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An Economics Review of North Atlantic Salmon Restoration: U.S. Fair Share Working Papers

by

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Preface

The three economics working papers collected in this report were prepared for presentation and discussion by the informal group that met in Copenhagen on January 20-22, 1988 to discuss fair sharing of Atlantic salmon. The papers address three terms of reference which the delegations from Canada, Greenland, Denmark, and the United States previously agreed upon.

U.S. Fair Share Working Paper No. 3(3) covers total costs and benefits of the restoration programs in the United States between the years 1960 and 2012, or 25 years from what was then the current year (i.e., from 1987). The delegations decided that rivers shared by Canada and the United States should be excluded from the analysis. U.S. Fair Share Working Paper No. 3(4) discusses investment in salmon restoration in terms of costs per adult returning to New England rivers. Finally, U.S. Fair Share Working Paper No. 3(5) identifies and briefly expands on additional socioeconomic topics including net national benefits and economic impacts from salmon restoration.

U.S. Fair Share Working Paper Number 3(3)

Total Economic Costs and Benefits of North Atlantic Salmon Restoration in the United States, 1960-2012

Introduction

This paper presents an economic assessment of total costs and benefits of North Atlantic salmon restoration in rivers in the northeastern United States. Although restoration of salmon in New England began before 1960 and will, if completed, benefit many generations of recreationists and preservationists, the assessments are limited to the years 1960 to 2012, or 25 years after the current year, 1987. Also, the analysis is limited to **direct** costs and benefits associated with recreational fishing for salmon and with the diversion of water from hydroelectric plants to fish passages. Indirect economic impacts related to multiplier effects are highlighted in U.S. Fair Share Working Paper No. 3(5). Finally, separate assessments are reported to the extent possible for each river system. As directed, the international rivers, St. Croix, Aroostock, Meduxnekeag, and Prestile are excluded.

This paper uses the economic perspective on costs and benefits. In the words of economist Kenneth Arrow (1972) when discussing criteria for Federal investment in water resources:

> *"Investment is the allocation of current resources, which have alternative productive uses, to an activity whose benefits will accrue over the future. The benefits take the form of productive goods and services. The cost of an investment is the benefit that could have been derived by using the resources in some other activity."* (p. 410)

In our case, the United States government, along with other public agencies and private companies, is "producing" North Atlantic salmon for the direct, long term benefit of recreationists and other citizens of the United States. The direct cost of this investment is comprised of the benefits forgone by not using the same resources to produce other valued commodities, including the value of forgone electricity. However, it should be understood that this paper is not a cost-benefit analysis of North Atlantic salmon restoration in the United States--the allocative efficiency of salmon restoration is not at issue here. Instead, we concern ourselves with only the potential **total** economic benefit of salmon restoration which is threatened by interception.

The paper is arranged as follows. For the benefit of "non-economists," Section II describes the conceptual framework used in the assessments. The cost assessment is reported in Section III followed by the benefit assessment in Section IV. Section V summarizes the results.

II. The Conceptual Framework

Definitions

This section is written to convey a basic understanding of the economic concepts used in this paper. Since this paper is not the place to "teach" economics, the reader is asked to see Gittinger (1982) or another book on project evaluation for a more detailed explication.

It is important to distinguish between financial and economic costs. **In ordinary usage, "cost" usually means monetary expenditure, or the financial outlay of currency.** Thus, to an accountant or budget manager, cost is synonymous with expenditure. In contrast, economists focus on the opportunities that are forgone when productive resources such as labor, capital, and natural resources are used to produce a good or service. For example, the labor, concrete, steel, and land used to construct a fish passage obviously cannot be used to construct, say, a bridge or highway. **The value of the foregone opportunity--that is, the value to society of what these resources would otherwise have been used to produce--is an economic, or opportunity cost of fish passage construction.** Thus, the opportunity cost of these resources is the value of production and consumption that is foregone. Only opportunity costs should enter an economic analysis of public investments.

Next consider how one **measures** opportunity costs. One awkward possibility is to count the number of man-hours, the weight of materials, and the area of land that are used in production. Alternatively, market prices often serve as an appropriate standardized measure of resource values, particularly when the markets for the productive resources are competitive. Consequently, opportunity costs and financial costs may be **mathematically** equal. However, there are many cases when these separate types of costs differ. For example, the financial cost of hiring unemployed workers for a public project is simply equal to expenditures on salaries and benefits. In contrast, the economic, or opportunity cost of using unemployed labor is zero since the workers were not producing goods or services anyway. A more pertinent example concerns the argument that the diversion of water from hydroelectric power plants to fish passages may increase the price of electricity to some households in New England, and that this is an additional cost of salmon restoration. Certainly, the households will view the price increase as a higher financial cost, but from a larger, societal point of view, the exchange of income between households and utility companies is merely a **transfer payment**--a zero sum effect, if you will.[1] Finally, interest paid by the federal government and utility companies on loans for capital construction (for example, hatcheries and fish passages) are transfers of income from taxpayers and utility companies to lending agencies. Interest on debt is not an economic cost, however, since it does not result directly in a change in the production or quality of goods and services.

We have been discussing opportunity costs in terms of foregone benefits. That is, economic value, whether benefits in the case of gains or opportunity costs in the case of losses, is determined by the satisfaction of human wants. In economics, this satisfaction is measured by an individual's **maximum willingness-to-pay** for a commodity. **THE AGGREGATE BENEFIT, THEN, OF A PARTICULAR PUBLIC INVESTMENT IS THE SUM OF EACH INDIVIDUAL'S MAXIMUM WILLINGNESS-TO-PAY.** As for opportunity costs, market prices often reveal these benefits. However, common property and public goods aspects of a North Atlantic salmon resource necessitate the use of other methods to elucidate benefits. These benefits, addressed in part in a previous U.S. working paper written by Kay *et al.* (1987) and provided at the Edinburgh meeting on fair sharing, include recreational fishing, aesthetic values such as observing salmon runs, and "existence" values related to the preservation of salmon in New England rivers and to bequesting North Atlantic salmon stocks to future generations. [2]

There you have it. Economic costs are opportunity costs measured in terms of the benefits of forgone production and consumption, and economic benefits are best measured in terms of maximum willingness-to-pay. This perspective on the use of productive resources correctly ignores mere transfers of income between parties and avoids counting costs and benefits more than once.

A Graphical Presentation

Several methods can be used to measure the economic value of natural resources such as North Atlantic salmon. Two approaches--replacement cost and willingness-to-pay--are described here with the aid of a graph.

The basic assumption of the replacement cost approach is that the economic benefits of a natural resource are at least as great as the minimum opportunity cost of restoration. In our case, the opportunity costs of restoring North Atlantic salmon include capital costs (for example, hatcheries, fish passages, vehicles), operations and maintenance costs (such as personnel, smolts, repair, enforcement, trapping, and trucking), administrative costs, and research costs. In Figure 3(3).1, the average costs of salmon restoration are portrayed in stylized fashion by line **AC**.

In contrast, maximum willingness-to-pay is the ideal measure of restoration benefits. It is represented in Figure 3(3).1 by the well known relationship, a demand curve (line **D**). In principle, an aggregate demand curve is a locus of the maximum that society is willing to pay for each additional adult salmon returning to New England rivers. Therefore, the area beneath a demand curve and between stock sizes 0 and, say, S* is a cumulative measure of maximum willingness-to-pay. This area--abS*0--is clearly greater than the total minimum opportunity cost of restoration which is portrayed in Figure 3(3).1 by area fcS*0. The residual, net benefit--area abcf--is called **consumer surplus**.

