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**Enhanced Salmonid Production in British Columbia, Canada
During 1978-2004 (1977 – 2003 Brood Years)**

by

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ABSTRACT

Lehmann, S. and J. R. Irvine. 2005. Canadian Enhanced Salmonid Production During 1978-2004 (1977-2003 brood years). (NPAFC Doc. 869). 12 p. Fisheries and Oceans Canada.

The Salmonid Enhancement Program (SEP) in British Columbia, Canada was undertaken in 1977 to rebuild stocks and increase catch through the expanded use of enhancement technology. The program comprises nearly 300 projects that produce chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), chum (*O. keta*), pink (*O. gorbuscha*), and sockeye salmon (*O. nerka*), as well as small numbers of steelhead salmon (*O. mykiss*) and cutthroat trout (*O. clarki*). Projects include hatcheries, fishways, spawning and rearing channels, habitat improvements, flow control works, lake fertilization, and small classroom incubators, and range in size from spawning channels releasing nearly 100 million juveniles annually, to schools with classroom incubators that release fewer than one thousand. Data from facilities that operate outside the direction of SEP are not included in this report. Steelhead and cutthroat are a provincial government responsibility, but some enhancement takes place at SEP facilities under a cooperative arrangement. Steelhead and cutthroat numbers in this report do not include releases from facilities operated by the Freshwater Fisheries Society of BC.

Introduction

The Salmonid Enhancement Program (SEP) in British Columbia, Canada was undertaken in 1977 primarily to rebuild depressed stocks and increase catch through the expanded use of enhancement technology. The program was designed to increase fishing opportunities, involve the public and raise awareness, create jobs and increase economic development in coastal and First Nations communities, and improve understanding of salmonid populations.

SEP incorporated three existing spawning channels built in the 1960's and five production hatcheries that began operation in the early 1970's. SEP was combined with Habitat Management in 1995 and is currently managed by the Oceans, Habitat and Enhancement Branch (OHEB) of Fisheries & Oceans Canada. The enhancement program comprises nearly 300 projects throughout British Columbia that produce chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), chum (*O. keta*), pink (*O. gorbuscha*), and sockeye salmon (*O. nerka*), as well as small numbers of steelhead salmon (*O. mykiss*) and cutthroat trout (*O. clarki*).

Projects include hatcheries, fishways, spawning and rearing channels, and small classroom incubators, ranging in size from spawning channels producing nearly 100 million juvenile salmon annually to school classroom incubators releasing fewer than one thousand juveniles. Projects are operated by OHEB staff or contracted to community and native groups, as well as by volunteers with some OHEB support. Up to 10,000 volunteers participate annually in habitat restoration and improvement projects. OHEB works with First Nations, industry, community groups and other government agencies to design and implement habitat restoration projects.

A public involvement and education program offers technical support and funding to volunteers who operate community salmonid enhancement and stewardship projects, training and supporting the public to actively monitor, protect, and improve fish habitats. OHEB developed educational packages to teach children about salmon and the need to protect habitat and watersheds. OHEB staff also provide technical advice to enhancement activities, including hatcheries, which operate outside OHEB.

The purpose of this document is to present a summary of release information from enhancement facilities in BC. More details are available from the Enhancement Support and Assessment Unit within the Oceans, Habitat & Enhancement Branch.

Methods

Depending on the species and enhancement approach, fish are released at various stages. Chum and pink salmon are released either immediately after emergence from channels or incubation boxes (unfed fry) or after one month of feeding (fed fry). Coho are released as fry, either at emergence or after 3 to 5 months of rearing, or as smolts after one year of rearing. Most sockeye emigrate volitionally from channels soon after emergence, although a small number are hatchery incubated and short-term reared. Sockeye are also enhanced through lake fertilization programs, and most migrate to sea after one year of lake rearing. Coastal stocks of chinook are released after 3 - 4 months of rearing, while interior stocks are frequently reared for one year. As the latter constitute a very small component of the total numbers of chinook released, they are not tabulated separately in this report. Releases from hatcheries are usually estimated by subtracting known egg and fry mortalities from egg numbers while releases from manned channels are estimated by sampling outmigrants.

