policy alternatives. As described earlier, economic benefits are comprised of benefits to consumers (consumer surplus) and benefits to producers (producer surplus). Total economic performance is increased when the sum of surpluses is increased. I-O models do not measure benefits to consumers, and (although an industry's income subsumes producer surplus) do not accurately measure benefits to producers. I-O analysis simply measures economic transfers — the shift of money from one group to another — the overall benefit of which, in general, is zero (Edwards 1990). This does not suggest that I-O does not have legitimate uses. However, the measurement of economic benefits, efficiency, or community well-being is not one of these legitimate uses.

Why Input-Output Analysis Does Not Measure Net Economic Benefits

Although the fact that I-O analysis does not measure net economic benefits is well-known to experienced I-O practitioners (e.g., Steinback 1999; Hushak 1987), it is often questioned by those less familiar with the methodology. Accordingly, this section outlines some of the primary reasons why I-O does not measure net economic benefits.

- *Input-output analysis does not consider opportunity costs of vessel operators.*

Opportunity cost is defined as the value of the highest-valued alternative use of resources that are used in a given economic activity (Gwartney and Stroup 1997). For example, the owner of a halibut charter vessel does not have to pay additional money to use the vessel itself in the halibut fishery — he already owns the vessel. However, there is an opportunity cost in that the vessel could be used in another sport fishery, such as the salmon fishery.[19] An economic agent (such as a vessel owner) will only engage in an activity if the economic returns from that activity exceed the opportunity costs. For example, a rational vessel owner will only use a charter vessel in the halibut fishery if the resulting economic returns in the halibut sport fishery are higher than those available in other fisheries, during the specific time period in question. Opportunity costs are thus a key element in determining economic behavior and economic benefits (Sutinen 1980).

Input-Output analysis does not account for opportunity costs, because these costs do not appear as financial transfers. The relevance of this insight to fishery allocation may be illustrated by the following stylized example. Assume that a commercial halibut long-liner operates out of a small rural fishing village. Given the equipment available on the vessel, the facilities of the rural port, and entry restrictions in other fisheries, this commercial fisherman may have few significant income earning possibilities other than halibut fishing. In other words, the opportunity cost of halibut fishing is low. A charter boat owner operating out of an urban port, however, may have greater options — there may be a variety of sport fisheries in which the boat could operate. Hence, the charter operator has high-value options, and a high opportunity cost. Similar examples are provided by Sutinen (1980).

Even assuming that both vessel operators earn an identical financial return (e.g., $50,000 in pre-tax accounting profit), the true *economic* gain of the commercial fisherman is greater, because he has lower opportunity costs. Put another way, if regulators were to prohibit both operators from fishing for halibut, the commercial fisherman would be worse off. Although both operators would lose $50,000 in initial income, the charter operator could regain much of that loss in another fishery, while the commercial operator might have few other options. This difference is reflected in the *opportunity cost* of fishing — it indicates the value of available options (Sutinen 1980). Because I-O analysis only considers financial transfers, it ignores opportunity costs, and cannot consider the potential value of alternate options available to different groups of vessel operators.[20] This distinction is important when one considers fishermen or charter operators in small rural communities, where alternative employment options are limited.

A more extreme implication of the absence of opportunity costs is that natural disasters such as oil spills or toxic waste pollution appear to generate net regional *benefits* from an I-O perspective, because they generate regional expenditures on clean-up and restoration (Edwards 1990; Grigalunas and Congar 1995). However, few would argue that oil spills or toxic pollution increase the well-being of society, because the money spent on clean-up could otherwise be spent on other goods and services valued by consumers. Moreover, pollution reduces the value that producers and consumers obtain from fish. A more appropriate analysis of social benefits, as reflected in a full-scale benefit cost analysis, would account for these opportunity costs, and would thus reflect the social losses generated by natural disasters (Edwards 1990).

Aside from illustrating the importance of opportunity costs in an economic analysis, such counter-intuitive results of I-O underscore a more critical limitation of the methodology. That is, according to I-O analysis, *all changes that increase the flow of money within an economy will appear to have positive impacts on income and jobs, even if those changes are the result of a natural disaster with massive net economic losses* (Grigalunas and Congar 1995). Accordingly, a large oil spill, which generates massive clean up costs and net economic losses to society, still appears to generate new income and employment — and appears to be a positive change from an economic impact perspective.

- *Input-output analysis is based on static patterns of labor and inputs.*

Within a regional economy, a portion of all wages is paid to resident laborers; this money is "recycled" within the economy as the residents spend their earnings on local goods and services. However, a portion of wages is paid to non-residents; this money is generally removed (leaks) from the regional economy. I-O analysis is based on a current snapshot of labor and input use patterns, and assumes that this pattern remains constant regardless of policy changes. Largely as a result of this characteristic, I-O does not (in general) appropriately account for changing labor patterns, and may overestimate total impacts on regional income and jobs to residents. This is particularly likely in cases where the economy is close to full-employment.