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[1] In contrast, water diverted from power plants to fish passages will reduce the production of electricity. The opportunity cost of the diverted water is the value to households of the forgone power. This economic cost is included in the following cost assessment.

[2] These benefits are discussed in more detail in Section IV.

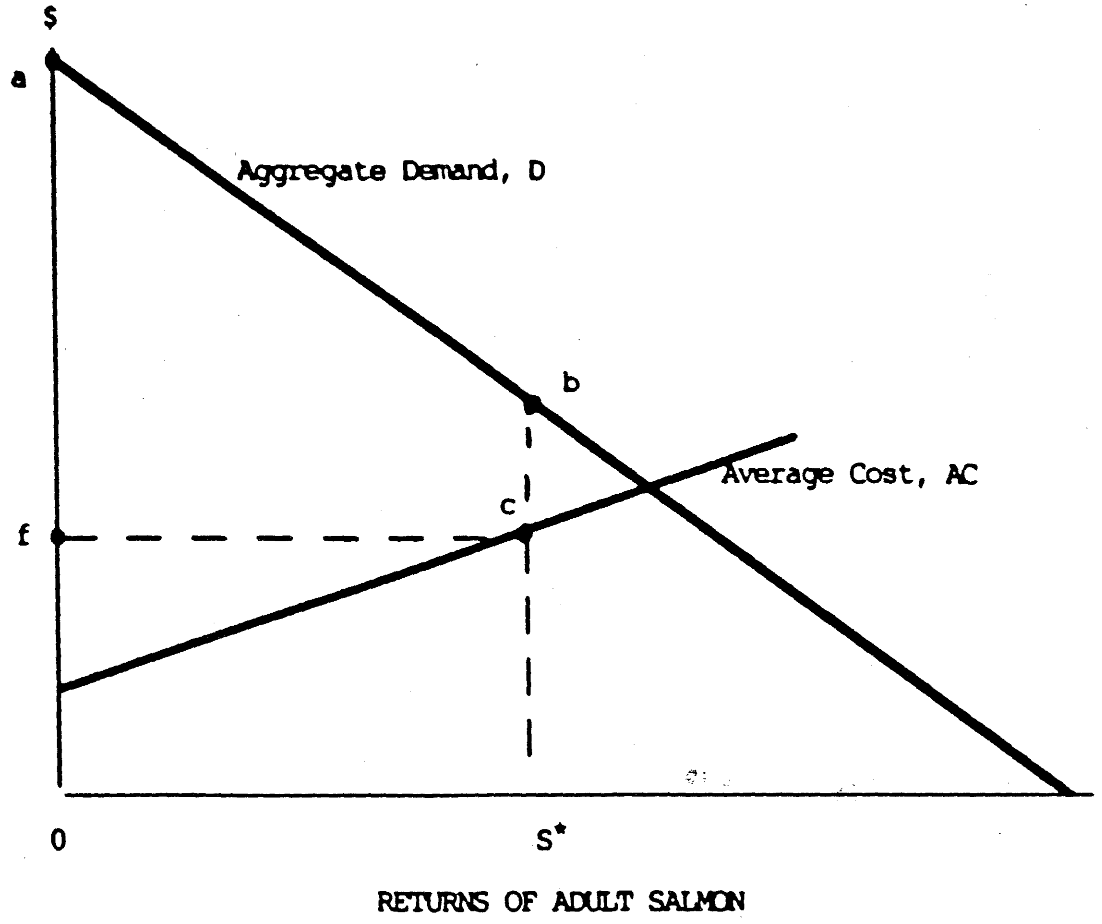

Figure 3(3).1. An aggregate demand curve (D) traces society's maximum willingness-to-pay for each additional return of adult salmon. An average cost curve (AC) traces the average opportunity cost of achieving the given number of returns.

The following sections report approximations of these two measures of the total economic value of salmon restoration in New England rivers. Costs are examined in Section III. Several measures of maximum willingness-to-pay are reported in Section IV. The latter measures are drawn from the environmental economics literature. The best available information was used to derive these measures.

III. Opportunity Costs of North Atlantic Salmon Restoration

Cost Categories

It bears repeating that the economic costs of salmon restoration are measured by the opportunity costs of the productive resources used to restore the North Atlantic salmon stocks. Accordingly, we avoid exaggerating total costs by excluding transfer payments from the analysis. Unless otherwise stated, the information for this assessment was generously provided by Dan Kimball of the U.S. Fish and Wildlife Service in Newton Corner, Massachusetts. As is usually the case for this type of analysis, market prices are used as measures of opportunity costs.

Opportunity costs can be classified in a number of ways. In terms of time, there are past, current, and future opportunity costs. Opportunity costs can also be classified as private costs related to fish passages around hydroelectric dams, and public, or government costs associated with gathering information (such as research and monitoring), enforcement (such as enforcing catch quotas), and administration. Finally, costs are often broken down into capital, operations and maintenance, research, and administration categories. We use a combination of these three classifications.

Tables 3(3).1 and 3(3).2 list the simple sums of past, current, and future opportunity costs of salmon restoration in New England. Government costs include hatchery construction, habitat enhancement, fish production, research, and law enforcement by the Fish and Wildlife Service, the Forest Service, the National Marine Fisheries Service, and the states of Connecticut, Massachusetts, and Maine. Private costs incurred by utility companies are for constructing, operating, and maintaining fish passages around hydroelectric dams. These opportunity costs, which are reported separately for river basins, are grouped into capital and all "other" costs. (The latter category includes all opportunity costs other than capital costs.) Table 3(3).3 lists past, current, and future opportunity costs due to reduced hydroelectric power for each river basin.[3]

The simple sum of all opportunity costs reported in Tables 3(3).1, 3(3).2, and 3(3).3 between the years 1960 and 1986 is approximately $101.5 million. (All opportunity costs and benefits in this paper are reported in constant 1986 $US.) In addition, opportunity costs between the years 1987 and 2012 are expected to be about $162.3 million if one simply adds the time series. However, it is routine for economists to use the **present value criterion** when aggregating current and future opportunity costs. The present value criterion, which "discounts" future opportunity costs to their current, or present value, incorporates the fact that future resource costs are valued less today. That is, resources invested today could yield a time series of benefits in another use. The rate at which these forgone benefits would accumulate is the discount rate. Mathematically, the present value in year 1987 (PV_{1987}) of a future opportunity cost incurred in year t (OC_t) is

3(3).1a
$$PV_{1987} = OC_t / (1 + r)^t$$

where r is the discount rate in decimal form (for example, 4% is 0.04). By extension, the total present value of a time series of future opportunity costs ending in time period T (for example, 25 years, or 2012-1987=25) is:

3(3).1b
$$PV_{1987} = \sum_{t=0}^{t=T} OC_t / (1 + r)^t.$$

(Notice that the value of t in the year 1987 is zero.)

