Economic Contribution & Value of Hatcheries in Oregon & Washington

Prepared for Hatchery & Wild Coexist
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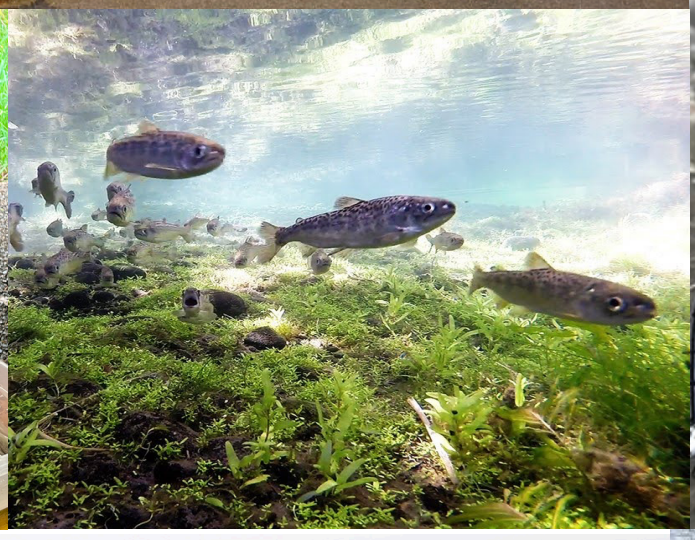


TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

Salmon and trout hatcheries throughout Oregon and Washington produce fish that are released to streams to enhance harvest and conservation. These hatchery fish are valuable for commercial and recreational fisheries, for augmenting wild stocks, for research and educational purposes, as well as for ecosystems that depend on anadromous fish as a vital part of the food chain. Hatcheries are located throughout Oregon and Washington and are operated by federal and state agencies as well as numerous Tribes. Hatchery fish are the predominant source of salmon and trout fish harvested commercially and recreationally in Oregon and Washington. This study acknowledges that there is an ongoing scientific discussion regarding the proper management of fish hatcheries and the effects of hatchery fish on wild populations. The intent of this study is not to weigh in on how hatcheries are managed, but rather to highlight the current role and economic value of hatchery operations and hatchery fish in Oregon and Washington.

There have been numerous studies of the economic activity supported by fishing and the net economic values of fishing in Oregon and Washington. However, there is a paucity of information regarding the economic role of hatcheries. This study aims to fill that gap. Specifically, this study aims to address the following questions:

- What economic activity (jobs and income) in Oregon and Washington is currently supported by hatchery operations and hatchery-produced fish? In answering this first question, we focus on the economic contribution of hatcheries to the Oregon and Washington state economies. Fish hatcheries support economic activity, much of it in rural areas for which fishing and other natural resource-based economic activity are prime drivers of the local economy. We focus on three ways in which fish hatcheries support economic activity: 1) hatchery operational spending, 2) tourism spending by recreational anglers fishing for hatchery-origin fish, and 3) commercial fishing for hatchery-origin fish.
- What net economic benefit to recreational anglers, the commercial fishing industry, and others is supported by hatchery fish, through enhanced fishing opportunities and harvest? Net economic benefits of hatcheries are the values above costs provided by hatcheries and hatchery fish. For example, net economic values measure the profit to commercial fishermen of harvesting hatchery salmon, or the net value (above costs) to recreational anglers of taking a fishing trip to harvest hatchery salmon or trout.
- What are the social and cultural benefits of hatchery fish to Tribes and others in the Pacific Northwest based on the role of salmon in the ecosystem? Salmon are culturally, ecologically, and socially important in the Pacific Northwest to Tribes and many residents of the region. While these values are challenging to quantify in economic terms, the role of hatchery salmon in increasing the abundance of salmon in our streams, rivers, and oceans is important to many people in our region.

In focusing on the above three questions, this analysis is not intended to be a cost benefit analysis of Oregon and Washington hatcheries. Rather, the analysis focuses on the current role and contribution of hatcheries to the two states economies and the net values to state residents of current activities that are supported by hatcheries. A cost benefit analysis would need to construct an alternative reality of conditions and economic activities that would exist without hatcheries, including the state of wild salmon and trout populations, marine ecosystem conditions, and freshwater ecosystem conditions without hatchery trout and salmon. That is not the aim of this analysis. Rather, the purpose of this analysis is to highlight the current contribution and role of fish hatcheries in the Oregon and Washington state economies.

This study is not a cost benefit analysis of Oregon and Washington hatcheries, but rather focuses on the **current economic role and contributions of hatcheries in Oregon and Washington**.

Throughout this analysis, to focus on the value of hatcheries, we have made a key assumption that the hatchery contribution to economic activity and net economic value is equal to the estimated proportion of fish caught that are hatchery versus wild. In other words, if 75% of the catch in a fishery is estimated to be of hatchery origin (i.e., catch card data indicates that 75% are fin clipped), then we assume that 75% of the value of fish caught and 75% of the trip effort is supported by hatcheries. Particularly for recreational fishing, this approach of allocating the proportion of total fishing economic activity and net values that is attributable to hatcheries may result in an overestimate or an underestimate of the economic value and economic activity supported by hatcheries (depending on whether the number of trips taken, the spending per trip, and the enjoyment per trip supported by hatchery fish is equal to, higher than, or lower than the percent of fish that are hatchery fish). We expect that this approach may provide a substantial underestimate of recreational fishing effort and value that is supported by hatcheries as much commercial and recreational fishing might not occur (due to regulations or angler inclination) without hatchery fish. For example, many fisheries are dominated by hatchery fish or only allow anglers to retain hatchery fish and require wild fish to be released; absent hatchery fish is it possible that there would be little to no angling in these fisheries. If that is the case, then the proportion of value that is supported by hatcheries may be much greater than the proportion of fish that are hatchery fish, with the result that the estimates of economic value in this report would likely be substantial underestimates.

Unless stated otherwise, all values presented in this report are in 2021 dollars.

HATCHERY FISH CATCH & EFFORT DATA

Much of the economic value of hatcheries is related to recreational (or sport) and commercial fishing. This section provides the data that underpins the economic analysis of hatchery-supported fishing activities, including data on the proportion of total sport and commercial catch that is hatchery fish, the value of commercial fishing catch, and the level of recreational participation or number of recreational fishing trips taken that are supported by hatchery fish catch. We use catch card data from Oregon Department of Fish and Wildlife (ODFW) and Washington Department of Fish and Wildlife (WDFW), along with data in ODFW and WDFW documents to estimate the proportion of salmon, steelhead, and trout catch that is hatchery fish. Catch card data provided by ODFW and WDFW are presented in **Table ES-1**. In Oregon, data from catch cards indicate that 68% of all salmon/steelhead catch (freshwater and marine combined) is clipped fish, while in Washington that data indicate that 65% of freshwater salmon/steelhead catch is clipped fish and 69% of marine catch is clipped fish.

As these are the best data available on wild versus hatchery salmon/steelhead catch, we assume that the percent of total sport fish economic value supported by hatchery fish is equal to the percent of catch that is clipped as reported in the raw angler card data. For commercial fish catch, we assume 75% of all salmon catch value in Oregon and Washington is of hatchery origin, a slightly higher proportion than for recreational catch, based on data from WDFW and the fact that for the Columbia River sport fishery, an estimated 79% are clipped fish and the ocean fishery may be most similar to the Columbia River fishery (as the Columbia River is the largest contributor to the Oregon commercial fishery). These assumptions may over- or under-estimate the proportion of catch that is of hatchery origin, for the following reasons:

- The percent hatchery fish may be undercounted since a portion of hatchery fish are not clipped (the portion depends on the agency managing the hatchery).
- On the other hand, the percent hatchery may be over-counted since people may not report their wild catch as much as their clipped catch.

Given these uncertainties regarding the raw data and the unknown magnitudes of the error effects, the estimated percent of catch that is hatchery fish for each type of fish may be underestimated or overestimated.

For trout, we estimate that hatchery fish comprise approximately 70% of the catch in both Oregon and Washington based on reports from WDFW, ODFW, and analysis of Oregon trip effort, hatchery trout releases, and return to creel data from ODFW (see **Section 2.1** for more detail).

Table ES-1: Estimated Proportion of Catch that is Hatchery Origin

Fishery	State	
	Oregon	Washington
Recreational		
Freshwater salmon/steelhead	68%	65%
Saltwater salmon	68%	70%
Trout*	70%	70%
Commercial		
Salmon	75%	75%

Source: Highland Economics' analysis of sport angler catch card raw data provided by Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife. Note that the percent clipped or marked fish for the WDFW data is based on the proportion of marked fish out of the total fish that were reported as marked or unmarked, and not the total fish caught as some anglers did not include data on whether their catch was marked.

**No data were available on the proportion of trout caught in Oregon or Washington that are of hatchery origin. For that reason, we derive an estimate based on a variety of data from Oregon, including: number of trout hatchery releases, the average return to creel rate for trout in Oregon, estimate of catch per day, and average trip length to estimate that 70% of the total trout catch in Oregon is of hatchery origin, and make the further assumption that 70% of trout fishing trips in Oregon are supported by hatcheries.*

Using the above data on the proportion of catch that is of hatchery origin, combined with data from a variety of sources on total trip effort in Washington and Oregon for recreational fishing, key findings for recreational fishing are as follows:

- **Oregon annual sport fishing trips**: Based on a variety of data sources, we estimate that in Oregon annually there are approximately 2 million sport salmon freshwater trips, 2 million sport trout trips, and 67,000 sport saltwater salmon trips. We assume that the proportion of trips that are supported by hatcheries is equal to the percent of fish caught that are of hatchery origin, as shown in Table ES-1. We therefore estimate that hatchery-supported trips include: 1,360,000 freshwater salmon/steelhead fishing trips, 1,445,000 trout fishing trips, and 46,000 marine salmon fishing trips.
- **Washington annual sport fishing trips**: Based on US Fish and Wildlife Service data and WDFW data, we estimate that in Washington there are approximately 1,736,000 freshwater salmon sport trips, 1,879,000 steelhead sport fishing trips, 2,512,000 trout fishing trips and 425,400 marine salmon sport fishing trips. Again, assuming that the proportion of trips that are supported by hatcheries is equal to the percent of fish caught that are of hatchery origin as shown in Table ES-1, we estimate that Washington hatchery-supported trips include: approximately 1,128,000 freshwater salmon sport trips, 1,879,000 steelhead sport fishing trips, 1,758,000 trout fishing trips and 293,500 marine salmon sport fishing trips.

For commercial and treaty fishing we estimate the following:

- **Commercial salmon catch in Oregon**: Average annual ex-vessel salmon commercial catch in Oregon from 2015 to 2020 was valued at $7.2 million; assuming 75% is of hatchery origin based on our analysis of data from ODFW, we estimate $5.4 million in commercial catch ex-vessel value is from hatchery salmon. Ex-vessel value is the dollar value of commercial landings, based on the price per pound at first purchase of the commercial landing multiplied by the total pounds landed.
- **Commercial salmon catch in Washington**: Average annual salmon commercial catch value (ex-vessel value) in Oregon from 2015 to 2020 was $25.4 million; assuming 75% is of hatchery origin based on our analysis of data from WDFW, we estimate $19.0 million annually in commercial catch value is from hatchery salmon.
- **Treaty commercial catch in the Columbia River:** Based on estimated catch numbers, average weight per fish, and average price per pound for salmon, we estimate ex-vessel value of annual treaty catch at $7.9 million, with 75% estimated to be of hatchery origin this translates to $5.9 million in annual ex-vessel catch value of hatchery salmon.
- **Treaty commercial catch off the Washington Coast:** We estimate ex-vessel value of annual Washington Coast treaty catch at $12.2 million, with 75% estimated to be of hatchery origin this translates to $9.1 million in annual ex-vessel catch value of hatchery salmon.

Economic Activity Supported by Hatcheries

Fish hatcheries support economic activity, much of it in rural areas for which fishing and other natural resource-based economic activity are prime drivers of the local economy. Specifically, fish hatcheries support economic activity (jobs and income) throughout Oregon and Washington in the following ways:

1. Hatchery operations, which provides employment and income to hatchery employees as well as results in spending in local communities for equipment repair, utilities, and other inputs.
2. Tourism spending by anglers on recreational fishing trips to areas where the local fish population is largely hatchery fish or is enhanced by hatchery fish releases.
3. Commercial fishing activity for salmon that is supported by hatchery releases.
4. Tourism spending by visitors to fish hatcheries.

For each of these pathways (with the exception of tourism spending by visitors to hatcheries)[1], we estimate the total statewide expected expenditures in Oregon and Washington associated with hatcheries and hatchery-produced fish, and the level of economic activity sustained at hatcheries and in the commercial and recreational fishing sectors related to hatcheries. In addition to estimating these direct effects of economic activity in the fishing sector and hatchery operations, we also estimate the indirect and induced ripple effects of spending in related sectors. Indirect and induced effects include economic activity supported at businesses that supply inputs or services to hatcheries or commercial/recreational fishing businesses, businesses supported by the spending of hatchery employee wages, hospitality sector businesses catering to recreators, etc. The sum of the direct, indirect, and induced effects equals the total economic contribution of hatcheries. Jobs presented in this analysis represent both part-time and full-time annual jobs, while labor income includes all employee compensation (including benefits) as well as proprietor income. All labor income estimates are presented in 2021 dollars.

HATCHERIES SUPPORT JOBS & INCOME THROUGH:

- Hatchery operation spending:
  - $24.7 million in annual income & 350 jobs in Oregon
  - $52.0 million in annual income & 640 jobs in Washington
- Fishing-related spending by recreational anglers catching hatchery fish:
  - $115.5 million in annual income & 3,240 jobs in Oregon
  - $112.7 million in annual income & 2,900 jobs in Washington
- Commercial fishing activity catching hatchery fish:
  - $11.9 million in annual income & 210 jobs in Oregon
  - $24.4 million in annual income & 440 jobs in Washington

The total estimated contribution of each of these types of impacts is summarized in **Table ES-2** for Oregon and in **Table ES-3** for Washington. More detailed results and data sources for each of these types of impacts are presented in **Section 3**. In reviewing the results in the tables, there are several important aspects to note: 1) most of these economic effects are experienced primarily in rural areas with economies that rely on natural resource activities such as fish production and fishing, and 2) the economic activity generated by hatcheries requires relatively low funding by Oregon government: just 8% of budgets at ODFW operated hatcheries in Oregon is from the general fund ($2.3 million annually) while approximately 41% is from the state budget in Washington ($16.6 million annually). In other words, by operating these hatcheries, the jobs and income as reported in the tables below are supported with relatively low funding from state budgets.

[1] We do not quantify the economic contribution of tourism spending by visitors to hatcheries as there is some evidence from interviews with hatchery managers and tourism-related businesses located near hatcheries that hatcheries may not measurably increase the spending occurring in a region as a high proportion visitors to hatcheries may be in the region for other reasons.

Table ES-2: Total Economic Contribution of Oregon Hatchery Operations to the Oregon State Economy

Source	Jobs (Full and Part-Time Jobs)	Annual Labor Income (Employee Compensation & Proprietor Income)
Hatchery Operational Expenditures	350	$24,700,000
Spending by Recreational Anglers (Fishing Trips and Fishing Equipment)	3,240	$115,500,000
Commercial & Treaty Fishing for Salmon	210	$11,900,000
Total	**3,800**	**$152,100,000**

Source: Highland Economics analysis
Note: This includes direct, indirect, and induced effects.

Table ES-3: Total Economic Contribution of Washington Hatchery Operations to the Washington State Economy

Source	Jobs (Full and Part-Time Jobs)	Annual Labor Income (Employee Compensation & Proprietor Income)
Hatchery Operational Expenditures	640	$52,000,000
Spending by Recreational Anglers	2,900	$112,700,000
Commercial & Treaty Fishing for Salmon	440	$24,400,000
Total	**3,980**	**$189,100,000**

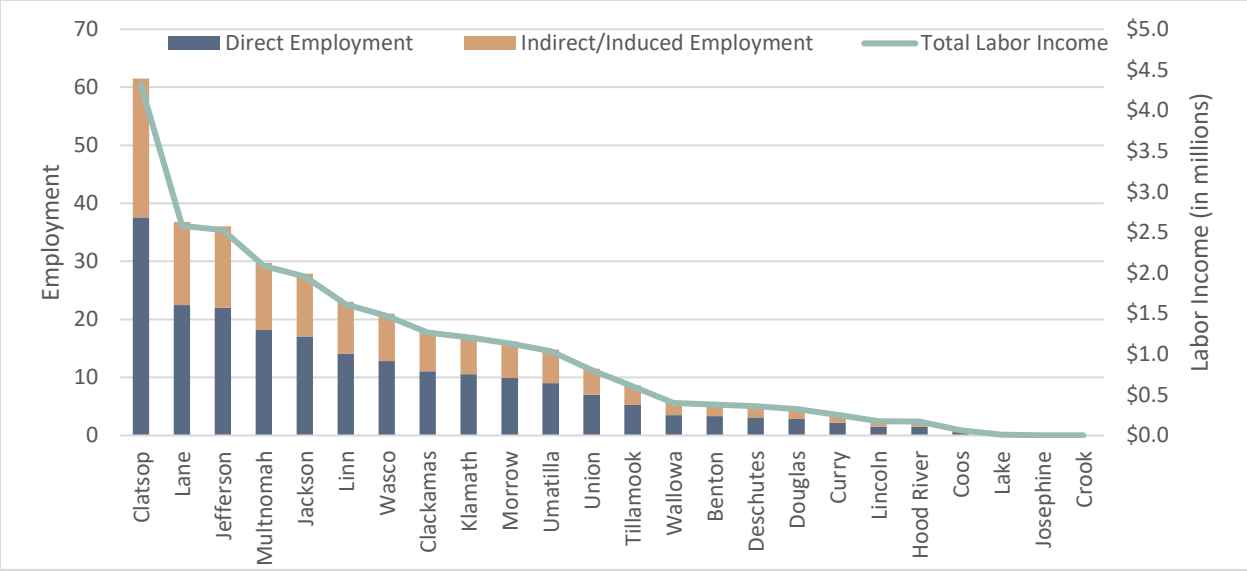
Source: Highland Economics analysis
Note: This includes direct, indirect, and induced effects.

The estimates presented in Tables ES-2 and ES-3 are estimates of economic *contribution*, and not necessarily of economic *impact*. Economic contribution is a measure of the total current economic activity supported by hatcheries, while economic impact would be a measure of the *additional* economic activity that results from hatcheries (i.e., the change that would occur if hatcheries were not operational) and is much more difficult to analyze and estimate. For example, this analysis estimates the economic contribution of all recreational angler spending associated with hatcheries; if recreational anglers were to choose to forego a fishing trip, they may instead spend the same amount of money on other activities in the local economy, with similar effects on economic activity (i.e., spending may simply be redirected, although potentially in different geographic areas). As such, fishing locations that are primarily frequented by local anglers may have less of an overall impact on economic activity than fishing locations that attract many non-resident anglers. Similarly, while state funds to operate hatcheries could be spent on other economic activities in the state, the rural areas that host hatcheries may not be the locations that would receive the funding for other economic activities.

In terms of economic activity by location in each state, **Figures ES-1 and ES-2** summarize the economic activity by county supported by hatcheries operational spending, based on the location of hatcheries and their budgets (for Oregon) or the proportion of fish reared at each facility (Washington)**. Figures ES-3 and ES-4** use this same information coupled with population data from the 2020 Census to highlight how the level of economic activity on a per capita basis that is supported by hatchery spending in each county. This method provides an approximation of where the economic effects of hatchery operational spending are experienced in each state, but likely overstates the economic effects experienced in rural counties as not all economic effects of the hatcheries would likely be experienced in the county where

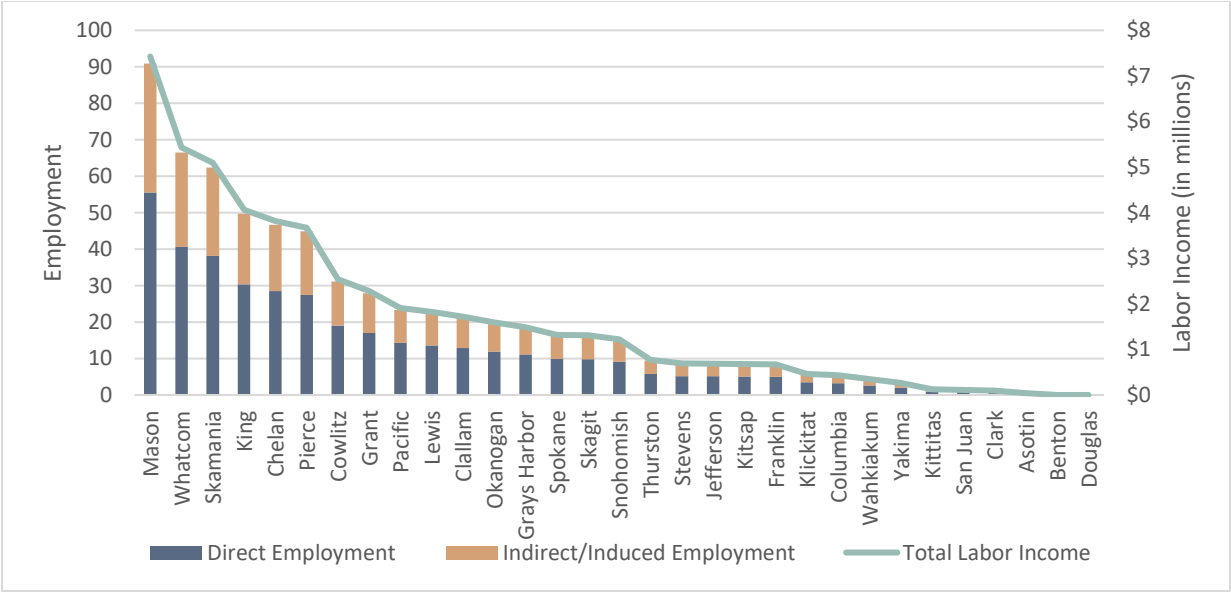
the hatchery is located, as some indirect/induced economic effects would be experienced in the more urban areas of the state that provide some of the inputs or administrative support to hatcheries. However, this provides a general sense of where the economic activity supported by hatchery operational spending is distributed throughout the two states.

