REVIEW OF ECONOMIC LITERATURE AND RECOMMENDATIONS FOR IMPROVING ECONOMIC DATA AND ANALYSIS FOR MANAGING COLUMBIA RIVER SPRING CHINOOK

DRAFT

A Report to Oregon Department of Fish and Wildlife in fulfillment of ODFW Agreement No. 005-4132S-Wild

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27 December 2005

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EXECUTIVE SUMMARY

This report addresses the use of economic analysis to support decisions on the allocation to recreational and commercial fisheries of upriver wild spring Chinook impacts. It addresses this question through a review of existing economic literature related to Columbia River spring Chinook and to the concepts of valuation, impacts and allocation.

Charge to the Committee

The charge to the review committee is to evaluate the state of knowledge on the economics of Columbia River fisheries, with emphasis on the spring Chinook fishery. The evaluation is to use the best available information to:

- Explain basic economic concepts related to natural resource valuation, impacts and allocation,
- Summarize previous work specific to the Columbia River fisheries,
- Apply previous studies to frame the use and applicability of fisheries economics to current Columbia River fishery allocation decisions

Structure of the Report

The report comprises six sections:

1. Introduction
2. Economic Concepts Related to Fishery Allocation
3. Review of Literature on the Economics of Columbia River Salmon
4. Application of Existing Literature to Impact Allocation
5. Conclusions and Recommendations
6. References

Section 1. Introduction

This section describes the methods used to prepare this report. It also includes brief descriptions of the elements that form the context of economics and Columbia River spring Chinook impact allocation. These elements are the upriver spring Chinook impact allocation, the legal framework, economic characteristics of spring Chinook fisheries, economics and allocation.

Two additional sections describe the charge to the reviewers and the structure of the report.

Section 2. Economic Concepts Related to Fishery Allocation

This section addresses the first charge to the reviewers to explain basic economic concepts related to natural resource valuation, impacts and allocation. It summarizes general concepts of valuation, benefits and costs, net economic

value, and the economic allocation rule. Methods for valuing commercial and recreational fisheries are discussed. Impact analysis is described, with a summary of current guidance regarding its application and interpretation. Cost effectiveness analysis is also described.

Section 3. Review of Economics Literature Related to Columbia River Salmon

This section addresses the second element of the review charge: to summarize previous work specific to the Columbia River fisheries. The review of existing literature on commercial fisheries valuation, recreational fisheries valuation, and impact analysis finds a number of limitations related to data, assumptions, methodologies, and estimation procedures. For both commercial and recreational fisheries economic data is incomplete and only sporadically collected. The paucity of cost data presents a particular problem. Analysts are often compelled to use "rules of thumb" and multiple assumptions that lead to error and uncertainty in their estimates and weaken the applicability of analytical results. The lack of documentation of data and methods and the absence of data collection protocols and analytical methods are problems across many studies.

Section 4. Application of Economics to Allocation Questions

This section addresses the third element of the review charge: to apply previous studies to frame the use and applicability of fisheries economics to current Columbia River fishery allocation decisions. The general question we answer through a series of specific questions is *whether the existing information is sufficient and specific to the allocation question for Columbia River spring Chinook*. We find that in sum, the analyses are inadequate for economic decision making in the spring Chinook allocation question.

What does the literature tell us? The literature indicates that both the recreational and commercial salmon fisheries on the Columbia River, and specifically the spring Chinook fishery, generate positive net benefits and generate positive economic impacts. Each study, however, has limitations related to data, assumptions, methodologies, and estimation procedures. Remarkably few economic studies have evaluated the allocation of Columbia River salmon in general, and spring Chinook specifically.

What does the literature not tell us that is important to know? Several important pieces of economic information are not provided by the literature. There is no complete analysis of the economics of the commercial and recreation salmon fisheries, including spring Chinook. No valuation study has been conducted specifically for Lower Columbia River spring Chinook which is of adequate quality to evaluate economic benefits. Impact analyses do not demonstrate clear expenditure differences between the two sectors.

Is the data current and adequate for analysis? In general the data is neither current nor adequate in quantity or quality for analysis to support management decision making. Protocols for standardized economic data collection do not exist. Data collection and analysis is sporadic and often spurred by policy and economic emergencies. The sporadic conduct of studies and the use of non-standardized and non-specific data can result in "speculative" extensions which are unsupportable by the data.

Are similar methods used in analyses? There are no standard methodology protocols across studies and different studies address different questions. As a result, it is difficult to aggregate data, integrate research, and compare results across species, regions, and time. It also makes it difficult to compare market and non-market studies and account for error and biases across studies

Are available analyses designed to answer the questions asked in this review? The general answer is no. We provide more specific answers through three questions focused at valuation, impacts and allocation.

- Valuation Question -- Are the fish inherently more valuable in one sector than in another? The studies reviewed in this report do not support the contention that spring Chinook are inherently more "valuable" in the recreational or commercial sector. Existing work is too limited to answer this question.

- Impacts Question -- Can we compare the economic importance of sectors? Both commercial and recreational sectors generate positive economic impacts. Depending on market conditions, these impacts may be relatively similar. A more important question may be the distribution of these impacts.

- Allocation Question -- Can economics inform decisions about allocations? Yes. Both value-based and impact analysis, if properly supported with relevant and timely data, can provide useful information for understanding economic implications of allocation decisions. Useful analysis will require far better data than is presently available.

Section 4 also discusses common areas of misinterpretation and misuse of economic analyses.

Value versus impacts: Economic valuation and economic impact assessments measure different things. The results of one cannot be compared with another or used as respective surrogates.

Interpreting economic impact studies: Impact analyses provide a measure of the regional impact of economic activity associated with fishing. However, failure to document underlying assumptions limits the ability to assess the reasonableness of the type or size of reported multipliers as well as the general interpretation of results.

Substitution effects: Assumptions about the possibility of substitutes are critical to the analysis of changes in net benefits or impacts from a given change in regulation.

Application of multipliers: Multipliers are used for estimating economic impacts. They are not used to estimate economic values. Output multipliers larger than 2.5 should be carefully scrutinized.

Gross versus net benefits (revenues): Assigning value on the basis of benefits or revenues alone (without costs) leads to exaggerated results.

Lump-sum tradeoffs: "All or nothing" thinking ignores the importance of marginal changes in value. Efficient allocations are determined on the basis of incremental tradeoffs in net economic values.

Benefits transfer: Applying or "transferring" measures of economic benefits or value from one fishery to another is of limited usefulness unless there is a high degree of similarity among fisheries.

Stated preference: These approaches to valuing recreational fisheries, such as contingent valuation, are highly prone to bias. Because valuation is only "contingent," and not actual, people have an incentive to shape their responses to influence the results.

Revealed preference: These approaches to valuing recreational fisheries, such as the travel cost method, are highly sensitive to the way the models are constructed.

Section 5. Conclusions and Recommendations

The concluding section addresses the charge to provide a framework for the use and applying fisheries economics for allocation decisions. These conclusions and recommendations highlight the basic economic data and information needed to improve decision making and the approaches that the Oregon Department of Fish and Wildlife (ODFW) could use in integrating economic and social concerns into the management process, and the basic economic data and information needed to improve the decision making process. A total of eight recommendations are presented.

Five recommendations are made to improve the integration of economic and social concerns into the management process:

1. The ODFW should develop a research plan to define the basic set of economic data needed to assess commercial and recreational in-river fisheries, the core analyses to be conducted using that data, and a schedule for developing each on a routine basis.

2. The quality and timing of economic data collection and analysis should be better integrated into the management cycle. A research plan that outlines the core set of routine data collection and analyses will assist this integration.

3. A decision framework should be developed that integrates economic analysis into the broader management system.

4. ODFW should sponsor a workshop of economists for the purpose of developing an economics research plan for Columbia River fisheries.

5. ODFW should appoint an economist and other social scientist to the Columbia River Technical Advisory Committee or another committee providing science advice on Columbia River fisheries.

Since ODFW works closely with other Columbia River fish management partners, it would be desirable if these actions were taken together with those partners, rather than independently by ODFW.

We make three recommendations to improve the basic economic data and information informing the decision making process.

6. Given the long-standing needs of the entire Columbia River for relevant economic information on salmon fisheries, we recommend that a process for economic data collection be developed in a public-private partnership. The process would implement the data collection and analysis components of the research plan recommended in 5.1.1.

7. We recommend the development of a set of performance indicators that would reflect the objectives for economic performance of Columbia River salmon fishery management, the identification of routine data collection over these indicators, and the associated development of a plan for routine performance evaluation. This could be done in conjunction with the development of the research plan.

8. We recommend that objectives for economic performance of Columbia River fisheries be systematically evaluated consistent with legal and statutory requirements, and that a process be developed to ensure that plans for data collection and economic analyses stay current with changes in economic questions and issues.

Finally, we remark on the role of economics in the allocation question. The complexity and variability of the economic issues facing Columbia River fisheries make it impossible to find a stable economically "right" allocation. As complexity grows over time, so too will the difficulty of determining the economically best allocation. An exploration of alternative management tools, including markets for transferable user rights, would be worthwhile.

1. INTRODUCTION

Spring Chinook salmon contribute to the ecosystems, cultures, and economies of the Columbia River Basin. The history of Columbia River spring Chinook, like the history of salmon worldwide, illustrates the conflict between conservation, cultural and food values of Indian fisheries, commercial fisheries, recreational fisheries and competing economic developments including hydropower, transportation and irrigation. The challenge of conserving salmon stocks in the Columbia River is not unique and parallels efforts across the entire Northern Hemisphere (Lichatowich 1999; Taylor 1999; Blumm 2002; Montgomery 2003; ISAB 2005).

Mortality from commercial and recreational fishery harvest and harvest bycatch is only one of several sources of the total mortality experienced by spring Chinook salmon over its life cycle. But it is perhaps the most visible and controllable, affecting salmon that have survived to maturity and are returning to their natal rivers to spawn (ISAB 2005). Harvest impacts on protected wild fish become a vital control point in their recovery. Extensive fishery management processes exist to manage these impacts, and the continuing harvest opportunities of many commercial and recreational fishers depend on the degree to which this management is successful.

1.1 Methodology

The Director of ODFW contacted the Institute for Natural Resources (INR) on November 7, 2005 and asked whether Oregon University System faculty could assist the Department by developing a report for the Oregon Fish and Wildlife Commission on the economics of Columbia River spring Chinook fisheries. A meeting was held with ODFW staff on November 10, 2005 to discuss the scope of work for the project. INR recruited an interdisciplinary team of faculty members with expertise in the area to form the review team. Biographies of the review team are provided in Appendix 1. They developed an outline for the

report. Faculty research assistants at INR performed a literature review under the direction of the review team. They also obtained ODFW background documents. All documents were posted on a website for ease of access by the review team.

INR contacted ODFW to get a list of stakeholders in Columbia River fishery allocation. A list of these stakeholders and other experts contacted is attached as Appendix 2. Each person was asked to identify literature pertaining to (1) the economics and allocation of Columbia River fisheries, and (2) the economics and allocation of fisheries in other areas. They were also asked to identify any other experts that should be contacted. All literature sent to the review team was posted on the website if it was available in electronic form. All other documents are available at INR. The reference list in Section 6 of this report is divided for convenience into literature providing background and context on Columbia River fisheries, Columbia River salmon economics and general economic concepts and methods.

The review team prepared the draft report during December 2005 in order to provide it to the Fish and Wildlife Commission before its January 6, 2005 meeting. Due to the short time period for report preparation, we have not yet been able to circulate the report to reviewers.

1.2 Upriver Spring Chinook Impact Allocation

Commercial fisheries in the lower river need an upriver impact allocation to allow economically viable catch levels in target fisheries. Recreational fisheries in the mainstem also need an upriver impact allocation to maximize their fishing opportunities when spring Chinook are most abundant (WDFW/ODFW 2005).

The mechanism for managing harvest impacts on upriver spring Chinook is the "impact allocation." Impacts are defined as "the unintended mortalities of incidentally caught and released upriver wild spring Chinook. Impacts to listed fish are calculated as the percentage of the total listed population that represents mortalities as the result of fishing" (WDFW/ODFW 2005).

Now part of the 2005-2007 *U.S. v. Oregon* Interim Agreement, the impact allocation is based on a 2001 agreement on treaty Indian/non-Indian allocation of upriver spring Chinook that provides for a sliding scale harvest rate of upriver spring Chinook based on total upriver spring Chinook run size and ESA listed run size. The non-Indian allocation of impacts on Endangered Species Act (ESA)-listed upriver spring Chinook ranges from a low of .5% (for upriver runs <33,000) to a high of 2% (for upriver runs >82,000). The impact limit is shared between the Lower Columbia non-Indian commercial fishery and the mainstem recreational fishery (WDFW/ODFW 2005) with a small number of impacts to fisheries above McNary Dam.

The non-Indian portion of the upriver catch was not formally allocated among commercial and recreational fisheries until 2002. The current arrangement of sharing impacts was adopted in 2004. The formula is based on the determination of preseason impacts to guide management of specific fisheries as well as in-season transfers of impact allocations to reflect changing conditions in the fisheries (WDFW/ODFW 2005).

1.3 Legal Framework

A complex judicial and administrative scheme regulates the harvest of Columbia River salmon and steelhead. Ordinarily, regulation of these fisheries would be a state matter. Starting in 1915, however, Oregon and Washington recognized the need to manage Columbia River fisheries concurrently. They adopted the Columbia River Fish Compact, which was ratified by Congress in 1918. It established an interstate agency to allocate in-river commercial harvests. Neither state can act unilaterally to affect detrimentally the common right of licensees of the other state to take fish from the Columbia. Oregon and Washington jointly adopt seasons and rules.