In contrast, past opportunity costs must be **grown** to their present value in order to account for the time series of foregone benefits. Accordingly, the present value in the year 1987 of a past opportunity cost is

3(3).2a
$$PV_{1987} = OC_t (1 + r)^t$$

and the present value of a series of past opportunity costs is the summation:

3(3).2b
$$PV_{1987} = \sum_{t=0}^{t=T} OC_t (1 + r)^t$$

where T is the most distant year in this exercise (that is, 1987-1960=27).

The present values of past and current/future opportunity costs are reported in Table 3(3).4. Inflationary expectations were not built into the calculations since inflation is a

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[3] All past, current, and future capital costs were spread evenly across years within the appropriate time periods. Accordingly, future "other" costs and the opportunity costs of forgone hydroelectric power were increased incrementally at a constant rate to reflect the gradual addition of capital stock. In contrast, "unknown" other costs and forgone hydroelectric power for the past (that is, for the years 1960-1986) were indexed to past capital costs by multiplying past capital expenditures (derived as just explained) by the observed ratios of variable costs to future capital costs. We used Kay *et al.*'s (1987) value of 12 cents per kilowatt hour as the opportunity cost of forgone hydroelectrc power.

Table 3(3).1. Public opportunity costs of North Atlantic salmon restoration ($US million in 1986)

		Past 27 years (1960 to 1986)		Current/Future 26 years (1987 to 2012)	
State	**River Basin**	**Capital**	**Other** [a]	**Capital**	**Other** [a]
ME	Androscoggin	0	0	0.11	2.12 (2.4)
	Kennebec	0	0	0.55	10.69 (12.3)
	Penobscot	19.40	13.94 (40.1)	1.15	22.45 (25.8)
	Royal	0	0	0.06	0.12 (0.1)
	Saco	0.44	0.35 (1.0)	0.19	3.64 (4.2)
	St. George	0	0	0.01	0.24 (0.3)
	Union	1.52	1.06 (3.1)	0.10	2.00 (2.3)
NH, MA	Merrimack	1.22	5.93 (17.2)	2.01	17.94 (20.6)
NH, MA, VT, CT	Connecticut	2.56	12.55 (36.4)	1.38	27.03 (31.0)
RI	Pawcatuck	0.12	0.70 (2.2)	0.11	0.94 (1.0)
SUB-TOTALS		$25.3	$34.5	$5.7	$87.2
		$59.8		$92.9	
TOTAL			$152.7		

[a] Other costs refer to operations and maintenance, research, and administrative costs. Percentages of total "other" costs are shown parenthetically.

proportional increase in **all** prices and, therefore, does not reflect a change in the relative scarcity value of a single productive resource. A social discount rate of 4% was used to grow past opportunity costs and to discount current and expected future opportunity costs. Although no single rate of social discounting exists, 4% is a convenient, round number that is within the range of values recommended by Lind (2 to 4.6%; 1982) for Federal projects. A sensitivity analysis is not presented since this review is an exploration of restoration benefits and not an efficiency analysis of restoration.

Table 3(3).2. Private opportunity costs of North Atlantic salmon restoration ($US million in 1986)

		Past 27 years (1960 to 1986)		Current/Future 26 years (1987 to 2012)	
State	**River Basin**	**Capital**	**Other** [a]	**Capital**	**Other** [a]
ME	Androscoggin	2.0	0.08	6.1	0.34
	Kennebec	0	0	10.7	1.70
	Penobscot	1.3	0.50	8.0	3.57
	Royal	0	0	0	0.02
	Saco	0	0	4.0	0.58
	St. George	0	0	0.2	0.04
	Union	0	0	0.4	0.32
NH, MA	Merrimack	5.6	0.98	9.9	2.71
NH, MA, VT, CT	Connecticut	29.8	0.015	11.7	4.29
RI	Pawcatuck	0.1	0	0.9	0.15
SUB-TOTALS		$38.8	$1.6	$51.9	$13.7
		$40.4		$65.6	
TOTAL		$106.0			

[a] Other costs refer to operations and maintenance, research, and administrative costs.

The present value of opportunity costs for the total expected investment (past, current, and proposed, but excluding the boundary rivers) is approximately $299.6 million. This opportunity cost represents a very large commitment by the United States to North Atlantic salmon restoration. Past and current/future present values from Table 3(3).4 can be roughly prorated to river basins using the percentages listed in Table 3(3).1 for "other" costs.

Conclusions

The $299.6 million approximation probably underestimates the true present value of opportunity costs of the U.S. North Atlantic salmon restoration project. First, opportunity costs prior to the year 1960 and those now planned for after the year 2012 were excluded. In addition, it was not possible to consider contingencies for changes in the relative value of resources used in salmon restoration. In particular, the opportunity cost of forgone hydroelectric power is likely to increase relative to that for other productive resources in the U.S. economy, but the size of the relative price change during the next 25 years would be conjectural. These calculations also exclude the significant commitment of time and resources made by over 50 fishing organizations in New Eng-

Table 3(3).3. Opportunity cost of reduced hydroelectric power ($US million in 1986)

State	River Basin	Past 27years (1960 to 1986)	Current/Future 26 years (1987-2012)
ME	Androscoggin	0.02	0.09
	Kennebec	0	0.47
	Penobscot	0.14	0.99
	Royal	0	0.01
	Saco	0	0.16
	St. George	0	0.01
	Union	0	0.09
NH, MA	Merrimack	0.27	0.75
NH, MA, VT, CT	Connecticut	0.85	1.19
RI	Pawcatuck	0.004	0.04
SUB-TOTAL		$1.3	$3.8
TOTAL		**$5.1**	

land, including the Atlantic Salmon Federation, Restoration of Atlantic Salmon in America, Penobscot Salmon Club, and Connecticut River Salmon Association. Finally, the exclusion of costs associated with salmon restoration in the boundary rivers is a significant omission. From a strict economic perspective, investment in these rivers is a further economic cost that should be included. When included, the present value of salmon restoration costs increases by $41.7 million to $341.3 million [Table 3(3).4].

IV. Benefits of Salmon Restoration

As stated in Section II, economic benefits are most appropriately measured by maximum willingness-to-pay. Nevertheless (and contrary to popular belief), a market is not necessary for the existence of economic benefits. Indeed, markets (and prices) emerge from economic behavior when demand exists, costs of supply are low relative to demand, commodities are divisible into manageable units, and ownership by buyers and sellers is exclusive. In these cases, benefits are **revealed** by price. In other cases, maximum willingness-to-pay must be elucidated by other demand revealing methods such as the willingness-to-pay study reported by Kay *et al.* (1987).

