The Economic Effects of Pacific Northwest National Fish Hatchery Salmon Production:

Four Mid-Columbia River Hatcheries

July 12 2002

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The Economic Effects of Pacific Northwest National Fish Hatchery Salmon Production:

Four Mid-Columbia River Hatcheries

The Economic Effects of Pacific Northwest National Fish Hatchery Salmon Production:: Four Mid-Columbia River Hatcheries[1]

Introduction

The main purpose of this report is to obtain preliminary, reconnaissance-level estimates of the economic effects of salmon hatchery production from National Fish Hatcheries (NFH) located in the Columbia River Basin in the Pacific Northwest. The U.S. Fish and Wildlife Service (USFWS) operates a number of salmon hatcheries on the Columbia River in the Pacific Northwest. This report focuses on four of these hatcheries on the Columbia River and tributaries above Bonneville Dam (see Figure 1). These four hatcheries (Spring Creek, Little White Salmon, Carson and Willard) are primarily *mitigation* hatcheries: hatcheries which were established to compensate for the loss of salmon through habitat destruction and dam construction on the Columbia River. The hatcheries produce economic effects in several ways, including: (1) human use of hatchery-produced fish, including commercial and recreational fishing and non-consumptive recreational use: (2) hatchery budget expenditures including salary expenditures and sending associated with fish production (non-salary expenditures), and (3) ecological-use and existence value of salmon populations. This report focuses on the first two types of effects.

The following topics are addressed in this report: (1) status of salmon populations in the Pacific northwest; (2) the role and purpose of USFWS hatcheries; (3) general discussion of Pacific hatchery production; (4) USFWS salmon production; (5) salmon returns; (6) economic effects of salmon returns; (7) economic effects of hatchery operations; and (8) summary and conclusions.

Section 1

Status of Salmon Populations in the Columbia River Basin[2]

Salmon have long played an integral role in the economy and culture of the Pacific Northwest. As late as the mid-19th century, up to 16 million adult salmon and steelhead returned annually to spawn in the Columbia River basin. The fish migrated as far as the river's headwaters in British Columbia or 600 miles up the Snake River to Shoshone Falls in central Idaho (NPPC 1986).

[1] Help and assistance from the following individuals is gratefully acknowledged: Ed LaMotte, Manager, Spring Creek NFH; Speros Doulos, Manager, Little White Salmon/Willard NFH Complex; Bill Thorson, Manager, Carson NFH; and Judy Maule, formerly USFWS, Region 1. Dr. Hans Radtke and Dr. Shannon Davis of The Research Group, Corvallis OR and Dr. Chris Carter of the Oregon Department of Fish and Wildlife provided comments and suggestions which significantly improved this report. Any and all errors of fact or interpretation are the sole responsibility of the author.

[2] A detailed analysis of historic and current Pacific Northwest salmon production and use is beyond the scope of this report. A number of references provide detailed background information on the biological and social issues associated with salmon production and use in the Pacific Northwest. For example see: (1) **Upstream** by the National Research Council (1996); (2) **Salmon Fishers of the Columbia** by Courtland L. Smith; and (3) **Salmon Without Rivers** by Jim Lichatowich. For a critique from industry and other commercial river users of the past and current efforts at resolving salmon issues, see **The Great Salmon Hoax** by James L. Buchal

In the past 100 years, however, overfishing, habitat degradation, and the construction of dams on the river have led to a dramatic decrease in salmon and steelhead numbers. Fisheries managers have used artificial production to try to replace harvest opportunity resulting from lost runs of fish that once spawned in habitat no longer available. Various agencies and organizations have built more than 90 artificial production facilities in the basin to try to replace lost salmon and steelhead populations (CBFWA 1990). Nevertheless, salmon and steelhead runs to the Columbia have continued to plummet. Runs from 1995 to 1999 averaged less than 1 million returning salmon and steelhead. Runs from the late 1930's to 1999 have averaged only slightly more (ODFW and WDFW 2000). Restrictive harvest regulations are in place and dams are operated to improve the downstream migration of young salmon. For the past five years (1995-99), wild stock salmon and steelhead have made up about ¼ of the total annual Columbia River run. (ODFW and WDFW 2000, p. 6).

Columbia River Fishery Development[3]

Columbia River salmon were central to Native American Indian life. Columbia River Indians made use of the salmon for thousands of years prior to the arrival of Europeans. Lower Columbia Indians were decimated in the early 1800's by introduced European diseases. Europeans began using salmon about 1830, and by 1861 commercial fishing became important. In 1866, salmon canning began and the non-Indian commercial fishery grew very rapidly. The early commercial fishery used gill nets, seines hauled from beaches, traps and fishwheels. Later, purse seines and trolling boats using hook and lines entered the fishery. Sturgeon set lines (mostly unbaited snagging lines) were used when sturgeon became commercially valuable in the early 1880's. Mid-Columbia Indians continued to use their traditional dip and hoop nets, with a primary fishing location at Celilo Falls. Recreational or sport fishing began in the late 19th century and occurred primarily in tributaries. The main-stem Columbia sport fishery did not become important until after World War II.

Development of the Columbia River commercial fishery was rapid since its beginnings in the 1860's. The number of canneries increased to a peak of 39 in 1886. The amounts and type of gear employed also increased. Known peak amounts of gear licensed were 2,856 gillnet boats in 1915, 104 haul seines in 1928, 506 traps in 1926, and 76 fish wheels in 1899. Indian and a few non-Indian dipnetters were also licensed. Dipnet licenses peaked at 477 in 1935.

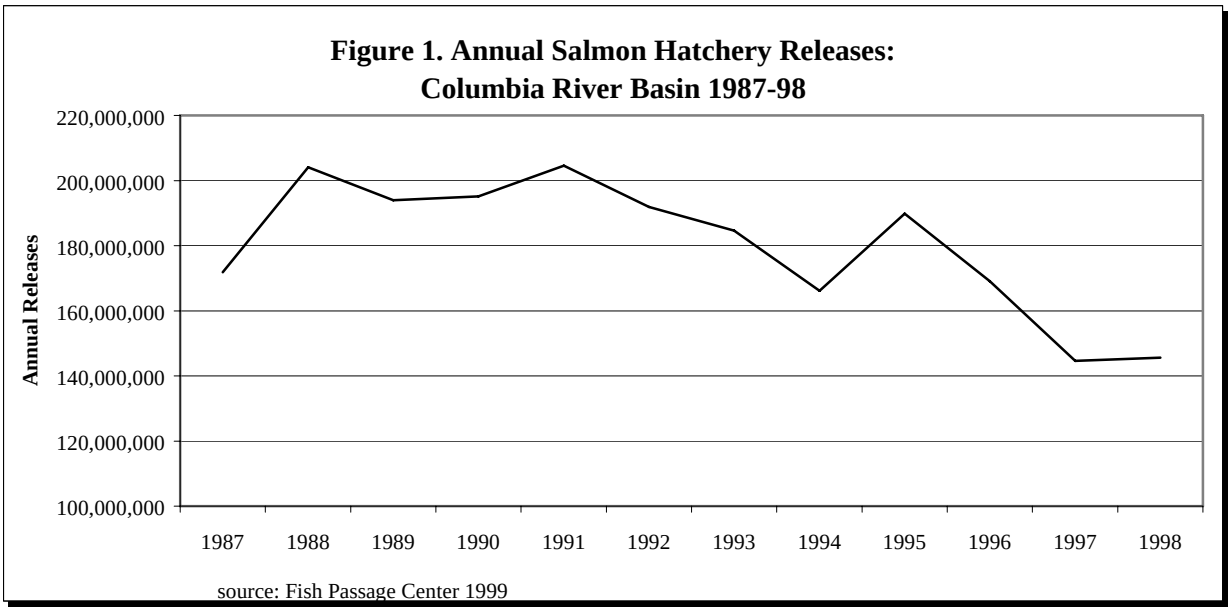
The commercial industry initially fished on the vast runs of spring and summer Chinook salmon. Other species and races entered the catch later when these Chinook runs declines. Landings exceeded 40 million pounds, annually, in 1883, 1884, 1895, 1911, 1915-1919, and for the last time in 1925. The peak year of landings was 1911, with 49.5 million pounds.

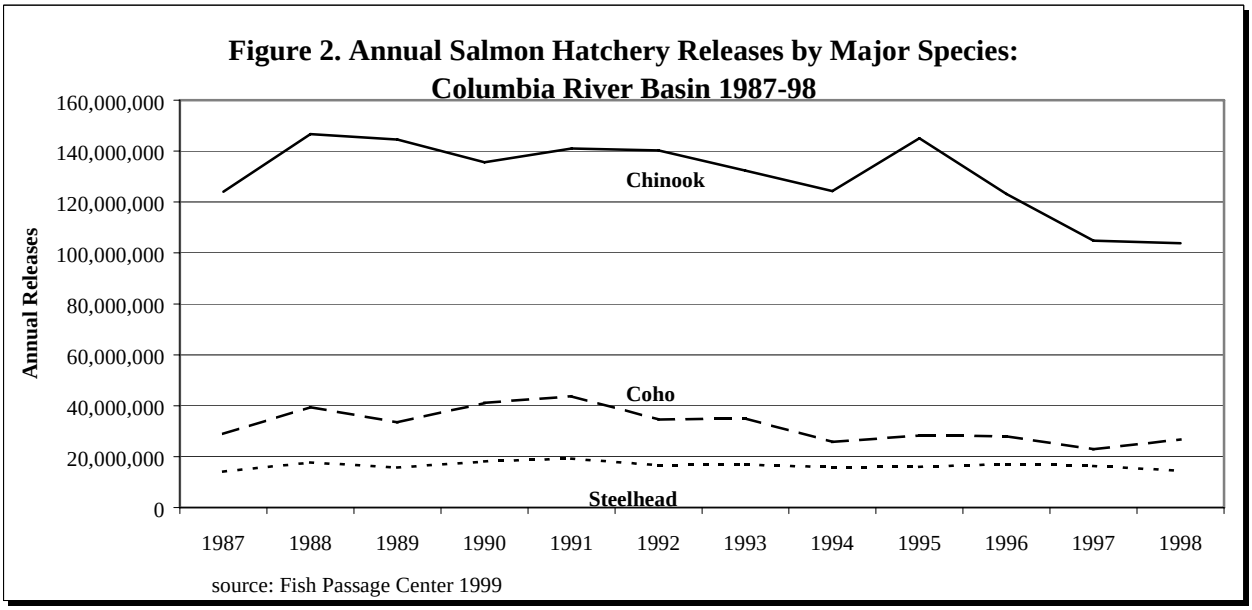
Total Releases

Figures 1 and 2 show total annual releases in the Columbia River Basin for all salmon (including steelheads) in general and by major species for the period 1987-98. Total annual salmon releases ranged from a low of 144.4 million in 1997 to a high of 204.4 million in 1991. Annual

[3] This section is taken from **Status Report: Columbia River Fish Runs and Fisheries, 1938-1999.** Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife October 2000, pp 6-9.

releases during this period averaged 180 million fish. Chinook salmon averaged 72.7 percent of annual releases, coho 18 percent, steelhead 9.2 percent and sockeye 0.1 percent.





Bonneville Dam (completed in 1938 and operated by the Corps of Engineers) is the first major upstream dam on the Columbia River, located 146 miles from the mouth of the river (ODFW and WDFW 2000). Table 1 shows Columbia River Basin hatchery releases by species and whether the releases occur above or below the dam.

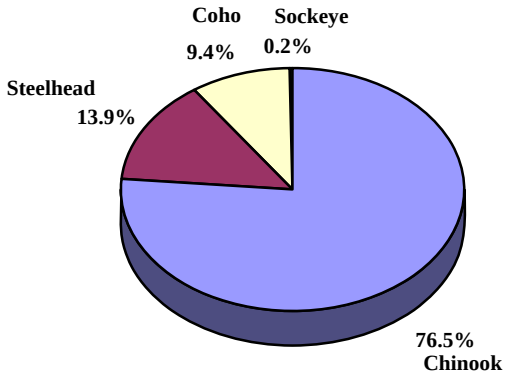
Table 1.
Columbia River Basin Releases Above and Below Bonneville Dam
(Releases in millions)

	Chinook		**Coho**		**Steelhead**		**Sockeye**		Total
	Above	Below	Above	Below	Above	Below	Above	Below	
1987-99 average	59.9	71.6	8.5	23.8	12.2	4.3	0.265	0	180.0
Percent of species	45.1 %	54.9 %	26.3 %	73.7 %	73.7 %	26.3 %	100 %	0 %	

Source: Fish Passage Center 1999.

Figures 3 and 4 show the percentage by species of all dam releases below and above Bonneville Dam, respectively. On average from 1987 to 1999, about 55 percent of total Chinook releases occurred below the dam with 45 percent occurring above the dam. Almost 74 percent of all coho releases occurred below the dam while 26 percent were released above the dam. Most steelhead releases took place above the dam (74 percent) and all sockeye releases were above the dam. Figure 3 shows the distribution by species of all releases above Bonneville Dam during the period 1987-98. Chinook salmon accounted for over ¾ of all releases, while steelhead, coho and sockeye accounted for considerably smaller percentages.

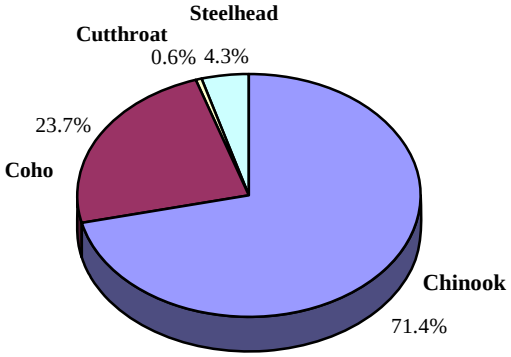
Figure 3. Distribution of Hatchery Releases Above Bonneville Dam: 1980-98



source: Fish Passage Center 1999

Figure 4 shows the distribution of salmon releases below Bonneville Dam. Chinook salmon account for slightly over 71 percent of all releases while coho, steelhead and cutthroat account for 23.7, 4.3 and 0.6 percent respectively.

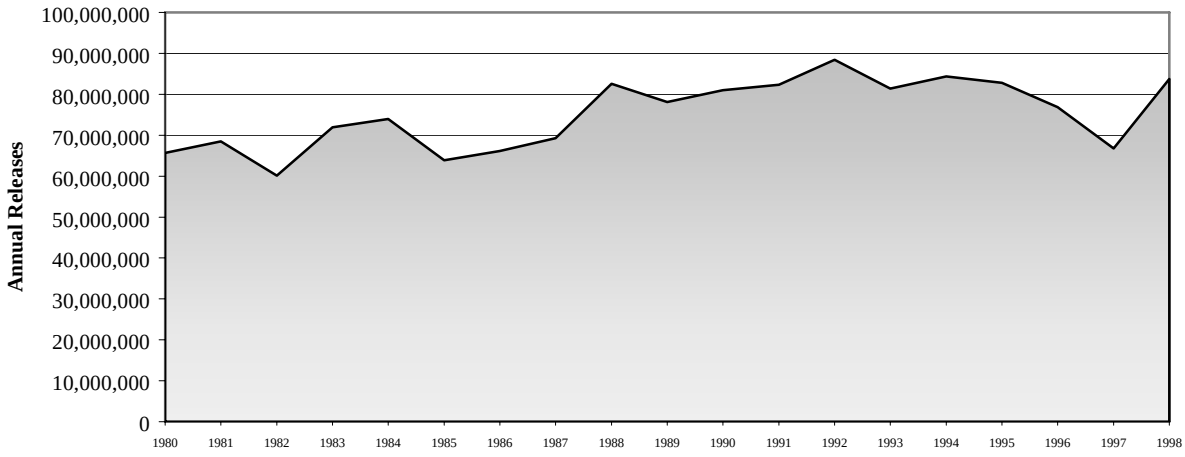
Figure 4. Distribution of Hatchery Releases Below Bonneville Dam: 1987-98



source: Fish Passage Center 1999

Figure 5 shows an 18-year trend for total hatchery releases above Bonneville Dam. The high year showed 88.5 million releases in 1992 with a low year of 60.2 million in 1982. The average over this period was 79.3 million releases annually.

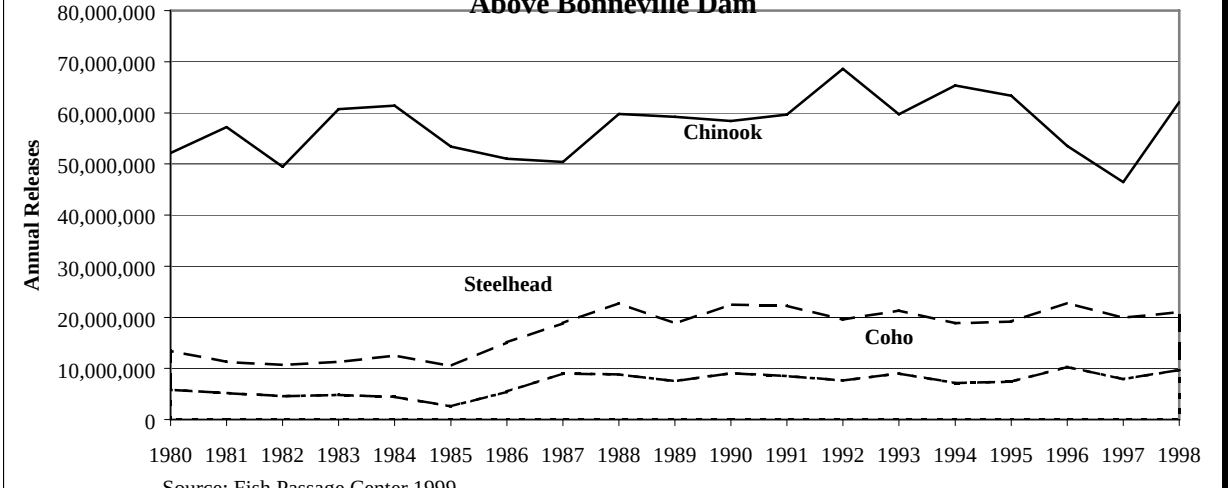
Figure 5. Total Hatchery Releases: Columbia River Basin Above Bonneville Dam



source: Fish Passage Center 1999

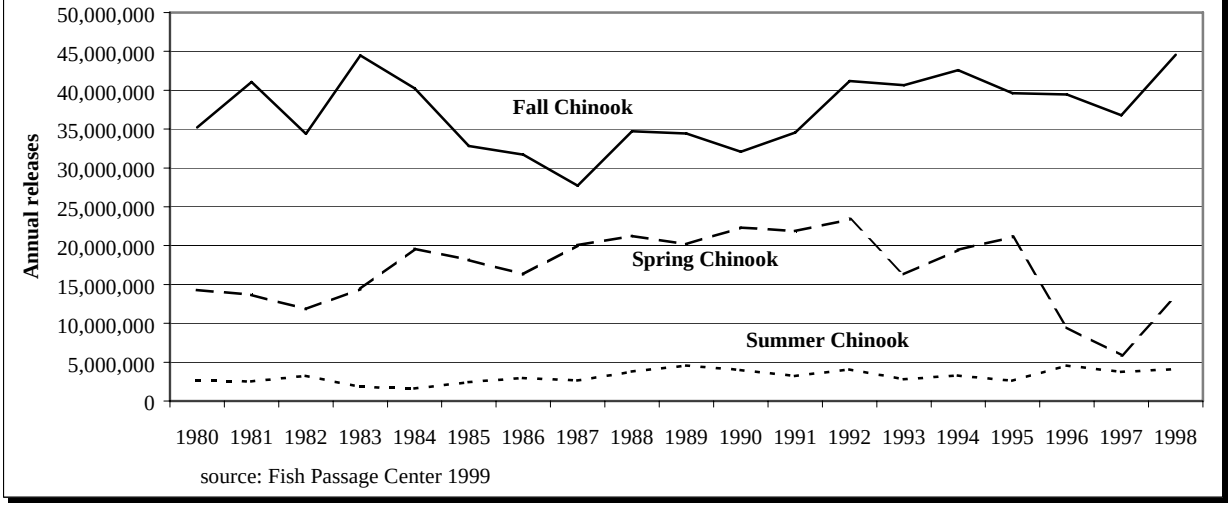
Figure 6 shows hatchery releases above Bonneville Dam broken out by major species, including chinook, coho and steelhead. Figure 7 partitions these releases by species. It can be seen that the decrease in total releases from 1995 to 1997 was primarily due to a significant decline in spring chinook releases; fall chinook declined slightly and steelhead and coho releases remained relatively constant during this period.

Figure 6. Columbia River Hatchery Releases by Species: Above Bonneville Dam



Source: Fish Passage Center 1999

Figure 7. Chinook Hatchery Releases by Species: Above Bonneville Dam 1980-98

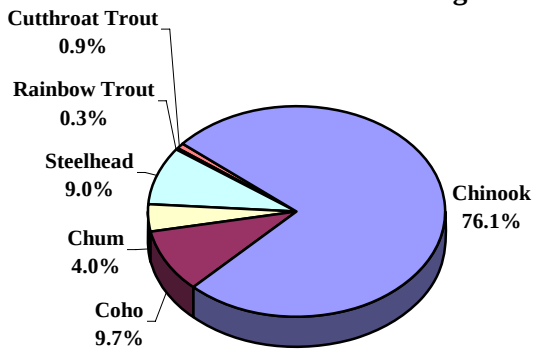


source: Fish Passage Center 1999

USFWS Hatchery Releases

Figure 8 shows annual NFH production in Region 1 by species as a percentage of total Region 1 NFH production (number of fish). Salmon (including steelhead) account for over 99 percent of total annual production.

