# National and Regional Economic Analysis of the Four Lower Snake River Dams

## A review of the 2002 Lower Snake Feasibility Report/Environmental Impact Statement Economic Appendix (I)

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## About Earth Economics

Earth Economics is a non-profit located in Tacoma, Washington, dedicated to researching and applying the economic solutions of tomorrow, today. Earth Economics provides robust, science-based, ecologically sound economic analysis, policy recommendations and tools to positively transform regional, national and international economics, and asset accounting systems. Earth Economics has extensively studied the economic benefits of outdoor recreation in Washington State, producing reports at the state, county, city, and agency level.

# GLOSSARY OF TERMS USED IN THIS STUDY

AAEV – Average annual equivalent value is the average cost or benefit of owning an asset over its entire life.

aMW – average megawatt, the electricity produced by continually generating one megawatt for one year (8,760 megawatt-hours)

BC Ratio – Benefit-Cost Ratio

BPA – Bonneville Power Administration

DREW – Drawdown Regional Economic Workgroup

Ecosystem Services – Benefits people derive from nature, free of charge.

FR/EIS - Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement or Lower Snake River Feasibility Report, conducted by the USACE in 2002

HydroAmp – A measure of a dam's reliability

LSR – Lower Snake River, located in southeast Washington

NWW – Walla Walla District of USACE

O&M – Operations and Maintenance

O&M,R – Operations and Maintenance, Repair

PATH – Plan for Analyzing and Testing Hypotheses

PUV – Passive use values are the values that are not associated with actual use, but the value people place on knowing something exists, even if they will never use it.

USACE – United States Army Corps of Engineers

WRC – Water Resource Council, guidelines used by USACE for economic and social analysis

# National Economic Analysis of the Four Lower Snake River Dams

## A REVIEW OF THE 2002 LOWER SNAKE FEASIBILITY REPORT/ENVIRONMENTAL IMPACT STATEMENT ECONOMIC APPENDIX (I)

## EXECUTIVE SUMMARY

This report presents a thorough analysis of the benefits and costs of the four Lower Snake River dams in both "keep dam" and "breach dam" scenarios. The dams were originally purposed for hydropower and navigation benefits, but in order to achieve a positive benefit-cost ratio, indirect benefits for navigation and power and additional credits for the use of "cheap hydroelectric power" over coal-fired plants were included.[1] Additionally, the original analysis did not account for lost direct and indirect benefits, such as the recreational benefits associated with a free-flowing river or tribal fishing benefits.

This report concludes that the benefits created by the four dams are outweighed by the costs of keeping them. Furthermore, with the possible exception of navigation and irrigation water supply, the current benefits would not be lost, but rather increased, if the dams were breached. Due to subsidies and unclear rail and barge cost data, the verdict is still out on whether there is an economic benefit to shipping by barge over rail. The four Lower Snake River dams in southeast Washington do not provide a net benefit to the nation, and they may never have.

This document should be used to inform the Army Corps of Engineers, the Walla Walla District of the Corps, key decision-makers, and concerned ratepayers.

### KEY CONCEPTS AND CONCLUSIONS

- The Snake River dams have two authorized purposes: hydropower and navigation. The direct benefits of these purposes do not surpass the costs of maintaining them.
- In many years, the costs of operating the dams outweigh the value of the electricity produced; these costs are then passed on to the ratepayers. Breaching the dams would save ratepayers money.
- The current state of the four Lower Snake River dams yield a yearly benefit-cost ratio of 0.15, well below a positive return on investment.
- A free-flowing river yields a yearly benefit-cost ratio of 4.3 in term of National Economic Development (NED). These benefits are not realized with the current state of the river.
- Wild salmon are keystone species in trophic webs from the North Pacific Ocean to the far reaches of the Lower Snake River and tributaries, but their stocks are not recovering. Salmon are important for food provision, cultural value, and for sustaining other key species throughout the Pacific Northwest.

# INTRODUCTION

Beginning in the early 1900s, the U.S. Army Corps of Engineers (USACE) assessed the possibility of building dams along the Lower Snake River of southeast Washington to ease navigation along its turbulent waters. These four dams were marketed to the public and the administration as providers of clean hydroelectric energy that would also allow barge access to Lewiston, effectively making it a port for inland northwest producers to gain easier access to international markets. In the early 1900's, there were several failed attempts to gain support from Congress to build the dams due to a benefit-cost ratio below one. In 1937, USACE proposed the construction of four dams along the Lower Snake River. As was the case in previous attempts to sway decision makers in favor of the dams, hydropower and navigation benefits did not come close to matching the costs related to the project.[2] In order to justify costs, proponents of the dams claimed "indirect benefits", or benefits that should not have been included in a NED analysis (and evident in the report by Corps planners) but may have provided some to the region. These benefits included recreation, water supply for irrigation purposes, and additional credits for the use of hydropower over coal-fired power plants.[1]

USACE built a series of four dams on the Lower Snake River between 1966 and 1975. At the time of construction, the dams may well have provided a net benefit to the nation, especially when indirect benefits (e.g., reservoir recreation) were considered. However, those original estimates did not account for lost indirect benefits, such as recreational or fishing opportunities associated with a free-running river. Since then, the region's sources of electrical power have become more diverse, new infrastructure and shifting markets have made other forms of transportation competitive with barge shipment, and impacts on wildlife (i.e., salmon) have become a much higher policy priority. When such factors shift so substantially, the USACE should review a project's overall balance of benefits to costs.

From 1995 to 2002, the Walla Walla District (NWW) of USACE commissioned a 33 million dollar study in an attempt to improve fish passage through the hydropower system on the four dams.[5] This study, the Lower Snake River Juvenile Salmon Migration Feasibility Report/ Environmental Impact Statement (FR/EIS), extensively reviewed the effects of four alternative scenarios aimed to improve fish passage and provide the greatest benefit to the nation. The scenarios are as follows: Alternative 1, no change; Alternative 2, maximum transport of juvenile fish; Alternative 3, major system improvements; and Alternative 4, dam breaching.[a]

The NWW found that Alternative 3, major system improvements, would improve fish passage while providing the greatest value to the nation. Since the release of the study, and even within the study itself, contradicting values have been found that drastically change the report's findings. Even the NWW found that fish passage did not improve as projected with Alternative 3, and later implemented Alternative 2,[b] maximum transport of juvenile fish, in an attempt to improve survival rates. Note that both Alternatives 2 and 3 have been implemented at this point, in addition to other programs such as spilling and the use of large numbers of hatchery fish in an attempt to raise adult returns.

[a] For a detailed description of each alternative, see Section 2.2 of the 2002 FR/EIS.

[b] The degree to which Alternative 2 was implemented is not publically known.

The purpose of this document is to unravel the economic benefits and costs of the four Lower Snake River (LSR) dams by reviewing literature. Identified studies were used in a benefit-cost analysis (BCA) that establishes the ratio of positive-to-negative economic effects of the LSR dams. Additionally, projected benefits and costs of dam removal were analyzed. Given that much of the research and the studies used to calculate the original benefit-cost analysis were convoluted and sometimes inaccurate, each benefit or cost category was examined in detail and updated where possible. When updated estimates were not available, values from the 2002 FR/EIS were used.[3] Following the 1983 Water Resource Council (WRC) Guidelines for National Economic Development (NED), this report does not include all benefits and costs regularly used in BCA today, such as impacts on ecosystem services or passive use values.[c]

[c] Recently, the Administration released a Presidential Memorandum directing all federal agencies to integrate ecosystem service values into their benefit-cost analyses.

# BENEFIT-COST ANALYSIS OF THE LOWER SNAKE RIVER

This section presents a benefit-cost analysis of the four Lower Snake River dams. Each assumption underlying the category estimates are outlined in detail. To remain consistent with the 2002 USACE study, cost and benefit trends are projected for only 20 years, after which they are assumed consistent through year 100.

There are several challenges in developing a full benefit-cost analysis for the LSR dams. The 2002 USACE study, while highly detailed, no longer reflects current conditions or management practices, as at least some of the recommendations in Alternative 2 (maximum transport of juvenile salmon) and Alternative 3 (major system improvements) were implemented following that study. An additional complication is that, with few exceptions, the 2002 study does not offer actual benefit or cost values for Alternative 1 (existing conditions); rather, the focus is on the net contributions of Alternatives 2 through 4, relative to the then-existing conditions. The reason for this is that the 2002 FR/EIS reports only the marginal[d] benefits and costs associated with Alternatives 2 through 4, without providing baseline values for "business as usual" (Alternative 1). The lack of baseline values makes estimating the total benefits or costs associated with Alternatives 2 through 4 exceptionally challenging.

In some benefit-cost categories (such as recreation), there is an opportunity cost associated with the current project. These costs are measured as the dollar value of the resources in their next best alternative use.[4] In the case of recreation, the current value of recreation should also consider the forfeited recreation opportunities from having a reservoir as opposed to a free-flowing river.

The FR/EIS took 7 years and cost $33 million.[5] Without another in-depth study focused on the benefits and costs of operating the LSR system itself, the best approach is to update those values for which current data and cost estimates are available, and to accept the remaining original values in the 2002 report (adjusted to 2015 dollars). This report attempts to reevaluate the benefit-cost ratio of the LSR dams based on the best available information from both the 2002 study and more recent analyses. This approach is consistent with USACE planning guidance in that a report of this age is in need of updates, but not too old to warrant starting from scratch.

Table 1 represents the best known point estimates for the current state of the four Lower Snake River dams and for a breach dam, free-flowing river scenario. The following section details how each point estimate was derived for each benefit/cost category. Some estimates may be under- or over-valued, and narrative is provided in the following section as to how these varying estimates may alter the benefit-cost ratio, but are not included as point estimates as further research is needed. All values are Average Annual Economic Value[e] (AAEV) over 100 years, discounted[f] at 6.875 percent. NWW used a discount

[d] Marginal values represent differences between baseline values and those associated with alternative proposals. For instance, if baseline costs are $1M per year, and annual costs of the alternative are $1.1M, the marginal cost of the alternative is $100,000 ($0.1M).

[e] Average annual equivalent is the average cost or benefit of owning an asset over its entire life.

[f] A discount rate is the cost of borrowing money. It is used to determine the present value of future cash flows or costs. The ACOE currently uses a discount rate of 6.875%.

rate of 6.875 percent in the 2002 FR/EIS, although the 2015 Federal Discount for Corps projects is 3.375 percent in economic analysis.[6] A discount rate can drastically effect a projects costs and benefits. Using a lower discount rate of 3.375 percent would cause the values to be greater, resulting in an even lower benefit-cost ratio. It should be noted that the 2016 rate is 3.125.

**TABLE 1. BENEFIT-COST TABLES IN KEEP/BREACH DAM SCENARIOS (VALUES IN THOUSANDS, 2015 USD[g], AAEV)**

| | Keep Dams and Maintain | | Breach Dams | |
|---|---|---|---|---|
| **Benefit/Cost Category** | **Benefit** | **Cost** | **Benefit** | **Cost** |
| Hydropower | $202,644 | | | $0** - $261,758 |
| Navigation | $7,574 | | | $7,574 |
| Recreation | | | | |
| Angler | $30,890 | $34,880* | $65,770 | |
| Non-Angler | $13,993 | $1,370,020* | $1,370,020 | $13,993 |
| Total Recreation | $44,883 | $1,404,900* | $1,435,790 | $13,993 |
| Commercial Fishing | $2,795 | $2,165* | $4,924 | |
| Tribal Fishing | Included in commercial | | Included in commercial | |
| Water Supply | | | | $22,506 |
| Implementation and O&M | | $296,030 | | $28,832 |
| Total | $257,860 | $1,703,095 | $1,440,714 | $334,664 |
| Benefit/Cost Ratios | 0.1514 | | 4.3049 – 19.7614** | |

*Some costs illustrate forfeited benefits, which would be realized in the next alternative.

**Assumes the region does not have to purchase electricity from an external provider, due to the current surplus of power within the region.

As can be observed in the benefit-cost ratios[h] presented in Table 1, the benefits obtained in a scenario with breached dams far surpasses that of keeping the dams. Hydropower and navigation do not provide a positive benefit-cost ratio on their own. With the inclusion of indirect benefits (e.g., lost recreation benefits), the ratio becomes even lower in a "keep dam" scenario, producing a BC ratio of .15. Much of this is due to the foregone benefits of recreation ($1.4 billion), which could also help to revitalize the local economy by bringing in tourism dollars. Clearly, total welfare would be improved by breaching the dams. The opportunity cost of not doing so amounts to the difference in net benefits (benefits minus cost) between the two scenarios. Therefore, every year, about $2.4 billion (2015 dollars) in economic benefits are lost by keeping the dams.

Moreover, given a close examination of the studies informing these cost-benefit calculations, the difference between the scenarios may be even larger. There are still benefit-cost categories that have not been updated to show current estimates. Nor are certain categories included in the BCA at all, such as ecosystem services or passive use values, both of which would decrease the benefit-cost ratio of a "keep dam" scenario.

[g] All dollar values are adjusted from annual nominal values to 2015 $US according to the Bureau of Labor Statistics' Consumer Price Index (CPI). Available at: http://data.bls.gov/cgi-bin/cpicalc.pl.

[h] A benefit-cost ratio of 1 means that the benefits produced by a project equal the costs associated with the project. A ratio below 1 indicates that the costs are greater than benefits, which is a poor economic investment.

# BENEFIT-COST TABLE EXPLANATIONS AND SOURCES

## HYDROPOWER

The highest-valued economic benefit of the LSR dams is hydropower,[i] yet the Pacific Northwest has an excess of power-generating capacity, even during peak demand. Eliminating the power produced by the dams would not require additional infrastructure or place a higher demand on non-renewable sources.