Figure ES-1: Economic Contribution in the State of Oregon of Hatchery Operational Spending by County



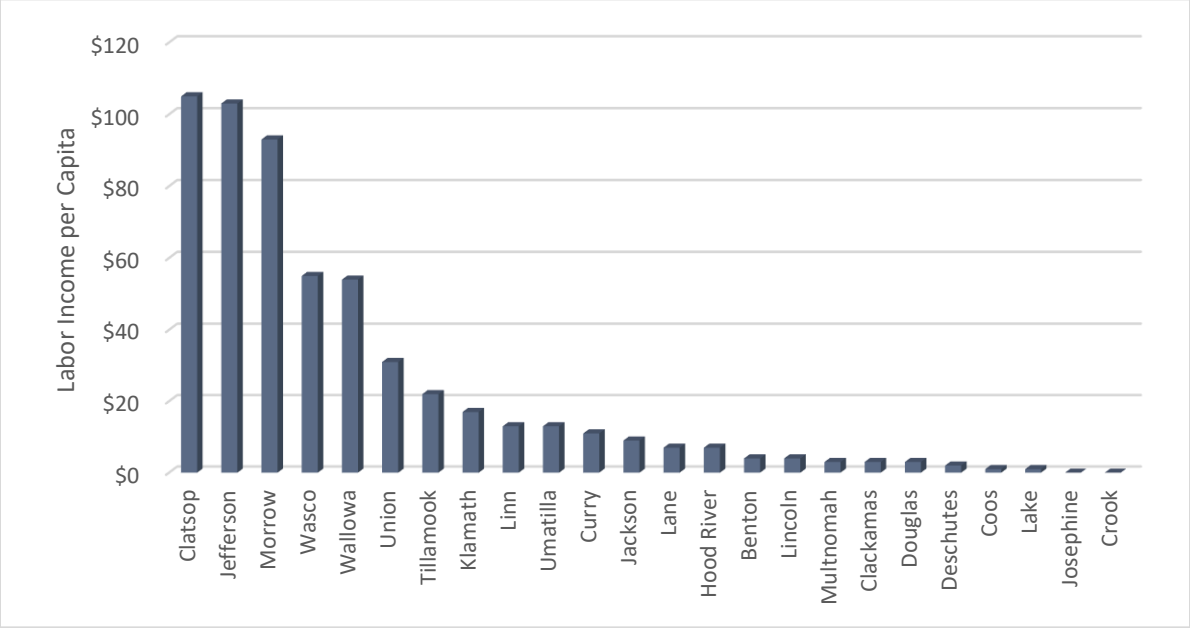
Source: Highland Economics' analysis of fish production facility operations using IMPLAN model of Oregon State.

Figure ES-2: Economic Contribution in the State of Washington of Hatchery Operation Spending by County



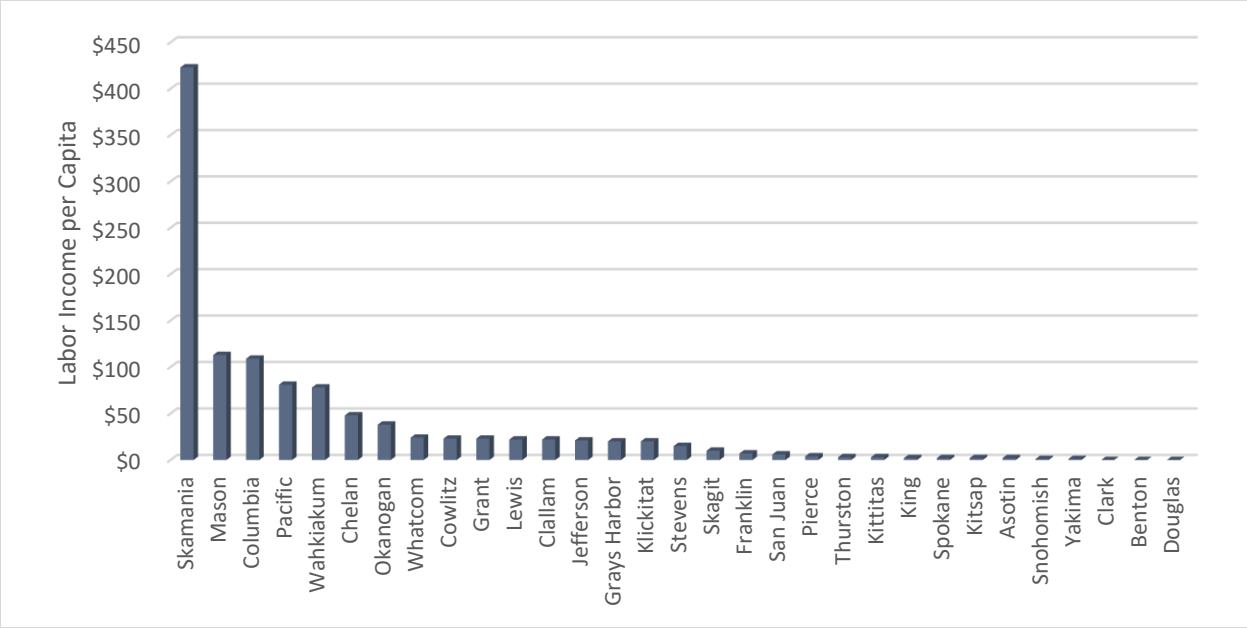
Source: Highland Economics' analysis of fish production facility operations using IMPLAN model of Washington State.

Figure ES-3: Per Capita Labor Income Contribution of Hatchery Operation Spending by County in the State of Oregon



Source: Highland Economics' analysis of fish production facility operations using IMPLAN model of Oregon State and 2020 county population data from the US Census bureau.

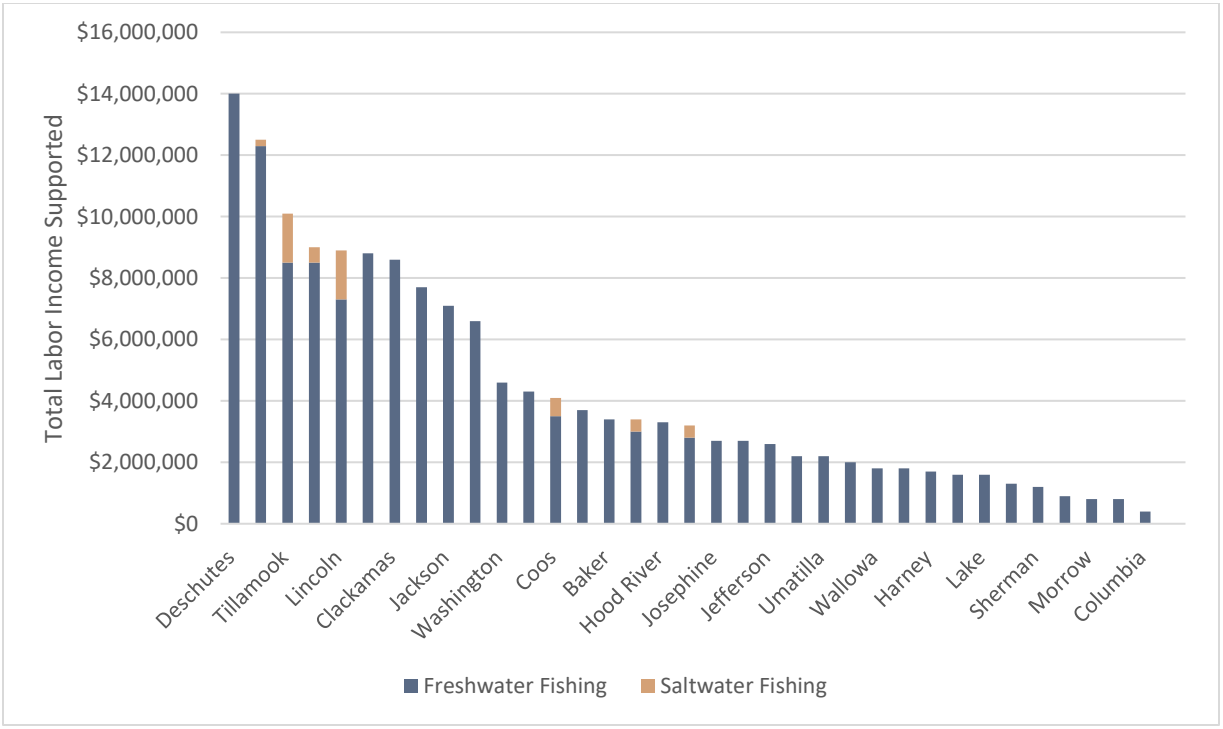
Figure ES-4: Per Capita Labor Income Contribution of Hatchery Operation Spending by County in the State of Washington



Source: Highland Economics' analysis of fish production facility operations using IMPLAN model of Washington State and 2020 county population data from the US Census bureau.

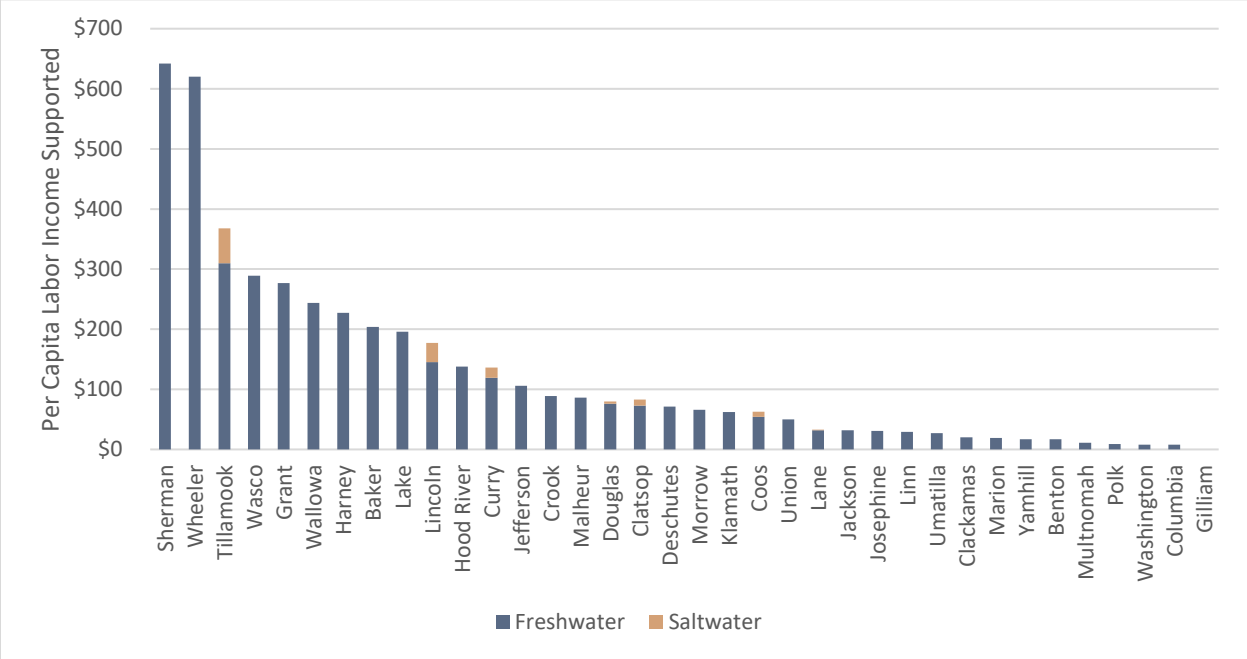
As shown in Table ES-2, fishing-related expenditures by recreational anglers that are due to hatchery fish is estimated to support a total of $115.5 million in statewide income annually in Oregon. The approximate geographic distribution by county of the $115.5 million in total income in Oregon is shown in **Figure ES-5**. **Figure ES-6** presents the same data on a per capita basis, highlighting the counties with the largest impact relative to their population size. In Sherman, Wheeler, Tillamook, Wasco, Grant, Wallowa, Harney, and Baker counties the data suggest that recreational fishing related to hatcheries supports more than $200 of income on a per capita basis. The allocation by county is based on data from a 2009 study sponsored by ODFW that estimated the total freshwater fishing trip expenditures and saltwater fishing trip expenditures in each Oregon County; we assume the same percentage distribution of freshwater trip spending and saltwater trip spending to each county as found in the 2009 study and allocate the $115.5 million using those percentage distributions. These are very approximate estimates by county as they are based on fishing trip destinations and spending patterns by county from a 2009 study. We do not have similar data on expenditures by county in Washington, so we do not allocate economic contribution by county in Washington. Economic activity for commercial and treaty fishing for salmon in both states is concentrated in coastal areas of both states and the Columbia River.

Figure ES-5: Oregon Labor Income (Direct, Indirect, Induced) Supported by Hatchery-Related Recreational Fishing Trips: Approximate Distribution by County



Source: Highland Economic analysis using % of total freshwater and saltwater expenditures by Oregon County from (Dean Runyan Associates, 2009).

Figure ES-6: Oregon Labor Income (Direct, Indirect, Induced) Per Capita Supported by Hatchery-Related Recreational Fishing Trips: Approximate Distribution by County



Source: Highland Economic analysis using % of total freshwater and saltwater expenditures by Oregon County from (Dean Runyan Associates, 2009).

NET ECONOMIC VALUE SUPPORTED BY HATCHERIES

While the preceding section estimated how hatcheries and hatchery fish contribute to economic activity that supports jobs and income in Washington and Oregon, this section focuses on net economic benefits generated. While spending on hatcheries and on fishing generates economic activity and many entities benefit, these benefits are generated at a cost (e.g., the spending on hatcheries is a cost to the funding entities, while the wages of employees supported in related businesses is a cost to their employers; similarly, the spending by recreational anglers spurs economic activity and income in tourism-related businesses but is a cost to the angler). In contrast, the benefits presented in this section are *net benefits,* benefits that exceed costs. Specifically, this section discusses the following types of net values or net benefits:

1. Net value to recreational anglers of fishing opportunities (i.e., benefits in excess of their fishing travel costs and equipment costs estimated and analyzed in Section 3, known in the economic literature as consumer surplus).
2. Cultural, social, and economic value to Tribes of salmon.
3. Net value, or profits, to commercial fishing operators (i.e., revenues less costs incurred).
4. Net value to hatchery visitors of recreational enjoyment and educational value, in excess of travel costs incurred.
5. Net value to all Oregon and Washington residents that value hatchery fish for social, cultural, or ecological reasons.

Many of the key benefits of the fish production provided by hatcheries noted in the list above are not quantifiable. For example, for Oregon and Washington Tribes, for thousands of years, salmon and steelhead have been an inseparable part of their history, culture, and societies. These fish have played an essential role in many aspects of tribal life, including subsistence, intertribal trade, and even religion (Columbia River Inter-Tribal Fish Commission, 2021). Because of the importance of salmon and steelhead to their life and culture, Tribes in Oregon and Washington are directly involved in hatchery operations. At least 23 Tribes are involved in operating 46 facilities that grow and release salmon, steelhead, and trout in the two-state region. In addition to operating hatcheries, the importance of hatcheries for many Tribes in the region is evident from interviews of representatives of key northwest tribal fisheries organizations. The fisheries manager at the Columbia River Inter-Tribal Fisheries Commission and the education/outreach manager of the Northwest Indian Fisheries Commission indicate that their perspective on hatcheries is that hatchery operations are necessary to protect the salmon and steelhead populations they depend on; wild fish alone could not support the needs of Tribes in the Pacific Northwest (Meyer, 2021; Matylewich, 2021). Without the support of hatchery production, Tribes would lose an important source of food and commercial activity. Without the hatcheries Tribes would lose an essential component of cultural traditions and religious ceremonies. As a result, Tribes are fiercely supportive of hatcheries and the production of the fish species they rely on (Meyer, 2021; Matylewich, 2021).

HATCHERIES SUPPORT ECONOMIC, SOCIAL, CULTURAL, & ECOLOGICAL VALUES

Many important and valuable benefits are not quantifiable, including Tribal and other cultural values, ecological, values, and social values. Quantifiable values include:

- Recreational value of hatchery fish to sport anglers annually:
  - $227.9 million in Oregon
  - $412.4 million in Washington
- Commercial fishing profits from salmon hatchery catch annually:
  - $3.2 million in Oregon
  - $6.6 million in Washington
- Recreational/educational value to hatchery visitors annually:
  - $14 million in Oregon
  - $1.6 million+ in Washington

Further, although again not quantified in this analysis, salmon provide tremendous ecological value, and additional economic value, by supporting other species in the ecosystems they inhabit. One study found that salmon have ecological importance for 138 different species in Oregon and Washington (Cederholm, et al., 2000). Because salmon acquire most of their bodily mass in the ocean, and then return to inland waterways to spawn, salmon provide an important transport of nutrients from the ocean to freshwater ecosystems (Cederholm, et al., 2000). One example of the importance

of salmon in sustaining other species is the role of salmon as a food source for the Southern Resident Killer Whale (SRKW) population that is found mostly off British Columbia, Washington, and Oregon. Approximately 80 percent of the whales' diet consists of salmon (mostly Chinook), and salmon abundance has been positively associated with whale birth rates, social group size and connection, and health outcomes (Center for Whale Research, 2022). Salmon availability in the winter and spring period is especially important to the SRKWs, which can be improved through increasing spring Chinook production in fish hatcheries in Oregon and Washington.

For benefits that are quantifiable, we rely on studies that have examined the value of fishing and fish abundance to residents of the Pacific Northwest and elsewhere. **Table ES-4** summarizes our findings regarding the net economic benefits supported by hatcheries in Oregon and Washington. As shown in the table, the value of recreational angling dominates the net economic values quantified. However, as noted above, if the ecological, cultural, and social values supported by salmon and trout were also quantifiable, these benefits would also be sizable. For example, studies show that the average households in Oregon and Washington may be willing to pay from approximately $50 to $200 per year for increasing local, regional, or state-wide populations of salmon by 50 percent to 100 percent (Bell, Huppert, & Johnson, 2003; Layton, Brown, & Plummer, 1999). These studies were not specific to hatchery-supported populations, so we do not apply these estimates in this analysis. However, given that there are over 1.6 million Oregon households and over 2.9 million Washington households, the value for salmon abundance across all households is quite large (e.g., if households were willing to pay an average of $50 for the additional fish abundance that hatcheries provide that support ecosystems, cultural values, and social values, this would equate to approximately $80 million value in Oregon and $145 million value in Washington.)

Table ES-4: Estimated Net Economic Value of Hatcheries & Hatchery Fish in Oregon and Washington

Net Economic Value (Benefits Exceeding Costs)	Oregon	Washington	Total
Value to Recreational Anglers	$227,900,000	$412,400,000	$640,300,000
Value to Commercial Fishing (Profit)	$3,200,000	$6,600,000	$9,900,000
Value to Hatchery Visitors	$14,000,000	$1,600,000+	$15,600,000+
Ecological, Cultural, Social Values	Not Quantified	Not Quantified	Not Quantified
Total	**$245,100,000+**	**$420,600,000+**	**$665,800,000+**

As it is the largest estimated value, **Table ES-5** provides more detail on the values estimated regarding the estimated net economic benefits of hatchery fish in supporting recreational fishing. Consistent with our approach above in estimating the economic activity supported by hatcheries, we assume that the proportion of fishing trips that are supported by hatcheries is equal to the proportion of fish caught that are hatchery fish.[2] As noted above, this approach of allocating the proportion of fishing expenditure and net fishing value based on the proportion of fish caught that are hatchery versus wild may result in an overestimate or an underestimate of the economic value supported by hatcheries (depending on whether the number of trips taken and the enjoyment per trip supported by hatchery fish is equal to, higher than, or lower than the percent of fish that are hatchery fish). Also of note methodologically,

[2] Many studies have found that in addition to influencing the number of trips taken, the value per fishing trip is increased with higher catch rates. Trying to separately estimate the effect of these two different variables (quantity of trips and value per trip) is a complex process and not attempted in this analysis.

findings from a study of recreational salmon anglers in Washington and Oregon indicates that anglers want to conserve wild salmon populations but that for fish caught, hatchery salmon are valued as highly or more highly than wild salmon. Based on the findings of this study, and the fact that values from the economic literature were developed from surveys of anglers in fisheries with a mix of hatchery and wild fish, this study assumes that the per trip economic values of fishing from the literature are applicable and appropriate to estimate the value of recreational fishing trips supported by hatchery fish.

Table ES-5: Estimated Net Value to Anglers of Hatchery Supported Recreational Fishing in Oregon and Washington

Type of Fishing Trip	Estimated Value per Trip	Oregon		Washington	
		# of Annual Trips	Estimated Annual Net Economic Value to Anglers	# of Annual Trips	Estimated Annual Net Economic Value to Anglers
Salmon/Steelhead	$85	1,406,000	$119,510,000	3,301,000	$280,585,000
Trout	$75	1,445,000	$108,375,000	1,758,000	$131,850,000
Total		**2,851,000**	**$227,885,000**	**5,059,000**	**$412,435,000**

Other values supported by hatcheries but not quantified above include the value of hatchery fish for subsistence fishermen and for research and education. While data on subsistence catch is not available, in 2020, for example 18,793 salmon fish weighting a total of 99,141 pounds were donated to the Oregon food bank, local food banks, and other charitable organizations by ODFW-operated fish hatcheries to support local food security (Oregon Department of Fish and Wildlife, 2021). Fish and fish eggs from hatcheries also support research and education. In 2020, 8,649 fish and 120,841 eggs were provided for experimental, scientific, or educational uses as identified in management plans or other ODFW Watershed District agreements (Oregon Department of Fish and Wildlife, 2021). These eggs and fish were provided to grade schools, universities, for show ponds, and for a turbine study.

1 INTRODUCTION

Salmon and trout hatcheries throughout Oregon and Washington produce fish that are released to streams to enhance harvest and conservation. These hatchery fish are valuable for commercial and recreational fisheries, for augmenting wild stocks, for research and educational purposes, as well as for ecosystems that depend on anadromous fish as a vital part of the food chain. Hatcheries are located throughout Oregon and Washington and are operated by federal and state agencies as well as numerous Tribes. Hatchery fish are the predominant source of salmon and trout fish harvested commercially and recreationally in Oregon and Washington. This study acknowledges that there is an ongoing scientific discussion regarding the proper management of fish hatcheries and the effects of hatchery fish on wild populations. The intent of this study is not to weigh in on how hatcheries are managed, but rather to highlight the current role and economic value of hatchery operations and hatchery fish in Oregon and Washington.