Figure 8. USFWS Region 1Hatchery Production by Species as Percentage of Total Production. 1995-99 Annual Average



source: Clark et al. 1999

Table 3 shows a comparison of NFH production by area. USFWS Region 1[1] on average produces about 50.8 million chinook (both spring and fall species), 6.5 million coho, 6 million steelhead and about 750,000 trout. States which include portions of the Columbia River basin (Oregon, Washington and Idaho) account for 59 percent of total chinook production, 100 percent of coho production, 85 percent of steelhead production and 23 percent of trout production. The four hatcheries addressed in this report account for about 43 percent of total Region 1 chinook production and 23 percent of coho production.

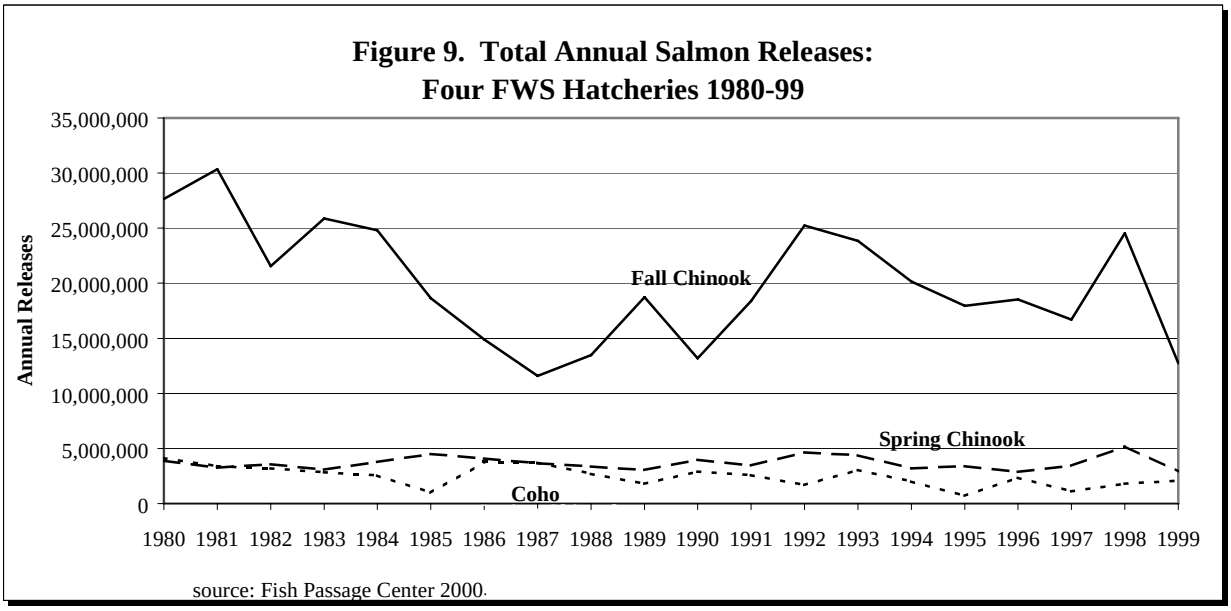
Table 3.
Comparison of USFWS Hatchery Production by Area.
Annual Average 1995-99. Millions of Fish

Area	Chinook	Coho	Steelhead	Trout
Region 1	50.8	6.5	6.0	0.75
OR, WA, ID	29.9	6.5	5.1	0.17
Four Hatcheries	21.7	1.5	0	0

Source: U.S. Fish and Wildlife Service 2000.

[1] Region 1 is made up of California, Nevada, Idaho, Oregon, Washington and Hawaii.

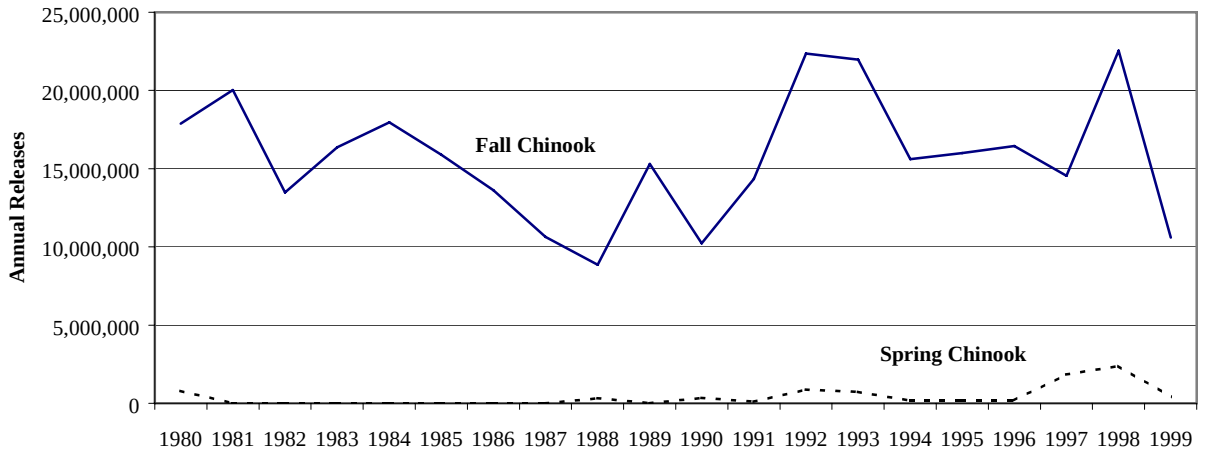
Figure 9 shows aggregate hatchery releases for the three major species produced by the four Columbia River hatcheries. Over the 19-year period from 1980-99, fall chinook releases averaged 18.1 million per year, with a high of 30.4 million in 1981 and a low of 11.6 million in 1987. Spring chinook releases averaged 3.6 million per year with a high of 5.2 million in 1998 and a low of 2.9 in 1996. Coho releases averaged 1.6 million per year, with a high of 4.1 million releases in 1980 and a low of 706 thousand in 1995.



Figures 10 through 13 show fish releases from 1980 to 1999 for each of the four NFH addressed in this report. Figure 10 shows the annual releases for the Spring Creek NFH. Fall chinook have been the predominant fish produced at Spring Creek. Fall chinook production averages about 15.7 million fish per year. The highest level of production occurred in 1998 with 22.5 million fish produced; the lowest year of production was 1988 when 8.9 million fish were produced. Spring chinook are also produced, but in sharply reduced numbers. During the period 1980 to 1999, spring chinook were produced in 12 different years with no production in 8 years. During the 12 production years, annual production averaged 695 thousand with a high in 1998 of 2.4 million and a low of 99 thousand in 1991.

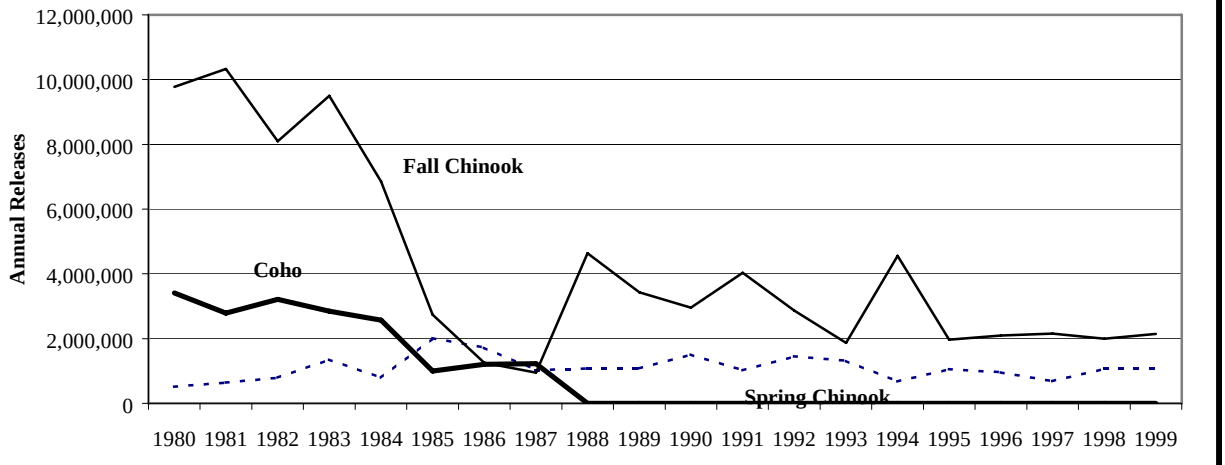
Little White Salmon NFH has produced fall chinook, spring chinook and coho over the past 20 years. The current emphasis is on fall and spring chinook. Fall chinook production has averaged 4.2 million annually over the past 20 years, with a high of 10.3 million in 1981 and a low of 949 thousand in 1987. Spring chinook production averaged 1.1 million annually, with a high of 2 million in 1985 and a low of 511 thousand in 1980. The hatchery produced coho from 1980 to 1987, averaging 2.3 million per year.

Figure 10. Spring Creek NFH :
Annual Releases 1980-99



source: Fish Passage Center, 2000

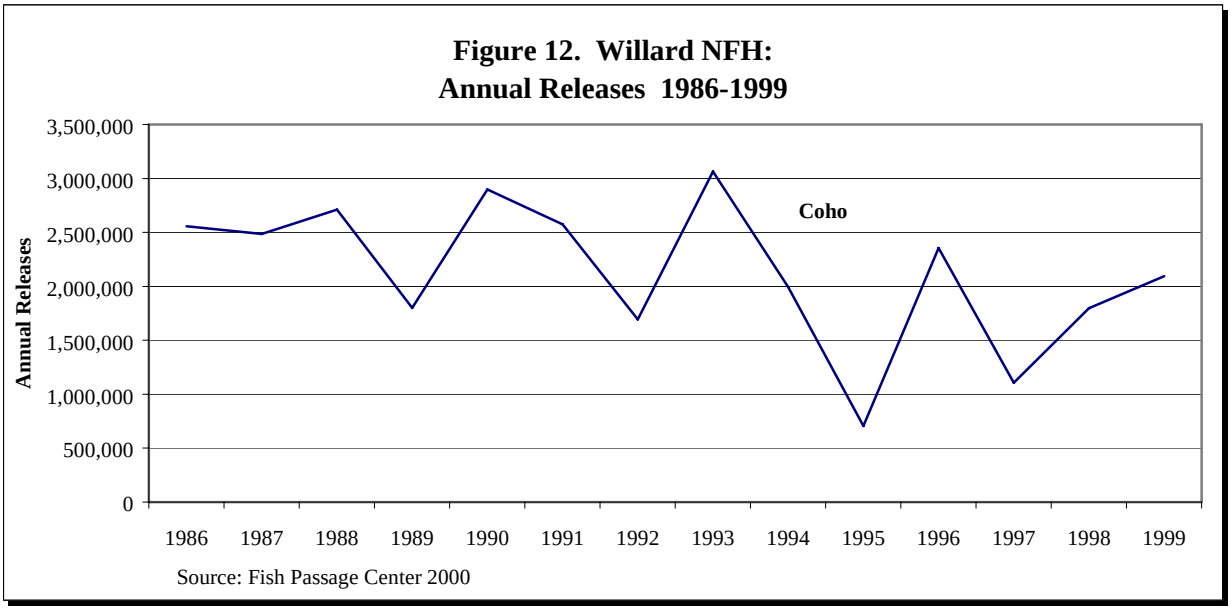
Figure 11. Little White Salmon NFH
Annual Releases 1980-99



Source: Fish Passage Center 2000

Willard NFH production is exclusively coho. Annual average production from 1980 to 1999 was 2.1 million fish with a high of 3.1 million in 1993 and a low of 706 thousand in 1995.

Figure 12. Willard NFH: Annual Releases 1986-1999



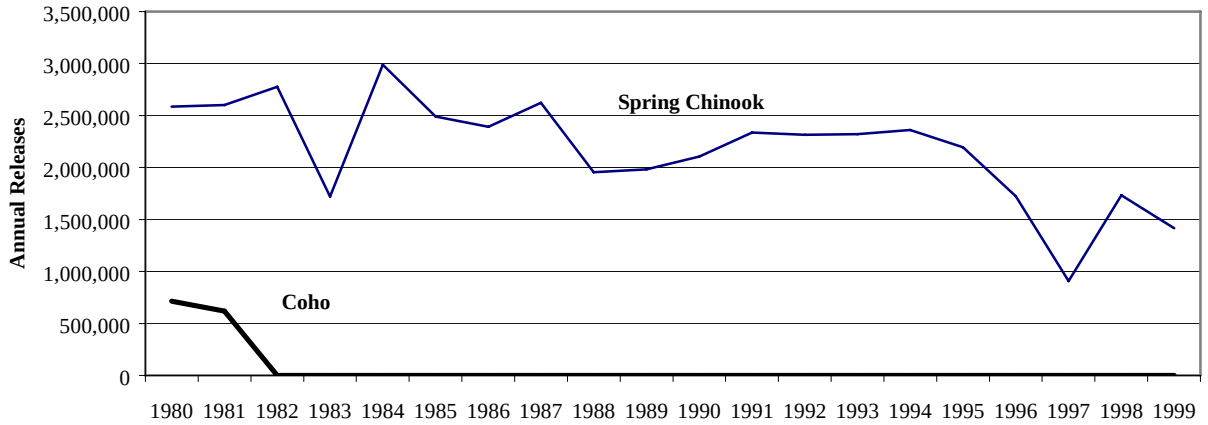
Source: Fish Passage Center 2000

Carson NFH produces about 2.2-million spring chinook annually. The highest level of production occurred in 1984 at 3 million fish annually; the lowest level of production was in 1997 at 908 thousand fish.

Figures 14-16 show aggregate production for all four hatcheries for each of three salmon species; spring chinook, fall chinook, and coho. Total spring chinook releases averaged 3.7 million with a high of 5.2 million in 1998 and a low of 2.9 million in 1996. Total fall chinook production averages 19.9 million fish annually, with a high of 30.4 million in 1981 and a low of 11.6 million in 1987. Coho production averages 2.5 million fish per year, with a high of 4.1 million in 1980 and a low of 706 thousand in 1995.

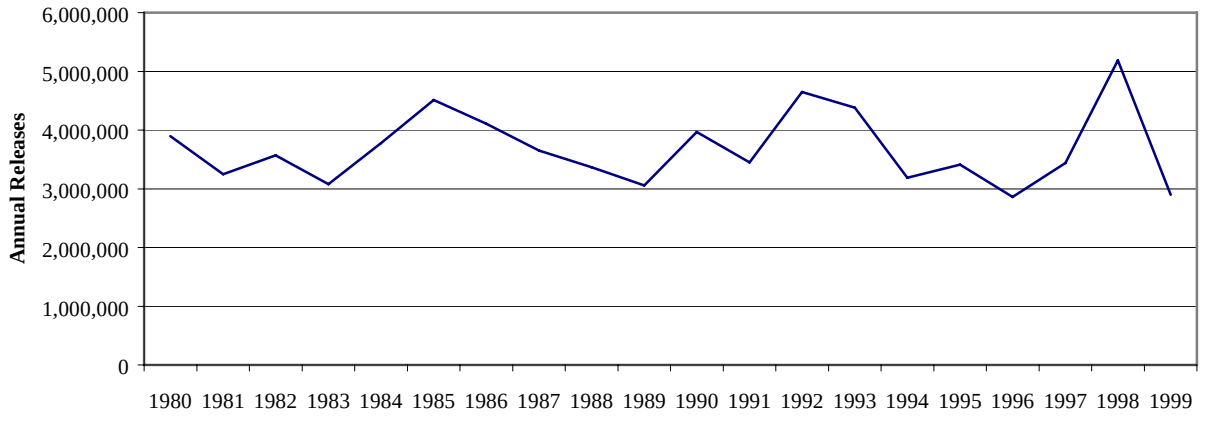
Figure 17 shows total aggregate annual production for all four Columbia River hatcheries for all produced species from 1980 to 1999. The number of fish produced from 1980 to 1999 totaled over 522 million.

Figure 13. Carson NFH
Annual Releases 1980-99



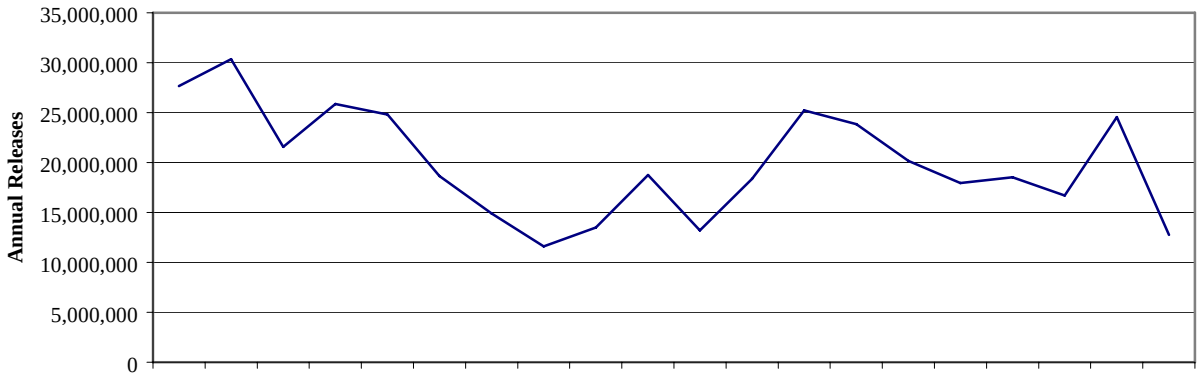
source:Fish Passage Center 2000

Figure 14 Total Annual Spring Chinook Releases:
Four National Fish Hatcheries 1980-99



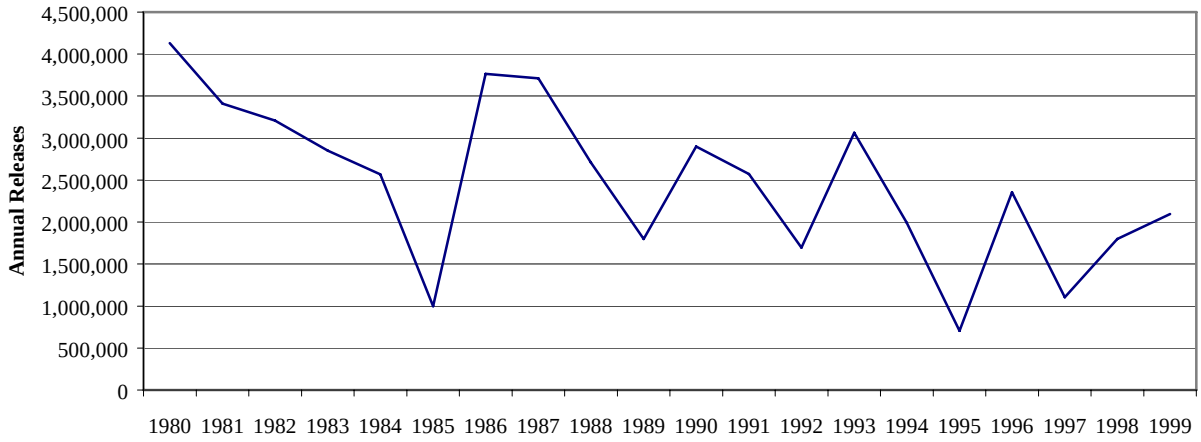
source: Fish Passage Center 2000

Figure 15. Total Fall Chinook Releases: Four FWS Hatcheries 1980-99



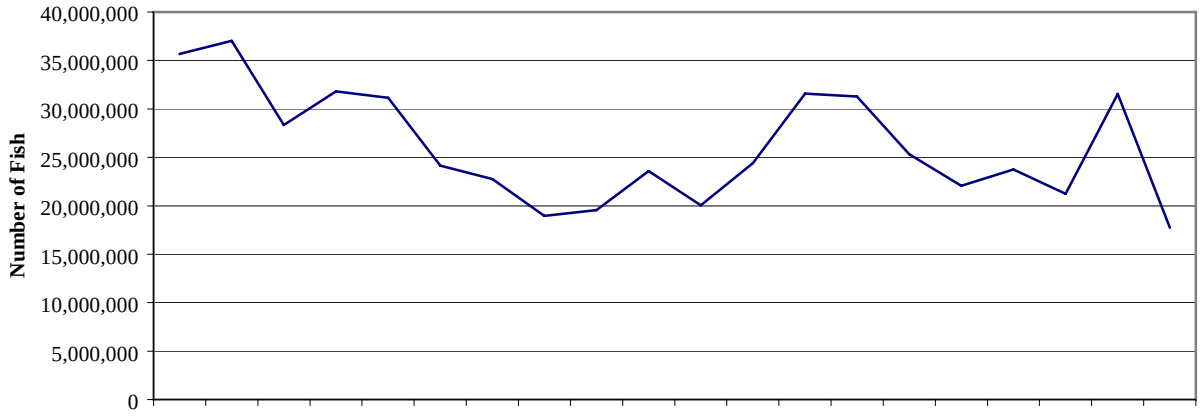
source: Fish Passage Center 2000

Figure 16. Total Annual Coho Releases: Four FWS Hatcheries 1980-99



source: Fish Passage Center 2000

Figure 17. Total Aggregate Production: Four Columbia River Hatcheries 1980-99



source: Fish Passage Center 2000.

Section 2.

Fish Returns

The magnitude of the economic effects of Federal hatchery production depends on the magnitude of hatchery fish returns; the greater the percentage of hatchery releases returning[5] to the Columbia River, the higher the potential for economic use of the returning fish. A variety of factors affect salmon mortality rates at different life cycle stages of the salmon. Once the salmon are released from the hatchery, mortality may occur from transportation downstream from dam passage at Bonneville, from predators and from environmental conditions such as water temperature, sedimentation and flow levels. Once in the ocean, mortality may occur from predators and environmental conditions such as temperature and food availability. Returning to the Columbia River and migrating upstream to spawn, salmon are subject to predation, mortality from dam passage at Bonneville and mortality from various types of environmental conditions.

