Economic Impacts of Salmon Fishing

February 12, 2001

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Executive Summary

This report presents estimates of the economic impact per salmon in 1998 dollars. Economic impact is the set of direct effects and ripple effects of spending money for salmon fishing. In this report, the economic impact is estimated as the impact that spending has on the total sales of goods and services related to salmon fishing. Every $1.00 spent for recreational salmon fishing produces about $1.85 in total sales for all goods and services used directly and indirectly by recreation anglers. Every $1.00 spent for purchasing commercial dock-side salmon produces about $1.53 in total sales for all goods and services used directly and indirectly by salmon processing.

Salmon from Clear Creek are caught along the Sacramento River and in the ocean. For each salmon caught and kept along the Sacramento River, the estimated total economic impact ranges from a low of $545 to a high of $1,100. For each salmon caught in ocean commercial fishing, the estimated economic impact ranges from $22 to $46 per salmon. For each salmon caught in ocean recreational fishing, the estimated economic impact ranges from $154 to $239 per salmon. The large differences in economic impacts may be a function of fishing effort. One day of commercial fishing yields more fish than one day of recreational fishing.

The method presented in this report can be used to estimate the economic impacts of Clear Creek salmon production. Once the number of Clear Creek adult salmon are estimated, the per salmon impacts in this report can be used to derive the economic impacts of Clear Creek salmon production. Further, the dynamic data used in this report are publicly available thus the data can be easily updated from year to year. Hence, as the estimates of Clear Creek salmon production change from year to year, the numbers in this report can be easily updated and the economic impacts of salmon from Clear Creek can be continually and quickly updated.

The reference spreadsheets are at

Salmon Econ Tables 1-7

Fish Damage Tables

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Acknowledgements Professor David Gallo, Department of Economics, California State University at Chico, significantly contributed to this report. He has performed several fishery economics studies and pointed me to the relevant data and literature for the Sacramento River. Professor Jim Wilen, Department of Agricultural and Resource Economics, University of California at Davis, reviewed the calculations and provided guidance for interpreting the calculated data. Ms. Cindy Thomson, economist with the U.S. National Marine Fisheries Service, provided ocean data and discussions about data interpretations. Any errors of this report, however, are those of the author.

1. Introduction This report fulfills a request from the NRCS Redding Field Office to update the data for the economic value of salmon to recreation and commercial industries. The economic value to recreation and commercial industries is, in the economics lexicon, called "economic impact". This report estimates the economic impact of recreational and commercial salmon fishing.

Introduction to the Economic Method In economics, the words "value" and "impact" have very different meanings. Appendix A, ***A Mini-Crash Course in Economics***, presents a detailed discussion about the difference between "value" and "impact" and explains why "value" is so difficult to estimate. Value and impact are briefly defined here:

"Value" is a measure of the satisfaction brought by, in this case, salmon that cannot be brought by any other object. Economic value may be the most misunderstood and abused concept of all. Economic value is also a familiar part of everyone's life, and confusion of familiarity with theoretical understanding is common (Peterson, Driver, and Brown, p.12). The "value" of salmon is due only to salmon. In economics, the value of salmon is called "consumer surplus". Estimating the "value of salmon" requires estimating consumer surplus. Estimating consumer surplus is a major research project. Such research is currently being requested by the U.S. National Marine Fisheries Service (interview, Cynthia Thomson, February 2001).

"Impact" is the effect of spending on an economy. The economy is composed of separate business entities which interrelate with each other to produce final goods and services. When there is a change in spending, that change ripples through the related business entities thereby changing the total sales, income, and employment within those businesses (Miernyk, p.42). When, for example, spending for salmon fishing increases, then total sales, employment, and income increase within the region in which the fishing takes place. Therefore, the "impact" of salmon fishing is the set of direct effects and ripple effects caused by spending for recreational and commercial salmon fishing. This report estimates economic impact. The estimates are presented in Tables 1 through 6 at the end of this report. Miscellaneous calculations are presented in Table 7, also at the end of this report.