Annual egg and juvenile release targets for hatcheries are set pre-season for each stock, in consultation with project managers, stock assessment biologists and harvest management biologists. Potential adult

production (based on previous average survival rates), species interactions, effects on natural stocks, harvest concerns, habitat capacity and project capacity are considered when developing targets.

Enhanced contributions and survivals of chinook, coho, and chum salmon are estimated by marking a portion of the fish released and subsequently recovering these marked fish in fisheries and the escapement. Pinks are not currently marked. Marking occurs prior to release, and recovery takes place through sampling programs in the sport, commercial and aboriginal fisheries and through recovery programs on the spawning grounds and at enhancement sites. Marks vary by species, with coded wire tags used for chinook, coho and some chum stocks, and fin clips for other chum stocks. Beginning in 1996, most enhanced coho from southern B.C. have been marked with a fin clip to enable the prosecution of selective hatchery-mark fisheries.

It is not possible to assess each enhancement project and release strategy. Consequently, certain stocks are used as indicators, their production is marked annually and rigorous escapement sampling and estimation programs are normally carried out. Survival and exploitation estimates are used for time series analyses of both wild and enhanced populations.

Few projects enhance sockeye. Production is estimated using run reconstruction or historical survivals. Experimental groups of reared sockeye may be marked with fin clips, with recovery on the spawning grounds or at the project. No marking of pinks has occurred since brood year 1992.

Some species and stocks are given an otolith mark to estimate enhanced contributions to terminal areas. Thermal marking is coordinated through the Stock Assessment Branch at the Pacific Biological Station. Additionally, a few stocks, mainly sockeye, have been marked with strontium chloride, a naturally occurring salt.

Results

Release numbers from hatcheries and manned spawning channels operated by OHEB staff, contracted to community and native groups or operated by volunteer groups under the direction of OHEB staff are provided by brood (Table 1) and release (Table 2) year. Releases for 2004 are broken down by area (Table 3). Production from unmanned channels, overwintering ponds, lake enrichment programs and other habitat restoration projects are not included in the tables. Steelhead and cutthroat numbers do not include releases from facilities operated by the Freshwater Fisheries Society of B.C. Additional information about steelhead and cutthroat releases can be found in Fisheries Inventory Database on the B.C. Ministry of Sustainable Resource Management web site at <http://www.bcfisheries.gov.bc.ca/>. Locations of larger facilities reporting releases in the tables are shown in Figures 1a, 1b and 1c. Data for the final year presented (2003 brood and 2004 release year) are preliminary and will be updated in future reports. Similarly, this report updates release numbers provided in earlier reports. Releases from some facilities funded through the Aboriginal Fisheries Strategy that receive significant technical support from OHEB are included.

Total releases approximately doubled between the 1977 and 1988 brood years, with the largest numerical increase for chum fry. Since 1995, poor marine survival for some southern B.C. chum stocks led to decreased escapement, resulting in lower production for several years. Declining harvest rates for Fraser River chum led to reductions in egg targets for 1999 at Fraser River facilities. Maximum production of chinook and coho smolts releases was reached in the early to mid 1980s. In recent years, increased efforts were made to rebuild severely depressed stocks, including upper Skeena and interior Fraser River coho. Unfed pink releases fluctuate annually because of the natural cycles in the Fraser River and the phasing in and out of pink projects since the 1988 brood year. Pink fed fry releases peaked in 1985 at more than 5 million but have since declined because of reduced emphasis on this strategy. Since 1994, disease

mortality for some years has affected spawning success for Skeena River sockeye channel production. Production from Fraser River sockeye channels fluctuates because of natural cycles. The Salmonid Enhancement Program (SEP) has been operating with an annual deficit since 1996. In 2004, DFO initiated a review to determine if budget targets could be met with least impact on objectives. Production reductions were targeted to minimize impact on fisheries and were focused where stocks were strong and there were large hatchery surpluses. Production was maintained for all stocks enhanced for rebuilding objectives. No further reductions are proposed for 2005 brood to meet budget constraints.