Figures 18 through 33 on the following pages summarize salmon returns in general for the Columbia River and for the four FWS hatcheries specifically. Four general categories of returns include: (1) returns to the Columbia River; (2) returns to Bonneville Dam; (3) returns of spawning salmon to the respective hatcheries; and (4) coded wire tag (CWT) returns for each of the FWS hatcheries.

Columbia River Returns

Figure 18 shows the estimated annual number of salmon entering (returning to) the Columbia River from 1938 to 1999. Two major categories are shown: (1) chinook (fall and spring) and coho salmon; and (2) other salmon which includes sockeye, chum, and summer chinook. The variability of the Columbia River salmon runs can be seen in comparing the average run size with the maximum and minimum runs over the years. The average annual run size over the 62-year period was about 1.2 million salmon per year. The maximum over this period was 2.6 million salmon in 1987 and the low was 481,000 in 1996. The volatility of salmon runs is seen in the rapid rise from the mid-1980's to the late 1980's and the subsequent rapid decline from a peak of 2.6 million in 1987 to low of 481,000 in 1996.

Figure 19 shows the aggregate fall and spring chinook and coho returns as a percentage of total salmon returns to the Columbia River. For most of the period shown, the percentage of chinook and coho has been in the high 80's and higher, with the exception of the early 1950's to the early 1960's. Average percentage over the 62-year period has been 83 percent with a high of 96.4 percent in 1986 and a low of 54 percent in 1959.

Figure 20 summarizes returns at Bonneville Dam from 1980 to 2000. Most of the fish counted at Bonneville have been fall chinook and steelhead trout, at 34.9 and 34.3 percent respectively[6]. Spring chinook accounted for 11.4 percent and sockeye, coho and summer chinook for the remaining

[5] Returns include salmon that return to the respective hatcheries to spawn (hatchery returns) and salmon that are caught or used in some fashion (use returns).

[6] Percentages are based on total returns over the period 1980 to 2000.

20 percent.

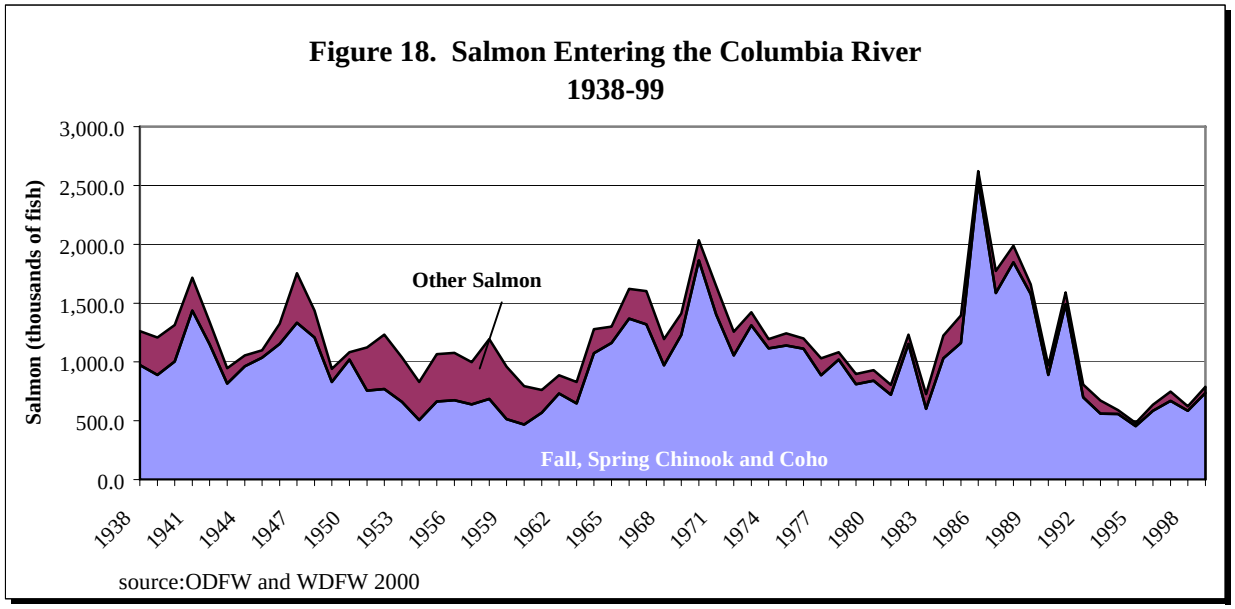


Figure 18. Salmon Entering the Columbia River
1938-99
Salmon (thousands of fish)
3,000.0
2,500.0
2,000.0
1,500.0
1,000.0
500.0
0.0
Other Salmon
Fall, Spring Chinook and Coho
1938
1941
1944
1947
1950
1953
1956
1959
1962
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
1998
source:ODFW and WDFW 2000

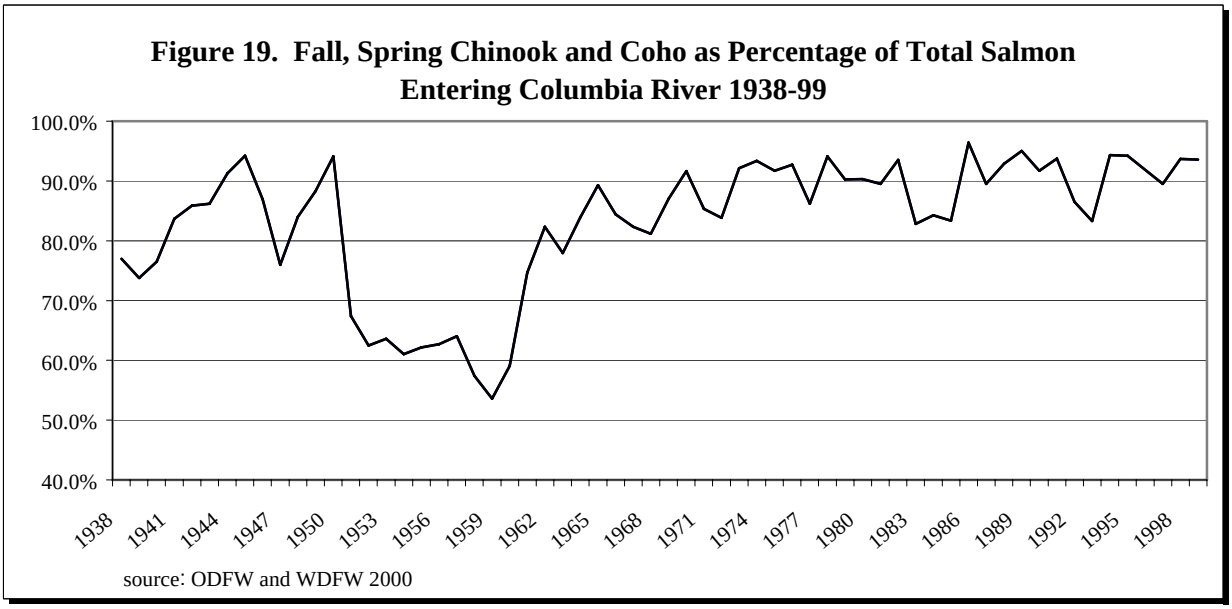
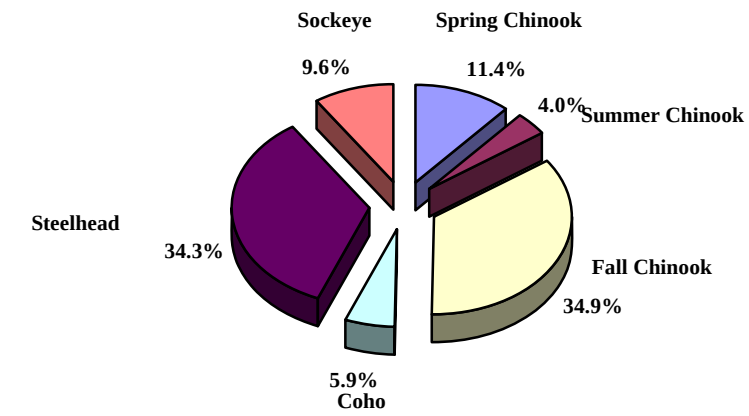


Figure 19. Fall, Spring Chinook and Coho as Percentage of Total Salmon
Entering Columbia River 1938-99
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
1938
1941
1944
1947
1950
1953
1956
1959
1962
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
1998
source: ODFW and WDFW 2000

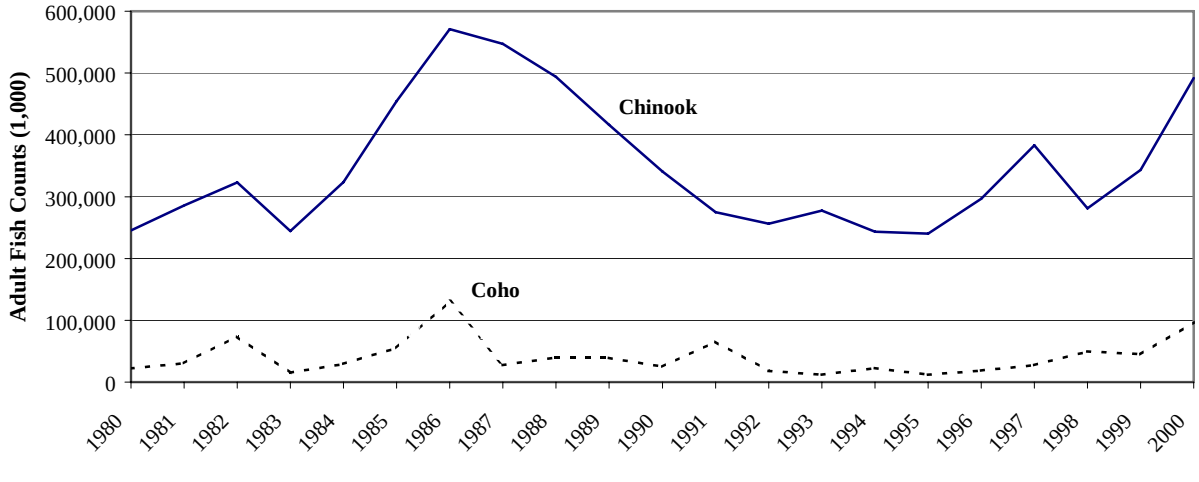
Figure 20. Returns by Species: Bonneville Dam 1980-2000



source: Fish Passage Center 2001

Figure 21 shows the trend of chinook and coho returns at Bonneville Dam over the 1980-2000 period. Both chinook and coho show a large increase in the number of returns in the mid-1980's followed by significant declines. However, from the mid-1990's, both salmon types show substantial increases in Bonneville returns. Over the indicated period, chinook returns averaged 350,000 annually with a high of 571,000 in 1986 and a low of 240,000 in 1995. Coho returns averaged 40,800 with a high of 130,800 in 1986 and a low of 11,700 in 1993.

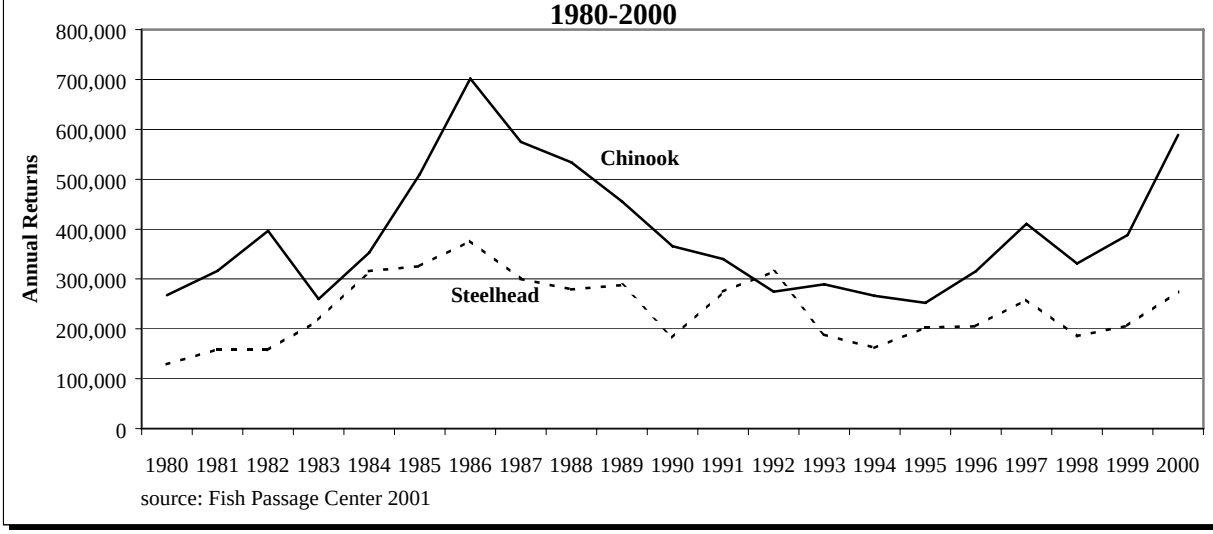
Figure 21. Chinook and Coho Returns: Bonneville Dam 1980-2000



Source: Fish Passage Center 2001

Figure 22 compares chinook returns with steelhead returns at Bonneville Dam from 1980 to 2000. Steelhead returns averaged 238,400 annually during this period with a high return of 376,750 in 1986 and a low return of 129,254 in 1980.

Figure 22. Chinook Salmon and Steelhead Passage at Bonneville Dam: 1980-2000



source: Fish Passage Center 2001

Federal Hatchery Returns

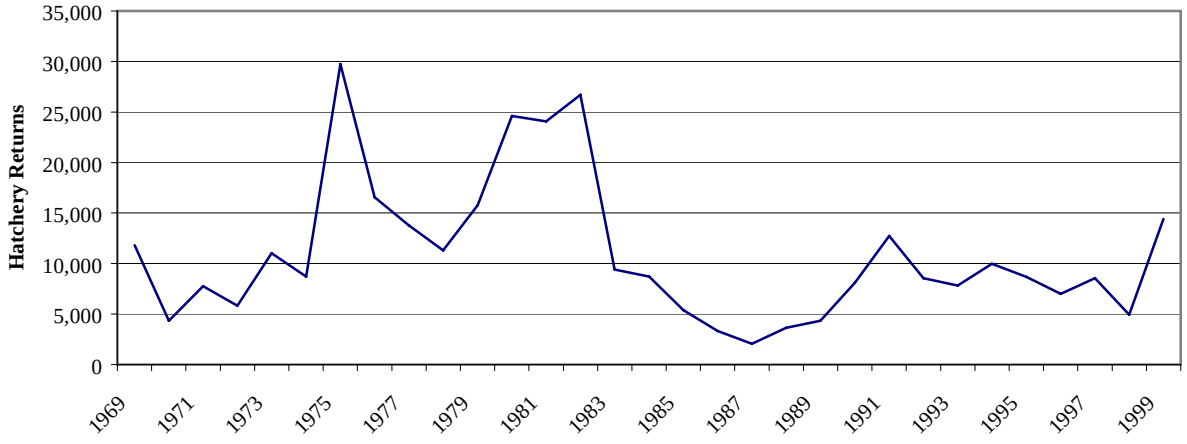
Figures 23 through 26 show annual salmon returns to the four Federal hatcheries from 1969 to 1999. Figure 23 shows Spring Creek NFH returns. During the 31 year period, fall chinook returns to the hatchery averaged 10,950 annually, with a high in 1975 of 29,729 salmon and a low of 2,064 in 1987.

Figure 24 depicts spring chinook returns to the Carson NFH. Annual returns averaged 3,410 with a maximum of 10,622 in 1990 and a low of 489 in 1995.

Figure 25 shows fall and spring chinook returns to the Little White Salmon NFH. Annual spring chinook returns averaged 1,767 with a high of 4,553 in 1987 and a low of 56 in 1974. Fall chinook returns averaged 3,088 with a high of 8,005 in 1997 and a low of 620 in 1985.

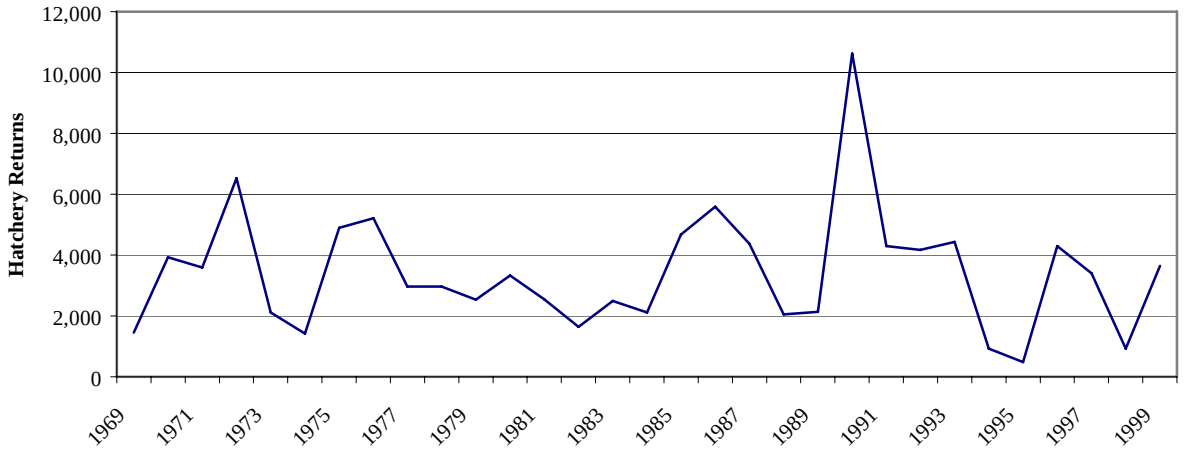
Figure 26 shows coho hatchery returns for the Little White Salmon and Willard NFH=s. The past 31 years show a very cyclical return pattern. Overall, annual returns averaged 7,856 with a high of 30,589 in 1982 and a low of 502 in 1996.

Figure 23. Spring Creek NFH
Fall Chinook Hatchery Returns: 1969-99



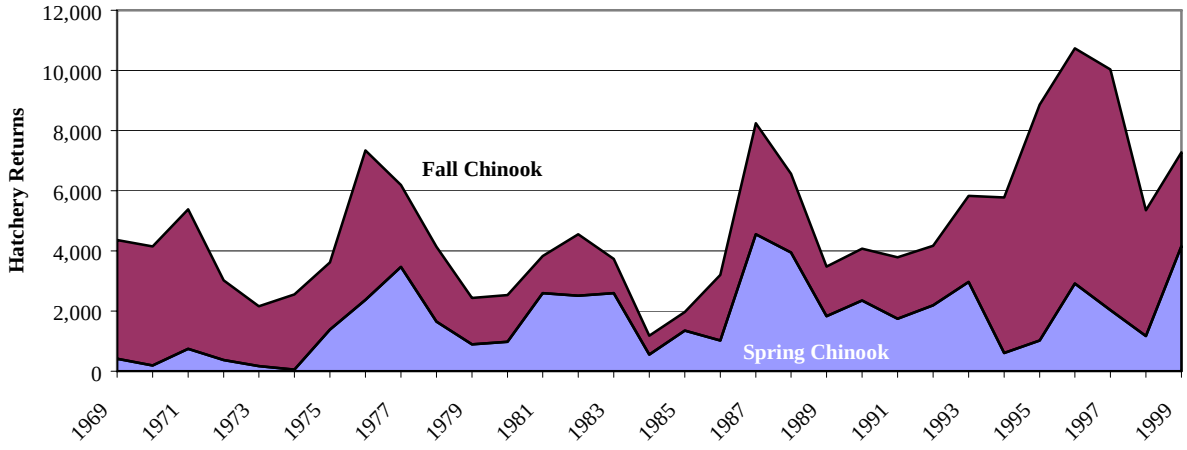
source: ODFW and WDFW 2000

Figure 24. Carson NFH
Spring Chinook Hatchery Returns: 1969-99



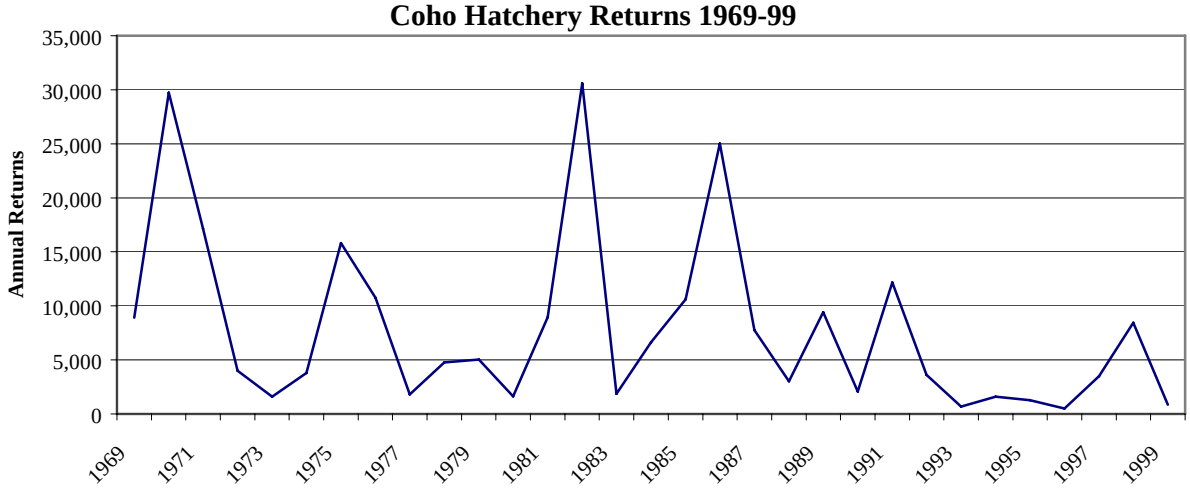
source: ODFW and WDFW 2000

Figure 25. Little White Salmon NFH
Fall and Spring Chinook Hatchery Returns: 1969-99



source: ODFW and WDFW 2000

Figure 26. LWS/Willard NFH:
Coho Hatchery Returns 1969-99



Source: ODFW and WDFW 2000

Coded Wire Tag Use Returns

The term ”coded wire tag” refers to small wire tags that are inserted into hatchery produced salmon juveniles before being released. The tags are encoded with the name of the hatchery that produced the salmon, the date of release and the brood stock year. When caught, the tags are returned to the FWS along with information on the location of where the fish was caught, date of catch and the purpose of the catch (i.e., commercial, recreation, tribal use, scientific research, etc.). This program, administered by the FWS and funded by the Bonneville Power Administration, has three main objectives: (1) to estimate the total survival of each production group; (2) to estimate the contribution of each production group to various fisheries; and (3) to prepare an annual report for all FWS hatcheries in the Columbia River basin (Pastor July 1997).