2. Economic Impact Whenever an angler spends one dollar, that one dollar circulates through the economy and creates more than one dollar's worth of products and services. Appendix A, ***A Mini-Crash Course in Economics***, also presents a detailed explanation of the economic multiplier. This report uses two multipliers which were obtained from the 1998 IMPLAN proprietary data purchased by USDA NRCS in California (see MIG 1998 in References): 1.853067 is the multiplier for recreational fishing along the Sacramento River and in the ocean, and 1.525288 is the multiplier for commercial ocean fishing.

Let us consider how the recreational multiplier of 1.853067 is used to estimate the ripple effects of the Sacramento River salmon angler. It has been estimated that the salmon angler spends about $93.85 per fishing day (see Table 7 Column D). Given that the recreational multiplier equals 1.853067, that $93.85 is first directly injected into the economy and then ripples through the economy to produce another $79.77 in total sales. Thus, the $93.85 produces a total of about $173.62 in gross sales.

The $173.62 is an estimate of "impact", not "value". Why doesn't the $173.62 per day imply the value of salmon to people? First, if the people who would spend the $93.85 per day to fish were denied the opportunity to fish and they spent the $93.85 on other recreational activities, then the $93.85 represents the value of vacationing. Second, people who provide goods and services to salmon anglers – people who supply the food, run the motels, or provide transportation – do not have to like salmon or want salmon preserved in order to earn income from the salmon anglers. The people who provide goods and services to anglers would provide those goods and services to *anyone* who would pay for them. Thus, the economic multiplier estimates impact on regional market activities.

The IMPLAN multiplier is static. It is meant to be used as a one-shot estimate of impact. Multipliers are estimated as immediate impacts. In reality, the recreational multiplier could be 1.853067 for only a few years or for many years. However, we can say that in the short run, when the $1.00 of recreational fishing expenditure ripples through the economy, it produces about $1.85 in total sales within the region. For the long run, three or more years into the future, Miernyk recommends a dynamic model (p. 33). Thus, one cannot, without further information, use the IMPLAN multiplier more than three to five years into the future.

3. Estimated Economic Impact As already mentioned, estimating economic impact requires two types of information: estimated expenditures and estimated economic multipliers. Estimated expenditures used in this report are: (1) recreational salmon fishing along the Sacramento River, (2) commercial ocean salmon purchases at dock-side, and (3) recreational salmon fishing in the ocean. Estimated economic multipliers are: (1) recreational fishing, and (2) commercial fishing.

3.1 Economic Impact due to Sacramento River Salmon Salmon fishing along the Sacramento River is recreational. The primary data used were creel survey data gathered along the Sacramento River by the California Department of Fish and Game. The secondary data used were average expenditures per angler day derived from primary expenditure data of the US Fish and Wildlife Service. The expenditure data are indexed to 1998.

Studies estimating the Sacramento River salmon fishing values (Meyer Resources, Inc.; USFWS and USBR) and studies of areas beyond the Sacramento River (Charboneau and Hay; Gorden, Chapman, and Bjornn; Huppert; Layman, Boyce, and Criddle) provided the initial economic framework for this report. After reviewing these studies, it was decided to use recently published primary data.

3.1.1 Estimated Impact Tables 1 through 5, found at the end of this report, present estimated Sacramento River impacts. Table A, below, summarizes Tables 1 through 5.

Table A: Summary of Tables 1 through 5

	Year	Fishing Days per Salmon	Dollars per Salmon (1998 dollars rounded to nearest 10)	
			Expenditure	Economic Impact, Output
Table 1	1998	3.13	$300	$550
	1997	no data available	no estimate possible	
	1996	no data available	no estimate possible	
	1995	no data available	no estimate possible	
Table 2	1994	3.83	$360	$680
Table 3	1993	5.66	$540	$1,000
Table 4	1992	5.61	$530	$990
Table 5	1991	6.29	$600	$1,110

Parameters used:
Expenditure Dollars per Fishing Day = $93.85
Output Multiplier for Recreational Fishing in California = 1.853067

Table A, above, summarizes Tables 1 through 5 in terms of the following:

(1) Fishing days per salmon: From 1991 to1998 the days required to catch one salmon decreased 50% (for 1995 through 1997 no creel data are available). These data came from the California Department of Fish and Game, "Sacramento River System Sport Fish Catch Inventory".