OHEB continues to implement habitat restoration and stewardship projects throughout B.C. Cooperative programs with other governmental and non-governmental agencies include constructing side-channels, increasing water flows, stabilizing stream banks, enriching nutrient poor lakes and rivers, and rebuilding estuary marshes.

Since 1998, conservation concerns for certain populations of wild salmon, primarily coho and sockeye, have constrained salmon harvest. Many remaining fisheries focus on enhanced stocks.

Summary

Data are presented for releases by brood and release year, species and release stage for facilities under the direction of the Oceans, Habitat & Enhancement Branch of Fisheries & Oceans Canada. Since 1998, Fisheries & Oceans Canada has implemented more conservation based management of salmon fisheries, with many fisheries are being directed towards enhanced stocks.

Figure 1a Locations of selected British Columbia, Canada enhancement facilities

Enhancement Sites Within the Fraser River Watershed and the Lower Mainland

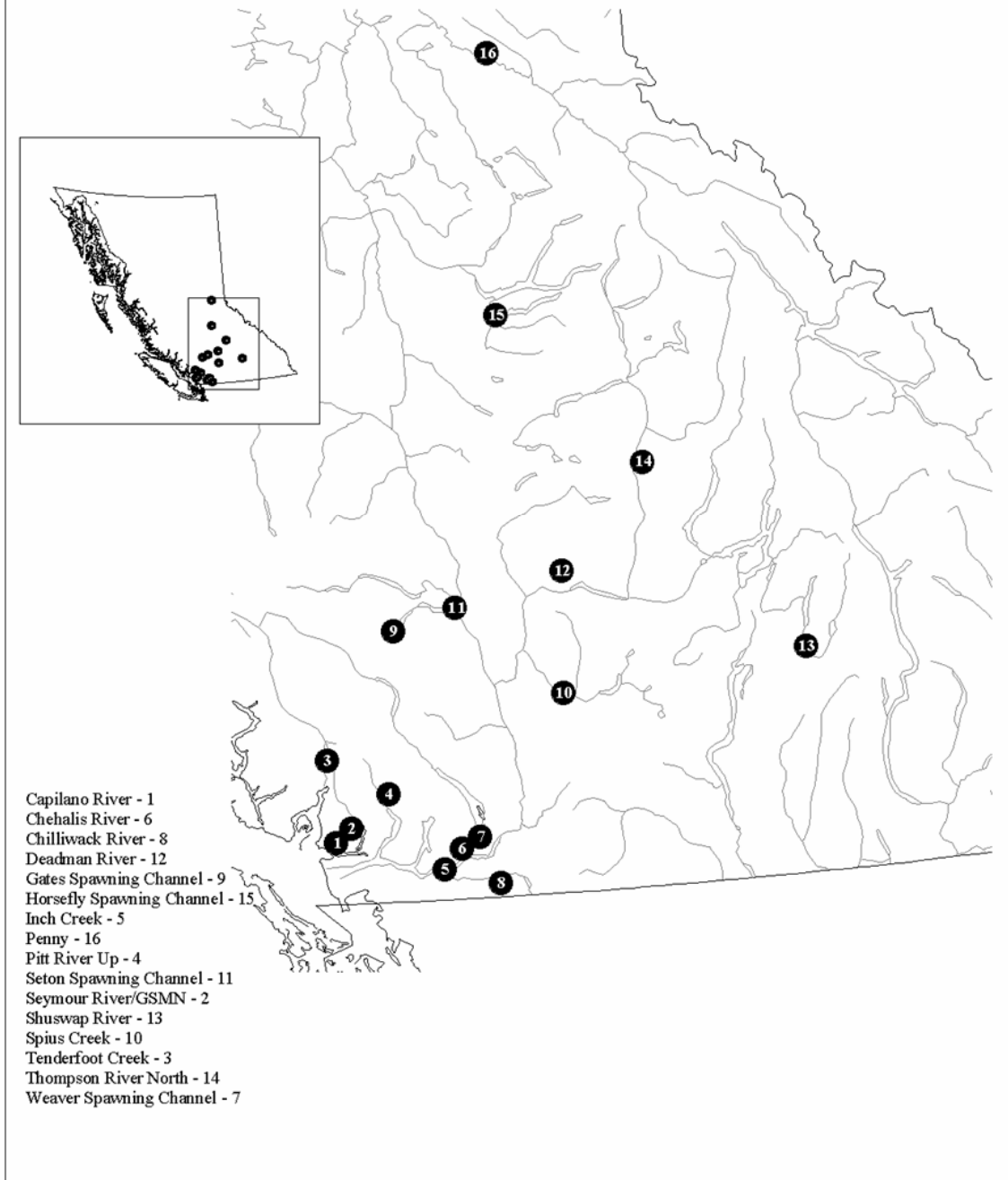


Figure 1b Locations of selected British Columbia, Canada enhancement facilities.