To illustrate, assume that a change in fisheries policy results in the commercial sector being given a relatively larger allocation of the halibut harvest. Accordingly, the sector will likely demand more inputs and labor. As stated by Hushak (1987, p. 446): "If final demand for a sector increases, however, it is not necessarily true that each of the processing sectors from which inputs are purchased […including regional labor…] will expand to provide the increase in inputs demanded by the given sector. If they do not expand, the necessary inputs (labor) will be imported. The activity instead "leaks" out of the region. In regions where capital and labor are fully employed, much of these indirect effects and even the direct effect is likely to come through regional imports." Standard I-O models do not account for these shifts in labor or other resource use patterns, and thus often overestimate the amount of economic activity that remains in a local economy (Kuehn et al. 1985; Hushak 1987).

An important concept in economic analysis is that new jobs only provide real economic benefits if the newly employed workers were previously unemployed regional residents (McConnell and

Brue 1992). If workers simply move from one employer to another, or if they are hired from outside the regional economy, the new jobs do not represent an economic benefit to the region.[21] In fact, the influx of new laborers that accompanies some policy changes can lead to net decreases in quality-of-life for local residents, as a result of new traffic, congestion, and pressure on natural resources. I-O analysis does not recognize these critical distinctions, and therefore overestimates the economic gain associated with "new" income and jobs.

- *Input-output analysis does not measure benefits to consumers of fishery products.*

Recall, the benefit to the consumer of purchasing any good (e.g., fresh halibut from a fish market, a sport fishing trip for halibut) is the difference between that which the consumer would be willing to pay for the good, and that which the consumer actually pays. This difference is measured as *consumer surplus*, as discussed above. Because I-O only measures the financial transfer from consumers to producers, or amount that consumers pay for goods (without consideration for the actual *value* of the goods to consumers), it totally disregards the net benefits received by consumers (Edwards 1990; Hushak 1987; Grigalunas and Congar 1995). Accordingly, any benefits received by sport fishermen or consumers of halibut will be overlooked by a pure I-O analysis.

- *Input-output analysis does not measure offsetting impacts.*

Money cannot "disappear" from the economy. If it is not spent in one area of the broader economy, then it must be either saved or spent in another area of the economy. For example, if fishery allocation policies result in sport anglers spending less money on recreational halibut fishing, they will likely spend more money on other forms of recreational activity (e.g., hunting, camping, recreational salmon fishing, etc.). If grocery shoppers cannot purchase fresh halibut, they will likely purchase another type of seafood. This is based on the economic concept of *substitution.* In general, if one fishery sector in a region loses income as a result of a fisheries allocation policy, other sectors in the region (or sometimes outside of the region) will gain income (Edwards 1990). These "offsetting impacts" generally negate the **indirect** and **induced** effects measured by I-O analysis — this is why benefit-cost analysis does not measure these effects. Largely due to offsetting impacts, "…there is no particular relationship (even in algebraic sign) between changes in net social [i.e., national] benefits … and changes in regional incomes." (Scott 1984, p. 253; Edwards 1990). Of course, those interested in economic benefits in a single region may place little importance on offsetting losses in other regions or in the broader national economy. However, in many cases, offsetting effects may occur within a single region. Because standard I-O does not account for offsetting impacts, it may overestimate economic impacts on a region's producers.

Common Misinterpretations of I-O Results and Data

The above-mentioned limitations of input-output analysis in fisheries policy analysis are well known to regional economists and I-O practitioners (Kuehn et al. 1985; Steinback 1999; Hushak 1987). For example, as stated by Steinback (1999, p. 7):

"…[benefit cost analyses] determine the economic value to society of an activity by evaluating both costs and benefits. In doing so [benefit cost analysis] considers whether resources

> are being put to their best use. Economic impact assessments [e.g., I-O] on the other hand, are conducted to describe *financial gains and losses of management actions by identifying how economic activity changes within each sector*." [emphasis added]

Accordingly, the limitations mentioned in the above paragraphs apply to all I-O, even those analyses conducted according to the most stringent quality standards. However, additional problems occur if an I-O analysis is not properly conducted, if the data is of poor quality, or if the results are misinterpreted. This section addresses common mistakes in I-O analysis.

Common Mistake #1: Misuse of multipliers

I-O multipliers are used to transform an initial direct effect on income or expenditures into an estimate of aggregate impact on income or employment that accounts for all spending and re-spending within the economy. However, many resource managers have only a vague understanding of the inner workings of an I-O model (Steinback 1999), leading to potential misinterpretations and misuses of I-O multipliers (Edwards 1990). Although an in-depth discussion of I-O multipliers is beyond the scope of this paper, a simple example is used to illustrate the importance of appropriate multiplier use.