(2) Estimated expenditure dollars per salmon: The expenditure per fishing day in 1998 dollars is $93.85 which is a 1996 expenditure per day indexed to 1998 (see Table 7 Column D). This was derived from the 1996 U.S. Fish and Wildlife Service "National Survey of Fishing, Hunting, and Wildlife-Associated Recreation". The expenditure of $93.85 per fishing day was used in Tables 1 through 5 . From 1991 to 1998 the consumer price index increased 19% while the days per fish declined 50% (see Table 7 Columns J and K). Because the percent change in the days per fish is greater than the percent change in prices, the days per fish is more important in determining the change in angler expenditures over the 1991 to 1998 period. Tables 1 – 5 , in the first shaded box, show that the expenditure dollars per salmon range from approximately $300 to $600 in 1998 dollars.

(3) Estimated economic impact in output: For every dollar a sport salmon angler spends along the Sacramento River, approximately $1.85 in total sales is produced within the region. Tables 1 – 5, in the second shaded box, show that the regional impact of one salmon on total sales ranges from approximately $550 to $1,110.

3.1.2 Comparing Estimates with Previous Studies Comparing Table A data with previous studies, we have the following three comparisons.

(1) Fishing Days per Salmon Table A shows that in 1991 the average fishing days per salmon was 6.29 along the Sacramento River. It is interesting to note that the 1984 study prepared by the US Fish and Wildlife Service and the US Bureau of Reclamation used 6.39 fishing days per salmon (see Table 16, page 36, USFWS and USBR in References). Thus, the fishing days per salmon used in the 1984 study approximately equals the fishing days derived from the oldest creel survey data used in this report.

(2) Expenditure Dollars per Salmon Table A shows that the estimated expenditure dollars per salmon range from approximately $300 to $600. The following two studies estimated expenditures per salmon.

Meyer Resources, Inc. estimated that an angler spent about $48.35 in 1983 dollars per salmon (Table 15, page 21). In 1998 dollars, this is approximately $80 per salmon (see Table 7 Column A at the end of this report). This $80 value falls outside of the $300 to $600 range summarized in Table A.

USFWS and USBR estimated that an angler spent about $247.87 in 1983 dollars per salmon (Table 14, page 35). In 1998 dollars, this is approximately $410 per salmon (see Table 7 Column B at the end of this report). This $410 value is falls within the $300 to $600 range summarized in Table A.

(3) Multiplier Table A showed that the multiplier used in this report for recreational fishing is 1.853067. Previous studies have used other multipliers. Meyer Resources Inc. used a 1980 DWR multiplier of 3.49 for recreation services (Meyer, Table 17). USFWS and USBR (p.33) used a 1980 DWR "net income multiplier" of 2.15. Both of these are greater than the multiplier used in this report. The IMPLAN multiplier was used because IMPLAN is specifically a regional impact model and was built to provide multipliers for impact analysis. Further, IMPLAN multipliers are commonly used by economists.

3.2 Economic Impact due to Ocean Salmon Ocean salmon fishing consists of commercial and recreational fishing. The exvessel and expenditure information for both of these activities is contained in Table 6 at the end of this report. The Pacific Fishery Management Council is the source of the data (see References). Table 6 contains information for the time period 1991 to 1998. All dollar values have been indexed to 1998.

3.2.1 Economic Impact of Ocean Commercial Salmon The "exvessel value" is the gross revenue earned by commercial fishermen when they sell their catch to processors at dock-side. The exvessel value estimates the fisherman's cost plus the fisherman's profit. The exvessel value is being interpreted in this report to be the "expenditures" made in the first post-catch market activities. It is the first processing step. Thus, in this report, the exvessel value is used as an expenditure creating ripple effects through the consumer markets.

The Catch Table 6 Column A shows the commercial catch for 1991 - 1998. The catch increases and decreases from year-to-year. There appears to be no pattern.