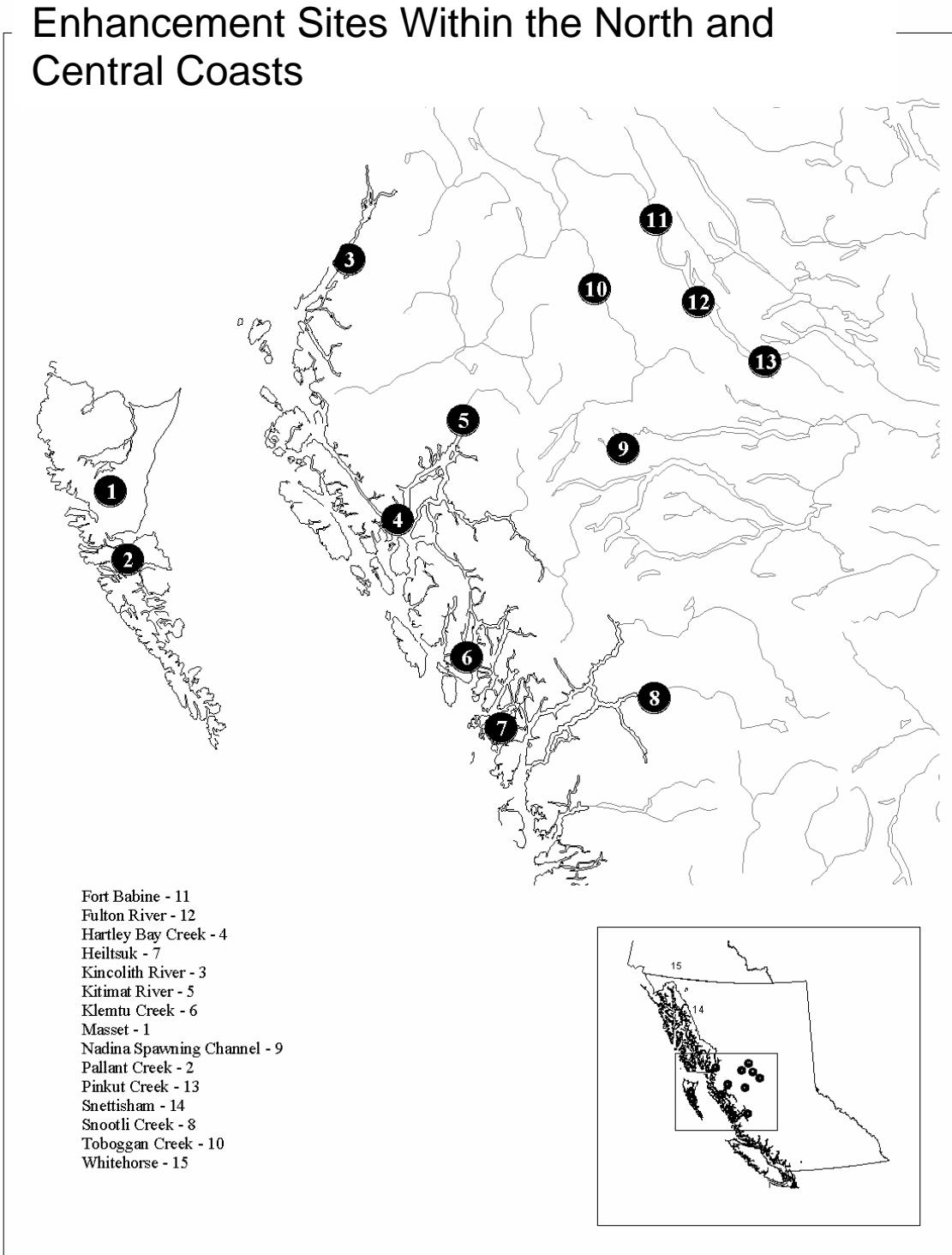


Figure 1c Locations of selected British Columbia, Canada enhancement facilities.