1.1 PURPOSE AND SCOPE

There have been numerous studies of the economic activity supported by fishing and the net economic values of fishing in Oregon and Washington. However, there is a paucity of information regarding the economic role of hatcheries. This study aims to fill that gap. Specifically, this study aims to address the following questions:

- What economic activity (jobs and income) in Oregon and Washington is currently supported by hatchery operations and hatchery-produced fish? In answering this first question, we focus on the economic contribution of hatcheries to the Oregon and Washington state economies. Fish hatcheries support economic activity, much of it in rural areas for which fishing and other natural resource-based economic activity are prime drivers of the local economy. Specifically we focus on three ways in which fish hatcheries support economic activity: 1) hatchery operational spending, 2) tourism spending by recreational anglers fishing for hatchery-origin fish, and 3) commercial fishing for hatchery-origin fish.
- What net economic benefit to recreational anglers, the commercial fishing industry, and others is supported by hatchery fish, through enhanced fishing opportunities and harvest? Net economic benefits of hatcheries are the values above costs provided by hatcheries and hatchery fish. For example, net economic values measure the profit to commercial fishermen of harvesting hatchery salmon, or the net value (above costs) to recreational anglers of taking a fishing trip to harvest hatchery salmon or trout.
- What are the social and cultural benefits of hatchery fish to Tribes and others in the Pacific Northwest based on the role of salmon in the ecosystem? Salmon are culturally, ecologically, and socially important in the Pacific Northwest to Tribes and many residents of the region. While these values are challenging to quantify in economic terms, the role of hatchery salmon in increasing the abundance of salmon in our streams, rivers, and oceans is important to many people in our region.

In focusing on the above three questions, this analysis is not intended to be a cost benefit analysis of Oregon and Washington hatcheries. Rather, the analysis focuses on the current role and contribution of hatcheries in the two state economies and the net values to state residents of current activities that are

supported by hatcheries. A cost benefit analysis would need to construct an alternative reality of conditions and economic activities that would exist without hatcheries, including the state of wild salmon and trout populations, marine ecosystem conditions, and freshwater ecosystem conditions without hatchery trout and salmon. That is not the aim of this analysis. Rather, the purpose of this analysis is to highlight the current contribution and role of fish hatcheries in the Oregon and Washington state economies.

1.2 Methodology, Key Data Sources and Key Assumptions

This study relies on existing data and literature regarding fish catch, fishing effort, fishing trip expenditures, and the net economic benefits of fish and fishing. Key data sources include: Washington Department of Fish and Wildlife (WDFW), Oregon Department of Fish and Wildlife (ODFW), U.S. Fish and Wildlife Service (USFWS), Pacific Fisheries Information Network (PacFIN), US National Marine Fisheries Service (NMFS), and studies sponsored by WDFW, ODFW, and others on the economic value of fishing in Oregon and Washington.

Throughout this analysis, to focus on the value of hatcheries, we have made a key assumption that the hatchery contribution to economic activity and net economic value is equal to the proportion of fish caught that are hatchery versus wild. In other words, if 75% of the catch in a fishery is estimated to be of hatchery origin (i.e., catch card data indicates that 75% are fin clipped), then we assume that 75% of the value of fish caught and 75% of the trip effort is supported by hatcheries. Particularly for recreational fishing, this approach of allocating the proportion of total fishing economic activity and net values that is attributable to hatcheries may result in an overestimate or an underestimate of the economic value and economic activity supported by hatcheries (depending on whether the number of trips taken, the spending per trip, and the enjoyment per trip supported by hatchery fish is equal to, higher than, or lower than the percent of fish that are hatchery fish).

Our methodology to estimate the economic activity associated with hatcheries is a two-step process:

1. We estimate the total statewide expected expenditures in Oregon and Washington associated with hatcheries and hatchery-produced fish, and the level of economic activity sustained at hatcheries and in the commercial and recreational fishing sectors related to hatcheries.
2. In addition to estimating these direct effects of economic activity in the fishing sector and hatchery operations, we also estimate the indirect and induced ripple effects of spending in related sectors. Indirect and induced effects include economic activity supported at businesses that supply inputs or services to hatcheries or commercial/recreational fishing businesses, businesses supported by the spending of hatchery employee wages, hospitality sector businesses catering to recreators, etc. The sum of the direct, indirect, and induced effects equals the total economic contribution of hatcheries.

We use IMPLAN models to translate expenditures and direct economic activity into total economic contribution estimates. IMPLAN is a commonly used input-output economic model to measure total economic effects of an industry, policy, or economic change. We use two IMPLAN economic models, one of the Oregon State economy and one of the Washington State economy, to estimate the total economic contribution of hatcheries to statewide jobs and labor income. Jobs presented in this analysis represent both part-time and full-time annual jobs, while labor income includes all employee

compensation (including benefits) as well as proprietor income. All labor income estimates are presented in 2021 dollars.

These effects are estimates of economic *contribution*, and not necessarily of economic *impact*. Economic contribution is a measure of the total current economic activity supported by hatcheries, while economic impact would be a measure of the *additional* economic activity that results from hatcheries (i.e., the change that would occur if hatcheries were not operational) and is much more difficult to analyze and estimate. For example, this analysis estimates the economic contribution of all recreational angler spending associated with hatcheries; if recreational anglers were to choose to forego a fishing trip, they may instead spend the same amount of money on other activities in the local economy, with similar effects on economic activity (i.e., spending may simply be redirected, although potentially in different geographic areas). As such, fishing locations that are primarily frequented by local anglers may have less of an overall impact on economic activity than fishing locations that attract many non-resident anglers. Similarly, while state funds to operate hatcheries could be spent on other economic activities in the state, the rural areas that host hatcheries may not be the locations that would receive the funding for other economic activities. This analysis also focuses on the economic contribution rather than the economic impacts as the biological, social, and economic changes that would occur in the absence of hatcheries are uncertain and beyond the scope of this analysis, as noted above.

To estimate the net value (including economic, recreational, social, ecological, and cultural values) of hatcheries and hatchery-produced fish to recreational anglers, commercial fishing, Tribes, hatchery visitors, Tribes, and others, we rely on estimates of value from published literature.

2 FISH CATCH & EFFORT DATA

Much of the economic value of hatcheries is related to recreational (or sport) and commercial fishing. This section provides the data that underpins the economic analysis of this value, including data on the proportion of total sport and commercial catch that is hatchery fish, and the level of recreational participation or number of recreational fishing trips taken that are supported by hatchery fish catch. A key part of the analysis is the proportion of total catch that is hatchery fish. We use catch card data from ODFW and WDFW, along with data in ODFW and WDFW documents to estimate the proportion of salmon, steelhead, and trout catch that is hatchery fish.

In summary, for recreational fishing this section finds that:

- **Oregon hatchery salmon/steelhead recreation catch**: Average annual salmon/steelhead catch in Oregon from 2008 to 2018 was 308,300 fish, of which catch card data indicate that 68% is fin clipped; we therefore assume that 68% of Oregon salmon/steelhead catch, or 208,100 fish annually, are of hatchery origin.
- **Oregon hatchery trout catch**: Average hatchery releases in Oregon from 2010 to 2019 were 5.8 million trout annually; data from an ODFW study indicate that approximately 32% of trout released in studied water bodies were caught. We assume 32%, or 1.85 million hatchery trout annually, are caught in Oregon. We estimate that this estimate of hatchery fish catch accounts for approximately 70% of all trout caught in the State.
- **Washington hatchery salmon/steelhead recreation catch**: Average annual salmon/steelhead catch in Washington from 2010 to 2019 was 680,165 fish of which catch card data indicate that 65% of freshwater catch and 69% of marine catch is fin clipped; we therefore assume that these proportions of catch are of hatchery origin, or approximately 458,900 fish annually.
- **Washington hatchery trout recreational catch**: Average hatchery releases in Washington from 2011 to 2020 were 17.3 million trout annually; lacking data on catch in Washington, we assume that, as in Oregon, 32% of hatchery trout are caught, or 5.55 million trout caught annually in Washington.
- **Oregon annual sport fishing trips**: Based on a variety of data sources, we estimate that in Oregon annually there are approximately 2 million sport salmon freshwater trips, 2 million sport trout trips, and 67,000 sport saltwater salmon trips. We assume that the proportion of trips that are supported by hatcheries is equal to the percent of fish caught that are of hatchery origin. We therefore estimate that hatchery-supported trips include: 1,360,000 freshwater salmon/steelhead fishing trips, 1,445,000 trout fishing trips, and 46,000 marine salmon fishing trips.
- **Washington annual sport fishing trips**: Based on US Fish and Wildlife Service data and WDFW data, we estimate that in Washington there are approximately 1,736,000 freshwater salmon sport trips, 1,879,000 steelhead sport fishing trips, 2,512,000 trout fishing trips and 425,400 marine salmon sport fishing trips. Again, assuming that the proportion of trips that are supported by hatcheries is equal to the percent of fish caught that are of hatchery origin, we estimate that Washington hatchery-supported trips include: approximately 1,128,000 freshwater salmon sport trips, 1,879,000 steelhead sport fishing trips, 1,758,000 trout fishing trips and 293,500 marine salmon sport fishing trips.

For commercial and treaty fishing, this section finds that:

- **Commercial salmon catch in Oregon**: Average annual salmon commercial catch in Oregon from 2015 to 2020 was valued at $7.2 million; assuming 75% is of hatchery origin based on our analysis of data from ODFW, we estimate $5.4 million in commercial catch revenue is from hatchery salmon.
- **Commercial salmon catch in Washington**: Average annual salmon commercial catch value (ex-vessel value) in Oregon from 2015 to 2020 was $25.4 million; assuming 75% is of hatchery origin based on our analysis of data from WDFW, we estimate $19.0 million annually in commercial catch revenue is from hatchery salmon.
- **Treaty commercial catch in the Columbia River:** Based on estimated catch numbers, average weight per fish, and average price per pound for salmon, we estimate ex-vessel value of annual treaty catch at $7.9 million, with 75% estimated to be of hatchery origin this translates to $5.9 million in annual ex-vessel catch value of hatchery salmon.
- **Treaty commercial catch off the Washington Coast:** We estimate ex-vessel value of annual Washington Coast treaty catch at $12.2 million, with 75% estimated to be of hatchery origin this translates to $9.1 million in annual ex-vessel catch value of hatchery salmon.

2.1 Sport Catch

This subsection presents total sport catch in Washington and Oregon, as well as the estimated sport catch that is of hatchery origin.

2.1.1 Oregon

ODFW estimates the total sport catch harvest of salmon and steelhead based on the data from sports harvest angler tags (punch cards) that anglers are requested to return at the end of each angling season. According to ODFW, approximately 6% to 14% of anglers returned their sports harvest angler tags (punch cards) in the period 2014 to 2018 (Oregon Department of Fish and Wildlife, 2020). Recognizing that the catch card data do not represent the total catch, the Department developed a methodology in 1964[3] based on angler survey data to expand the data to estimate total catch. This method is still in use today, although at the time the methodology was developed, a higher proportion of anglers returned their cards (Jones, 2021). The ODFW estimated total salmon and steelhead sport catch is shown in **Table 2-1**.

[3] As noted by ODFW: “All catch estimates from salmon-steelhead tag returns have been corrected for nonresponse bias, using the method described in "An Evaluation of the Punch Card Method of Estimating Salmon-Steelhead Sport Catch," by Ronald H. Hicks and Lyle D. Calvin, Oregon State University Agricultural Experiment Station, Technical Bulletin 81, November 1964.”

Table 2-1: Estimated Total Annual Salmon & Steelhead Sport Catch, 2008-2018

Year	Salmon-Steelhead Annual Tags Issued (a)	% of Salmon-Steelhead Annual Tags Returned	Annual Estimated Salmon Catch	Annual Estimated Steelhead Catch	Annual Total Catch
2008	225,161	18.25	107,583	72,876	180,459
2009	259,981	18.67	239,756	85,607	325,363
2010	232,627	20.65	191,074	99,353	290,427
2011	228,056	21.02	216,907	76,461	293,368
2012	249,221	16.88	215,640	110,935	326,575
2013	245,589	16.3	249,624	66,169	315,793
2014	305,397	13.81	437,079	78,084	515,163
2015	300,023	12.11	374,559	79,543	454,102
2016	287,388	10.07	176,721	93,450	270,171
2017	261,728	10.41	203,918	34,657	238,575
2018	249,431	6.09	135,773	45,164	180,937
Average 2008-2018	258,600	14.93	231,694	76,573	308,267
Average 2013-2018	274,926	11.47	262,946	66,178	329,124

Source: (Oregon Department of Fish and Wildlife, 2020).

To estimate the proportion of this catch that is hatchery fish, ODFW provided the raw data from the returned angler tags. These data, as analyzed for this study, are summarized in **Table 2-2**.

Table 2-2: Oregon Angler Reported Annual Salmon & Steelhead Sport Catch (Retained and Released), Raw Data from Angler Cards, Average 2013-2018

Species	Reported Catch	% Reported Catch	Reported Catch Clipped	% Reported Catch Clipped
Chinook	31,821	56%	16,978	53%
Coho	14,525	25%	11,399	78%
Steelhead	10,648	19%	10,097	95%
Total	56,994	100%	38,474	68%

Source: Highland Economics' analysis of sport angler catch card raw data provided by Oregon Department of Fish and Wildlife.

As these are the best data available on wild versus hatchery catch, we assume that the percent of total sport fish caught that are hatchery fish is approximately the percent of catch that is clipped as reported in the raw angler card data. This assumption may over- or under-estimate the proportion of catch that is of hatchery origin, for the following reasons:

- The percent hatchery fish may be undercounted since a portion of hatchery fish are not clipped (the portion depends on the agency managing the hatchery).
- On the other hand, the percent hatchery may be over-counted since people may not report their wild catch as much as their clipped catch.

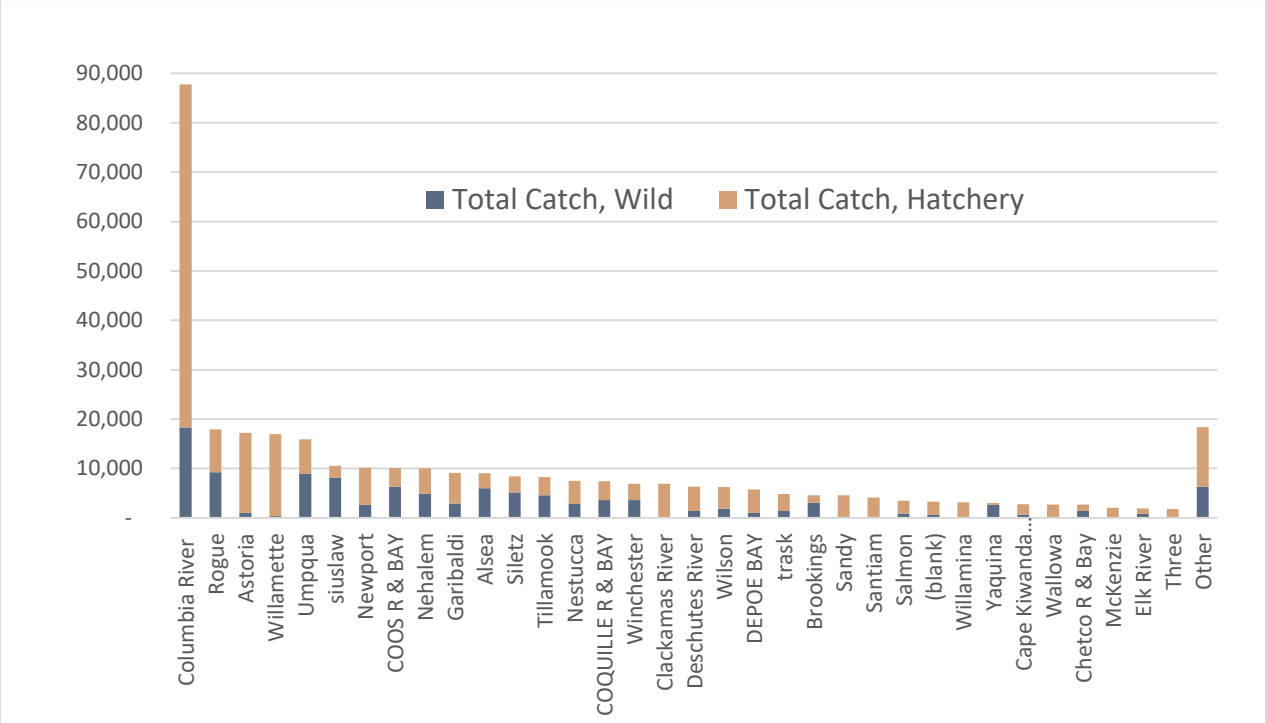
Given these uncertainties regarding the raw data and the unknown magnitudes of the error effects, the estimated percent of sport catch that is hatchery fish for all salmon/steelhead and for each species may be underestimated or overestimated. Based on the above data, the estimated salmon and steelhead total and hatchery origin sport catch in Oregon from 2008 to 2018 is presented in **Table 2-3**. **Figure 2-1** also presents the raw sport angler catch card data showing clipped (hatchery) and non-clipped fish (assumed to be wild) caught by waterbody.

Table 2-3: Estimated Annual Sport Catch in Oregon, Total & Hatchery Origin

Species	Estimated Total Sport Catch	Estimated % Hatchery Origin	Estimated Sport Catch of Hatchery Fish
Expanded Count, Total, ODFW Estimate, Average 2008-2018	308,267		
*Chinook**	*172,111*	*53%*	*91,800*
*Coho**	*78,563*	*78%*	*61,700*
*Steelhead**	*57,593*	*95%*	*54,600*
*Total**		*68%*	*208,100*

Source: Highland Economics' analysis of raw sport angler catch card data provided by Oregon Department of Fish and Wildlife.
**Highland Economics' estimate.*

Figure 2-1: Estimated Hatchery & Wild Sport Catch, Oregon, by Waterbody



Source: Highland Economics' analysis of raw sport angler catch card data provided by Oregon Department of Fish and Wildlife.

ODFW does not estimate total trout sport catch (Jones, 2021). However, the stated Oregon hatchery objective is for return to creel of 40% or more; Oregon Administrative Rule (OAR) 635-500-0105(3)b specifies that the "stocking of yearling trout will be discontinued or modified where return to the angler is consistently less than 40% of the number released". Further, a 2019 ODFW study of rainbow trout caught between 2014 and 2017 in 14 lakes and reservoirs across Oregon estimated the return to creel rate of hatchery rainbow trout (Oregon Department of Fish and Wildlife, 2019).[4] These varied by fish size, with return to creel catch rates of: 79% for trophy-sized trout, 36% for catchable-sized fish, and 26% for legal-sized trout. Based on the 2019 ODFW fish propagation report, of the fish stock released, 93% of all trout released were rainbow trout (so the data from the 2019 study of rainbow trout catch is

EACH YEAR OREGON HATCHERIES PROVIDE AN ESTIMATED:

208,000 sport-caught salmon

1.85 million sport-caught trout

[4] Specific locations included Lake of the Woods, Philips Reservoir, Lost Creek Reservoir, Wallowa Lake, Empire Lakes (Lower and Upper), Hagg Lake, Garrison Lake, Pine Hollow Lake, Clear Lake, Dorena Reservoir, Dexter Reservoir, Cottage Grove Reservoir, and Timothy Lake. At each of these locations, hatchery fish were released with external tags visible to anglers. Angler exploitation was estimated using the proportion of tags returned after being adjusted by a tag reporting rate, which is estimated by releasing small numbers of high reward tags (e.g., worth $50 USD upon return) simultaneous to standard tags (no monetary value). Based on ODFW hatchery release data by location, nearly all (approximately 87%) of trout are released into lakes and reservoirs.

applicable to nearly all hatchery trout). In addition, 67% of all trout releases were fingerlings, 26% were legal, and 7% were trophy (Oregon Department of Fish and Wildlife, 2020). We weight the return to creel rates by size by the percent released by size and find that approximately 32% of Oregon hatchery releases are caught.

Based on these data, we conservatively assume an average return to creel rate of 32%; in other words, we assume that 32% of trout hatchery releases are caught by anglers. Given the OAR, we expect this is a conservative estimate as management will adapt to increase return to creel rates. Over the period 2010 to 2020, an average of 5.8 million hatchery trout annually were released by ODFW in Oregon (Oregon Department of Fish and Wildlife, 2010-2020). Assuming 32% of these were caught by anglers results in an estimate of ***1.85 million hatchery trout caught annually in the state***.

2.1.2 Washington

Table 2-4 summarizes Washington State salmon sport catch from 2010 to 2019. These data include estimates for the sport catch in the Columbia River (and its tributaries), the Puget Sound, and the coastal areas (Willapa and Grays Harbor). In the table, the "Other" category includes chum, pink, and sockeye salmon and marine-caught steelhead. The data indicate that annual catch is highly variable, increasing 158 percent between subsequent years (2010-2011) and dropping 74 percent in others (2015-2016). This variability is strongly influenced by the pink salmon catch, which the data indicate fluctuate every other year; for example, in 2013 recreational anglers caught over 500,000 pink salmon while the following year the data indicate that fewer than 100 were caught.

WASHINGTON HATCHERIES PROVIDE AN ESTIMATED:

460,000 sport-caught salmon

5.55 million sport-caught trout

Table 2-4: Estimated Washington Salmon & Steelhead Sport Harvest, 2010-2019

	Marine[1]				Freshwater					
Year	Chinook	Coho	Other	Subtotal	Steelhead	Chinook	Coho	Other	Subtotal	Total
2010	66,284	58,626	3,389	128,299	144,374	104,656	58,091	31,967	339,088	467,387
2011	60,902	101,573	145,790	308,265	138,213	120,327	89,196	331,783	679,519	987,784
2012	81,748	208,792	4,410	294,950	124,528	116,359	72,767	71,807	385,461	680,411
2013	73,494	164,656	138,490	376,640	86,572	155,707	123,566	417,532	783,377	1,160,017
2014	75,651	265,211	4,088	344,950	103,159	121,791	135,727	63,597	424,274	769,224
2015	78,371	224,654	202,726	505,751	128,137	172,675	52,497	277,373	630,682	1,136,433
2016	54,161	23,035	5,018	82,214	97,005	110,173	40,270	57,834	305,282	387,496
2017	71,062	75,100	18,360	164,522	38,976	110,338	56,491	49,444	255,249	419,771
2018	66,615	110,180	6,255	183,050	42,793	65,145	34,525	37,749	180,212	363,262
2019	42,212	132,109	54,902	229,223	23,590	59,236	65,075	52,745	200,646	429,869
Average 2010-2019	67,050	136,394	58,343	261,786	92,735	113,641	72,821	139,183	418,379	680,165

Sources: (Washington Department of Fish and Wildlife, 2010-2019; Washington Department of Fish and Wildlife, 2010-2020; Washington Department of Fish and Wildlife, 2010-2019; Washington Department of Fish and Wildlife, 2010-2019)

1/These data include catch from Puget Sound and coastal bays (Willapa and Grays Harbor).