In 1968, the Supreme Court held that Indian tribes with treaty rights to fish may not be limited by state regulations that infringe on those rights. Following this decision, the Federal District Court for the District of Oregon in the case *United States v. Oregon* became the forum for allocating the harvest of fish that enter the Columbia River system. The court retains continuing jurisdiction. Harvest quotas are set by Oregon and Washington after negotiations with the treaty tribes and the federal government and adopted with court approval. A Technical Advisory Committee advises the *Oregon* court.

By the late 1980s, the tribes, states and federal government reached agreement on a harvest plan for co-management of Columbia salmon and steelhead. The Columbia River Fish Management Plan (CRFMP) largely replaced annual litigation over conservation and harvest management of the shared Columbia River salmon resource. The CRFMP has expired and the parties are negotiating a new plan. The “2005-2007 Interim Management Agreement for Upriver Chinook, Sockeye, Steelhead, Coho and White Sturgeon” controls fishery management until a new plan is adopted and approved by the court (WDFW/ODFW 2005).

Outside the three-mile limit, ocean fishing is regulated by the federal government under the Fishery Conservation and Management Act of 1976 (FCMA). The FCMA establishes the Pacific Fishery Management Council (PFMC), which is composed of representatives of Washington, Oregon, California and Idaho, one representative of the Indian tribes, and the federal government. 16 U.S.C. § 1852 (a)(6). The PFMC develops a regional fishery management plan which must be consistent with applicable law, including Indian treaty rights, and must consider the regulations of coastal states. 16 U.S.C. §§ 1853(a)(1)(C); 1853(b)(5).

Starting in 1991, several evolutionarily significant units of salmon and steelhead in the Columbia Basin were listed as threatened or endangered under the ESA (Williams 2005). Upper Columbia spring Chinook were listed as endangered in 1999. The listings further complicated fishery management since the ESA prohibits "take" of listed species. The National Marine Fisheries Service became a key decision maker in harvest management because through the ESA consultation process and resulting biological opinions which authorize "incidental take." Without the biological opinions all commercial and recreational fishers would have to obtain incidental take permits (Blumm 2002). The *2005-2007 Interim Management Agreement* addresses ESA requirements for Indian and non-Indian fisheries.

The Oregon Fish and Wildlife Commission (OFWC) is responsible for implementing the policies and programs of the state for the management of wildlife (which includes fish). The Commission is to do so consistent with the overall state wildlife policy which is to provide the optimum recreational and aesthetic benefits for present and future generations of the citizens of this state, ORS 496.012. The Commission is directed to:

> "represent the public interest of the State of Oregon and implement the following coequal goals of wildlife management:
> . . . . . .
> (3) To permit an orderly and equitable utilization of available wildlife.
> . . . . . .
> (6) To provide optimum recreational benefits.
> (7) To make decisions that affect wildlife resources of the state for the benefit of the wildlife resources and to make decisions that allow for the best social, economic and recreational utilization of wildlife resources by all user groups."

The OFWC also has an express duty to protect, preserve, propagate, cultivate, develop and promote all fishes under its jurisdiction, ORS 506.036. The policy for food fish, which include all salmon, is:

> "to provide the optimum economic, commercial, recreational and aesthetic benefits for present and future generations of the citizens of this state. In furtherance of this policy, the goals of food fish management are:
> . . . . . .
> (3) To permit an <u>optimum and equitable utilization</u> of available food fish.
> . . . . . .
> (5) To regulate food fish populations and the utilization and public enjoyment of food fish in a manner . . . . . provides <u>optimum commercial and public recreational benefits</u>.
> (6) <u>To preserve the economic contribution of the sports and commercial fishing industries</u> in a manner consistent with sound food fish management practices.

(7) To develop and implement a program for optimizing the return of Oregon food fish for Oregon's recreational and commercial fisheries." ORS 506.109 (emphasis added).

In the only case to interpret this provision, the Oregon Court of Appeals said that the statute "requires the balancing of various competing interests and give the Commission broad discretion in implementing policies to reach the legislature's articulated goals." *Schlip v. Oregon Fish and Wildlife Commission,* 75 Or. App. 462, n. 5 (1985). The court agreed with the Commission that nothing in the statute requires that historical allocations to users or seasons be maintained. *Id.* at 465.

In summary, in making harvest allocations between recreational and commercial fisheries in the Columbia River system, the OFWC is bound by the terms of the *2005-2007 Interim Management Agreement* under *U.S. v. Oregon* in order to meet federal statutory and treaty obligations. With that allocation as a given, the OFWC has broad discretion under Oregon law to decide what allocation between recreational and commercial fisheries represents the public interest. ORS Chapters 496 and 506 both direct the Commission to consider economic factors along with social, recreational, aesthetic and resource management factors. As noted by the court in *Schlip,* the legislature has required the Commission to balance various competing interests as it makes fishery management decisions. Since Oregon and Washington must act jointly to determine the allocations, the Commission provides guidance to ODFW staff in how the staff should carry out negotiations for the actual management agreement with the State of Washington.

1.4 Economic Characteristics of Spring Chinook Fisheries

Spring Chinook heading upriver are large, bright and strong fish with a high fat content - they are highly prized both as a recreational catch and as a premium product in food service and retail markets. These characteristics of upriver spring Chinook place harvest opportunities at a premium. Intense competition among commercial and recreational fishers for these fish illustrates not only how highly they are prized but also the complex nature of the fisheries and their valuation.

Although it is usual to think of commercial and recreational fisheries as producing different types of values, these values are not entirely exclusive. Commercial fisheries emphasize market values – revenues to the fishery, incomes of fishers, and the impacts of their expenditures – but they also entail non-market values associated with job satisfaction, stability, flexibility, food provision and minimal conflicts.

Recreational fisheries emphasize non-market values – satisfaction of the recreational experience, subsistence and gourmet food, stability, and flexibility – but they also produce market values through angler expenditures and the impacts of these expenditures.

To talk about value is to talk about net benefits (revenues minus costs), and these can be represented at different levels and for different attributes. Value can be produced at the individual, business, or social level. Fishery management is generally concerned with the social value produced by a publicly owned resource - net social benefits. The determination of which fishery or combination of fisheries produces greater value to society is an empirical one that varies across fisheries and changes over time. There is no general answer. The weighting of values ultimately is a political determination to be made in policy bodies such as the Oregon Fish and Wildlife Commission, within their broader management mandates.

1.5 Economics and Allocation

What can economics bring to the allocation decision? Allocation is the essence of economics: the sharing of scarce resources among competing uses. As one type of allocation problem, the question of allocating limited impacts on ESA protected stocks and associated harvest among commercial and recreational fisheries on the Columbia River points directly to the key economic concepts that arise from economics: valuation, impacts and distribution, all under variable conditions. Information on the value of commercial and recreational fisheries, on the economic impacts generated by these fisheries, and the distribution of those impacts can all help inform the management decision about allocation.

The joint staff document (WDFW/ODFW Oct 19, 2005) describes different measures of success for the mainstem non-Indian fisheries. Three primary measures of success are identified for the recreational fishery: season length, angler trips, and catch which, taken together, produce angler opportunity and catch rates. Two primary measures of success are identified for the commercial fishery: total landings and price per pound, which taken together produce gross revenues.

These measures of success indirectly describe how people within these fisheries value them. They also underlie the societal valuation of these fisheries, their economic impacts, and the distribution of their impacts. But information representing a more comprehensive understanding of “success” and “values” is often incomplete and limits our ability to improve economic benefits and social welfare.

In contemporary management these limited measures of success combine with advocacy and public testimony to form the current economic information base informing management decisions. In particular, these measures inform the decision of the OFWC, and ultimately the Compact, regarding the “best” way to share a specified allocation impact among commercial and recreational fisheries.

The purpose of this review is to examine the larger information base of economic data, analyses and reports and to assess the utility of that information for further informing the allocation decision.

1.6 Charge to the Reviewers

The review committee is asked to evaluate the state of knowledge on the economics of Columbia River fisheries, with emphasis on the spring Chinook fishery. The review is to use the best available information to:

- Explain basic economic concepts related to natural resource valuation, impacts and allocation,
- Summarize previous work specific to the Columbia River fisheries,
- Apply previous studies to frame the use and applicability of fisheries economics to current Columbia River fishery allocation decisions

1.7 Structure of the Report

The report is structured in the following way. Section 2 reviews key economic concepts related to fishery allocation: valuation, impacts and cost-effectiveness. Section 3 reviews the existing literature related to the economics of Columbia River salmon, including studies of commercial and recreational fishery valuation, and economic impact analyses. Section 4 examines the degree to which the existing literature applies to the question of impact allocation. This section includes a discussion of how existing studies can be used to inform decision making as well as discussion of common areas of misinterpretation and misuse of economic analyses. Section 5 concludes the report through a series of recommendations regarding how economic and social concerns could be better integrated into management and how economic data and analysis can be used to improve management decisions.

2. ECONOMIC CONCEPTS RELATED TO FISHERY ALLOCATION

Economic analysis helps decision makers decide how fisheries resources can best be used by providing a way to assess: (1) the creation of benefits under various management actions; as well as (2) the impact of those actions on local, regional and national economies.

Best practices for these two types of economic assessment are discussed extensively in the fishery economics and environmental management literature. Unfortunately, these methods are often poorly applied. This can occur because the economic question being asked is not clearly stated, and baseline information is either unavailable, piecemeal or not current. It can also occur because the two types of assessment are confused with one other.

This section describes the concepts of valuation, impacts, and cost-effectiveness and highlights key considerations in their application to the determination of the best use of the Columbia River's fisheries resources.

2.1 Valuation, Impacts and Cost-Effectiveness

2.1.1 Valuation

The more something is valued the more people are willing to pay for it. People are willing to pay more for a pound of fresh wild caught Columbia River spring Chinook than they are for a pound of Chilean farmed Chinook. Similarly, recreational fishers are willing to travel much further to catch a large spring Chinook, incurring higher costs in doing so, than they are willing to travel to catch a small cutthroat trout.

The satisfaction people get from consuming store-bought spring Chinook or from catching a spring Chinook is called "use value". People are also willing to pay today for the opportunity to buy or catch fish in the future. This is called "option value". Some people may never consume or fish for spring Chinook but are willing to pay something toward the conservation of wild fish stocks or to maintain viable fishing communities. This is known as "existence value".

The allocation question centers on use value. Allocation of harvest or impacts between commercial and recreational fishers has no direct bearing on existence and option values. However, these values may apply to fisheries if people feel strongly that there should always be some commercial and recreational fishing for spring Chinook and are willing to pay for their continuation.

2.1.1.1 Benefits and Costs

To calculate the net economic value to society of recreational and commercial fishing we need to understand both the benefits and costs of these activities.

Benefits are the consumers' maximum willingness to pay for marketed fish or to catch the fish themselves. In deciding their willingness to pay consumers consider factors such as quality, quantity and their personal satisfaction gained from eating or catching the fish. Maximum willingness to pay is equal to an individual's expenditure on fish or fishing plus any extra amount they would be willing to pay above this expenditure to buy the fish or go fishing. Most people are willing to pay a little bit more for a pound of fish than they actually expended, or are willing to pay a bit more to go fishing than they actually expended . This extra amount, or "consumer surplus" can be measured by conducting economic analysis (Holland 2002).

The resource cost of commercial and recreational fishing is the value of

productive resources such as labor, capital and fish stocks used in harvesting the fish. Resource cost is another term for "opportunity cost." Economists use these terms to distinguish the value of resources in acquiring some good or service, compared to the direct monetary expenditures incurred in acquiring that same good or service. For example, the true resource cost of catching a fish includes the cost of equipment, labor and fuel, and the cost of providing hatchery fish to replace the harvested fish. Opportunity costs may also include the loss of benefits associated with growth and reproduction if the fish were allowed to escape. Some financial expenditures such as taxes are not resource costs because they are a redistribution of income for fishers to society as a whole (Holland 2002).

If a few economic rules are followed, such as having active markets and checking that relatively small changes in the availability of a resource do not change prices (for example, the price of fuel doesn't change in Astoria for small boats when more Chinook are running) then expenditures can be used as proxies for resource costs (Holland 2002.)

2.1.1.2 Net Economic Value

Once the total benefits and costs of commercial and recreational fishing have been estimated, the net economic value of each activity can be calculated. This is the final measure produced in cost-benefit analyses. Net economic value is the total benefit produced by the fishing activity minus its total costs.

2.1.1.3 The Economic Allocation Rule

Having determined net economic value for commercial and recreational fishing, fisheries managers are, in principle, in a position to allocate the spring Chinook fishery between commercial and recreational fishers on economic grounds.

The allocation that generates the most benefits for society is the one that maximizes net economic value across the two sectors. For example, assume recreational fishers have proposed that any extra 1000 spring Chinook be allocated to them from the commercial fisher share. Assume this increases the net economic value of recreational fishery by $35.00 a fish for a total gain in net economic value for the sector of $35,000. Now suppose the net economic value of a commercial caught fish is $40.00. The loss of net economic value to the commercial sector is $40,000. The change in net economic value to society is $35,000 minus $40,000. In this example, society is worse off overall by $5,000 because the proposed reallocation produces negative net benefits.

We recognize that allocation decisions are not this simple. Nevertheless so long as net economic values are being estimated following standard economic procedures (for example, see Edwards 1990, 1991 and Hundloe 2002 for excellent technical guides to calculating net economic values for recreational and

commercial fisheries) questions about whether or not a reallocation from one fishing sector to another makes society better off can be evaluated in a systematic manner (Blamey 2002).