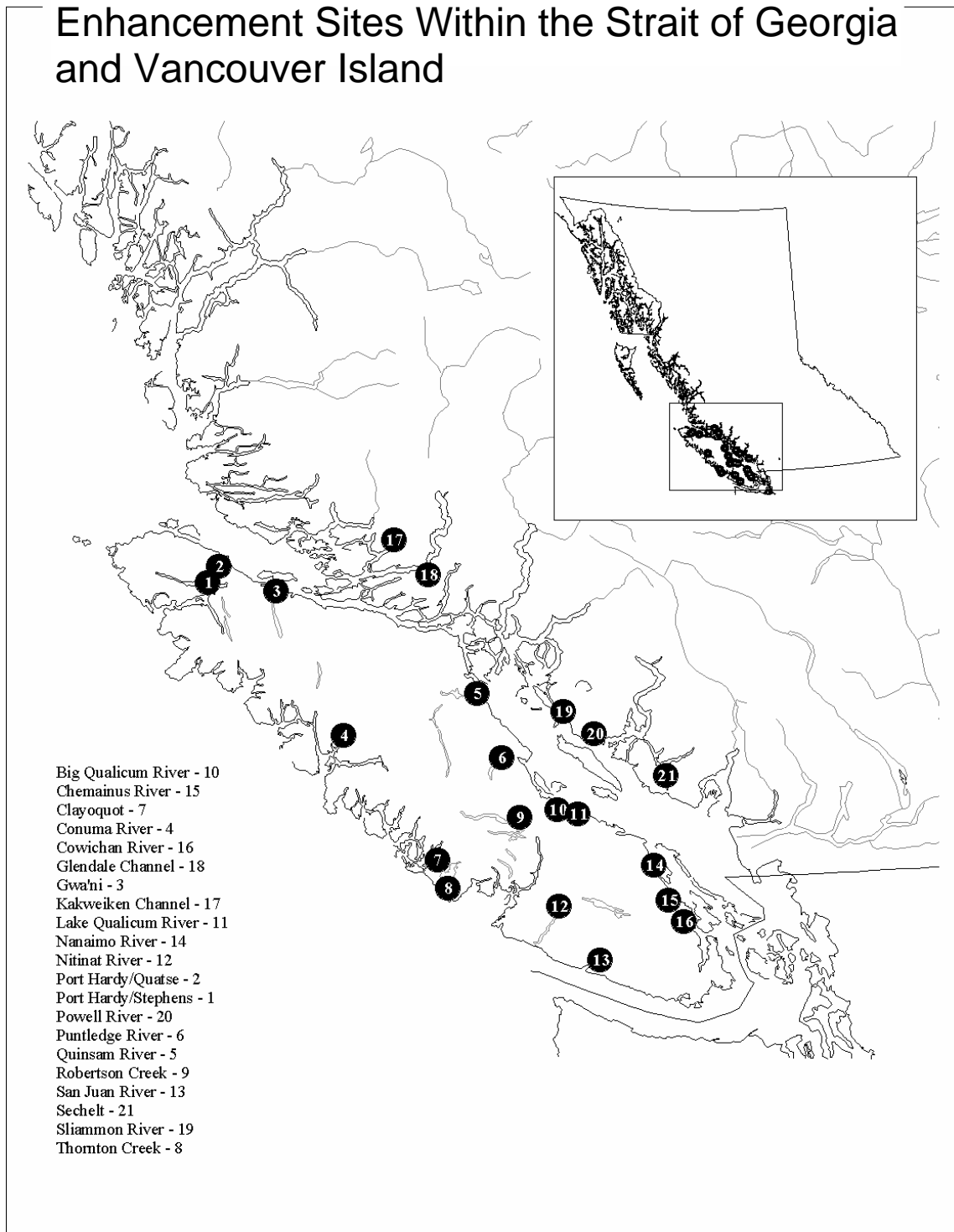


Table 1. Releases of juveniles by brood year from OHEB hatcheries and manned channels in British Columbia, Yukon, and Transboundary Area, Canada

Brood Year	Chinook	Chum		Coho		Pink		Sockeye	Cutthroat	Steelhead
		Unfed	Fed	Fry	Smolt	Unfed	Fed			
1977	13,620,370	52,127,027	1,904,625	2,073,819	2,984,462	31,029,220		191,179,000		127,810
1978	14,253,404	48,218,296	5,535,566	1,012,721	3,741,951	750		133,739,000		268,918
1979	16,379,080	69,550,228	9,191,947	3,691,819	4,963,264	26,145,904	358,639	200,179,521	682	310,292
1980	19,850,845	70,604,678	29,684,300	2,449,038	5,229,572	4,705,834	1,859,631	191,071,400	3,012	396,584
1981	17,563,349	50,709,042	68,980,710	7,311,022	4,889,684	33,113,088	492,034	170,814,370	9,732	711,136
1982	24,854,529	86,930,258	69,365,130	10,773,108	6,898,222	2,510,301	423,038	194,054,919	43,077	956,643
1983	29,374,066	83,266,067	85,579,589	8,930,958	13,585,563	27,341,916	1,521,896	128,964,333	33,970	1,400,810
1984	34,864,768	52,525,108	103,779,630	12,887,280	12,000,760	3,783,368	2,296,285	226,572,635	72,347	1,311,591
1985	42,736,623	41,608,091	102,464,677	8,868,652	9,690,856	25,432,597	5,057,021	157,434,930	109,045	1,501,462
1986	53,815,001	96,273,382	85,842,800	11,505,565	10,079,759	11,585,712	4,509,098	180,106,075	157,749	2,073,374
1987	63,631,981	101,411,170	75,979,591	8,066,239	9,521,191	43,221,480	4,807,689	122,439,076	179,737	1,896,518
1988	64,254,578	108,566,723	87,928,664	7,668,159	11,162,586	13,504,123	2,827,349	198,689,081	194,543	1,940,636