The Exvessel Values Table 6 Column D gives the "exvessel value" for the total commercial catch. Table 6 Column F shows that the exvessel value per salmon, adjusted to 1998 dollars, decreases (with one exception in 1992) steadily from 1991 to 1998. The range is from a low of $14.15 per salmon in 1998 to a high of $30.46 per salmon in 1992.

The Economic Impact Table 6 Column S provides estimates of the regional impact of commercial salmon fishing on the total sales in California. The impact ranges from a low of $21.59 in 1998 to a high of $46.46 in 1992.

3.2.2 Economic Impact of Ocean Recreational Salmon The data in Table 6 show that the recreational value per ocean salmon is higher than the commercial value per ocean salmon at dock-side. The ocean recreation expenditures only estimate the cost of the ocean boat trips. These expenditure data do not include the cost of travelling from home

to the boat and back home again. Thus, these numbers are a lower bound for ocean recreation expenditures.

The Catch Table 6 Column B shows the recreational catch for 1991 - 1998. As with the commercial catch, the recreational catch increases and decreases from year-to-year. The recreational catch changes in the same direction as the commercial catch in each year. As with the commercial catch, the smallest catch occurred in 1992 and the largest catch occurred in 1995.

The Expenditure Recreational ocean fishing can occur on either a charter boat or on a private skiff. The average expenditure for each type of boat comes from Thomson and Huppert (see References). When adjusted to 1998 dollars, the average expenditure per trip for a charter boat is $108.78 and for a private skiff is $72.50. Table 6 Columns G through K multiply the number of charter boat trips and private skiff trips by the average expenditure per trip producing the total expenditures in each year for each type of boat. Table 6 Column L shows that the estimated expenditure, averaged over the two types of recreational boats, ranges from a low of approximately $83 per salmon in 1995 to a high of $129 per salmon in 1992.

The Economic Impact Table 6 Column U provides estimates of the regional impact of recreational ocean salmon fishing on the total sales in California. The impact ranges from a low of $153.55 in 1995 to a high of $239.59 in 1992.

3.2.3 Weighted Average Economic Impact In order to obtain an average per ocean salmon expenditure, Table 6, in Columns M through Q, calculates a weighted average. The dollars per salmon for commercial is weighted by the percent of ocean catch which was made commercially and added to the dollars per salmon for recreation which is weighted by the percent of ocean salmon caught recreationally. Column Q shows the weighted average expenditure, in 1998 dollars, ranges from a low of $39.24 in 1997 to a high of $63.97 in 1992. Table 6 Column W shows the output impact ranges from a low of $69.34 in 1997 to a high of $111.94 in 1992.

4. Summary Tables B and C below provide summaries of the estimates.

Table B summarizes the estimated expenditures, the basis of economic impact. For each type of expenditure there is a lower bound estimate and an upper bound estimate. The bounds were estimated from the variability in the fishing effort from 1991 through 1998.

Table B: Summary of Expenditures

Estimated Expenditures, 1998 dollars	Lower Bound	Upper Bound
Sacramento River Salmon, dollars per salmon	$ 300	$ 600
Ocean Commercial Salmon, exvessel dollars per salmon	$ 14	$ 30
Ocean Recreational Salmon, dollars per salmon	$ 83	$ 129
Ocean Weighted Average, dollars per salmon	$ 39	$ 63

Table C summarizes the estimated economic impacts in terms of total sales. These are the direct and ripple effects salmon fishing has on the larger economy. The estimated impacts give information about how changing salmon populations can affect the local economy.

Table C: Summary of Regional Output (Total Sales) Impacts

Estimated Output Impacts, 1998 dollars	Lower Bound	Upper Bound
Sacramento River Salmon, dollars per salmon	$ 545	$ 1,100
Ocean Commercial Salmon, dollars per salmon	$ 22	$ 46
Ocean Recreational Salmon, dollars per salmon	$ 154	$ 239
Ocean Weighted Average, dollars per salmon	$ 69	$ 112

Increasing the salmon population increases economic activity. The current data indicate that every additional dollar spent on salmon fishing produces almost one additional dollar in total sales within the region.