The dams generate a median of 795 average megawatts[j] (aMW) of power each year (sold on the market for $203 million, 2015 dollars)[7] – seven percent of the region's overall hydropower capacity (11,600 MW).[8] Collectively, hydro supplies just over 40 percent of the Northwest's electricity, which means that the four LSR dams contribute just 2.9 percent of the region's power. However, the regional grid is overbuilt – it has a 4,600 aMW surplus, more than five times the energy supplied by LSR dams.[9] Furthermore, in 2015, the Snake River dams produced just 748 aMW, the second lowest level in recent history.[10]

Wind generation has been growing steadily in the Pacific Northwest since first being introduced to the grid in the early 2000's, adding to the surplus of power. Further complicating the region's surplus power issues, Endangered Species Act (ESA) regulations sometimes prohibit spilling water over the dams (based on impacts of high dissolved oxygen levels on salmon); in these instances, the Bonneville Power Administration's (BPA) only option is to run water through the turbines, producing higher levels of electricity than is demanded. When high-wind periods occur in high-water years, hydropower may displace wind generation, pushing wind generators offline. In fact, in 2011 and 2012, the BPA blocked wind farm access to their regional grid, effectively idling their wind generators.[11] After wind farms sued for breach of contract, BPA proposed partial payments to suppliers to idle their turbines.[12]

Regionally,[k] wind generation has steadily grown since 2005 (see Figure 1), even as the proportional contribution of the LSR dams has remained static. Since 2008, wind turbines have consistently produced more power than these dams – by 2013, wind contributed over twice as much electricity as the LSR dams, with the installed capacity to produce more.[l] This trend has been observed – albeit more recently – within Washington State. Wind turbines were very new to Washington in the year the NWW-USACE released its report, but have since grown dramatically (see Figure 1). The passage of Initiative 937 in 2006, which requires Washington's large utilities to obtain 15 percent of their power from renewable energy sources, specifically excludes hydropower.[13] That portfolio target has been phased in, beginning at three percent in 2012, and shifting to nine percent in 2016, before full implementation in 2020. By 2013, wind power had already generated more electricity than all four LSR dams combined. Arguments that the LSR must be retained for their power generation are incorrect. The hydropower produced by the dams already has been superseded by wind technologies.

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[j] An average megawatt (aMW) is the electricity produced by continually generating one megawatt for one year (8,760 megawatt-hours).

[k] Defined as those states contributing at least a portion of their electrical generation directly to BPA's grid (Idaho, Montana, Nevada, Oregon, Washington, and Wyoming).

[l] Washington had 3,075 MW of installed wind power capacity as of 2015.

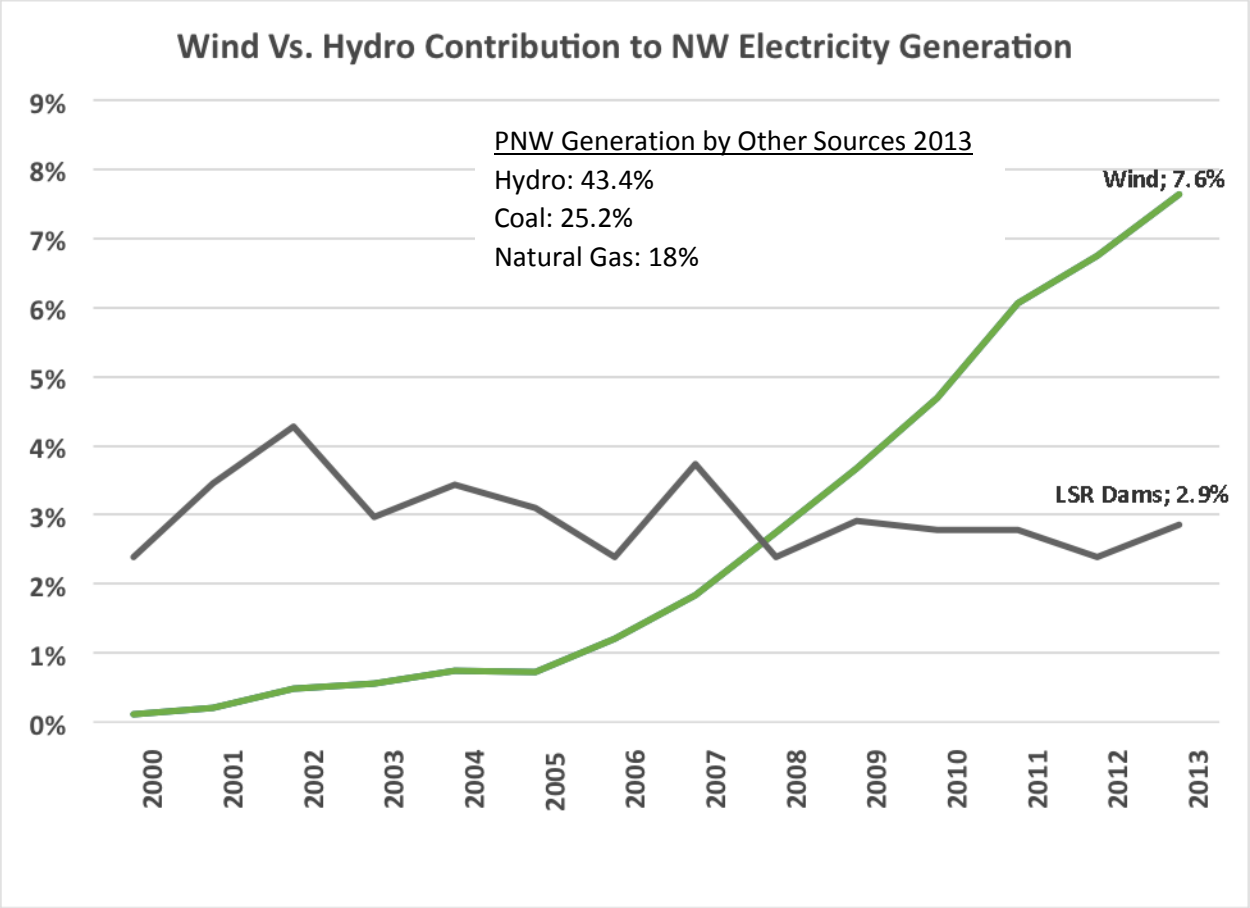



FIGURE 1: CONTRIBUTION TO NW ELECTRICITY GENERATION[14]

One counter argument worth considering is the relative reliability of wind energy. Wind generators are imperfect sources for electricity – most significantly, their output varies substantially from hour to hour. Yet the output of hydroelectric dams, despite their "always on" status, also varies widely from year-to-year, following larger-scale weather and climate dynamics. In fact, the LSR dams generally produce less and less power each year ($R^2$ = 0.1348, Coefficient = -0.0011).[m] Additionally, the FY 2016-2017 Integrated Program Review released by BPA in 2014 proved that the dams' reliability has decreased over the past years (shown by their HydroAmp Scores, a measure of reliability), and an aging infrastructure and non-routine maintenance make budget restrictions even more worrisome.

Although wind power is often critiqued for its hour-to-hour variability, year over year production data shows it to be more predictable than hydro ($R^2$ = 0.88, Coefficient = 0.0045). Even during droughts, winds continue to blow. Another factor stems from the scale of the technology – each LSR dam houses only six turbines, whereas windfarms typically include scores, if not hundreds, of turbines. When

[m] The root cause is unclear, but annual LSR dam electrical generation has generally been declining since the mid-1970s (Lower Granite Dam, the last LSR dam constructed, began operations in April of 1975). Signs point towards decreased reliability in addition to gradually diminishing streamflow. See US Geological Survey, 2015, National Water Information System, Site 13334300 (Snake River near Anatone, WA), available at: http://nwis.waterdata.usgs.gov/nwis.

turbines need to be pulled offline for maintenance or replacement, the proportional impact is likely to be much greater for conventional hydroelectric dams. This report does not suggest that all hydropower in the region be taken offline, but merely observes that decommissioning the four LSR dams would not increase the risk of power shortages, as wind generation – a relatively new source since the 2002 study – already produces more than three times the electricity of the LSR dams.

### With Dams

According to Jones (2015), between 2009 and 2014, the LSR dams produced a median amount of 795 aMW, based on Mid-Columbia (MIDC)[n]. A report released on the revenue of the LSR dams states that the average revenue from FY 2010-2015 was $202.6 million. However, in both 2011 and 2012, higher-than-average spring flow increased the power generated by the LSR dams, requiring wind generators to be idled at times. In 2015, the Snake River dams produced just 748 aMW, the second lowest level in recent history.[15] According to the NWW, [16] this level of power generation yielded only $144.5 million in electricity for the FY.

#### COSTS TO MAINTAIN THE DAMS – HYDROPOWER

According to the 2002 FR/EIS,[17] 91 percent of total operations and maintenance costs can be attributed to hydropower operations. The 100 year AAEV Operations and Maintenance (O&M) costs are $296 million (2015 dollars), $269 million of which can be attributed to hydropower operations. Assuming benefits of $279 million (2015 dollars), the dams are barely breaking even when evaluating the benefits and costs of hydropower alone, see Table 2 below. In years of low generation, the costs to the NWW and BPA are greater than the value of the hydroelectric power produced.

### Breach Dams

Electricity is a homogenous good, and therefore the source of production has little impact on the market, but rather an impact on the overall supply. Because the Northwest has a surplus of power, the energy produced by the dams will be immediately replaced by other electricity-generating resources that often do not operate due to the oversupply.

Should the LSR dams be decommissioned, the cost of replacing the power they generate would vary by source. Technologies for electrical generation are rapidly evolving, and markets – and pricing – are responding accordingly. Although not required from a capacity standpoint, wind and solar generation are becoming increasingly cost-competitive with more traditional generation modes. Both wind and solar energy production are expected to rise consistently for the foreseeable future, while the costs continue to decline.[18]

Due to the region's power surplus, new infrastructure would not need to be built. The NWPCC 7th Northwest Power Plan[19] states that efficiency gains could cover all increased demand, with the grid remaining in surplus for at least the next 20 years. Therefore, for this report, we assume that for the first 20 years, power is purchased on the open market at a cost of $262.5 million. For the remaining years, the replacement cost of solar power[o] ($259 million) is used in combination with open market

[n] The closest trading hub for the Lower Snake River dams is the Mid-Columbia (MIDC) trading hub. (Jones, 2015)

[o] Solar generation capacity is greatest in the summer months, when daylight is longest. Coincidentally, power generation is lowest for the LSR dams during the summer months when demand is high, especially in Eastern Washington.

purchases.[p] The 100 year AAEV for replacing the power generated by the Lower Snake River dams is therefore $262 million. Because the cost to produce the hydropower on the Snake River is greater than the value produced, there may be a small reduction in residential bills. These estimates are static. Alternatively, due to the surplus there is no need to purchase additional power. There will be no additional cost to the nation. Therefore a value of $0 is also given in the benefit-cost table.

As can be seen in Table 2 below, the cost of producing the power supplied by the LSR dams is greater than the cost of purchasing power on the open market.

**TABLE 2. COST OF MAINTAINING THE LSRD VS. REPLACEMENT POWER COSTS (VALUES IN THOUSANDS, 2015 USD)[20]**

| Total Annual Cost to Keep LSRD* | Open Market Purchases (Years 1-19) and Solar Generation (Years 20-100) | |
|---|---|---|
| | Purchase Cost | Total Difference |
| **$269,387** | $261,758 | -$7,629 |
| **Estimated Monthly Difference In Residential Bills** | **-$0.027** | |

*Assumes 91% of total O&M is attributed to hydroelectric power

## NAVIGATION

Overall, freight volumes passing through the Ice Harbor locks (the lowest on the Snake River) have declined 20 percent since the 2002 study. Barges on LSR reservoirs are used to transport wood chips, wheat and barley, pulses (e.g., garbanzo beans), and rapeseed (canola). Commodity producers can choose shipping via rail or road. Since 2008, in large part a pipeline has moved petroleum to a refinery in Salt Lake City. Container-on-barge shipping down the Columbia effectively ended after container ships abandoned the Port of Portland in 2015.

The cost differentials between barges and rail have halved since the 2002 FR/EIS. The greater flexibility of rail makes it a more viable choice for sellers, greatly increasing the pool of potential buyers. Barge transportation decline is especially true for wood chips, which declined 63 percent (by volume) from the 1992 to 1997 study period. (See Table 3.) Of far greater significance, grains (chiefly wheat and barley) have been somewhat more stable, having declined by 8 percent. The NWW incorrectly projected that grain shipments would actually increase 72% by 2017 (See Appendix A for projections).[21] Additionally, construction of a pipeline to a refinery in Salt Lake City has led to the near collapse of petroleum shipments by river (an 87 percent decline). Farmers and shippers are also building their own rail systems and train loaders. This has decreased shipments by barge.

[p] This value can be found by multiplying actual generation numbers of the dams by Avista and Idaho Power avoided cost rates of 35.10 per MWh. (Jones, 2015)

TABLE 3: TONNAGE BY COMMODITY GROUP (000 TONS)

| Commodity | 1987-96[22] | 1992-97[23] | 2010-14[24] | Percent change 1987-96 to 2010-14 | Percent change 1992-97 to 2010-14 |
|---|---|---|---|---|---|
| Wood chips | 550.5 | 634.0 | 236.0 | -57% | -63% |
| Grain | 3,051.4 | 3,038.0 | 2,800.0* | -8% | -8% |
| Petroleum | 116.4 | 120.0 | 15.8 | -86% | -87% |
| **Total** | **3,718.3** | **3,792.0** | **3,051.8** | -18% | -20% |

*Only 2012 figures were available.