2.1.1.4 Valuing Commercial Fisheries

The gross benefits of commercial fishing are in practice measured using the ex-vessel price and poundage of commercially caught fish. This is the gross value of the fish without processing, preparation and the marketing services needed to bring the fish to the supermarket, fish shop or restaurant. The ex-vessel fish is the closest product to the fish caught by the recreational sector (Holland 2002).

Once gross benefits have been estimated the private and social costs of fishing have to be subtracted from them to derive the net economic value of commercial fishing.

The private and social costs of fishing can be estimated using cost-earnings surveys. Data on cost and earnings needs to be updated regularly so that changes in structure of the sector can be taken into account. This is especially important if the fishing fleet is undergoing a rationalization or restructuring. The confidential nature of this data requires extra care in how it is collected and used.

Table 2.1 shows the type of information that should be collected in a cost-earnings survey.

Table 2.1: Data needed to calculate the net economic value of commercial fisheries:

Gross benefit:	• The ex-vessel price of spring Chinook sold multiplied by the weight of fish sold.
Private costs of fishing	• Fuel • Crew Payments • Repairs and Maintenance • Insurance • Interest • Freight and marketing • Leasing • Depreciation • License fees and levies
Public costs of fisheries management	• Fisheries management costs not cost recovered from the industry such as hatchery costs • Subsidies

Source Holland (2002).

2.1.1.5 Valuing Recreational Fisheries

Guided recreational fishing
The economic value of guided recreational fishing can be calculated in a manner similar to the economic value of commercial fishing. The gross willingness to pay is the average price paid per trip times the total number of guided trips. The private and public costs are identical to those of the commercial sector.

Unguided recreational fishing
Valuing unguided recreational fishing is challenged by the absence of a market for non-guided recreational fishing from which to determine anglers' willingness to pay.

In the absence of market prices, three approaches have been developed to value unguided recreational fishing: revealed preference, stated preference and benefits transfer.

Revealed Preference: The revealed preference approach is based on actual angler behavior and is particularly suited to recreational activities such as fishing. The most common approach is the Travel Cost Method (TCM), which uses the travel and related expenditures of anglers to reveal their willingness to pay for fishing. People fishing for spring Chinook in the mainstem have residences which are different distances from the Columbia River. The travel cost approach is based on the assumption that the number of trips generally declines with increasing distance from the site as the travel cost increases (Blamey 2002; Loomis 2005; Shaw 2005).

A statistical equation generates the net economic value using travel costs and other trip related expenditures (as a proxy for willingness to pay for fishing) and the number of trips taken. By observing how recreational fishing trips vary with changes in run size, fishing opportunity and the level of angler congestion, economists can estimate the change in net economic values with changing recreational fishing conditions.

Revealed preference approaches such as the TCM are theoretically sound and have the advantage that they are based on actual behavior of recreational fishers. In practice, however, estimation can be difficult due to complexities associated with relevancy of the different costs, the multi-purpose nature of recreation, substitute fishing locations, different quality of the sites, site congestion, and non-catch related fishing benefits such as being on the water, observing wildlife, enjoying time with friends (Blamey 2002).

An issue related to the interpretation of revealed preference approaches is that they can only value observed fishing conditions. For example if anglers currently catch one fish every two fishing days, a TCM approach will not be suitable for

estimating the change in economic value resulting from a management change that would result in five fish caught every fishing day.

Stated Preference: Where the economic value of a hypothetical change in fishing conditions is required, a stated preference study can be used. Methods such as Contingent Valuation ask anglers, for example, how much they are willing to pay for an improvement in recreational fishing success, increase in bag limits or increase in season length. The resulting willingness to pay is then multiplied by the number of fishers to get a total "consumer surplus" as a measure of value (Blamey 2002). This approach is conceptually more straightforward than revealed preference approaches and can be conducted using mail, phone or in person interviews (Blamey 2002; Loomis 2005; Stevens 2005).

Because it is based on hypothetical rather than actual behavior, the CVM is subject to response biases (Blamey 2002). A typical response bias includes strategic misrepresentation (understating or overstating value) to try and influence the outcome. This type of bias can be influenced by the wording of a questionnaire or even by the fact that a survey is being conducted. Reducing the potential bias depends on the way the valuation question is framed and asked.

For example, the two following questions are likely to elicit very different responses: How much would you pay to have the commercial allocation of spring Chinook transferred to the recreational sector? How much would you be willing to pay to catch an extra fish each fishing trip?

Other response biases are also possible with the Contingent Valuation Method. Respondents may get clues form the content of a questionnaire to infer a particular value that may not have occurred to them previously. The types of scenarios outlined in the questions may not accurately reflect the policy choices under consideration. Surveyors and respondents may have different definitions of the amenities that comprise the policy choice, or they may have different understandings of the policy, economic or social context (Blamey 2002). Each of these sources of bias may direct the study away from an accurate representation of value.

Benefits Transfer: The benefits transfer approach uses information on the value of environmental goods and services generated in one context for valuing similar goods and services in a different context. Because it does not involve the collection of new data, benefits transfer is based on the review of values calculated from other recreational fisheries. Values may represent the same species at different sites, or different species at the same site (Blamey 2002; Ready and Navrud 2005).

Benefits transfer is widely used by government agencies because it is a faster and lower-cost approach to estimating benefits than conducting original studies. However, this approach carries a high potential for "transfer error," where

estimates of values at the study site may not accurately reflect those at the application site. Studies assessing the validity of benefits transfer by comparing the value estimates between two sites commonly find statistically significant differences between values at the two sites (Ready and Navrud 2005.)

As a technique, benefits transfer is most useful when it is not possible or practical to conduct an original fishing valuation study due to limited budgets and/or time constraints. However, the reliability of the approach is questionable and depends on the similarities in the fisheries being valued, similarities in fisher characteristics, the degree of documentation to assess the extent of similarities, and the accuracy of the original study. Additionally, an important consideration is the sensitivity of the management decision to possible errors in the magnitude of benefits (Blamey 2002).

2.1.2 Impact Analysis

Impact analysis accounts for the total effect across the economic region under study of a change in economic activity resulting from a particular event such as a change in commercial or recreational fishing activity. The most popular tool for analyzing impacts is the input-output (I-O) model, due in part to the availability of ready-made I-O models such as IMPLAN (Hughes 2003).

I-O models are based on the idea that income injected into an economy by exports has a multiplier effect, as it is re-spent locally. The level of re-spending is based on how much local businesses and consumers buy from local businesses. An I-O model quantifies these interactions in a transactions table that describes the value of goods and services exchanged between sectors in a given year. In this way a transactions table reflects the way a sector is linked to all other sectors and to final demand (Hughes 2003).
.
Both commercial and recreational fishing generate economic impacts to local economies. Financial activity is associated with the purchase of goods and services used in fishing. These purchases produce direct and indirect effects on business revenues, jobs and personal income. The extent of these effects determines the extent of the impact (Carter 2003).

It is very easy to confuse economic impacts with economic values. However, they are fundamentally different measures. Economic value represents the value of a fishery to society as a whole. Economic impacts, in contrast, describe the financial impacts on coastal and state economies in terms of the income, employment and revenues from commercial and recreational salmon fishing and related activities.

It is important to understand that economic impacts reflect the region described in the model, such as a county or group of counties. At a larger level, for example the state of Oregon or Pacific Northwest, negative impacts in one county may be

balanced out by positive changes somewhere else. For example, if recreational fishing for spring Chinook in the mainstem was not possible due to a small Chinook run, anglers might fish at Oregon coastal locations instead. At the state level, increased recreational spending in coastal counties would make up for the loss of revenue in the mainstem Columbia River counties. Even if recreational fishers gave up completely, the money they no longer spent on fishing could be spent on new activities such as hunting or gardening.

Although these economic impacts may not make a large difference at the level of the state or national economy, they do often make a difference at a smaller scale, and their distribution is a matter of interest to fishery managers. Effects of fisheries allocations on constituents or communities that would benefit or be harmed are important considerations in fishery policy.

2.1.2.1 Conducting an Impact Analysis

An impact analysis consists of two components: the collection of expenditure information and an estimate of the financial impact of this expenditure on a region.

An impact analysis begins with the collection of information about expenditures by commercial and recreational fishers. These expenditures are the same financial information that forms the basis for estimating resource costs in an analysis of net economic value. For a commercial fishery the cost component of a costs and earnings survey is needed. For a recreational fishery, a survey of expenditures by recreational fishers is required (Edwards 1990, Hundloe 2002).

The premise of the I/O framework is that each industry sells its output to other industries and final consumers and in turn purchases goods and services from other industries, workers and land owners. Mulkey and Hodges (2000) lay out some key components of local economics that affect how impacts are realized in an economy.

Local economies have two parts – basic industries (e.g. fishing) and service industries (e.g. restaurants). Basic industries sell goods and services to markets located outside local area. Service industries provide goods and services to local businesses and residents. Each type of industry has a different effect within the local economy.

Basic industries attract money from outside the local economy, which then circulates within the local area through spending and respending by local service industries. New money is eventually lost through leakages such as tax payments to state and federal governments, savings, profits to nonresidents, or payments for imported goods and services.

This is the framework from which total economic impacts can be calculated. The key is to determine division of basic and service industries within an area, then to assess the relationship between changes in basic sectors and resulting changes in the service sector.

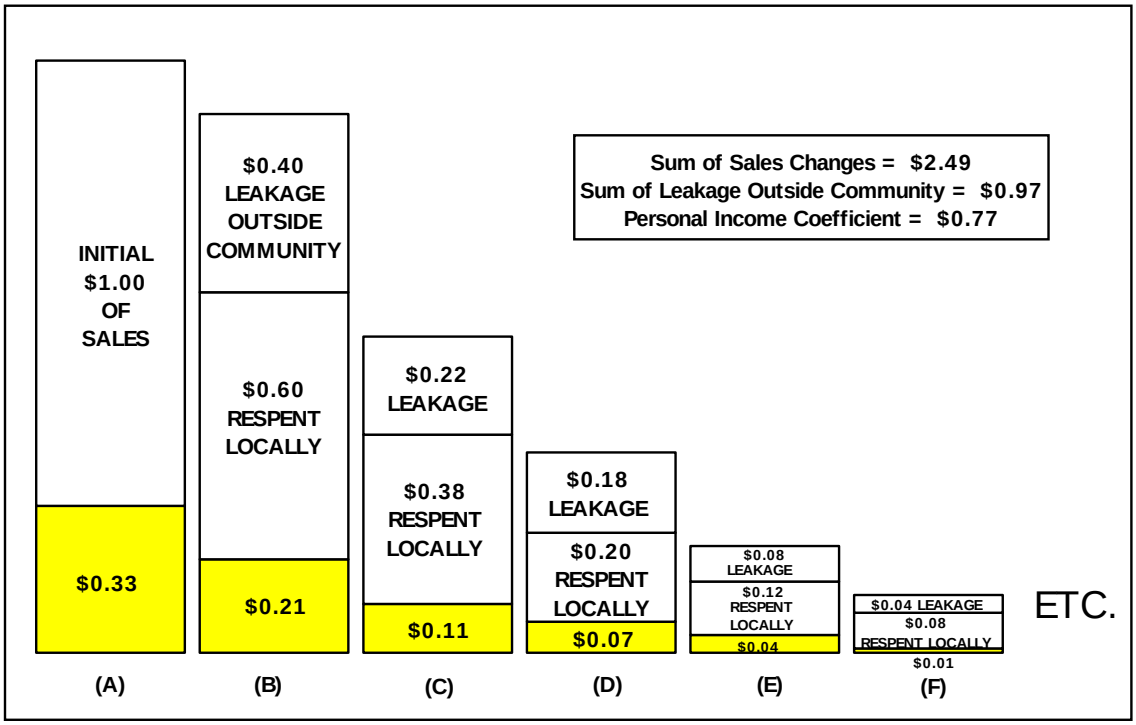
I/O tables produce two main types of multipliers:

An “expenditure multiplier” calculates how much money is "stirred up" in an economy. This does not necessarily mean that someone is making a wage or profit from this money because it does not take into account the costs involved in this economic activity. A commercial fishing company employing many people may be expanding rapidly by buying lots of new equipment and paying the highest prices for commercially caught spring Chinook. The company may actually be operating at a loss and reducing the economic impact within the region (Carter 2003).

An “income multiplier” is defined as the amount of personal income (salaries, wages and dividends to shareholders) that is directly and indirectly generated from an increase in expenditures. It is a more useful measure of the contribution of a sector's activity. The type of industry that the expenditure first occurs in determines the size of the income multiplier. In an industry that is labor intensive, the output expenditure multiplier may not be very large while the income multiplier is above average. On the other hand, if the industry goes through several transactions but is not very labor intensive throughout the process, the expenditure multiplier may be large and the income multiplier small.

Carter (2003) demonstrates the application of income multipliers in Figure 2.2. Local personal income generated is the shaded part of the expenditure multiplier. The personal income multiplier measures the income generated as a result of a change in sales. In the first round of export sales, $0.33 of local personal income is generated. The other $0.67 in the initial round goes to purchase supplies and services from other industries. These industries also create wages, salaries, and profits. As these sales work through the economy, a total of $0.77of personal income is generated from every $1 of increase in sales.

Figure 2.1 Output (Sales) Multiplier And Personal Income Coefficient



Note: The shaded portion of the output (sales) that goes to households in terms of wages, salaries, and profits is called personal income.
Source Carter 2003.

Sometimes economic impact analyses will estimate changes in employment resulting form changes in income. These are usually based on fixed ratios and so are oversimplifications of the relationship between regional income and employment, and should therefore be treated with caution. Further, it provides no additional economic information to the decision maker because it is based on the income data.