The method and data sources in this report can be used in the future to estimate the economic impact of Clear Creek salmon production. Most of the data used in this report are publicly available. The data can be easily updated by loading Tables 1-7 into Excel. In addition, all that is needed is an estimate of the number of adult Clear Creek salmon caught and kept along the Sacramento River and in the ocean.

Appendix A A Mini-Crash Course in Economics

A.1 Value Economic value is strictly and narrowly defined by economic behavior in a context of supply and demand. Value is the amount of money a person is willing to give up in order to obtain something. Or, it is the amount of money required to compensate a person for the loss of something. Measuring economic value is an attempt to predict economic choices among various conditions (Peterson, Driver, and Brown, p.12). Correctly estimating the value of salmon means, for example, predicting the water allocation choice between instream water use for salmon and diverted water use for irrigation or hydropower.

In addition to fishing, the social value for salmon would include the two broad categories of eco-tourism and other values. Eco-tourism is tourism based on natural attractions. Two obvious market examples are jet boat rides on the Sacramento River, and rafting trips of the Sacramento River Preservation Trust. Other examples include picnics, camping, and bicycling. The difficult part of this work will be to isolate that part of the value which is due to salmon. Other values for salmon are those which are not at all represented in market activities. These are values which people hold but for which there is no market mechanism for expressing their value. People might value the ecological aspects of salmon. For example, increasing salmon runs increases contributions to the food chain. Another example, increasing salmon runs increases the nutrient cycling from the ocean back to the upland areas. People might value the social aspects of salmon. For example, some people value knowing salmon are flourishing even if they never see a salmon or visit the area – this is known as an "existence value". And some people might value living near salmon streams – this is known as an "amenity value". For more detail about social value, see Randall, or Nicholson, or USEPA given in the References.

There are various methods for estimating value. In part, this is because there are various components of social value to estimate. For salmon there are several possible components: value to recreational anglers, value to people who want to eat salmon, value to people who enjoy just seeing the salmon, and value to people who want to have salmon in the water even if they never eat, catch, or see salmon. In part, there are various estimation methods because of data availability. For example, there are regularly published data which indicate how much people spend for recreational fishing and how much people spend to buy salmon at dock-side from commercial anglers. However, there are no regularly published dollar data about how important salmon are for viewing or just for existence. To obtain the latter values requires significant research work.

Willingness-to-Pay (WTP) Willingness-to-pay (WTP) is the total gross value of, in this case, salmon. WTP is composed of two parts: (1) expenditure, and (2) consumer surplus (see USEPA p. 61).

Expressed as an equation:

Willingness-to-Pay = Expenditure + Consumer Surplus. (Equation 1)

In Equation 1, "expenditure" is the amount of money people actually spend to fish salmon, or to purchase salmon as food, to view salmon, or to preserve salmon for future generations. "Consumer surplus", on the other hand, is the value people receive beyond the amount they actually spend. Stated another way, consumer surplus is that part of the total gross value which is lost when the salmon population disappears or diminishes.

To estimate WTP one needs to estimate a set of demand curves: a demand curve for recreational salmon, a demand curve for commercial salmon, a demand curve for people who want to simply see salmon in the river, and a demand curve for people who want salmon in the river even if they do not expect to fish, or eat, or see the salmon. Each demand curve traces out the amount of salmon that will be purchased at each price level. When the price of salmon fishing or preservation increases sufficiently, the amount of fishing days or the amount of preservation will decrease, assuming all other parameters remain constant. This occurs because people have constraining budgets and cannot afford to pay endlessly higher prices to fish or to preserve the fish. Thus, the demand curve contains both desire and income characteristics. The higher the desire, the more willing people are to pay. The higher the income, the more able people are to pay. Desire and income work together to produce the observed behavior: When prices rise high enough, the quantity demanded decreases. There are several ways to estimate a demand curve: travel-cost method, land-value method (also known as hedonic property value method), contingent valuation techniques (Randall, pp.300-309), and the "averting behavior" method (USEPA, p.79). These methods require many more resources than were available for this report.