Figure 2-2 and **Figure 2-3** show the proportion of the salmon sport catch for marine and freshwater bodies, respectively. The marine catch is split between the Puget Sound and coastal areas, of which the Puget Sound comprises 60% of the marine salmon catch. For freshwater, half of the total catch occurs in Columbia River or its tributaries, nearly 40% comes from rivers that empty into the Puget Sound, and about 10% are caught in coastal rivers.

Figure 2-2: Washington Marine Sport Catch by Area, 2010-2019

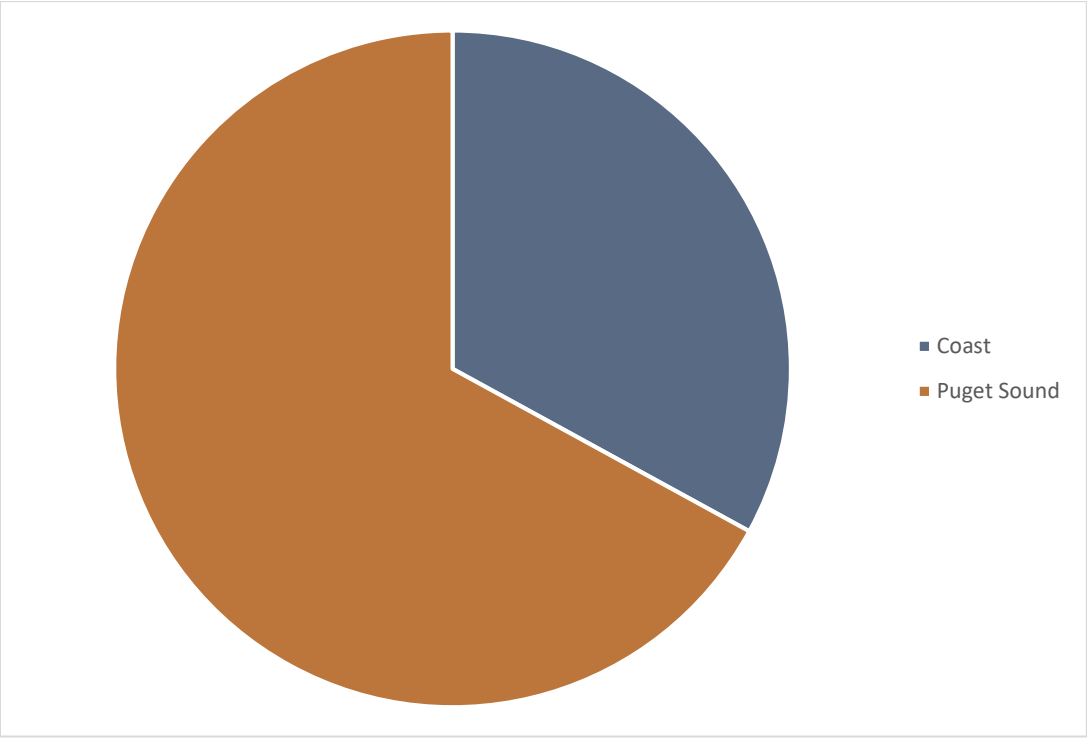


Figure 2-3: Washington Freshwater Sport Catch by Area, 2010-2019

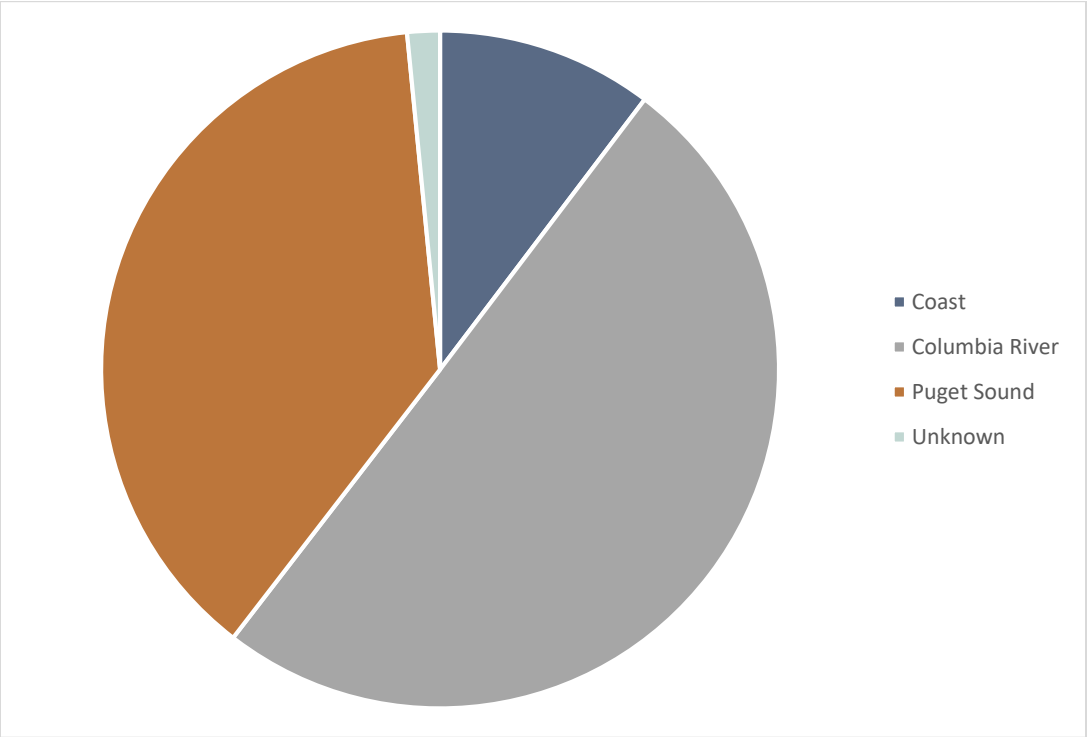


Table 2-5 presents the data on hatchery versus wild catch for all freshwater salmon harvest in Washington State. Chum, pink, and sockeye fish are not fin clipped, so it is not feasible to estimate the

percent hatchery from these species. For freshwater, combining the total number of fish Chinook and coho caught by species by location with the data in **Table 2-5**, we estimate that approximately 65% of freshwater salmon catch in Washington State is marked fish (for an estimated total sport catch of hatchery fish of 170,000 fish annually), with the cautions noted above in Section 2.2.1 that this may be an underestimate or an overestimate. Data from the marine sport salmon fishery indicate that 92% of marine-caught chinook and 58% of marine-caught coho come from hatcheries (Washington Department of Fish and Wildlife, 2010-2019). Across both species, the proportion of marine catch that is clipped or marked as hatchery fish is 69% (for a total of approximately 290,000 fish annually). We expect that these data may under-estimate the importance of hatchery salmon, as a 2010 WDFW report noted that hatcheries produce over 75% of all salmon harvested in Washington State (Washington Department of Fish and Wildlife, 2010).

Table 2-5: Washington Angler Reported % Marked Fish, Raw Data from Angler Cards, Average 2010-2020

Area	Chinook	Coho	Steelhead
Columbia River	76%	49%	100%
Puget Sound Rivers	58%	94%	100%
Coastal Rivers	95%	51%	98%
All Freshwater	64%	66%	100%
Marine (Puget Sound and Bays)	92%	58%	100%

Source: Highland Economics' analysis of sport angler catch card raw data provided by Washington Department of Fish and Wildlife. Note that the percent clipped or marked fish is based on the proportion of marked fish out of the total fish that were reported as marked or unmarked, and not the total fish caught as some anglers did not include data on whether their catch was marked.

No data were available on the number of trout caught in the State's waters. For that reason, we base estimates of caught trout on hatchery releases and the average return to creel rate used for Oregon: 32%. According to WDFW records, from 2011 to 2020, over 173,390,000 trout were released from Washington fish rearing facilities (Washington Department of Fish and Wildlife, 2011-2021). Assuming 32% were caught by anglers, an estimated ***55.49 million trout were caught in Washington from 2011-2021, or 5.55 million annually***.

2.2 Recreational Effort

This section summarizes data on the number of days and trips spent fishing for salmon, steelhead, and trout in Oregon and Washington.

2.2.1 Oregon

Table 2-6 summarizes the estimated number of fishing trips in Oregon for salmon, steelhead, and trout fishing. We base our estimates of total fishing trips in Oregon on existing survey data and previous studies. For freshwater fishing, we base our estimates on data from the following two studies: the 2011 US Fish and Wildlife Service Survey of Hunting, Fishing, and Wildlife Viewing in Oregon and a 2008 study sponsored by ODFW on Fishing, Hunting, Wildlife Viewing, and Shellfishing in Oregon. Using these studies, we estimate that there are approximately 2 million fishing trips annually for freshwater salmon/steelhead fishing and approximately the same number for trout fishing. For saltwater salmon

angling, we use the estimate developed by the Oregon Ocean Salmon Management Program at ODFW: 67,000 annual saltwater salmon fishing trips. While all of these trips are supported by the presence of hatchery fish as hatchery fish are the predominant source of fish caught (retained or released) on angling trips, we assume that a portion of these trips and associated recreation enjoyment and recreational spending would occur even without hatchery production at current wild salmon population levels. **We attribute economic value associated with hatcheries based on the percent of fish caught that are estimated to be of hatchery origin. For salmon and steelhead fishing trips, both saltwater and freshwater, we assume 68% (as shown above in Table 2-3) of trips are supported by hatchery production as this is the estimated proportion of the total catch that is of hatchery origin.** This may be a substantial underestimate of recreational fishing effort and value that is supported by hatcheries as recreational fishing might not occur (due to regulations or angler inclination) without hatchery fish. For example, many fisheries are dominated by hatchery fish or only allow anglers to retain hatchery fish and require wild fish to be released; absent hatchery fish is it possible that there would be little to no angling in these fisheries. If that is the case, then the proportion of value that is supported by hatcheries may be much greater than the proportion of fish that are hatchery fish, with the result that the estimates of economic value in this report would likely be substantial underestimates.

EACH YEAR OREGON HATCHERY CATCH SUPPORTS AN ESTIMATED:

1.4 million salmon sport fishing trips

1.4 million trout sport fishing trips

For freshwater salmon and steelhead fishing trips, in addition to the results from the two surveys indicating that the total number of trips (and the number of fishing days) is approximately 2 million annually, another method focusing on catch rate and total catch supports this estimate. Two million fishing days annually, with annual catch of approximately 308,000 fish, indicates approximately 6.5 days fishing per salmon/steelhead retained (or said differently, a catch rate of approximately 0.13 fish per salmon/steelhead fishing day). This is similar to catch rates for salmon and steelhead reported in numerous other studies and Oregon creel surveys. For example, based on creel survey data, a 2018 report conducted for ODFW estimated effort for fish caught for non-Columbia River coastal freshwater fishing at 6.0 to 7.5 days for Chinook, 15.0 days for Coho, and 4 days for steelhead. For the lower Columbia River, the report estimated effort was 4.3 to 6.3 days for Chinook and 3.5 days for Coho and 16.4 for steelhead (The Research Group, 2018).[5]

[5] This 2018 report also estimated the number of salmon and steelhead fishing trips on the Oregon coast; analysis of these data for the Oregon Coast appear to corroborate the accuracy and current validity of the estimated freshwater salmon/fishing trips used in this report. The 2018 report estimated the number of days of fishing in freshwater areas in inland Coastal regions, including areas generally west of the Coast Range crest and in sampling areas 9 and 10 of the Columbia River (The Research Group, 2018). The estimates were not survey-based like the Dean Runyan or USFWS estimates but were rather based on estimated freshwater steelhead and salmon catch in inland coastal areas and estimated number days of fishing required per fish caught. The 2018 report provided an estimate of coastal freshwater fishing days during the period 2010 to 2017. Averaging the data indicates an average annual number of fishing days of 1,116,000. To compare this to the estimate of coastal trips reported in the 2008 Dean Runyan survey data, we use the Dean Runyan data regarding the average number of days per freshwater fishing trip, adjusted for the percent of coastal fishing trips that are overnight

For trout fishing trips, we use the estimated hatchery trout catch of 1.85 million (see Section 2.1.1 above), and the estimate by ODFW of 1 trout caught per trout fishing day (Oregon Department of Fish and Wildlife, 2010) to estimate 1.85 million hatchery trout fishing days. To convert trout fishing days to trout fishing trips, we use data from a 2006 survey conducted on behalf of ODFW (Reponsive Management, 2006). This survey indicates that 28% of Oregon trout anglers usually take an overnight trip when fishing for trout. Assuming that the average trip for overnight anglers is a two-day fishing trip, and assuming all other anglers average a one-day fishing trip, then the average trout fishing trip length would equate to approximately 1.28 days per trip.[6] Assuming 1.28 days per trip, then 1.85 million hatchery trout fishing days translate to 1,445,000 hatchery-related trout fishing trips annually. As shown in Table 2-6, surveys conducted on behalf of ODFW and USFWS indicate approximately 2 million trout fishing trips annually in Oregon. The estimate of 1.445 million trips related to hatcheries implies that approximately 70% of trout fishing trips are hatchery-related. This matches the estimate of the percent of salmon trips that are hatchery-related and corresponds with information from ODFW that "ODFW

trips (i.e., multi-day trips). With this approach, it appears that the Dean Runyan data may indicate approximately 1 million freshwater angling/fishing trips in coastal areas in 2008. This is very similar to the average estimate of 1,116,000 days of coastal steelhead/salmon freshwater fishing for the period 2010 to 2017 from the 2018 report.

[6] Data from the 2011 USFWS survey indicates that Oregon freshwater fishing trips average 1.14 days per trip, including all freshwater species. If this is accurate for trout fishing trips, our data on the number of fishing trips would be a conservative underestimate.

hatcheries provide more than 70 percent of the fish harvested in the state's sport and commercial salmon, steelhead, and trout fisheries" (Oregon Department of Fish and Wildlife, 2019).

Table 2-6: Oregon Recreational Fishing Effort, Angler Trips

Data	Source			Estimated Total Trips	Estimated Trips Supported by Hatchery Fish
	US Fish and Wildlife Service Survey, 2011 (Anglers 16+)	Dean Runyan Associates Survey (for ODFW), 2008	Ocean Salmon Management Program, ODFW, 2010-2020		
Salmon & Steelhead Fishing (Freshwater)	*2,396,000*[a]	1,859,000		2,000,000	1,360,000
Trout Fishing	*2,175,000*[a]	1,713,000		2,000,000	1,445,000
Salmon Fishing (Saltwater)	*270,000*[b]	328,000	67,000	67,000[c]	46,000

Source: (Ocean Salmon Management Program, Oregon Department of Fish and Wildlife, 2020), (Dean Runyan Associates, 2009) (Pacific Fishery Management Council, 2021).

a/ Data were presented as fishing days; this is converted to the estimated number of trips based on the average number of days fishing on all freshwater fishing trips for all species.

b/ Data were presented as fishing days; this is converted to the estimated number of trips based on the average number of days fishing on all saltwater fishing trips for all species.

c/ ODFW Ocean Salmon Management Program data is expected to be more accurate than the other sources, which are surveys of licensed anglers. Note that relative to freshwater fishing, where there are many more anglers and fishing days, the % error of margin in surveys for saltwater fishing estimates is expected to be larger.

2.2.2 Washington

Table 2-7 presents data from the 2006 and 2011 US Fish and Wildlife Survey of Fishing, Hunting, and Wildlife-Associated Recreation[7] for Washington State on the number of freshwater trips and days of fishing effort by species. Averaged across the two years, there were approximately 2 million freshwater salmon fishing days, 2 million steelhead fishing days and nearly 3 million trout fishing days, as shown in the bottom rows of **Table 2-7**. Converting these data to trips[8], this represents approximately 6.1 million trips for salmon, steelhead, and trout (1.7 million salmon fishing trips, 1.9 million steelhead fishing trips, and 2.5 million trout fishing trips). Since data from WDFW indicate that about 65% of freshwater-caught salmon are of hatchery origin (see **Table 2-5** above), we

EACH YEAR WASHINGTON HATCHERY CATCH SUPPORTS AN ESTIMATED:

3.0 million salmon/steelhead sport fishing trips

1.8 million trout sport fishing trips

[7] Data from the 2016 US Fish and Wildlife Survey are not yet available at the state level.

[8] The US Fish and Wildlife Survey provides data on the number of days of fishing for each species, but only provides the number of fishing trips for all freshwater fishing (i.e., number of trips are not provided by fish species). In the absence of other data, we apply the average trip length (days per trip) for all freshwater fishing trips to estimate the number of trips for salmon, steelhead, and trout freshwater fishing (i.e., we assume that for each species, the trip length is the same).

assume that the same proportion of salmon freshwater sport fishing trips are supported by hatcheries. Because all of the freshwater steelhead are from hatcheries, all of these trips are assumed to be attributable to hatcheries. For trout, in the absence of other data, we assume that Washington is similar to Oregon and that 70% of trout are from hatcheries (see Section 2.2.1).

As with the Oregon data, we compare how these fishing effort estimates compare with the reported total salmon catch and estimated catch rates for freshwater salmon fishing. WDFW data indicate that the average annual freshwater sport salmon catch in Washington has been approximately 300,000 fish per year from 2010 to 2019, while from 2000 to 2009 it was approximately 230,000 fish per year (Washington Department of Fish and Wildlife, 2021). This implies a catch rate of approximately 1 fish for every 6.5 to 8.5 days of fishing, which is more days of fishing (or a lower catch rate) than suggested in the Oregon data, but still within the reasonable range given the reported catch rates presented above in Section 2.2.1.

For marine salmon, WDFW reports data on the annual sport marine fishing trips in Washington (see **Table 2-8**). We use the average number of trips per year reported by WDFW for 2010 to 2019: 425,400 trips. Based on the average proportion of salmon catch that is hatchery, we assume 69% of marine sport trips are attributable to hatchery fish, or approximately 293,500 trips per year.

Table 2-7: Estimated Washington Recreational Fishing Effort, Freshwater

Species	Annual Angler Days [a]	Annual Angler Trips [a]	% Hatchery Trips [b]	Hatchery Trips [c]
2011 US Fish and Wildlife Service Survey				
All Freshwater fishing	10,940,000	10,516,000		
Salmon (freshwater)	2,107,000	2,025,000	65%	1,316,000
Steelhead	2,974,000	2,859,000	100%	2,859,000
Trout	2,136,000	2,053,000	70%	1,437,000
2006 US Fish and Wildlife Service Survey				
All Freshwater fishing	7,782,000	6,382,000		
Salmon (freshwater)	1,763,000	1,446,000	65%	940,000
Steelhead	1,097,000	900,000	100%	900,000
Trout	3,622,000	2,970,000	70%	2,079,000
Average of 2006 and 2011 Survey Data				
Salmon (freshwater)	1,935,000	1,736,000	65%	1,128,000
Steelhead	2,035,500	1,879,000	100%	1,879,000
Trout	2,879,000	2,512,000	70%	1,758,000

a/ Source: (U.S. Fish and Wildlife Service, 2011). The US Fish and Wildlife Survey provides data on the number of days of fishing for each species, but only provides the number of fishing trips for all freshwater fishing (i.e., number of trips are not provided by fish species). In the absence of other data, we apply the average trip length (days per trip) for all freshwater fishing trips to estimate the number of trips for salmon, steelhead, and trout freshwater fishing (i.e., we assume that for each species, the trip length is the same).
b/ Based on Highland Economics' analysis of sport angler catch card raw data provided by Washington Department of Fish and Wildlife. Trout percent based on Oregon study (see Section 2.1.1).
c/ Estimated by multiplying the annual angler trips (column 3) by the % hatchery trips (column 4).

Table 2-8: Estimated Washington Marine Angler Trips, Recreational Salmon

Year	Trips
2010	388,496
2011	497,772
2012	529,528
2013	561,006
2014	571,591
2015	633,018
2016	244,925
2017	258,292
2018	289,263
2019	280,514
2010-2019 Average	**425,441**
Hatchery Trips (69% of annual average)	**293,554**

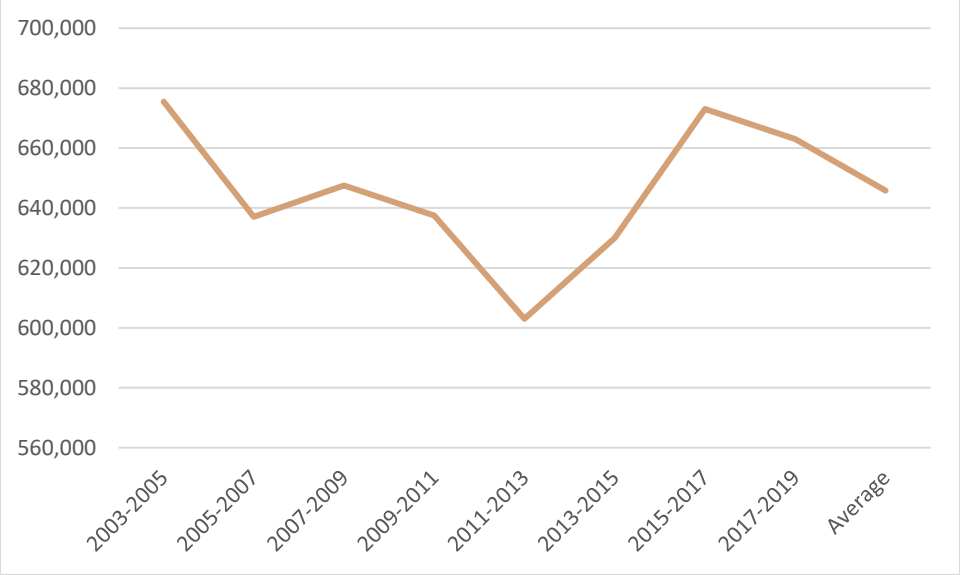
Source: (Washington Department of Fish and Wildlife, 2010-2020).

2.2.3 Trends in Angler Effort

Much of the data presented above is either an average over the last 10 years or is from surveys conducted 10 or more years ago. To verify if these data are likely to be an accurate representation of current angler effort, we look to data on fishing license sales in the Oregon and Washington. The available data are presented in the table and figure below. **Table 2-9** summarizes data from the last five years on the number of anglers purchasing fishing licenses in Oregon and Washington from 2017 to 2021. These recent data show fluctuation, but no clear trend in license sales over the last five years.

A longer time period showing the historic trends (2003 to 2019) and future projections of the number of Oregon fishing licenses sold (resident and non-resident), as analyzed by ODFW, are presented in **Figure 2-4**. As shown in the figure, fishing license sales appeared to peak in the late 1980's. Between 2000 and 2019, the historic fishing license sales have averaged approximately 650,000 annually. Sales in this time period have varied between approximately 600,000 to 700,000 licenses annually, with no clear long-term trend indicating that future demand for licenses will be higher or lower. Consistent with this interpretation, ODFW projects that angler sales will remain in this range also for the next five years (Oregon Department of Fish and Wildlife, 2019). Similarly, data from the 2001 and 2011 U.S. Fish and Wildlife Service Surveys of Hunting, Fishing, and Wildlife Viewing for Oregon and Washington indicate that the number of fishing days and the expenditures on fishing were fairly consistent in those two time periods. Based on these available data, we conclude that the data presented above on angler effort from 2008 and 2011 represent well the current angling effort.