The common **output multiplier** indicates the change in total economy output generated by a change in the output of a specific sector. An output multiplier of 1.5 for commercial fishing indicates that a $1 increase in expenditures for output from the commercial fisheries sector requires $1.50 in output from the entire regional economy, including the commercial fishing sector (Edwards 1990). However, policy makers are often interested in impacts on regional income instead of total output, leading to the use of the common **ratio multiplier.** This multiplier is generated by dividing the **total income effect** of an exogenous change by the **direct income effect**. Using Steinback's (1999) analysis of Maine fishing as an example (see Table 1), a direct income effect of 0.15 indicates that for every additional dollar of resident expenditure on recreational fishing, the recreational fishing industry itself earns $0.15 dollars of income. A total income effect of 0.30 indicates that after all spending and re-spending is complete, the total effect on total regional income of that same dollar of expenditure is equal to $0.30. In this case, the ratio multiplier would be 0.30/0.15 = 2.0.[22]

The common mistake is that policy makers often confuse the **total income effect** (0.30) with the **ratio multiplier** (2.0). That is, they improperly multiply a direct change in *expenditure* by the ratio multiplier, seeking the ultimate change in total regional income. In fact, if one wishes to calculate the final impact on regional income of a change in expenditure (for a specific sector), the appropriate multiplier is the direct income effect discussed above (0.30) — also known as the **Keynesian multiplier**. Improper (yet common) use of the ratio multiplier in this case leads to significant overestimation of true income effects (Edwards 1990). This misuse of the ratio multiplier may be encouraged by programs such as IMPLAN, which do not automatically calculate Keynesian multipliers (Steinback 1999).

Even if multipliers are interpreted correctly, caution must be exercised in their use because all multiplier projections are based on a region's current industrial structure and linkages, and further assume sufficient productive capacity within the region to satisfy the predicted increase in final expenditures (Kuehn et al. 1985; Steinback 1999). To the extent that these assumptions do not hold, I-O multipliers will provide biased estimates of economic activity. Moreover, the extent to which a multiplier accurately forecasts economic impacts will depend on the extent to which the underlying I-O model data represents future conditions and linkages in the region of interest, which depends on the source of I-O data (Kuehn 1985). For example, I-O models based on extensive (and often expensive) regional surveys are considered more representative and accurate than those based on non-survey average data (Kuehn 1985).[23]

Common Mistake #2: Using national instead of regional data.

Pre-packaged I-O models such as IMPLAN allow estimates of regional economic impacts. However, such national-scale models often include data and assumptions drawn from national data samples. That is, some of the sectoral relationships and input-output patterns assumed to apply to a specific region are actually based on data gathered from a national sample. For example, IMPLAN assumes national average production coefficients and margins (Steinback 1999), unless alternate data is specified by the end-user. In some cases, national averages may be sufficient to explain regional economic activity. However, in other cases, significant bias may result, particularly if the region of interest does not conform closely to national average production patterns. Accordingly, users of pre-packaged I-O analysis "must be willing to accept these [national assumptions] and estimation methods or have the ability to incorporate user-supplied data to improve the accuracy of their impact estimates" (Steinback 1999, p. 9).

Common Mistake #3: Using average instead of marginal data.

I-O analysis is based on a "snapshot" of industry input and output linkages at a single point in time (Kuehn et al. 1985). That is, it is based on the average use of inputs and sale of outputs by the various sectors in the model. However, it is well known that the actual *marginal effects* of changes in fishery policy on various industries may diverge from the *average effects*. For example, as noted above, the common IMPLAN I-O model uses average production coefficients and margins to assess economic impacts (Steinback 1999). However, the relationship between physical inputs and outputs may change, as the production rate of an industry changes (Kuehn et al. 1985). Accordingly, average production coefficients will likely differ from the applicable marginal coefficients — leading to biased economic impact estimates. As stated by Steinback (1999, p. 23), "the effective use of the IMPLAN system for conducting regional EIA's [economic impact analyses] may well depend on users' abilities to incorporate additional survey data, [and] adjust region-specific technological coefficients." That is, I-O users must either supply their own data and/or models to improve the accuracy of the I-O results, or accept potential biases implicit in the use of average data by IMPLAN and other pre-packaged routines.