## WITH DAMS

With decreased shipments on the Lower Snake River, the total benefits of shipping by barge have also decreased. The benefits barge shippers once realized between cost per ton-mile for truck/rail and truck/barge have also diminished, see Table 4 below. As this gap narrows, what was once a $20.1 million (1998 dollars) benefit to barge shippers in 1998 is now only a $7.6 million (2015 dollars) benefit. The AAEV of this benefit also equates to $7.6 million (and a net present value (NPV) of $110.4 million). Note that these benefits are static.

TABLE 4 SHIPPING COSTS COMPARISON (RME[24])

| Shipping Cost Per Ton Mile | | | |
|---|---|---|---|
| **Mode** | **1998** | **2015** | **% Change** |
| Truck | $0.1000 | $0.1400 | 40% |
| Rail | $0.0500 | $0.0633 | 26.6% |
| Barge | $0.0100 | $0.0393 | 293% |

Furthermore, a recalculated analysis[25] of the benefits of navigation presented in the 2002 FR/EIS finds that the additional rail rate charged to shippers is only seven cents per ton more than barging, reducing benefits to $0.44 million. Overall, regardless of calculation methods, use of the LSR locks and channels has decreased significantly, barge costs have nearly tripled and the corrected O&M,R costs are significantly higher. Therefore, the benefits have also decreased.

### COSTS TO MAINTAIN THE DAMS – NAVIGATION

The NWW assigns nine percent of total O&M costs to maintaining the navigational channels and locks. According to Waddell,[26] $26.6 million of the total $296 million (2015 dollars) 100-year AAEV O&M costs is attributable to navigational purposes.

## BREACH DAMS

Since the 2002 study was published, petroleum movement has shifted from barge to pipeline, effectively ending that portion of demand for LSR navigation. Container shipping through the Port of Portland has also effectively ended. The cost of navigation for a free-flowing river is therefore assumed to mirror the benefits under current conditions, as calculated by Jones (2015). That amounts to an AAEV of $7.6 million per year (NPV of $110.4 million).

## RECREATION

A free-flowing Lower Snake River would provide immense recreational benefits that are not currently realized with the reservoirs. These benefits would be a net gain for the nation that could boost the regional economy. Recreation benefits (or costs) are measured in two ways in the FR/EIS: National Economic Development (NED) and Regional Economic Development (RED) values. The RED account focuses on changes in economic activity within the region. These benefits include values such as jobs and income produced. RED benefits are not valued at the national level because WRC guidelines assume that increased economic activity in one region is mirrored with decreased economic activity in others. Recreation value for the NED account is assessed as the consumer surplus, or the value that a recreation consumer receives above what they actually paid for. This method follows the WRC guidelines and was used by the USACE in the in the 2002 FR/EIS.

Recreational benefits along the Lower Snake River are considered indirect benefits of the dams. The dams were not intended to provide recreational benefits, but do nonetheless. However, the dams' construction also led to loss of recreational benefits. Most of the activities associated with a free-flowing Lower Snake River are not possible with the reservoirs. A free-flowing Lower Snake would provide greater recreational benefits than the reservoirs.

### WITH DAMS

#### ANGLING

Recreational angling benefits in the USACE 2002 study[3] are found in Table 3.2-10 (page I3-68). Upon completion of the FR/EIS, the Walla Walla District implemented Alternative 3 (major system improvements). Because the effectiveness of system improvements on endangered wild salmon species was overestimated, the NWW has since implemented Alternative 2 (maximum fish transport). Because Alternative 3 provided the greatest recreational benefits with the LSR dams in place, the value of $21.2 million ($30.9 million in 2015 dollars) per year is used here, as seen in table 3.2-10 of the FR/EIS.

#### GENERAL RECREATION

The USACE's 2002 AAEV value of $31.6 million (1998 dollars; $46 million in 2015 dollars) per year[27] for general recreation (non-angling) on LSR reservoirs is based on a 1999 study by Agricultural Enterprises, Inc. (AEI) in collaboration with the University of Idaho.[28] The value of $31.6 million was derived by conducting five recreation visitor-use surveys on existing users to obtain trip data such as the main reason for visitation, number of trips taken, and the associated trip expenditures. The surveys conducted in 1999 were used to assess the willingness to pay for general reservoir recreation (non-angler) and visitor days demanded.

However, John McKean, the lead author of the 1999 AEI study, re-conducted his analysis in 2005[29]using the same survey data that was used in the 1999 study. McKean's recalculation yielded an annual consumer surplus value of only $9.6 million (1998 dollars; $14.0 million in 2015 dollars) for general recreation on the reservoirs as opposed to $31.6 million. Part of the confusion has to do with the interpretation of survey results, which can have a drastic impact on the estimate of the value of non-angler recreation. One survey in particular, designed to assess non-anglers' willingness-to-pay (WTP) to visit the LSR reservoirs, received a substantial number of responses from those expressing a "high preference for fishing" (85 of 417 usable surveys, or 20 percent), thereby representing anglers rather than non-anglers. Based on all 417 surveys, the 1999 study estimated a WTP of $71.31 per trip. With an

average trips per year of 8.4, the total WTP was estimated at $31.6 million per year ($45.0 million in 2015 dollars), based on the estimated 52,984 unique non-anglers per year. These 417 "non-anglers" did in fact include those expressing a "high preference for fishing".

When McKean (2005) excluded those respondents who had indicated a high preference for fishing (effectively dropping 85 respondents assumed to be anglers, leaving a population of 332 non-angler respondents), he calculated the WTP at $24.65 per trip ($29.96 in 2015 dollars), or $206.17 per non-angler per year ($250.55). This results in a total non-angler recreational value for the LSR reservoirs of only $9.6 million per year ($13.7 million in 2015 dollars). The distinction is important – recreationists who value fishing as one of their highest priorities should not have been included in the non-angler dataset. Their presence overstates the WTP estimates for non-anglers by $46.66 per trip, and the annual AAEP values by $22.0 million – well over three times the corrected value. Table 5 below shows the differences in interpretation of survey responses between the AEI study used in the 2002 FR/EIS and McKean's updated study in 2005.

**TABLE 5: CORRECTING BIAS IN SURVEY RESULTS FOR NON-ANGLER RECREATION**

| | **AEI et al 1999 (1998$)** | **2015$** | **McKean et al 2005 (1998$)** | **2015$** |
|---|---|---|---|---|
| WTP per trip, all surveys (417 responses) | $71.31 | $101.59 | -- | -- |
| WTP per trip, excluding likely anglers (332 responses) | -- | -- | $24.65 | **$35.12** |
| Average trips per year | 8.364 (417 responses) | | 7.36 (332 responses) | |
| WTP per recreationist per year | $596.44 | $849.68 | $181.42 | **$258.45** |
| Unique non-anglers visiting the LSR | 52,984 | | | |
| AAEV of non-anglers visiting the LSR | $31,601,610* | $45,019,760 | $9,612,569 | **$13,693,930** |
| Net Present Value (NPV) | | $653,976,070 | | **$198,926,423** |

**The difference with the value reported in USACE 2002 ($31.578M) appears to stem from rounding error.*

Thus, given the existing studies and assumptions behind the derivation of different values, we would recommend using McKean's 2005 work, a single demand function which provides the average WTP value across all non-angling activities, $181.42 per person per year ($220.47 in 2015 dollars). This value is found by multiplying the WTP per trip ($24.65) by the estimated trips per non-angler per year (7.36 for the corrected non-angler survey respondents). Further investigation into the validity of multiple demand functions for this dataset would be required to include those values in a direct comparison with the regression used in AEI 1999 study and 2002 LSR feasibility report.

### TOTAL RESERVOIR RECREATION

Assuming that all angler-related estimates are accurate, correcting for the bias in the 1999 interpretation of the non-angler survey responses (subtracting for high fishing preference) results in a total contribution of recreational activities of $30.8 million ($44.9 million in 2015 dollars). Table 3.2-10 summarizes the values provided in the original study, those adjusted for McKean's' 2005 update to the value of recreation, and then values adjusted to 2015 dollars.

**TABLE 6. ADJUSTING RESERVOIR RECREATION VALUES**

| Table 3.2-10 FR/EIA - Annualized (AAEV) Value of Recreation Benefits over 100 Years ($ millions) (1998 dollars) (6.875 percent discount rate) | 2002 FR/EIS (Alt 3, 1998$) | Adjusted Estimate (1998$) | 2015$ |
|---|---|---|---|
| General Recreation | $31.60 | $9.61 | $14.00 |
| Angling | | | |
| Resident and Steelhead | $2.08 | $2.08 | $3.03 |
| Steelhead-Tributaries | $18.96 | $18.96 | $27.61 |
| Salmon-Tributaries | $0.18 | $0.18 | $0.26 |
| Total Recreational Fishing | $21.21 | $21.21 | $30.89 |
| **Total General Recreation and Angling** | **$52.81** | **$30.83** | **$44.90** |

## BREACH DAMS

### ANGLING

Angling benefits in a dam breach scenario were estimated using information from the 2002 FR/EIS. It should be noted that more current studies have shown greater angling benefits from the removal of the Lower Snake River dams than presented in the FR/EIS. These studies, however, are not directly comparable with the FR/EIS due to methodological differences in terms of the chosen study area and estimation methods. Nevertheless, newer studies estimate that the type of activities that would take place and the amount of fish present would increase the value gained by recreationalists above that of the NWW's original 2002 estimates.[30]

For this report, angling benefits of $86.8 million ($126.4 million in 2015 dollars) are assumed. These estimates are considered to be conservative given the findings of more current studies. Further information on this point estimate can be found in Table 3.2-10 on page I3-68 of the FR/EIS.

### GENERAL RECREATION

A free-flowing Snake River would open up new recreational opportunities such as jet-boating, rafting, and increased wildlife viewing, camping and hiking. When the original FR/EIS was conducted, the Drawdown Economics Workgroup produced four estimates for recreation based on a rigorous survey. This survey was conducted in Washington, Idaho, Oregon, Montana, and California and was used to identify the type and number of recreation users that would visit a free-flowing Lower Snake River. Survey recipients were asked whether they would "Definitely Visit", "Probably Visit", "Probably Not Visit", or "Definitely Not Visit" a free-flowing Lower Snake River. From this, a consumer surplus value can be obtained from survey respondent's willingness to pay through a travel cost demand model, referred to as the "High NED" value. The total NED value is the product of consumer surplus and total general recreation visits.

The FR/EIS uses an NED value that assumes visitation only by survey respondents that indicated they 'definitely' or 'probably' would visit, but assumes that survey non-respondents would not visit. This estimate was considered the "Middle Use 2" estimate, or the middle-high estimate. The FR/EIS also negated the findings of the travel cost demand model, and assumed a consumer surplus value obtained from the reservoir fishing analysis, which is referred to as the "Low NED" value. The point estimate used in the FR/EIS is $86.5 million (2015 dollars, $59.5 million in 1998).

Earth Economics conducted a thorough analysis of the study used in the FR/EIS (found in Appendix C) and recommends a point estimate that falls between the high and middle-high estimate. This estimate assumes that visitation will be the greatest during the first four years following dam removal, by assuming that all respondents indicating they would "definitely" and "probably" visit, would in fact visit. In years 5-100, California respondents that marked they would "definitely" visit would visit, while "probably" (yes) respondents would not visit. Response assumptions for Washington, Idaho, Oregon, and Montana stay consistent through years 1-100, assuming visitation by "definitely" and "probably" (yes) responses.

Based on these assumptions, we recommend using NED benefits for general river recreation of $1.4 billion[31] per year (2015 dollars; $942 million in 1998). This estimate conforms to current and established best practices on survey-derived data.

### TOTAL RECREATION

Assuming angling recreation benefits of $126.4 million and general river recreation benefits of $1.4 billion per year, the new point estimate for AAEV over 100 years at a 6.875 percent discount rate is now $1.5 billion.

## COMMERCIAL FISHING

The current value of commercial fishing has not been calculated, and the PATH and DREW workgroups that conducted the estimates used in the FR/EIS report provided only projections of fish counts, and the marginal contribution of Alternatives 2 through 4. However, based on these values, it is possible to approximate the actual economic contributions of each alternative. By dividing the marginal benefit of Alternatives 2 through 4 (Table 7) by the marginal increases in harvest levels for each (see Table 8), it is possible to calculate a per-fish value for each commercial fishery for each alternative (see Table 9). Applying the average value per fish to the original harvest estimates, it is possible to re-estimate the average annual contribution for all four alternatives (see Table 10).