Figure 2-4: Historic Oregon Fishing and Hunting Licenses, Average Annual by Biennium



Source: (Oregon Department of Fish and Wildlife, 2019).

Table 2-9: Angling License Sales in Oregon and Washington, 2017-2021

	Paid Fishing License Holders	Resident Fishing License, Tags, Permits and Stamps	Non-Resident Fishing License, Tags, Permits and Stamps	Total fishing Licenses, Tags, Permits and Stamps	Cost - Resident Fishing License Tags Permits and stamps	Cost - Non-Resident Fishing License Tags Permits and stamps	Gross Cost - Fishing Licenses
Oregon							
2021	627,029	724,036	141,838	865,874	$20,785,552	$5,780,822	$26,566,374
2020	622,861	717,585	132,824	850,409	$20,997,049	$5,557,788	$26,554,837
2019	650,435	767,654	139,035	906,689	$22,552,402	$5,886,252	$28,438,654
2018	628,490	790,676	151,831	942,507	$19,784,871	$5,353,139	$25,138,010
2017	638,912	807,074	151,939	959,013	$19,068,220	$5,272,164	$24,340,384
Average	**633,545**	**761,405**	**143,493**	**904,898**	**$20,637,619**	**$5,570,033**	**$26,207,652**
Washington							
2021	705,809	1,482,436	163,069	1,645,505	$30,582,120	$4,220,802	$34,802,922
2020	641,060	1,373,008	158,946	1,531,954	$30,504,767	$4,298,518	$34,803,285
2019	607,816	2,020,090	218,809	2,238,899	$25,756,338	$3,841,773	$29,598,111
2018	686,037	2,201,891	244,692	2,446,583	$26,276,726	$4,211,894	$30,488,620
2017	688,025	2,225,890	236,575	2,462,465	$26,534,081	$4,111,852	$30,645,933
Average	**665,749**	**1,860,663**	**204,418**	**2,065,081**	**$27,930,806**	**$4,136,968**	**$32,067,774**

Source: US Fish and Wildlife Service National Fishing License Reports for 2017 through 2021.

2.3 Commercial Catch

Commercial salmon landings by port in Oregon and Washington is reported by the Pacific Fisheries Information Network, not including treaty catch value, as shown in Table 2-10. These onshore landings do not include landings of salmon in ports in Alaska and other "distant water" fisheries by boats from Oregon and Washington. This analysis focuses only on assessment of the economic value or economic contribution of commercial landings in Oregon and Washington as these are the fisheries most influenced by hatchery operations in these two states (i.e., we do not include the value of salmon landed in Alaska or other distant waters as a relatively small portion of these salmon are likely to have originated in Oregon or Washington hatcheries.) The ex-vessel value of commercial salmon and steelhead landings in Oregon and Washington are presented in **Table 2-10**. Ex-vessel value is the dollar value of commercial landings, based on the price per pound at first purchase of the commercial landing multiplied by the total pounds landed.

Table 2-10: Commercial Catch, Salmon Troll Fishery, Average Annual Landing Value (Ex-Vessel Value) for the Years 2015 to 2020 (Millions, 2021 $)

Port Area	Chinook	Chum	Coho	Pink	Sockeye	Steelhead	Area Average
Oregon							
Brookings, OR	$0.4	$0.0	$0.0	$0.0	$0.0	$0.0	$0.4
Columbia River, OR	$3.5	$0.0	$0.4	$0.0	$0.0	$0.0	$3.9
Coos Bay, OR	$0.9	$0.0	$0.0	$0.0	$0.0	$0.0	$0.9
Newport, OR	$1.8	$0.0	$0.0	$0.0	$0.0	$0.0	$1.8
Tillamook, OR	$0.2	$0.0	$0.0	$0.0	$0.0	$0.0	$0.2
Oregon Total	$6.7	$0.0	$0.4	$0.0	$0.0	$0.0	$7.2
Washington							
Coastal WA	$2.0	$0.1	$0.1	$0.0	$0.0	$0.0	$2.3
Columbia River, WA	$2.8	$0.1	$0.8	$0.0	$0.0	$0.4	$4.1
N. Puget Sound, WA	$2.9	$1.7	$0.8	$0.2	$0.8	$0.1	$6.4
S. Puget Sound, WA	$3.3	$3.2	$1.0	$0.0	$0.1	$0.1	$7.7
Unknown WA Port	$1.8	$1.2	$0.6	$0.0	$1.3	$0.1	$5.0
Washington Total	$12.7	$6.3	$3.4	$0.2	$2.2	$0.6	$25.4
Oregon and Washington							
OR & WA Total	$19.5	$6.3	$3.7	$0.2	$2.2	$0.6	$32.6

Source: (Pacific Fisheries Information Network, 2021)

Per the ODFW Ocean Salmon Management Program, the percent of commercial catch that is of hatchery origin is not easy to estimate as salmon landed by Oregon commercial vessels originate from many different fisheries with different hatchery management practices (i.e., different proportions of hatchery fish fins are clipped) and are from hatcheries in different states (Eric Schindler, 2021). The Ocean Salmon Program does evaluate the origin of hatchery fish that are caught in the ocean commercial and recreational fishery (although it does not evaluate the percent of all catch that originate in hatcheries). Their data indicate that the largest contributor of hatchery fish caught in the Oregon ocean salmon fishery is the Columbia River system (fish are also caught that were raised in hatcheries in Washington and California, and to a lesser extent, Alaska and Canada) (Oregon Department of Fish and Wildlife Ocean Salmon Project, 2018).

Overall, ODFW has recently noted that 70% of total commercial *and* recreation salmon, steelhead, and trout catch are of hatchery origin (Oregon Department of Fish and Wildlife, 2019). In 2010, ODFW noted that 75% of salmon harvested commercially are produced by hatcheries (Oregon Department of Fish and Wildlife, 2011). For the Columbia River sport fishery, an estimated 79% are hatchery fish, based on returned angler cards, using the methods described above. **Given these data, and that the ocean fishery may be most similar to the Columbia River fishery (as the Columbia River is the largest contributor to the Oregon commercial fishery), we assume that 75% of commercial salmon catch in Oregon is hatchery origin.**

For Washington, data from the marine sport salmon fishery indicate that 92% of marine-caught chinook and 58% of marine-caught coho come from hatcheries (Washington Department of Fish and Wildlife, 2010-2019). The weighted average catch for the two salmon species (proportion of catch from each species multiplied by the proportion of each species that is of hatchery origin) is 69%. Further, as noted

above, a 2010 WDFW report noted that hatcheries produce over 75% of all salmon harvested in Washington State (Washington Department of Fish and Wildlife, 2010). Based on these data, we make the same assumption as for the Oregon fishery and **assume that 75% of commercial salmon catch in Washington is hatchery origin.** For marine-caught steelhead, 100% originated from hatcheries. **Table 2-11** summarizes estimated commercial catch value of hatchery fish.

Table 2-11: Commercial Catch, Salmon Troll Fishery, Estimated Average Annual Landing Value (Ex-Vessel Value) of Hatchery Fish, 2015-2020

Port Area	Catch value (Millions, 2021$)
Brookings, OR	$0.30
Columbia River, OR	$2.93
Coos Bay, OR	$0.68
Newport, OR	$1.35
Tillamook, OR	$0.15
Oregon Total	**$5.40**
Coastal WA	$1.73
Columbia River, WA	$3.08
N. Puget Sound, WA	$4.80
S. Puget Sound, WA	$5.78
Unknown WA Port	$3.75
Washington Total	**$19.05**
OR & WA Total	**$24.45**

2.3.1 Treaty Commercial Catch

Table 2-12 summarizes the treaty commercial catch on the Columbia River Mainstem above Bonneville Dam. The catch data includes landings in both Oregon and Washington. Tribes with treaty-reserved rights in the Columbia River Basin include the Yakama, Warms Springs, Umatilla, and Nez Perce (Pacific Fishery Management Council, 2022).

Table 2-12: Treaty Commercial Catch on the Columbia River (Number of Fish)

Year	Chinook [1]	Coho [2]	Sockeye [3]	Steelhead [3]	Sturgeon [3]	Total
2015	353,031	2,275	22,999	14,957	1,587	668,134
2016	174,939	5,321	13,058	13,687	1,293	598,253
2017	141,845	7,000	3,251	1,179	903	514,041
2018	76,388	3,590	5,398	6,322	987	463,808
2019	76,902	3,928	652	2,699	1,206	358,380
2020	N/A	11,913	4,067	7,846	1,438	N/A
Average	**164,621**	**5,671**	**8,238**	**7,782**	**1,236**	**520,523**

1/ Treaty catch above Bonneville Dam. Source: (Pacific Fishery Management Council, 2021), Tables B-20
2/ Source for 2017: (Pacific Fishery Management Council, 2021), Table B-21. Source for other years: (Oregon Departmet of Fish and Wildlife, 2015-2020)
3/ Treaty catch from Bonneville Dam to McNary Dam. Source: (Oregon Departmet of Fish and Wildlife, 2015-2020)

The annual treaty commercial catch in Washington waters is summarized in **Table 2-13** below. These areas include the Puget Sound, the coastal areas of Grays Harbor and the Quinault River, and ocean waters. Tribes with treaty-reserved fishing rights in western Washington include the Lummi, Nooksack, Swinomish, Upper Skagit, Sauk-Suiattle, Stillaguamish, Tulalip, Muckleshoot, Puyallup, Nisqually, Squaxin Island, Skokomish, Suquamish, Port Gamble S'Klallam, Jamestown S'Klallam, Lower Elwha Klallam, Makah, Quileute, Quinault, and Hoh (Pacific Fishery Management Council, 2022).

Table 2-13: Treaty Commercial Catch on the Washington Coast (Number of Fish)

Year	Chinook	Chum	Coho	Pink	Sockeye	Total
2015	150,039	623,325	64,282	580,801	72,694	1,491,141
2016	103,920	559,306	262,955	88	25,536	951,805
2017	158,586	665259	176,863	124,542	22481	1,147,731
2018	127,462	443,460	219,748	107	618492	1,409,269
2019	124,698	148,493	130,002	241,118	9,468	653,779
2020	N/A	130,881	135,760	5	3,364	N/A
Average	**132,941**	**428,454**	**164,935**	**157,777**	**125,339**	**1,130,745**

Notes: Does not include the Columbia River Mainstem Catch included in Table 2-13
Source: (Pacific Fishery Management Council, 2021), Tables A-15, A-16, A-25, A-26, B-20, B-21, B-25, B-27, B-29

We use the average number of fish caught in the above tables to estimate the annual value of the treaty commercial catch. The average weight per fish comes from data published by the Pacific Fishery Management Council and the Oregon Department of Fish and Wildlife, which is summarized in **Table 2-14** below. The average price per pound of fish by species comes from the Pacific Fisheries Information Network (PacFIN) APEX reporting system. The average commercial prices for fish caught in the Columbia River are summarized in **Table 2-15** and the average prices fish caught on the Washington Coast are summarized in **Table 2-16** below. While these prices represent all commercial fishing those areas and are therefore not specific to treaty-caught fish, they are the best approximation for the value per pound of treaty-caught fish.

Table 2-14: Average Weight Per Fish by Species

Species	Average Weight per Fish (in lbs)
Chinook [1]	11.4
Coho [1]	5.8
Pink [1]	3.8
Sturgeon [2]	25.1
Sockeye [2]	3.9
Steelhead [2]	8.0
Chum [2]	7.5

1/ Source: (Pacific Fishery Management Council, 2021)
2/ Source: (Oregon Departmet of Fish and Wildlife, 2015-2020)

Table 2-15: Average Price per Pound of Salmon on the Columbia River

Year	Chinook	Coho	Sockeye	Steelhead	Sturgeon
2015	$3.14	$1.77	$2.05	$1.58	$0.32
2016	$4.00	$1.95	$3.07	$1.70	$0.32
2017	$4.69	$2.24	$4.45	$1.94	$0.33
2018	$5.58	$2.34	$4.27	$2.69	$0.29
2019	$3.86	$1.99	$3.53	$3.44	$0.29
2020	$3.10	$1.84	$3.85	$1.85	$0.29
Average	**$4.06**	**$2.02**	**$3.54**	**$2.20**	**$0.31**

Note: All prices were adjusted to 2021 dollars using the Consumer Price Index.
Source: (PacFIN, 2020), Average of Port Areas: Columbia River, OR and Columbia River, WA

Table 2-16: Average Price per Pound of Salmon on the Washington Coast

Year	Chinook	Chum	Coho	Pink	Sockeye
2015	$3.28	$0.64	$1.65	$0.27	$1.87
2016	$3.22	$0.82	$2.16	$2.20	$2.79
2017	$4.24	$1.00	$2.29	$0.33	$3.02
2018	$4.76	$1.01	$2.20	$1.25	$2.14
2019	$3.79	$0.83	$2.25	$0.29	$2.46
2020	$3.04	$0.82	$1.87	N/A	$3.64
Average	**$3.72**	**$0.85**	**$2.07**	**$0.87**	**$2.65**

Note: All prices were adjusted to 2021 dollars using the Consumer Price Index.
Source: (PacFIN, 2020), Average of Port Areas: Coastal WA, N. Puget Sound, S. Puget Sound, Unknown WA Port

Ex-vessel value is usually calculated as he price per pound at first purchase of the commercial landings multiplied by the total pounds landed. As such, we combine the values in the tables above (number of fish, weight per fish, and price per pound) and apply the estimated proportion of catch that is hatchery-origin of 75% to estimate the value of the treaty commercial fisheries supported by hatcheries on the Columbia River and Washington Coast. These values are summarized in **Table 2-17** below.

Table 2-17: Estimated Ex-Vessel Value of Annual Treaty Catch

Species	Total Ex-Vessel Harvest Value			Estimated Ex-Vessel Harvest Value Supported by Hatcheries		
	Columbia River	Washington Coast	Total	Columbia River	Washington Coast	Total
Chinook	$7,596,000	$5,616,000	$13,212,000	$5,697,000	$4,212,000	$9,909,000
Chum	N/A	$2,740,000	$2,740,000	N/A	$2,055,000	$2,055,000
Coho	$67,000	$1,987,000	$2,054,000	$50,250	$1,490,250	$1,540,500
Pink	N/A	$521,000	$521,000	N/A	$390,750	$390,750
Sockeye	$114,000	$1,307,000	$1,422,000	$85,500	$980,250	$1,066,500
Steelhead	$136,000	N/A	$136,000	$102,000	N/A	$102,000
Sturgeon	$10,000	N/A	$10,000	$7,500	N/A	$7,500
Total	$7,923,000	$12,172,000	$20,095,000	**$5,942,250**	**$9,129,000**	**$15,071,250**

Source: Highland Economics analysis

3 ECONOMIC CONTRIBUTION OF FISH HATCHERIES

Fish hatcheries support economic activity, much of it in rural areas for which fishing and other natural resource-based economic activity are prime drivers of the local economy. Specifically, fish hatcheries support economic activity (jobs and income) throughout Oregon and Washington in the following ways:

5. Hatchery operations, which provides employment and income to hatchery employees as well as results in spending in local communities for equipment repair, utilities, and other inputs.
6. Tourism spending by anglers on recreational fishing trips to areas where the local fish population is largely hatchery fish or is enhanced by hatchery fish releases.
7. Commercial fishing activity for salmon that is supported by hatchery releases.
8. Tourism spending by visitors to fish hatcheries.

For each of these pathways (with the exception of tourism spending by visitors to hatcheries)[9], we estimate the total statewide expected expenditures in Oregon and Washington associated with hatcheries and hatchery-produced fish, and the level of economic activity sustained at hatcheries and in the commercial and recreational fishing sectors related to hatcheries. In addition to estimating these direct effect of economic activity in the fishing sector and hatchery operations, we also estimate the indirect and induced ripple effects of spending in related sectors. Indirect and induced effects include economic activity supported at businesses that supply inputs or services to hatcheries or commercial/recreational fishing businesses, businesses supported by the spending of hatchery employee wages, hospitality sector businesses catering to recreators, etc. The sum of the direct, indirect, and induced effects equal the total economic contribution of hatcheries.

We use IMPLAN models to translate expenditures and direct economic activity into total economic contribution estimates. IMPLAN is a commonly used input-output economic model to measure total economic effects of an industry, policy, or economic change. We use two IMPLAN economic models, one of the Oregon State economy and one of the Washington State economy, to estimate the total economic contribution of hatcheries to statewide jobs and labor income. Jobs presented in this analysis represent both part-time and full-time annual jobs, while labor income includes all employee compensation (including benefits) as well as proprietor income. All labor income estimate are presented in 2021 dollars.

These effects are estimates of economic *contribution*, and not necessarily of economic *impact*. Economic contribution is a measure of the total current economic activity supported by hatcheries, while economic impact would be a measure of the *additional* economic activity that results from hatcheries (i.e., the change that would occur if hatcheries were not operational) and is much more difficult to analyze and estimate. For example, this analysis estimates the economic contribution of all recreational

[9] We do not quantify the economic contribution of tourism spending by visitors to hatcheries as there is some evidence from interviews with hatchery managers and tourism-related businesses located near hatcheries that hatcheries may not measurably increase the spending occurring in a region as a high proportion visitors to hatcheries may be in the region for other reasons.

angler spending associated with hatcheries; if recreational anglers were to choose to forego a fishing trip, they may instead spend the same amount of money on other activities in the local economy, with similar effects on economic activity (i.e., spending may simply be redirected, although potentially in different geographic areas). As such, fishing locations that are primarily frequented by local anglers may have less of an overall impact on economic activity than fishing locations that attract many non-resident anglers. Similarly, while state funds to operate hatcheries could be spent on other economic activities in the state, the rural areas that host hatcheries may not be the locations that would receive the funding for other economic activities. This analysis also focuses on the economic contribution rather than the economic impacts as the biological, social, and economic changes that would occur in the absence of hatcheries are uncertain and beyond the scope of this analysis. Rather, the purpose of this analysis is to highlight the current contribution and role of fish hatcheries in the Oregon and Washington state economies.

The total estimated contribution of each of these types of impacts is summarized in **Table 3-1** for Oregon and in **Table 3-2** for Washington. More detailed results and data sources for each of these types of impacts are presented in the subsections below.

In reviewing the results in **Table 3-1** and **Table 3-2**, there are several important aspects to note: 1) most of these economic impacts are experienced primarily in rural areas with economies that rely on natural resource activities such as fish production and fishing, and 2) that the economic activity generated by hatcheries requires relatively low funding by Oregon government: just 8% of budgets at ODFW operated hatcheries in Oregon is from the general fund ($2.3 million annually) while approximately 41% is from the State budget in Washington ($16.6 million annually). In other words, by operating these hatcheries, the jobs and income as reported in the tables below are supported with relatively low funding from state budgets.

Table 3-1: Total Economic Contribution of Oregon Hatchery Operations to the Oregon State Economy

Source	Jobs (Full and Part-Time Jobs)	Annual Labor Income (Employee Compensation & Proprietor Income)
Hatchery Operational Expenditures	350	$24,700,000
Spending by Recreational Anglers	3,240	$115,500,000
Commercial & Treaty Fishing for Salmon	210	$11,900,000
Total	3,800	$152,100,000

Source: Highland Economics analysis
Note: This includes direct, indirect, and induced effects.

Table 3-2: Total Economic Contribution of Washington Hatchery Operations to the Washington State Economy

Source	Jobs (Full and Part-Time Jobs)	Annual Labor Income (Employee Compensation & Proprietor Income)
Hatchery Operational Expenditures	640	$52,000,000
Spending by Recreational Anglers	2,900	$112,700,000
Commercial & Treaty Fishing for Salmon	440	$24,400,000
Total	3,980	$189,100,000

Source: Highland Economics analysis
Note: This includes direct, indirect, and induced effects.

3.1 HATCHERY OPERATIONS

This section presents data on expenditures for hatchery operations throughout the States of Oregon and Washington (based on recent budget allocations), and the associated economic activity supported.

3.1.1 Hatchery Expenditures

Hatchery operations in Oregon are funded by the state as well as the federal government. For the 2019 to 2021 biennium, the Oregon Department of Fish and Wildlife Inland Fisheries program, which includes the hatchery program, had a total budget in the 2019 to 2021 biennium of $169.1 million, of which $86.9 million is federally funded. [10] Of the total ODFW budget, 38%, or $64.3 million, funded the hatchery program (Oregon Department of Fish and Wildlife, 2019).[11] For the 32 ODFW hatcheries, budget data from ODFW indicates that 8% of their operating budget is funded from the state general fund, 17% is from licenses, and the remaining 75% of hatchery costs are funded by utilities or federal funding sources (Oregon Department of Fish and Wildlife, 2018). While a portion of the hatchery program funding goes to administrative costs and other programs that are not spent at the hatcheries, ODFW accounting indicates that roughly $50 million went to hatchery operations in the 2019-2021 biennium (Seabourne, 19-21 Hatchery Funding, 2021; Seabourne, ODFW Hatchery Budget Analyst, 2021). [12] We use the annual average ($25 million) to estimate the impacts of hatchery expenditures in Oregon counties.

Operating costs for the two national fish hatcheries in Oregon operated by U.S. Fish and Wildlife Service are $1.5 million.[13] The remaining hatcheries, operated primarily by Tribes, are estimated to have annual

[10] The amounts have been adjusted from their original values ($162.85 million and $83.7 million, respectively) to 2021 using the Consumer Price Index. We assume that funding is evenly distributed throughout the biennium, which runs from July 2019 through June 2021, and therefore one-quarter of the total spending occurred in 2019, half in 2020, and one quarter in 2021.

[11] The original amount ($61.9 million) was adjusted for inflation using the Consumer Price Index and the method described in Footnote 10. For the 2021-2023 agency requested budget, ODFW requested $171,933,586 million for the inland fisheries program, of which 40% ($68.8 million) would be for hatcheries management.

[12] The original estimate of $48 million was adjusted for inflation to 2021 dollars using the Consumer Price Index and the method described in Footnote 10.

[13] The original budgets ($620,000 and $730,000 in 2017 dollars) were adjusted for inflation to 2021 dollars.

operating costs of $1.7 million. [14] The total spending at hatcheries for all Oregon counties is estimated at $28.7 million annually. Based on the data provided by ODFW on expenditures by hatchery, and the location of hatcheries in the state, **Table 3-3** presents the estimated annual expenditures at hatcheries by county in Oregon.