Benefit Categories

The impetus for restoration of North Atlantic salmon to rivers in New England was to restore opportunities for recreational salmon fishing. Among the factors which are likely to affect recreational benefits there are the expected catch rate, the size of individual

Table 3(3).4. Present value of opportunity costs of salmon restoration ($US million in 1986)[a]

Area	**Past** **27 years** **(1960 to 1986)**	**Current/Future** **26 years** **(1987 to 2012)**	**Total** **53 years** **(1960 to 2012)**
Excluding boundary rivers	$189.7	$109.9	$299.6
Including boundary rivers	$191.6	$149.7	$341.3

[a] The interested reader can roughly prorate these costs to individual river basins with the percentages reported in Table 3(3).1 for future "other" costs.

fish, and, of course, the consumption of salmon. However, economic valuation is not limited to harvesting and consumption alone. Indeed, aesthetic or, non-consumptive use values are enjoyed by those who either visit hatcheries and/or observe salmon runs from river banks and observation areas at dams. This value should not be underestimated given the historical evidence that in 1879 "hundreds" of people from Bristol, New Hampshire came to observe eight adult salmon laying in a pool in the Pemigewassett River (The Bristol Enterprise, August 9 and 16, 1879). Nowadays, tens of thousands of people visit salmon hatcheries and viewing centers at fish ladders annually. Finally, each year Americans demonstrate a great willingness-to-pay to restore severely depleted wildlife populations. Contributions to conservation organizations are usually made without expectation of personal use benefits. Concerning salmon restoration, many people will undoubtedly derive personal satisfaction merely from knowing that salmon have been restored to their native rivers (preservation value) and/or that the restored stocks are available for use by others, particularly future generations (bequest value). Together, these values are referred to as existence values. **ALTHOUGH ECONOMIC RESEARCH INTO EXISTENCE VALUES, AND TO AN EXTENT NON-CONSUMPTIVE USE VALUES, IS A RELATIVELY NEW APPLICATION OF ECONOMIC THEORY, RECENT STUDIES SHOW THAT EXISTENCE BENEFITS OFTEN RIVAL USE VALUE.**

Recall that the opportunity costs of North Atlantic salmon restoration are for increasing the stock size of salmon returning to rivers in New England. In turn, stock size affects a number of factors which determine demand and, therefore, benefits. Typically, economists use the number of recreation days as the quantity variable in demand models. The value of a recreation day depends on a number of factors including catch rate for anglers and observation rate for wildlife observers, both of which are determined in part by stock size. Similarly, aesthetic benefits depend on the number of salmon actually observed in their environment. Other factors likely to affect the economic value of a recreation day include income, salmon consumption, travel costs, uncertainty about future supply, and uncertainty about future demand.

As for catch rate, the last four factors are affected either directly or indirectly by interception. That is, salmon consumption is affected by stock size; travel costs (part of the "price" of fishing) is determined by distance to the nearest recreation site which has a suitable salmon population; supply uncertainty depends directly on the unknown extent of future interception and its effect on stock sizes; and demand uncertainty is affected by the future year that salmon stocks reach a suitable size for fishing.

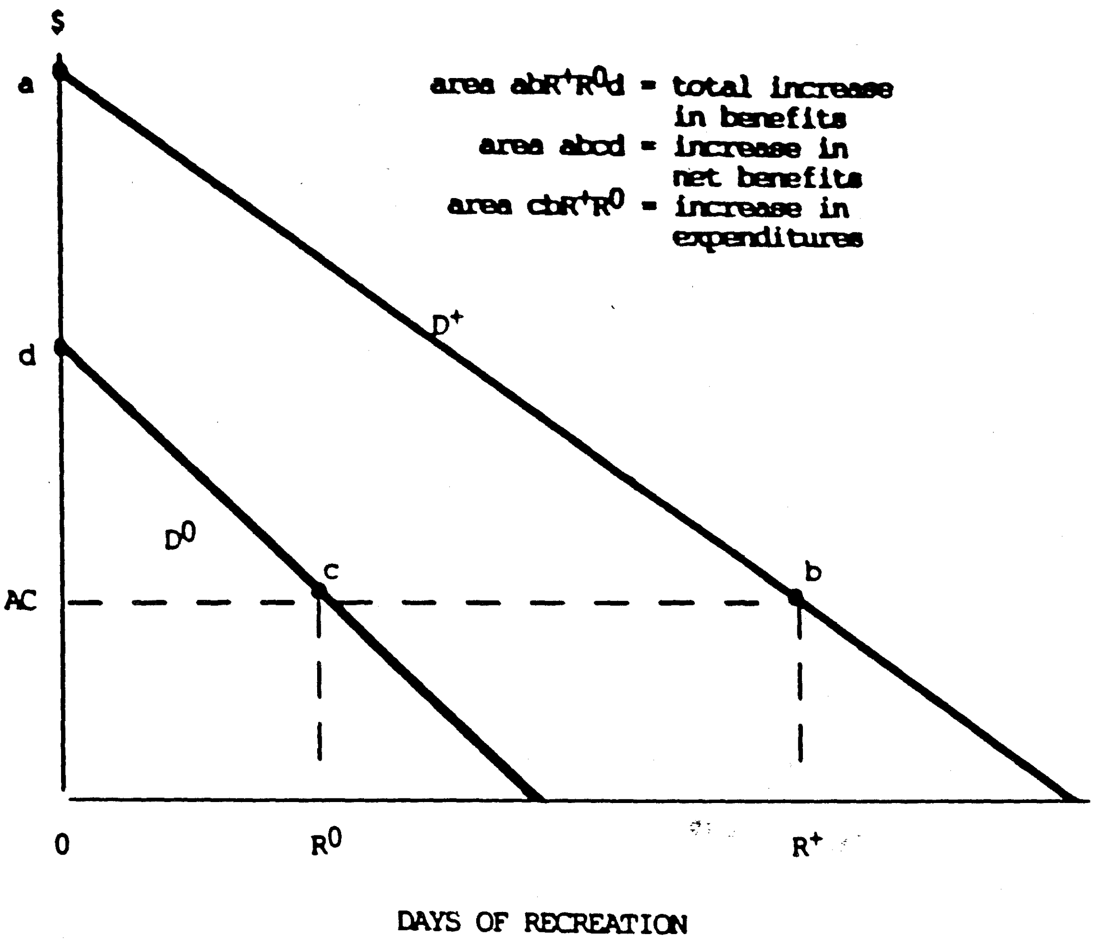

Figure 3(3).2. A demand curve traces an individual's maximum willingness-to-pay for each additional user-day when stock size is intially low (D^{o}) and then high due to restoration (D^{+}). AC is the average cost to recreationists for fishing or for observing salmon.

Figure 3(3).2 portrays the total use benefits of the proposed North Atlantic salmon restoration project (fishing and observation). D^0 represents a demand curve for recreation days prior to the successful completion of restoration. Given the average cost of recreation (AC), total benefits are area $dcR^0 0$. In contrast, salmon restoration, through its effect on stock size and catch, increases demand to, say, D^+. Total benefits in this case are area abR^+0. Thus, the increase in total benefits is area abR^+R^0cd. (Although not drawn, average cost may also decrease and lead to a further increase in total benefits.) Part of this area--area cbR^+R^0 --is costs incurred by recreationists in their pursuit of salmon (such as the opportunity cost of gasoline for travel). The remaining benefit--area abcd--is the net benefit, **surplus**. Although surplus is "free" to individuals, it is a significant and real component of total benefits and, therefore, must never be overlooked in an economic analysis. Surplus is analogous to profit for producers. Whereas efficiency analyses evaluate only changes in surplus (and profit), we remain focused on changes in total benefits as required.

Figure 3(3).2 is appropriate for recreational fishing and for simply observing salmon. The total benefits associated with existence values could also be drawn, but the quantity axis most likely would be stock size. In this case, total user costs are zero by definition since no personal use is involved.

Regrettably, there has not been a sufficient amount of economic research done on the potential benefits of the North Atlantic salmon restoration project to provide project-specific estimates of total benefits. Instead, we draw on Kay *et al.'s* (1987) pilot study of net benefits and other, secondary sources of information on salmon fishing already reported in the environmental economics literature. The next subsection summarizes these studies.