For each Federal hatchery on the Columbia River, a certain percentage of each production group in a given year are tagged and the total number of coded wire tags that are eventually returned is assumed to be indicative of the total number of fish caught from that particular production group. For example, if 24.8 percent of a particular production group is tagged, then each tagged fish represents 4.03 fish for the production group as a whole (1 divided by 0.248). Consequently, if 100 tags are returned, this is assumed to represent 403 actual fish caught.

Information contained in the annual CWT reports include (for each hatchery and for each production group): (1) the number of released salmon; (2) the number of tagged salmon; (3) the actual number of recovered salmon; (4) estimates of the total number of fish caught; (5) the total number caught in each use category (see Table 3); and (6) the geographic area where ocean salmon where caught (Alaska, British Columbia, Washington, Oregon and California).

Table 4a shows **total return rates** (the sum of hatchery returns, commercial and recreational harvest, tribal harvest and miscellaneous returns divided by total number of releases) for each hatchery based on the total number of years for which CWT data is available for that particular hatchery. **Table 4b** shows only CWT **harvest rates** (the sum of recreational and commercial harvests [including tribal harvest] divided by total releases). The tables show the overall average and the highest and lowest single year return or harvest rate (a rate of 10 salmon per 1,000 releases is a one percent return rate).

Looking at **Table 4a**, the highest average total return rate is for Willard NFH at 4.24, followed by Little White Salmon NFH fall chinook at 4.16, Spring Creek NFH at 2.85, Little White Salmon NFH spring chinook at 2.35 and Carson NFH at 2.24. The highest single year total return rate was 19.77 for Little White Salmon fall chinook; the lowest single year total return rate was Little White Salmon spring chinook at 0.0012 (1.2 returns per 1,000 releases).

Table 4b shows annual CWT **harvest rates** by hatchery. Willard NFH had the highest harvest rate at 2.42, followed by Little White Salmon NFH fall chinook at 2.31, Spring Creek NFH at 2.22, Little White Salmon NFH spring chinook at 0.89 and Carson NFH at 0.86. The highest single year harvest was 15.9 by Little White Salmon NFH fall chinook; the lowest single year harvest rate was 0 by

Little White Salmon NFH spring chinook.

Table 5 shows return rates broken out by hatchery returns and harvest rates. Average annual hatchery return rates ranged from 1.85 to 0.62; harvest rates ranged from 2.42 to 0.86.

Table 3
Use Categories for Coded Wire Tag Returns

Categories:		
spawning ground	*treaty ceremonial*	*foreign research vessels*
test fishery net	*treaty troll*	*treaty subsistence*
mixed net and seine	*sport (charter)*	*sport (private)*
ocean troll - day boat	*ocean troll - trip boat*	*sport jetty*
Columbia River gillnet	*fish trap*	*hatchery*
Columbia River sport	*freshwater sport*	*ocean troll (non-treaty)*
estuary sport	*ocean sport*	*squid gillnet by-catch*

Source: Pastor 1997

Table 4a
Annual CWT Total Return Rates by Hatchery
(Returns per 1,000 Releases)

Hatchery	Years of Data	Average	High	Low
Spring Creek	15	2.84	9.87	0.46
Willard	10	4.24	16.98	0.72
LWS FC	9	4.16	19.77	0.64
LWS SC	11	2.35	10.46	0.0012
Carson	11	2.24	4.13	0.22

Source: Pastor, Annual Reports 1994 - 2001

Table 4b
Annual CWT Harvest Rates by Hatchery
(Fish Harvested per 1,000 Releases)

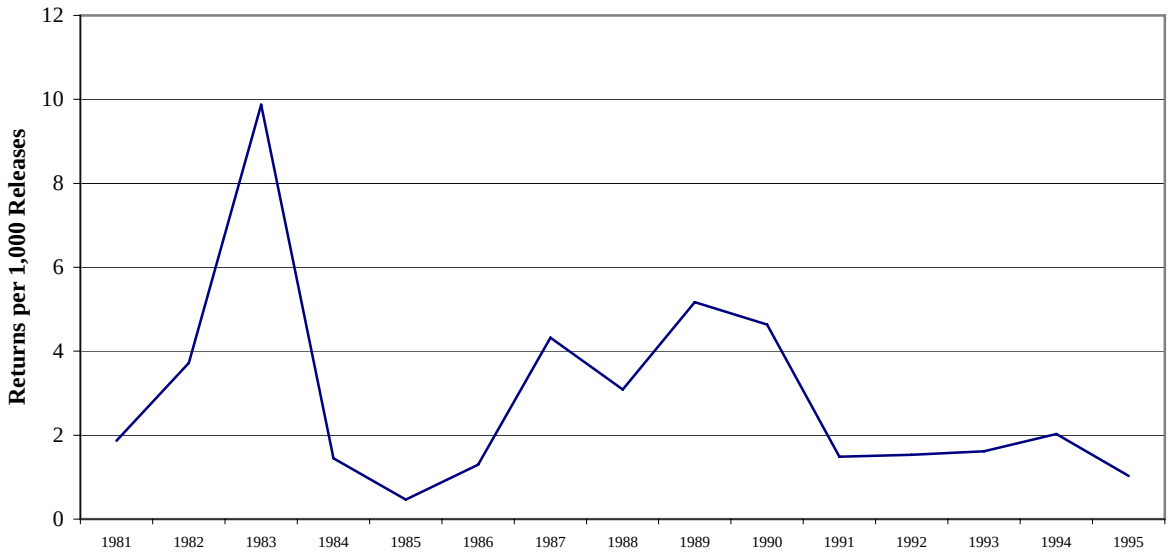
Hatchery	Years of Data	Average	High	Low
Spring Creek	15	2.22	7.93	0.39
Willard	10	2.42	12.69	0.14
LWS FC	9	2.31	15.90	0.28
LWS SC	11	0.89	5.17	0.0
Carson	11	0.86	3.0	0.01

Table 5
CWT Hatchery Return Rates and Harvest Rates by Hatchery
(Returns and Harvest per 1,000 releases)

	Hatchery Returns			Harvested Fish		
Hatchery	Average	High	Low	Average	High	Low
Spring Creek	0.62	1.94	0.07	2.22	7.93	0.39
Willard	1.82	4.29	0.26	2.42	12.69	0.14
LWS FC	1.85	3.87	0.97	2.31	15.9	0.28
LWS SC	1.46	5.30	0.0010	0.89	5.17	0.0
Carson	1.38	3.97	0.08	0.86	3.0	0.01

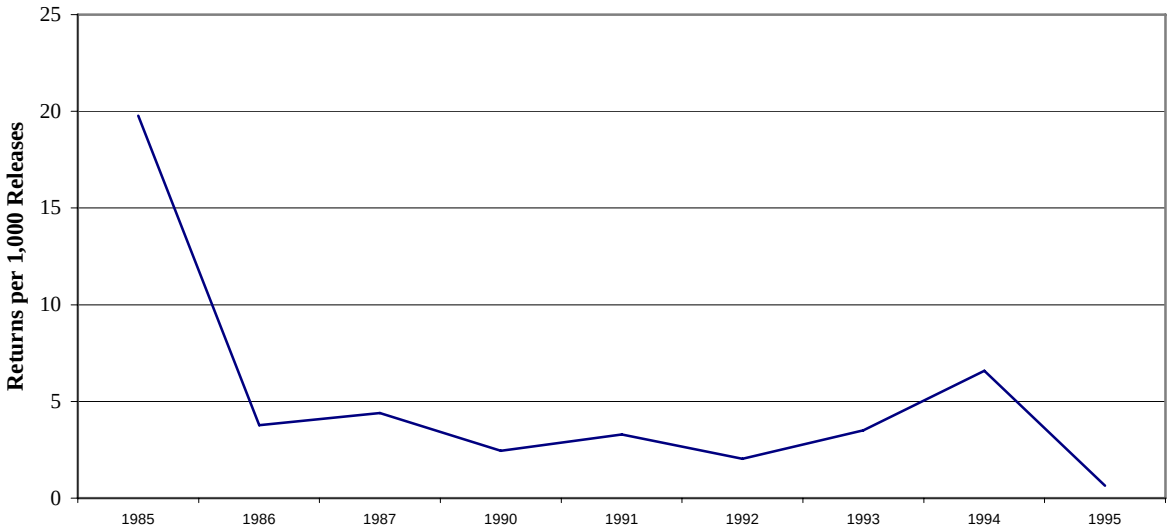
Figures 29 through 33 show annual total return rates (both hatchery returns and harvest) for the four hatcheries.

Figure 29. Spring Creek NFH: Fall Chinook CWT Total Returns
(Total Returns per 1,000 Releases)



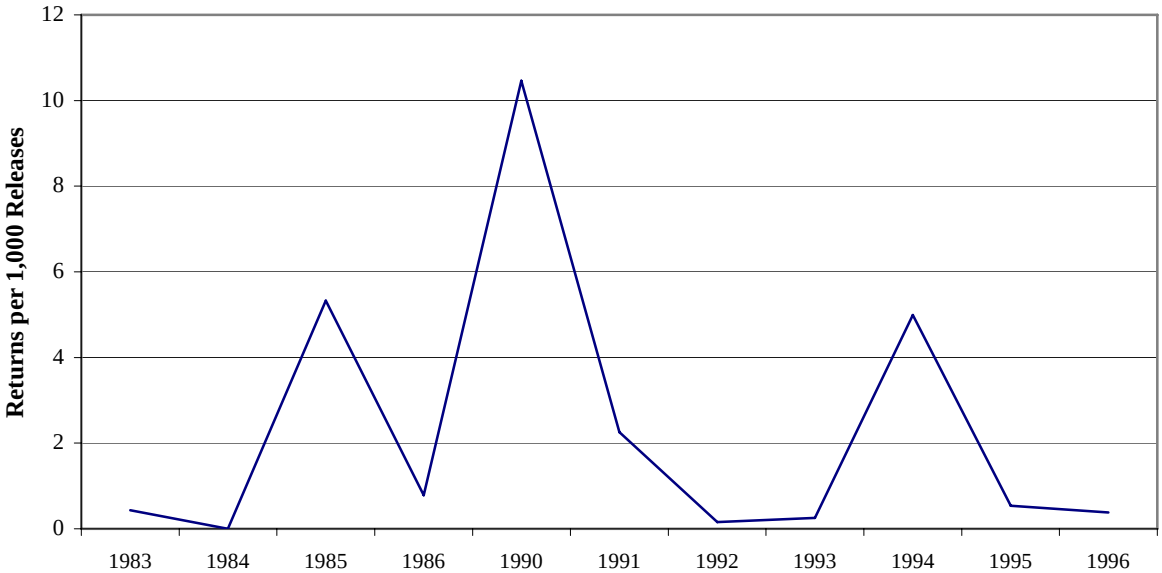
source: Based on data in Pastor 2000.

Figure 30. Little White Salmon NFH: Fall Chinook CWT Total Returns
(Returns per 1,000 Releases)



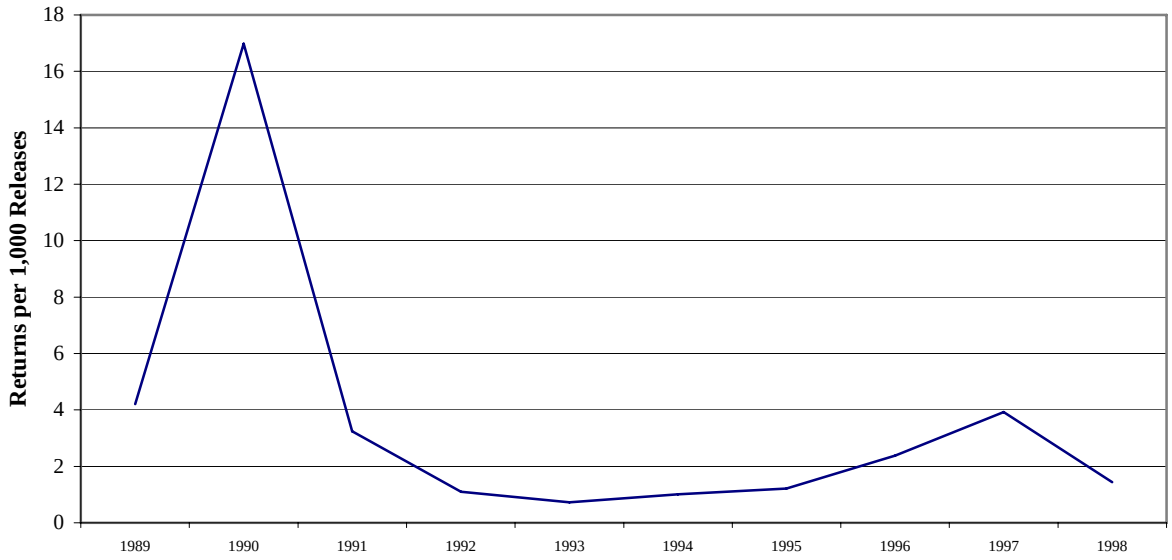
source: Based on data in Pastor (2000).

Figure 31. Little White Salmon NFH: Spring Chinook CWT Total Returns
(Returns per 1,000 Releases)



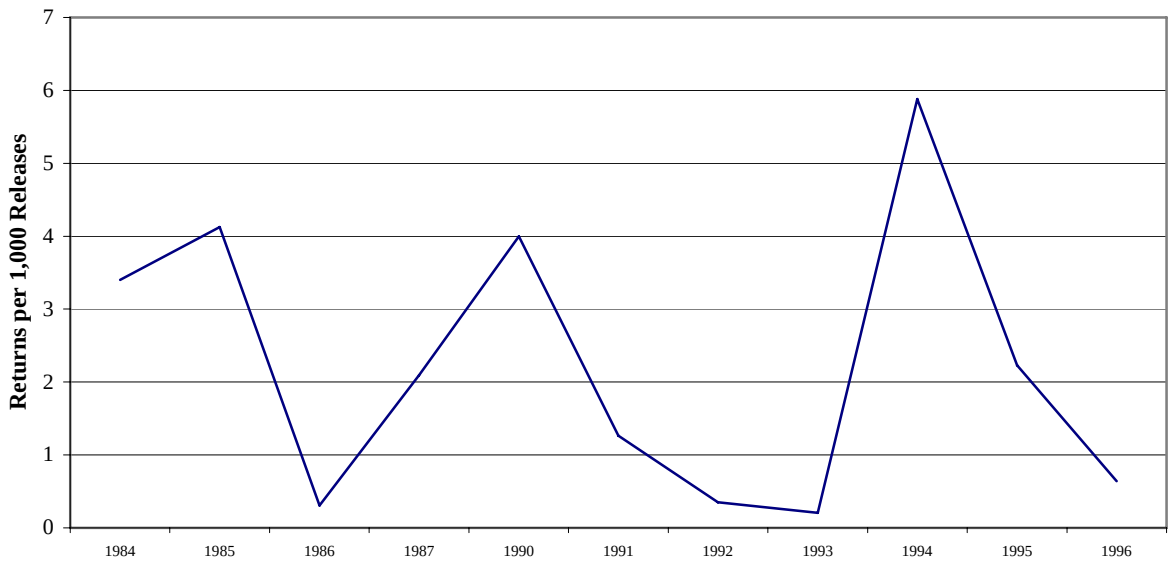
Source: Based on data in Pastor (2000)

Figure 32. Willard NFH: Coho CWT Total Returns
(Returns per 1,000 Releases)



source: Based on data in Pastor (2000)

Figure 33. Carson NFH Spring Chinook CWT Total Returns
(Returns per 1,000 Releases)



source: Based on data in Pastor (2000)

Section 3.
Recreational Use of Returning Columbia River Salmon

Columbia River salmon (both wild and hatchery produced) provide for a number of activities dependent on the collection and harvesting of the returning fish. These activities include:

- Recreational fishing
- Commercial fishing
- Tribal use (includes cultural, religious and subsistence use)
- Scientific research
- Artificial propagation

The focus in this report is on the economic effects of the recreational and commercial use of NFH-produced salmon. As such, the economic effects estimated in this report represent a subset of the total economic effects associated with NFH-produced salmon. The economics section of this report discusses this in more detail.

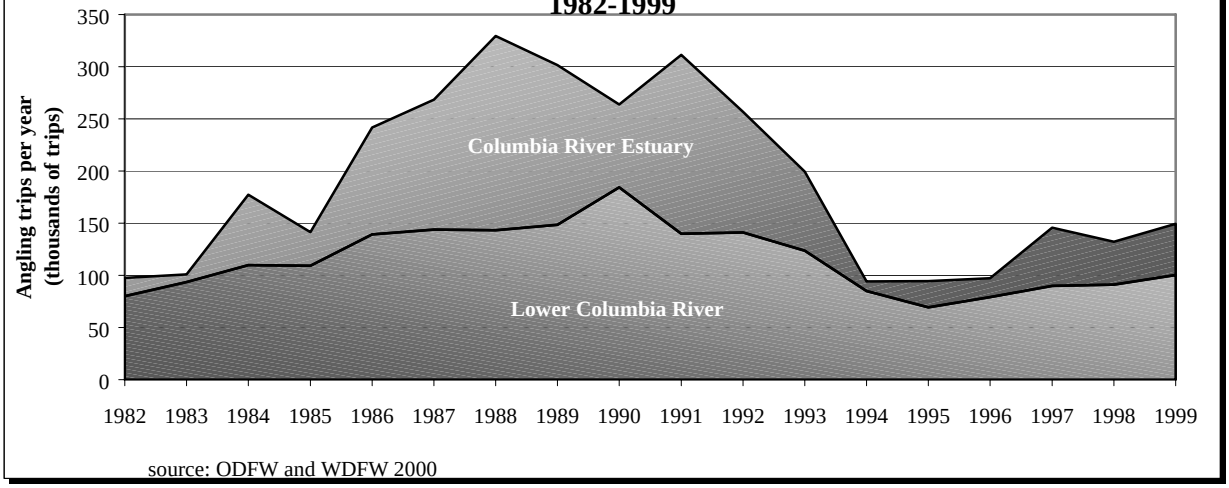
Recreational fishing for Columbia River salmon

The vast majority of returning Columbia River salmon are caught in one of three areas: (1) the ocean[7]; (2) the Columbia River estuary; and (3) the lower Columbia River (defined as up-river from the estuary and below Bonneville Dam). Figures 34 through 42 summarize recreational angling in these areas. It should be noted that catch figures include both wild and hatchery produced salmon. Regulations for recreational fishing on the Columbia River are set by the Washington Department of Fish and Wildlife and the Oregon Department of Fish and Wildlife (ODFW and WDFW 2000, p. 11). These regulations affect timing, length, equipment restrictions and catch limits.

Figure 34 shows annual angler trips (includes boat and bank fishing, private and charter) for salmon from 1982 through 1999 for both the lower Columbia and the estuary. Angling trips to the Lower Columbia averaged 115,000 trips annually from 1982 through 1999. The highest number of trips occurred in 1990 at 184,000 and the lowest number of trips occurred in 1995 at 69,000. Recreational angling trips averaged 74,000 annually in the Columbia River estuary with a high of 186,000 in 1988 and a low of 7,100 in 1983. From about 1986 to 1994, the annual number of estuary angling trips to the Columbia River estuary was comparable to the number of angling trips to the lower Columbia. Since 1994, a significant majority of angling trips have been to the lower Columbia.

[7] Includes British Columbia.

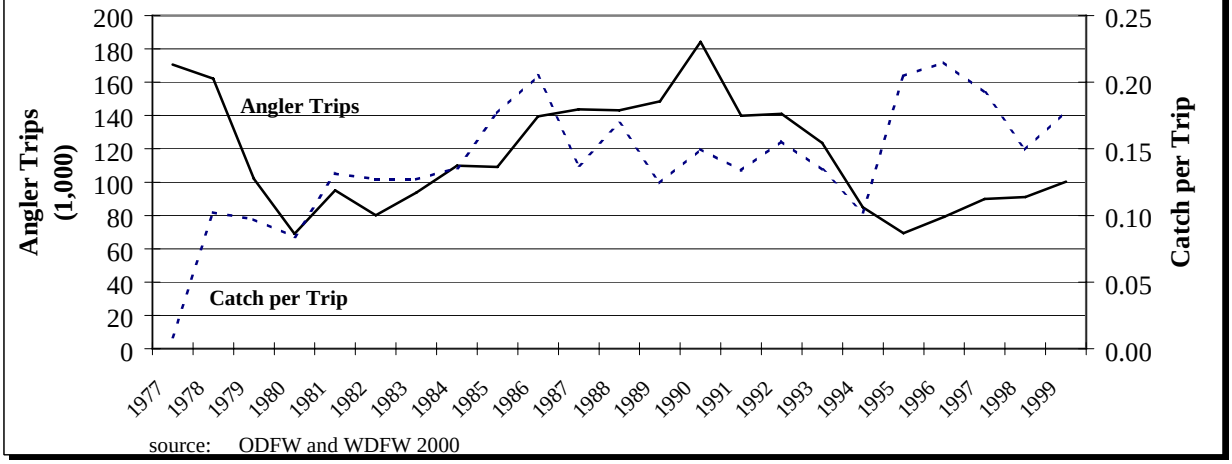
Figure 34. Angler Trips for Salmon:
Lower Columbia River and Columbia River Estuary
1982-1999



source: ODFW and WDFW 2000

Figure 35 compares angling trips to catch effort (number of fish caught per trip) for the lower Columbia. From 1977 to 1999, angling trips averaged 116,000 annually, with a high of 184,300 trips in 1990 and a low of 69,000 trips in 1980. Over this period, catch has shown a fairly steady progression from a low of 0.01 in 1977 to 0.21 in 1997. The average catch rate from 1977 through 1999 was 0.14.