2.1.2.2 Applying an Impact Analysis

It is important to realize that an I-O model provides a snapshot of an economy at a given point in time for a defined region**.** The estimation of impacts of a positive or negative change in the economy rests on the interrelationships among businesses that exist for that specified point in time in that region.

Given these conditions, what information is needed for understanding an I-O analysis?

- Size of region modeled. County? State? Interstate?
- Substitution possibilities: If fishing opportunities are reduced, are alternative fishing opportunities available? Does physical capital (e.g. boats, docks) have alternative uses?

- Accounting stance: Are apples and oranges being compared or is the comparison being made on a similar basis? For example, are expenditures on fishing equipment being compared to incomes earned in fishing?
- Resource constraints: Have resource constraints been considered in interpretation of expansion?
- Expenditure location: Is information provided on where the expenditure occurred?
- Price impacts: Has the possibility of changes in prices with changing size of catch been addressed?
- Employment impacts: What has been assumed about the relationship between income and employment? For example, who gets (or loses) a job with an expansion or decline or in catch? What types of jobs are involved?
- Local government impacts: To what extent has the effect on public services been considered? (Edwards 1990; Mulkey and Hodges 2000; Hundloe 2002.)

2.1.3 Cost Effectiveness

This section is based on a useful description of cost-effectiveness analysis provided as guidance to subbasin planners (IEAB 2003). Cost-effectiveness analysis is a way to assess how to get the biggest "bang for the buck." Cost-effectiveness analysis is appropriate for alternative actions that 1) produce the same or similar type of output, 2) have costs and output that can be measured or reasonably estimated, and 3) have costs large enough to justify the additional analysis. Cost-effectiveness analysis can be used to compare two or more alternative projects when the projects have the same type of output. For example among alternative rearing sites for select area fisheries, which achieve production targets at least cost?

There are two general types of cost-effectiveness analysis. Type 1 addresses the selection of a set of actions from among several alternatives. Actions that achieve the objective for the least cost are the most cost-effective. Type 2 addresses the selection of a single cost-effective action from among several alternatives.

In Type 1, a number of actions that achieve progress towards an objective are available, but not all actions need be or can be implemented. The objectives may be reached with a subset of the actions, or a limited budget may preclude taking all feasible actions. For any given objective, the costs of alternative approaches per unit of the objective are calculated. These are called unit costs. Next, the projects are arrayed in ascending order of unit costs. The cumulative amount of output is the most that can possibly be achieved within the limited budget. If there is a fixed objective, projects are selected until the objective is met, and the

cumulative cost is the least possible cost for achieving the objective. This presumes that the actions are independent in that the total amount of output can be calculated as the sum of all.

In Type 2, selecting one action precludes any other from being selected. This type of problem occurs when a unique resource can only be used for one purpose. In this case, cost-effectiveness is used to determine which alternative use will provide the most output per dollar. The cost and output are calculated for each alternative, and the cost-effectiveness decision selects that plan with the lowest unit cost.

3. REVIEW OF ECONOMICS LITERATURE RELATED TO COLUMBIA RIVER SALMON

The second charge to the review team was to summarize previous work specific to the Columbia River fisheries, Section II discussed the valuation techniques used by economists for estimating economic benefits and impacts. The following section reviews studies which apply these techniques in conducting economic analysis on Columbia River commercial and recreational salmon fisheries, particularly the spring Chinook fishery. This is not an exhaustive review but a summary of research considered relevant for managing and allocating Lower Columbia River spring Chinook. The results of this summary are evaluated in later sections to address key questions for managing spring Chinook fisheries.

3.1 Fishery Valuation

3.1.1 Commercial Fisheries

Carter and Radtke (1986) conducted one of the first modern economic studies of the Columbia River non-treaty spring Chinook gill net fishery. Before this work most economic analysts were using total revenues or proportional “rules of thumb” to estimate economic profits from salmon fisheries (e.g.,50-90% of total revenues --Rettig and McCarl 1984). Presaging issues confronting contemporary managers, the study was designed to inform managers on implications of allocation decisions of spring Chinook between the recreational and commercial fishery.

Although the study was primarily designed to compare income expenditures resulting from input-output analysis, the authors also developed cost and revenue data useful for cost benefit analysis. This data is estimated from previous analyses and updated using a survey from a subset of commercial fishers and processors to estimate costs/revenues of a representative vessel and

plant. The authors estimate pre tax net return (revenue minus expenses) at $2,500 or an average annual 26% return on investment for a representative Columbia River gillnetter. Spring Chinook represent 25% of gross revenues but variable or fixed costs attributable to spring Chinook are not presented.

This early work highlights a number of important methodological issues in conducting economic analysis intended for allocation, including Columbia River spring Chinook. The authors note the difference between economic value and output or expenditures and argue against using gross revenue as a surrogate for net economic value. They also argue the need to conduct analysis of both the commercial and recreational salmon fisheries that reflect user values including quality of life analysis (efficiency) since this data is not reflected in expenditure data. They further note that reallocating commercial harvests to a recreational fishery can reduce overall harvests due to the differential selectivity of commercial and recreational gear. A key limitation of their work, here and elsewhere, is the relatively poor documentation of data and methods in determining harvester and processor costs and expenditures (Hanna, Thomson, and Young 1994).

In 1994 Radtke and Davis conducted a more detailed economic evaluation of the non-treaty Columbia River gillnet fishery in order to assess the asset value of the gillnet fleet based on present value calculations (i.e., aggregated discounted net revenues over a fifteen year time period). They based their analysis on a detailed survey of licensed processors and harvesters and estimated plant and fleet costs from almost three hundred returned surveys. Based on their detailed analysis of expenditure and revenues they estimated average revenues ($23,000) and profits (35% of net revenue). They use this value and a range of other possible net revenue values (e. g. 55% and 100% of gross revenues) to calculate an asset price for the fleet ranging from $25.6 to $71.0 million for the period 1986-1993. They also estimate the one year lease price at $26.6 thousand and a permanent buyout ranging from $144-$172 thousand. The analysts did not attempt to estimate the costs or benefits of reallocating salmon between the recreational and commercial fleet.

Although the report is very detailed, the analysis is surprisingly limited. One explanation was the severe time constraints under which the project was conducted because of the immediate need to provide documentation of the dire economic situation befalling the industry. This problem raises the issue of potential bias when using survey data collected during periods of economic downturns, pending allocation decisions, or buyouts. The analysis included measures of variance and estimates of potential sampling error. One interesting aspect of the survey was the use of a model “guide” to help fishers in calculating their revenues and expenditures.

Radtke, Davis and Johnson (1999), working with biological modelers and a Columbia River salmon lifecycle biological model (PATH), conducted a comprehensive impact and efficiency analysis on recreational, commercial, and treaty Indian ocean and in-river fisheries. They used a 100-year model at different discount rates for three levels of assumptions of hydropower actions on salmon survival. They also evaluated four alternative hydrosystem operations to determine losses or gains in economic efficiency and regional income on commercial and recreational salmon fisheries. Due to the paucity of cost data for the commercial fisheries the modelers assumed that costs equaled 70% of revenues. They also were compelled to use recreational data from studies conducted during the 1970's and 1980's (e.g., Brown et al. 1976). They estimated that the combined value of recreational and commercial catch of spring and summer Chinook was $49.95 million. They found that among the four different hydrosystem alternatives, annual benefits for commercial and recreational fishing ranged from $.16 million to $1.59 million from the base case (or up to $3.49 million at a zero discount rate). They found that total loss in economic value resulting from four different river operational scenarios across 100 years varied between $6.6 million to $21.52 million for spring/summer Chinook.

This study highlights some of the difficulties in conducting complex and comprehensive analysis of recreational and commercial salmon fisheries. The authors were compelled to use "rules of thumb" and multiple assumptions due to lack of economic data. The error and uncertainty in their data and estimates bracket any increase or decrease to either sector due to allocation changes. They note eight major unresolved issues regarding assumptions. Many of the economic methods were not well documented. In addition there was no attempt to compare economic costs to the fisheries relative to costs in other sectors of the economy. Finally, they noted that shifting Snake River production from recreation to commercial would have very little economic effect because most of the Snake river fish are not accessible to the ocean commercial fishery.

Huppert et al. (2004) discussed salmon economic issues as part of a larger study reviewing the effects of increased water diversion from the main stem of the Columbia River in the context of Washington State's Columbia River Initiative. . This study looked at broad effects from five water use scenarios and economic effects on many uses of the Columbia River including recreational and commercial salmon fishing. The authors noted that only the spring Chinook fishery had prices greater than 50% of the average salmon price during 1988-1997. The authors also noted the rapid reduction in prices for troll and gillnet fishery over the last fifteen years and speculated that the contemporary gillnet industry is unprofitable, and that farmed salmon production will keep ex-vessel prices depressed. They note that most contemporary studies cite older studies

which state that costs are 50% of gross revenues. They assume, however, that with decreasing output prices, costs may be closer to 100% of gross revenues. The authors ignore the rapid rise in salmon prices over the last few years due to niche market development. The authors also note the paucity of commercial fishery salmon troll and gillnet data, particularly cost and expenditure data.

The PFMC conducts an annual analysis to evaluate the biological and economic changes predicted to occur in the ocean salmon fishery (PFMC 2005). Although the most recent annual report is more than 300 pages, less than one page of discussion and two tables summarize the economic fishery issues. These tables show changes in expected ex-vessel revenue and changes in recreational fishing trips and community income due to changes in the management and abundance of ocean salmon. There is no cost or expenditure analysis and no cost benefit analysis. The report shows that landings, ex-vessel revenue, and recreational income decreased significantly in 2005 (40-70% or more compared to historical average) due to harvest constraints to protect weak runs of salmon. These constraining stocks include Sacramento River winter Chinook, Klamath fall Chinook, various runs of coho, and various Columbia River stocks. There was no documentation of who conducted the analysis and how the results were derived. The report notes that spring Chinook is rarely encountered in PFMC managed fisheries due to the timing of the troll fishery which occurs after spring Chinook have migrated into the Columbia River.

3.1.2 Recreational Fisheries

A number of the research studies discussed in 3.1.1.also addressed valuation of recreational salmon fisheries. Methods include net economic valuation based on market prices (e.g., fishing charters or guides), contingent valuation, and travel cost techniques discussed in 2.0.

In Carter and Radtke's 1986 seminal paper on the potential economic effects of reallocating spring Chinook to the recreational fishery, the authors conduct a survey of salmon fishing guides on the Clackamas River to estimate expenditure data for use in an IO regional personal income model (see 3.2). Although the data does not include fixed costs, the authors develop a simple cost and revenue model that shows that "guide profit" is over half of total trip revenue (e.g., $150 revenue per trip, $96 profit). With more refined and complete data, these surveys could be used to estimate net economic value per trip and per fish derived from fishing for Clackamas River spring Chinook.

Carter and Radtke also use Brown et al's 1980 study to estimate the expenditures for non-guided salmon fishing, although they note this is a "rough" estimate since it is an average among all salmon and steelhead anglers across the state. They recommend conducting additional economic research on the Willamette River recreational spring Chinook fishery including estimating the response of anglers to the size of run and catch rate. They also note the need to

conduct efficiency analysis for anglers in order to obtain estimates of economic value. An improved recreational survey of fishing guides and recreational fishers would allow economic values to be estimated and compared for both guided and non-guided anglers.

As a result of ESA listings and the growing need for valuation of Columbia River salmon, Olson, Richards, and Scott (1991) conducted a contingent valuation study to measure the use and existence values of doubling the Columbia River salmon and steelhead run by 2000. They conducted a large phone survey of 700 users (recreational anglers) and 700 non-users in the Pacific Northwest and asked respondents to estimate their willingness to pay to double salmon and steelhead runs using their electricity bill as a payment vehicle. Recreational user-respondents were asked to directly estimate willingness to pay for increased catch rates. The authors found that the average net value per recreational trip was $111.46 and marginal willingness per fish per trip was $18.47. Average willingness to pay for regional sport value (i.e. from users excluding existence value) for all salmon fishing per trip was $111.48. Average willingness to pay per sport-effort day was $49.33, and average willingness to pay per salmon was estimated at $45.68. The marginal willingness to pay per trip (i.e., the value of an additional trip above their normal number of trips) was $45.07 and the marginal value of an extra fish caught was $18.47.The authors estimated their values from spreadsheet models rather than statistical “econometric” models and results were averaged over all Columbia River salmon and steelhead fisheries in the main-stem and basin, and across all respondents regardless of demographic characteristics, base catch rate, or frequency of trips.

The marginal rate of $18.47 for an additional fish per trip was an estimate for all Columbia River Chinook at all locations regardless of species, fish size, or fish stock. The results, therefore, cannot be directly applied to any specific run but are indicative of likely average and marginal values for salmon in the context of the specific questions posed at the time of the research. The results certainly cannot be used to infer any actual economic value for recreationally caught spring Chinook in 2005, which ostensibly should have higher relative values due to its characteristics as both an excellent food fish and a “trophy” fish. Although the overall study appears to be reasonably well constructed, like many contingent or experimental estimates (where no real dollars change hands) there are major questions about how their survey methods impacted actual bid prices. For example, the bid vehicle (electricity rates) is not one normally associated with fishing experience and may elicit a different response than if the vehicle was the price of a salmon recreational fishing stamp. Since Northwest power rates are relatively low compared to the rest of the nation (due, for example, to excluding “external” social costs associated with loss of fish and wildlife), if there exists a starting price bias, this vehicle may also have biased bids down relative to bids elicited if power rates represented the true costs associated with environmental externalities.