Past Research

Kay *et al.* (1987) applied a survey technique called the contingent valuation method to elucidate New Englander's maximum willingness-to-pay for salmon restoration. On average, households who were interested in fishing for salmon (about 27% of the population, or about 1.21 million households) were willing to pay an average of $25.83 for salmon restoration, and households who were generally interested in preserving salmon for personal observation and for use by future generations (about 58% of the population, or about 2.23 million households) were willing to pay $22.43 on average.

Several comments are in order regarding Kay *et al.'s* (1987) study. First, it is not possible to transform the use benefits for fishing and observing salmon into benefits per recreation day. This is not a serious problem, though, since we are currently interested in an approximation of only total benefits and not in the shape and position of the demand curve per se. Second, their study elicits only estimates of changes in net benefits (that is, surplus) from respondents such as area abcd in Figure 3(3).2. Therefore, total use benefits are underestimated since travel-related costs associated with recreation are not included. Finally, Kay *et al.'s* (1987) study probably underestimates the net present value of the salmon restoration project, assuming that future returns of adult salmon can be predicted with a high degree of certainty. First, they followed a conservative procedure when accounting for non-respondents to the survey. In addition, their vehicle of payment (for example, increased license fees) could have biased valuations downward. Furthermore, households were asked for annual valuations over only a one to five year payment period even though benefits would be received over a life time. This reduces the operational income constraint since total income during one to five years is less than life time income. On the other hand, their study was not designed to assess the negative effect of supply uncertainty on maximum willingness-to-pay. Also, there is evidence that respondents were confused by the way the valuation questions were framed. Finally, Kay *et al.* (1987) did not use a time series of annual willingness-to-pay when calculating the present value of net benefits.

A second regional study of salmon recreation was conducted in Maine during 1980. This study, which used the travel cost method, reports that recreational fishing surplus is $118 per day, or approximately **twenty times greater** than the Kay *et al.* (1987) figure even if we assume conservatively that anglers fish for salmon an average of only five times a year. Whereas the Kay *et al.* (1987) study probably underestimates the net benefits of certain salmon restoration for reasons given above, this travel cost study most certainly overestimates surplus since distant and non-respondents are underepresented in zonal travel cost studies.

Other economic studies of salmon recreation were conducted in the northwestern and Great Lakes regions of the United States. With one exception (Brown and Mendelsohn, 1984), these studies report surplus values for trips, fishing days, or fish [vis-a-vis the entire year; Table 3(3).5] and, therefore, can not be compared directly to Kay *et al.'s* (1987) results. Furthermore, respondents to Kay *et al.'s* (1987) survey valued future changes in salmon stocks while most of the studies summarized in Table 3(3).5 evaluate existing stocks. Nevertheless, a casual review of Table 3(3).5 suggests that values reported for salmon

Table 3(3).5. Net benefits of recreational salmon fishing

Surplus per (constant 1986 $US):

Trip	Day	Fish	Season	Reference
18 - 57	17 - 30	-	-	Sorg and Loomis (1986)
-	0.40 - 23	-	-	Sample and Bishop (1982)
-	19	-	-	Gordon et al. (1973; modified by Sorg and Loomis [1986])
-	118	-	-	Kimball, D. (USF&WS; personal communication)
-	-	122 - 163	-	Crutchfield and Schelle (1979; adjusted by Meyer, Brown and Hsaio [1983])
-	-	157 - 164	-	Loomis and Brown (1984)
-	-	-	120	Brown and Mendelsohn 1984)

fishing are substantially greater than in Kay *et al.* (1987).

We are not aware of any studies of the net benefits associated with observing salmon or of existence values for salmon other than what Kay *et al.* (1987) report. However, Table 3(3).6 summarizes observation and existence benefits for four other wildlife species, three of which (bald eagles, grizzlies, big horn sheep) are, like salmon, spectacular to view in the wild. The mean value reported by Kay *et al.* (1987) for observing and preserving salmon in New England rivers falls within the range of these values.

Three approaches are used to estimate the future net benefits of the proposed salmon restoration project. The first approach uses Kay *et al.'s* (1987) estimate of $25.83 as the annual net benefit of salmon fishing for a fishing household. Although low compared to other studies, it serves here as an approximation of the net value of a salmon resource currently characterized by a low standing stock and by future supply uncertainty. Hence, we assume that $25.83 is the mean **option price** which is composed of the expected value of future net benefits plus **option value**, or the "insurance premium" for avoiding future supply uncertainty (see Freeman [1985] for a discussion of option price and option value). Accordingly, total annual net benefits for fishing are $25.83 times about 1.21 million households, or $31.3 million. Thus beginning with a small annual bet benefit of only $25.83, one may suspect that the economic benefits of salmon fishing aggregated across households and the 25 year time horizon will be quite large.

The second approach uses Brown and Mendelsohn's (1984) surplus estimate of $120 as the net annual benefit of salmon fishing. Total annual net benefits in this case are calculated as $120 x 1.21 million households, or $145.2 million. This amount serves as an upper bound for annual net benefits since it is based on an existing, viable recreational salmon fishery in their study.

Table 3(3).6. Net annual benefits of observation and existence values

Species	Observation & Existence Values	Only Existence Values	Reference
Bald eagles	\$13 - 43	\$ 11-47	Boyle and Bishop (1985)
Striped shiner	-	5 - 14	Boyle and Bishop (1985)
Grizzly bear	25 - 26	18 - 29	Brookshire *et al.* (1983)
Bighorn sheep	22 - 28	8 - 9	Brookshire *et al.* (1983)

The final approach multiplies the mean values from Table 3(3).5 for surplus per fish (approximately \$152) and per day-fished (approximately \$20 excluding the suspiciously high estimate of \$118) by the increase in catch and fishing effort projected by the U.S. Fish and Wildlife Service. [Appendix 3(3).I contains the projections for catch and effort provided by Dan Kimball of the U.S. Fish and Wildlife Service.] However, the reader should note that the method used to project future catch and effort is conservative since adjustments for how increased returns of adult salmon will increase both individual and aggregate demands for salmon fishing could not be made. Therefore, this final approach provides a lower bound for net benefits for discussion purposes.

Net benefits associated with observation and existence values will be calculated the same way in each approach whereby total annual surplus is assumed to be \$22.43 times about 2.23 households (Kay *et al.*, 1987), or \$50 million.

As for opportunity costs, future net benefits must be discounted to a present value in order to account for the rate of return on the investment and because of time preferences. That is, we take as datum that a future benefit of, say, \$1 million is valued less than a current benefit of \$1 million. Equation 3(3).1b is modified to be

3(3).3

$$PV_0 = \sum_{t=0}^{t=T} SB_t/(1 + r)^t$$

where SB_t is surplus benefits in year t. Depending on the approach taken, SB_t is either: (1) the Kay *et al.* estimate for fishing (\$31.3 million); (2) the Brown and Mendelsohn-based (1984) calculation for fishing (\$145.2 million); (3) \$152 times increased catch in year t projected by the U.S. Fish and Wildlife Service; (4) \$20 times the increased number of fishing days in year t projected by the U.S. Fish and Wildlife Service; or (5) the Kay *et al.* (1987) estimate for observation and existence value (\$50.0 million). The present values of net benefits determined by each approach range from \$851 million to \$3,245 million [Table 3(3).7].