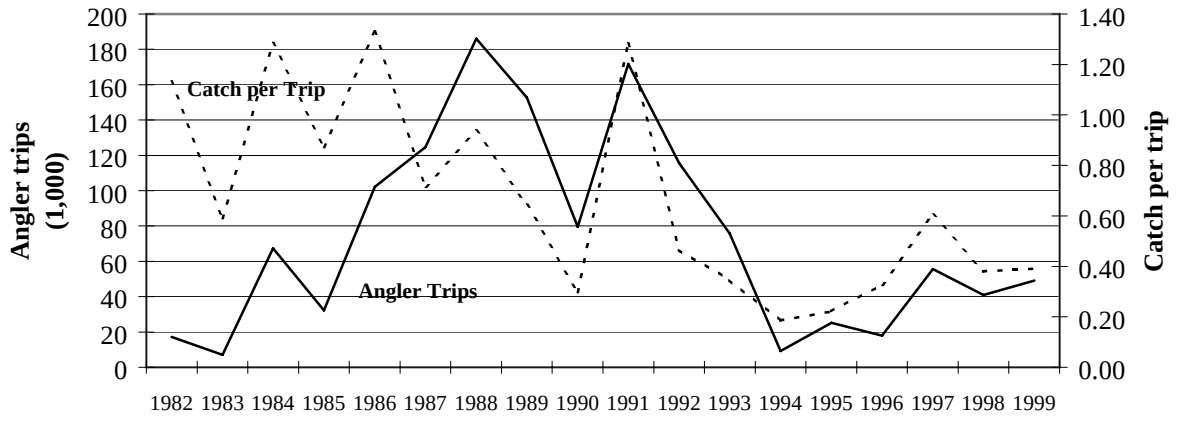
Figure 35. Angling Trips and Catch Effort:
Lower Columbia River Salmon Fishing
1977-99



source: ODFW and WDFW 2000

Figure 36 shows angler trips and catch effort for the Columbia River Estuary from 1982 to 1999. Angler trips averaged 74,000 annually with a high of 186,100 in 1988 and a low of 7,100 in 1983. Since 1994, angling trips have averaged 33,000 annually, increasing from 9,200 in 1994 to 49,100 in 1999. The catch rate from 1982 through 1999 averaged 0.78 annually, with a high of 1.33 in 1986 and a low of 0.18 in 1994. From 1994 to 1999, the catch has more than doubled, from 0.18 to 0.39.

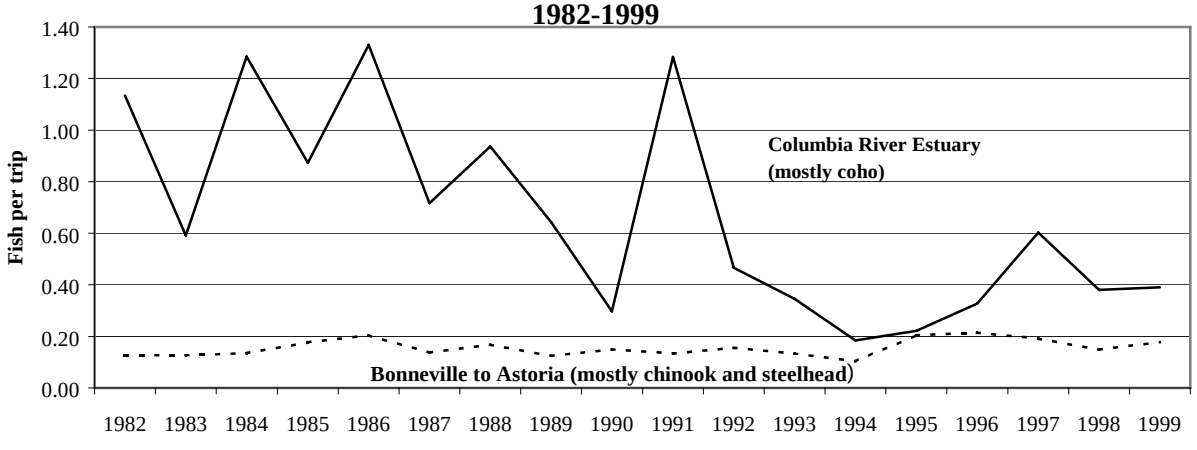
Figure 36. Angler Trips and Effort:
Recreational Salmon Fishing, Columbia River Estuary 1982-1999



source: ODFW and WDFW 2000

Figure 37 compares catch rates for the lower Columbia River and the Columbia River estuary. The estuary catch rate averaged 0.94 from 1982 to 1989 and then dropped almost by half to 0.45 from 1990 to 1999.

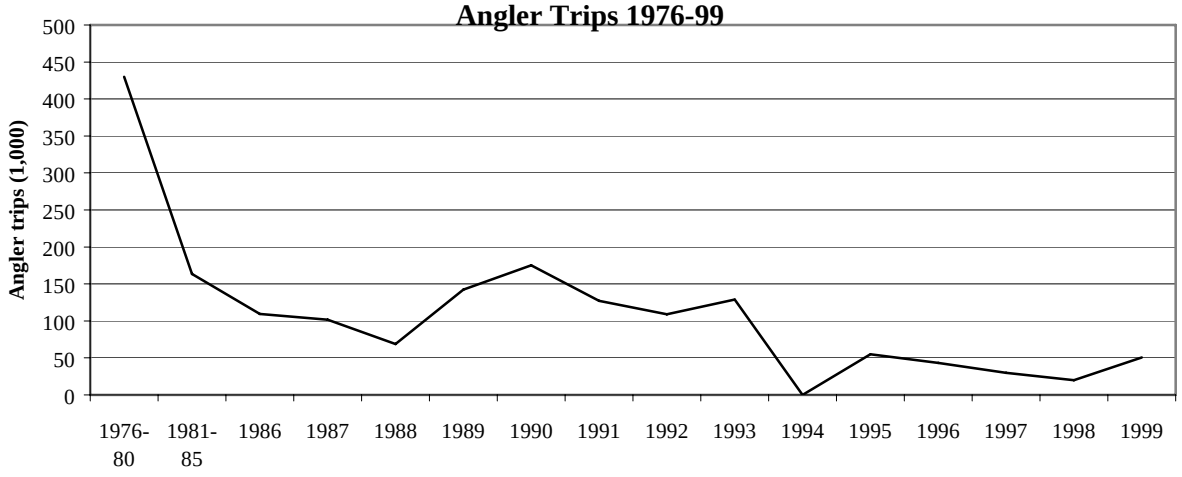
Figure 37. Fish Caught per Recreational Trip:
Lower Columbia River and Estuary Salmon Catch
1982-1999



source: ODFW and WDFW 2000

The past 25 years has seen a significant decline in recreational ocean fishing for salmon in the Pacific Northwest. Figure 38 shows annual angling trips for ocean salmon fishing off the Washington coast from 1976 through 1999. The overall average during this period was about 109,000 trips annually, with a high average of 429,800 from 1976 to 1980 and a low of 0 in 1994. From 1994 to 1999, ocean angling trips have averaged 40,000 annually.

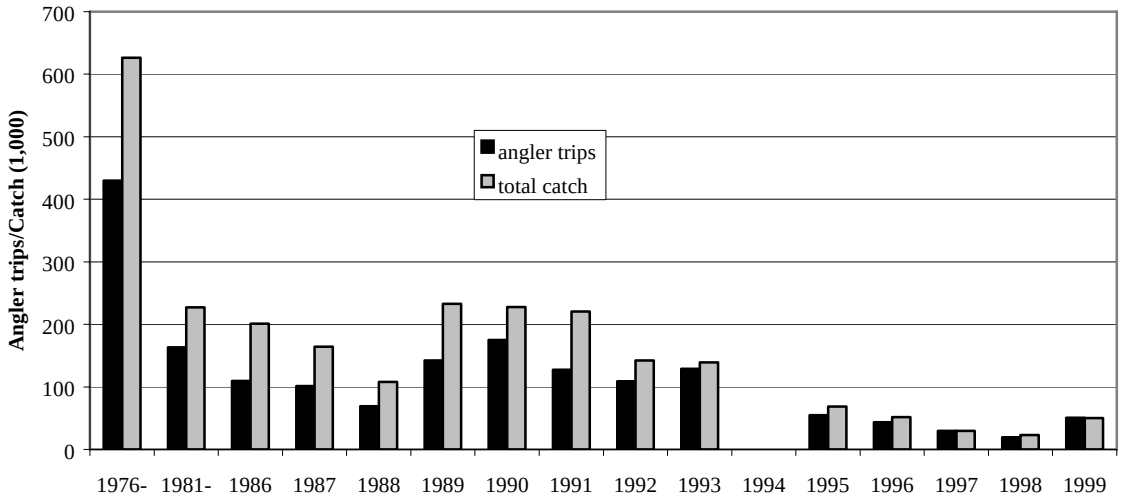
Figure 38. Washington Ocean Recreational Salmon Fishing: Angler Trips 1976-99



Source: PMFC 2000 p. A-43

Figure 39 compares angler trips with total catch for Washington ocean salmon fishing. Total catch averaged 157,000 annually from 1976 to 1999, which reflects a catch rate of 1.43. During the last five years of data, 1995 to 1999, the catch per trip averaged 1.12, about a 22 percent decline from the 1976-1999 average.

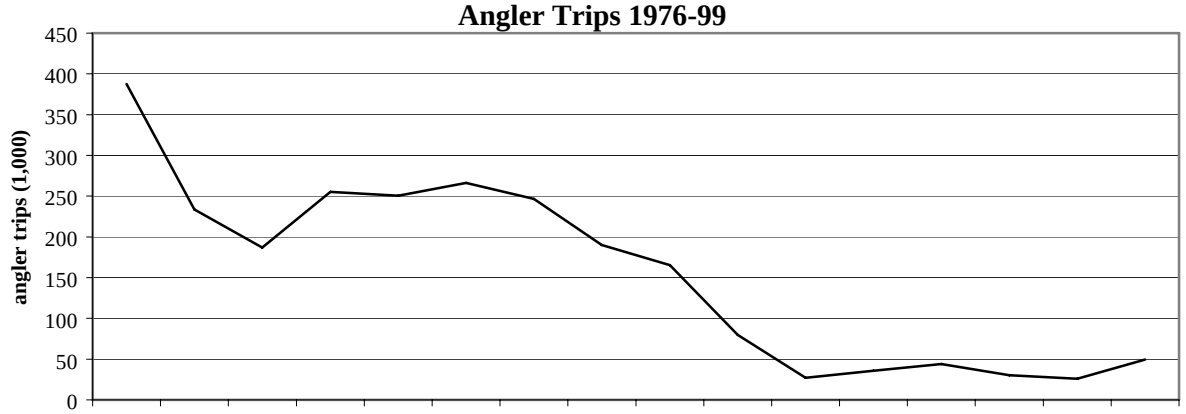
Figure 39. Washington Ocean Recreational Salmon Fishing Angler Trips and Catch (chinook and coho) 1976-99



source: PMFC 2000 pp. A-43, A-45

Figure 40 shows Oregon ocean salmon angling trips from 1976 to 1999. The 25-year average was 155,000 annually. From 1986 to 1994, annual angling trips declined over 86 percent. Since 1994, the annual average has been on an overall upward trend, averaging 35,000 trips per year, a 30 percent increase from 1994.

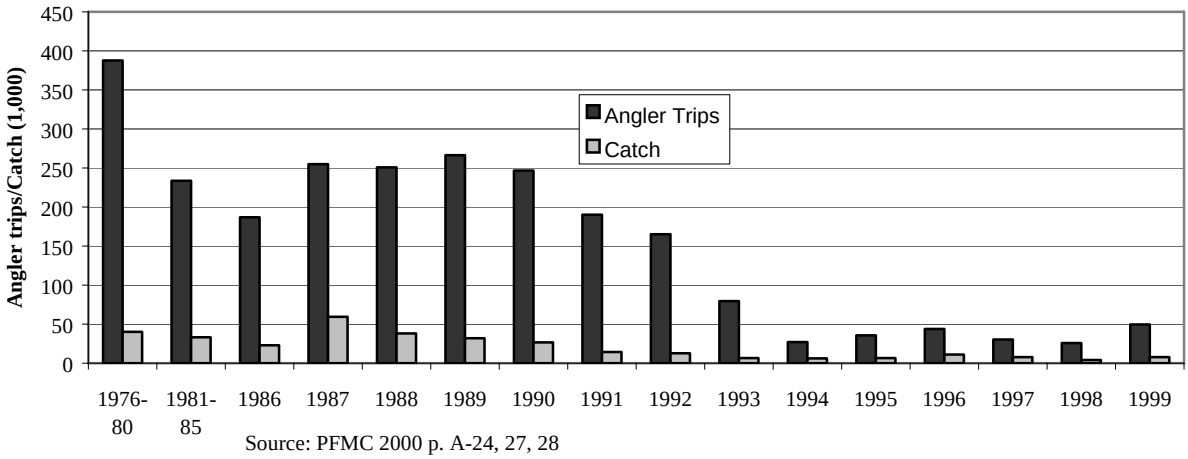
Figure 40. Oregon Ocean Recreational Salmon Fishing: Angler Trips 1976-99



Source: PFMC 2000 p. A-24

Figures 41 compares Oregon angling trips and catch for recreational salmon fishing. Total catch averaged 152,000 fish from 1976 to 1999. From 1976 to 1992, total catch averaged 253,000 annually; from 1993 to 1999, total catch averaged only 21,000, a decline of 92 percent.

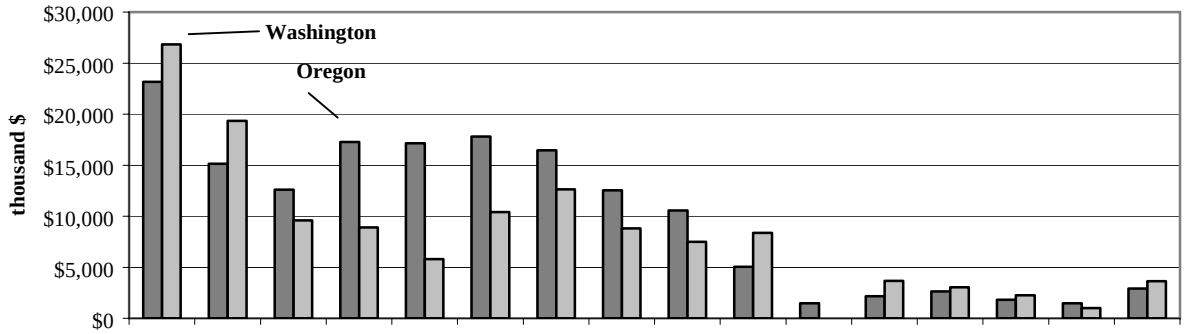
Figure 41. Oregon Ocean Recreational Salmon Fishing: Angler Trips and Catch (chinook and coho) 1976-99



Source: PFMC 2000 p. A-24, 27, 28

Figure 42 summarizes annual total personal income derived from recreational ocean salmon fishing for both Oregon and Washington. For Oregon, income averaged slightly over $10 million annually from 1976 to 1999. From 1976 to 1992, the annual average was $15.8 million; from 1993 to 1999, the annual average was $2.5 million, a decrease of 84 percent. In Washington, the 25-year annual average was $8.2 million. The average from 1976 to 1993 was $11.8 million; the average from 1994 to 1999 was $2.3 million, a decline of 81 percent.

Figure 42. State Personal Inome Impacts of Recreational Ocean Salmon Fishing Washington and Oregon 1976-99 (1999 Dollars)



Source: PFMC 2000

Section 4.
Commercial Salmon Catch in the Pacific Northwest

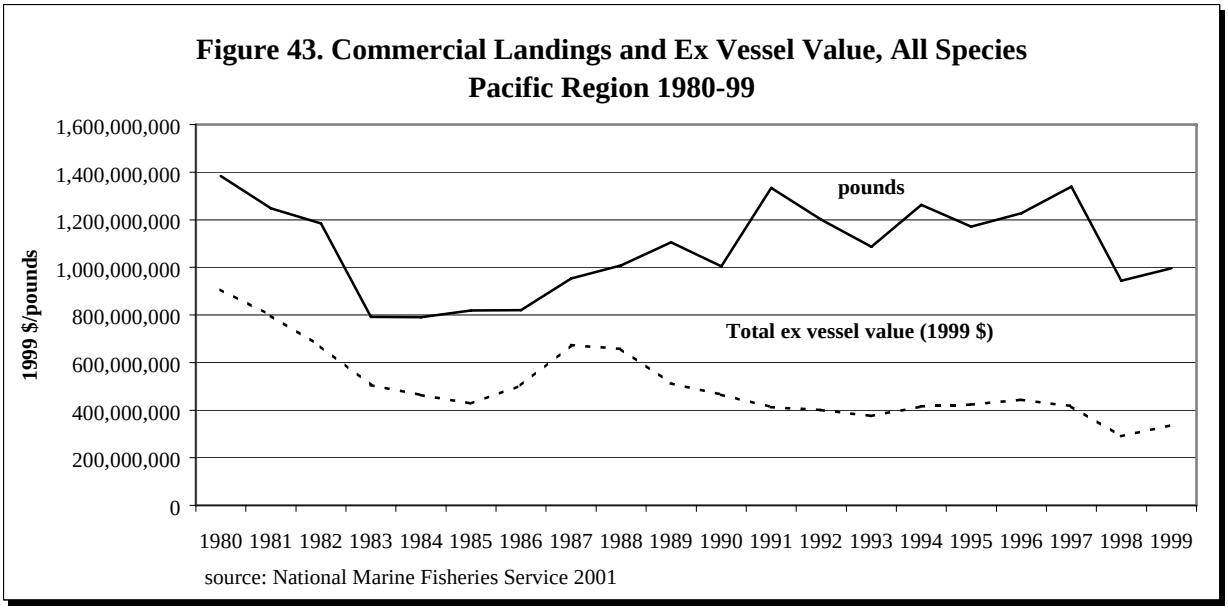
Similar to the recreational salmon harvest, commercial salmon fishing in the Pacific Northwest has declined significantly in recent years even as the total commercial fish harvest has generally increased. During the 1998-99 period, U.S. commercial landings averaged 9.2 billion pounds annually. The most caught species was pollock (walleye) averaging 2.7 billion pounds annually (29 percent of total catch); salmon (all species) averaged 644 million pounds (7 percent of total catch) annually. Total ex vessel value of the U.S. commercial catch averaged $3.1 billion in 1998-99. Shrimp had the highest total commercial value at $515 million (17 percent of total U.S. commercial value); salmon came in fourth (behind crab and lobsters) with a total commercial value of $257 million (8 percent of total commercial value.

All of the U.S. commercial salmon catch comes from the Pacific Northwest. Alaska accounts for 97 percent of the commercial salmon catch with 626 million pounds of salmon. Washington State accounts for about 2 percent with 13.9 million pounds and Oregon accounts for less than 0.3 percent with 1.8 million pounds.

Pacific Region All Species Commercial Catch

Figure 43 shows total commercial catch (all species) in pounds for the Pacific region (California, Oregon and Washington) and total ex vessel value of the catch from 1980 to 1999. The total annual catch averaged 1.1 billion pounds with a high of 1.4 billion in 1980 and a low of 791 million in 1983, a 43 percent drop. From 1984 to 1997, total commercial catch increased by almost 70 percent, from 790 million pounds to 1.3 billion pounds. Total annual ex vessel value averaged $505 million annually with a high of $906 million in 1980 and a low of $291 million in 1998, a decline of 68 percent.

Figure 43. Commercial Landings and Ex Vessel Value, All Species Pacific Region 1980-99



Pacific Region Chinook and Coho Catch

Figure 44 shows commercial chinook catch and ex vessel prices for the Pacific region from 1980 to 1999. Aside from a sharp upward spike in the late 1980's, both total catch and ex vessel value experienced a long-term general decline during this period. Commercial chinook catch averaged 14.6 million pounds during this period with a high of 37.6 million pounds in 1988 and a low of 5.9 million pounds in 1998. From 1980 to 1999, commercial chinook salmon catch declined by 55 percent. Ex vessel value averaged $37 million dollars annually, with a high of $125 million in 1988 and a low of $7.3 million in 1998. From 1980 to 1999, total ex vessel value declined by 83 percent.