In an attempt to explicitly measure recreational sports fishing values where congestion costs may impact social welfare for urban fishing, Berrens, Bergland, and Adams (1993) estimated consumer surplus of recreational fishers for spring Chinook in the Willamette and Clackamas rivers and estimated willingness to pay for an increase in run size of 10% and 20%. This was a contingent valuation study based on willingness to pay for expected increases in fishing trips and catch associated with an increase in run size where congestion (crowding from anglers) may increase. The study was part of a larger survey conducted by The Research Group (1989) to estimate values and expenditures for spring Chinook. Personal surveys were conducted at four sites along the Clackamas Rivers and out of 302 interviews, 209 surveys were usable. The data was used within a statistical model (double censored log likelihood model) to estimate willingness to pay and determine importance of congestion and run size.

The authors found that the average and marginal willingness to pay for recreational fishing was respectively $11.87 and $7.82 per fish for the season. They did not find any congestion effect. Based on these findings they conclude that there are no economic grounds for reallocation of catch from the commercial to recreational sectors. However, the analysis was plagued by a number of methodological problems associated with the limited number of observations and data, the limited range of run size and congestion scenarios, absence of base catch rates, and other estimation and modeling issues. It is doubtful whether results could be applied to the Columbia River mainstem recreational fishery. The authors note a caveat that their results are “context-dependent” (e.g., status and characteristics of stock, geographic location, specific setting at the time of the study) and that values cannot be applied outside the framework of the study.

Huppert et al. (2004) applied the results of the Olson, Richards and Scott 1991 study in an attempt to draw conclusions about the relative value of the recreational and commercial salmon fisheries in the Lower Columbia River. They attempted some simple “back of the envelope” analyses to estimate the increase in recreational fishing value associated with increasing run size for ocean and Lower Columbia River recreational fishing opportunities. They estimated that since the average value per trip (from Olson, Richards, and Scotts work) is $111.46 per trip ($142.63 in 2002 dollars) they could multiply this by total trips to determine the existing value of the recreational fishery ($27.3 million). However, our review shows they made a number of methodological errors including substituting angler days for trips and using catch rates of 1.13 fish per trip rather than 2.44. These mistakes overestimate the value of the fishery by at least 100%. They compound this error by attempting to estimate the increased marginal value of one additional harvested fish due to changes in the run size by using Olson Richards, and Scotts estimate of the average willingness to pay ($111.46) rather than marginal willingness ($18.47).

Their calculation significantly overestimates the value of reallocating commercial harvests of spring Chinook to the recreational sector. Although their analysis was a simple attempt to demonstrate the potential application of economic studies, their research results could be used in efforts to advocate for reallocation of salmon runs. Because the analysis is fundamentally flawed, it cannot be used to infer recreational or commercial economic values for spring Chinook.

In 2003, Carter updated a review by Johnson (1994) of studies which have used non-market economic methods (TCM-Travel Cost Method; CVM-Contingent Valuation Method) for estimating the value of anadromous salmon and steelhead. It is not clear whether the author reviewed these articles for quality and relevance. The summary is shown in Tables 3.1.

Table 3.1. Salmon and Steelhead Values (per angler day) - Selected Studies

Steelhead

LOCATION	REF; DATE	METHOD	$1992 per day	$2002 per day
Idaho	Loomis & Sorg, 1985	TCM	19.60	23.62
Oregon	Strong;1983	TCM	23.59	28.42
Idaho	Loomis & Sorg, 1985	CVM	27.83	33.53
Oregon	Brown, Chou-Yang & Richards, 1983	TCM	29.82	35.93
Oregon	Brown, Sorhus & Gibbs;1980	TCM	30.87	37.20
Rogue River	Olsen, et al.;1994	CVM	25.90; 33.30	31.21; 40.12
Oregon	Loomis;1986	TCM	37.35	45.00
OR/WA	Olsen, Richards & Scott;1990	CVM	37.63	45.34
OR/WA	Riely;1988	TCM	38.07	45.87
Columbia R.	Olsen, Richards & Scott;1990	CVM	50.18	60.46
Oregon	Meyer, Brown & Hsiao;1983	TCM	59.68	71.91

Salmon

LOCATION	REF; DATE	METHOD	$1992 per day	$2002 per day
Oregon	Loomis;1986	TCM	18.07	21.77
Oregon	Brown, Sorhus & Gibbs;1980	TCM	21.95	26.45
Rogue River	Olsen, et al.;1994	CVM	25.80; 36.80	31.09; 44.34
OR/WA	Riely;1988	TCM	27.92	33.64
Alaska	Hanneman & Carson;1991	CVM	32.34 - 59.99	38.97 – 72.28
OR/WA	Olsen, Richards & Scott;1990	CVM	35.43	42.69
B.C.	Cameron & James;1987b	CVM	49.96	60.20
Columbia R.	Olsen, Richards & Scott;1990	CVM	53.36	64.29
Oregon	Meyer, Brown & Hsiao;1983	TCM	60.36	72.73

Ocean Salmon

LOCATION	REF; DATE	METHOD	$1992 per day	$2002 per day
B.C.	Cameron & James;1987b	CVM	27.68	33.35
Oregon	Riely;1988	TCM	32.37	39.00
Washington	Crutchfield & Schelle;1978	CVM	34.85	41.99
Oregon	Bergland & Brown;1988	TCM	46.49	56.02
Oregon	Meyer, Brown & Hsiao;1983	TCM	53.29	64.21
OR/WA	Olsen, Richards & Scott;1990	CVM	55.54	66.92
Washington	Riely;1988	TCM	76.15	91.75

Salmon and Steelhead (combined)

LOCATION	REF; DATE	METHOD	$1992 per day	$2002 per day
Oregon	Brown, Singh & Castle;1965	TCM	32.37	39.00
Oregon	Brown, et al.;1976	TCM	47.71	57.49
Chetco	Johnson, Shelby & Moore;1989	CVM	31.31	37.72

Salmon vs. Steelhead Values (per angler day) - Selected Studies – 1992 $ (2002$)
Salmon Fishing Values vs. Steelhead Fishing Values

LOCATION	REF; DATE	SALMON	STEELHEAD
Oregon	Brown, Sorhus & Gibbs;1980	21.95 (26.45)	30.87 (37.20)
Rogue	Olsen, et al.;1994	25.80; 36.80 (31.09; 44.34)	25.90;33.30 (31.21; 40.12)
OR/WA	Riely;1988	27.92 (33.64)	38.07 (45.87)
Idaho	Gordon, Chapman & Bjornn;1973	80.92 (97.50)	159.12 (191.73)
Oregon	Loomis;1986	18.07 (21.77)	37.35 (45.00)
OR/WA	Olsen, Richards & Scott;1990	35.43 (42.69)	37.63 (45.34)

Salmon and Steelhead Values ($) - Selected Studies
Values Stated in Terms of Average Value per Fish Caught

LOCATION	REF; DATE	Average Value per Fish Caught ($)	Average Value per fish Caught (2002$)
OR/WA	Olsen, Richards & Scott;1990	Ocean salmon 41.61 Coastal salmon 36.72 Coastal steelhead 64.06	Ocean salmon 53.22 Coastal salmon 46.97 Coastal steelhead 81.93
Rogue	Olsen, et al.;1994	Summer steelhead 82.00 Fall Chinook 75.60 Winter steelhead 44.20 Spring Chinook 63.60	Summer steelhead 104.88 Fall Chinook 96.69 Winter steelhead 56.53 Spring Chinook 81.34

Salmon and Steelhead Values ($) - Selected Studies
Values Stated in Terms of Marginal Value per Fish Caught on Last Trip

LOCATION	REF; DATE	Marginal Value per Fish Caught ($)	Marginal Value per fish Caught (2002$)
OR/WA	Olsen, Richards & Scott;1990	Ocean salmon 25.26 Coastal salmon 14.81 Coastal steelhead 24.96	Ocean salmon 30.44 Coastal salmon 17.85 Coastal steelhead 30.08
Rogue	Olsen, et al.;1994	Summer steelhead 26.80 Fall Chinook 16.50 Winter steelhead 18.70 Spring Chinook 17.70	Summer steelhead 32.29 Fall Chinook 19.88 Winter steelhead 22.53 Spring Chinook 21.33

Most of the studies estimate value per fishing day and results range from approximately $20/day to slightly over $100.00. Where average and marginal fish values are estimated, values range from $37-$97 and $15-$30 respectively. These values could be used in a benefits-transfer analysis (2.1.6). However, caution should be used in applying these values to other fisheries given the context specific issues associated with each estimation and the estimation error. This would be particularly true for spring Chinook given the unique characteristics of the stock and fishery (e.g., the high trophy status and high food value). However, this summary is valuable for providing the range of daily (trip), average, and marginal values found in over 30 different recreational fishing studies of anadromous salmon and steelhead.

3.2 Fishery Economic Impacts

I-O models allow tracking of effects of changes in location or amount of expenditure in commercial or recreational fisheries that might result from changes in allocation or changes in landings from other causes.

Studies addressing the economic impacts of fisheries in the Columbia, Willamette and Snake Rivers span almost twenty years. They range in degree of geographic and species specificity and are reviewed in chronological order below. Additional information is provided by the U.S. Fish and Wildlife Service, which periodically surveys anglers at the state level to determine economic impacts, but does not itemize estimates by river basins in their more recent research publications (USFWS 2002)

3.2.1. Allocation of Willamette River Spring Chinook

Almost twenty years ago the ODFW was concerned with obtaining economic information to inform a potential allocation decision of Willamette River spring Chinook between the recreational and commercial fishery (Carter and Radtke 1986). This analysis takes an I-O approach to estimating impacts on the commercial and recreational fishery of a change in allocation of spring Chinook. It is conducted in an era before ESA protections were an additional consideration, and is the first documented use of IMPLAN model to look at the

economic impacts of fishery regulation in the Pacific Northwest. Carter and Radtke is a seminal I-O analysis referenced in subsequent reports (also discussed in 3.1.1.), and provides a detailed discussion of I-O methodology.

The analysis focuses on the potential personal expenditure income impacts due to total closure of the winter commercial fishery for spring Chinook. Impacts on the commercial fisheries (losses) and recreational fisheries (gains) are compared.

The authors calculate net returns to Columbia River gillnetters and estimate the personal impact of one spring Chinook to Astoria. They also estimate statewide expenditures on recreational salmon fishing and make assumptions about the number of additional angler days generated per additional fish and expected catch proportion.

They determine that the income lost to the Astoria area from a loss of commercial fishing ($756,525) exceeds the income gain to communities around the recreational fisheries ($527,340 – $674,065). But data inadequacies make it difficult for the analysts to recommend that spring Chinook be allocated from the recreational fishery to the commercial fishery.

The authors make several recommendations for addressing data gaps that remain pertinent today. For the recreational fishery, they recommend conducting additional economic research on:

- response of recreational anglers to size of run and catch rate
- proportion of recreational expenditures that come from outside the region.
- values placed by anglers on fishing
- quality of life and the fishing experience.

For the commercial fishery, they recommend conducting additional research on:

- expenditures of the commercial fleet
- expenditures of seafood plants.

This study was followed in 1989 by a survey of anglers participating in the Willamette River spring Chinook fishery. The survey was designed to provide the data required for economic impact analysis identified as missing in the 1986 I-O analysis (The Research Group 1989), including demand for recreational fishing, angler preferences, valuation and costs.

3.2.2. Columbia River Recreational Fisheries

Two years after the Willamette River spring Chinook run study, the ODFW sponsored a 1991 survey in order to better understand the economic importance of Oregon's recreational fisheries and to improve their management. A large mail and phone survey yielded data that were scaled up to the total number of licenses. The IMPLAN model was used to calculate the state-level economic

impacts of recreational fishing on Columbia River anadromous and resident fish (The Research Group 1991a; 1991b).

Oregon Impacts

	Per angler day	Total (1991 million $)
Trout	$26.36	93.3
Salmon	$38.59	53.1
Steelhead	$30.37	23.1

Updating the recreational data collected in the 1991 survey, Carter (2003) presents a summary of estimated state-level impacts for both commercial and recreational salmon and steelhead fishing in Oregon.

Recreational Impacts

Type of Angling (Species and water type)	Estimated state level personal income impact of trip expenditures per angler day (2002 $)
Steelhead	$44.26
Salmon, ocean (20% charter; 80% private)	$60.21
Salmon, inland	$43.65

Commercial impacts

	Ex-vessel Price Per Pound	State Income Impact Per Pound	State Income Impact Per Fish
Coho	$0.75	$1.85	$13.01
Chinook	$1.54	$3.13	$34.18

3.2.3. River Operations

In 1999 Radtke and colleagues modeled the economic contribution of the Basin's anadromous fish production in the lower Snake River juvenile salmon migration study. This study evaluated four alternative hydrosystem operations and their potential economic impacts on commercial and recreational salmon fisheries.

Using a life cycle model (PATH) that tracks different salmon and steelhead stocks, the authors used three levels of assumptions regarding impacts of hydropower actions on biological survival and analyzed the effects of those different survival levels on the efficiency of recreational, commercial, and treaty fisheries.

The study has several methodological issues that limit its application. No cost data are available for either the tribal or non-tribal gill net fishery, requiring the

analysts to make assumptions about the proportion of revenues represented by costs. The recreational analysis uses transfer benefits values but provides no documentation of their origin. In addition, the methodology used in the study is poorly documented. The authors note several issues related to model assumptions.

Despite data limitations, the authors are able to conclude that shifting Snake River stocks from the recreational to the commercial fishery would have very little economic effect because most of the Snake River fish are not accessible to the commercial fishery.