Table 3-3: Annual Hatchery Expenditures by County, Oregon

County	Total Annual Hatchery Operations Budget
Clatsop	$5,007,000
Lane	$2,995,000
Jefferson	$2,934,000
Multnomah	$2,420,000
Jackson	$2,269,000
Linn	$1,873,000
Wasco	$1,708,000
Clackamas	$1,469,000
Klamath	$1,403,000
Morrow	$1,316,000
Umatilla	$1,203,000
Union	$933,000
Tillamook	$701,000
Wallowa	$463,000
Benton	$441,000
Deschutes	$416,000
Douglas	$378,000
Curry	$293,000
Lincoln	$205,000
Hood River	$199,000
Coos	$75,000
Lake	$9,000
Josephine	$3,000
Crook	$2,000

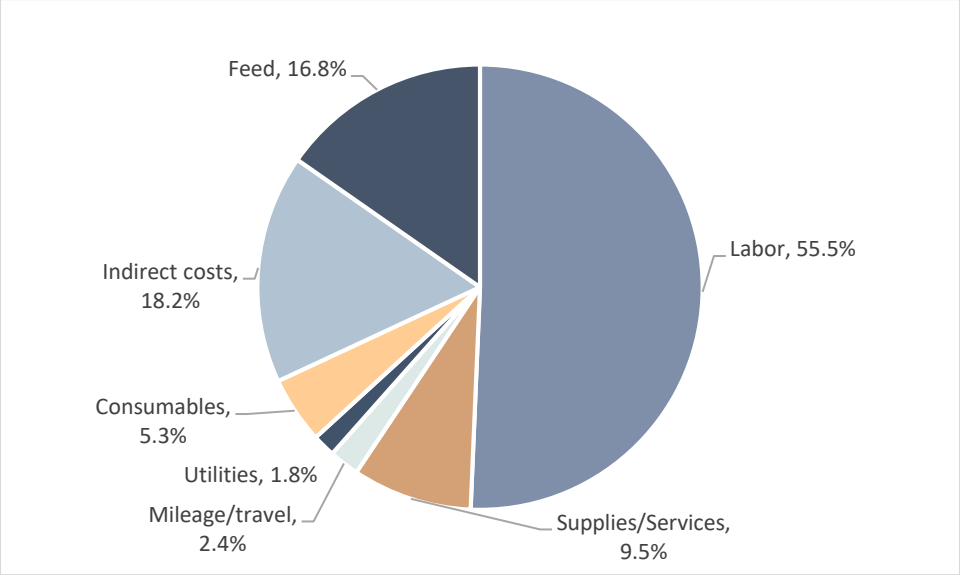
Source: Highland Economics' analysis

Note: The total ODFW hatchery budget was allocated to ODFW hatchery facilities based on their average annual fish releases from 2010-2020 (Oregon Department of Fish and Wildlife, 2010-2020). Operating costs for other Oregon hatcheries were estimated based on the average cost of fish production from the ODFW data, and assuming that ODFW average costs of production per salmon or trout released are the same as for other facilities.

Figure 3-1 provides a breakdown of hatchery spending by category in Oregon. As no data were available for a similar analysis for Washington, we assume the same breakdown by category in Washington.

[14] Operating costs for other Oregon hatcheries were estimated based on the average cost of fish production from the ODFW data, and assuming that ODFW average costs of production per salmon or trout released are the same as for other facilities. These figures do not include budget expenditures from the roughly 13 Salmon and Trout Enhancement Program (STEP) hatcheries, which are primarily volunteer-run facilities that are funded through grants and fundraising, and in some cases are supported by ODFW (Herkamp, 2021).

Figure 3-1: Hatchery Spending by Category, Oregon



Source: Highland Economics' analysis of ODFW data on 2019-2021 annual operating hatchery expenditures for Roaring River, Wizard Falls, Klamath, Oak Springs, and Wallowa hatcheries.

For WDFW hatchery spending in Washington, we use the 2017-19 biennial WDFW budget dedicated to 'Fish Production for Sustainable Fisheries', which totaled $80.8 million (Washington Department of Fish and Wildlife, 2016).[15] Of this, about 41% comes from State funds, 22% from federal funding, and 36% from private/local funds. Converting this to an annual budget and adjusting the value for inflation results in an annual budget of approximately $40.4 million (in 2021 dollars) to support WDFW fish production facilities. Absent data from WDFW on spending by hatchery, we allocate this funding to counties based on the location of hatcheries throughout the state and the average annual fish releases from each facility from 2011-2020 (Washington Department of Fish and Wildlife, 2011-2021). Specifically, we assume that hatchery facility expenditures are proportional to fish releases (i.e., if a facility accounts for 5% of fish releases, we allocate 5% of hatchery expenditures to that facility). The remaining hatcheries, operated primarily by Tribes, are estimated to have annual operating costs of $19.7 million.[16] The estimated budget expenditures by county are summarized in **Table 3-4** below.

[15] The budget amount has been adjusted from its original value ($162.85 million and $83.7 million, respectively) to 2021 using the Consumer Price Index. We assume that funding is evenly distributed throughout the biennium, which ran from July 2017 through June 2019, and therefore one-quarter of the total spending occurred in 2017, half in 2018, and one quarter in 2019.

[16] Operating costs for other Washington hatcheries were estimated based on the average cost of fish production from the WDFW data, and assuming that WDFW average costs of production per salmon or trout released are the same as for other facilities.

Table 3-4: Estimated Annual Hatchery Spending by County, Washington

County	Total Annual Hatchery Operations Budget
Mason	$8,572,000
Whatcom	*$6,269,000*
Skamania	$5,880,000
King	*$4,687,000*
Chelan	$4,402,000
Pierce	*$4,233,000*
Cowlitz	$2,934,000
Grant	$2,629,000
Pacific	$2,197,000
Lewis	$2,099,000
Clallam	*$1,982,000*
Okanogan	*$1,837,000*
Grays Harbor	*$1,717,000*
Spokane	$1,520,000
Skagit	*$1,515,000*
Snohomish	*$1,406,000*
Thurston	*$889,000*
Stevens	$796,000
Jefferson	*$788,000*
Kitsap	*$785,000*
Franklin	$772,000
Klickitat	*$535,000*
Columbia	$496,000
Wahkiakum	$400,000
Yakima	$307,000
Kittitas	*$142,000*
San Juan	$128,000
Clark	$110,000
Asotin	$48,000
Benton	$0
Douglas	$0

Source: Highland Economics' analysis

Note: The total WDFW hatchery budget was allocated to ODFW hatchery facilities based on their average annual fish releases from 2011-2020 (Washington Department of Fish and Wildlife, 2011-2021). Operating costs for other Oregon hatcheries were estimated based on the average cost of fish production from the WDFW data, and assuming that WDFW average costs of production per salmon or trout released are the same as for other facilities. When WDFW was available for certain facilities, operations budgets were estimated based on the number of fish produced on average from 2019 to 2021 using data from the Regional Mark Information System (Regional Mark Processing Center, 2019-2020). Budgets that were at least partially derived from this alternative data source are italicized in the table above.

3.1.2 Hatchery Operations Economic Contribution

Based on the data presented above, we estimate the total economic impacts of hatchery operations in Oregon and Washington. **Table 3-5** and **Figure 3-2** summarizes the economic impacts of hatchery operations in Oregon while **Table 3-6** and **Figure 3-** summarizes the economic impacts of hatchery operations in Washington. In Oregon, including hatchery operation support, directly and indirectly, 350 total jobs and $24.7 million total annual labor income. In Washington, hatchery operations support 640 jobs (directly and indirectly) and $52.0 million in labor income annually. The economic impacts were modeled on a statewide basis. We allocate them to each county based on the proportion of fish reared in each county at hatcheries, as shown in **Figures 3-2 through 3-5**. **Figures 3-3 and 3-6** provide information on the labor income on a per capita basis supported in each county from hatchery operational spending. Allocating economic contribution by county based on the location of hatcheries provides an approximation of where the economic impacts are experienced in the state, but likely overstates the economic impacts experienced in rural counties as not all economic impacts of the hatcheries would likely be experienced in the county where the hatchery is located, as some indirect/induced economic impacts would be experienced in the more urban areas of the state that provide some of the inputs or administrative support to hatcheries. However, this provides a general sense of where economic impacts of hatchery operational spending are distributed throughout the two states.

EACH YEAR HATCHERY OPERATIONS SUPPORT ANNUAL LABOR INCOME ESTIMATED AT:

$24.7 million in Oregon

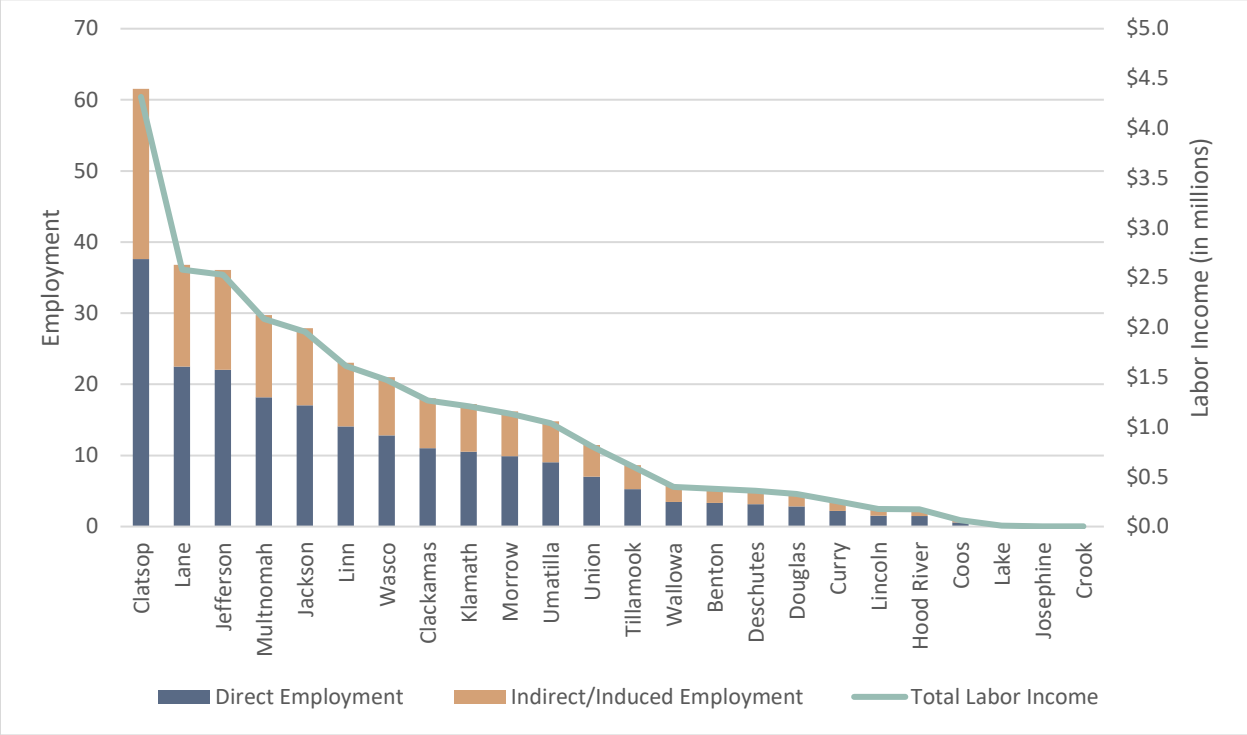
$52.0 million in Washington

Table 3-5: Economic Contribution of Hatchery Operations Spending, Oregon

Source	Jobs (Full and Part-Time Jobs)	Annual Labor Income (Employee Compensation & Proprietor Income)
Direct	220	$17,700,000
Indirect	30	$1,600,000
Induced	110	$5,400,000
Total	350	$24,700,000

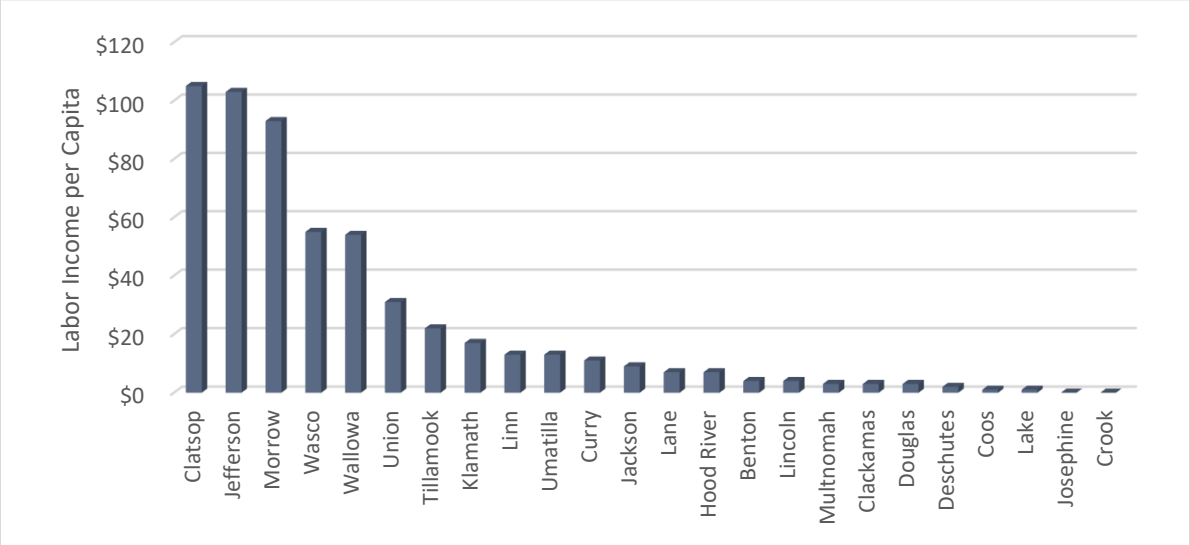
Source: Highland Economics' analysis of fish production facility operations using an Oregon IMPLAN model.
Note: Totals may not sum due to rounding.

Figure 3-2: Economic Contribution in the State of Oregon of Hatchery Operational Spending



Source: Highland Economics' analysis of fish production facility operations using IMPLAN model of Oregon State.

Figure 3-3: Per Capita Labor Income Contribution of Hatchery Operation Spending by County in the State of Oregon



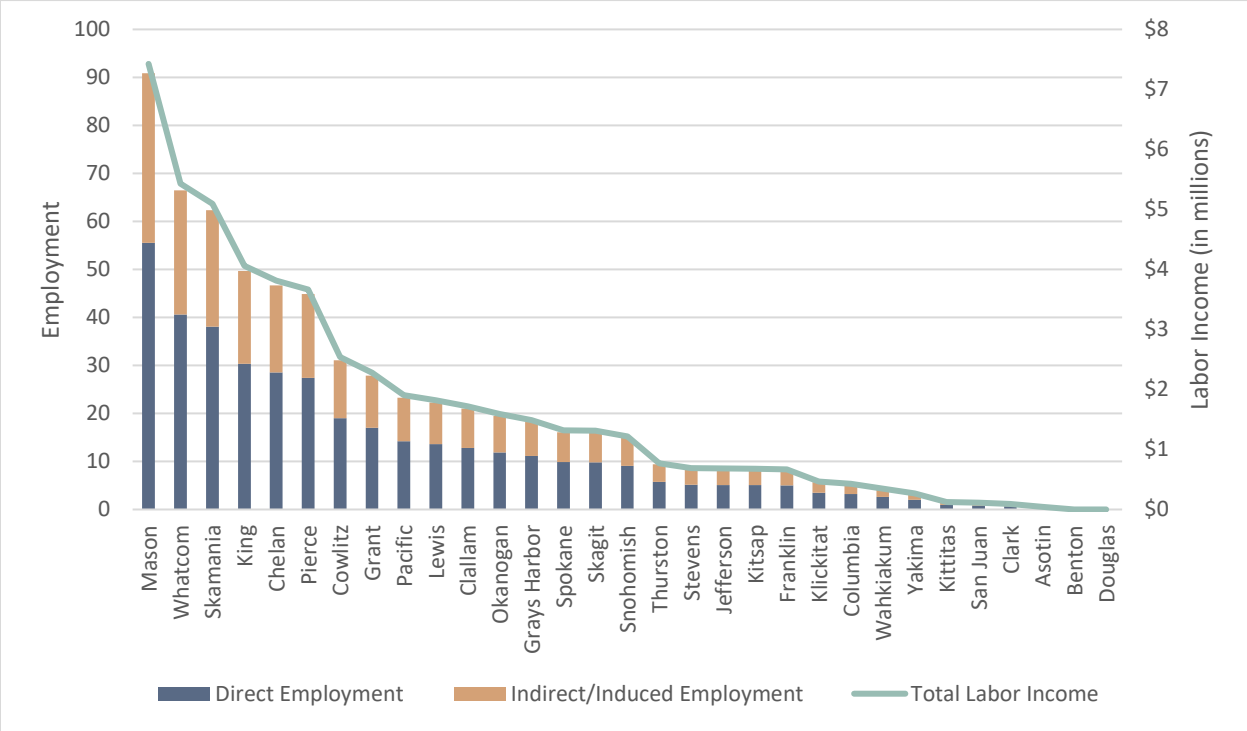
Source: Highland Economics' analysis of fish production facility operations using IMPLAN model of Oregon State and 2020 county population data from the US Census bureau.

Table 3-6: Hatchery Operations Economic Contribution, Washington

Source	Jobs (Full and Part-Time Jobs)	Annual Labor Income (Employee Compensation & Proprietor Income)
Direct	390	$37,300,000
Indirect	60	$4,000,000
Induced	190	$10,800,000
Total	640	$52,000,000

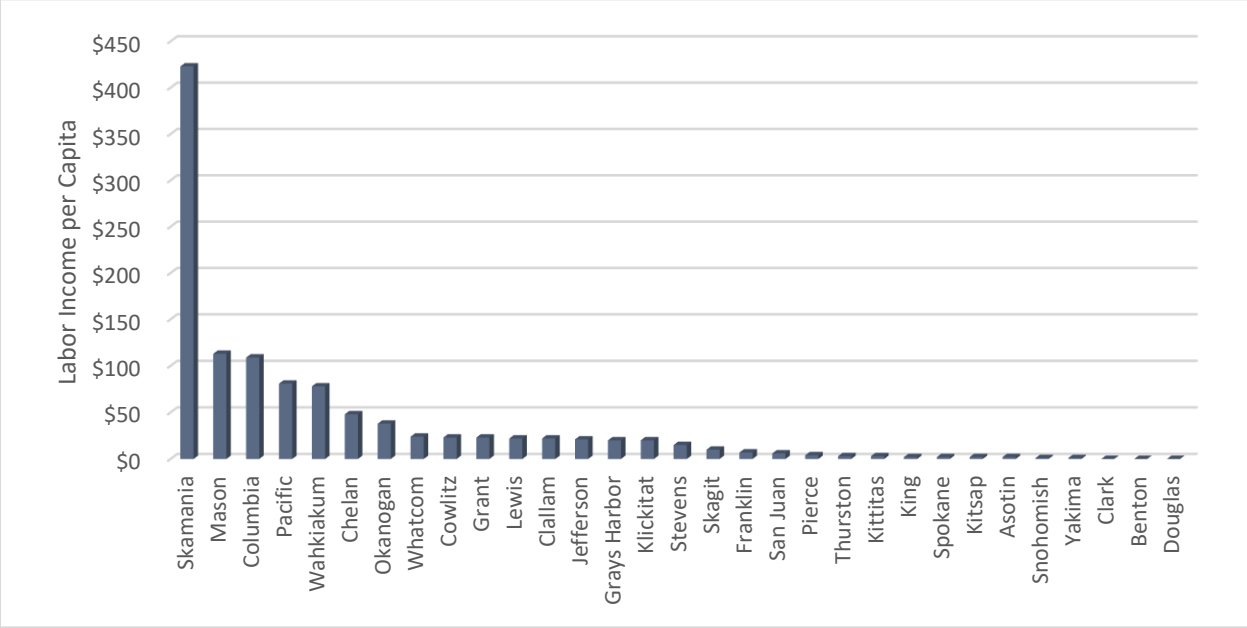
Source: Highland Economics' analysis of fish production facility operations using a Washington IMPLAN model.
Note: Totals may not sum due to rounding.

Figure 3-4: Economic Contribution in the State of Washington of Washington Hatchery Operation Spending



Source: Highland Economics' analysis of fish production facility operations using IMPLAN model of Washington State.

Figure 3-5: Per Capita Labor Income Contribution of Hatchery Operation Spending by County in the State of Washington



Source: Highland Economics' analysis of fish production facility operations using IMPLAN model of Washington State and 2020 county population data from the US Census bureau.

3.2 Recreational Angling

Spending by recreational anglers contributes to the local economy, both near their place of residence and at their fishing destination, as anglers purchase equipment and supplies, food and gas, and services at restaurants and overnight accommodations. Several studies have estimated the expenditures by recreational anglers in Oregon and Washington based on survey data of licensed anglers in the states. This section combines data on the recreational angling expenditures with data from **Section 2.2** on the estimated recreational fishing trips supported by hatcheries to estimate the total economic impact of recreational angling in the two states. Expenditures include spending on trip-related items such as food, fuel, and lodging; as well as spending on fishing equipment (fishing rods, reels, and lines but not including equipment that can be used for other purposes such as vehicles, tents, etc.). As discussed in **Section 2**, we assume that the proportion of fishing trips that are hatchery related is equal to the proportion of fish caught that are from hatcheries. The economic contribution estimates presented below include the total economic activity associated with angler spending. This includes the multiplier effects of angler spending, as money spent at businesses such as restaurants, sporting goods stores, and hotels gets re-spent in other economic sectors.

3.2.1 Recreational Angling Expenditures

To estimate expenditures per trip, we use the available information on recreational angling expenditures from surveys previously conducted in Oregon and Washington. As summarized in **Table 3-7**, these sources on angling expenditures include the US Fish and Wildlife Service surveys from 2011, a survey of Oregon anglers conducted in 2008, and a national survey conducted by the National Marine Fisheries Service (NMFS) of marine angler expenditures, with estimate provided separately for each state. The values estimated in these surveys vary, sometimes widely. The 2011 US Fish and Wildlife Service survey data provided total expenditures by category separately for saltwater and freshwater angling; we divide this by the number of freshwater and saltwater fishing trips estimated in the same survey to derive average per trip expenditures shown in **Table 3-7**. The 2008 Dean Runyan survey of Oregon recreational anglers conducted for ODFW provided total expenditures by type of trip (day, overnight, and by distance from home) separately for saltwater and freshwater angling; we converted this to an average expenditure per saltwater and freshwater recreational trip based on the proportion of trips of each type. Finally, the NMSF survey estimated expenditures per trip estimated for each state for three trip types of marine recreational fishing: for hire, private, and shore trips. We estimate a weighted average across all trip types using the proportion of trips in each category, as estimated by NMFS. As shown in the table, the average expenditure per marine recreational fishing trip in Oregon estimated by NMFS is generally higher than the estimates provided by the other surveys of marine recreational anglers. For this analysis, we assumed that the average of the available values was the best representation of angler per trip expenditures.