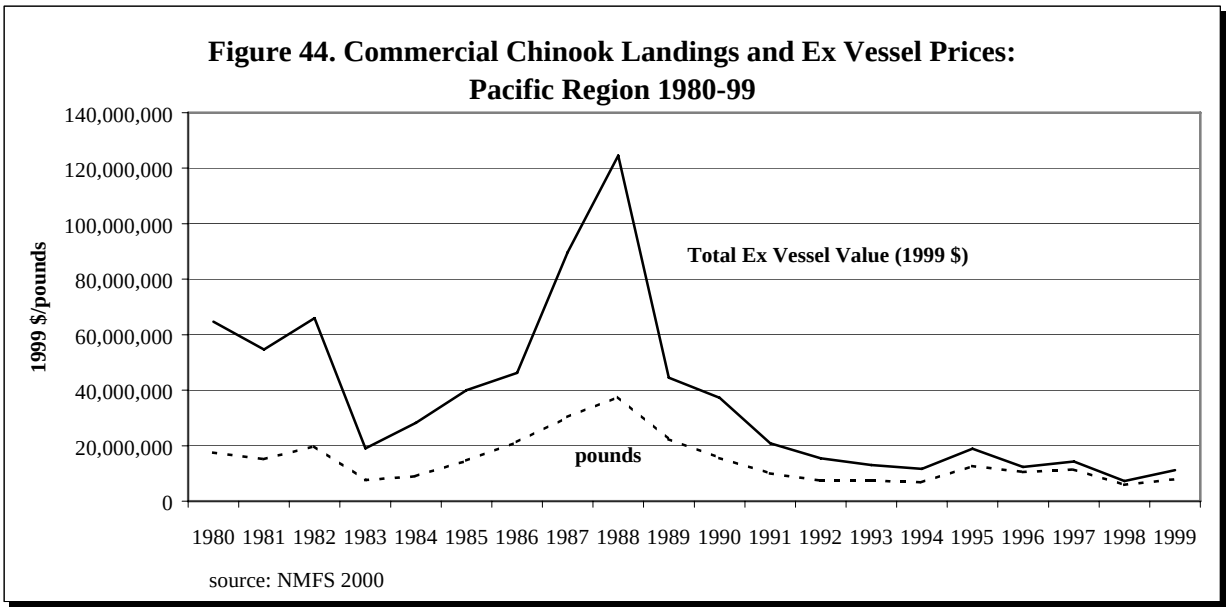
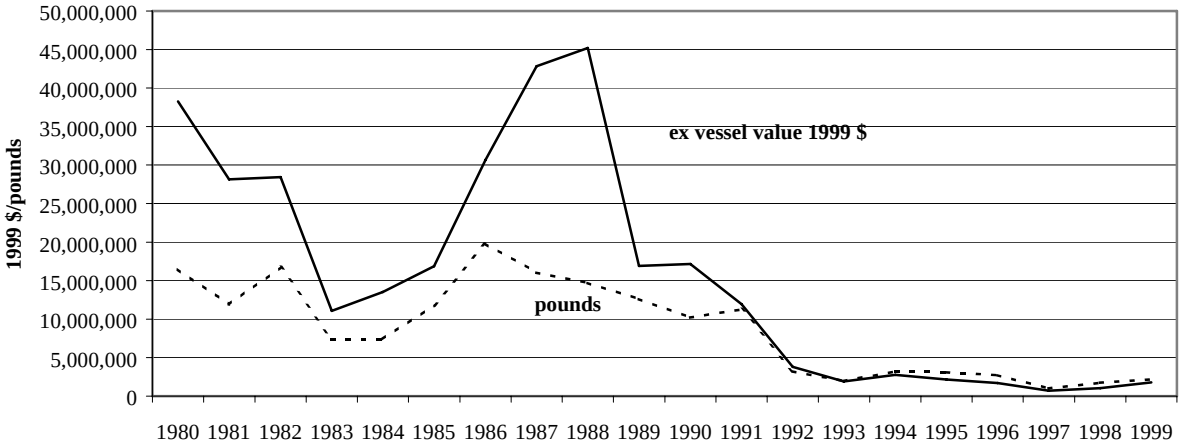


Figure 45 shows total annual commercial coho catch and ex vessel value for the Pacific region from 1980 to 1999. Total commercial catch averaged 8.8 million pounds annually, with a high of 19.8 million pounds in 1986 and a low of 977 thousand pounds in 1997. Ex vessel value averaged $15.8 million annually from 1980 to 1999 with a high of $45.2 million in 1988 and a low of $685 thousand in 1997. Price per pound averaged around $1.45 annually, with a high of $3.07 in 1988 and a low of $0.59 in 1998. For the last nine years (1991-99), ex vessel price per pound averaged $0.83.

Figure 46 compares ex vessel prices for chinook, coho and for all commercially caught species in the Pacific region from 1980 to 1999. Prices for all three have declined significantly since 1980. The composite price for all species averaged $0.48 annually from 1980 to 1999. From 1980 to 1989, ex vessel price per pound averaged $0.60; from 1990 to 1999, the annual average was $0.35, a decline of 42 percent. Both chinook and coho commercial prices show similar trends. Overall, chinook per pound ex vessel value averaged $2.30 from 1980 to 1999. During the 1980's, the per pound price averaged $2.94; during the 1990's the annual average was $1.66, a 44 percent decrease. The ex vessel price for coho averaged $1.45 from 1980 to 1999. From

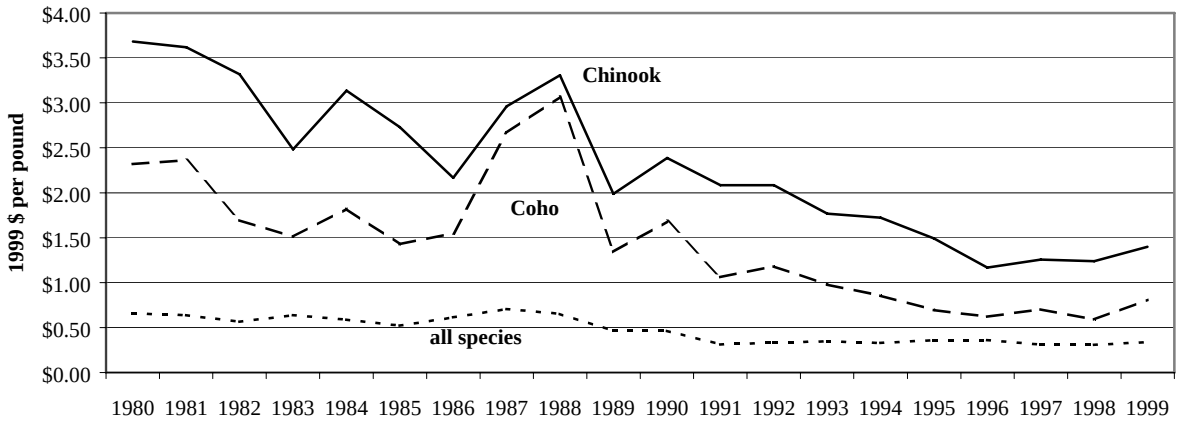
1980 to 1989, the price averaged $1.98; from 1990 to 1999, the price averaged $0.92, a drop of 54 percent.

Figure 45. Commercial Coho Landings and Ex Vessel Value
Pacific Region 1980-99



source: National Marine Fisheries Service 2001

Figure 46. Commercial Ex Vessel Prices, by Species
Pacific Region 1980-98

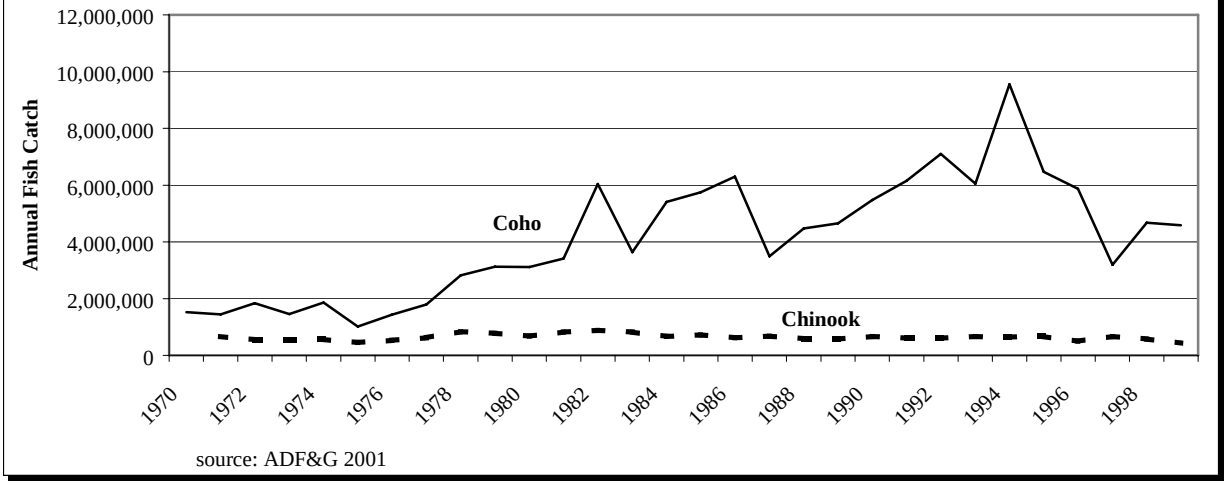


source: National Marine Fisheries Service 2001

Alaska Commercial Chinook and Coho Catch

As previously mentioned, Alaska typically accounts for over 97 percent of all salmon caught commercially in the U.S. Figure 47 shows Alaskan commercial chinook and coho catch from 1970 to 1999. Coho commercial catches (number of fish) averaged 4.1 million over the 30-year period with a high of 9.6 million in 1994 and a low of 1 million in 1975. From 1970 to 1980, coho commercial catches averaged 1 million annually; from 1981 to 1999, the average increased to 3.2 million. Chinook commercial catches averaged 642 thousand annually from 1970 to 1999; the highest commercial catch was 877 thousand in 1982 and the lowest annual catch was 430 thousand in 1999.

Figure 47. Alaska Chinook and Coho Commercial Catch: Annual Catch 1970-99

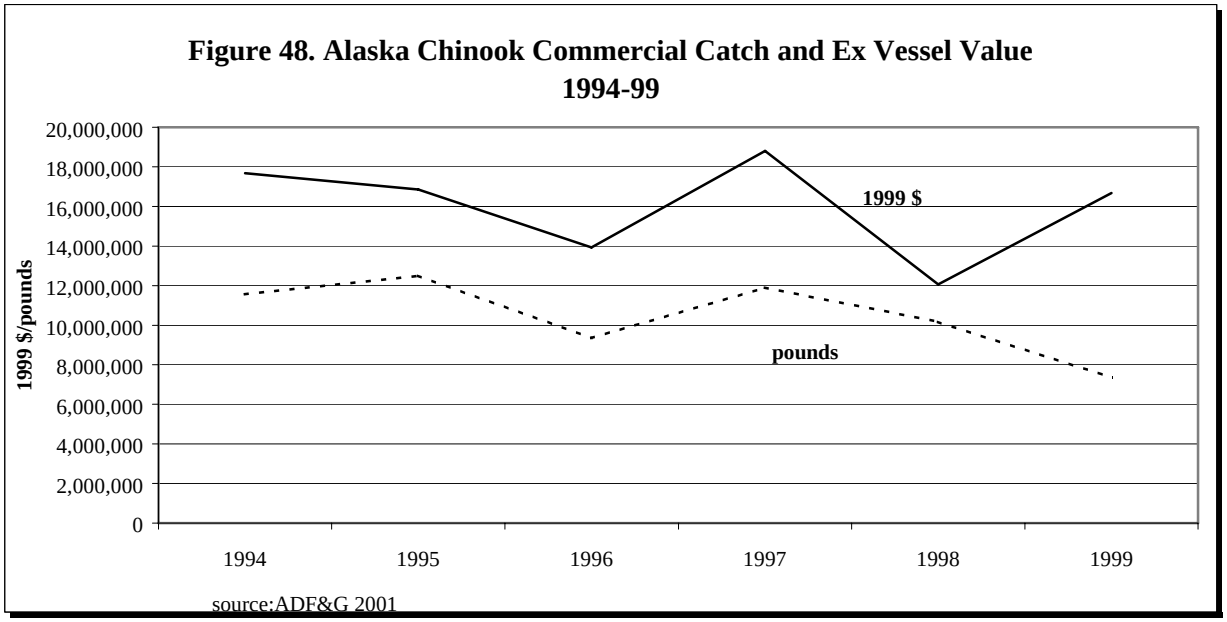


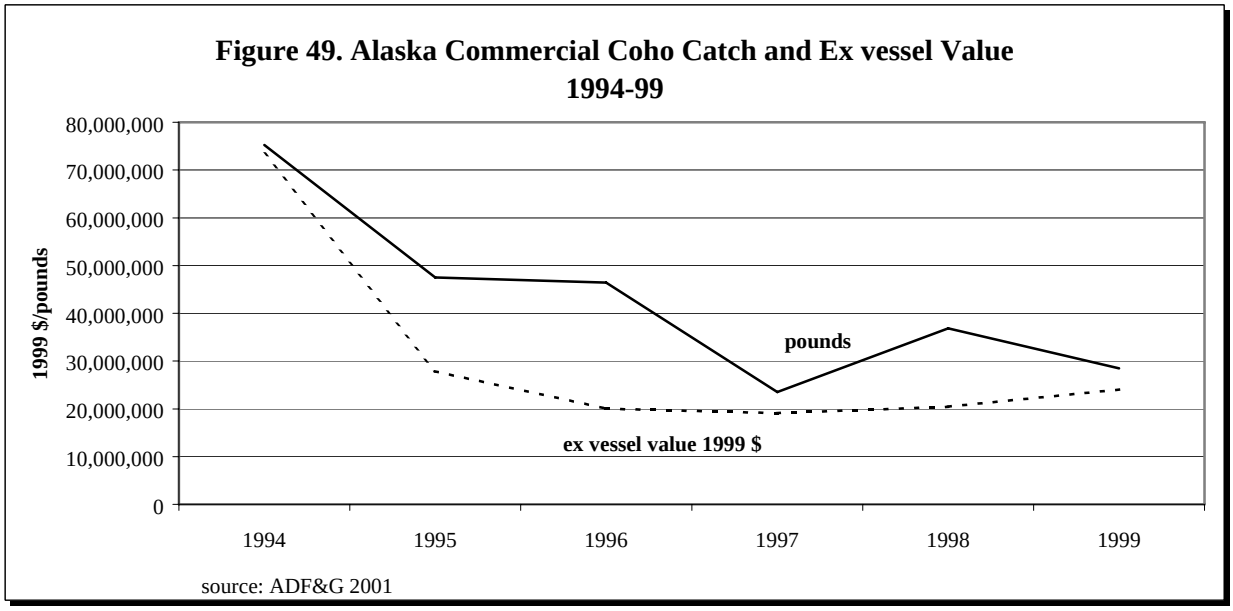
source: ADF&G 2001

Figures 48 and 49 show total pounds caught and total ex vessel price for chinook and coho salmon from 1994 to 1999. Commercial chinook salmon catches averaged 10.5 million pounds during this period. Total ex vessel value averaged $16 million and price per pound ranged from $1.17 and $2.27 with an average of $1.51. Commercial coho catch averaged 43 million pounds annually from 1994 to 1999. The change in catch from 1994 to 1999 represented a 62 percent decline. Total annual coho ex vessel value averaged $29.1 million from 1994 to 1999. The change from 1994 to 1999 represented a 62 percent decrease. Price per pound averaged $0.68 during this six-year period.

British Columbia Commercial Chinook and Coho Catch

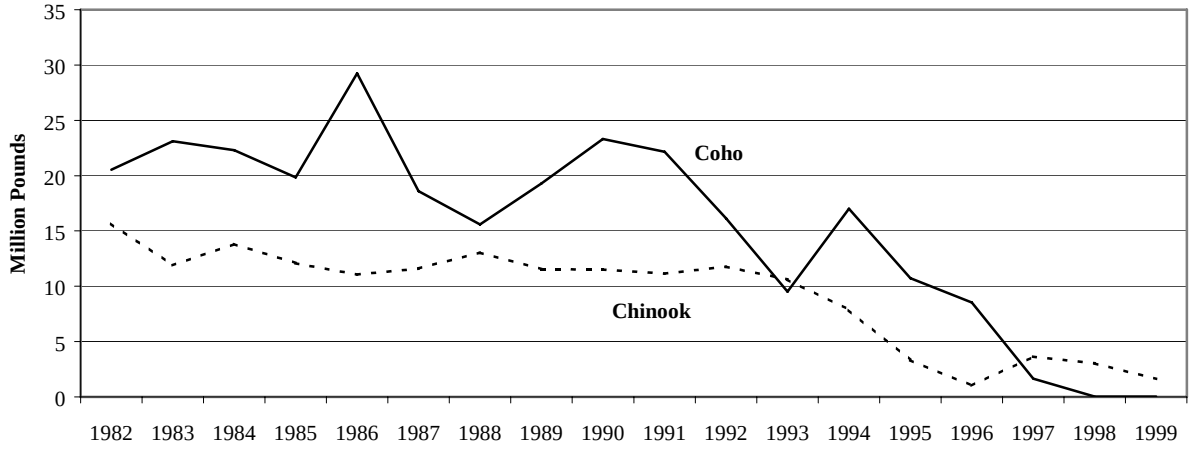
A sizeable number of Columbia River salmon are caught commercially in Canada, principally by commercial fishing fleets out of British Columbia. Figures 50 and 51 show commercial coho and chinook catch and ex vessel value, respectively. Chinook and coho typically make up





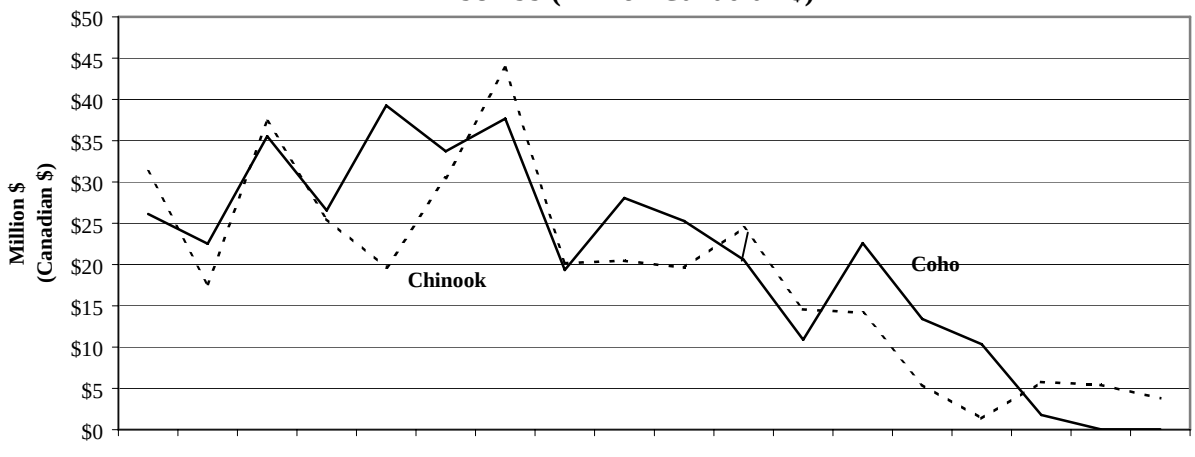
between 15 to 20 percent of British Columbia salmon catch (sockeye and pinks comprise the vast majority of the remaining catch). Coho commercial catch averaged 15.4 million pounds from

Figure 50. British Columbia Commercial Chinook and Coho Catch 1982-99 (Millions of Pounds)



source: British Columbia Salmon Marketing Board 2001

Figure 51. British Columbia Chinook and CohoCommercial Catch Value 1982-99 (Million Canadian $)



source: British Columbia Salmon Marketing Board 2001

Personal Income Impacts, Oregon and Washington Commercial Salmon Fishing

Figures 52 and 53 summarize commercial fishing personal income impacts for Oregon and Washington. Both states have suffered dramatic declines in personal income derived from the commercial salmon industry. From 1976 to 1999, commercial salmon-related personal income averaged $17.9 million annually in Oregon with a high of $55.1 million in 1988 to a low of $2.9 million in 1999, a decline of 95 percent. In Washington, commercial salmon-related personal income averaged $5.4 million with a high of $46.3 million in 1976-80 (annual average for these years) and a low of $32 thousand in 1994. Since 1994, annual personal income associated with commercial salmon fishing has averaged $317 thousand annually.

