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Canadian Enhanced Salmonid Production
During 1978-2009 (1977 – 2008 Brood Years)

by

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Abstract

The Salmonid Enhancement Program (SEP) in British Columbia, Canada was initiated in 1977 to rebuild stocks and increase catch through the expanded use of enhancement technology. The program comprises over 400 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 British Columbia.

Introduction

The purpose of this document is to summarize release information from enhancement facilities in British Columbia (BC) and the Yukon Territory. More detailed information is available from the Salmonid Enhancement Planning and Assessment Unit within the Oceans, Habitat & Enhancement Branch of Fisheries and Oceans Canada.

The Salmonid Enhancement Program (SEP) in British Columbia, Canada was initiated 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 over 400 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, habitat improvements, flow control works, lake fertilization 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 hundred 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. Numbers of fish estimated as originating from these restoration projects are not reported here.

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.

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 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. The proposed targets are included in the Integrated Fisheries Management Plan which is made available for discussion to industry, the public and other interested groups.

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 and a large proportion of sockeye and chum 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 and coho stocks and finclips used for chum and sockeye stocks. Beginning in 1996, most enhanced coho from southern B.C. have been marked with a fin clip to enable the prosecution of mark selective 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.

There are relatively few projects that enhance sockeye and pink salmon. Expected adult sockeye production is estimated using run reconstruction or historical survivals. Experimental groups of reared sockeye, mainly stocks of conservation concern, 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 a thermal otolith mark to estimate enhanced contributions to terminal areas. Thermal marking is coordinated with the Stock Assessment Division. Additionally, a few stocks, mainly sockeye, have been marked with strontium chloride, a naturally occurring salt, or with calcein, a fluorescing dye.

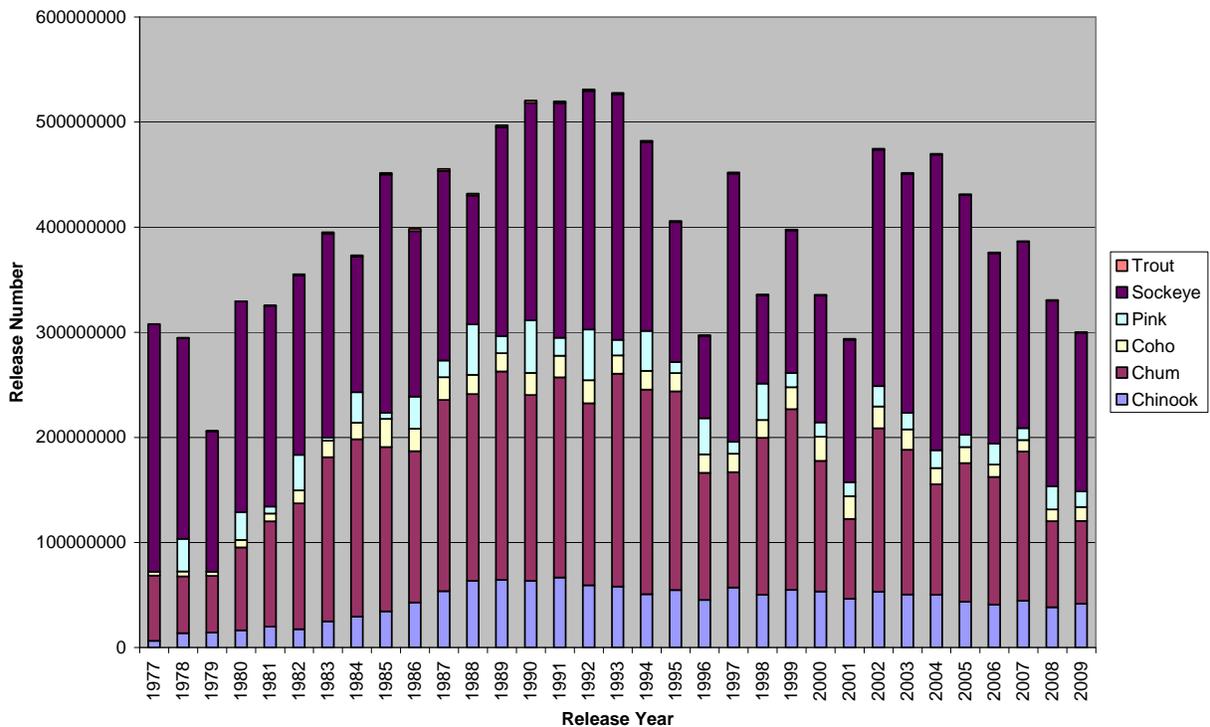
Results

Release numbers are provided by brood (Table 1) and release (Table 2) year. Releases in 2009 are broken down by area (Table 3). Data for the final year presented (2008 brood and 2009 release year) are preliminary and will be updated in future reports. Similarly, this report updates release numbers provided

in earlier reports. Many of the numbers have changed slightly since the last report. The data were transferred to a new, more detailed, database in 2010. During this process errors were identified and corrected, including some duplicated and some missing releases. These errors mainly occur due to the large numbers of transfers from major facilities to smaller projects. The new database will help identify these types of errors more quickly. There was a major duplication in the 2008 releases of sockeye, the correction of which has resulted in a much lower number released in this report. Locations of larger BC facilities reporting releases in the tables are shown in Figures 1a, 1b and 1c.

The tables include releases 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. 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 the Stocking Reports on the Freshwater Fisheries Society of BC web site at <http://www.gofishbc.com>. Releases are reported for facilities funded through the Aboriginal Fisheries Strategy only for projects that receive significant technical support from OHEB.