They also found, more specifically:

- Estimated value of combined recreational and commercial catch of spring and summer Chinook at $49.95 million.
- Changes in benefits under the four different operations for the commercial and recreational ranged from $.16 million to $1.59 million from the base case.
- The analysis of four options that decreased runs estimated a range of impacts from $11.09 million to $33.82 million for spring/summer Chinook and $82-$233 million for all species in total.
- Shifting entire recreational catch to commercial would decrease personal income between $8-$65 million.
- Spring/summer Chinook in 1998 accounts for about 20% of the impact of all Columbia River salmon (fall Chinook dominate).

Errors and uncertainty in the above estimates would bracket any increase or decrease to either sector.

3.2.4 Select Area Fisheries

In 1993, the Bonneville Power Administration initiated funding of the Columbia River Terminal Fisheries Project (now named the Select Area Fishery Evaluation (SAFE) project), a 10-year comprehensive program to investigate the feasibility of terminal fisheries in Youngs Bay and other sites in Oregon and Washington. This cooperative project between the ODFW, Washington Department of Fish and Wildlife (WDFW), and Clatsop County Economic Development Council's (CEDC) Fisheries Project explored the means to increase harvest of hatchery fish while providing greater protection to weak wild salmon stocks. The project's 2004 Completion Report identifies a range of economic impacts associated with the Select Area fisheries (North et al. 2004).

The SAFE project considers the protection of ESA-listed stocks as its highest priority. The report cites 80-90% harvest rates of SAFE stocks and describes a detailed monitoring program. It documents an increase in availability of salmon to the fisheries as a result of project actions, provide information on the ex-vessel market for salmon, the economic value of the fisheries and the value of this

project to the industry, in the context of fishing alternatives (North et al. 2004).

The economic data used in the SAFE final report were generated through a 1996 study (Radtke and Davis 1996.) This study examined the economic potential of expanding the pilot-scale Youngs Bay select-area fisheries into seven new sites: four in Oregon (Tongue Point, Blind Slough, Clifton Channel and Wallace Slough) and three in Washington (deep River/Gray's Bay, Steamboat Slough/Skamokawa Creek, and Cathlamet Channel). Costs and revenues associated with the expansion were estimated, and used as the basis of an input-output analysis of the potential economic impact of a phased program expansion.

The authors note that the economic impacts of activity related to harvesting salmon depend on many factors, including species, ex-vessel price, mode of fishing, geographic area of harvest, and processed product. They found that based on existing economic models used to estimate both the commercial as well as recreational impact of salmon harvested on the West Coast, the increased survival of salmon acclimated and released in the Lower Columbia River system had the potential to increase the ex-vessel revenues received by the Columbia River gillnetters by $11 million (at an estimated acclimation and release cost of about $3.5 million). They further estimated that the expansion project had the potential to generate about $19 million additional to the Lower Columbia River economies and about a total of $24 million to the state economies of Oregon and Washington. (Radtke and Davis 1996.)

A review of the report by two of the Northwest Power and Conservation Council's scientific advisory committee, the Independent Scientific Review Panel (ISRP) and the Independent Economic Analysis Board (IEAB) identified some information gaps regarding economic impacts of the SAFE fisheries (ISRP/IEAB 2005). Information on costs of achieving project goals is missing, allowing only a partial characterization of project benefits (gross, rather than net incremental benefits). Maximizing the value of harvest, as well as the project overall, requires a consideration of both costs and benefits and how they change under different conditions.

The review also noted that economic components (costs and benefits) are not part of ongoing monitoring and evaluation, but should be. The SAFE project is currently sponsoring the collection of gillnet cost and earnings data to support further analysis of economic impacts (personal communication, H. Radtke, 6 December 2005.)

3.2.5 Columbia River Basin Fisheries

At the request of the Northwest Power and Conservation Council, the IEAB assessed the economic contribution of Columbia basin fish to coastal and Columbia River communities (IEAB 2005a). The report focuses on current fisheries, their contribution to local economies, and the sources of the salmon and steelhead that support these fisheries. It also provides some historical

context for Columbia River salmon fisheries and identifies significant changes that have affected fisheries over time.

The IEAB measured regional economic impacts of income related to salmon and steelhead fisheries. The estimate includes both wild and hatchery fish, and economic value from both commercial harvests and recreational harvests wherever they occur. Tribal harvests for commercial markets are included. Ceremonial and subsistence catch is not included.

The I-O model generating these impacts uses factors for smolt-to-adult survival rates, hatchery production levels, and harvest regulations. Regional economic impacts (REI) are the measure of value; the unit of value is household personal income. REI is the income generated by harvesting wherever Columbia Basin fish are caught, and in the case of commercially harvested fish, preparing a marketable product, plus the indirect or secondary impacts on other economic activities (the multiplier effect.) As noted in Section 2.2, REI measures short-term economic contribution under current conditions and is not a valid measure of the long-term effects on the economy of changes in fish abundance or policy (IEAB 2005a).

Depending on assumptions for fish production and harvest, the estimated economic impacts varied from $40 million to $142 million per year. Based on fish production and harvest in recent years, the annual personal income impacts total $142 million annually to West Coast communities (Alaska to California), an amount that may support some 3,600 jobs. Of the $142 million in economic impacts, about 63 percent was generated by the Columbia in-river fishery. About 35 percent of the total economic contribution is accounted for by the spring and summer Chinook fisheries (IEAB 2005a).

The report also provides a useful description of the effect of economic development in the Columbia Basin fisheries in reducing the total harvest and changing the composition of salmon returning to the Columbia River. Commercial landings of salmon and steelhead harvested in the Columbia River declined from around 20 million pounds in the late 1940's to a very low level in 1993, when a total of just over one million pounds of salmon was harvested.

Another trend described in the report is the increasing importance of farmed salmon in the international seafood market. This infusion of new supply has resulted in significant reductions in salmon prices that, combined with reduced catch, has put substantial economic pressure on commercial salmon fisheries. As returning fish numbers have declined, so have the revenues received by fishers and the resulting household income generated for inland communities.

The report also describes recent changes in some trends. Since 2000, numbers of adult salmon and steelhead available for harvest have increased dramatically. In 2004, prices for certain salmon products increased, indicate increased

demand for specialty products, such as "wild caught" salmon. The decline in the U.S. dollar has also helped increased prices for most salmon products (IEAB 2005a).

3.2.6 Idaho Recreational Fisheries

Idaho sponsored an economic analysis of the Snake River steelhead fishery that described the contribution a restored salmon fishery could make to state and local economies (Reading 1999). Updates of this analysis were performed in 2003 and 2005 (Reading 2003; 2005). These studies show large local and state-level economic impacts from recreational salmon and steelhead fishing.

The Idaho salmon studies were reviewed in 2005 by the IEAB. The motivation for the review was to explain the divergence of impacts form salmon fishing estimated in the Reading studies and the IEAB's study of the economic contribution of Columbia River salmon (IEAB 2005b). Reading (2005) reported that recreational fishing from a restored salmon and steelhead recreational fishery would have economic output impacts of $544 million annually in Idaho. The IEAB (2005b) estimated that recreational and commercial fishing for salmon and steelhead originating in the Columbia River Basin creates $140 million in total personal income throughout the western U.S. and Canada.

The IEAB noted that salmon and steelhead fishing can result in large local impacts in some cases but found that Reading's analysis substantially overstates these impacts. They identified three factors explaining most of the difference between the two studies.

- The two studies report entirely different economic measures. Reading uses angler expenditures and value of output as measures of impact. The IEAB study reports personal income, which includes wages and salaries, proprietor's incomes and certain net incomes. Expenditures, value of output and personal income are all very different measures. Personal income is normally a fraction of value of output.

- The two studies cover different geographical areas. The IEAB provide estimates for the entire western U.S. and Canada, while Reading estimated impacts for Idaho.

- Reading's economic impact estimates are too large. The Reading study overstates the increase in the amount of expenditure and value of output attributable to a restored salmon and steelhead fishery. This overestimate results from using a number of salmon and steelhead fishing trips for the restored fishery that is too high and an overstated value of output.

The IEAB finds that Reading's economic impact from the restored fishery is actually the impact of the entire fishery, not the incremental impact of restoration

relative to recent conditions. O'Laughlin (2005) shows that recent run sizes and fishing levels account for much of the run size associated with Reading's restored fishery. After accounting for all of these factors Reading's restored fishery would provide a personal income contribution in Idaho similar to the $7 million estimated by the IEAB for the Snake River region.

3.3 Fishery Cost Effectiveness

Sylvia and Graham (1992) conducted a Type 2 cost-effectiveness analysis of harvest reduction actions to promote recovery of Snake River fall Chinook. The analysis assessed the least-cost approach to recovery among three alternatives. They found that complexities in the estimation of recreational benefits, uncertainty about the effect of a single fishery on population size when mixed-stock fisheries exist, and unreliability of data all complicated the search for a least-cost harvest reduction approach.

4. APPLICATION OF ECONOMICS TO ALLOCATION QUESTIONS

4.1 Using Existing Studies to Inform Decision Making

The third element of the review charge is to apply the previous studies to frame the use and applicability of fisheries economics to current Columbia River fishery allocation decisions. The general question we answer in Sections 4.1.1. – 4.1.5 is whether the existing information is sufficient and specific to the allocation question for Columbia River spring Chinook.

4.1.1 What does the literature tell us?

Valuation: The literature indicates that both the recreational and commercial salmon fisheries on the Columbia River, and specifically the spring Chinook fishery, generate positive net benefits. Revenues appear to exceed costs in the commercial fishery and the recreational guide fishery, and surveys indicate positive net benefits in the recreational salmon fisheries. Although no study found that costs exceed benefits, some analysts speculate that given rapid negative changes in commercial market conditions, financial profits in the commercial salmon fisheries may soon approach zero (Huppert et al. 2004). Each study, however, has limitations related to data, assumptions, methodologies, and estimation procedures. In terms of economic valuation, there was no single study using the same or similar techniques conducted during the same period which compared the value of the commercial and recreational spring Chinook salmon fisheries.

Impacts: Both commercial and recreational salmon fisheries generate local, statewide, and regional economic impacts. Impact analysis using I-O models

and based on personal expenditure data have been conducted for both the commercial and recreational spring Chinook fishery. Expenditure analyses suggest that average estimated values per fish for the commercial and recreational fisheries are within 20% of each other.

Allocation: There have been remarkably few studies conducted over the last twenty years to evaluate economic issues, values, and impacts for allocating Columbia River salmon in general, and spring Chinook specifically. Authors of primary studies which collected original data for either the commercial or recreational spring Chinook salmon fishery indicated that their findings did not warrant reallocating spring Chinook from one sector to the other based on grounds of economic efficiency or economic impact (e.g., Carter and Radtke 1986, Berrens, Bergland, and Adams 1993).

4.1.2 What does the literature not tell us that is important to know?

Valuation: Because there are only a handful of studies which are conducted at irregular schedules and designed to address different questions, there is no complete analysis across time representing the economics of the commercial and recreation salmon fisheries, including spring Chinook. The few existing studies function as static "prisms" of partial perception within a larger kaleidoscope of dynamic biological, economic, and policy changes. For example, a significant piece of information missing from the valuation analysis for the commercial fishery is the changing price for commercial licenses. These licenses, since they can be bought and sold on a commercial market represent asset values that theoretically should embody economic supply and demand information including the expected time stream of discounted aggregated harvesting costs, supply constraints, output market prices, risks, and management actions. The only asset study was conducted by Radtke and Davis in 1994 using a snapshot of survey data collected primarily for impact analysis, during stressful economic and policy conditions, rather than actual market transaction data.

There is no valuation study conducted specifically for Lower Columbia River spring Chinook which is of adequate quality to evaluate economic benefits. Although the large number of studies for West coast salmon may help bracket the possible ranges of value for spring Chinook on the Columbia River, it is impossible to know whether the "true" average/marginal economic value per fish is closer to $100/$50 or $40/$10 per fish. In addition we know remarkably little about the recreational salmon fishers since the recreational studies had either too few questions, too few observations, or too little analysis. Little information exists on the demographic or psychological characteristics of recreational fishers and how they respond to changes in catch rates, quality, and seasons. Most of the recreational studies were "add-on" studies to surveys with other objectives. This makes it difficulty to apply these studies as future fishing conditions or angler demographic characteristics change.

Impacts: The impact analysis is sporadic and not always well documented. It does not demonstrate clear-cut differences between the two sectors for total expenditures.

Allocation: This review suggests that the existing handful of studies do not adequately inform decision makers regarding the economic dimensions of Columbia River spring Chinook allocation because they do not have the appropriate focus, scope, or periodicity to adequately understand the economic characteristics of the fishery. Taken together, the analyses are an inadequate information base for managing Lower Columbia River spring Chinook.

4.1.3 Are the data current and adequate for analysis?

Valuation: In general the data is neither current nor adequate in quantity or quality for purposes of informing policymakers for management and allocation. For the commercial industry, the output market price data is very good since it is closely monitored by the state in order to collect *ad valorem* taxes. Cost data for the commercial industry is collected sporadically by outside vendors every ten to fifteen years. The cost data is updated every 3-5 years through selected interviews but the process is poorly documented. The recreational economic valuation data is totally inadequate—two studies conducted in the early nineties are the only source of information and only one of the studies was specifically targeted at spring Chinook. Unfortunately that study had a number of technical and methodological problems. This paucity of data has required some analyses to use recreational economic salmon fishing data from the 1970's and 80's. Given the large statistical errors and the general problem of contingent "hypothetical valuation" producing willingness to pay estimates 2.5-3 times larger than actual cash payments (List and Gallet 2001, Murphy et al. 2005), these analyses are inadequate for informing management and allocation decisions. In addition, many of the non-market studies measure different things (e.g., catch and value per trip, catch and value per angler per trip, average and marginal value per angler per day, marginal fish per season, etc.). This has resulted in confusion and mistakes in analysis and interpretation.