EACH YEAR HATCHERIES SUPPORT FISHING TRIP EXPENDITURES ESTIMATED AT:

$265.5 million in Oregon

$332.1 million in Washington

Table 3-7: Summary of Per Trip Expenditures by Data Source, 2021 $

Expenditure Type & Location	Data Source			Per Trip Value Used in the Analysis
	US Fish and Wildlife Service, 2011 survey data	Dean Runyan (for ODFW), 2008 survey data	National Marine Fisheries Service, 2017 survey data	
Trip-Related Expenditures (Lodging, food, transportation, bait, ice, etc.)				
Oregon				
Freshwater fishing	$81	$71		**$76**
Saltwater fishing	$154	$173	$196	**$174**
Washington				
Freshwater fishing	$40			**$40**
Saltwater fishing	$111		$238	**$174**
Fishing Equipment Expenditures*				
Oregon				
Freshwater fishing	$15	$105		**$15**
Saltwater fishing	$29			**$29**
Washington				
Freshwater fishing	$16			**$16**
Saltwater fishing	$44			**$44**

Sources: Highland Economic analysis of: (Dean Runyan Associates, 2009); (U.S. Fish & Wildlife Service, 2018) (U.S. Fish and Wildlife Service, 2018), (National Marine Fisheries Service, National Oceanic and Atmospheric Science Administration, 2020). Data for several of these sources was presented as total expenditures; we use data from each report on the estimated number of trips by each type (such as overnight/day/local) to estimate a weighted average expenditure per trip.

**Only includes fishing-specific equipment, such as fishing rods, reels, and lines and does not include equipment that can be used for other purposes such as vehicles, tents, etc.*

Table 3-8 presents estimated total recreational fishing expenditures in Oregon. This table combines the data presented in **Table 3-7** above with the data presented in Section 2 on estimated number of recreational saltwater and freshwater fishing trips by state. These expenditure estimates assume that salmon and trout angling trip expenditures are equal to the average of all freshwater trip expenditures (these types of freshwater angling trips represent the bulk of freshwater trips based on the survey data, so this is a reasonable assumption), and that marine salmon recreational angling trip expenditures are equal to the average of all saltwater trip expenditures (again, this is a reasonable assumption as the survey data indicate that most saltwater recreational fishing trips in Oregon and Washington are for salmon). The estimates presented in **Table 3-7** and **Table 3-8** are lower than total recreational fishing expenditure data presented in several other studies because 1) they are adjusted for the proportion of recreational fishing trips that are estimated to be supported by hatcheries, and 2) because the number

of saltwater fishing trips estimated in several prominent surveys such as the US Fish and Wildlife Service far exceed the number of saltwater fishing trips we use in this study based on data from WDFW and ODFW. Note that the values in **Table 3-8** are averages; individual fishing trip expenditures may be much lower or much higher (such as guided or charter fishing trips that support professional fishing guides).

Table 3-8: Estimated Hatchery-Supported Salmon and Trout Recreational Fishing Expenditures in Oregon and Washington

Expenditure Type & Location	Location		
	Oregon	Washington	Total
Trip-Related Expenditures (Lodging, food, transportation, bait, ice, etc.)			
Freshwater fishing	$213,100,000	$191,700,000	$404,800,000
Saltwater fishing	$8,000,000	$51,200,000	$59,200,000
Fishing Equipment Expenditures*			
Freshwater fishing	$43,100,000	$76,300,000	$119,400,000
Saltwater fishing	$1,300,000	$12,900,000	$14,200,000
Total	$265,500,000	$332,100,000	$597,600,000

Highland Economics analysis, combining data from Table 3-7 on expenditure per trip, and data on the number of angler recreational fishing trips supported by hatcheries from Table 2-7 and Table 2-8.
**Only includes fishing-specific equipment, such as fishing rods, reels, and lines and does not include equipment that can be used for other purposes such as vehicles, tents, etc.*

3.2.2 Recreational Angling Economic Contribution

Table 3-9 and **Table 3-10** summarize the total economic impact of recreational fishing expenditures associated with fish hatcheries in Oregon and Washington, respectively. Impacts of trip-related spending are shown separately from fishing equipment-related spending; this is because fishing equipment may be spent at the trip destination or closer to home. Also, it is feasible that anglers would take fewer trips without hatchery fish but still purchase a similar amount of fishing equipment, in which case fishing equipment spending would not be as supported by hatcheries as fishing trips.

HATCHERY-SUPPORTED RECREATIONAL FISHING TRIPS CONTRIBUTE TO AN ESTIMATED:

- $115.5 million in annual labor income and 3,240 jobs in Oregon
- $112.7 million in annual labor income and 2,.930 jobs in Washington

In total, including both types of spending (trip-related and fishing equipment-related) and all types of economic effects (direct, indirect, and induced), in Oregon an estimated 3,240 jobs and $115.5 million in income are supported annually by recreational fishing experiences associated with hatcheries. In Washington, a total of 2,700 jobs and $100 million in income are estimated to be supported by

recreational spending associated with hatcheries.[17] Approximately 4% of the economic contribution in Oregon is related to marine recreational fishing while approximately 19% of the economic contribution in Washington is related to marine recreational fishing.

The approximate geographic distribution of the $115.5 million in total income in Oregon is shown in **Figure 3-6,** while **Figure 3-7** shows these same data on a per capita basis, highlighting the counties with the largest impact relative to their population size. In Sherman, Wheeler, Tillamook, Wasco, Grant, Wallowa, Harney, and Baker counties the data suggest that recreational fishing related to hatcheries supports more than $200 of income on a per capita basis. Allocation at the county level of income supported by recreational fishing is based on a 2009 study sponsored by ODFW that estimated the total freshwater fishing trip expenditures and saltwater fishing trip expenditures in each Oregon County; we assume the same percentage distribution of freshwater trip spending and saltwater trip spending to each county and allocate the $115.5 million using those percentage distributions. These are very approximate estimates by county as they are based on fishing trip destinations and spending patterns by County from a 2008 survey. We do not have similar data on expenditures by County in Washington, so we do not allocate economic contribution by Washington County.

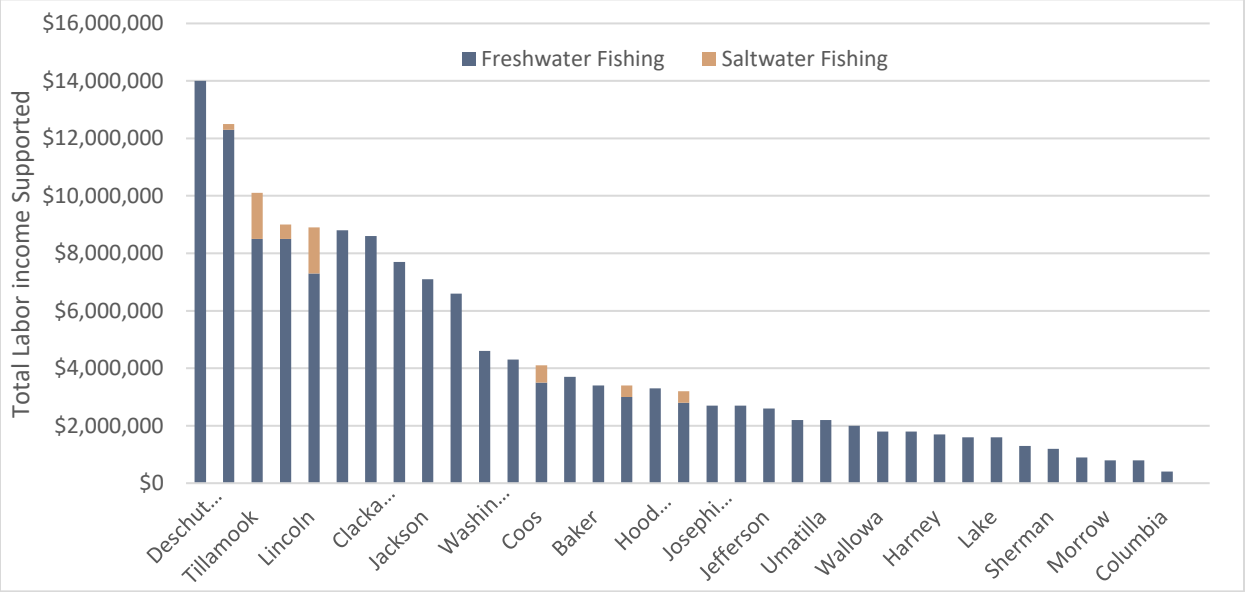
Table 3-9: Estimated Oregon Employment and Income Supported by Recreational Fishing Trip Expenditures Supported by Hatchery Fish

Source of Impact	Direct	Indirect	Induced	Total
Employment (Full and Part-Time Jobs)				
Trip-Related Spending	2,000	300	450	**2,750**
Fishing Equipment	370	40	70	**490**
Total	2,380	350	520	**3,240**
Income (Employee Compensation & Proprietor Income)				
Trip-Related Spending	$60,600,000	$17,000,000	$21,600,000	$99,300,000
Fishing Equipment	$10,400,000	$2,300,000	$3,500,000	$16,200,000
Total	$71,000,000	$19,300,000	$25,100,000	$115,500,000

Note: Totals may not sum due to rounding.
Source: Highland Economics analysis using IMPLAN model of Oregon State

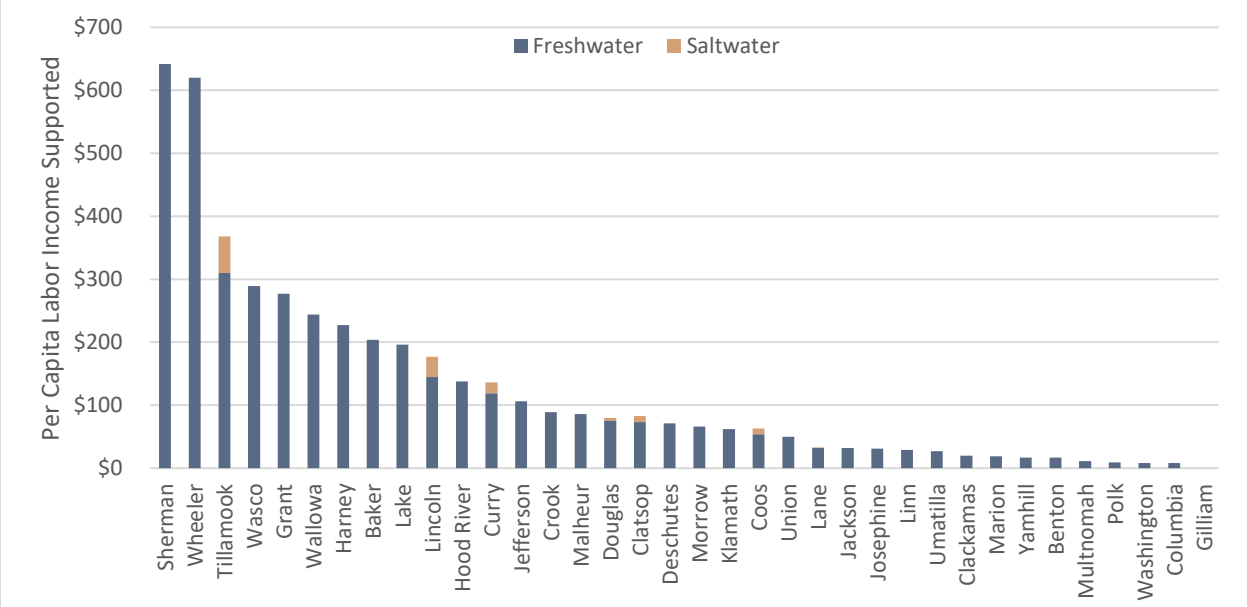
[17] The economic contribution per dollar of expenditure is lower in Washington partly because the allocation of expenditures between category of spending (i.e., lodging, gas, food, etc.) is different for both saltwater and freshwater fishing than in Oregon. This study uses the data from the 2011 US Fish and Wildlife Survey on allocation of expenditure by category to model economic contribution in IMPLAN.

Figure 3-6: Oregon Labor Income (Direct, Indirect, Induced) Supported by Hatchery-Related Recreational Fishing Trips: Approximate Distribution by County



Source: Highland Economic analysis using % of total freshwater and saltwater expenditures by Oregon County from (Dean Runyan Associates, 2009).

Figure 3-7: Oregon Labor Income (Direct, Indirect, Induced) Per Capita Supported by Hatchery-Related Recreational Fishing Trips: Approximate Distribution by County



Source: Highland Economic analysis using % of total freshwater and saltwater expenditures by Oregon County from (Dean Runyan Associates, 2009).

Table 3-10: Estimated Employment and Income Supported by Recreational Fishing Expenditures in Washington Associated with Hatcheries

Source of Impact	Direct	Indirect	Induced	Total
Employment (Full and Part-Time Jobs)				
Trip-Related Spending	1,600	210	320	**2,120**
Fishing Equipment	640	70	100	**810**
Total	2,240	280	420	**2,930**
Income (Employee Compensation & Proprietor Income)				
Trip-Related Spending	$53,300,000	$14,400,000	$17,600,000	$85,300,000
Fishing Equipment	$17,500,000	$4,300,000	$5,700,000	$27,400,000
Total	$70,800,000	$18,700,000	$23,300,000	$112,700,000

Note: Totals may not sum due to rounding.
Source: Highland Economics analysis using IMPLAN model of Washington State.

3.3 Commercial Fishing Economic Impacts

As discussed in Section 3.3., this analysis focuses on the value and economic impact of the commercial salmon fishery onshore landings (which do not include landings of salmon in ports in Alaska and other "distant water" fisheries by boats from Oregon and Washington). This analysis focuses only on commercial landings in Oregon and Washington as these are the fisheries most influenced by hatchery operations in these two states (i.e., we do not include the value of salmon landed in Alaska or other distant waters as a relatively small portion of these salmon are likely to have originated in Oregon or Washington hatcheries.)

Commercial Catch of Hatchery Salmon Contributes To an Estimated:

- $11.9 million in labor income annually and 210 jobs in Oregon
- $24.4 million in labor income annually and 440 jobs in Washington

Several studies conducted in Washington and Oregon recently have analyzed the economic impacts of commercial fishing. These analyses used models developed specifically to estimate the economic contributions of Pacific Coast Fisheries, including the Fishery Economic Assessment Model (FEAM, used in analyses prior to 2016), and the input-output model for Pacific Coast Fisheries (IO-PAC) that is maintained by National Marine Fisheries Service Northwest Fisheries Science Center. IO-PAC is a customized IMPLAN model. Rather than conducting a new IMPLAN analysis, we use values from these recent studies using the customized commercial fishing IMPLAN model. Estimates from relevant prior studies that have estimated the economic impacts of commercial salmon fishing in Oregon and Washington are presented in **Table 3-11.**

As presented in **Table 3-11**, the data from two different analyses of the economic impacts of commercial fishing in Oregon present similar levels of employment and income impacts from a given level of ex-vessel salmon landing value. The data available from Washington does not allow for this type of analysis, as it reports the onshore landing value only yet presents employment and income supported for both the onshore and distant landing value. Therefore, we do not use the data from the Washington study but rather assume that the relationship between ex-vessel value and employment and income is similar in Washington as it is in Oregon. Taking the average from the two recent studies of commercial fishing in Oregon, we assume for both Washington and Oregon that approximately $0.92 in total income in the state is supported for every $1 of ex-vessel landing value, and we assume 16.5 jobs are supported in the state for every $1 million in ex-vessel landing value.

Table 3-12 combines these values with the data in section 3.3 on ex-vessel salmon commercial catch values in Oregon and Washington and Columbia River treaty commercial catch values. As shown in the table, we estimate that the total economic activity from commercial fishing supported by hatcheries from 2015 to 2020 was approximately 210 jobs and $11.9 million in income annually in Oregon and approximately 440 jobs and $24.4 million annually in Washington. This economic activity generated by commercial and treaty salmon harvests from Oregon and Washington waters represent a small part of each state's economy but are important at the community level along the Oregon and Washington Coasts, the Strait of Juan de Fuca, and the Puget Sound areas.

Table 3-11: Relationship Between Commercial Landing Value & Total Employment and Income Supported by Commercial Salmon Fishing

Parameter	Source & Location		
	Oregon: TRG 2021 (data from 2019)	Oregon: EcoNorthwest, 2019 (data from 2017)	Washington: TRG, 2008 (data from 2006)
Salmon Ex-Vessel Value, Onshore Landings Only	$4,339,000		$9,554,000
Salmon Ex-Vessel Value, Onshore & Distant Water Landings		$28,340,000	*Not presented in study*
Total Income Supported	$4,228,000	$24,700,000	$21,305,000*
Total Jobs Supported	69	478	507
Total Income Supported Per $1 Ex Vessel Value	$0.97	$0.87	N/A**
Total Jobs Supported Per $1 Million Ex Vessel Value	16.0	16.9	N/A**

Data Sources: Highland Economic analysis of: (EcoNorthwest for Oregon Department of Fish and Wildlife, 2019). Data in Table 3-10 are derived from Exhibit 17, Exhibit 11, and Exhibit 8. (The Research Group for Washington Department of Fish and Wildlife, 2008). Data in Table 3-10 are derived from Table 4. (The Research Group for Oregon Department of Fish and Wildlife, 2021). Data in Table 3-10 are derived from Table II.6 and Figure 2.3; we estimate total on-shore only economic contributions based on the estimated onshore total economic contribution and salmon comprising 1.3% of the economic contribution.

**This is income and employment supported by onshore and distant water landings.*

***Ratios are not feasible to calculate from this study, because it only presents on shore landing ex-vessel value and does not provide distant water land value for salmon, but it presents total income and jobs supported for combined*

both onshore and distant water landings. It is therefore not feasible to estimate a ratio of landing value to jobs and income supported.

Table 3-12: Estimated Total Employment and Income Supported by Commercial Salmon Fishing

Type of Value	Oregon	Washington	Total
Salmon Ex-Vessel Value Supported by Hatcheries, Onshore (Average, 2015-2020)	$5,400,000	$19,050,000	$24,450,000
Tribal Ex-Vessel Value, Columbia River Treaty Harvest (allocated 50% to WA, 50% to OR)	$7,500,000	$7,500,000	$15,000,000
Total Statewide Income Supported	$11,900,000	$24,400,000	$36,300,000
Total Statewide Jobs Supported	210	440	650

3.4 Hatchery Visitation Expenditures

In addition to fish production, hatcheries often serve a dual purpose as education and recreation centers, allowing the public to visit the facilities and learn about fish propagation and the life cycle of the species produced there, and in some cases visit nearby outdoor recreation facilities. Typical visitors include tourists and school groups. As a destination, the hatcheries can act as a source of economic activity, even if visitors do not spend money at the hatcheries themselves. Visitors, especially those from outside the local area, are likely to spend money at nearby businesses. This section explores the potential impacts of this hatchery visitor spending.

In 2011, ODFW estimated that approximately 1.4 million people visit Oregon's hatcheries annually (Oregon Department of Fish and Wildlife, 2011). **Table 3-13** and **Table 3-14** display information on the number and type of visitor to hatcheries in Oregon and Washington

Table 3-13: Oregon Hatchery Visitation

Hatchery	County	Estimated # of Visitors	Activities at Hatchery
Bonneville Hatchery	Multnomah	1,000,000	Fish viewing and feeding, tours, informational displays, outdoor recreation
Imnaha Satellite Facility	Wallowa	5,000	Outdoor recreation
Irrigon Hatchery	Morrow	4,000	Tours, informational displays
Leaburg Hatchery	Lane	90,000	Tours
Looking Glass Hatchery	Union	<2,000	Tours, fish viewing, informational displays
Other Hatcheries	Various	~300,000	
Total		1,400,000	

Sources: (Oregon Department of Fish and Wildlife, 2020; Oregon Department of Fish and Wildlife, 2016; U.S. Fish and Wildlife Service - Pacific Region, 2011; Withalm, 2021)

Table 3-14: Washington Hatchery Visitation

Hatchery	County	Estimated # of Visitors	Activities at Hatchery
Carson National Fish Hatchery	Skamania	2,000	Tours, information and education programs
Cottonwood Creek Acclimation	Asotin	20	
Dayton Acclimation	Columbia	20	
Leavenworth National Fish Hatchery	Chelan	150,000	Outdoor recreation, tours, fish viewing
Lyons Ferry Hatchery	Columbia	840	Informational displays
Makah National Fish Hatchery	Clallam	600	Tours
Quinault National Fish Hatchery	Grays Harbor	3,500	Tours
Spring Creek National Fish Hatchery	Skamania	5,000	Tours, open houses, outdoor recreation
Tucannon Hatchery	Columbia	1,200	Tours, outdoor recreation, informational displays
Other Hatcheries		Not known	
Washington State Total		163,000+	

Sources: (U.S. Fish and Wildlife Service, 2007; U.S. Fish and Wildlife Service, 2011; Oregon Department of Fish and Wildlife, 2016; McMillen Jacobs Associates and DJ Warren Associates, 2016; U.S. Fish and Wildlife Service, 2009; U.S. Fish and Wildlife Service, 2017)

To estimate the spending generated by hatchery visitors, we reviewed studies of spending patterns of similar visitors, including a surveyed on day user/non-boater spending profile at 16 U.S. Army Corp of Engineer's (USACE) project areas in the U.S. (Chang, Propst, & Stynes, 2003) and a survey of visitors to State of California historical parks (BBC Research & Consulting, 2011). Based on the spending patterns found in these two studies, we estimate that each party visiting a hatchery may spend approximately $15 within 25 miles of the site, primarily on gas and food.[18] As shown in **Table 3-15**, this represents approximately $9.4 million potential visitor spending associated with the known visitation at fish hatcheries in Oregon and Washington. However, we do not complete an economic contribution analysis of this spending as interviews with managers of several fish hatcheries, including at Bonneville Fish Hatchery (Which represents the vast majority of visitation estimates), indicated that nearly all visitors to hatcheries are traveling through the region for other reasons and then choose to stop to visit the hatchery on their travel (i.e., any spending in the region by hatchery visitors may not be related to the hatchery).