**TABLE 7: ESTIMATED NET AVERAGE ANNUAL COMMERCIAL FISHING EFFECTS (1998 DOLLARS)[32]**

| AAEV @ 6.875% Discount Rate | Alt2 | Alt3 | Alt4 |
|---|---|---|---|
| Ocean | $0 | $12,340 | $380,650 |
| In-river | $159,770 | $145,530 | $1,105,800 |
| Total | $159,770 | $157,870 | $1,486,450 |

Table 8: Projected Harvest for Commercial Fisheries for Year 25 (USACE 2002)[32]

| Commercial Harvest (number of fish) | Alt1 | Alt2 | Alt3 | Alt4 |
|---|---|---|---|---|
| Ocean | 3,596 | 3,596 | 4,329 | 30,050 |
| ***Marginal gains*** | | ***0*** | ***733*** | ***26,454*** |
| In-river | | | | |
| Non-treaty | 2,387 | 2,655 | 2,852 | 20,078 |
| Hatchery | 51,679 | 60,533 | 57,986 | 132,257 |
| Treaty Indian | 101,869 | 108,491 | 106,792 | 169,125 |
| *Subtotal_In-river* | *155,935* | *171,679* | *167,630* | *321,460* |
| ***Marginal gains*** | | ***15,744*** | ***11,695*** | ***165,525*** |
| *Subtotal_Commercial* | *159,531* | *175,275* | *171,959* | *351,510* |
| ***Total marginal gains*** | | ***15,744*** | ***12,428*** | ***191,979*** |

**TABLE 9: ESTIMATED VALUE PER FISH (1998 DOLLARS)**

| Value per fish | Alt2 | Alt3 | Alt4 | Average value per fish |
|---|---|---|---|---|
| Ocean | | $16.83 | $14.39 | **$15.61** |
| In-river | $10.15 | $12.44 | $6.68 | **$9.76** |

**TABLE 10: ESTIMATED AVERAGE ANNUAL COMMERCIAL FISHING EFFECTS (1998 DOLLARS)**

| AAEV @ 6.875% Discount Rate | Alt1 | Alt2 | Alt3 | Alt4 |
|---|---|---|---|---|
| Ocean | $56,141 | $56,141 | $68,481 | $449,131 |
| In-river | $1,521,527 | $1,681,297 | $1,826,827 | $2,932,627 |
| **Total** | $1,577,668 | $1,737,438 | $1,895,308 | $3,381,758 |
| ***(2015 dollars)*** | *$2,297,162* | *$2,529,795* | *$2,759,661* | *$4,924,006* |

## WITH DAMS

Table 7 in the previous section illustrates the benefits commercial fisheries receive with dams. Because commercial fishing values have not been updated, benefits under Alternative 3 (major system improvements) are assumed to be accurate. Given this assumption, we recommend using a point estimate from commercial fishing of $1.9 million (2.8 million in 2015 dollars). It should be noted that although reported salmon counts have increased since 2000, wild salmon stocks have not recovered as predicted under Alternative 3 and have in fact declined, even with the additional implementation of Alternative 2.[33] The increase in total salmon counts is a result of increased hatchery production.

## BREACH DAMS

Table 7 in the previous section illustrates the benefits commercial fisheries would receive without the dams. Due to commercial fishing values not being updated, benefits under Alternative 4 (dam breaching) are assumed to be accurate. This analysis uses a point estimate from commercial fishing of $3.4 million ($4.9 million in 2015 dollars).

## TRIBAL FISHING

In the 2002 USACE study, information on Treaty Indian fisheries was based on the work of the DREW Anadromous Fish Workgroup. The DREW workgroup includes In-river Treaty Indian Fisheries within the Commercial Fisheries category. However, what was not economically accounted for in the 2002 study were the costs incurred by traditional native peoples. The reservoirs prevent the full breadth of historical traditions such as fishing, hunting, harvesting berries and roots, and religious and cultural ceremonies.

## WATER SUPPLY

Approximately 34,000 acres of irrigated farmland use the reservoirs produced by the Lower Snake River dams for water supply. Should the dams be breached, these farms would either need to drill wells to reach the aquifers or modify their water withdrawal systems. The water supply values do not reflect the value of the water that is supplied, but the modification costs that would be incurred if the dams were to be breached. Because of this, there are no costs or benefits associated in the "with dams" scenario.

### WITH DAMS

Although the Snake River reservoirs provide irrigation to approximately 34,000 acres of farmland, the costs versus benefits have not been calculated as the 2002 FR/EIS assessed this as a net change over the existing with dam condition.

### BREACH DAMS

There have been no additional studies conducted on the cost of not having a reservoir for irrigation, and therefore the point estimate used in the analysis is the $15.4 million ($22.5 million in 2015 dollars)[34] estimate from the 2002 FR/EIS. However, review to date indicates that the pumping capacity used to calculate these increased pumping costs is significantly overstated. The FR/EIS shows that the increased pumping costs would yield 1 foot of water across 34,000 acres every 19 days. The FR/EIS also assumes that the land would no longer be used for crop production, as opposed to switching to crops that demand less water, e.g., wheat or wine grapes.

## IMPLEMENTATION, OPERATIONS, AND MAINTENANCE

Costs associated with the dam are all considered costs of either hydropower or navigation. According to the 2002 FR/EIS,[35] 91% of the costs can be attributed to the dams for hydropower purposes, with the remaining 9% being allocated to navigation. Although these costs vary by dam, this report looks at the costs and benefits associated with all four Lower Snake River dams, and therefore an average is used (91%/9%).

Our analysis uses updated cost values to the 2002 FR/EIS. Waddell (2015) reevaluated Appendix E of the 2002 FR/EIS, which outlines the cost estimates of maintaining the existing Snake River system and implementing Alternative 3, major systems improvements. To arrive at updated cost values, Waddell synthesized data collected from the NWW Civil Works Activities report (2012), Bonneville Power Administration's Integrated Program Review (2014), and the Lower Snake River Programmatic Sediment Management Plan (2014). Without transparent cost reporting from NWW and BPA, the inclusion of estimates by Waddell provides the best available updated picture of costs. Should further data become available, an independent assessment of operating costs should be undertaken.

According to Waddell,[36] the 2002 FR/EIS underestimated the costs of keeping the dams with improvements by at least $224.0 million per year (2015 dollars) and overestimated the costs of breaching the dams by $38.6 million (2015 dollars)[q]. Waddell's analysis does include the Bureau of Reclamation flow augmentation costs[r] noted in the FR/EIS, but these cost have substantially increased since the agreements were signed around 2005.[37]

### With Dams

Cost estimates for maintaining the dams include six major cost categories: Improving Fish Passage (system improvement costs as required by the Endangered Species Act), Operations and Maintenance Costs, Turbine Rehab Costs, Lower Snake River Compensation Plan Cost, BPA Power Service Cost, and Navigation and Flow Conveyance Dredging.[s]

Waddell's updated cost for maintaining the Lower Snake River dams is $296 million (in 2015 dollars) based on an annual average equivalent over 100 years with a discount rate of 6.875%, beginning in 2015. The NWW originally estimated that maintaining the dams would only cost $56.5 million per year ($72.0 million in 2015 dollars). The NWW underestimated the cost of maintaining the dams by $224.0 million (2015 dollars) per year.

### Breach Dams

If the NWW were to breach the dams, Waddell finds that the annual average equivalent cost would be $28.8 million (in 2015 dollars). Most of the costs of breaching would arise within the first 10 years. Once major construction and mitigation programs have ended, maintenance costs from river recreation upkeep would remain.

## ADDITIONAL CONSIDERATIONS

The 2002 FR/EIS made assumptions concerning the 40,000 acres of project lands that precluded any analysis of economic benefits that could be derived through return of some of this land to agricultural use, which was mostly viniculture and orchards. (Prohibition caused a shift to nearly all orchard). While a detailed evaluation of the possible benefits was beyond the scope of effort contained in this report, Waddell conducted a cursory review to establish the economic plausibility of such reuse while allowing for maximum restoration and preservation of riparian and other adjacent lands providing ecological service to the natural flora and fauna. Review of the 1934 surveys, historical research and other information contained in the FR/EIS shows that 4-5000 acres could be put back into high value, (e.g., viniculture and orchards). This land, once transferred to the state, could yield at least $20 million/year in leases based on unirrigated acreage suitable for viniculture and nearly twice that if irrigated. Since viniculture requires only a fraction of the 34,000 acres of irrigation noted for the crops currently under irrigation on Ice Harbor pool, more than sufficient water and water rights are available to offset the FR/EIS claim of a $15 million year cost through lost irrigation. However, this number is based on excessive water use. It should be noted that under Washington State Department of Natural Resource ownership, the lease or income from land sales could be used to fund education expenses in the state. In addition to this direct benefit to the state's education budget and thus the taxpayer, additional direct,

[q] Assumes AAEV breaching costs of $67.318M ($31.6M, 1998 dollars).

[r] Contracts to ensure a specified amount of water flows downstream to the Snake River dams.

[s] System Improvements and Turbine Rehab do not occur in every year, while the other costs are ongoing.

indirect and tax revenues what be realized from a vibrant viniculture and associated infrastructure such as rustic inns, restaurants, and float tasting tours in the Lower Snake Valley. This is all in addition to the recreation benefits noted elsewhere in this report. Further study will be conducted to determine the full scope of these benefits.

# CONCLUSIONS

This report provides a benefit-cost analysis of two scenarios: keeping the four LSR dams in place or breaching the dams. It is clear that keeping the dams is no longer beneficial to the nation, Northwest ratepayers, or the regional economy. The recreation and tourism values alone trump any benefit that may be provided by hydropower and navigation benefits to shippers from removing the dam. As was found in the accompanying RED analysis, the jobs provided by a thriving recreation community could easily replace any jobs lost by the removal of the four dams. In addition, the removal of the dams will give the dwindling wild salmon species the fighting chance needed to combat issues surrounding climate change. It is clear that the four LSR dams do not provide sufficient benefit to the nation or to the regional economy. The river should thus be restored to its near natural state.

# Regional Economic Analysis of the Four Lower Snake River Dams

## A REVIEW OF THE 2002 LOWER SNAKE FEASIBILITY REPORT/ENVIRONMENTAL IMPACT STATEMENT ECONOMIC APPENDIX (I)

## INTRODUCTION

This report estimates the number of jobs that will be provided by outdoor recreation spending in the six southeast Washington counties along the LSR as a result of dam breaching. In January 2015, Earth Economics released a report entitled *Economic Analysis of Outdoor Recreation in Washington State*, one of the most comprehensive studies of its kind in the state. This economic contribution analysis follows the same methodologies to analyze the regional economic effect of increased outdoor recreation spending.

The Earth Economics statewide report found that the six southeast Washington counties along the LSR (Asotin, Columbia, Franklin, Garfield, Walla Walla, and Whitman) were among the lowest performers for total expenditures in outdoor recreation. A free-flowing LSR will attract visitors from across the country. These visitors will increase spending and foster the growth of income, jobs, and tax revenue. While local users may not spend much to visit the river, long-distance participants will likely dine at local restaurants and bars, stay in campgrounds or hotels, and buy from local shops. This analysis finds that a free-flowing LSR will significantly boost the economic activity within these six counties, which in turn will boost incomes, create jobs, and generate local, state, and federal taxes. A free-flowing LSR can be a vessel for economic development through outdoor recreation tourism.

### ECONOMIC CONTRIBUTIONS AND IMPACTS

The terms economic contribution analysis and economic impact analysis, though often used synonymously, are in fact distinctly different measures of economic effects. Both address economic activity as defined by an economy's structure (sectors present and their interface), the spatial boundaries of an economy, and the producers and consumers acting within the economic framework. For policy and business purposes, researchers define regional economies at different scales (city, county, multi-county, state, and national) and in terms of market and non-market measures of well-being.

**Economic contributions** describe the aggregate economic activity within a given boundary that is generated by initial consumer expenditures as measured through market transactions. **Economic impact**, on the other hand, refers to new money generated within a boundary either by 1) improving the economic interactivity of sectors (i.e. increasing the multipliers) or 2) attracting increased spending from consumers outside of the regional economy. Thus, economic impact describes the "injection" of new money into markets, while economic contribution describes the "circulation" of existing money. The analysis presented here does not differentiate between new money and local resident spending and should thus be considered an economic contribution analysis.

Economic contribution analyses recognize that there are substitutes for consumers within every possible geographic region of analysis. In this case, a consumer could spend their recreation budget on outdoor recreation either locally or elsewhere or, alternatively, on movies, bars, or other activities. These decisions translate into different types of economic activity and consumer satisfaction. Since each regional economy has its own unique structure, it also has its own "multiplier," or ratio of economic activity resulting from an initial expenditure. The higher the multiplier, the more money that recirculates within the local economy. Usually, the larger the geographic area, the more likely it is that the economic structure will be comprised of diverse sectors, suppliers, and wage earners. Economic activity can be measured in terms of jobs, spending, salaries, tax collections, and industries' economic contribution.

This analysis used local data on economic and industry relationships to predict revenue flows to existing businesses (direct contributions), effects on related industries from which purchases are made (indirect contributions), and effects from expenditures made through the affected household incomes and salaries (induced contributions). Local economic models were derived using IMPLAN data from the U.S Bureau of Labor Statistics (BLS), the U.S. Bureau of Economic Analysis (BEA), the U.S Census Bureau and other sources.

## METHODOLOGIES

Breaching the dams and allowing a free-flowing LSR will increase outdoor recreational activities such as fishing, camping, hiking, and birdwatching. The increase in opportunities for these activities will in turn influence consumer spending in many economic sectors and associated supply chains. Food, beverage, fuel, and retail expenditures can, and usually do, accompany a recreational visit. The spending per visit depends on factors such as participant origin, park location, park amenities, and type of recreational activity. In this analysis, these factors were captured through peer-reviewed literature, expert validation, and GIS modeling.

The methodology for conducting an economic contribution analysis of the Lower Snake River requires data and assumptions on 1) participant activities, 2) participant expenditures, and 3) participants' origins. The steps for conducting this analysis were as follows: 1) identify participant activities from the original surveys related to a free-flowing LSR, 2) use peer reviewed literature to create expenditure profiles for the different participant activities and calculate total expenditures per participant category, 3) allocate expenditures to counties, and 4) conduct an economic contribution analysis using IMPLAN, an economic input-output modeling software. The economic output was modeled at the county level, and GIS analysis was used to allocate the effects to legislative districts. The following sections outline these steps in greater detail.

### Participant Activities and Activity Days

The original studies of LSR recreation grouped users into the eight different participant activities seen in Table 11 below. These eight participant categories are later grouped into two categories: "General Recreation" (non-angling), and "Angling".

Activity days were estimated using a previous Earth Economics analysis[38] which reviewed the findings of the recreational analysis presented in the FR/EIS and Dr. John Loomis' original report[39] to the NWW. The original survey sought to identify the type and number of recreation users that would visit a free-flowing Lower Snake River and included participants in Washington, Idaho, Oregon, Montana, and California.

Survey recipients were asked whether they would "Definitely Visit", "Probably Visit", "Probably Not Visit", or "Definitely Not Visit" a free-flowing Lower Snake River.