To estimate WTP, one also needs the quantity of salmon which is currently demanded for each demand curve. Having the demand curves and the quantity of salmon for each demand curve, one could estimate the change in total willingness-to-pay (WTP) for each segment of the population by integrating each demand curve from the currently observed quantity of salmon to the increased level of salmon due to a change in the ecosystem (such as a change in the quantity of instream water, a change in quality of water, or a change in gravel conditions). WTP is most commonly considered in terms of changing quantities. It is the value of an increment in the output of salmon due to, in this case, the restoration of Clear Creek (see Randall, p. 297, for a general discussion of WTP). Summing the WTP over all demand curves gives the change in total gross social value of salmon. WTP has also been explained as the tradeoff people make in order to fish or preserve salmon (USEPA, p. 60).

Expenditures Expenditure, as can be seen in Equation 1, is one component of WTP. An expenditure is an amount of money a person spends to obtain some aspect of salmon: recreation, food, ecosystem contributions, or aesthetics. Expenditures are usually *not* an estimate of the value of salmon. To see how expenditures relate to value, consider the following: Suppose a person plans to spend $700 this year for a vacation of salmon fishing. The $700 is the expenditure part of WTP. We assume that the gross value of salmon to this person is at least $700. Otherwise, the angler would not plan to spend that much money. But, suppose, after planning the vacation, the angler learns there are no salmon to fish this year. What would this angler do with the $700? There are two possibilities. The first possibility is that the angler still spends the money on salmon. If the angler were to, for example, donate the $700 to a Save-the-Salmon Fund, then the $700 would be a lower bound for the value of salmon to that person. In this case, expenditure *would be* a lower bound estimate of salmon value (remember, we still have the consumer surplus part of WTP). The second possibility is that the angler spends the money on something else. If the angler were to spend the money on another vacation, then the $700 represents the value of a vacation, not the value of salmon. In this second case, the value of salmon is contained only within the consumer surplus part of WTP for salmon.

Expenditures have been estimated in this report and form the basis for estimating economic impact. Every dollar an angler spends increases total sales, employment, and income to those who directly or indirectly serve the angler. More is written about impact later in this appendix.

Consumer Surplus Recalling Equation 1, consumer surplus is the value people receive for which they did not have to spend money. Stated another way, consumer surplus is that part of the total gross value which is lost when the salmon population disappears or diminishes. See Randall (Figure 16.2, page 295) or Nicholson (Chapters 5 and 6) for a more complete discussion of consumer surplus. Consumer surplus is that part of total value which is due only to salmon. It is that part of total value which cannot be substituted by any other good or service. To see this, reconsider the hypothetical example given above.

Reconsider the person who had planned to spend $700 for a vacation of salmon fishing along the Sacramento River. Most likely, this person would have enjoyed salmon fishing more than the $700 budgeted for the trip. After learning that salmon fishing was closed this year, what would the angler really lose? The angler will not lose the $700 worth of value because this $700 will buy value elsewhere. The $700 will either buy another type of vacation or it will provide the satisfaction of donating to Save-the-Salmon Fund. What the angler does lose is the value which only the salmon experience would have brought and for which there is no substitute. Let us suppose the angler decides to spend the $700 on water skiing. The angler will most likely enjoy some consumer surplus from water skiing. However, that angler is most likely to suffer loss because the first choice was to fish for salmon. The second choice was to water ski. Thus, it reasonable to expect that the consumer surplus from salmon exceeds the consumer surplus from water skiing. The dead weight loss, the loss which cannot be recovered by substitution, is the difference in

consumer surplus. The loss is the salmon consumer surplus minus the water skiing consumer surplus. The loss is the value which salmon brings and for which there are no substitutes.