The use of average instead of marginal data also has potential impacts on the implications of job creation, as predicted by an I-O model. As noted above, I-O is based on current average employment patterns. However, there is no guarantee that current patterns of employment will be maintained as different industries expand or contract. For example, new jobs in one fisheries sector (i.e., the charter fishery) might be filled by workers previously employed in other fisheries sectors (i.e., the commercial fishery). Such changes in employment patterns are not captured by the snapshot of financial linkages upon which standard I-O models are based, unless specifically programmed by the I-O practitioner.

IV. Benefit Cost Analysis vs. Economic Impact Analysis (I-O)

The following table summarizes benefit cost analysis and I-O analysis, as applied to fisheries allocation decisions.[24]

Table 2. Comparison of Input-Output Analysis and Benefit Cost Analysis

	Input-Output Analysis	Benefit-Cost Analysis
What it measures:	Indicators of total economic activity, including changes in total income, jobs, and expenditures.	Changes in net economic value, including value to producers and consumers of fishery goods and services.
Regional Scope:	Can be conducted for specific regions or nationwide.	Often measures net social benefits on a national scale, but can measure regional benefits as well.
Accounts for the Value of Alternative Uses of Resources?	No-opportunity costs are ignored.	Yes-opportunity costs are a key component.
Measures Net Economic Benefits to Consumers?	No-benefits to consumers are not considered. Consumers enter analysis only as a source of expenditures.	Yes-estimates consumer surplus.
Measures Net Economic Benefits to Producers?	Not directly, but I-O results may be used to provide an approximation of producer surplus.	Yes-estimates producer surplus.
Assesses changes in social well-being resulting from changes in fishery policy?	No	Yes
Accounts for Changes in Labor and Input Use Patterns?	No-based on a static snapshot of labor and input use patterns.	Yes-can account for changes in labor and input uses.
Accounts for Indirect and Induced Effects?	Yes-these effects are critical, even though they may be offset by counter-effects in other regions.	No-these effects are assumed to be negligible, given likely offsetting effects.
Accounts for Offsetting Impacts?	No	Yes
Assesses the net economic return generated through use of a fishery stock (economic efficiency)?	No	Yes
Considers Distribution of Revenues and Expenditures?	Yes-considers distribution of impacts on income and employment.	Generally no, but can be used to assess benefits and costs to different groups.
Considers Role of Time in Economic Activity?	No	Yes

Common Myths Regarding the Use of Economic Information in Fisheries Allocation

Given the previous descriptions of Benefit Cost Analysis and I-O analysis, it is possible to discuss and debunk some common but fallacious "economic" arguments used for various types of fishery allocation policies. The following paragraphs discuss ten common myths associated with the measurement of net economic benefits for fisheries applications.

Myth 1: The harvest allocation that produces the most income or revenue is preferred from an economic standpoint.

Fact 1: This myth is discussed in depth by Edwards (1991). In general, this myth is propagated by a general confusion over what constitutes economic value. As discussed above, the economic value of revenue or gross income cannot be ascertained without information concerning opportunity costs, or alternative uses of productive assets. Also, recall that revenue to one group is simply an expense to another group — the simple transfer of money does not create economic value. The difficulty with this argument is best illustrated by the "oil spill" example, in which an event such as the 1989 *Exxon Valdez* oil spill brought hundreds of millions of dollars of revenue to those involved in the clean up of the oil, as well as additional revenue to area hotels, restaurants, etc. Nonetheless, the *Valdez* oil spill did not create economic value.

Myth 2: Since consumer surplus doesn't involve the transfer of "real" money, it does not represent a real economic value and should not be used in fishery allocation decisions.

Fact 2: Again, this myth is based on confusion over the meaning of economic value. The true consumer value of a fishery product is the difference between the "worth" of that product to a consumer (what he would be willing to pay to obtain it) and the amount of money that is actually paid. Edwards (1991) provides examples which substantiate the value of consumer surplus as a measure of true economic value. For example, a consumer who receives a "free gift" of a tuna steak or a fishing trip will have a legitimate value for these products, even though his expenditure is zero. Under the common "expenditures as value" argument, the value of these products would be zero. Also, when the price of fish products decreases, consumers feel better off, because their consumer surplus has increased. Under the "expenditures as value" argument, price decreases would result in lower values, and would be *opposed* by consumers. Clearly, this is not the case.

Myth 3: The activity that involves the most dockside expenditures must have the highest economic value, and should be given the higher allocation.

Fact 3: This argument suffers the same problems as the "revenue" argument discussed above. Revenues and expenditures are simply the flip side of the same monetary transfer — the net value of which is zero (Edwards 1991). The *Exxon Valdez* oil spill resulted in vast expenditures, yet did not create economic value for society. In contrast, a gift of a "free" fishing trip creates real value for the recipient, even if no money changes hands. Economic value and financial transfers are not identical, and financial transfers cannot be interpreted as a measure of well-being.