Next, we must add to the surplus measure the present value of opportunity costs associated with recreation days (fishing and observation). Data from the U.S. Fish and Wildlife Service's 1980 *National Survey of Fishing, Hunting, and Wildlife-Associated Recreation* (1982) were used to derive an annual average opportunity cost of \$113 per fisherman for transportation, fees, equipment, licenses, and food and lodging. This amount is quite similar to opportunity costs reported by Sorg and Loomis (1986) for salmon fishing in Idaho. Direct information was not available to de-

Table 3(3).7. Present value of total benefits of salmon restoration, 1967-2012[a,b] ($US million in 1986)

Benefit Category	Approach 1	Approach 2	Approach 3 (catch-basis)	Approach 3 (effort-basis)
A. Net benefits				
fishing	520	2,414	20	30
observation/ existence	831	831	831	831
Total net benefits	1,351	3,245	851	861
B. Costs				
fishing	1,598	1,598	1,598	1,598
observation	1,062	1,062	1,062	1,062
Total costs	2,660	2,660	2,660	2,660
C. Total (A + B)	4,011	5,905	3,511	3,521
D. Total future benefits for non-boundary rivers (C - 0.266·C)	**2,944**	**4,334**	**2,577**	**2,584**

[a] See text for explanation of the approaches.

[b] The interested reader can roughly prorate these costs to individual river basins with the percentages reported in Table 3(3).1 for future "other" costs.

rive estimates of opportunity costs for observing salmon, although these costs are likely to be considerably less than for fishing since opportunity costs for equipment, licenses, and food and lodging are unlikely. However, fishermen's costs for transportation and user fees--36% of total costs in the *National Survey*--can serve as a rough gauge of the opportunity costs for observers. Accordingly, opportunity costs per salmon observer are estimated to be $41 annually (that is, $113 x 0.36).

The opportunity costs are aggregated across recreationists as follows. Recall Kay *et al.'s* (1987) estimate that approximately 1.21 million households are likely to participate in salmon fishing. Assuming conservatively that opportunity costs per capita and per household are about equal (that is, there is one salmon fisherman in each fishing household), we calculate annual opportunity costs to be $136.7 million by the time the salmon restoration project is successfully completed ($113 x 1.21 million). Unfortunately, Kay *et al.* (1987) did not report the number of people interested in observing wildlife (they report the number of households interested in observing salmon **and** in bequest value). However, it is probably safe to assume that people who fish and those with a bequest value also have an interest in observing salmon in the wild. Accordingly, total opportunity costs associated with observing salmon are calculated to be $91.4 million annually (2.23 million households times $41). Combining the two cost categories yields $228.3 million annually.

Unlike for the surplus calculations where households were asked for equal annual statements of willingness-to-pay beginning with the current year, actual opportunity costs will increase proportionally with increases in stock sizes. Consequently, U.S. Fish and Wildlife projections for the relative increase in salmon stocks returning to New England rivers were used to prorate costs between the years 1987 and 2012. Importantly, costs attributable to returns of native salmon were **excluded** from the calculations so as not to exaggerate the total benefits of the restoration project. In this case, equation 3(3).3 becomes

$$PV_0 = \sum_{t=0}^{t=T} (p_t E)/(1 + r)^t \qquad 3(3).4$$

where E is total annual opportunity costs upon completion of the restoration project (i.e., \$228.3 million) and p_t is the percent completion by year t. For example, the U.S. Fish and Wildlife Service projects that roughly 51% of the long term annual harvest rate will be achieved by the year 1990. Hence, p_3 (where $t = 1990 - 1987 = 3$) is 0.51 and p_tE is (0.51 x \$228.3 million), or \$116.4 million in 1990 and about \$104 million in present value ($r=0.04$). Following this procedure, the present value of future costs is calculated to be \$2,660 million. (Again, the reader is reminded that this "large number" is derived from plausible, "small" numbers for annual opportunity costs incurred by individuals.)

Finally, the present values of total future benefits are reduced by 26.6% in order to adjust for the exclusion of boundary rivers from the assessment. With this adjustment, the present value of total future benefits is calculated to be between \$2,577 and \$4,334 million. These values can be roughly prorated to river basins using the percentages listed in Table 3(3).1 for future "other" costs.

Conclusions

The calculations of economic value measured in terms of total maximum willingness-to-pay exceeds value estimated in terms of replacement cost (recall the previous discussion of Figure 3(3).1 in Section II). The present value calculations of total future benefits of salmon restoration range from about \$2.6 to \$4.3 billion (constant \$US in 1986). However, there are several important omissions that must be mentioned--omissions necessitated by a lack of necessary information and by constraints on the assessment. First, past benefits were not included because catch and effort data for the years 1960-1986 were not readily available. Second, contingencies associated with increased future scarcity of outdoor recreation relative to market commodities could not be included since relative values could not possibly be quantified. Third, incidental benefits derived from other fish populations which benefit from fish passages are unknown but could be sizeable [see McConnell and Strand (1981) for an example involving shad]. Similarly, the value of enhanced wild runs was not included. Fourth, population growth for people in New England during the next 25 years was not accounted for in the benefits calculation. Fifth, future benefits enjoyed by tourists from outside New England who partake in salmon fishing and observation are expected to be large, but are unknown. Sixth, the exclusion of boundary rivers results in a systematic 26.6% underestimate of total benefits (approximately \$1 to \$1.6 billion depending on which approach is used). Finally, the assessment was truncated at 25 years even though the benefits of salmon recreation will continue well beyond the year 2012. This constraint omits an additional \$2.6 to \$4.1 billion in total benefits (present value) if the usual 50 year time horizon is used.

V. Summary

Based on the best available information and with careful attention paid to economic theory, this working paper presented calculations of the total economic value of the proposed North Atlantic salmon restoration project. As mutually agreed upon, the calculations exclude boundary rivers, are prorated among the remaining river basins in New England, and are limited to the years 1960-2012. Total present and future benefits measured in terms of the present value of maximum willingness-to-pay are calculated to be between $2.6 and $4.3 billion (constant 1986 $US). In contrast, the present value of past (years 1960-1986) and present/future (years 1987-2012) opportunity costs are calculated to be $0.3 billion. As explained in Section II, maximum willingness-to-pay is more appropriate than replacement costs as a measure of total economic benefits.