Dr. David Gallo conducted a literature review looking for estimates of consumer surplus. His literature review was funded by the Anadromous Fish Restoration Program of the U.S. Fish and Wildlife Service. He found three studies which estimated consumer surplus for river salmon fishing. The rivers were not in California. In 1998 dollars, the estimated values range from a low of $17.35 for Chinook Salmon in Alaska (Layman, Boyce, and Criddle) to a high of $142.80 for Salmon in Idaho (Gorden, Chapman, and Bjornn). The only California estimate was for saltwater salmon fishing and that ranges from $89.23 to $440.21 (Huppert). Thus, we do not have an estimated consumer surplus value which clearly applies to California rivers, nor do we have estimates which are within the same order of magnitude. The known range of estimates in 1998 dollars is $17.35 to $440.21.

A study conducted by USFWS and USBR estimated the willingness-to-pay (WTP) for salmon fishing. In 1998 dollars, they estimated a WTP of $930 per salmon (see Table 7 Column C). The $930 estimate for WTP is about $330 greater than the highest per salmon expenditure of $600 given in Table 5 of this report. Rearranging Equation 1, we see this $330 difference implies a consumer surplus value:

$330 Consumer Surplus = $930 Willingness-to-Pay - $600 Expenditures.

This $330 magnitude falls within the $17.35 - $440.21 range for consumer surplus Dr. Gallo found in his literature review. However, without further investigation, it is not appropriate to use this $330 as an estimate of consumer surplus because we are not sure if the $930 WTP estimate from the USFWS/USBR and $600 expenditure estimate of this report came from the same set of assumptions.

The true value of salmon is that value which only salmon brings. Summing the consumer surplus of each demand curve over all demand curves produces the total net social value of those who want salmon for all of the various reasons. The net social value is the correct indicator of salmon's social value. Estimating this value requires enormous research work. However, estimating this value will more likely represent public support for salmon when competing uses of water become more valuable. Recently, in California, the use of water for electric power generation has become more competitive with instream uses. If the value of salmon were estimated using consumer surplus (estimating the value which only salmon brings and for which there is no substitute), then the increasing competition with power generation will have been somewhat anticipated because tradeoffs would have been considered in the salmon valuation. The most compelling reason to use consumer surplus is sustainability in policy implementation. When a policy truly provides value to people, people are more likely to continue supporting the policy even after that policy becomes more expensive to maintain. That is, when the opportunity cost of salmon increases because of the higher value of using water for other purposes, the poli-

cy to deliver water to salmon is more likely to be maintained when consumer surplus is estimated.

A.2 Impact Recall, in economics "value" and "impact" are different. Impact is a market consequence of spending. Whenever an angler spends one dollar, that one dollar circulates through the economy and creates more than one dollar's worth of products and services. The one dollar which is actually spent by the angler is called a "direct effect". That dollar directly goes into the local and regional economy to purchase restaurant meals, lodging, transportation, etc. In addition, there are ripple effects (known in some literature as "secondary and tertiary effects", and also known as "indirect and induced effects"). In this report, an average Sacramento River angler is assumed to spend about $93.85 per fishing day. Some anglers spend more, some spend less. That $93.85 per day is spent directly on restaurants, a motel, fishing supplies, etc. Once that $93.85 is spent by the angler, that money ripples through the regional economy. That $93.85 multiplies in the regional economy because the restaurant owner purchases supplies and labor and each of these, once employed, purchases supplies and/or labor from others. Similarly, the motel and retail fishing supply stores purchase their inputs and labor which, in turn, purchase their needs.

A "multiplier" is used to estimate the impact that salmon activities have on the local/regional economy. This report uses a multiplier of 1.853067 for recreational fishing and 1.525288 for commercial fishing. These multipliers were obtained from 1998 IMPLAN proprietary data purchased by USDA NRCS in California (MIG 1998 in References). The IMPLAN model does not estimate the duration of this impact. That is, we do not know for how many years the multiplier will be 1.853067 for recreational fishing. This multiplier could be relevant for a few years or for many years. In the short run, when the $93.85 per fishing day ripples through the Sacramento River area, it provides an additional $79.77 in total sales.

Table A.1, below, interprets the IMPLAN output multipliers for both recreational and commercial fishing. For reading ease, the multipliers have been rounded to two decimal places. Consider the recreational multiplier. Table A.1 states that for every $1.00 spent on recreational salmon fishing, a total of $1.85 worth of products and services is generated in the local and regional economy. Table A.1 shows that the first infusion is the dollar actually spent by the angler. This is the "direct effect". That dollar produces 30 cents as an "indirect" effect and 55 cents as an "induced" effect. The text in Table A.1 provides the definition for each of these effects.