Figure 52. Oregon State Personal Income Impacts: Commercial Ocean Salmon Fishery (chinook and coho) 1976-99

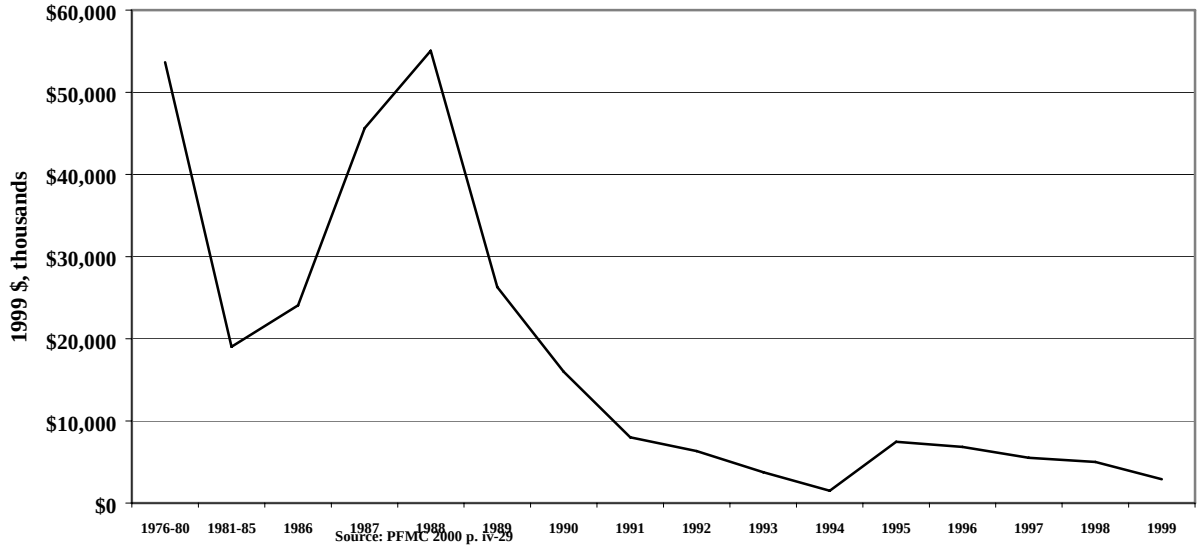
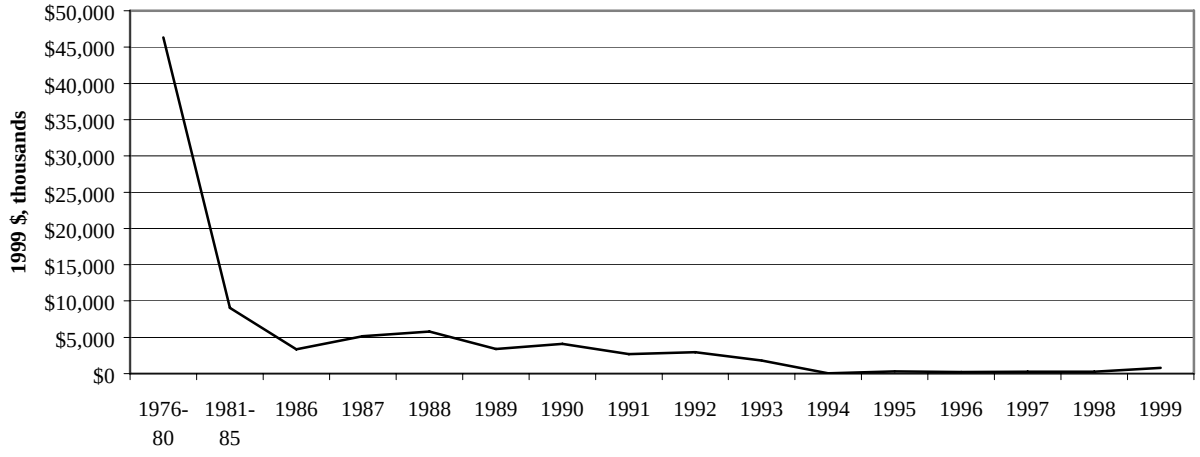


Figure 53. Washington State Personal Income Impacts: Commercial Ocean Salmon Fishery 1976-99



Source: PFMC 2000 p. iv-30

Section 5.
The Economic Value and Impacts of Hatchery Mitigation

Federal salmon hatcheries provide a variety of environmental and natural resource goods and services. These services can be grouped into six broad categories:

- **Recreation**
  - Replacing lost fishing opportunities
  - Creating additional fishing opportunities
  - Visitor Center and facility tours
- **Commercial**
  - Ocean and Columbia River commercial salmon fishing
- **Tribal**
  - Cultural
  - Religious
  - Subsistence
  - Commercial
- **Ecological use**
  - Food chain
- **Information**
  - Environmental and fisheries educational programs
  - Fisheries research
  - Fish health diagnostics
- **Federal spending**
  - Hatchery budget expenditures and their effect on local and regional economies

People who use the above services benefit in the sense that their individual welfare or satisfaction level increases with the use of a particular good or service. One measure of the magnitude of the change in welfare or satisfaction associated with using a particular good or service is ***economic value***. Aside from the effect on the individual, use of the good or service usually entails spending money in some fashion. These expenditures, in turn, create a variety of effects collectively known as ***economic impacts***.

Economic value is the economic trade-off people would be willing to make in order to obtain some good or service. It is the maximum amount people would be willing to pay in order to obtain a particular good or service minus the actual cost of acquisition. In economic theory this is

known as *net economic value* or *consumer surplus* (see Freeman and Boyle et al. for more detailed information). In the context of this report, estimates of the economic value of a salmon fishing day (one person fishing for a portion of one day for salmon) are used to determine the aggregate economic value of recreational fishing for salmon produced by the four Federal salmon hatcheries on the mid-Columbia River in the Pacific Northwest.

Economic impacts refer to employment, employment income, industrial output and federal and state tax revenue that occur as the result of consumer expenditures on hatchery-related goods and services. For this report, three types of impacts are addressed: (1) impacts associated with annual consumer expenditures on fishing for Federally produced salmon; (2) impacts associated with expenditures on commercial fishing for federally produced salmon; and (3) impacts associated with annual hatchery budget expenditures.

A comprehensive economic analysis of Federal salmon hatcheries would incorporate estimates of the total societal benefits and costs associated with the hatcheries. For example, benefits would include not only the valuation of salmon fishing but also the valuation of the scientific knowledge and environmental education services provided by the hatcheries and the valuation of an enhanced ecological environment. On the cost side, in addition to annual budget expenditures, the opportunity costs[8] of natural resources such as land and water and the costs of capital improvements would also be included (Loomis and Fix).

Because of time and resource constraints and the limited amount of available information, a comprehensive analysis as discussed above is beyond the scope of this study. Consequently, this report focuses on economic values, impacts and costs, which can be estimated using currently available information. As a result, both benefits and costs as calculated in this report represent conservative, reconnaissance-level estimates of total social benefits and costs.

This report focuses on: (1) the economic value of recreational salmon fishing; (2) the impacts of recreational fishing expenditures, including employment, employment (personal) income and Federal and State tax revenue; (3) the economic value and impact of commercial fishing for federally-produced salmon, including ex-vessel value and employment-related (personal) income; and (4) hatchery budget expenditures, including both salary and non-salary expenditures.

Economic Value of Recreational Salmon Fishing

Net economic value (consumer surplus) estimates for salmon fishing were obtained from the report, **Coastal Salmonid and Willamette Trout Hatchery Program Review, Appendix C – Economic Considerations** (Carter 1999). These estimates were in turn based on a review of a number of valuation studies on recreational salmon fishing in the Pacific Northwest (see pages 7-12 and 19 in Carter for further details). **Table 6** summarizes the net economic values for the three salmon species produced by the four Federal hatcheries, further delineated by whether the fish was caught in the ocean or river (including the Columbia River estuary). The dollar values shown are the recreational fishing values *per harvested fish.* These estimates are then multiplied

[8]"Opportunity costs represent foregone benefits of using the resources in their next best use. For example, river front property occupied by a hatchery could be used as a state park." (Loomis and Fix p. 4).

by the number of fish caught annually to obtain total annual economic value associated with the recreational catch of Federally produced salmon.

Table 6
Net Economic Values for Sport Fish: Pacific Northwest Salmon
(Dollars per Fish)

	Fall Chinook	Spring Chinook	Coho
Ocean	$53.65	$53.65	$53.65
River	$80.48	$107.30	$53.65

Source: Carter 1999. p. 19 (adjusted to 2001 dollars)

Tables 7 and 8 show annual economic value for ocean and river sport salmon fishing respectively. These estimates are based on average CWT harvest rates for each hatchery (see Table 4b.).

Table 7
Annual Economic Value of Ocean Sport Fishing
(Based on Average CWT Harvest Rates for each Hatchery)

Hatchery	Species	Fish Caught	$ Per Fish	Total
Spring Creek	Fall Chinook	1,408	$53.65	$75,539
Willard	Coho	1,199	$53.65	$64,326
LWS	Fall Chinook	155	$53.65	$8,316
LWS	Spring Chinook	0	$53.65	$0
Carson	Spring Chinook	0	$53.65	$0
Total		2,762		$148,181

Table 8
Annual Economic Value of River Sport Fishing
(Based on Average CWT Harvest Rates for each Hatchery)

Hatchery	Species	Fish Caught	$ Per Fish	Total
Spring Creek	Fall Chinook	3,299	$80.48	$265,504
Willard	Coho	1,856	$53.65	$99,574
LWS	Fall Chinook	234	$80.48	$18,832
LWS	Spring Chinook	565	$107.30	$60,625
Carson	Spring Chinook	1,517	$107.30	$162,774
Total		7,471		$607,309

Table 9 summarizes sport fishing annual economic value estimates for each of the hatcheries. Total annual river sport fishing economic value comes to $607,309 and annual ocean sport fishing economic value comes to $148,181 for an annual total of $755,490.

Table 9
Summary of Annual Economic Value of Sport Fishing
(Based on Average CWT Harvest Rates for each Hatchery)

Hatchery	Species	Total Sport River Value	Total Sport Ocean Value	Total Sport Value
Spring Creek	Fall Chinook	$265,504	$75,535	$341,043
Willard	Coho	$99,574	$64,326	$163,900
LWS	Fall Chinook	$18,832	$8,316	$27,148
LWS	Spring Chinook	$60,625	$0	$60,625
Carson	Spring Chinook	$162,774	$0	$162,774
Total		$607,309	$148,181	$755,490

Economic Impact of Recreational Salmon Fishing

Spending associated with recreational salmon fishing can generate a substantial amount of economic activity in local and regional economies. Anglers spend money on a wide variety of goods and services. Trip-related expenditures may include expenses for food, lodging and transportation. Most anglers also buy equipment and fishing–related goods and services such as rods, reels, lures, hooks, lines, bait, boats, boat fuel, guide and outfitter services, camping equipment, and memberships in fishing clubs and organizations. Because this spending directly affects towns and communities where these purchases are made, fishing can have a significant impact on local economies, especially in small towns and rural areas. These direct expenditures are only part of the total picture, however. Businesses and industries that supply the local retailers where the purchases are made also benefit from angler expenditures. For example, a family may decide to purchase a set of fishing rods for an upcoming vacation. Part of the total purchase price will go to the local retailer, say a sporting goods store. The sporting goods store in turn pays a wholesaler who in turn pays the manufacturer of the rods. The manufacturer then spends a portion of this income to cover manufacturing expenses. In this way, each dollar of local retail expenditures can affect a variety of businesses at the local, regional and national level.

Table 10 shows recreational fishing days (both fresh and salt water), associated expenditures, industrial output, jobs and earnings for the U.S. and the Pacific Northwest region in 1996.

Table 10
Recreational Fishing Effort and related Economic Impacts, 1996
U.S. and Pacific Northwest
(All figures except jobs in millions: jobs in thousands)

Area	Fishing days[9]	Expenditures[10]	Output[11]	Jobs[12]	Earnings[13]
U.S.	625.9	$37,797	$108,449	1,210.1	$28,259
Oregon	7.9	$623	$1,173	14.9	$304.9
Washington	12.9	$704	$1,358	16.7	$373.8
Alaska	5.3	$548	$957	12.6	$261.6
State totals	26.1	$1,875	$3,488	44.2	$940.3

Source: Maharaj and Carpenter 1997

[9] A fishing day is defined as one person fishing for at least part of a day.

[10] Includes both travel-related and equipment costs.

[11] Output is the total value of production or total sales plus or minus inventory (MIG, Inc. p. 253).

[12] Includes both full and part-time employment.

[13] Earnings are defined as "the earnings that are received by households from the production of regional goods and services and that are available for spending on these goods and services" (U.S. Department of Commerce, p.22).

In 1996, U.S. participation in recreational fishing resulted in over 625 million fishing days with over $37 billion in related expenditures. One way to help place these expenditures in context is to think of these expenditures as the annual sales revenue of a company. If such were the case, this company would rank 28th on the 2000 Fortune 500 list (adjusted to year 2000 dollars), ahead of such companies as Sears and Roebuck, Proctor and Gamble and Intel (Fortune 2001). These expenditures resulted in over $108 billion in industrial output, $28 billion in earnings and over 1.2 million jobs. For the Pacific Northwest region (Oregon, Washington and Alaska), recreational fishing amounted to over 26 million angler days, with associated expenditures of $1.9 billion, industrial output of $3.5 billion, earnings of over $940 million and over 44,200 jobs.

Tables 11 and 12 show expenditure estimates for recreational river and ocean fishing for Federally produced salmon, respectively. Total expenditures are calculated by multiplying the number of fish caught by fishing effort (the number of days it takes one person to catch one fish) by expenditures per day. The 2.78 angler days per fish in **Table 11** is based on the combined annual average catch effort for the lower Columbia River (Bonneville Dam to Astoria, 1977-1999) and the Columbia River estuary (1982-1999) (ODFW and WDFW 2000). The 0.85 angler days per fish in **Table 12** is based on a composite annual average of Washington and Oregon recreational ocean salmon fishing effort from 1976 to 2000 (PMFC 2000). The expenditures per fishing day are based on estimates in Carter (1999), adjusted to 2001 dollars.

Table 11
Annual Expenditures on River Sport Fishing
(Based on Average CWT Harvest Rates for each Hatchery)

Hatchery	Fish Caught	Angler Days Per Fish	Expenditures per Angler day	Total Expenditures
Spring Creek	3,299	2.78	$66.80	$612,638
Willard	1,856	2.78	$66.80	$344,667
LWS (Fall Chinook)	234	2.78	$66.80	$43,455
LWS (Spring Chinook)	565	2.78	$66.80	$104,923
Carson	1,517	2.78	$66.80	$281,713
Total	7,471			$1,387,396

Source: Angler days per fish: ODFW and WDFW 2000; Expenditures per angler day: Carter 1999.

Table 12
Annual Expenditures on Ocean Sport Fishing
(Based on Average CWT Harvest Rates for each Hatchery)

Hatchery	Fish Caught	Angler Days Per Fish	Expenditures per Angler day	Total Expenditures
Spring Creek	1,408	0.85	$62.82	$75,183
Willard	1,199	0.85	$62.82	$64,023
LWS (Fall Chinook)	155	0.85	$62.82	$8,277
LWS (Spring Chinook)	0	0.85	$62.82	$0
Carson	0	0.85	$62.82	$0
Total	2,762			$147,483

Source: Angler days per fish: PMFC 2000. Expenditures per Angler day: Carter 1999.

Tables 13 and **14** show the personal income impacts associated with recreational fishing expenditures on federally produced salmon. "Personal income" refers to income that is generated through fishing-related expenditures and employment, including direct, indirect and induced effects. Direct effects are simply the initial effects or impacts of spending money; for example, spending money in a grocery store for a fishing trip or purchasing fishing line or bait are examples of direct effects. The purchase of the fishing line by a sporting goods retailer from the line manufacturer or the purchase of canned goods by a grocery from a food wholesaler would be examples of indirect effects. Finally, induced effects refer to the changes in production associated with changes in household earnings (and spending) caused by changes in employment related to both direct and indirect effects. More simply, people who are employed by the grocery, by the food wholesaler, and by the line manufacturer spend their earnings on various goods and services which in turn generate a given level of output. The dollar value of this output is the induced effect of the initial fishing expenditures[14].

In **Tables 13 and 14**, total personal income is calculated by multiplying the number of fish caught by the number of days necessary to catch one fish by the personal income impacts per angling day. The 2.78 angler days per fish in **Table 13** is based on the combined annual average catch effort for the lower Columbia River (Bonneville Dam to Astoria, 1977-1999) and the Columbia River estuary (1982-1999) (ODFW and WDFW 2000). The 0.85 angler days per fish in **Table 13** is based on a composite annual average of Washington and Oregon recreational ocean salmon fishing effort from 1976 to 2000 (PMFC 2000); and personal income impacts per angler day are from Carter (1999) adjusted to 2001 dollars.

[14] More technically, direct effects are production changes associated with the immediate effects of changes in final demand (in this case, changes in angling expenditures); indirect effects are production changes in those industries directly affected by final demand; induced effects are changes in regional household spending patterns caused by changes in regional employment (generated from the direct and indirect effects) Taylor et al. 1993, Appendix E, p. E-1)

Table 13
Personal Income Impacts of Angler Expenditures for Sport River Salmon
(Based on Average CWT Harvest Rates for each Hatchery)

Hatchery	Fish Caught	Angling Days per Fish	Personal Income Impacts per Angler Day	Total Personal Income Impacts
Spring Creek	3,299	2.78	$40.57	$372,076
Willard	1,856	2.78	$40.57	$209,328
LWS (Fall Chinook)	234	2.78	$40.57	$26,392
LWS (Spring Chinook)	565	2.78	$40.57	$63,723
Carson	1,517	2.78	$40.57	$171,094
Total	7,471			$842,613

Source: Angling days per fish: ODFW and WDFW 2000; Personal income impacts per day: Carter 1999.

Table 14
Personal Income Impacts of Angler Expenditures for Sport Ocean Salmon
(Based on Average CWT Harvest Rates for each Hatchery)

Hatchery	Fish Caught	Angler days per fish	Personal Income Impacts Per Angler day	Total Personal Income Impacts
Spring Creek	1,408	0.85	$56.10	$67,141
Willard	1,199	0.85	$56.10	$57,174
LWS (Fall Chinook)	155	0.85	$56.10	$7,391
LWS (Spring Chinook)	0	0.85	$56.10	0
Carson	0	0.85	$56.10	0
Total	2,762			$131,706

Source: Angler days per fish: PMFC 2000; Personal income impacts per angler day: Carter 1999.

Generally speaking, **non-resident expenditures** bring "outside" money into the area and thus generate employment and income impacts in that particular area. The magnitude of these impacts depends, in part, on the degree of self-sufficiency of the area under consideration. For example, a county with a high degree of self-sufficiency (out-of-county imports are comparatively small) will generally have a higher level of impacts associated with a given level

of expenditures than a county with significantly higher imports (a comparatively lower level of self-sufficiency). Consequently, the economic impacts of a given level of expenditures will generally be less for rural and other less economically integrated areas compared with other, more economically diverse areas or regions.

Resident expenditures on salmon fishing benefit businesses that depend on salmon anglers for at least a part of their business revenue. For a given area, however, residents spending money on salmon fishing translates into less spending on other activities. Consequently, spending by residents is simply a transfer of expenditures from one set of goods and services to another; some businesses gain while others lose.

The economic impacts estimated in this report are aggregate or gross region-wide impacts. Information on where expenditures may occur locally and the magnitude of resident and non-resident expenditures (resident and non-resident relative to the geographical area of interest, whether a small town, region or state) is not currently available. In order to calculate "net" economic impacts, much more detailed information would be necessary on expenditure patterns and angler characteristics. Since this information is not currently available for all the areas potentially affected by Federal salmon production, the gross region-wide estimates in this report are used as an upper bound for net economic impacts (for additional information, see Loomis p. 191 and U.S. Department of Commerce pp. 7-9).

Economic Impacts of Commercial Fishing

Table 15 shows the annual economic value and impact of commercial fishing for federally produced salmon. Commercial value is defined as **ex vessel value**, which is the price per pound received at the dock multiplied by total number of pounds caught. Price per pound was estimated for chinook and coho salmon using National Marine Fisheries Service data on commercial landings and value in the Pacific Northwest from 1996 to 2000 (U.S. Department of Commerce 2001). **Personal income impacts** per caught fish represent the direct, indirect and induced income effects of commercial fishing expenditures from catching the fish to processing to final disposition (commercial or retail). Personal income generated per harvested fish was obtained from Carter (1999) and adjusted to 2001 dollars.

Average annual catch for the four hatcheries totaled 31,687 with a total ex vessel value of $545,676 and total personal income impacts of $1,198,465.

Table 15
Annual Ex Vessel Value and Personal Income Impacts of Commercial Fishing
(Based on Average CWT Harvest Rates for each Hatchery)

Hatchery	Commercial Fish Harvest	Ex Vessel Price Per Fish	Personal Income Impacts Per Fish	Total Ex Vessel Value	Total Personal Income Impacts
Spring Creek	25,102	$18.15	$39.65	$455,601	$995,294
Willard	2,239	$5.00	$13.78	$11,195	$30,853
LWS (Fall Chinook)	3,805	$18.15	$39.65	$69,061	$150,868
LWS (Spring Chinook)	122	$18.15	$39.65	$2,314	$4,837
Carson	419	$18.15	$39.65	$7,605	$16,613
Total	31,687			$545,676	$1,198,465

Section 6.
Economics Summary

Over and above the major contributions of the mid-Columbia River Federal salmon hatcheries to salmon conservation, scientific information and mitigation in the Pacific Northwest, the production and release of salmon by the four hatcheries result in a significant amount of related economic activity, even with very low CWT harvest rates that have averaged less than 0.3 percent in recent years (less than 3 harvested fish per 1,000 releases).

Tables 16 through 25 summarize recreational and commercial use of Federally produced salmon in the Columbia River. **Tables 16** shows the annual number of fish caught by hatchery and by use for the average CWT total return rate (see **Table 4a**) for each hatchery (overall average of 0.32 percent annually).

Table 16
Annual Total Returns and Harvest by Type of Use and Hatchery
Average CWT Total Returns and Harvest

Use Type	Spring Creek	Willard	Little White Salmon	Carson	Total
Average CWT Total Return Rate	0.28 %	0.42 %	0.35 %	0.22 %	0.32 %
Sport River	3,299	1,856	799	1,517	7,471
Sport Ocean	1,408	1,199	155	0	2,762
Commercial	25,102	2,239	3,927	419	31,687
Hatchery	8,382	3,976	4,828	3,141	20,327
Other	145	0	175	12	332
Total	38,336	9,270	9,884	5,089	62,579

Table 17 (and several tables which follow) show the effects of doubling the average CWT return and harvest. This is not to imply or argue that such return rates will occur or be sustained over time; however the last couple of years have seen a dramatic increase in the number of salmon returns to the Columbia River.[15] Consequently, the economic effects of doubling the return and harvest rates are provided as an example of the potential magnitude of economic impacts associated with significantly higher salmon returns to the Columbia River.