Assuming that all responses of "Definitely Visit" or "Probably Visit" would in fact result in a visit, Earth Economics concluded that visitation would be the greatest during the first four years. After the initial four-year period, distance is expected to be a discouraging factor for Californian visitors, thus it was assumed that respondents indicating they would "probably visit" would not in fact visit. Visitation from the other surveyed states (Washington, Idaho, Oregon, and Montana) was expected to remain consistent through years one to 100.

The FR/EIS assumes that there will be constraining capacity issues with general recreation in the first 20 years after dam breaching that will limit the availability of recreational opportunities. The expected general recreation restraints for years one, five, and ten are presented in the table below. By year 20, recreational opportunities should be fully available without constraints. Constraints to fishing were not calculated due to lack of fisheries data.

**TABLE 11. RECREATION ACTIVITIES ASSOCIATED WITH A FREE-FLOWING RIVER AND CARRYING CAPACITY CONSTRAINTS**

| Activity | Year 1 | Year 5 | Year 10 | Year 20-100 |
|---|---|---|---|---|
| Jet Boating, Jet Skiing | 20% | 50% | 70% | 100% |
| Raft/Kayak/Canoe | 30% | 50% | 80% | 100% |
| Swimming | 20% | 40% | 100% | 100% |
| Picnic/Primitive Camping | 80% | 100% | 100% | 100% |
| Developed Camping | 60% | 90% | 100% | 100% |
| Hike and Mountain Bike | 80% | 100% | 100% | 100% |
| Hunting | 50% | 80% | 100% | 100% |
| Angling | X | X | X | X |

## VISITOR EXPENDITURES

With the participant activities identified, we then formed expenditure profiles for each category using information gleaned from industry studies on national forest visitor spending,[40] state park visitor spending,[41] and national park visitor spending.[42] The expenditure profiles estimate the dollar amount spent per person per day in each economic sector from lodging to miscellaneous retail. With the expenditure profiles defined, spending in each economic sector was then multiplied by visitors for each activity, yielding values for total annual expenditures associated with each activity group. The total expenditure profiles were then summed across all activities. The table below shows the average expenditures, visitation and total expenditures for each activity in Year 1.

TABLE 12. ACTIVITY EXPENDITURES

| Activity | Per-Person Per-Day Expenditures | Year 1 Visitation | Total Expenditures |
|---|---|---|---|
| Jet Boating, Jet Skiing | $86 | 213,320 | $18,435,879 |
| Raft/Kayak/Canoe | $76 | 1,035,728 | $78,932,634 |
| Swimming | $20 | 679,257 | $13,546,222 |
| Picnic/Primitive Camping | $7 | 167,400 | $1,171,800 |
| Developed Camping | $22 | 219,294 | $4,872,158 |
| Hike and Mountain Bike | $45 | 5,434,062 | $243,096,142 |
| Hunting | $69 | 561,371 | $38,838,154 |
| Fishing | $137 | 744,594 | $102,207,216 |
| **Total** | **$55.34 (Average)** | **9,055,025** | **$501,100,203** |

## ALLOCATION TO COUNTY AND LEGISLATIVE DISTRICTS

This analysis tracks only the economic activity within the six counties surrounding the LSR in southeast Washington and does not track expenditures made outside of the region. Many out-of-state visitors will purchase equipment and groceries in preparation for their trip, but these expenditures were not tracked in this study. Total expenditures for each visitor type were obtained by multiplying visitor days by appropriate expenditure rates.

Visitor days and expenditures were distributed to counties and legislative districts using a GIS tool called the "Huff Model". The Huff Model models distribution based on population density and the distance of population centers (census tracts) to sites of interest. General recreation activity days were allocated to a combined point data set of Washington Department of Fish and Wildlife and Recreation and Conservation Office boat launches that were within a quarter mile of the LSR. Fishing distribution was derived from 1-day fishing licenses issued in WA and distributed based on Washington Department of Fish and Wildlife and Recreation and Conservation Office boat launches that were within a quarter mile of the LSR.

## IMPLAN ANALYSIS

After the expenditure profiles for each activity category were calculated and allocated to county and legislative districts, the next step was to map the visitor expenditures to IMPLAN industry sectors. Impact Analysis for Planning (IMPLAN) is an economic modeling software used to estimate economic contributions and impacts. It uses annually updated input/output models to describe the inter-sectoral economic relationships of a given geography. IMPLAN models receive consumer expenditures per economic sector per geographic area as an input.

IMPLAN V3.1 includes 440 industry sectors based on the Bureau of Economic Analysis' latest Benchmark Input-Output Study. All expenditures were mapped to one of the 440 IMPLAN sectors, resulting in expenditures being made in a 1 of 14 IMPLAN economic sectors. Although each recreation activity has a different expenditure profile associated with it, the table below shows the expected average expenditures across all activities made in each economic sector.

Table 13. Average Expenditure Profile for All Activities in Year 1

| IMPLAN Industry Sector | Per-Person Per-Day Expenditures | Total Expenditures |
|---|---|---|
| Hotels and motels, including casino hotels | $6.29 | $69,869,095 |
| Other accommodations | $1.36 | $11,184,591 |
| Food services and drinking places | $6.60 | $74,482,087 |
| Retail - Food and beverage | $9.17 | $83,824,598 |
| Retail - Gasoline stations | $19.17 | $140,007,498 |
| Scenic and sightseeing transportation and support activities for transportation | $0.39 | $5,591,676 |
| Transit and ground passenger transportation | $0.79 | $3,017,626 |
| Other amusement and recreation industries | $1.75 | $19,011,523 |
| Other Federal Government enterprises | $2.61 | $20,149,806 |
| Other state and local government enterprises | $2.17 | $14,220,355 |
| Retail - Miscellaneous | $2.93 | $38,435,032 |
| General and consumer goods rental except video tapes and discs | $1.61 | $19,462,750 |
| Seafood product preparation and packaging | $0.0009 | $3,372 |
| Soft drink and ice manufacturing | $0.50 | $1,840,196 |
| **Total** | **$55.34** | $501,100,203 |

In this analysis, expenditures were summed for all activities by IMPLAN sector at the county level (legislative district-level data and models were not available). As an example, expenditures on gasoline, whether for boats, automobiles, or off-highway vehicles, were summed into one sector. Input-output models may show that only a portion of expenditures on gasoline stay in Washington State, since most crude oil is delivered from outside the state.[43] Because most of this spending immediately leaves the state, it does not have the chance to circulate around the economy to generate additional economic activity.

Input-output models also calculate multipliers for a given region (county, multi-county, or state). Multipliers show how initial expenditures generate additional economic activity as the initial money is re-spent by other businesses and workers. For example, a county that has boat producers, boat repair shops, and boat retailers is poised to capture more of the expenditures on boat-related goods and services because many of the inputs and suppliers come from within the region. Generally, though not always, the more diverse a county- or state-level economy, the less it must import in order to provide recreational goods and services.

## VISITATION, EXPENDITURES, AND CONTRIBUTIONS

This section of the report will detail the results of the contribution analysis. All results are based on the expected visitation as shown by the survey results.

### VISITATION BY COUNTY

For the four years following dam breaching, the LSR study area will likely receive over nine million participant days. Visitation will then decrease to an estimated 4.6 million, but continue to steadily rise over the following 95 years. The table below shows visitation estimates by county for the first 20 years of the 100-year planning period.

**TABLE 14. EXPECTED VISITATION TO A FREE-FLOWING LOWER SNAKE RIVER**

| | Totals* | Asotin | Columbia | Franklin | Garfield | Walla Walla | Whitman |
|---|---|---|---|---|---|---|---|
| Year 1 | 9,055,025 | 2,059,982 | 442,002 | 2,693,033 | 493,369 | 925,733 | 2,440,906 |
| Year 5 | 4,602,198 | 1,085,250 | 219,527 | 1,325,235 | 267,840 | 465,928 | 1,238,418 |
| Year 10 | 6,289,805 | 1,454,670 | 303,844 | 1,843,626 | 353,315 | 640,193 | 1,694,157 |
| Year 20 | 6,599,938 | 1,522,559 | 319,339 | 1,938,892 | 369,023 | 672,218 | 1,777,908 |

*Visitation estimates derived from surveys conducted for the 2002 FR/EIS

### EXPENDITURES BY COUNTY

Table 12 below shows the estimated expenditures made in each county. Expected expenditures represent the estimates for one year and not the summation of a range of years.

**TABLE 15. EXPECTED EXPENDITURES AS A RESULT OF RECREATION FROM A FREE-FLOWING LOWER SNAKE RIVER (VALUES IN MILLIONS, 2015 USD)**

| Year | Total | Asotin | Columbia | Franklin | Garfield | Walla Walla | Whitman |
|---|---|---|---|---|---|---|---|
| Year 1 | $501.1 | $120.4 | $23.6 | $141.8 | $30.1 | $50.5 | $134.7 |
| Year 5 | $291.6 | $74.5 | $13.1 | $77.4 | $19.5 | $28.8 | $78.1 |
| Year 10 | $347.9 | $86.8 | $16.0 | $94.7 | $22.4 | $34.7 | $93.4 |
| Year 20 | $373.1 | $92.4 | $17.2 | $102.5 | $23.7 | $37.3 | $100.2 |

## ECONOMIC EFFECTS

All economic activity triggered by the initial expenditures was captured by region-specific economic IMPLAN models[t] that estimate how expenditures will "ripple" through the economy. The economic contribution analysis estimates the portion of expenditures that register as sales retained within the region (direct contributions). Some money also leaves the regional economy when an expenditure is made (leakages), and these funds are not counted as an economic contribution. Intermediate sales made from industry to industry purchases within the supply chain are also counted in this analysis (indirect contribution). In addition, the contribution analysis includes the purchases made with the salaries and wages of those employed in the supply chain (induced contribution). The total economic contribution is a summation of the direct, indirect, and induced economic contributions.

The spending associated with recreation along a free-flowing LSR will generate substantial economic activity throughout the region, with the greatest economic activity occurring in the first four years. In

[t] In this analysis, the region is defined as the six counties surrounding the Lower Snake River in Washington (Asotin, Columbia, Franklin, Garfield, Walla Walla, and Whitman).

Year 1, recreation expenditures will total $501 million. These expenditures will provide $288 million in direct economic contributions after leakages, $48 million in supply chain activity to produce outdoor recreation goods (i.e. indirect contribution), and $48 million in household wages that will stimulate further economic activity (induced contribution). Thus, in Year 1, economic contributions throughout the region should total $384 million (See Table 16). Economic activity is seen in nearly 150 different industry sectors, from lodging and restaurants to insurance carriers and grain farming. This shows that recreation dollars have a large effect on the region. For the full contribution analysis results, see Appendix B.

**TABLE 16. ECONOMIC CONTRIBUTION OF RECREATION DIRECT EXPENDITURES (VALUES IN MILLIONS, 2015 USD)**

| | Totals | Asotin | Columbia | Franklin | Garfield | Walla Walla | Whitman |
|---|---|---|---|---|---|---|---|
| Year 1 | $383.8 | $111.3 | $13.3 | $109.2 | $16.4 | $44.0 | $84.0 |
| Year 5 | $203.1 | $50.0 | $7.3 | $60.1 | $10.5 | $24.5 | $47.7 |
| Year 10 | $244.5 | $59.3 | $8.9 | $73.3 | $12.1 | $29.7 | $57.5 |
| Year 20 | $263.0 | $63.5 | $9.7 | $79.2 | $12.8 | $32.1 | $61.8 |

Year 1 spending will also contribute to over 4,000 full- and part-time jobs.[u] These jobs estimates encompass only outdoor recreation-related jobs supported within the county, although other jobs may be supported in other industries, in neighboring counties or within the region.

**TABLE 17. JOBS SUPPORTED BY RECREATION EXPENDITURES**

| | Total | Asotin | Columbia | Franklin | Garfield | Walla Walla | Whitman |
|---|---|---|---|---|---|---|---|
| Year 1 | 4161 | 1104 | 181 | 1177 | 219 | 529 | 951 |
| Year 5 | 2380 | 663 | 99 | 640 | 135 | 294 | 526 |
| Year 10 | 2876 | 788 | 121 | 785 | 157 | 357 | 640 |
| Year 20 | 3098 | 843 | 131 | 849 | 168 | 385 | 691 |

Outdoor recreation along the LSR will largely support jobs in restaurants, local shops, recreation providers, and hotels. Additionally, both induced and indirect jobs will stem from these initial expenditures. Indirect jobs occur further along the supply chain, such as when restaurants purchase local produce, thus supporting jobs for local producers. Induced jobs are generated when outdoor recreation-related employees spend their wages within the economy.

Economic contribution and job estimates were also assigned to legislative districts. The LSR is surrounded by two legislative districts: 9 and 16. Legislative District 9 contains Adams, Asotin, Franklin,

[u] It is expected that a high proportion of total outdoor recreation jobs are part-time jobs. For example, the U.S. Forest Service and National Parks Service hire many seasonal workers in the summer who are students the rest of the year.

Garfield, and Whitman County, and Legislative District 16 contains Columbia and Walla Walla County.[v] The tables below show the economic contribution and jobs supported by outdoor recreation consumer expenditures within the two legislative districts.

**TABLE 18. ECONOMIC CONTRIBUTION FROM RECREATION EXPENDITURES BY LEGISLATIVE DISTRICT (VALUES IN MILLIONS, 2015 USD)**

| | Total | LD 9 | LD 16 |
|---|---|---|---|
| Year 1 | $383.8 | $323.9 | $59.9 |
| Year 5 | $203.1 | $169.8 | $33.3 |
| Year 10 | $244.5 | $204.1 | $40.5 |
| Year 20 | $263.0 | $219.4 | $43.6 |

**TABLE 19. JOBS SUPPORTED BY RECREATION EXPENDITURES BY LEGISLATIVE DISTRICT**

| | Total | LD 9 | LD 16 |
|---|---|---|---|
| Year 1 | 4304 | 3574 | 730 |
| Year 5 | 2380 | 1976 | 404 |
| Year 10 | 2876 | 2384 | 492 |
| Year 20 | 3098 | 2567 | 531 |

[v] Legislative District 9 also contains a portion of Spokane County, while Legislative District 16 is partially in Benton County.