Myth 4: The sector with the highest total value for fish harvests should be granted 100% of the allocation.

Fact 4: As discussed in detail by Edwards (1990; 1991), the allocation decision must be viewed from a marginal perspective. From an economic perspective, one must consider whether a marginal (i.e., small) shift in allocation from one sector to another will increase or decrease total social value. Because the marginal value of fish allocation (i.e., the value of the last fish allocated) will differ depending on the total allocation to each sector, regulators must consider the net economic effects of successive small changes in allocation. For example, if commercial fishermen are allocated more and more of the total harvest, the market for halibut will become more saturated with fish, and the price will decrease. Hence, as more of the allocation shifts, the economic value of the new (commercial) fish to society declines. At the same time, reductions in the charter harvest will make halibut fishing trips more scarce, and the value of the few remaining trips will increase markedly. Regulators must balance, on the margin, the value of harvest allocation gained by one sector with the value of harvest lost by another sector.

Figure 2. Marginal Benefits of Halibut Allocation: A Simple Illustration

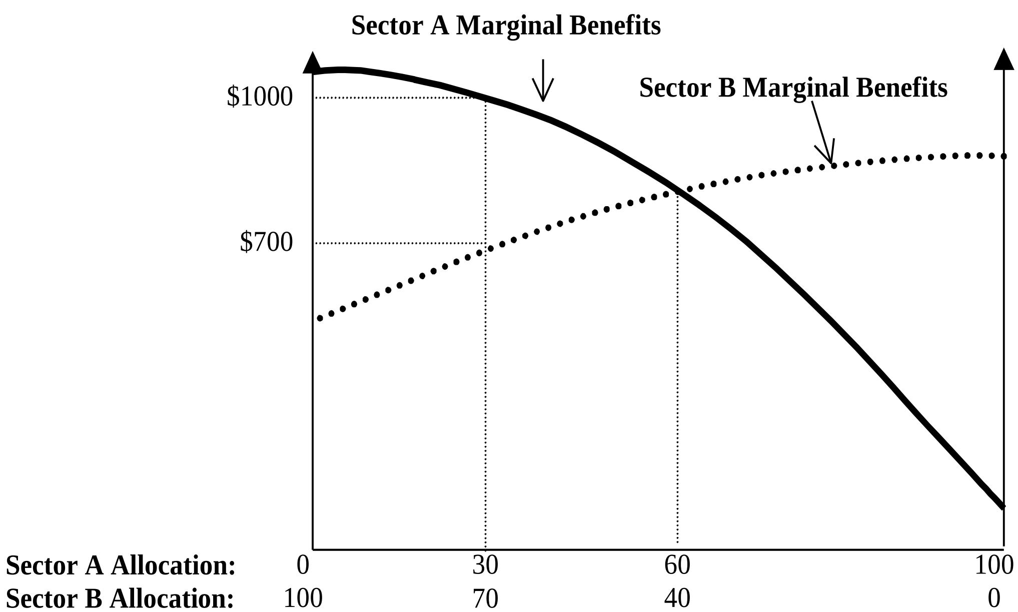


Figure 2 above illustrates the fundamental concepts of marginal benefits and costs, based on a hypothetical allocation of 100 tons of harvest. The solid bold curve represents the marginal benefits of each additional (marginal) ton of harvest, to Sector A. The dashed bold curve represents the marginal benefits of each additional (marginal) ton of harvest, to Sector B. For example, the 30th ton of halibut is worth $1000 to Sector A, while the 70th ton of halibut is worth $700 to Sector B. At this potential allocation point, the benefits of an additional ton of halibut allocation to Sector A is greater than the benefits of an additional ton of allocation to Sector B—this is indicated by the height of the marginal benefit curve for Sector A, which is at this point higher than the marginal benefit curve for Sector B. Accordingly, society would benefit from a policy that would allocate more halibut to Sector A and less to Sector B. However, this pattern is reversed for any allocation that provides greater than 60 tons to Sector A—beyond this point, a marginal ton of halibut provides greater net benefits to Sector B. The allocation point that provides the maximum net economic benefits is the point at which the net economic benefit from the marginal ton of halibut is equal for both Sectors. In Figure 2, this point is characterized by a 60 ton allocation to Sector A and a 40 ton allocation to Sector B. Movement in any direction from this optimal point results in greater losses to one sector than are gained back in benefits to the other sector. Note that this optimal solution cannot be identified without reference to the marginal benefits of additional halibut allocation to each group.[25]

Myth 5: The allocation that produces the most jobs is best, especially in small rural communities.