1989	63,254,499	83,008,150	92,214,006	9,617,976	11,699,468	47,373,147	2,884,163	206,752,792	164,027	1,840,159
1990	66,114,433	94,291,267	94,759,699	8,527,864	12,092,119	46,254,273	1,023,076	223,080,058	181,781	1,841,700
1991	59,326,978	76,457,221	96,839,355	9,192,045	10,689,827	46,709,818	1,584,525	227,135,058	178,076	1,642,679
1992	57,663,640	113,382,987	89,286,432	6,367,148	10,365,043	12,982,461	1,781,339	233,649,779	159,793	1,200,172
1993	50,534,844	101,495,532	93,399,435	6,457,407	10,749,888	36,575,827	1,576,168	179,704,118	172,851	1,061,360
1994	53,131,692	85,189,766	103,998,196	6,250,436	10,619,207	8,576,269	1,981,042	133,196,977	120,128	1,008,803
1995	45,082,659	33,223,512	87,665,283	6,833,280	11,298,960	32,317,111	2,001,615	78,186,811	128,428	960,635
1996	56,839,800	16,662,042	93,102,003	5,784,716	11,795,961	9,456,957	1,472,567	257,799,453	138,214	711,072
1997	49,786,398	45,104,033	104,106,311	5,212,022	11,594,104	33,090,039	1,640,496	85,229,632	85,676	995,164
1998	54,095,664	80,420,855	91,556,525	9,104,197	14,377,559	13,643,600	150,482	136,673,928	127,234	647,365
1999	53,211,715	45,515,245	78,593,285	8,367,907	12,780,771	10,588,053	3,198,637	122,772,649	105,283	670,415
2000	45,648,030	16,468,059	59,351,149	8,734,094	12,752,744	12,193,240	999,207	139,308,827	76,387	686,101
2001	52,784,982	73,981,946	81,394,064	7,870,302	13,538,679	16,885,480	2,550,411	228,104,415	52,844	779,046
2002	50,327,033	55,510,125	82,166,151	5,529,432	10,388,040	14,589,187	1,160,523	234,696,513	79,746	623,695
2003	46,347,283	37,561,318	54,687,248	4,143,964	n/a	15,624,437	1,423,758	205,857,590	73,944	606,235