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Appendix 3(3).I

Projected Catch and Effort for Recreational Salmon Fishing[a]

Year	Catch (thous)	Adjusted[b] Catch (thous)	Effort (thous)	Adjusted[c] Effort (thous)
1987	1.95	1.77	24.9	23.0
1988	1.68	1.50	20.4	18.5
1989	4.52	4.34	55.0	53.1
1990	4.91	4.73	64.2	62.3
1991	6.46	6.28	79.6	77.7
1992	4.63	4.45	54.3	52.4
1993	3.37	3.19	39.8	37.9
1994	7.75	7.57	85.3	83.4
1995	11.16	10.98	122.8	120.9
1996	12.21	12.03	134.3	132.4
1997	11.56	11.38	127.2	125.3
1998	9.62	9.44	105.8	103.9
1999	8.21	8.03	90.3	88.4
2000	13.00	12.82	143.0	141.1
2001	12.18	12.00	134.0	132.1
2002	8.64	8.46	95.0	93.1
2003	9.99	9.81	109.9	108.0
2004	8.56	8.38	94.2	92.3
2005	13.26	13.08	145.9	144.0
2006	9.60	9.42	105.6	103.7
2007	12.11	11.93	133.2	131.3
2008	11.27	11.09	124.0	122.1
2009	11.80	11.62	130.0	128.1
2010	11.80	11.62	130.0	128.1
2011	11.80	11.62	130.0	128.1
2012	11.80	11.62	130.0	128.1

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[a] Source: Dan Kimball, U.S. Fish and Wildlife Service, Newton Corner, MA. The USFWS projections end in year 2008. The numbers for years 2009 to 2012 were extrapolated from the trends.

[b] Catch projections were reduced by 180 fish each year to adjust for catch of wild salmon.

[c] Effort projections were reduced by 1,900 days each year to adjust for effort on wild salmon.

Value of Restored Adult Salmon Returning to Home Waters

I. Introduction

This paper presents calculations of the "value" of adult salmon returning to United States home waters based on the total costs of production. As directed, calculations are limited to the years 1960 to 2012, or 25 years from the present. Also, the calculations are limited to the direct economic, or **opportunity costs** of salmon restoration (public and private costs of capital, operations, maintenance, research, and administration) and the value of forgone hydroelectric power. The adherence to economic theory avoids double counting and excludes mere transfer payments among Americans. [See Sections II and III in the previous U.S. Fair Share Working Paper No. 3(3) for a discussion of the economics perspective used in cost and benefit analyses and for background information on the cost calculations that are used here.] Finally, and unlike in Working Paper No. 3(3), the international rivers, St. Croix, Aroostock, Meduxnekeag, and Prestile were included in these calculations since only average ratios of total costs to adult returns are reported (the assumption being that average cost per return is approximately equal regardless of river basin).

II. Results and Discussion

Costs

Section III in U.S. Fair Share Working Paper No. 3(3) contains calculations of past and future opportunity costs of salmon restoration in New England. Public costs are comprised of opportunity costs for construction, operations and maintenance, stock assessments, research, enforcement, fish culture, trapping and transportation, and personnel by the Fish and Wildlife Service, the Forest Service, the National Marine Fisheries Service, and the states of Connecticut, Massachusetts, and Maine. Private costs are incurred by utility companies for construction and operations and maintenance of fish passages. Finally, directing water away from hydroelectric dams to fish passages results in a further opportunity cost to society of foregone hydroelectric power.

The simple sums of total past (years 1960-1986) and current/future (years 1987-2012) opportunity costs of salmon restoration (including boundary rivers) are reported in Table 3(4).1. However, it is routine and appropriate for economists to use the **present value criterion** when aggregating past and future opportunity costs to a present value since this approach accounts for temporal aspects of opportunity costs [see Section III of U.S. Working Paper No. 3(3)]. Accordingly, past opportunity costs are **grown** to their present value with the formula:

3(4).1a

$$PV_{1987} = \sum_{t=o}^{t=T} OC_t(1 + r)^t;$$

where $PV1_{987}$ is present value expressed in the current year 1987, OC_t is the opportunity cost in time period t (t = 1987 - year), r is the social discount rate in decimal form (for example, 4% is 0.04), and T is the terminal time period which in this case is the most distant year in the past (for example, 27 for the year 1960). Similarly, the present value of

Table 3(4).1. Opportunity costs of salmon restoration (constant $US million in 1986)

Aggregation Method	**Past** **27 years** **(1960 to 1986)**	**Current/Future** **26 years** **(1987 to 2012)**	**Total** **53 years** **(1960 to 2012)**
Simple addition across years	$104.2	$204.3	$308.5
Present value	$191.6	$149.7	$341.3

Table 3(4).2. Returns of adult stocked salmon

	Past **27 years** **(1960 to 1986)**	**Current/Future** **26 years** **(1987 to 2012)**	**Total** **53 years** **(1960 to 2012)**
	31,770	678,571	710,341

a series of current and future opportunity costs is calculated by

$$PV_{1987} = \sum_{t=0}^{t=T} OC_t / (1 + r)^t; \qquad \text{3(4).1b}$$

where T is the terminal future year (that is, 25 for the year 2012, or 2012-1987). The social discount rate excluding inflationary expectations used in this calculation is 4% (for example, r=0.04). Using formulae (1a) and (1b), the present value of total past and future opportunity costs of restoration are calculated to be $191.6 and $149.7 million, respectively [Table 3(4).1].

Adult returns

Approximations of adult stocked salmon returning to rivers in New England are listed in Table 3(4).2. ICES (1987) estimates the number of stocked salmon returning between 1967 and 1986 to be 46,429.[1] For this paper, annual returns for the previous seven years (1960 to 1966) are assumed to be equal to mean returns between 1967 and 1971 (that is, 733), bringing the total for past returns to about 51,560. This figure was reduced by 733 for each year (by about 19,790) to 31,770 as an adjustment for returns of native salmon since these salmon can not be attributed to the restoration program [Table 3(4).2].

In contrast, the U.S. Fish and Wildlife Service projects future returns of salmon for their proposed restoration project between the years 1987 and 2012 at approximately 697,629 (Dan Kimball, personal communication). This figure was also reduced by about 733 fish annually in order to adjust for returns of native salmon. [Appendix 3(4).I contains the U.S. Fish and Wildlife Service's projections for annual adult salmon runs.]

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[1] This estimate is of the total United states run size (one sea-winter salmon) including the estimated run in rivers with and without traps and corrected for exploitation and non-reporting (Ref: C.M. 1987/Assess:12 table 6, p. 60)

Table 3(4).3. Total average costs of adult stocked salmon returning to rivers in New England (constant $US in 1986)

Past 27 years (1960 to 1986)	Total 53 years (1960 to 2012)
$6,030	$480

Accordingly, future returns of stocked salmon between the years 1987 and 2012 are projected to be about 678,571 [Table 3(4).2][2].

Average Costs

It is difficult to select a single cost index to represent the economic value of salmon runs. First [and as discussed in detail in Sections II and IV of U.S. Working Paper No. 3(3)], economic benefits are best measured in terms of society's maximum willingness-to-pay for--not opportunity costs of--restoration. Second, it is always desirable from society's point of view to minimize the opportunity costs of a public project such as salmon restoration. Hence, low restoration costs should not suggest that the project has low value. Third, there are numerous ways to prorate fixed, capital costs across salmon production depending on the time frame and expectations of uncertain, future salmon runs. Also, unit costs of production will vary considerably depending on whether one begins with total costs (including fixed, capital costs) or total variable costs and on whether average or marginal opportunity costs are of interest. Selection of a particular type of analysis depends on the specific question being asked. With these difficulties in mind, the most helpful index of the opportunity cost of production for discussion purposes probably is the ratio of total opportunity costs of restoration to total returns of adult stocked salmon--"total average costs of returns." Two ratios are reported in Table 3(4).3. Between 1960 and 1986 "total average cost" was approximately $6,030 [constant 1986 $US; combine Tables 3(4).1 and 3(4).2]. In contrast, "total average cost" during the entire 53 year period from 1960 to 2012 (inclusive) is about $480. The latter index is less because of expected increases in returns during the next 25 years [see Appendix 3(4).I].

