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Enhanced Salmonid Production in British Columbia, Canada
During 1978-2003 (1977 – 2002 Brood Years)

by

S. Lehmann¹ and J. R. Irvine²

¹Fisheries and Oceans Canada
Oceans, Habitat and Enhancement Branch
401 Burrard Street
Vancouver, B.C. V6C 3S4
CANADA

²Fisheries and Oceans Canada
Science Branch, Stock Assessment Division
Pacific Biological Station
Nanaimo BC V9T 6N7
CANADA

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ABSTRACT

Lehmann, S. and J. R. Irvine. 2004. Canadian Enhanced Salmonid Production During 1978-2003 (1977-2002 brood years). (NPAFC Doc. 801). 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 occurs 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, generate jobs and 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). 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 finclips 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 finclips, 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 2003 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 on the B.C. Fisheries web site (<http://www.bcfisheries.gov.bc.ca/>) at <http://srmapps.gov.bc.ca/apps/fidq/stockedSpeciesSelect.do>. Locations of larger facilities reporting releases in the tables are shown in Figures 1a, 1b and 1c. Data for the final year presented (2002 brood and 2003 release year) are preliminary and will be updated in future reports. Similarly, this report updates preliminary 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.

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 wild coho stocks 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

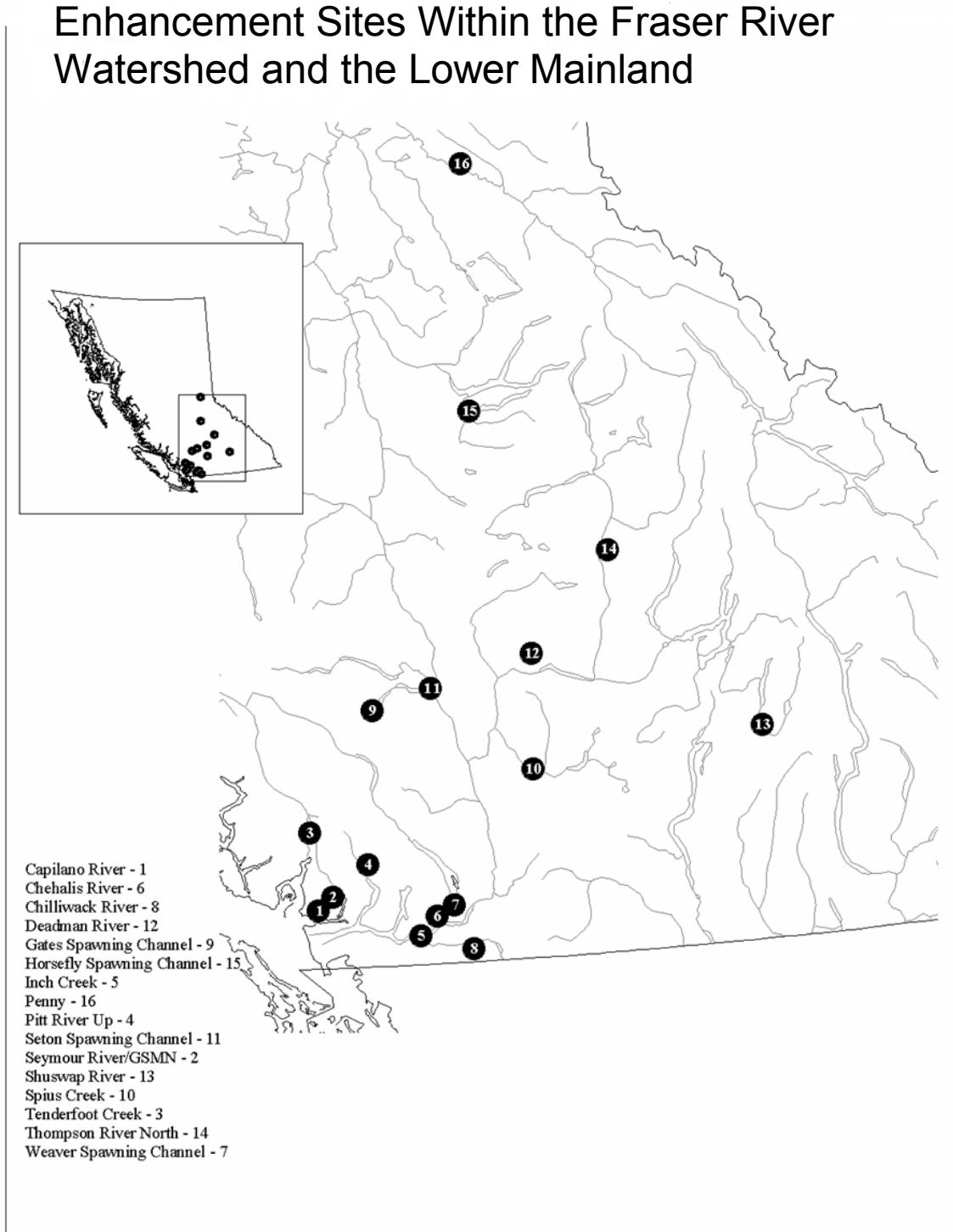
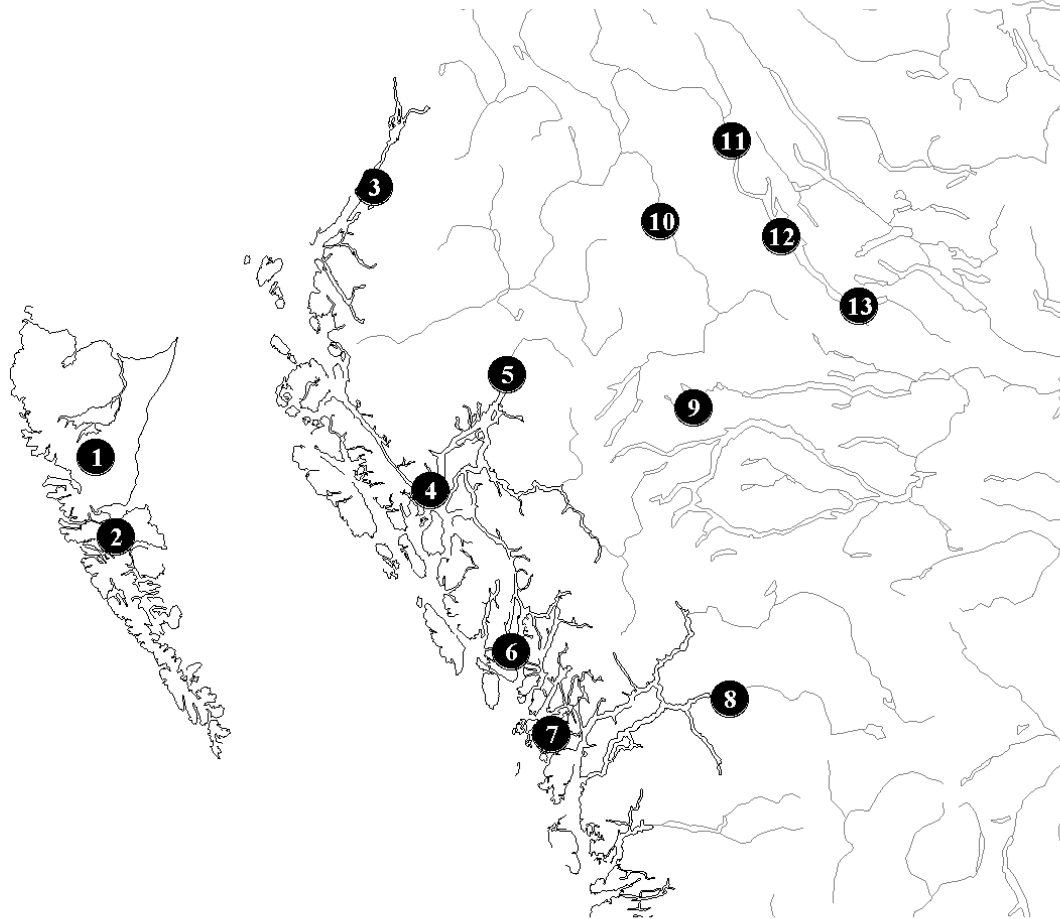


Figure 1b Locations of selected British Columbia, Canada enhancement facilities.

Enhancement Sites Within the North and Central Coasts



- Fort Babine - 11
- Fulton River - 12
- Hartley Bay Creek - 4
- Heiltsuk - 7
- Kincolith River - 3
- Kitimat River - 5
- Klemtu Creek - 6
- Masset - 1
- Nadina Spawning Channel - 9
- Pallant Creek - 2
- Pinkut Creek - 13
- Snettisham - 14
- Snootli Creek - 8
- Toboggan Creek - 10
- Whitehorse - 15

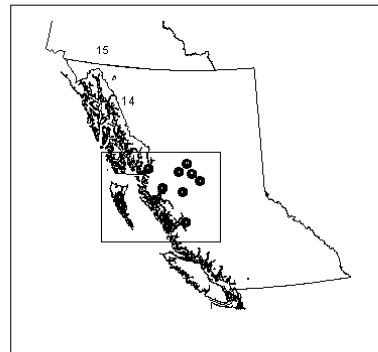


Figure 1c Locations of selected British Columbia, Canada enhancement facilities.