Impacts: Many of these problems also apply to the impact analysis, since in some cases the same source data was used for estimating values and impacts. In general, expenditure data is not collected on a systematic basis and not well documented. In other cases the studies are methodologically incorrect (e.g., Reading 2005).

Allocation: Protocols for standardizing and collecting data on the commercial and recreational Columbia River salmon fisheries do not exist. This problem is also true for the ocean salmon fisheries managed by the PFMC. While price data is good if not very good (particularly in Oregon), the quantity and quality of cost data is inadequate. Much of the data collection is conducted by private

companies hired by private groups. Data collection and analysis is sporadic and often spurred by policy and economic emergencies. Often the work is completed under tight time constraints and limited budgets. These problems raise significant questions regarding bias, even when the technical work may be well done. In addition, the sporadic nature of the work and the use of non-standardized and non-stock specific data can result in "speculative" extensions which the original work cannot support. All these problems make it difficult to apply this work for management or allocation purposes. It is one reason that the analysts urge caution in applying the results.

4.1.4 Are similar methods used in analyses?

Valuation: Most Columbia River salmon valuation studies are conducted by individual researchers, contractors, and consulting companies rather than by agency staff. There is no standard protocol for frequency or methodology and although each individual researcher or firm may conduct research in a consistent manner, protocols are not standardized across studies. The different studies also address different questions. These problems make it difficult to aggregate data, integrate research, and compare results across species, regions, and time. It also makes it difficult to compare market and non-market studies and account for error and biases across studies.

In addition, while there have been expenditure surveys to support market-based valuation and impact analysis, there have been no documented travel cost studies of Columbia River salmon fisheries. This is surprising given that travel cost data could be used to conduct both market and non-market research while also supporting impact analysis. For example, with the appropriate design, a survey of Clackamas and Willamette River guides could generate information useful for market, non-market, and impact analysis. Conversely, some of the surveys conducted by Radtke and Davis (e.g., 1993) for the Lower Columbia River gillnet fishery contain questions regarding willingness of fishers to receive compensation for purchasing their business and/or permits. In addition there may be existence values associated with preserving a commercial fishery with historic and cultural importance. This suggest that non-market studies could be used for analyzing the value of the gillnet fishery, as well as the recreational fishery.

Impacts: Impact studies for Columbia River fisheries are all based on the I-O model IMPLAN, as modified for regional fisheries. Data are updated over time.
The Research Group has conducted the bulk of the impact analysis on Columbia River Chinook fisheries (including spring Chinook) using personal income expenditures. Analyses of Idaho recreational fishery impacts, conducted by Ben Johnson Associates (Reading 2005) have used sales output to estimate recreational salmon fishery impacts. These two approaches generate different results and are not directly comparable. This type of problem indicates the need

for standardizing protocols if the work is to be used for large scale studies within a basin or region.

Allocation: Valuation studies, whether or not they use market information, are designed for the identical purpose (i.e. measuring economic values, net economic benefits, producer and consumer surplus, etc) and if carefully constructed, results can be theoretically comparable. In the applied world this is far more difficult given the inherent weaknesses and biases of these approaches, particularly where there are few if any market signals to ground truth or "tune" the studies. In addition, public resource allocation decisions are rarely made for a single objective such as economic efficiency or economic impacts. Probably the most integrated work conducted on the spring Chinook allocation question was by Carter and Radtke (1986). Although they used different techniques to conduct the cost-benefit and impact analysis, they used the same surveys and in some cases raw data to analyze market values, non-market values, and economic impacts. Collecting data at the same time using standardized protocols allows studies to be more easily compared.

4.1.5 Are available analyses designed to answer the questions asked in this review?

Valuation Question -- Are the fish inherently more valuable in one sector than in another?

The studies reviewed in this report do not support the contention that spring Chinook are inherently more "valuable" in the recreational or commercial sector. This is because answering questions about "inherent" valuation requires understanding context, markets, and institutions. The valuation problem is illustrated in the classic conundrum: is a one carat diamond more valuable than a gallon of water -- on a desert island? Could one say that the first spring Chinook caught is inherently more valuable in one sector than the other? What about the 100,000th fish caught? Or is the tradeoff of "equal marginal value" somewhere in-between?

The limited number of studies over the last twenty years and their timing, design, and quality, are inadequate to address questions of economically efficient allocation. This is not because the studies are not relatively well done (some of them are), but rather that the work is too limited to answer inherently complex question. What could be a reasonable answer in a particular time period may be quite different in another period. For example, twenty years ago market price for spring Chinook was very high (over $6.00 per pound ex-vessel) but has decreased over a fifteen year period, only to have rebounded during the last three or four years (now approaching $5.00/lb). Commercial harvest costs and technology have also changed during that time period but so have costs and technology for recreational angling (gasoline, electronic fish finders). Can one

say, given these changes in the market, that allocating the majority of fish to one sector generates greater economic value?

The studies reviewed in Section 3.0 are too limited in frequency and methodology to address complex allocation questions. And when authors have made the attempt, they did not generate results, or provide a defensible reasons, to support reallocation (e.g., Berrens, Bergland, Adams 1993; Huppert et al. 2004). Certainly developing better designed and more frequent studies can provide informed perspectives, and even reveal allocative distributions which are not economically efficient. However, given the year-to-year dynamic market issues which characterize commercial and recreational markets for spring Chinook, and given the inherent limitations of even the best economic studies, it may be an illusion to believe that well crafted economic analysis can lead to analysis supporting incremental levels of reallocation.

Impacts Question -- Can we compare the economic importance of sectors?

The review in Section 3.0 shows that both commercial and recreational sectors can generate positive economic impacts, and that depending on market conditions, these impacts may be relatively similar (e.g., Carter and Radtke 1986). Possibly a more important question is the distribution of these impacts—for example is the impact within a narrow area or is it diffused across regions? Or do impacts occur within regions with significant wealth, or locations with high poverty? Even if impacts are roughly similar, illustrating the "equity" tradeoffs under different allocations may be important to decision makers given the objectives of management.

Allocation Question -- Can economics inform decisions about allocations?

Economic analysis can inform decisions about allocations of Columbia River salmon. Both valuation and impact analysis, if properly supported with relevant and timely data, can provide useful information for understanding economic implications of allocation decisions. This information can also be analyzed within single or multiple objective frameworks to evaluate economic tradeoffs under ESA policy constraints. Useful analysis will require far better data and analysis than is presently available. But if the long run objective is to solve the allocation problem, a more effective solution may be to invest resources in institutional analysis in order to develop approaches for allocating spring Chinook which can take into account changing values and market conditions.

4.2 Common Areas of Misinterpretation and Misuse of Economic Analyses

4.2.1 Value versus Impacts

"Values" and "impacts" are as incomparable as "apples and oranges." Economic

valuation and economic impact assessments measure different things and the results of one cannot be compared with another or used as respective surrogates. An economic impact is not the same as an economic benefit.

When economic information pertaining to the allocation of spring Chinook between commercial and recreational fishers is presented it is important to be clear about the type of economic analysis used to generate the information.

- An impact study will generally refer to input-output analysis and the use of multipliers.
- An economic valuation study will usually refer to willingness to pay, opportunity or resource costs, net economic value, and/or consumer and producer surplus.

Some of the basic information used in determining economic value and economic impacts is the same, but the analysis is different.

Impact analysis alone usually would not determine the allocation of spring Chinook between recreational and commercial fishers. It can only show the local or regional economic activity as a change in allocation. To assess the allocation of spring Chinook that will generate the greatest social benefits using economic criteria, an economic valuation is required. It is also useful and important to remember that accounting for financial transactions does not necessarily capture all the benefits associated with fishing activity.

4.2.2. Interpreting Economic Impact Studies

Impact analyses provide a measure of the regional impact of economic activity associated with fishing. However, the ability of an impact analysis to accurately represent impacts depends on a number of key assumptions which are often left undocumented:

- Size of region modeled
- Existence of substitution possibilities:
- Expenditure location
- Price effects
- Resource constraints

Failure to document these assumptions limits the ability to assess the reasonableness of the type or size of reported multipliers as well as the general interpretation of results.

4.2.3 Substitution Effects

What is assumed about the possibility of substitutes is critical to the analysis of changes in net benefits or impacts from a given change in regulation. Are substitute recreational activities available if spring Chinook fishing is not? Do substitute commercial fishing opportunities for spring Chinook exist? How people

respond to changing fishing opportunities influences changes in benefits and costs that accrue to them, as well as changes in their expenditure patterns. All affect the economic outcome of a regulatory change.

Often studies are conducted with the implicit assumption that no substitutes exist for the activity being analyzed. In the absence of substitute opportunities, loss of an opportunity is analyzed as a complete economic loss. However if substitutes do exist, loss of a given opportunity may not result in a total loss of benefits or expenditure. In the case of impact analyses, it is important to also know whether the location of the substitute activity is within or outside the region of study.

4.2.4 Application of Multipliers

Multipliers are used for estimating economic impacts. They are not used to estimate economic values.

An increase or decrease in production has a multiplier effect created by local re-spending of expenditures by individuals and businesses. Multipliers are generated in I-O models based on the key assumption of fixed-proportions, where input use moves in lockstep fashion with production. Thus, a decrease in salmon catch will be assumed in an I-O model to generate a proportional decrease in purchases of fishing gear, fuel and other fishing inputs. This may or may not be the case (Hughes 2003.)

Hughes (2003) summarizes reasonable values for local economy multipliers based on empirical work.

County employment Size class	**Average multiplier**	**Probable range**
1,000-2,999	1.7	1.5-1.9
3,000-4,999	1.8	1.5-2.0
5,000-9,999	1.9	1.6-2.1
10,000-19,999	2.0	1.8-2.2
20,000-49,999	2.2	2.0-2.4
50,000 and over	2.2	2.0-2.5

Output multipliers larger than 2.5 should not be taken at face value.

Hughes also notes that all things otherwise being equal, multipliers will tend to be higher where:

- The community is larger with a more diverse economy
- The community is a substantial distance from competitive retail/service centers
- The per capita income is low.

As Carter (2003) has described, looking at output multipliers is a way to look at how much money is “stirred up” in an economy through sales, but it doesn’t

necessarily mean that local wages or profits are being made. A more useful measure of economic contribution is the amount of personal income that is directly or indirectly generated from changes in sales. This is called the “personal income coefficient.”

Expenditure multipliers are popular with advocates because they result in the appearance of bigger regional impacts associated with an activity such as recreational or commercial fishing. Nevertheless expenditure multipliers only measure total spending and take no account of the cost of providing goods and services. This is analogous to measuring personal wealth by the amount a person spends rather than how much the person earns (Edwards 1990).

4.2.5 Gross versus Net Benefits (Revenues)

Recreational and commercial fishing interests will often use a “revenues argument” along the following lines: *When ex-vessel revenues are less than what anglers spend to go fishing the economic value of fish caught commercially is less than the recreational value. More fish should therefore be allocated from the commercial to recreational fishers* (Edwards 1991).

On financial grounds the argument is incomplete. Revenues are financial benefits to industries but they are also equal to financial costs to customers. Thus, a financial transaction itself is a transfer of money, the net effect of which is zero. The revenues argument is exaggerated because, until the costs of production are subtracted, it is impossible to determine from revenue data alone whether a businesses is earning profit.

The revenues argument can also promote waste and inefficiency because it focuses on maximizing output with no consideration of the costs of increasing output. The unsoundness of the revenues argument could also work against its proponents. For example, an increase in the recreational share of a fishery could actually result in lower expenditures by anglers because it becomes easier to catch fish. This does not mean that the economic value to recreational fishers of the improved fishing is negative.

4.2.6 Lump-Sum Tradeoffs

The “all or nothing argument” can take various forms including the following: *When the economic value of commercial fishing exceeds the economic value of the recreational sector, commercial fishers should receive the entire total allowable catch* (Edwards 1991).

Looking at tradeoffs in this lump-sum manner ignores the importance of marginal changes in value. Efficient (highest net benefit) allocations of a fish stock are determined on the basis of incremental tradeoffs in net economic values (i.e., the difference between total economic value and total resource costs) when different

uses are in conflict. By overlooking tradeoffs in net economic value, the all or nothing argument fails to identify the most efficient allocation of fish harvested for food and sport fishing. This will almost always result in some fish allocated to both recreational and commercial fishing.

4.2.7 Benefits Transfer

Many attempts at benefits transfer are of limited usefulness because:

- The recreational fisheries being valued are often very different and involve different species.
- The characteristics of anglers often differ from fishery to fishery.
- Accuracy of the original studies is often difficult to verify because the published documents do not describe in detail how the study was carried out.
- The potential for transfer error is high.
- In particular, Columbia River spring Chinook has unique sporting and culinary characteristics. Benefits transfer error from other salmon studies may be particularly large and the values of limited use (Hundloe 2002).

4.2.8 Stated Preference

Stated preference approaches to valuing recreational fisheries, such as contingent valuation, are highly prone to bias. Because valuation is only "contingent," and not actual, people have an incentive to shape their responses to influence the results. Analysis suggests that mean hypothetical values from contingent valuation are 2.5 to 3 times greater than actual cash payments (List and Gallet 2001, Murphy et al. 2005).