Fact 5: Recall, the value of a job depends on many factors — and the value of the same type of job can differ markedly between regions. In the extreme, if the economy is in full employment and wages do not change, the economic value of a job to existing residents is zero, because the new workers must be imported from outside the region. In contrast, if many workers are unemployed, the value of jobs to those workers may be substantial. One cannot simply add up the number of jobs created and use this sum as a proxy for economic value — one must consider the economic value of jobs created (which may be zero or close to zero), added to the economic value represented by consumer and producer surplus.

Myth 6: Benefit cost analysis cannot consider the distribution of benefits — and therefore ignores potentially devastating economic effects on small rural fishing communities.

Fact 6: Although BCA practitioners often ignore the distribution of economic benefits to simplify the analysis, an appropriately conducted BCA *can account* for the distribution of benefits among regions and different effected groups. Indeed, by accounting for the value of alternative uses of scarce resources (i.e., alternate employment opportunities for commercial or charter operators, or alternate fisheries), benefit cost analysis explicitly accounts for differences in opportunities available in small rural fishing villages.

Myth 7: Although benefit cost analysis provides more exact measures of net economic benefits, the use of I-O as a substitute is acceptable where I-O may be conducted at lower time and money cost.

Fact 7: Many policy and academic publications (e.g., NPFMC and ISER 1997; Steinback 1999) emphasize the ease of use of computerized I-O routines such as IMPLAN. Experienced users of I-O tend to treat such ease of use with suspicion, as it may lead to widespread use of I-O by those untrained in its proper use and interpretation (Steinback 1999). However, in other cases, I-O is promoted as a quick, inexpensive substitute for BCA — perhaps not equivalent but acceptable if the data for a BCA is questionable or not readily available. However, despite its potential ease of use, *I-O is not a substitute for BCA*. Policies based solely on the results of I-O can actually reduce the total economic value that residents derive from publicly owned halibut stocks (NPFMC and ISER 1997). Recall, I-O analyses will often show *positive* income and employment effects of major disasters such as oil spills. Moreover, the ease of use of I-O by untrained individuals often leads to misinterpretations and misuses of I-O results, as detailed above.

Myth 8: Because benefit cost analysis is case-specific and subject to so many uncertainties, input-output analysis provides more reliable and accurate results, particularly when generated by standardized programs such as IMPLAN.

Fact 8: Both BCA and I-O are subject to potential uncertainties and biases. However, the uncertainties and potential biases of I-O are often obscured by the use of pre-packaged computer software such as IMPLAN. Like all economic analysis, the accuracy of the end results of an I-O model will depend on the accuracy of model parameters. Where BCA is subject to measurement and other sources of error described above, I-O is based on national average production coefficients and other parameters that may not apply equally to all regions and all situations. Accordingly, I-O will not necessarily provide more accurate or reliable results. Note also, as described above, that I-O and BCA results characterize different aspects of socioeconomic consequences, so it is not strictly possible to "compare" quantitatively the results of I-O to those of BCA.

Myth 9: An appropriate measure of net economic benefits should include impacts on secondary industries such as restaurants, motels, retail shops, and similar businesses.

Fact 9: As described above, secondary effects of fisheries policy changes are almost always offset by nearly equal and opposite gains or losses elsewhere in the economy. For example, a gain in restaurant business in Valdez, Alaska due to an increase in halibut charter business will almost always be offset by similar losses in restaurant business in other communities that offer substitute recreational services (e.g., hunting, salmon fishing. etc.). Accordingly, it is *not appropriate* to count secondary effects as *net economic benefits*. Policy makers may wish to consider implications for the regional distribution of income associated with these secondary effects, as forecast by an I-O model. However, it is important to recognize that such impacts have no quantifiable relationship to net economic benefits.

Myth 10: Non-market valuation methods such as contingent valuation do not provide appropriate measures of net economic benefits, because they are not based on actual market transactions.

Fact 10: Non-market valuation methods such as contingent valuation provide appropriate measures of net economic benefits. For example, the appropriateness of contingent valuation estimates for informing government policy has been formally supported by an NOAA Blue Ribbon Panel of Experts (Arrow et al. 1993). Like all forms of empirical analysis, non-market analysis must be carried out according to stringent research standards, or the resulting benefit estimates will be subject to considerable bias (Arrow et al. 1993; Mitchell and Carson 1989; Grigalunas and Congar 1995; Freeman 1993). When conducted according to proper standards, however, contingent valuation and other forms of non-market analysis can provide appropriate measures of net economic benefits or losses resulting from fishery allocation policies (Arrow et al. 1993).

V. Guidelines for Policy Analysis

Based on the previous discussions, the following guidelines should be followed when using economic information to assess halibut allocation options.

1) Input-Output (I-O) analysis should not be used as a substitute for benefit cost analysis (BCA). Net economic benefits are the appropriate indicator of the economic consequences of a fisheries allocation policy—these benefits are measured only by benefit cost analysis.