Any projection of fish population size is subject to considerable uncertainty. For example, the projected run of adult salmon for the year 1986 (made in 1984) was approximately 2.4 times greater than actual estimated returns for that year. To illustrate the potential effect of such uncertainty on cost ratios consider the possibility that salmon runs will be only half the size projected by the U.S. Fish and Wildlife Service for their proposed restoration program. In this case, the cost ratio for the years 1960 to 2012 increases to $882.

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[2] Projected returns of adult stocked salmon are inherently uncertain, particularly projections over25 years. Certainly, part of the uncertainty concerns the unknown outcome of the Fair Sharing talks.

Appendix 3(4).I

Run Size Projections for New England Rivers[a]

Year	Run Size	Adjusted Run Size[b]
1987	6,038	5,305
1988	7,314	6,581
1989	8,846	8,113
1990	9,356	8,623
1991	12,029	11,296
1992	12,815	12,082
1993	13,170	12,437
1994	13,880	13,147
1995	15,074	14,341
1996	23,534	22,801
1997	24,225	23,492
1998	24,380	23,647
1999	24,718	23,985
2000	26,328	25,595
2001	37,038	36,305
2002	37,679	36,946
2003	37,782	37,049
2004	38,047	37,314
2005	40,368	39,635
2006	47,497	46,764
2007	47,520	46,787
2008	37,021	36,288
2009	37,442	36,709
2010	38,023	37,290
2011	38,760	38,027
2012	38,745	38,012

[a] Source: Dan Kimball, U.S. Fish and Wildlife Service, Newton Corner, MA (personal communication). The run size numbers were approximated from a graph. Values for the years 2010 to 2012 were approximated from the reported trend.

[b] As an adjustment for returns of native salmon, the historical trend of about 733 fish was subtracted from projected run sizes.

Further Socioeconomic Considerations of North Atlantic Salmon Restoration in the United States

I. Introduction

This working paper annotates several socioeconomic factors related to North Atlantic salmon restoration in the United States which are not covered in U.S. Fair Share Working Paper Nos. 3(3) and 3(4). Although, most of these factors are interrelated and dependent on results contained in U.S. Fair Share Working Paper No. 3(3), they are not forced into an unnecessarily long and continuous discussion. [U.S. Fair Share Working Paper No. 3(3) should be read before this paper.] Instead, they are brought to the reader's attention in highlighted form. As in the two other economics working papers for the United States, the best available information is used in this report.

II. Additional Socioeconomic Factors Related to Salmon Restoration

(1) Additional Opportunity Costs and Benefits

The cost and benefit analyses in Sections III and IV (respectively) of U.S. Fair Share Working Paper No. 3(3) exclude the international rivers, St. Croix, Aroostock, Meduxnekeag, and Prestile, and are restricted to a 25 year time horizon including year 2012. However, from a purely economics perspective, an analysis of a project's benefits (or costs) should not be limited artificially in space or time. Accordingly, the present value of past and future costs for the excluded river basins between the years 1960 and 2012 is approximately $37 million, and the present value of the additional total future benefits between 1987 and 2012 is calculated to range between $3.5 and $5.9 billion [constant $US in 1986; see U.S. Fair Share Working Paper No. 3(3) for detailed information].

Concerning the time horizon, the present value of additional future opportunity costs (non-capital public and private costs and foregone hydroelectric power) of salmon restoration between the years 2012 and 2037 under a 50 year time horizon (typical of water resource project evaluations) is $36.3 million for all river basins planned for restoration ($9.7 million prorated to excluded rivers). Similarly, the present value of additional future benefits under the 50 year time horizon are calculated to range from $1.6 to $2.5 billion for all river basins ($0.4 to $0.7 billion prorated to excluded rivers). These calculations use a 4% rate of social discount (which excludes inflationary expectations) and assume conservatively that salmon runs will not increase beyond levels projected for the year 2012 by the U.S. Fish and Wildlife Service (Dan Kimball, personal communication).

(2) Economic Efficiency of Public Investment into Salmon Restoration

A vital consideration of federal regulatory actions and water resources projects is the allocative efficiency of public investments. In conventional terms, it is important to know whether the benefits of a project exceed the opportunity costs of resources used in project development. This issue is different from a separate assessment of the total opportunity costs and total (vis-a-vis net) benefits of salmon restoration as reported in U.S. Fair Share Working Paper No. 3(3).

The successful completion of the salmon restoration project as described and projected by the U.S. Fish and Wildlife Service may in fact be an efficient use of productive resources. Based on calculations already reported in Section IV of U.S. Fair Share Working Paper No. 3(3), the net present value of salmon restoration between the years 1987 and 2012 is projected to be positive regardless of whether boundary rivers are excluded: $0.7 to $3.1 billion for all river basins and $0.5 to $2.3 billion when boundary rivers are excluded (constant $US in 1986). These calculations begin with information on the present value of total net benefits reported in Table 3(3).5 in U.S. Fair Share Working Paper No. 3(3) and subtract the present value of project opportunity costs found in Table 3(3).4 of the same working paper. Net present values would be greater with the 50 year time horizon because capital costs after the year 2010 are expected to be zero (Dan Kimball, U.S. Fish and Wildlife Service, personal communication), but annual benefits remain at their highest level once salmon runs reach and maintain their peak size.

(3) Economic Impacts

Economic impact analysis, unlike benefit-cost analysis, describes how expenditures on, say, recreation influence income, production, and employment in related markets. Thus, economic impact analysis is more directly related to economic activity than to economic value. [See Section II in U.S. Fair Share Working Paper No. 3(3) for a brief discussion of the distinction between financial and economic/social benefit analysis.] In particular, anglers not only buy fishing equipment, but they also buy gasoline, food, and lodging. Those who travel to observe salmon runs also incur significant travel-related costs. From a financial perspective, the expenditures have further local and regional impacts in markets that supply these recreation service industries. The extent of the impacts on regional income and employment are approximated with economic multipliers.

Calculations of potential economic impacts related to North Atlantic salmon restoration are derived from expenditures already projected for recreationists in Table 3(3).7 in U.S. Fair Share Working Paper No. 3(3) and from multipliers reported by Radtke (1984) for recreational salmon fishing in the state of Oregon. Although no economic impact analysis of salmon recreation has been conducted for New England, the total output (2.85), income (1.33), and employment (0.000078) coefficients for direct, indirect, and induced effects are similar to other recreational fisheries in the United States [compare to Schuler (19870].

Annual expenditures by recreationists who will either fish for salmon or who are likely to observe salmon runs were projected in Section IV of U.S. Working Paper No. 3(3) to be about $228.3 million (constant $US in 1986) by the year 2012. Expenditures before this year are likely to be less since the stocks will be growing during this time, but expenditures after this year will be greater as the stocks increase toward their projected size. Hence, $228.3 million is being used as a representative annual figure.

Finally, the expenditure figure is multiplied by the respective total impact coefficients to calculate potential gross annual economic impacts attributable to salmon recreation: (1) a $650.7 million output impact; (2) a $303.6 million income impact; and (3) 17,807 jobs. These annual projections can be reduced by 26.6% to exclude boundary rivers.

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