[18] From the USACE study, we used the day user/non-boater spending profile shown in Table 5 of the report (Chang, Propst, & Stynes, 2003). From the California study, we used the average spending per visitor to State Historical Parks shown in Figure A-5 and applied the spending category percentages for day trip visitors shown in Figure A-6 (BBC Research & Consulting, 2011). Both spending profiles were adjusted for inflation to 2021 dollars using the Consumer Price Index prior to averaging them together.

Table 3-15: Hatchery Visitation & Potential Associated Spending

Type of Value	Oregon	Washington	Total
Estimated Visitation	1,400,000	163,000+	1,563,000+
Estimated # Parties (Assuming 2.5 people/party)	560,000	65,200+	625,200+
Estimated Expenditure	$8,400,000	$1,000,000+	$9,400,000+

4 ECONOMIC VALUE OF HATCHERY SALMON: RECREATIONAL, CULTURAL, AND ECOLOGICAL VALUE TO PEOPLE

While the preceding section estimated how hatcheries and hatchery fish contribute to economic activity that supports jobs and income in Washington and Oregon, this section focuses on net economic benefits generated. While spending on hatcheries and on fishing generates economic activity and many entities benefit, these benefits are generated at a cost (e.g., the spending on hatcheries is a cost to the funding entities, while the wages of employees supported in related businesses is a cost to their employers; similarly, the spending by recreational anglers spurs economic activity and income in tourism-related businesses but is a cost to the angler). In contrast, the benefits presented in this section are *net benefits,* benefits that exceed costs. Specifically, this section discussed the following types of net values or net benefits:

1. Net value to recreational anglers of fishing opportunities (i.e., benefits in excess of their fishing travel costs and equipment costs estimated and analyzed in Section 3).
2. Net value, or profits, to commercial fishing operators (i.e., revenues less costs incurred).
3. Net value to hatchery visitors of recreational enjoyment and educational value, in excess of travel costs incurred.
4. Net value to all Oregon and Washington residents that value hatchery fish for social, cultural, or ecological reasons.

To estimate these benefits, we rely on studies that have examined these types of values to residents of the Pacific Northwest and elsewhere. **Table 4-1** summarizes the findings derived in this section regarding the net economic benefits supported by hatcheries in Oregon and Washington. As shown in the table, the value of recreational angling dominates the net economic values quantified. However, if the ecological, cultural, and social values supported by salmon and trout were also quantified, these benefits would also be sizable. For example, studies show that the average households in Oregon and Washington may be willing to pay from approximately $50 to $200 per year for increasing local, regional, or state-wide populations of salmon by 50 percent to 100 percent (Bell, Huppert, & Johnson, 2003; Layton, Brown, & Plummer, 1999). These studies were not specific to hatchery-supported populations, so we do not apply these estimates in this analysis. However, given that there are over 1.6 million Oregon households and over 2.9 million Washington households, the value for salmon abundance across all households is quite large (e.g., if households were willing to pay an average

HATCHERIES SUPPORT ECONOMIC, SOCIAL, CULTURAL, & ECOLOGICAL VALUES

Many important and valuable benefits are not quantifiable, including Tribal and other cultural values, ecological, values, and social values. Quantifiable values include:

- Recreational value of hatchery fish to sport anglers annually:
  - $227.9 million in Oregon
  - $412.4 million in Washington
- Commercial fishing profits from hatchery salmon catch annually:
  - $3.2 million in Oregon
  - $6.6 million in Washington
- Recreational/educational value to hatchery visitors annually:
  - $14 million in Oregon
  - $1.6 million+ in Washington

of $50 for the additional fish abundance that hatcheries provide that support ecosystems, cultural values, and social values, this would equate to approximately $80 million value in Oregon and $145 million value in Washington.)

Table 4-1: Estimated Annual Net Economic Value of Hatcheries & Hatchery Fish in Oregon and Washington

Net Economic Value (Benefits Exceeding Costs)	Oregon	Washington	Total
Value to Recreational Anglers	$227,900,000	$412,400,000	$640,300,000
Value to Commercial Fishing (Profit)	$3,200,000	$6,600,000	$9,900,000
Value to Hatchery Visitors	$14,000,000	$1,600,000+	$15,600,000+
Ecological, Cultural, Social Values	Not Quantified	Not Quantified	Not Quantified
Total	$245,100,000+	$420,600,000+	$665,800,000+

4.1 Recreational Anglers

The opportunity to go fishing and to catch fish provides value to recreational anglers. In economic terms, the net benefit or net value of fishing is equal to the value of the fishing experience less the cost of the experience. The cost of the experience, or the spending associated with fishing equipment and fishing trips, was analyzed in the preceding section, and spurs economic activity. However, in terms of for the angler, this spending is a cost, and the net value is the value or benefit of the experience less this cost.

There is a large body of literature estimating the net economic value of recreational fishing trips to anglers. This analysis focuses on studies of angling in the Pacific Northwest with target species of trout, salmon and/or steelhead (though we also include some studies of general recreational fishing in the Pacific Northwest since salmon/trout/steelhead are the predominant target species in this region). The value of a fishing trip or a fish caught can vary widely depending on the target species, the abundance of fish and associated catch rate, the aesthetics and quality of the surrounding environment, and the characteristics and demographics of the angler. The economic literature generally presents the net value of recreational fishing two ways: the extra value to the angler for each additional fish caught, and the value to the angler per fishing day or per fishing trip. Consistent with our approach in Section 4, we assume that the proportion of fishing trips that are supported by hatcheries is equal to the proportion of fish caught that are hatchery fish (i.e., many fishing trips would not occur if not for hatcheries).[19] We therefore focus on the economic value to the angler per fishing trip.[20] The approach we have taken in this study of allocating the proportion of fishing expenditure and net fishing value based on the proportion of fish caught that are hatchery versus wild may result in an overestimate or an underestimate of the economic value supported by hatcheries (depending on whether the number of

[19] Many studies have found that in addition to influencing the number of trips taken, the value per fishing trip is increased with higher catch rates. Trying to separately estimate the effect of these two different variables is beyond the scope of this study.

[20] The value per fishing trip typically exceeds the value of each fish caught on the trip as anglers derive enjoyment from the trip itself and the possibility of catching a fish.

trips taken and the enjoyment per trip supported by hatchery fish is equal to, higher than, or lower than the percent of fish that are hatchery fish).

Regarding the value of hatchery versus wild fish to recreational anglers, a 2013 study based on surveys of saltwater salmon anglers in Oregon and Washington State estimated the difference in value of hatchery versus wild salmon to recreational anglers, as measured by angler willingness to pay (WTP) per fish caught (Anderson & Lee, 2013). For retained salmon, the study found that there are "no significant observed differences between the WTP estimates of equally-sized wild and hatchery silver [coho] salmon". The study found that for a given fish size, hatchery chinook salmon were valued more per fish caught than wild, even when it was legal to keep the wild king salmon. Interviews with anglers indicated that this is because many anglers release the wild Chinook salmon for conservation purposes, and so would rather catch hatchery fish. For both Chinook and coho salmon, for fish that were released, anglers preferred wild fish. This study indicates that anglers want to conserve wild fish populations but that for fish caught, hatchery fish are valued highly. Based on the findings of this study, and the fact that values from the economic literature were developed from surveys of anglers in fisheries with a mix of hatchery and wild fish, this study assumes that the per trip economic values of fishing from the literature are applicable and appropriate to estimate the value of recreational fishing trips supported by hatchery fish.

Estimates of the economic value of recreational angling in the Pacific Northwest tend to fall between $70 and $90 per day. For example, a 2017 review conducted for the US Forest Service of diverse types of outdoor recreation found that across many studies of different target species, bodies of water and angling techniques, the average value estimated for the recreation net benefit of freshwater fishing in the Pacific Northwest is $80 per day (Rosenberger, White, Kline, & Cvitanovich, 2017).[21] Similarly, a 2018 study sponsored by the Oregon Parks and Recreation Department used a value of approximately $90 per fishing day[22] (saltwater and freshwater) to estimate the net economic value of fishing participation in Oregon (Rosenberger, 2018). A 2008 study sponsored by WDFW estimated the value of a salmon/steelhead fishing day (freshwater and saltwater) at $78 per day, and the value of trout fishing at $67 per day[23] (TCW Economics, 2008).

Most fishing trips in the Pacific Northwest are day fishing trips, so the value per trip is similar (although slightly higher, since some fishing trips are multiple days) than the value per fishing day. We conservatively assume that the value per fishing trip is similar to the findings cited above regarding value per day, and assume a mid-range value per fishing trip of $85 per salmon/steelhead fishing day and $75/trout fishing day. Applying these values to the estimated fishing trips supported by hatcheries (as estimated in **Section 2**) results in economic values presented in **Table 4-2**. As shown in **Table 4-2**, we estimate that the value of hatchery fish in Oregon and Washington provides net recreational value to anglers of approximately $640.3 million, with $227.9 million provided in Oregon and $412.4 million provided in Washington.

[21] The study value was $71.52 in 2017 dollars.

[22] The study value was $81.37 in 2018 dollars.

[23] The study values were $58 per day and $50 per day in 2006 dollars for salmon/steelhead and trout fishing, respectively.

Table 4-2: Estimated Annual Net Value to Anglers of Hatchery-Supported Recreational Fishing in Oregon and Washington

Type of Fishing Trip	Estimated Value per Trip	Oregon		Washington	
		# of Annual Trips Supported by Hatcheries	Estimated Annual Net Economic Value to Anglers Supported by Hatcheries	# of Annual Trips Supported by Hatcheries	Estimated Annual Net Economic Value to Anglers Supported by Hatcheries
Salmon/Steelhead	$85	1,406,000	$119,500,000	3,301,000	$280,600,000
Trout	$75	1,445,000	$108,400,000	1,758,000	$131,900,000
Total		2,851,000	$227,900,000	5,059,000	$412,400,000

4.2 COMMERCIAL FISHING

The direct net economic benefit of commercial fishing is the value of the commercial fishery over and above the costs to operate the fishery (i.e., the profits generated). The proportion of gross revenue that is profit varies by industry and by business, but in accordance with several past analyses, this analysis assumes that approximately 25% of ex-vessel salmon catch value is profit or net economic benefit (O'Higgins, Ferraro, Dantin, Jordan, & Chintala, 2010). **Table 4-3** summarizes the estimated net economic value supported by commercial salmon fisheries in Oregon and Washington, with an **estimated $3.2 million in profit to the commercial fishing industry in Oregon and $6.6 million in profit to the commercial fishing industry in Washington.**

Table 4-3: Annual Commercial Net Income from Catch of Hatchery Salmon

Type of Value	Oregon	Washington	Total
Salmon Ex-Vessel Value Supported by Hatcheries, Onshore (Average, 2015-2020)	$5,400,000	$19,050,000	$24,450,000
Tribal Ex-Vessel Value, Columbia River Treaty Harvest (allocated 50% to WA, 50% to OR)	$7,500,000	$7,500,000	$15,000,000
Total, Commercial Fishing Value	$12,900,000	$26,550,000	$39,450,000
Net Economic Value (Profit)	$3,200,000	$6,600,000	$9,900,000

4.3 VISITORS TO HATCHERIES

In 2019, ODFW estimated that approximately 1.4 million people visit Oregon's hatcheries annually (Oregon Department of Fish and Wildlife, 2019). Incomplete data from Washington indicate that at least 163,000 people visit hatcheries in Washington State. Visiting a hatchery provides educational and recreational enjoyment to state residents and tourists.

Recreational benefits of visiting hatcheries/hatchery education is estimated at approximately $10 per visitor per day. This estimate is based on published economic benefit values of visiting environmental education centers (Loomis, Updated Outdoor Recreation Use Values on National Forests and Other Public Lands, 2005) and school and education in California Parks and Forests (BBC Research & Consulting, 2011). Assuming $10 per visit, the 1.4 million visits to Oregon hatcheries provides recreational value of approximately $14 million annually. Similarly, the 163,000 estimate of the

minimum number of visits to Washington hatcheries provides recreational value of approximately $1.6 million annually.

4.4 TRIBES

For thousands of years, salmon and steelhead have been vital to the history, culture, and way of life indigenous societies in Oregon and Washington. These fish have been important for subsistence, intertribal trade, and even religion (Columbia River Inter-Tribal Fish Commission, 2021). Some cultural/religious ceremonies of Pacific Northwest tribes are structured around the return of salmon (Matylewich, 2021). Tribes in the region use salmon in every type of special occasion: weddings, funerals, birthdays, graduations, births, gifting celebrations, and holidays (Earth Economics, 2021). Today, salmon and steelhead remain an immensely important resource to native peoples in the Pacific Northwest.

To support continued access to salmon and steelhead for their life and culture, tribes in Oregon and Washington are directly involved in hatchery operations. At least 23 tribes operate 46 facilities that raise and release salmon, steelhead, and trout in the two-state region. These facilities release roughly 45 million fish annually, of which about 90 percent come from Washington facilities. The largest portion of tribal releases (42 percent) consist of Chinook (nearly all of which are Spring Chinook). Chum represent 31 percent, followed by coho (18 percent), and steelhead (3 percent). Trout comprise roughly 5 percent of releases.[24] The largest tribally-operated facilities (as measured by the average number of fish released annually) include the Keta Creek Fish Hatchery in King County (Muckleshoot Tribe), the Quinault National Fish Hatchery in Grays Harbor County (operated by the Quinault, Quileute, and Hoh tribes), and the Clear Creek Fish Hatchery in Pierce County (operated by the Nisqually Tribe). Tribes that operate multiple facilities include the Yakama, Warm Springs, Umatilla, Suquamish, Makah, Muckleshoot, Nisqually, Puyallup, Quileute, Quinault, Hoh, Skokomish, and Stillaguamish. ODFW-operated hatcheries also provide excess fish directly to some tribes to support tribal ceremonial and subsistence use, consistent with agreements and tribal jurisdiction.

In addition to operating hatcheries, the importance of hatcheries for many Tribes in the region is evident from interviews of representatives of key northwest tribal fisheries organizations. The fisheries manager at the Columbia River Inter-Tribal Fisheries Commission and the education/outreach manager of the Northwest Indian Fisheries Commission indicate that their perspective on hatcheries is that hatchery operations are necessary to protect the salmon and steelhead populations they depend on; wild fish alone could not support the needs of tribes in the Pacific Northwest (Meyer, 2021; Matylewich, 2021). Without the support of hatchery production, tribes would lose an important source of food and commercial activity. Without the hatcheries tribes would lose an essential component of cultural traditions and religious ceremonies. Even with the support of hatcheries, some tribes find the current fish production levels insufficient to meet their needs (Meyer, 2021; Matylewich, 2021). As a result, tribes are fiercely supportive of hatcheries and the production of the fish species they rely on (Meyer, 2021; Matylewich, 2021).

[24] Release data were compiled from datasets generated by ODFW, WDFW, and RMIS (Oregon Department of Fish and Wildlife, 2010-2020; Washington Department of Fish and Wildlife, 2011-2021; Regional Mark Processing Center, 2019-2020).

4.5 ECOLOGICAL VALUE & EXISTENCE VALUE

Salmon have value to Oregon and Washington residents, independent of their use (such as for recreation or commercial harvest). These non-use or existence values are generally higher for rare habitats or species (such as those classified as Threatened or Endangered), due to their relative scarcity, than for abundant species or habitats. Additionally, existence values are higher for iconic species, such as salmon. People's non-use values for salmon may be based on personal beliefs and moral ethics (i.e., believe enhancing salmon populations is the right thing to do), altruism (i.e., believing salmon should be abundant so that others can use it or benefit from salmon), and/or a desire to bequest the resource (i.e., believing salmon should be abundant for future generations). The most common way to measure value of a species such as salmon to people is through surveys in which people are asked about their willingness to pay to protect the species. These surveys are highly challenging to develop and implement well, and results from different surveys aiming to measure similar changes in resources can be highly variable.

A number of studies have examined the value of fish to residents of the Pacific Northwest. In Olsen *et al.* (1991), researchers surveyed residents on their values for salmon and steelhead in the Pacific Northwest. Measuring conservation value separate from recreational value was possible because researchers split their surveyed households into those that fish and those that do not fish. Households that do not fish had an average willingness to pay of $58 per year to double the population of fish, while households that do fish had an average willingness to pay of $162 (Olsen, Richards, & Scott, 1991).[25] While this was roughly one-third the willingness to pay of fishing households, the study indicates that non-anglers in the Pacific Northwest still value improvements to fish populations.

In 1996, Loomis measured the value to survey respondents of removing two dams on the Elwha River in Washington State, which would restore an anadromous fishery. Surveyed households included those in the dams' host county (Clallam), those in the State of Washington, and those in the rest of the country. Households were asked if they would be willing to vote for a referendum that would increase their taxes in order to pay for the dams' removal, effectively measuring their willingness to fund efforts to restore the fish population. Results indicated that Clallam County residents would be willing to pay $108 per year, Washington residents would be willing to pay $133 per year, and US residents outside of Washington would be willing to pay an average of $124 per year (Loomis, 1996).[26]

In 1998, Layton *et al.* surveyed over 1,600 Washington State households to elicit household values for programs that increase the populations of migratory, freshwater, and saltwater fish in the Columbia River and the Puget Sound area. The results showed that Washington households, on average, were willing to pay $16 - $52 per month to increase fish populations by 50 percent (Layton *et al.*, 1999).[27] In Bell *et al.* (2003), researchers surveyed five coastal communities in Oregon regarding their willingness to pay for local coho salmon enhancement programs. Findings indicate that households were willing to pay

[25] The study's original values ($26.52 and $74.16, respectively, in 1989 dollars) were updated to 2021 dollars using the Consumer Price Index.

[26] The study's original values ($59, $73, and $68, respectively, in 1994 dollars) were updated to 2021 dollars using the Consumer Price Index.

[27] The study's original values ($9.92 and $31.28, respectively, in 1998 dollars) were updated to 2021 dollars using the Consumer Price Index.

$65 to $182 per year to prevent the species from going extinct to $123 to $192 per year to double the population, depending on the community and the household income (Bell *et al.*, 2003).[28]

In summary, these studies show that households may be willing to pay from approximately $50 to $200 per year for increasing local, regional, or state-wide populations of salmon by 50 percent to 100 percent (Bell, Huppert, & Johnson, 2003; Layton, Brown, & Plummer, 1999). These values include both use and non-use values, with non-use values potentially being approximately one-third of use values based on the difference in the value of fish preservation by households who fish versus do not fish. Even so, these studies indicate that the non-use value of salmon to Oregon and Washington residents is substantial. However, as these studies do not distinguish between hatchery and wild salmon, and there is uncertainty regarding how people value hatchery versus wild salmon populations, we do not apply these values to estimate the existence value of hatchery salmon in Oregon and Washington.

Salmon also provide ecological value, and additional economic value, by supporting other species in the ecosystems they inhabit. One study found that salmon have ecological importance for 138 different species in Oregon and Washington (Cederholm, et al., 2000). For most of these species (59 percent), nutrients from salmon carcasses is important. For example, salmon support the both the flora and fauna in Pacific Northwest forests by supplying the vegetation with nutrients when salmon carcasses are left on the forest floor by predators (which also utilize part of the salmon's nutrients) (Page & Whetung, 2020). Because salmon acquire most of their bodily mass in the ocean, and then return to inland waterways to spawn, salmon provide an important transport of nutrients from the ocean to freshwater ecosystems (Cederholm, et al., 2000). Stream enrichment also occurs with excess fish from ODFW hatcheries. In 2020, for example, 33,362 carcasses were used for stream nutrient enhancement (Oregon Department of Fish and Wildlife, 2021).

Salmon serve as an important food source to many types of animals, including land mammals, birds, invertebrates, and sea mammals (Bugas, 2020; Cederholm, et al., 2000). Salmon sustain such species as grizzly bears, wolves, river otters, beaver, and bald eagles that are valued by people, with numerous surveys identifying high willingness to pay to enhance habitat and populations of these species (Richardson & Loomis, 2009). Thus, in addition to the direct value to people of salmon, salmon also provide an indirect benefit to people through their use as a food source and through their ecological role in sustaining many other valued species.

One example of the importance of salmon in sustaining other species is the role of salmon as a food source for the Southern Resident Killer Whale (SRKW) population that is found mostly off British Columbia, Washington, and Oregon. The SRKW population is listed as Endangered under the Federal Endangered Species Act and has only about 70 individuals (Oregon Department of Fish and Wildlife, 2020). The threat to the SRKW population is so high that in 2018 Washington Governor Inslee directed state agencies to take immediate actions to benefit the whales. Among the recommendations was to increase salmon production from fish hatcheries in order to provide food for the SRKW population (Oregon Department of Fish and Wildlife, 2020). Approximately 80 percent of the whales' diet consists of salmon (mostly Chinook), and salmon abundance has been positively associated with whale birth rates, social group size and connection, and health outcomes (Center for Whale Research, 2022). Salmon

[28] The study's original values ($41.13, $115.54, $78.15, and $121.81, respectively, in 2000 dollars) were updated to 2021 dollars using the Consumer Price Index.

availability in the winter and spring period is especially important to the SRKWs, which can be improved through increasing spring Chinook production in the fish hatcheries on the Columbia and Willamette Rivers. Accordingly, ODFW requested in their 2021-2023 budget an additional $5 million to increase production at the Oxbow and Leaburg/Willamette hatcheries (Oregon Department of Fish and Wildlife, 2020). Salmon hatcheries thus not only directly sustain salmon populations, but also sustain indirectly many other ecologically, socially, and economically valuable species and ecosystems.

4.6 OTHER

Hatchery fish provide a key food source for subsistence fishermen. Hatcheries also provide excess fish to food banks. In 2020, for example 18,793 salmon fish weighting a total of 99,141 pounds were donated to the Oregon food bank, local food banks, and other charitable organizations (Oregon Department of Fish and Wildlife, 2021). Hatcheries with surplus salmon donated to food banks in 2020 include: Big Creek, Bonneville, Canyonville, Clackamas, Clatsop City, Galesville Trap/Net Pen, Klaskanine, McKenzie, Minto Ponds, Nehalem, Rock Creek, Round Butte, Salmon River, Sandy, and Trask.

Fish and fish eggs from hatcheries also support research and education. In 2020, 8,649 fish and 120,841 eggs were provided for experimental, scientific, or educational uses as identified in management plans or other ODFW Watershed District agreements (Oregon Department of Fish and Wildlife, 2021). These eggs and fish were provided to grade schools, universities, for show ponds, and for a turbine study.

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