2) When combining the results of BCA and I-O to inform policy, the net economic benefit estimates generated by BCA should be given greater emphasis, compared to the economic activity estimates of I-O. When choosing the appropriate economic tool to assess economic consequences of halibut allocation policies (or any fisheries policy), BCA should be selected over I-O.

3) Where possible, benefit cost analysis should include new research *specific* to the halibut allocation decision in the Gulf of Alaska. Benefit estimates "transferred" from studies conducted in other regions, or for other fisheries, will often misrepresent the net economic benefits associated with halibut allocations in the Gulf of Alaska.

4) Benefit cost analysis should be conducted according to careful professional standards to avoid bias and misuse, and should be conducted by experts familiar with the specific BCA methods in question. Moreover, presentation of BCA results should make clear the potential limitations associated with the data and methodologies applied.

5) Where possible, sensitivity analysis should be conducted as part of a BCA, to illustrate the range of potential outcomes for net economic benefits to different groups.

6) Presentation of BCA results should be accompanied by explicit discussions of the groups to which benefit estimates apply. Where BCA results are aggregated over all stakeholder groups, this aggregation should be made explicit.

7) Information concerning net economic benefits (generated by BCA) is meaningful in its own right, without reference to I-O results. However, economic activity estimates (generated by I-O) can be misleading without reference to appropriate measures of net economic benefits.

8) If policy-makers wish to consider the results of I-O, these results must be interpreted properly within an economic framework. Specifically, it should be made clear that I-O results do not have quantifiable implications for net economic benefits or regional well-being.

9) If policy-makers wish to consider the results of I-O, pre-packaged routines such as IMPLAN should be tailored to the specific conditions of the region, by an expert familiar with the appropriate use and interpretation of I-O results.

10) Any presentation of I-O results should be supplemented with a discussion of real economic benefits. Specifically, the discussion should make clear the distinction between I-O results

and measures of real economic benefits, to avoid the common confusion between measures of economic activity and economic benefit.

11) Presentation of job creation estimates from I-O should be supplemented with discussions of the local employment context, and information concerning the estimated number of jobs that will be taken by previously unemployed workers.

12) Any discussion of I-O "multiplier" effects should include an explicit discussion regarding the assumptions implicit in the underlying analysis. Researchers must ensure that multipliers are used and interpreted properly. Finally, distinction should be made between the measures of economic activity measured by multipliers and measures of net economic benefits which are *not* related in any measurable way to I-O multipliers.

13) The net economic benefits of changes in halibut allocation should be assessed on a marginal basis. To identify the allocation that offers the greatest net economic benefits, researchers must assess the costs and benefits associated with sequential marginal changes in halibut allocation.

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VI. Endnotes

[1] Harvests in the early to mid-1990's ranged from 34-53 million pounds (Knapp 1997).

[2] Smaller Gulf of Alaska communities include Ahkiok, Akutan, Angoon, Atka, Belkofski, Chenega, Chenega Bay, Chignik, Chignik Lagoon, Chignik Lake, Craig, Elfin Cove, False Pass, Hoonah, Hydaburg, Ivanof Bay, Kake, Karluk, Kasaan, King Cove, Klawock, Klukwan, Larsen Bay, Metlakatla, Nanwalek/english Bay, Ninilchik, Old Harbor, Ouzinkie, Pelican, Perryville, Port Graham, Port Lions, Sand Point, Saxman, Seldovia. Tatitlek, Tyonek, and Yakutat. Communities not included in this list are included in the group of larger communities (Alaska Commercial Fisheries Limited Entry Commission 1999a).

[3] For example, preliminary log book data indicates 5.16 million pounds of charter harvest from areas 2-C and 3-A (Merrigan 1999).

[4] See definition of Optimum Yield in the Act (Section 3).

[5] See National Standard 8 of the Act (Section 301).

[6] A vast literature reviews these benefit cost methods, their conceptual basis, estimation issues and data requirements, assumptions, and limitations. References on this broad subject include: Mitchell and Carson (1989), Braden and Koldstat (1991), Freeman (1993), Dixon et al. (1994), Grigalunas and Congar (1995); Sassone and Schaffer (1978), and Peterson and Randall (1986).

[7] For example, the culture and atmosphere associated with an active fishing industry may provide benefits to local residents, even if they are not directly involved in fishing, simply because they derive satisfaction from the knowledge that an active fishing community exists.

[8] More technically, consumer surplus is an approximation of exact Hicksian welfare measures (Johansson 1987; Just et al. 1982).

[9] When calculating the total cost of a fishing trip to an angler, one must include all costs, including money paid to charter operators, money spent on bait and other consumable fishing supplies, and money spent in travel, and the opportunity cost of anglers recreation time, as described by Freeman (1993).