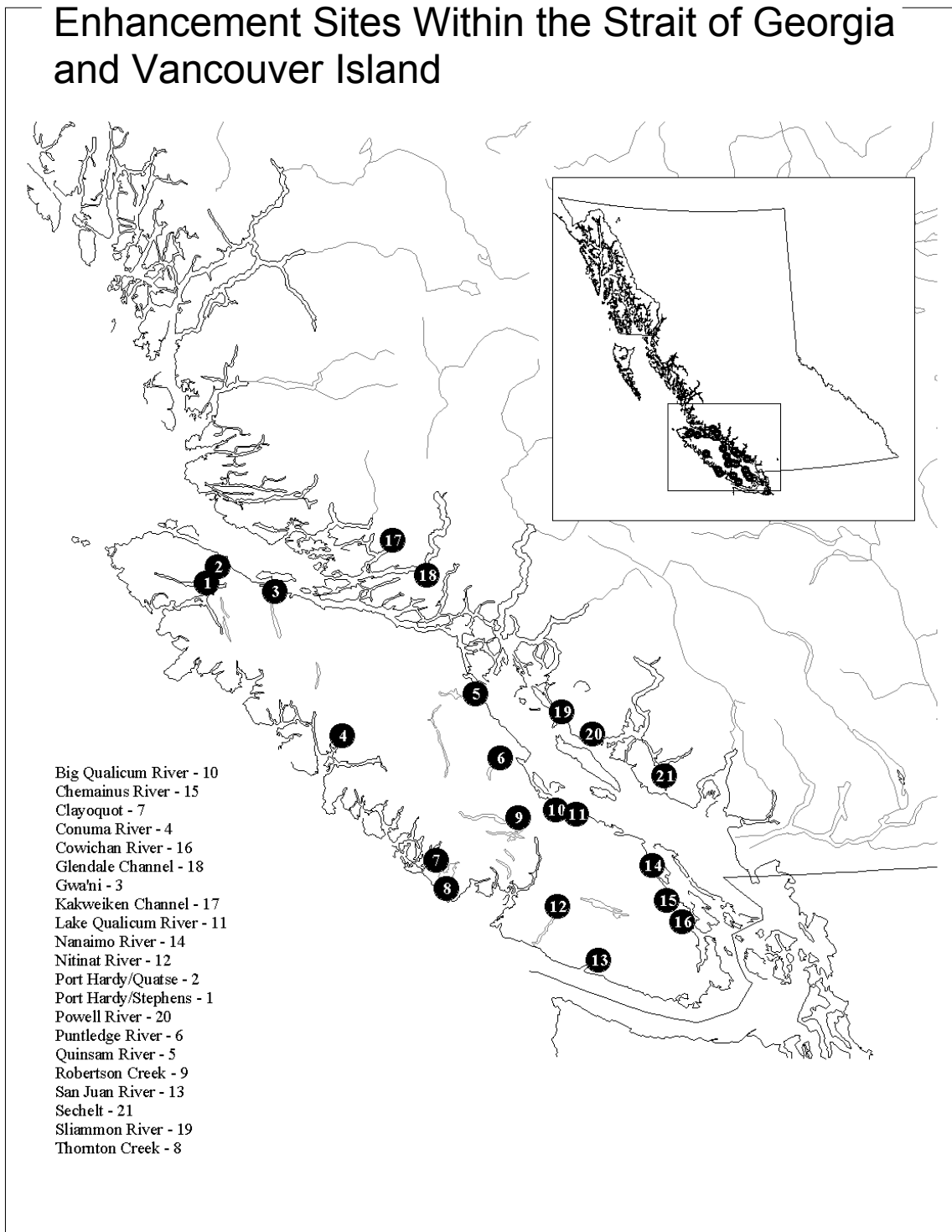


Table 1. Releases of juveniles by brood year from OHEB hatcheries and manned channels in British Columbia, Yukon, and Transboundary Area, Canada