Table 2. Releases of juveniles by release year from OHEB hatcheries and manned channels in British Columbia, Yukon, and Transboundary Area, Canada

Release Year	Chinook	Chum		Coho		Pink		Sockeye	Cutthroat	Steelhead
		Unfed	Fed	Fry	Smolt	Unfed	Fed			
1978	13,582,355	52,127,027	1,904,625	2,073,819		31,029,220		191,179,000		166,941
1979	14,266,797	48,218,296	5,535,566	1,012,721	2,984,462	750		133,739,000	682	290,453
1980	16,370,618	69,550,228	9,191,947	3,691,819	3,741,951	26,145,904	358,639	200,179,521	2,000	355,750
1981	19,818,676	70,604,678	29,684,300	2,449,038	4,963,264	4,705,834	1,859,631	191,071,400	5,700	500,275
1982	17,602,360	50,709,042	68,980,710	7,293,522	5,229,572	33,113,088	492,034	170,814,370	13,608	976,734
1983	24,875,258	86,930,258	69,365,130	10,790,608	4,889,684	2,510,301	423,038	194,054,919	37,913	1,191,999
1984	29,377,307	83,266,067	85,579,589	8,920,958	6,881,907	27,341,916	1,521,896	128,964,333	24,658	1,285,719
1985	34,453,016	52,525,108	103,779,630	12,840,556	13,576,282	3,783,368	2,296,285	226,572,635	92,728	1,329,526
1986	42,839,609	41,608,091	102,464,677	8,873,910	12,021,784	25,432,597	5,057,021	157,434,930	110,507	2,201,706
1987	53,704,259	96,273,382	85,842,800	11,557,031	9,694,943	11,585,712	4,509,098	180,077,635	162,435	1,889,935
1988	63,503,169	101,411,170	75,979,591	8,066,239	10,080,244	43,221,480	4,807,689	122,448,240	191,794	1,810,897
1989	63,972,035	108,566,723	87,928,664	7,668,159	9,521,191	13,504,123	2,827,349	198,639,174	181,020	1,791,215
1990	63,046,682	83,008,150	92,214,006	9,617,976	11,162,586	47,373,147	2,884,163	206,749,382	158,512	1,950,953
1991	66,089,512	94,291,267	94,759,699	8,527,544	11,699,468	46,254,273	1,023,076	223,152,651	184,025	1,626,254
1992	58,846,227	76,457,221	96,839,355	9,171,415	12,092,119	46,709,818	1,584,525	227,135,058	180,389	1,307,943
1993	57,699,414	113,382,987	89,286,432	6,388,098	10,689,827	12,982,461	1,781,339	233,649,779	162,443	1,160,891
1994	50,474,694	101,495,532	93,399,435	6,440,407	10,365,043	36,575,827	1,576,168	179,704,118	148,498	1,068,134
1995	53,799,002	85,189,766	103,998,196	6,267,436	10,749,888	8,576,269	1,981,042	133,196,977	116,773	940,106
1996	45,174,841	33,223,512	87,665,283	6,827,280	10,619,207	32,317,111	2,001,615	78,186,811	136,085	705,929
1997	56,599,109	16,662,042	93,096,966	5,773,882	11,298,960	9,456,957	1,472,567	257,799,453	136,258	886,307
1998	49,607,162	45,104,033	104,111,348	5,184,831	11,795,961	33,138,850	1,640,496	85,229,632	84,487	779,604
1999	54,415,602	80,420,855	91,556,525	9,139,665	11,594,104	13,594,789	150,482	136,672,678	126,087	687,682
2000	53,015,700	45,515,245	78,593,285	8,376,464	14,377,559	10,588,053	3,198,637	122,791,525	109,271	650,463
2001	46,069,569	16,468,059	59,351,149	8,734,094	12,780,771	12,193,240	999,207	139,287,310	74,831	657,980
2002	52,983,886	73,981,946	81,394,064	7,870,302	12,752,744	16,885,480	2,550,411	228,105,140	48,488	719,297
2003	50,203,606	55,510,125	82,141,151	5,529,432	13,538,679	14,589,187	1,160,523	234,692,171	81,654	656,209
2004	46,957,779	37,561,318	54,712,248	4,143,964	10,388,040	15,624,437	1,423,758	205,865,098	77,460	574,984