[10] Opportunity costs capture the net value of alternative uses of capital and other resources owned by the charter operator. For example, in order to use a vessel for halibut charter fishing, the operator gives up net benefits that might be gained through alternate uses of that vessel. These foregone benefits are one of the economic costs of charter halibut fishing, in that they represent real economic benefits given up as a result of operating in the halibut charter industry.

[11] However, in some cases, profits and producer surplus may be close approximations.

[12] For additional details on the calculation of producer surplus in the commercial fishery, see Edwards (1990) or most textbooks addressing fisheries economics topics (e.g., Iudicello et al. 1999; National Research Council 1999; Kahn 1998; Anderson 1986).

[13] Of course, there are a great many complications which must be addressed when applying the concepts of labor economics to benefit cost analysis (McConnell and Brue 1992). For example, in some cases, the secondary impacts generated by a newly employed in-migrant may represent a small but real economic benefit in a *regional* BCA—in that the offsetting secondary impacts would occur outside of the region in which the analysis is conducted. Sassone and Schiffer (1978) discuss the role of secondary effects in *regional* BCA. Such effects disappear in a national or wide-scope BCA. However, as discussed by Boardman et al. (1996), even in regional BCA, the counting of secondary effects is questionable. For example, any new benefits associated with the income of a new in-migrant would likely be at least partially offset by the regional costs imposed by new residents. For these reasons, even

regional BCA rarely includes secondary effects, including secondary effects associated with the incomes of new in-migrants.

[14] The legal context created by the Magnuson-Stevens Act prohibits discrimination against citizens (workers who are U.S. citizens) from different regions of the nation, suggesting that all citizen workers should be included in BCA of halibut allocation decisions. Accordingly, in a national-scale BCA, the issue of in-migrant labor is largely mute. In this case, the only relevant issues are the prior employment status of those taking new fishery jobs, and the impact of policy decisions on wage levels. However, in a regional-scale analysis, the prior employment status of new in-migrants is irrelevant, as these new workers are not given stake in the regional BCA analysis.

[15] One must subtract from these wages the opportunity cost of time for the unemployed workers, which in many cases is considered minimal. In the case of under-employed workers, one must subtract both the wages earned in their previous employment, plus the opportunity cost of the additional hours to be spent working in the fishery.

[16] If all prices and all wages increase to the same degree in any economy, the net buying power of individuals will remain constant, and net economic gain resulting from the inflationary wage increases will be zero.

[17] It is important to recognize, however, that these I-O results, in isolation, do not have any measurable implications for community well-being or net economic benefits. They cannot determine the allocation of fishery harvests that will provide the greatest economic gain to society, or to any industrial sector in isolation (Edwards 1990).

[18] Those interested in more detailed coverage of I-O methods are referred to marine and fisheries applications of I-O (e.g., Hushak 1987; Jin and Hoagland 1998; Andrews and Rossi 1986; Steinback 1999), and textbooks concerning I-O analysis (e.g., Miller and Blair 1985).

[19] Evidence suggests that operation in numerous fisheries is common in both the charter and commercial fisheries sectors in the Gulf of Alaska, given variations in the open seasons for specific species and the expected net benefits of fishing for specific species during specific times of the year (North Pacific Fishery Management Council et al. 1998; Gemmell 1999, personal communication).

[20] This example is simply meant to illustrate the interpretation of opportunity costs. It is NOT meant to suggest that an appropriate economic analysis would necessarily favor commercial fishermen.

[21] If wages increase significantly, then the amount of the average wage increase may represent a benefit in certain circumstances.

[22] These results are calculated from the estimates shown in Table 1. For example, 0.149 = 41,106 / 275,750, or the direct income effect of resident expenditures divided by total resident expenditures. The number 0.149 is rounded to 0.15 for simplicity of presentation.

[23] IMPLAN is an example of an I-O package for which several key components are based on non-survey for example, the I-O estimation is based on national average production coefficients (Steinback 1999).

[24] The information presented in these tables is compiled from Edwards (1990), Hushak (1987), Jin and Hoagland (1998), Andrews and Rossi (1986), Grigalunas and Congar (1995), Miller and Blair (1985) and Tyrrell and Harrison (1999), based on a similar table presented in Edwards (1990).

[25] In general, if a sector is allowed to operate without restrictions, it will continue to do so until the net marginal benefits of fishing (or guiding fishing trips) are equal to zero. That is, an effectively unrestricted commercial or charter sector will continue to operate until the benefits from additional operation (harvest) are equal to zero. Moreover, as the harvest of a sector declines (i.e., as its allocation shrinks) the net marginal benefits will often increase, holding all else constant.