[15] For example, fall chinook adult passage at Bonneville Dam has averaged 176,945 during a recent 10-year period; in 2001 the number was 400,170. Spring chinook passage averaged 21,085 during the same 10-year period; spring chinook passage in 2001 was 391,367. Coho passage averaged 31,265 during the 10-year period and totaled 259,520 in 2001 (Fish Passage Center, 2002, p. 84, 89).

Table 17 shows hatchery returns and harvest for a doubling of the average CWT total return rate (to 0.64 percent overall).

Table 17
Annual Total Returns and Harvest by Type of Use and Hatchery
Doubling of Average CWT Total Return Rate

Use Type	Spring Creek	Willard	Little White Salmon	Carson	Total
Doubling of CWT return rate to:	0.56 %	0.84 %	0.70 %	0.44 %	0.64 %
Sport River	6,598	3,712	1,598	3,034	14,942
Sport Ocean	2,816	2,397	310	0	5,523
Commercial	50,204	4,478	7,854	838	63,374
Hatchery	16,764	7,952	9,656	6,282	40,654
Other	290	0	0	24	314
Total	76,672	18,539	19,418	10,178	124,807

Table 18 shows the percentage distribution of use by hatchery for the average CWT total return rate (the same distribution is assumed to apply to the doubling of the return rate scenario).

Table 18
Annual Total Returns and Harvest by Percentage of Type of Use and by Hatchery
(Based on Average CWT Hatchery Returns and Harvest Rates for each Hatchery)

Use	Spring Creek	Willard	Little White Salmon	Carson	Total
Sport River	8.6 %	20.0 %	8.1 %	29.8 %	11.9 %
Sport Ocean	3.7 %	12.9 %	1.6 %	0.0 %	4.4 %
Commercial	65.5 %	24.2 %	39.7 %	8.2 %	50.6 %
Hatchery	21.9 %	42.9 %	48.8 %	61.7 %	32.5 %
Other	0.4 %	0.0 %	1.8 %	0.2 %	0.5 %
Total	100 %	100 %	100 %	100 %	100 %

Table's 19a and 19b summarize annual economic value and impact by hatchery for the average CWT harvest rate for each hatchery and a doubling of the harvest rate, respectively. Economic values and impacts include: (1) economic value for both river and ocean fishing (**sport value**); (2) trip and equipment expenditures associated with recreational fishing (**sport expenditures**) (3) personal income effects associated with expenditures on sport ocean and river fishing (**sport income**); (4) **commercial ex vessel value**; (5) personal income associated with commercial fishing expenditures (**commercial income**); and (6) **state and federal taxes** (on recreational expenditures).

Table 19a
Summary of Annual Economic Values and Impacts
(Based on Average CWT Harvest Rates for each Hatchery)

	Spring Creek	Willard	Little White Salmon FC	Little White Salmon SC	Carson	**Total**
CWT Harvest Rate	0.22 %	0.24 %	0.23 %	0.09 %	0.09 %	**0.17 %**
Sport value	$ 341,043	$ 163,900	$ 27,148	$ 60,625	$ 162,774	**$ 755,022**
Sport Expenditures	$ 612,638	$ 344,667	$ 51,732	$ 104,923	$ 281,923	**$1,395,883**
Sport Income	$ 439,217	$ 266,502	$ 33,783	$ 63,723	$ 171,094	**$974,319**
Commercial ex vessel value	$ 455,601	$ 11,195	$ 69,061	$ 2,314	$ 7,605	**$ 545,676**
Commercial income	$ 995,294	$ 30,853	$ 150,868	$ 4,837	$ 16,613	**$ 1,198,465**
State and Federal taxes (recreational expenditures)	$ 70,523	$ 45,676	$ 5,850	$ 11,856	$ 31,495	**$ 165,400**

Table 19b
Summary of Annual Economic Values and Impacts
Doubling of Average CWT Harvest Rate

	Spring Creek	Willard	Little White Salmon FC	Little White Salmon SC	Carson	**Total**
CWT Total Return Rate	0.44 %	0.48 %	0.32 %	0.18 %	0.18 %	**0.34 %**
Sport value	$ 682,086	$ 327,800	$ 54,296	$ 121,250	$ 325,548	**$ 1,510,980**
Sport expenditures	1,225,276	$ 689,334	$ 103,464	$ 209,846	563,846	**$ 2,791,766**
Sport income	$ 878,434	$ 533,004	$ 67,566	$ 127,446	$ 342,188	**$ 1,948,638**
Commercial ex vessel value	$ 911,202	$ 22,390	$ 138,122	$ 4,628	$ 15,210	**$ 1,091,352**
Commercial income	$ 1,990,588	$ 61,706	$ 301,736	$ 9,674	$ 33,226	**$ 2,396,930**
State and Federal taxes (recreational expenditures)	$ 141,046	$ 91,352	$ 11,700	$ 23,712	$ 62,990	**$ 328,746**

Table 20 shows annual employment associated with the personal income derived from recreational and commercial use of salmon for each of the hatcheries for average CWT harvest rates and a doubling of the average harvest rate (the employment figures do not include hatchery personnel). Employment was calculated using data on angler expenditures, associated salaries and wages and related employment obtained from the report, **The Economic Importance of Sport Fishing** (American Sportfishing Association 1998).

Table 20
Annual Employment Associated with Recreational and Commercial Income Derived from Federally Produced Salmon

	Spring Creek	Willard	Little White Salmon	Carson	Total
Average CWT harvest rate	58	24	21	15	118
Doubling of average harvest rate	116	48	42	30	236

Table 21a shows a comparison of personal income impacts to the average annual operations and maintenance (O and M) cost for each hatchery (Little White Salmon NFH and Willard NFH are treated as one hatchery for budget purposes). This is ***not*** a benefit – cost ratio but is simply a method to compare **one type** of economic impact to the annual cost of running the hatchery (based on annual average budgets from 1997 to 2001 adjusted to 2001 dollars). For the four hatcheries as a whole, for every dollar in O and M cost, 73 cents are generated in personal income.

Table 21a
Comparison of Personal Income Impacts and Annual Operations and Maintenance Budget Expenditures, by Hatchery
(Based on Average CWT Harvest Rates for each Hatchery)

	Spring Creek	LWS/Willard	Carson	**Total**
Personal Income Impacts: Recreation and Commercial Use	$ 1,434,511	$ 550,566	$ 187,707	**$ 2,172,784**
Average Annual O and M Costs (1997-2001)	$ 917,836	$ 1,547,482	$ 519,251	**$ 2,984,569**
Personal Income per $1 annual O and M Costs	$ 1.56	$ 0.36	$ 0.36	**$ 0.73**

Table 21b is similar to Table 21a except that capital maintenance and construction costs are added to O and M costs for each hatchery. Tables 22a and 22b are similar to Tables 21a and 21b and are based on a doubling of the average harvest rate for each hatchery.

Table 21b
Comparison of Personal Income Impacts and Annual Total Budget Costs, including Operations and Maintenance and Construction/Capital Improvements, by Hatchery
(Based on Average CWT Harvest Rates for each Hatchery)

	Spring Creek	LWS/Willard	Carson	**Total**
Personal Income Impacts: Recreation and Commercial Use	$ 1,434,511	$ 550,566	$ 187,707	**$ 2,172,784**
Average Annual O and M Costs plus Capital Improvements (1997-2001)	$ 1,010,537	$ 1,703,778	$ 571,695	**$ 3,286,010**
Personal Income per $1 annual O and M Costs plus Capital Improvements	$ 1.42	$ 0.32	$ 0.33	**$ 0.66**

Table 22a
Comparison of Personal Income Impacts and Annual Operations and Maintenance Budget Expenditures, By Hatchery
(Based on Doubling the Average CWT Harvest Rates for each Hatchery)

	Spring Creek	LWS/Willard	Carson	**Total**
Personal Income Impacts: Recreation and Commercial Use	$ 2,869,022	$ 1,101,132	$ 375,414	**$ 4,345,568**
Average Annual O and M Cost (1997-2001)	$ 917,836	$ 1,547,482	$ 519,251	**$ 2,984,569**
Personal Income per $1 annual O and M Cost	$ 3.12	$ 0.71	$ 0.72	**$ 1.46**

Table 22b
Comparison of Personal Income Impacts and Annual Total Budget Costs, including Operations and Maintenance and Construction/Capital Improvements, By Hatchery
(Based on Doubling the Average CWT Harvest Rates for each Hatchery)

	Spring Creek	LWS/Willard	Carson	**Total**
Personal Income Impacts: Recreation and Commercial Use	$ 2,869,022	$ 1,101,132	$ 375,414	**$ 4,345,568**
Average Annual O and M plus Capital Improvements (1997-2001)	$ 1,010,537	$ 1,703,778	$ 571,695	**$ 3,286,010**
Personal Income per $1 annual O and M plus Capital Improvements	$ 2.84	$ 0.65	$ 0.66	**$ 1.32**

Table 23 summarizes fish production and costs for each of the hatcheries from 1997 to 2001. Total annual cost is based on average annual O and M costs plus capital improvements and construction costs. Carson NFH has the highest cost per released smolt at $0.40 while Spring Creek NFH has the lowest cost at $0.06. The Little White Salmon/Willard complex has the highest cost per pound of smolts at $7.77 per pound; Spring Creek NFH has the lowest cost per pound at $3.87 per pound.

Table 24 shows the cost per harvested fish for each hatchery; this is the total cost of production (O and M costs plus capital improvement and construction costs) divided by the number of harvested fish (recreation and commercial harvests combined). For the four hatcheries combined, at the average CWT harvest rates, each harvested fish is associated with $78.39 in hatchery budget costs.

Table 23
Summary of Annual Hatchery Production and Costs (1997 – 2001)

	Spring Creek	LWS/Willard	Carson	Total
Average annual smolts released	17,026,024	6,791,739	1,425,484	25,243,247
Average annual pounds of smolts released	260,822	219,167	75,569	555,557
Smolts per pound released	65.3	31.0	18.9	45.4
Total Annual Cost	$1,010,537	$1,703,778	$571,695	$3,286,010
Cost per released smolt	$0.06	$0.25	$0.40	$0.13
Cost per pound of released smolts	$3.87	$7.77	$7.56	$5.91

Table 24
Fish Harvest and Cost per Harvested Fish,
By Hatchery
(Based on Average CWT Harvest Rates for each Hatchery)

	Spring Creek	LWS/Willard	Carson	Total
Total Fish Harvest	29,809	10,175	1,936	41,920
Cost per Harvested Fish	$ 33.90	$ 167.45	$ 295.30	$ 78.39

Table 25 shows a comparison of **selected** economic values with hatchery costs; this follows the same approach as Carter (1999, p. 26). This is not a comprehensive benefit – cost analysis; it is included here as an example of how value and cost estimates, however incomplete, may be combined to give a broad, preliminary indication of the degree of economic efficiency which the hatcheries operate at.

Sport fishing value is total annual net economic value or consumer surplus associated with recreational salmon fishing; commercial value is the annual ex vessel value of the commercial catch; total value is the sum of these two values; total costs are the annual O and M costs plus capital improvements and construction; value minus costs shows the net difference between total value and costs and value divided by costs shows the ratio of total value to total cost or the total value per $1 of total cost.

Table 25
Comparison of Annual Economic Value and Costs by Hatchery
(Based on Average CWT Harvest Rates for each Hatchery)

	Spring Creek	LWS/Willard	Carson
Sport Fishing Value	$ 341,043	$ 251,673	$ 162,774
Commercial Value	$ 455,061	$ 82,470	$ 7,605
Total Value	$ 796,644	$ 334,143	$ 170,579
Total Costs	$ 1,010,537	$ 1,703,779	$ 571,695
Value - Costs	**- $ 213,893**	**- $ 1,369,636**	**- $ 401,316**
Value / Costs	0.79	0.20	0.30

Based strictly on sport fishing and commercial harvest of hatchery produced fish, given past harvest and return rates, it would be difficult to justify the continued operation of the hatcheries

as currently managed if the sole management consideration is economic efficiency in the form of positive economic benefits. However, several factors should be kept in mind: (1) several categories of potentially significant benefits have not been included in total value, such as ecological benefits, existence value, scientific research and information and environmental education and learning; (2) currently there is no requirement that federal hatcheries produce positive net economic benefits in the context of a formal benefit – cost analysis. The continued operation of hatcheries with negative net benefits (based on benefits and costs which can be reasonably measured) implies one of two things; either economics is not a management consideration or the unquantified economic and non-economic benefits of hatchery salmon production outweigh the quantified negative benefits; and (3) once smolts are released into the Columbia River, hatchery managers no longer have any control over the production process. In looking at the economic benefits of Federal salmon hatchery production, the hatcheries are burdened with very low return and harvest rates. However, CWT data covers a relatively short span of years; what has happened in the past is not necessarily an adequate guide as to what will happen in the future. As mentioned previously, the past couple of years have seen record-breaking returns of salmon to the Columbia River; whether this continues or not is unknown at this time. However, future analyses may want to consider not only past data but also reasonable and scientifically defensible future scenarios to more accurately estimate economic benefits associated with federal salmon production.

To help put the information in Table 25 in context, **Table 26** shows the addition harvest needed (other things equal) so that total value equals total cost. In order to "break-even" (using only recreational and commercial value), Spring Creek NFH would have to increase the annual number of harvested fish by 0.6 per 1,000 releases; Little White Salmon / Willard Complex by 8 per 1,000 releases and Carson by 2 harvested fish per 1,000 releases.

Table 26
Additional Value and CWT Harvest Rates Required to Reach Break-Even Point

	Spring Creek	LWS/Willard	Carson
Average CWT Harvest Return Rate	0.22 %	0.20 %	0.09 %
Harvested Fish per 1,000 Releases	2.22	2.0	0.86
Average Annual Harvest	29,809	10,175	1,936
Total Value	$796,644	$344,143	$170,379
Composite Value per Harvested Fish	$ 26.73	$ 32.84	$ 88.01
Annual Value Increase to Reach "Break-even" point	$213,893	$ 1,369,636	$ 401,316
Additional Harvest needed	8,002	41,706	4,560
Required CWT Harvest Return Rate	0.28 %	1.0 %	0.29 %
Additional Harvested fish per 1,000 Releases	0.6	8	2

Appendix A

Economic Impacts of Hatchery Budget Expenditures

In addition to angler expenditures, hatchery budget expenditures also contribute to local and regional economies. **Table A-1** summarizes the economic impacts of both salary and non-salary budget expenditures for each hatchery. Salary expenditures have been reduced by 30 percent to account for taxes, insurance and other deductions. Separate input-output models[1] were used to estimate the impacts of local spending, regional (in-State but not local) and out of State spending for each hatchery for both salary and non-salary budget expenditures. The figures shown for economic output, employment, employment income[2] and tax revenue are aggregate totals for each hatchery across all spending locales. Tax revenue includes local, county, state and federal tax revenue generated by hatchery budget expenditures.

Table A-1. Columbia River FWS Hatcheries:
Economic Impacts from Annual Budget Expenditures
(Thousands, 1999 Dollars)

	Local Impacts			Regional Impacts		
Budget expenditures	Economic Activity generated	Employment	Employment income	Economic Activity generated	Employment	Employment income
Salary	$1,461	24	$474	$2,582	36	$877
Non-salary	$255	3	$67	$1,638	18	$519
Total	$1,716	27	$541	$4,220	54	$1,396

[1]The economic impacts of hatchery budget expenditures were derived using IMPLAN, a regional input-output modeling and software system. For additional information, see MIG, Inc.IMPLAN System and Olson and Lindall, IMPLAN Professional Software, Analysis and Data Guide.

[2]Employment income as used here is defined as "labor income" in the IMPLAN system and consists of employee compensation and proprietor income (MIG, Inc. 1999, p. 401). It is generally comparable to "employment earnings" used in the RIMS II system.

References

ADFG**. Salmon Commercial Catch and Ex Vessel Prices**. Alaska Department of Fish and Game. Fairbanks AK. 2001.

BCSMC**. Salmon Commercial Prices and Catch**. British Columbia Salmon Marketing Council. Vancouver, British Columbia. 20001.

Boyle, Kevin J., Brian Roach and David G. Waddington**. 1996 Net Economic Values for Bass, Trout and Walleye Fishing, Hunting and Wildlife-Associated Recreation.** Addendum to the 1996 National Survey of Fishing, Hunting and Wildlife-Associated Recreation. Report 96-2. Division of Federal Aid, U.S. Fish and Wildlife Service. Washington, D.C. August 1998.

Buchal, James L. **The Great Salmon Hoax**. Iconoclast Publishing Company. Aurora OR.1998.

Fish Passage Center. Hatchery Database. Miscellaneous years. Portland OR.

Huppert, Daniel D., David L. Fluharty with Eric E. Doyle and Amjoun Benyounes. **Economics of Snake River Salmon Recovery: A Report to the National Marine Fisheries Service**. School of Marine Affairs, College of Ocean and Fishery Sciences. University of Washington. Seattle WA. October 1996.

Lumley, Paul. *Over-the-Bank-Sales Increase Value to Tribal Fishers and Their Families*. **Wana Chinook Tymoo**. Issue 3, 1997. Columbia River Inter-Tribal Fish Commission. Portland OR. 1997.

MIG, Inc. **IMPLAN System** (1994 Data and Software). 1940 South Greely Street, Suite 101, Stillwater, MN 55082.

Miller, Ronald E. and Peter D. Blair. **Input-Output Analysis: Foundations and Extensions**. Englewood Cliffs NJ: Prentice-Hall, 1985.

National Research Council. **Upstream. Salmon and Society in the Pacific Northwest**. National Academy Press. Washington, D.C. 1996.

ODFW and WDFW. **Status Report. Columbia River Fish Runs and Fisheries, 1938 – 99**. Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife. Portland OR and Olympia WA. October 2000.

ODFW and WDFW. **Status Report. Columbia River Fish Runs and Fisheries, 1938 – 97**. Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife. Portland OR and Olympia WA. June 1998.

ODFW and WDFW. **Status Report. Columbia River Fish Runs and Fisheries, 1938 – 94**. Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife. Portland OR and Olympia WA. August 1995.

ODFW and WDFW. **Status Report. Columbia River Fish Runs and Fisheries, 1938 – 98**. Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife. Portland OR and Olympia WA. November 1999.

ODFW. **Coastal Salmonid and Willamette Trout Hatchery Program Review**. Appendix C – Economic Considerations. Draft. Oregon Department of Fish and Game. Corvallis OR. March 15, 1999.

Olsen, Darryll, Jack Richards and R. Douglas Scott. *Existence and Sport Values for Doubling the Size of Columbia River Basin Salmon and Steelhead Runs*. **Rivers**. Vol. 2, No. 1. Pp. 44-56. 1991.

Olsen, Darryll and Jack Richards. **Rogue River Summer Steelhead and Fall Chinook Sport Fisheries. Economic Valuation Study. Summary Report**. Sponsored by the Rogue Valley Council of Governments, Oregon Department of Fish and Wildlife, U.S. Forest Service and Bureau of Land Management. September 1992.

Olson, Doug and Scott Lindall. **IMPLAN Professional Software, Analysis and Data Guide**. 1940 South Greeley Street, Suite 101, Stillwater, MN 55082. 1996.

PFMC. **Review of 1998 Ocean Salmon Fisheries.** Pacific Fishery Management Council. Portland OR. February 1999.

PFMC. **Review of 1999 Ocean Salmon Fisheries.** Pacific Fishery Management Council. Portland OR. February 2000.

Radtke, Hans D., Shannon W. Davis and Rebecca L. Johnson. **Lower Snake River Juvenile Salmon Migration Feasibility Study. Anadromous Fish Economic Analysis. Abbreviated Version.** Prepared for Foster Wheeler Environmental Corporation and U.S. Army Corps of Engineers. October 1999.

Radtke, Hans. **The Changing Nature of Salmon Economics in the Columbia Basin**. Prepared for the Northwest Power Planning Council. Portland OR. April 26, 2000.

Scott, Michael J., Ronald J. Moe, Michael R. LeBlanc, and J. William Currie. *Columbia River Salmon: Benefit-Cost Analysis and Mitigation*. **Northwest Environmental Journal**. Vol. 3, No. 2. pp. 121-152. 1987.

Smith, Courtland L. **Salmon Fishers of the Columbia.** Oregon State University Press. Corvallis OR. 1979.

Statistics Canada. **Consumer Price index**. 1992-2000. Ottawa Ontario. 2001.

The Research Group. **Oregon Angler Survey and Economic Study.** Final Report. Prepared for Oregon Department of Fish and Wildlife. Corvallis OR. June 1991.

USFWS. **Little White Salmon/Willard National Fish Hatchery Complex. Station Development Plan**. U.S. Fish and Wildlife Service, Division of Engineering. Region 1. 1987.

USFWS. **Annual Report. Spring Creek National Fish Hatchery**. U.S. Fish and Wildlife Service. Underwood WA. 1997, 1998, 1999.

USFWS. **Annual Report. Little White Salmon/Willard National Fish Hatchery**. U.S. Fish and Wildlife Service. Cook WA. 1997, 1998, 1999.

USFWS. **Annual Report. Carson National Fish Hatchery**. U.S. Fish and Wildlife Service. Carson WA. 1997, 1998, 1999.

U.S. Department of Commerce. **Annual Consumer Price Index**. Bureau of Labor Statistics. Washington, D.C. 2001.

U.S. Department of Commerce. **Making Economic Information More Useful for Salmon and Steelhead Production Decisions**. Technical Memorandum NMFS F/NWR-8. National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Washington, D.C. 1984.

U.S. Department of Commerce. **Annual Landings**. National Marine Fisheries Service. Silver Springs MD. 2001.

Walsh, Richard G., Donn M. Johnson, and John R. McKean. *What Can We Learn From 20 years Of Work With TCM and CVM.* Annual Meeting, W-133 and Western Regional Science Association. Molokai, Hawaii. February 22, 1990.