# CONCLUSIONS AND ADDITIONAL RESEARCH

Indeed, there will be increased economic activity within the counties and legislative districts surrounding the LSR in southeast Washington. The large influx of visitors in Year 1 will have expenditures of $500 million and will generate nearly $400 million in economic contribution. This economic contribution will support and generate jobs, tax revenue, and boost incomes. The economic models clearly show that this economic activity will contribute to nearly 150 industry sectors, many of which are not directly related to the recreation industry.

What is not captured by this analysis are the up-river and down-river economic effects of a free-flowing river. This report does not capture economic effects that would occur in upriver communities, such as the city of Lewiston, ID. Lewiston's population grew at a slower rate than the rest of Idaho according to the 2010 Census (1.8% compared to 4.3%). A free-flowing LSR would increase tourism in Lewiston, making it a more attractive city to live in as incomes grow.

Additionally, the 2002 FR/EIS did not consider the economic effects of lost recreational value due to the potential loss of salmon species should system improvements fail to provide sufficient Snake River Chinook returns. These lost benefits were not considered in the 2002 FR/EIS economic analysis because it was assumed that Alternative 3 would increase salmon runs. However, given the failure of these improvements to restore runs, this must now be taken as a serious potential economic loss. Should a greater number of salmon return to spawn upstream, Idaho would likely have increased opportunities for recreational fishing.

Down-river, the effects may be even greater. Wildlife viewing generated the most consumer expenditures in Washington State in 2014.[44] Whale watching, centered on the Southern Resident Killer Whales, provides an immense value to the state through wildlife viewing opportunities. The Southern Residents rely on salmon for food. While it may be difficult to predict the mortality of these whales over time if wild and hatchery Snake Chinook fall below current levels, the killer whales' diminishing numbers will certainly have an impact on viewership and economic benefits that are now running at about $60 million per year in Washington.[45] Given the status of the Snake River stocks outlined in the Salmon Update/Reevaluation White Paper[46], a crashing population of wild/natural/hatchery Chinook could lead to starvation given that 70-80% of the Southern Residents' diet is Chinook. It should also be noted that the birth of nine calves would require at least 30,000 more Chinook per year that, under the current system, must come from commercial or sport fisheries.

# APPENDIX A: INFLATED SHIPMENT PROJECTIONS FOR LOWER SNAKE RIVER WATERWAY BY WALLA WALLA DISTRICT IN THE FR/EIS

| | Observed | | | | | | | | | | Projected | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 2002 | 2007 | 2012 | 2017 | 2022 |
| Grain | 2906 | 3981 | 2532 | 3109 | 3241 | 2612 | 2706 | 3135 | 3471 | 2821 | 3647 | 3799 | 3798 | 3892 | 4052 |
| Wood Chips and Logs | 461 | 394 | 320 | 304 | 375 | 500 | 854 | 910 | 857 | 530 | 694 | 694 | 694 | 694 | 694 |
| Petroleum | 117 | 105 | 115 | 108 | 106 | 108 | 129 | 137 | 144 | 95 | 127 | 136 | 145 | 156 | 167 |
| Wood Products | 46 | 52 | 45 | 42 | 74 | 61 | 45 | 58 | 68 | 28 | 66 | 79 | 101 | 128 | 148 |
| Other | 96 | 127 | 203 | 166 | 159 | 80 | 57 | 74 | 82 | 85 | 97 | 110 | 128 | 148 | 167 |
| Total | 3626 | 4659 | 3215 | 3729 | 3955 | 3361 | 3791 | 4314 | 4622 | 3559 | 4631 | 4818 | 4866 | 5018 | 5228 |

## APPENDIX B: CONTRIBUTION ANALYSIS BY COUNTY

VALUES IN THOUSANDS, 2015 USD

| | | Totals | Asotin | Columbia | Franklin | Garfield | Walla Walla | Whitman |
|---|---|---|---|---|---|---|---|---|
| Year 1 | Expenditures | $501,100 | $120,374 | $23,607 | $141,785 | $30,149 | $50,468 | $134,717 |
| | Leakages | -$117,285 | -$9,100 | -$10,301 | -$32,600 | -$13,734 | -$6,489 | -$50,680 |
| | Direct Contribution | $287,787 | $81,605 | $11,004 | $84,980 | $13,716 | $30,444 | $66,038 |
| | Indirect Contribution | $47,851 | $14,942 | $1,306 | $11,200 | $1,662 | $5,797 | $9,097 |
| | Induced Contribution | $48,177 | $14,727 | $996 | $13,004 | $1,037 | $7,737 | $8,902 |
| | Total Contribution | $383,815 | $111,274 | $13,307 | $109,185 | $16,415 | $43,978 | $84,037 |
| Year 5 | Expenditures | $291,557 | $74,505 | $13,138 | $77,419 | $19,536 | $28,830 | $78,130 |
| | Leakages | -$88,505 | -$24,535 | -$5,808 | -$17,361 | -$9,067 | -$4,319 | -$30,453 |
| | Direct Contribution | $152,485 | $36,577 | $6,058 | $46,743 | $8,747 | $16,961 | $37,399 |
| | Indirect Contribution | $24,932 | $6,674 | $713 | $6,151 | $1,046 | $3,193 | $5,085 |
| | Induced Contribution | $25,635 | $6,718 | $558 | $7,164 | $676 | $4,357 | $5,192 |
| | Total Contribution | $203,052 | $49,969 | $7,330 | $60,058 | $10,470 | $24,511 | $47,677 |
| Year 10 | Expenditures | $347,944 | $86,848 | $15,955 | $94,739 | $22,392 | $34,652 | $93,357 |
| | Leakages | -$103,441 | -$27,526 | -$7,017 | -$21,461 | -$10,323 | -$4,903 | -$35,896 |
| | Direct Contribution | $183,623 | $43,423 | $7,389 | $57,033 | $10,084 | $20,589 | $45,106 |
| | Indirect Contribution | $30,096 | $7,931 | $873 | $7,510 | $1,212 | $3,894 | $6,165 |
| | Induced Contribution | $30,784 | $7,968 | $676 | $8,735 | $773 | $5,266 | $6,191 |
| | Total Contribution | $244,504 | $59,322 | $8,938 | $73,278 | $12,070 | $29,749 | $57,461 |
| Year 20 | Expenditures | $373,112 | $75,222 | $10,487 | $89,523 | $14,055 | $38,910 | $69,816 |
| | Leakages | -$110,107 | -$11,725 | -$831 | -$10,345 | -$1,271 | -$6,822 | -$7,988 |
| | Direct Contribution | $197,522 | $46,478 | $7,983 | $61,625 | $10,681 | $22,208 | $48,546 |
| | Indirect Contribution | $32,401 | $8,492 | $944 | $8,116 | $1,286 | $4,207 | $6,646 |
| | Induced Contribution | $33,083 | $8,526 | $729 | $9,437 | $817 | $5,672 | $6,636 |
| | Total Contribution | $263,005 | $63,497 | $9,656 | $79,178 | $12,784 | $32,088 | $61,828 |

# APPENDIX C - REVIEW OF THE LOWER SNAKE RIVER JUVENILE SALMON MIGRATION FEASIBILITY REPORT/ ENVIRONMENTAL IMPACT STATEMENT 2002. SECTION I3-49 THOUGH I3-81 OF THE ECONOMIC APPENDIX (I) RECREATIONAL BENEFITS OF BREACHING THE FOUR LOWER SNAKE RIVER DAMS (NOVEMBER, 2015)

## INTRODUCTION

Earth Economics has been commissioned to review Appendix I, section 3.2 of the "Lower Snake Feasibility Report/Environmental Impact Statement"[47] (LSRFR) completed in 2002 as well as John Loomis' original report to the Walla Walla District (NWW) of the United States Army Corps of Engineers (USACE) "Recreation and Passive Use Values from Removing the Dams on the Lower Snake River to Increase Salmon"[48] published in 1999. Loomis' report offers eight different estimates for the value of recreation based on consumer surplus measures using varying methodologies and assumptions.

These eight potential value estimates and the values chosen by the NWW for representing these results are summarized in the tables below. The report to the NWW does not provide all eight estimates, but instead provides the middle estimates for visitation with low and high national economic development (NED) values. The numbers with borders are the values the NWW uses in their point estimate for recreation. Using these values, the point estimate used by NWW in 2002 for recreation is $73.128M (1998 dollars) annually.

TABLE 20. RECREATION VALUES FROM LSRFR[47] (VALUES IN MILLIONS, 1998 USD)

| Summary of General Recreation | 1 | Low NED | High Ned |
|---|---|---|---|
| General Recreation | | | |
| Reservoir Recreation | $31.6 | | |
| Middle Use Estimate 1 | | $36.9 | $192.7 |
| Middle Use Estimate 2 | | $59.5 | $310.5 |
| Recreational Fishing | | $45.228 | |
| | Point Estimate | $73.128 | |

The following table shows Loomis' original values presented to the NWW. Loomis estimates four different visitation levels in the report (low, middle, middle-high, and high). However, Loomis provides only one middle estimate in his final annualized table. The cells with black borders are John Loomis' suggested estimates for the value of recreation. Using these values, the final point estimate for recreation is between $95M and $349M (1998 dollars) annually using low and high NED values, respectively. These numbers are significantly higher than the numbers used by the NWW.

TABLE 21. RECREATION VALUES FROM LOOMIS RECREATION[48] (VALUES IN MILLIONS, 1998 USD)

| Summary of General Recreation | 1 | Low NED | High Ned |
|---|---|---|---|
| General Recreation | | | |
| Reservoir Recreation | $31.6 | | |
| Low Use Estimate | | $36.18 | $150.12 |
| Middle Use Estimate | | $80.85 | $335.53 |
| High Use Estimate | | $367.18 | $1,523.74 |
| Recreational Fishing | | $45.228 | |
| | Point Estimate | $94.478 | $349,158 |

Our review of the methodologies and underlying assumption concludes that the value estimates chosen to represent general river recreation expected in a free flowing Lower Snake River are not the most methodologically sound of all the estimates provided and the underlying assumptions behind the chosen estimates are not necessarily the most accurate. These estimates rely on two assumptions about visitors. The first assumption made is in regards to how survey respondents and non-respondents are assumed to behave given their answers to a well-conducted survey. The current point estimate assumes visitation only by survey respondents that indicated they 'definitely' or 'probably' would visit, but assumes that survey non-respondents would not visit. This assumption is referred to as "Middle Estimate 2". The second assumption deals with whether low or high national economic development (NED) values are used, which is based on how travel costs are measured. Travel costs are either measured by using survey respondents' reported costs of travel (e.g., transportation, lodging, food, etc.) or solely assumed travel costs associated with transportation to and from the river. The NWW estimates river recreation based strictly on transportation costs, or the "Low NED" value.

This analysis recommends the point estimate for recreation on a free-flowing Lower Snake River to be $956M (1998 dollars) annually, assuming an annual average equivalent[23] over 100 years at a 6.875% discount rate. This estimate assumes visitation by survey respondents stating that they 'definitely' or 'probably' would visit, applying this ratio to non-responders, and high NED values derived from a well-conducted survey. This methodology is applied to all survey respondents for years 1 through 4. For the remaining years (5-100), we assume that California survey respondents would only visit if they selected 'definitely yes' as a response, assuming zero visitation for 'probably' (yes), but applies this ratio to non-respondents. 'Definitely' or 'probably' (yes) respondents are still assumed to visit for Washington, Idaho, Montana, and Oregon respondents for years 5 through 100. Restoration projects in Washington have shown that there is an immediate increase in visitation after restoration projects, but this high level of visitation is not sustained in the long run.[49]

The first chapter of this report will review and explain in simple terms the methodologies used by Dr. Loomis[48] for calculating recreational benefits under two scenarios; recreation with the dam and recreation without. Next, Earth Economics will provide expert opinion on the point estimate that is believed to be the most representative of the study area with a dam removal scenario. Finally, Earth Economics will identify areas on how Dr. Loomis' work can be expanded to current best practices, such as the discount rate and the inclusion of ecosystem service values.

[23] Annual average equivalent is the average cost or benefit of owning an asset over its entire life.

# OVERVIEW OF THE CURRENT LOWER SNAKE RIVER FEASIBILITY REPORT

The first section of this report will review Appendix I, section 3.2 of the "Lower Snake Feasibility Report/Environmental Impact Statement"[47] completed in 2002 as well as Dr. John Loomis' original report to the Army Corps of Engineers Walla Walla District "Recreation and Passive Use Values from Removing the Dams on the Lower Snake River to Increase Salmon"[48] published in 1999. The purpose of reviewing this literature is to assess the methodology and assumptions behind the different recreation values given current state of the art in valuation methods.

Section 3.2 of Appendix I of the "Lower Snake Feasibility Report/Environmental Impact Statement" (LSRFR) provides national economic development (NED) values associated with (then) current recreation occurring at the dam reservoirs and estimated net changes in recreation that would result from the removal of the four Lower Snake River Dams.

## ASSUMPTIONS ABOUT VISITATION RATES AND INCURRED EXPENDITURES

The LSRFR study estimates the value that people put on recreational opportunities by administering a survey to current reservoir users and potential users of a free-flowing Lower Snake River. The survey was administered in Washington, Idaho, Oregon, Montana, and California (it does not include international visitors). This survey was used to estimate the number of visitors and the estimated expenditures that would be made during the trip. The expenditures are used to construct a demand curve from which consumer surplus values are calculated to reflect the non-monetary welfare that recreational visitors get.