Table A.1: Explaining the Multipliers

Recreational Multiplier	Commercial Multiplier	Definitions
$1.00	$1.00	**Direct effect** is the money actually spent by the angler (or the dock-side processor) in the local regional economy for food, lodging, transportation, etc.
$ .30	$ .19	**Indirect effect** is the ripple effect of those industries within the local region which are one step removed from those industries which directly serve the recreation angler or dock-side processor. These are typically industries such as food supplies to restaurants, construction services to motels, repair and maintenance to transportation, etc.
$ .55	$ .33	**Induced effect** is the ripple effect of increased household and/or institutional income. Thus, when people who work in the food, lodging, and transportation businesses which serve salmon anglers or processors earn money, they spend some of it within the local region.
$1.85	$1.52	**Total effect** is the sum of the direct effect, the indirect effect, and the induced effect.

References

California Department of Fish and Game, *Sacramento River System Sport Fish Catch Inventory*, 1995 publication date for the 1991 through 1994 data, prepared by L.H. Wilxom, J. Pisciotto, and C. Lake. 2000 publication date for the preliminary 1998 data.

Charboneau and Hay, 1978, "Determinants and Economic Values of Hunting and Fishing", Transactions, 43rd North American Wildlife and Natural Resources Conference, 391-403.

Gorden, Chapman, and Bjornn, 1972, "Economic Evaluation of Sport Fisheries: What Do They Mean?", Transactions, American Fisheries Society, 293-331.

Huppert, 1989, "Measuring the Value of Fish to Anglers: Application to Central California Anadromous Species", Marine Resource Economics 6, 89-107.

Layman, Boyce, and Criddle, 1996, "Economic Valuation of the Chinook Salmon Sport Fishery of the Gulkana River, Alaska, Under Current and Alternative Management Plans", Land Economics 72(1), 113-128.

Meyer Resources, Inc;, 1985, *The Economic Value of Striped Bass, Chinook Salmon, and Steelhead Trout of the Sacramento and San Joaquin River Systems*, Anadromous Fisheries Branch Administrative Report No. 85-03, submitted February 1985.

Miernyk, William H., 1967, *The Elements of Input-Output Analysis*, Random House, New York.

MIG 1998: Minnesota IMPLAN Group, Inc.; 1725 Tower Drive West, Stillwater, MN 55082. website: www .implan.com IMPLAN multipliers are output from IMPLAN software and data purchased by Watershed Planning Services, USDA-NRCS, Davis, California.

Nicholson, Walter, 1989, *Microeconomic Theory: Basic Principles and Extensions (4th ed.)*, The Dryden Press, Hinsdale, Illinois.

Pacific Fishery Management Council, 2000, *Review of 1999 Ocean Salmon Fisheries*, Portland, Oregon.

Peterson, George L., Beverly L. Driver, and Perry J. Brown, 1990, "The Benefits and Costs of Recreation: Dollars and Sense", in *Economic Valuation of Natural Resources*, Rebecca L. Johnson and Gary V. Johnson (eds), Westview Press, Boulder.

Randall, Alan; 1981, *Resource Economics: An Economic Approach to Natural Resource and Environmental Policy*, Grid Publishing, Inc., Columbus, Ohio.

Thomson, Cynthia J. and D. D. Huppert, 1987, *Results of the Bay Area Sport fish Economic Study (BASES)*, NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-78.

USEPA Office of the Administrator, 2000, *Guidelines for Preparing Economic Analyses*, EPA 240-R-00-003, September.

USFWS and USBR; 1984, US Fish and Wildlife Service, Division of Ecological Services, and the US Bureau of Reclamation, Mid-Pacific Region; *Evaluation Report of the Potential Impacts of the Proposed Lake Red Bluff Water Power Project on the Fishery Resources of the Sacramento River*, Sacramento