The types of bias that are common with contingent valuation studies are:

- Understating or overstating willingness to pay in an attempt to influence policy decisions.
- Symbolic responses, where fishers reflect their general attitude towards an issue rather than an actual willingness to pay.
- Part-whole bias where fishermen will respond with a willingness to pay that values an attribute that is larger or smaller in some sense than the one being surveyed for. For example, they may value all salmon fishing opportunities on the Columbia River not just spring Chinook fishing opportunities or they may be thinking about the additional enjoyment of more time on the water if there is an extension in the fishing season (Blamey 2002).

For this reason, contingent valuation studies need to be designed with care to avoid bias. Existing contingent valuation studies should be reviewed for evidence of bias before application.

4.2.9 Revealed Preference

Revealed preference approaches to valuing recreational fisheries, such as the travel cost method, are highly sensitive to the way the models are constructed. As a result, recreational analyses based on travel costs should explicitly address the following components:

- Which travel costs are included and whether they are legitimate to include in the model
- How multiple purpose or multiple destination trips are addressed and costs apportioned between different activities or destinations
- Whether substitute sites are included in the model. For example does a stated preference model for the mainstem Columbia River also include the Willamette and Clackamas Rivers. Studies have shown that if substitute sites are included in the model the results are better.
- How the effects of possible overcrowding and congestion are addressed (Blamey 2002).

5. CONCLUSION AND RECOMMENDATIONS

In this section we provide conclusions and recommendations regarding ways the ODFW could integrate economic and social concerns into the management process and the basic economic data and information needed to improve the decision making process.

5.1 Integrating Economic and Social Concerns into Management

5.1.1 Raising the Visibility of Economic Issues

A typical problem in the consideration of economic issues in fisheries management is that the information base is weak (too little and not directly relevant) and the timing of consideration is late. Fishery management is often faced with questions of allocation only after a fairly long history of having considered management as primarily a biological question of conservation. By the time allocation questions become paramount, agencies are fully invested in research and staff designed to generate the required biological information. Few resources remain to invest in economic staff and information. Because of the weak information base, economic considerations are considered only after decisions have been designed around conservation concerns. This leaves economic considerations in the position of being partially informed by existing analyses (which may not directly address the question at hand) and public testimony (which most often produces advocacy information rather than objective analyses.)

Rather than being conducted systematically, economic analysis is often conducted in a piecemeal fashion in response to a crisis or short-term problem. Once recognizing this mismatch, the question is how to accommodate information needs to inform allocation as well as conservation decisions. Typically, agencies even lack a framework within which to build a plan for data collection, research and staffing.

This review suggests that well-designed travel cost techniques, hybrid contingent valuation, and other techniques can generate fisheries information valuable for both cost-benefit analysis and impact analysis (e.g., Paulrud and Laitila 2003, Wheeler and Damania 2001, Layman, Boyce, and Criddle 1996). If properly designed, such studies could collect basin-wide data and also information targeted for specific regions and fisheries.

In addition, research to better understand human dynamics and responses to changing conditions would provide information useful to the design of more effective management approaches. This type of research would encompass questions such as angler response to changes in catch abundance and catch rates in recreational fisheries, producer response to prices and catch levels in commercial fisheries, and substitution effects among alternative fishing opportunities in both recreational and commercial fisheries.

Recommendation: The ODFW should develop a research plan to define the basic set of economic data needed to assess commercial and recreational in-river fisheries, the core analyses to be conducted using that data, and a schedule for developing each on a routine basis.

5.1.2 Timing of Consideration of Economic Issues

The timing and frequency of economic data collection must be carefully integrated into the timing of management and allocation decisions. Economic decisions, however, may not be on the same schedule as biological decisions. Harvest decisions require “real time” annual updates of both biological and market data. Conversely, making major management or allocation decisions a month or two before opening the salmon season would be economically inefficient and considered unfair by groups receiving proportionately lesser amounts of fish. The need for relevant research, thoughtful analysis and peer review requires a well planned process. Such a process exists for biological data collection and assessment of salmon (ISAB 2005). It does not exist for economic data collection and analysis.

This review indicates that the timing and frequency of economic data collection and analysis is inadequate for rational management and allocation of Columbia River spring Chinook. For the handful of relevant recreational value studies, data and analysis is 13-25 years old, yet the economic and institutional situation has been rapidly changing over the last two decades. Value-based studies of the

commercial industry have also been infrequent and have occurred in the "heat" of economic and policy emergencies with little time for peer review of proposals or analysis. Even when this work has been competently administrated and analyzed, the survey-based data collection raises concerns about neutrality and bias. The impact analysis, while occurring more frequently, is also based on surveys conducted 10 -15 years apart with poorly documented intermittent updates.

Recommendation: Given the value and importance of Columbia River salmon fisheries, the quality and timing of economic data collection and analysis should be better integrated into the management cycle. A research plan that outlines the core set of routine data collection and analyses will assist this integration.

5.1.3 Developing a Decision Framework:

Managing and allocating Columbia River spring Chinook and other Columbia river salmon requires that economic information be structured more broadly within a decision framework in order to integrate economic analysis with biological and policy information, structure comparative analysis, demonstrate tradeoffs, understand effects on (multiple) management objectives, and evaluate risk and uncertainty. Specifically the decision framework requires:

- Management objectives, strategies, and constraints
- An operational decision framework, (e.g., cost effectiveness or multiple objective analysis) consistent with the legal mandates, institutional framework, and management problems.
- Transparent, peer reviewed, and timely data and analysis consistent with informing the management process including evaluating economic effects of alternative strategies and relationship with management objectives
- Analysis of tradeoffs within the context of risk and uncertainty
- Final decisions
- Ongoing review and improvement of the process

Recommendation: A decision framework should be developed that integrates economic analysis into the broader management system

5.1.4 Working within Resource Constraints

Recognizing that funds to develop a research plan, build a decision framework, strengthen the role of social science advice and invest in economic data collection and analysis may be limited, low-cost approaches are needed to begin to address the quality, utility and visibility of economic information.

Recommendation: We recommend as a first step to implementing this report's recommendations that ODFW and its management partners sponsor a workshop

of economists for the purpose of developing an economics research plan for Columbia River fisheries.

5.1.5 Building a Process for Social Science Advice

One reason that social and economic considerations have a low profile or are left until late in the management process is that they have no representation in the complex system of scientific advice. In fishery management, information on human dimensions is typically provided by interest groups, through advisory panels or public hearings, rather than by scientific analysis based on systematic data collection. Occasional piecemeal analyses may also be conducted. Neither presents a complete or impartial representation of the human landscape of the commercial and recreational fisheries being managed. Neither allows forward planning. As a result, unintended consequences of management are common.

Building social science representation into scientific advisory bodies for Columbia River salmon management would promote the consideration of social science issues in a systematic and timely manner to help redress the social science knowledge gap in fisheries.

Recommendation: Appoint an economist and other social scientist to the Columbia River Technical Advisory Committee or another committee providing science advice on Columbia River fisheries.

5.2 Using Economic Data and Information to Improve Management

5.2.1 Routine and Integrated Data Collection and Assessment

One of the biggest problems revealed by this review is the ad hoc nature of the economic data collection and analysis process. This is surprising given the clear direction to the Commission to manage food fish to provide "the optimum economic, commercial, recreational and aesthetic benefits for present and future generations," ORS 506.036, and the rapid changes in commercial and sports fishing markets. The result is that data and analysis is inconsistent with the needs for responsible and informed public decision making. Given the context-specific nature of each analysis reviewed in this report and its age, inadequate methodology or documentation, and lack of peer review, most of this work cannot be updated or used for contemporary management and allocation. In many cases the detailed data is owned by private companies or individual analysts.

Recommendation: Given the long-standing needs of the entire Columbia River for relevant economic information on salmon fisheries, we recommend that a process for economic data collection be developed in a public-private partnership. The process would implement the data collection and analysis components of the research plan recommended in Section 5.1.1. The process would include:

- Evaluation of alternative data collection approaches to support information for a wide range of impact and valuation studies over time and across sector and regions.
- Determination of the frequency of intensive and broad-based data collection and analysis (e.g., every five to ten years), versus requirements for less intensive but timely and strategic updates of core and complementary information (e.g., every two years)
- Determination of responsibilities for data collection relative to analysis. For example one set of contractors could collect data and make it publicly available. A second set of contractors from various firms, institutions, or agencies could be hired to conduct timely and relevant analysis. The availability of public data could also attract additional analyses from academic researchers.

5.2.2. Monitoring and Evaluation

Every decision making process and information support system needs to be routinely monitored and evaluated on the basis of performance criteria. A performance review conducted every three to five years would address the following types of questions:

- Is the data and analysis sufficient for competently addressing management needs and objectives?
- Is the data of sufficient quality and quantity to meet the needs of the analysts?
- Is the analysis delivered on time?
- Does the analysis support the needs of decision makers?

Recommendation: We recommend the development of a set of performance indicators that would reflect the objectives for economic performance of Columbia River salmon fishery management, the identification of routine data collection over these indicators, and the associated development of a plan for routine performance evaluation. This could be done in conjunction with the development of the research plan recommended in Section 5.1.1.

5.2.3 Adaptive Management

Fishery management within the dynamic environment and complex institutions of the Columbia River is a challenging undertaking. By definition good decisions must be adaptive, i.e., rationally changing in response to new information. Adaptive management adds the further dimension of experimental approaches and learning by doing. With respect to economic data and analysis this requires that decision makers periodically evaluate whether management decisions are resulting in expected impacts and economic effects, consider whether experimentation with alternative approaches could yield useful new information, and, accordingly, revise data and analysis, or develop alternative regulatory and management tools.

Recommendation: We recommend that objectives for economic performance of Columbia River fisheries be systematically evaluated consistent with legal and statutory requirements, and that a process be developed to ensure that plans for data collection and economic analyses stay current with changes in economic questions and issues.

5.3 Final Remarks

This review has covered a wide range of economic issues related to valuation, impacts and allocation. The emphasis on economics stems from the charge to the reviewers. We acknowledge and understand that economics is only one component of the allocation question. Even considering economics alone, the economic complexity created by changes in costs and benefits due to changes in demand, supply and the many variables which affect these make it impossible to always be economically "right" in allocation. The complexity will only grow over time, as will the difficulty of determining the economically best allocation. These conditions suggest that an exploration of alternative management tools, including markets for transferable user rights, would be worthwhile.

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Appendices

Appendix 1: Experts and Stakeholders Contacted

Explanation: The following persons were contacted for the purpose of identifying literature pertaining to (1) the economics and allocation of Columbia River sportfisheries, and (2) the economics and allocation of sportfisheries in other areas.

Name	**Affiliation**
Shannon Davis	The Research Group
Liz Hamilton	Northwest Sportfishing Industry Association
Hobe Kytr	Salmon For All
John Loomis	Colorado State University
Doug Marker	Northwest Power Planning Council
Irene Martin	Salmon For All
Anton Paulrud	Swedish Board of Fisheries
Hans Radtke	The Research Group
Don Reading	Ben Johnson Associates, Inc.
Bob Rees	Tillamook Anglers
Dennis Richey	Oregon Anglers
Phil Ruder	Pacific University
Glen Spain	Pacific Coast Federation of Fishermen's Associations / Institute for Fisheries Resources
Harry Upton	Oregon Department of Fish and Wildlife
Frank Warrens	Pacific Fisheries Management Council

Appendix 2: Review Team Short Biographies

Susan S. Hanna
Professor, Coastal Oregon Marine Experiment Station, Department of Agricultural and Resource Economics, Oregon State University. Also affiliated with Oregon Sea Grant. Ph.D., Oregon State University, 1981. Research in marine economics and policy, with a focus on economic performance of fishery management, ecosystem-based fishery management, property rights, application of incentive-based tools; institutional design. Serves on the Science Advisory Board, National Oceanic and Atmospheric Administration; Independent Science Advisory Board, of the National Marine Fisheries Service, Columbia River Intertribal Fish Commission and Northwest Power and Conservation Council; Independent Economic Analysis Board, Northwest Power and Conservation Council. Past member of the Science Advisory Panel, U.S. Commission on Ocean Policy; Ocean Studies Board, National Research Council; Scientific and Statistical Committee, Pacific Fishery Management Council; Independent Science Review Panel, Northwest Power and Conservation Council; Marine Fisheries Advisory Committee, National Oceanic and Atmospheric Administration; National Research Council Committees on Protection and Management of Pacific Northwest Anadromous Salmonids and the Committee to Review Individual Quotas in Fisheries.

Michael Harte
Professor, Oregon State University; Director, Marine Resources Management Program/Sea Grant Extension Specialist, College of Oceanic & Atmospheric Sciences, Oregon State University. PhD., University of Victoria, British Columbia, Canada, 1994

Gilbert R. Sylvia
Associate Professor, Department of Agricultural and Resource Economics, Oregon State University and Superintendent, Coastal Oregon Marine Experiment Station at the Hatfield Marine Science Center in Newport. Ph.D., University of Rhode Island, 1989. Research interests focus on seafood marketing, fisheries policy, bioeconomic modeling, aquacultural business economics and aquacultural policy. Much of his research in cooperation with other academic departments, the seafood industry, and the state of Oregon. Has published in various fisheries policy and economics journals.

Gail Achterman
Director, Institute for Natural Resources, Adjunct Professor, Department of Forest Resources and Member, Water Resource Graduate Faculty, Oregon State University. J.D. and M.S. natural resource policy and management, University of Michigan, 1974, 1975. Research interests focus on natural resource and environmental law and policy, particularly the use of science to inform public policy decisions. Serves on the Oregon Transportation Commission. Before joining the Institute for Natural Resources, served as Executive Director of the Deschutes Resources Conservancy, a non-profit organization dedicated to watershed restoration. She practiced law for 18 years with Stoel Rives LLP and served as Governor Neil Goldschmidt's Assistant for Natural Resources.