The LSRFR provides four estimates of the value of general river recreation based on the findings of the survey. These results have been annualized and averaged over 100 years in the table below. Out of the four provided estimates, the LSRFR chose to use an average annual equivalent of $59.5M (1998 dollars) in benefits per year over 100 years for general recreation benefits with dam removal. For a detailed description on economic benefits, beneficiaries and NED values, please see appendix D.

Each of the values given in the table below is based on two different pairs of assumptions in relation to assumed visitation rates and willingness to pay (WTP) estimates derived from the surveys. The middle estimates are visitation estimates, while the NED values are based on low and high recreational values, changing in relation to the assumed expenditures.

TABLE 22. RECREATION BENEFITS WITH DAM REMOVAL (VALUES IN MILLIONS, 1998 USD @ 6.875%) (TABLE 3.2-13, LSRFR)

| | Low NED | High NED |
|---|---|---|
| Middle Estimate 1 | $36.9 | $192.7 |
| Middle Estimate 2 | **$59.5** | $310.5 |

### LOW AND HIGH NED VALUES

**Low NED:** Assumes lower bound estimate of recreational values. This estimate uses a cost per mile estimate obtained from the reservoir fishing analysis for the assumed total expenditures.

**High NED:** Assumes upper bound estimate of recreational values. This estimate is based on the findings from the survey on the estimated expenditures incurred to travel to a free-flowing Lower Snake River. These expenditures include more than car-related expenditures.

A low NED value was chosen because the survey respondents reported trip costs higher than average expenditures. The Low NED value ignores the findings of the survey and uses the cost-per-mile price variable in the travel cost method (TCM) general river recreation demand function. In our opinion, this cost-per-mile measure is a very low estimate of people's value of recreation.

### Estimating Visitation Rates

**Middle Estimate 1:** Assumes only survey respondents that indicated they would 'definitely' visit would visit and assumes that the rest of respondents would not visit including those that said they would 'probably' visit. It also assumes that that households that did not respond to the survey would visit at the same rate as households that responded to the survey.

**Middle Estimate 2:** Assumes that survey respondents that indicated that they would 'definitely' or 'probably' would visit would actually visit, but assumes that households that did not respond to the survey would not visit.

The LSRFR recognizes that assuming zero visitation from 'probably' (yes) respondents is unrealistic and hence uses the Middle Estimate 2 as the NWW point estimate. However, this point estimate assumes non-respondents would not recreate in the free flowing river at all, which is highly unlikely. Both middle estimates are quite conservative with at least one of their assumptions. In John Loomis' original report[48] to the NWW, four additional values are provided; a low visitation estimate and a high visitation estimate paired with low and high NED values. Loomis' low estimates assume only respondents that said they would definitely visit would visit, with zero visitation from both probable and non-respondents. The high estimates assume visitation by 'definitely' and 'probably' (yes) respondents, and applies this ratio to non-respondents. These estimates were not considered at all.

## Recommended Point Estimate

Survey-based methodologies for estimating visits to a recreational area are widely used. There has been extensive research on how to interpret survey responses through both empirical and theoretical research. It is safe to assume that a non-response to a survey does not necessarily imply a disinterest in the behavior being researched (in this case river recreation). A number of factors can affect a person's willingness to respond to a survey; ranging from distrust of the survey to more practical reasons like time constraints or unavailability.[50, 51] In general, current theory for using survey methodologies has shown that there is not a strong relationship between non-responses and survey biases.[52]

The LSRFR does not include the lower and upper bound estimates provided by Loomis' original recreation report.[48] These estimates are as follows:

**Lower Estimate:** Assumes just households that indicated they would 'definitely' visit with dam removal and assuming zero visitation from survey non-respondents.

**Upper Estimate:** Assumes households that indicated they 'definitely' or 'probably' would visit actually visit and assuming that all households would visit at the rate of survey respondents.

It has been found that there is no strong relationship between a survey's nonresponse rate and the expected behavior of that respondent. This illustrates that assuming zero visitation from non-respondents can drastically misrepresent actual visitation.[52] It is also conservative to assume only respondents stating they would 'definitely visit' would visit. Empirical research suggests that too many 'yes' responses were being recoded as 'no's' across survey-based studies if only completely certain 'yes' responses were retained.[53] It has also been found that the estimation of median WTP would be biased if the 'don't know' respondents were simply thrown out or recoded as 'No's'.[54] We believe that it is safest to assume that visitation is best predicted by assuming visitation by 'definitely yes' and 'probably yes' respondents and assuming zero visitation by 'definitely No' and 'probably No' respondents. The visitation estimates by respondents would be assumed for non-respondents as well. This rate would then be applied to all households within the region. Even though some 'probably yes' respondents may not visit, there will also be 'probably no' respondents that do visit.

TABLE 23. WOULD YOU VISIT A FREE-FLOWING LOWER SNAKE RIVER? (TABLE 2 LOOMIS RECREATION) [48]

| | Local Counties | Res of ID, Or, WA | MT | CA |
|---|---|---|---|---|
| Definitely Yes | 14% | 10% | 5% | 3% |
| Probably Yes | 28% | 24% | 15% | 21% |
| Probably No | 43% | 50% | 60% | 51% |
| Definitely No | 16% | 17% | 20% | 58% |

The use of the high NED value is also recommended. The low NED values ignore the findings of the survey and assume very low value placed on free flowing river recreation by using the 19 cent cost-per-mile estimate. This estimate makes values even smaller given that most visitors are assumed to be local. The LSRFR states that for reservoir recreation, most users will be local and therefore take shorter trips, typically of a day or less. The TCM used relies upon just transportation costs incurred traveling to and from the reservoirs, and does not include other costs, such as lodging. There is evidence that for recreation, survey-derived WTP estimates are not statistically different from WTP estimates derived from actual behavior-based methods.[55] This evidence shows that using the survey data to calculate consumer WTP can be statistically significant.

TABLE 24. RECREATION BENEFITS WITH DAM REMOVAL (VALUES IN MILLIONS, 1998 USD @6.875%) AS PRESENTED IN THE LOOMIS RECREATION REPORT (TABLE 8A)[48]

| | Low NED | High NED |
|---|---|---|
| Low Use Estimate | $36.18 | $150.12 |
| Middle Use Estimate | $80.85 | $335.53 |
| High Use Estimate | $367.18 | $1,523.74 |

*ADJUSTING FOR CALIFORNIA'S LARGE VISITOR CONTRIBUTION*

As was the conclusion in the LSRFR, it is unlikely that Californians would be able to sustain the high visitation rate as shown in the surveys. Assuming 'definitely yes' and 'probably' survey respondents would visit would yield 22 million visitors per year, 82% of the total visitors. To adjust for this, starting in year 5, it is assumed that only 'definitely yes' respondents from California are assumed to visit. Adjusting for this, only 3.5 million visitors will come from California, or 40% of visitors in years 5-100. The

following table illustrates the projected visitation to the Lower Snake River following restoration for all visitor origins. Underlined visitor days supplied are values that are restricted from a capacity standpoint.

| | Visitor Days Demanded | | Visitor Days Supplied | | | |
|---|---|---|---|---|---|---|
| **Activity** | Years 1-4 | Years 5-100 | Years 1-4 | Years 5-9 | Years 10-19 | Years 20-100 |
| Jet Boating, Jet Skiing | 1,066,599 | 327,362 | 213,320 | 163,681 | 229,153 | 327,362 |
| Raft/Kayak/Canoe | 3,452,425 | 1,059,623 | 1,035,728 | 529,811 | 847,698 | 1,059,623 |
| Swimming | 3,396,283 | 1,042,392 | 679,257 | 416,957 | 1,042,392 | 1,042,392 |
| Picnic/Primitive Camping* | 7,859,177 | 2,412,149 | 167,400 | 167,400 | 558,000 | 558,000 |
| Developed Camping* | 4,378,681 | 1,343,910 | 219,294 | 219,294 | 438,588 | 438,588 |
| Hike and Mountain Bike | 6,792,578 | 2,084,786 | 5,434,062 | 2,084,787 | 2,084,787 | 2,084,787 |
| Hunting | 1,122,741 | 344,593 | 561,371 | 275,675 | 344,593 | 344,593 |
| **Total** | **28,068,497** | **8,614,819** | **8,310,431** | **3,857,604** | **5,545,211** | **5,855,345** |

*Visitation restricted by number of sites available, also underlined.

Adjusting for California's visitation after year 4, the AAEV for general recreation is therefore $942.17M (1998 dollars) if we continue to assume a NED value of $160 per visitor, and $180.66M (1998 dollars) if we assume a NED value of $31 per visitor.

| | Low NED | High Ned |
|---|---|---|
| Low Use Estimate | $36.18 | $150.12 |
| Middle Estimate 1 (LSRFR) | $36.90 | $192.70 |
| Middle Estimate 2 (LSRFR) | $59.50 | $310.50 |
| California Adjusted Estimate | $180.66 | $942.17 |
| High Use Estimate | $367.18 | $1,523.74 |

## Final Point Estimate

After adjusting for California's survey responses, we recommend using NED benefits for general river recreation of $942M (1998 dollars) per year. This estimate conforms to current and established best practices on survey-derived data.[56] Assuming general river recreation benefits of $942M (1998 dollars), the new point estimate for annual average equivalent over 100 years at a 6.875% discount rate is now $955.8M (1998 dollars).

TABLE 25. SUMMARY OF RECREATION @6.875%, (VALUES IN MILLIONS, 1998 USD) (UPDATING TABLE 3.2-10 IN LSRFR[47])

| | With Dam | Low NED | High Ned |
|---|---|---|---|
| **General Recreation** | | | |
| Reservoir Recreation | **($31.60)** | | |
| Low Use Estimate | | $36.18 | $150.12 |
| Middle Estimate 1 (LSRFR) | | $36.90 | $192.70 |
| Middle Estimate 2 (LSRFR) | | $59.50 | $310.50 |
| California Adjusted Estimate | | $180.66 | **$942.17** |
| High Use Estimate | | $367.18 | $1,523.74 |
| **Angling** | | | |
| Resident and Steelhead | $2.07 | $5.20 | $13.84 |
| Steelhead-Tributaries | $17.73 | $3.36 | $30.90 |
| Salmon-Tributaries | $151 | $1.22 | $481 |
| Total Recreational Fishing | $19.96 | $8.68 | **$45.23** |
| **General Recreation and Angling** | | | |
| Total Reservoir | $51.56 | $8.68 | |
| Total Middle Estimate 1 | | $13.98 | $206.33 |
| Total Middle Estimate 2 | | $36.58 | $324.13 |
| **Point Estimate** | | | **$955.80** |

If these values were converted to 2015 dollars, the point estimate for recreation $1.39B, assuming an annual average equivalent over 100 years at a 6.875% discount rate.

TABLE 26. SUMMARY OF RECREATION @6.875%, (VALUES IN MILLIONS, 2015 USD) (UPDATING TABLE 3.2-10 IN LSRFR[47])

| | With Dam | Low NED | High Ned |
|---|---|---|---|
| **General Recreation** | | | |
| Reservoir Recreation | **($45.95)** | | |
| Low Use Estimate | | $52.61 | $218.29 |
| Middle Estimate 1 (LSFR) | | $53.66 | $280.21 |
| Middle Estimate 2 (LSFR) | | $86.52 | $451.50 |
| California Adjusted Estimate | | $262.70 | **$1,370.02** |
| High Use Estimate | | $533.92 | $2,215.69 |
| **Angling** | | | |
| Resident and Steelhead | $3.01 | $7.56 | $20.13 |
| Steelhead-Tributaries | $25.78 | $4.89 | $44.94 |
| Salmon-Tributaries | $220 | $1.77 | $699 |
| Total Recreational Fishing | $29.02 | $12.63 | **$65.77** |
| **General Recreation and Angling** | | | |
| Total Reservoir | $74.97 | $12.63 | |
| Total Middle Estimate 1 | | $20.33 | $300.02 |
| Total Middle Estimate 2 | | $53.20 | $471.32 |
| **Point Estimate** | | | **$1,389.84** |

# AREAS FOR FURTHER RESEARCH

## Discount Rate

The discount rate used in the 1999 LSRFR was set by the USACE at 6.875%. The discount rate is only applied to recreation benefits in the future, and not to current reservoir recreation benefits. The LSRFR does provide estimates at 4.75% discount rate (BPA Rate) and at 0.0% discount rate (Tribal Rate) but are provided purely for ornamental purposes and are not used in the final analysis. The 2015 Federal discount rate to be followed by the Army Corps of Engineers is set at 3.375%.

Discount rates are typically applied to capital investments to predict the net present value of future cash flows. These are sometimes called private discounting; discounting from the specific, limited perspective of private individuals or firms and their financial capital decisions.[57] On the other hand, social discounting reflects the broad society-as-a-whole point of view and is many times favored in projects with long time horizons in order maintain intergenerational equity and environmental justice concerns.[58] When discounting future consumer benefits from recreation, the implication made is that recreation benefits will not be worth as much in the future as they are today, i.e., people will value their recreational experiences at a discounted rate. In this valuation, the high discount rate used creates a bias in the values towards 'current' dam recreation and disadvantages free-flowing river recreation which begins to be valued twenty years in the future. Weighting future generations less than current generations is considered unethical, as it does not give a voice to those that may be affected in the future.

There has been much debate surrounding discount rates. In order to help solve this dilemma, Congress has set the discount rate for water resource agencies to use when evaluating water resource projects. These discount rates are set annually, by law (Section 80 of PL 93-251) and are based on the cost of government borrowing.[59] As stated earlier, the 2015 federal discount rate is set at 3.375%.