Table 3. Releases by Area in 2004 from OHEB hatcheries and manned channels in British Columbia, Yukon, and Transboundary Area, Canada

Area	Stat	Species						
		Chinook	Chum	Coho	Pink	Sockeye	Cutthroat	Steelhead
Yukon & Transboundary	120	243,045	100					
Total		243,045	100					
Nass R	03	70,903		90				
Total		70,903		90				
Skeena R	04A	266,009		137,348		119,700,000		
Total		266,009		137,348		119,700,000		
North Coast	04	25,000		28,035				
	06	1,484,453	4,338,437	669,452			8,330	69,373
Total		1,509,453	4,338,437	697,487			8,330	69,373
Queen Charlotte Is	01	203,000		25,285				
	02E	1,760	9,185,188	472,296				
Total		204,760	9,185,188	497,581				
Central Coast	07		1,579,210	26,728		71,337		
	08		6,890,772	10,756				
Total			8,469,982	37,484		71,337		
West Coast Vancouver Is	22	4,144,523	23,768,759	415,145				2,997
	23	8,729,866	353,552	988,457				
	24	487,742		140,523				
	25	3,455,418	3,704,567	69,765				
	26		2,500					
	27	246,934	30,000	534,090				
Total		17,064,483	27,859,378	2,147,980				2,997
Johnstone St	11		17,600	203,500	23,814			
	12	178,863	199,213	390,300	1,600,788	602,090		47,336
Total		178,863	216,813	593,800	1,624,602	602,090		47,336
Str of Georgia	13	4,083,740	24,000	1,417,402	6,216,635		5,438	22,335
	14	11,326,806	28,513,003	2,813,127	7,166,104		8,832	132,355
	15	817,046	976,905	288,619				
	16	298,098	10,000	154,184	312,064			900
	17	466,605	640,687	152,614	129,164			
	18	1,761,282	132,345	17,632				
	19	314,818	91,576	157,261				
	20	1,064,000	1,490	175,760				
	28	1,615,366	954,304	1,174,078	241,745		3,516	64,599
Total		21,747,761	31,344,310	6,350,677	14,065,712		17,786	220,189

Table 3 cont.

Area	Stat	Species						
		Chinook	Chum	Coho	Pink	Sockeye	Cutthroat	Steelhead
Lower Fraser	29A			1,860				
	29B	154,000	250,000	130,586	122,000		2,000	
	29C	145,659	159,068	389,129	202,407	5,851,159	29,270	23,273
	29D	1,959,580	8,682,603	1,548,241	1,023,744	45,230,512	20,074	89,372
	29E	1,723,484	1,767,687	1,587,328	9,730			122,444
Total		3,982,723	10,859,358	3,657,144	1,357,881	51,081,671	51,344	235,089
Upper Fraser	29F	394,814		317,173		5,810,000		
	29G					27,000,000		
	29I	174,275				1,600,000		
	29J			46,740				
	29K	1,120,690		48,500				
Total		1,689,779		412,413		34,410,000		
Total All Areas		46,957,779	92,273,566	14,532,004	17,048,195	205,865,098	77,460	574,984