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	8,852,842	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	198,725,634	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	8,510,942	12,109,041	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	5,212,020	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	14,379,424	13,643,600	150,482	136,673,928	127,234	647,365
1999	53,211,644	45,515,245	78,593,285	8,367,907	12,780,771	10,588,053	3,198,637	149,772,649	105,283	670,415
2000	45,094,758	16,468,059	59,351,149	8,731,094	12,737,679	12,193,240	999,207	181,839,955	76,387	686,101
2001	52,781,203	74,205,946	81,394,064	7,856,302	13,538,679	16,985,480	2,407,411	228,105,202	52,844	779,046
2002	49,734,890	55,510,125	82,141,156	4,800,160	n/a	14,589,187	1,160,523	234,686,221	76,230	551,975

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
		United	Fed	Smolt	United	Fed				
1978	13,582,355	52,127,027	1,904,625	2,073,819	2,984,462	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	8,858,100	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	198,675,727	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	8,510,622	11,716,390	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	5,184,829	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	53,015,629	45,515,245	78,593,285	8,376,464	14,379,424	10,588,053	3,198,637	149,791,525	109,271	638,463
2001	45,504,297	16,465,059	59,338,149	8,731,094	12,780,771	12,193,240	999,207	181,822,329	74,831	641,545
2002	53,016,407	74,171,946	81,407,064	7,856,302	12,737,679	16,985,480	2,407,411	228,102,036	48,488	704,545
2003	50,197,659	55,547,125	82,141,156	4,800,160	13,538,679	14,589,187	1,160,523	234,689,387	81,654	642,493

Table 3. Releases by Area in 2003 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	218,038	196					
Total		218,038	196					
Nass R	03	185,463	6,624	95				
Total		185,463	6,624	95				
Skeena R	04A	267,977		197,427		138,728,148		
Total		267,977		197,427		138,728,148		
North Coast	04			3,349				
	06	1,603,822	4,957,773	496,648			9,011	59,885
Total		1,603,822	4,957,773	499,997			9,011	59,885
Queen Charlotte Is	01	125,000		92,300				
	02E	14,885	19,070,684	500,570	12,189			
Total		139,885	19,070,684	592,870	12,189			
Central Coast	07		1,380,653	136,922		52,161		
	08	2,388,434	7,214,605	7,274		912,250		
Total		2,388,434	8,595,258	144,196		964,411		
West Coast Vancouver Is	22	3,806,479	25,673,344	394,667				10,496
	23	8,680,013	793,951	1,196,019		4,000,000		
	24	688,650		231,032				
	25	3,042,269	4,510,082	154,026				6,687
	27	697,033	39,095	472,034				12,000
Total		16,914,444	31,016,472	2,447,778		4,000,000		29,183
Johnstone St	11	12,000	31,000	190,500	31,000			31,290
	12	142,388	4,221,504	365,295	1,844,921	1,300,802		89,465
Total		154,388	4,252,504	555,795	1,875,921	1,300,802		120,755
Str of Georgia	13	4,064,707	24,000	3,182,765	6,245,666		8,263	18,379
	14	9,865,884	54,159,830	3,124,942	7,501,323		9,538	88,373
	15	803,183	1,340,839	253,877	94,611			
	16	305,426	296,682	283,325	20,000		4,800	7,500
	17	769,702	783,642	204,907				
	18	1,935,682	594,462	27,384				
	19	355,230	191,700	153,080				
	20	1,338,899	6,000	393,377				
	28	1,806,586	997,453	1,389,271			624	52,612
Total		21,245,299	58,394,608	9,012,928	13,861,600		23,225	166,864

Table 3 cont.

Area	Stat	Species						
		Chinook	Chum	Coho	Pink	Sockeye	Cutthroat	Steelhead
Lower Fraser	29A			5,739				
	29B	192,000	240,000	172,035				
	29C	178,800	187,269	468,805		9,827,058	35,628	24,123
	29D	2,871,371	9,306,956	1,712,575		45,968,968	13,790	112,383
	29E	1,992,394	1,659,937	2,159,627				129,300
Total		5,234,565	11,394,162	4,518,781		55,796,026	49,418	265,806
Upper Fraser	29F	386,940		244,550		2,790,000		
	29G	400				29,400,000		
	29I	170,194				1,710,000		
	29J			62,922				
	29K	1,287,810		61,500				
Total		1,845,344		368,972		33,900,000		
Total All Areas		50,197,659	137,688,281	18,338,839	15,749,710	234,689,387	81,654	642,493