## Regional Economic Development

Regional economic development (RED) should be reevaluated as different industries recirculate money within a local economy at different rates. Money in recreation and tourism industries tends to recirculate within the economy at a higher rate than many other industries, such as movie theaters or restaurants.[60] As a result of recreation economies having a diverse economic makeup there is more spending, and more spending means more income, jobs, and taxes.

## Ecosystem Service Values

Ecosystem services are defined as the benefits people derive from nature, free of charge. Breathable air, drinkable water, nourishing food, waste treatment, flood risk reduction, and stable atmospheric conditions are some examples. These benefits are conventionally not accounted for in accounting or economic contribution/impact analyses. In reality, ecosystem services create irreplaceable value and can amount to high cost savings and increased economic value to the state and the communities around the Lower Snake River.[61] In order to show their economic importance, ecosystem services can be valued in dollar units. In many cases these values reflect avoided costs, inputs into economic production processes, or into potentially marketable goods and services. Economists have developed a number of methods to translate ecosystem services into monetary values. A list of the most common valuation methodologies is provided in Appendix E.

In the absence of primary data for a site-specific valuation, values obtained from already published studies of sufficiently similar sites can be used as general approximations. This valuation methodology is referred to as benefit transfer. It is commonly applied in policy analysis, as decision makers require timely and cost-effective methods for valuing green spaces.

The following are just a few examples of ecosystem services present in the Lower Snake River Basin, which have not been valued and should be considered for valuation.

### AESTHETIC INFORMATION

Aesthetic Information is defined as enjoying the sights, sounds, smells, and presence of nature. This ecosystem service is often valued through the environmental attributes of property sales and hence reflects the added housing value to those who live close to outdoor recreational areas. As outdoor recreational areas expand with the removed dam, aesthetic values are expected to increase.

### WILDLIFE HABITAT

Recreational activities like wildlife viewing or hunting would not exist without the ecosystem service of habitat and nursery. Beyond recreation, however, ecosystems also provide safe havens for endangered species and other species important in food webs and in other ecological functions. In some cases, people value the existence of wildlife as an end in itself (intrinsic value of wildlife). Restoring the natural areas around the Lower Snare River is expected to benefit many water and land species, increasing the habitat value of the area. It should also be noted that "wildlife viewing" was the most lucrative outdoor recreation activity in Washington State.[62]

### WATER QUALITY

The Lower Snake River Basin has many rivers, lakes, and watersheds within it. The vegetated landscape around these water bodies plays an important function in improving or maintaining water quality, which eventually affects downstream users as well. Forest and grassland vegetation along riverbanks stabilize soils and prevent erosion, reducing sediment run-off. Vegetation, microbes, and soils remove pollutants and sediment from the water by adhering to contaminants, by reducing water speed to enhance infiltration, by biochemical transformation of nutrients and contaminants, by absorbing water and nutrients from the root zone of trees, by stabilizing eroding banks, and by diluting contaminated water.[63] Some species are able to provide clean water by removing pollutants and sediment from the water. It can be said that natural lands filter and control the flow of water in lieu of built infrastructure like water purification facilities, levies, and storm water systems. The cost of replacing these functions with built infrastructure, or replacement value, is one way to value water quality.

## INCLUSION OF PASSIVE USE VALUES

Passive use values, also referred to as "non-use" values, are values that are not associated with actual use of an ecosystem or its services.[64] For example, a person may be willing to pay to preserve an ecosystem even though they themselves may never visit it. This person values it just to know it exists. Passive use values are not included in the point estimates for a free-flowing Lower Snake River. The original studies include passive use values, but they are not used in the final BCA. [65]

# CONCLUSION

This analysis has found that the most accurate point estimate for recreation on a free-flowing Lower Snake River is $956M (1998 dollars, 1.4B in 2015 dollars) per year assuming an annual average equivalent over 100 years at a 6.875% discount rate. This estimate assumes visitation by survey respondents stating they 'definitely' or 'probably' would visit, applying this ratio to non-responders, and NED values derived from a well-conducted survey.

# APPENDIX D: A PRIMER ON VALUE MEASURES: ECONOMIC BENEFITS AND BENEFICIARIES

Economic benefits are a measure of the total change in social welfare, including market and non-market values. Market values refer to existing markets and recorded expenditures whereas non-market values refer to benefits obtained free of charge. Economic beneficiaries are those who gain welfare, or the economic benefits being measured. In this current scenario, the main beneficiaries are the communities along the Lower Snake River who are assumed to make up the largest percentage of visitors. If the dams were to be breached, beneficiaries would expand to more than just current reservoir users, such as businesses or long distance travelers looking for unique recreation opportunities.

The DREW Recreation Workgroup focused on two types of recreation activities that would occur on the Lower Snake River in all scenarios: angling and general recreation (non-angling water specific recreation which changes from one scenario to the other). General recreation specific to the reservoirs is boating and water skiing. If the four dams were to be breached, general recreation activities would expand to include drift boating, rafting, kayaking, and jet boating in addition to nature and wildlife viewing, hiking, and camping.

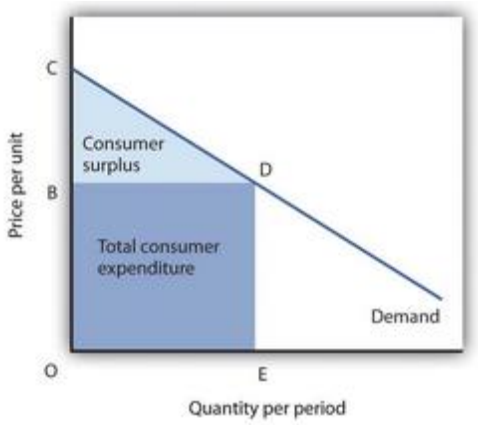
The recreation values used to measure the benefits derived from these activities reflect welfare gains or losses, beyond market transactions, obtained from the set of recreational opportunities available to people. Expenditures on recreational activities are used to estimate demand and willingness to pay for recreational activities. In this case these economic benefits represent consumer surplus values, or people's willingness to pay for recreation.

## NED Values and Consumer Surplus

National economic development, or NED values, illustrates the net effects or changes in the economic value of the national output of goods and services. NED benefits do not show the gains made in one region at the expense of another region. It is assumed in the LSRFR that if there is demand for certain types of recreation, that demand will be met within the country in one location or another. In this report, NED recreation values are measured in terms of consumer surplus or net willingness to pay (WTP).

Consumer surplus is the difference between the maximum price consumers would be willing to pay for a good or service and what they actually pay for it (see **Figure 2**). This difference is a gain for the consumer since they are paying less than the value they place on that benefit. For example, a Washingtonian may be willing to pay $50 to go hiking for one day on the Olympic Peninsula (this would be point C in Figure 14). If the actual cost of the hiking trip is only $20 (point D), then the hiker gains a net economic benefit (consumer surplus) of $30 per day (or the area of the triangle BCD). Even though they are obtained free of charge, the existence of extra benefits is strategic in the decision to visit an attraction or engage in an activity.

Figure 2. Consumer Surplus



# APPENDIX E ECOSYSTEM SERVICES AND VALUATION METHODOLOGIES

Typology for 21 Ecosystem Services

| Good/Service | Economic Benefit to People |
|---|---|
| Provisioning Services | |
| Food | Producing crops, fish, game, and fruits |
| Medicinal Resources | Providing traditional medicines, pharmaceuticals, and assay organisms |
| Ornamental Resources | Providing resources for clothing, jewelry, handicraft, worship, and decoration |
| Energy and Raw Materials | Providing fuel, fiber, fertilizer, minerals, and energy |
| Water Supply | Provisioning of surface and groundwater for drinking water, irrigation, and industrial use |
| Regulating Services | |
| Biological Control | Providing pest and disease control |
| Climate Stability | Supporting a stable climate at global and local levels through carbon sequestration and other processes |
| Air Quality | Providing clean, breathable air |
| Moderation of Extreme Events | Preventing and mitigating natural hazards such as floods, hurricanes, fires, and droughts |
| Pollination | Pollination of wild and domestic plant species |
| Soil Formation | Creating soils for agricultural and ecosystems integrity; maintenance of soil fertility |
| Soil Retention | Retaining arable land, slope stability, and coastal integrity |
| Waste Treatment | Improving soil, water, and air quality by decomposing human and animal waste and removing pollutants |
| Water Regulation | Providing natural irrigation, drainage, groundwater recharge, river flows, and navigation |
| Supporting Services | |
| Habitat and Nursery | Maintaining genetic and biological diversity, the basis for most other ecosystem functions; promoting growth of commercially harvested |

| | |
|---|---|
| | species |
| Genetic Resources | Improving crop and livestock resistance to pathogens and pests |
| Cultural Services | |
| Natural Beauty | Enjoying and appreciating the presence, scenery, sounds, and smells of nature |
| Cultural and Artistic Inspiration | Using nature as motifs in art, film, folklore, books, cultural symbols, architecture, and media |
| Recreation and Tourism | Experiencing the natural world and enjoying outdoor activities |
| Science and Education | Using natural systems for education and scientific research |
| Spiritual and Historical | Using nature for religious and spiritual purposes |

**Source:** Adapted from de Groot puc., 2002 and Sukhdev et al., 2010

### PRIMARY ECOSYSTEM SERVICE VALUATION METHODS

| | |
|---|---|
| Market Value | The value that an ecosystem good is sold for in a market. |
| Avoided Cost (AC) | The value of costs avoided that would have been incurred in the absence of particular ecosystem services. Example: The hurricane protection that is provided by barrier islands avoids property damages along coastlines. |
| Replacement Cost (RC) | The cost of replacing ecosystem services with man-made systems. Example: Natural water filtration is replaced with a costly man-made filtration plant. |
| Factor Income (FI) | The enhancement of income by ecosystem service provision. Example: Water quality improvements increase commercial fisheries catch and thereby also the incomes of fishermen. |
| Travel Cost (TC) | The cost of travel required to consume or enjoy ecosystem services. Travel costs can reflect the implied value of the service. Example: Recreational areas attract tourists. The value they place on that area must, at a minimum, be at least the price they were willing to pay to travel to it. |

| | |
|---|---|
| Hedonic Pricing (HP) | The reflection of service demand in the varying prices people will pay for associated goods. Example: Housing prices of properties in close proximity to recreational areas can be higher than those that are farther from these areas. |
| Contingent Valuation (CV) | The value for service demand elicited by posing hypothetical scenarios that involve some valuation of land use alternatives. Example: People would be willing to pay for increased wetland restoration, as expressed through surveys. |
| Group Valuation (GV) | Discourse-based contingent valuation, which is conducted by bringing together a group of stakeholders to discuss values in order to determine society's willingness to pay. Example: Government, citizen's groups, and businesses come together to determine the value of an area and the services it provides. |

## APPENDIX F: CHANGES IN RANKING OF RECREATIONAL ACTIVITIES

This chart shows gains and losses in popularity of recreational activities in Washington State. Many of the recreational activities that would expanded or gained from a free flowing Lower Snake River have gained in popularity in recent years, e.g., fishing, hiking, floating, camping.

**Table 3.19a: Changes in Rankings of Activities.**

| Activity | 2002 Rank | 2006 Rank | 2012 Rank | Difference in rank from 2002 to 2012 | Difference in rank from 2006 to 2012 | Difference in rank: mean of 2002 and 2006 rankings compared to the 2012 ranking | |
|---|---|---|---|---|---|---|---|
| Fishing for shellfish | 39 | 45 | 29 | 10 | 16 | 13 | Greatest gain in ranking |
| Visiting a nature interpretive center | 20 | 33 | 14 | 6 | 19 | 12.5 | |
| Climbing or mountaineering | 49 | 42 | 34 | 15 | 8 | 11.5 | |
| Firearms (hunting or shooting) | 22 | 41 | 21 | 1 | 20 | 10.5 | |
| Inner tubing or floating | 42 | 25 | 23 | 19 | 2 | 10.5 | |
| Camping—backpacking/primitive location | 46 | 47 | 36 | 10 | 11 | 10.5 | |
| Snowshoeing | 52 | 52 | 44 | 8 | 8 | 8 | |
| Softball | 48 | 40 | 37 | 11 | 3 | 7 | |
| Camping—tent camping with car/motorcycle | 26 | 19 | 16 | 10 | 3 | 6.5 | |
| Volleyball | 43 | 34 | 32 | 11 | 2 | 6.5 | |
| Hiking | 8 | 16 | 6 | 2 | 10 | 6 | |
| Aerobics or fitness activities, but not weights—at a facility | 33 | 13 | 17 | 16 | -4 | 6 | |
| Water skiing | 40 | 49 | 39 | 1 | 10 | 5.5 | |
| Fishing from a bank, dock, or jetty | 17 | 31 | 19 | -2 | 12 | 5 | |
| Beachcombing | 21 | 14 | 13 | 8 | 1 | 4.5 | |
| Picnicking, BBQing, or cooking out | 9 | 1 | 1 | 8 | 0 | 4 | |
| Horseback riding | 34 | 50 | 38 | -4 | 12 | 4 | |
| Wildlife viewing/photographing | 2 | 11 | 3 | -1 | 8 | 3.5 | |
| Boating—canoeing, kayaking, rowing, manual craft | 38 | 28 | 30 | 8 | -2 | 3 | |
| Badminton | 53 | 43 | 45 | 8 | -2 | 3 | |
| Fishing from private boat | 19 | 30 | 22 | -3 | 8 | 2.5 | |
| Jogging or running | 15 | 12 | 12 | 3 | 0 | 1.5 | |
| Snowboarding | 41 | 46 | 42 | -1 | 4 | 1.5 | |
| Weight conditioning—at a facility | 24 | 18 | 20 | 4 | -2 | 1 | |
| Tennis | 32 | 36 | 33 | -1 | 3 | 1 | |

SOURCE: WASHINGTON SCORP 2015

Endnotes

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