Releases from Enhancement Facilities in British Columbia and the Yukon, Canada



Total releases approximately doubled between the 1977 and 1988 brood years, with the largest numerical increase for chum fry. Poor marine survival in the mid to late 1990's for some southern B.C. chum stocks led to decreased escapement, resulting in lower production for several years. In 1999, egg targets at Fraser River facilities were reduced in response to lower harvest rates on Fraser River chum. Maximum production of chinook and coho smolts releases was reached in the early to mid 1980s. Since 1998 there has been an increased focus toward rebuilding severely depressed stocks, including interior Fraser River coho and Cultus Lake sockeye. Pink releases fluctuate annually because of the natural cycles (odd year

only) in the Fraser River. In 1999, a large pink spawning channel (20 million releases) on the Fraser was complexed for all species and is no longer managed as a spawning channel. Production from Fraser River sockeye channels fluctuates because of natural cycles. Since 1994, disease mortality in some years has affected spawning success for both Fraser River and Skeena River sockeye channel production. In 2004, (2005 or 2006 release year depending on species), to meet budget constraints, production was reduced where stocks were strong and returns to hatchery locations exceeded spawning requirements. Chinook and coho targets were the most affected. Production was maintained for all stocks enhanced for rebuilding objectives. Reduced releases for chinook and chum in 2008 resulted mainly from poor returns or poor river conditions, not from reductions in targets. Poor chum returns to Big and Little Qualicum rivers continued to result in low numbers released from the channels. Weaver Spawning Channel experienced high pre-spawn mortality, resulting in a very low number of fry migrating out in 2009.

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.

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. Enhancement activities are focused towards supporting targeted fishing opportunities on enhanced stocks and rebuilding severely depressed stocks.

Figure 1a Locations of hatcheries and manned spawning channels operated by OHEB staff or contracted to community and native groups within British Columbia's Fraser River watershed and lower mainland

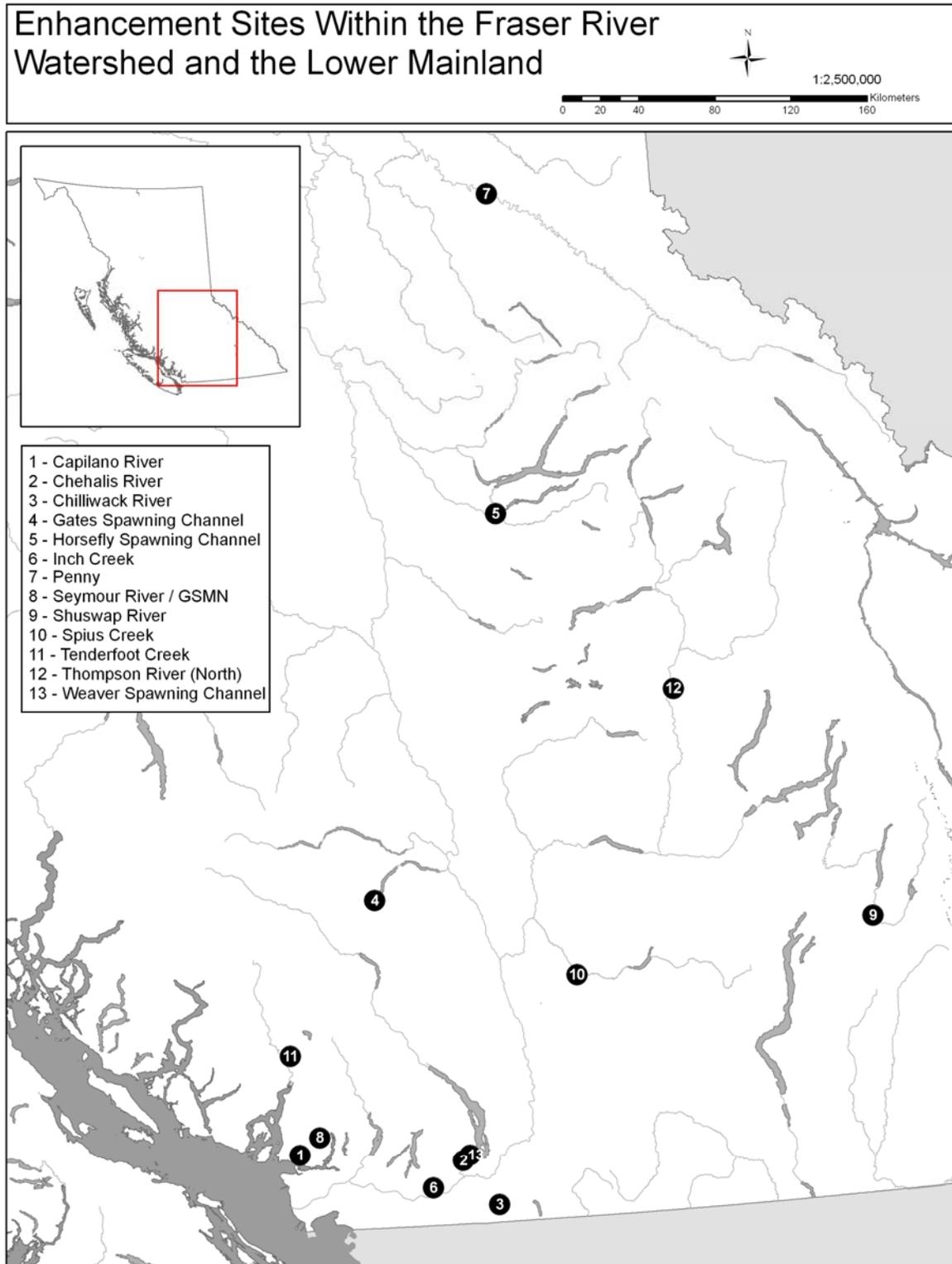


Figure 1b Locations of hatcheries and manned spawning channels operated by OHEB staff or contracted to community and native groups within British Columbia's North and Central Coast Regions.

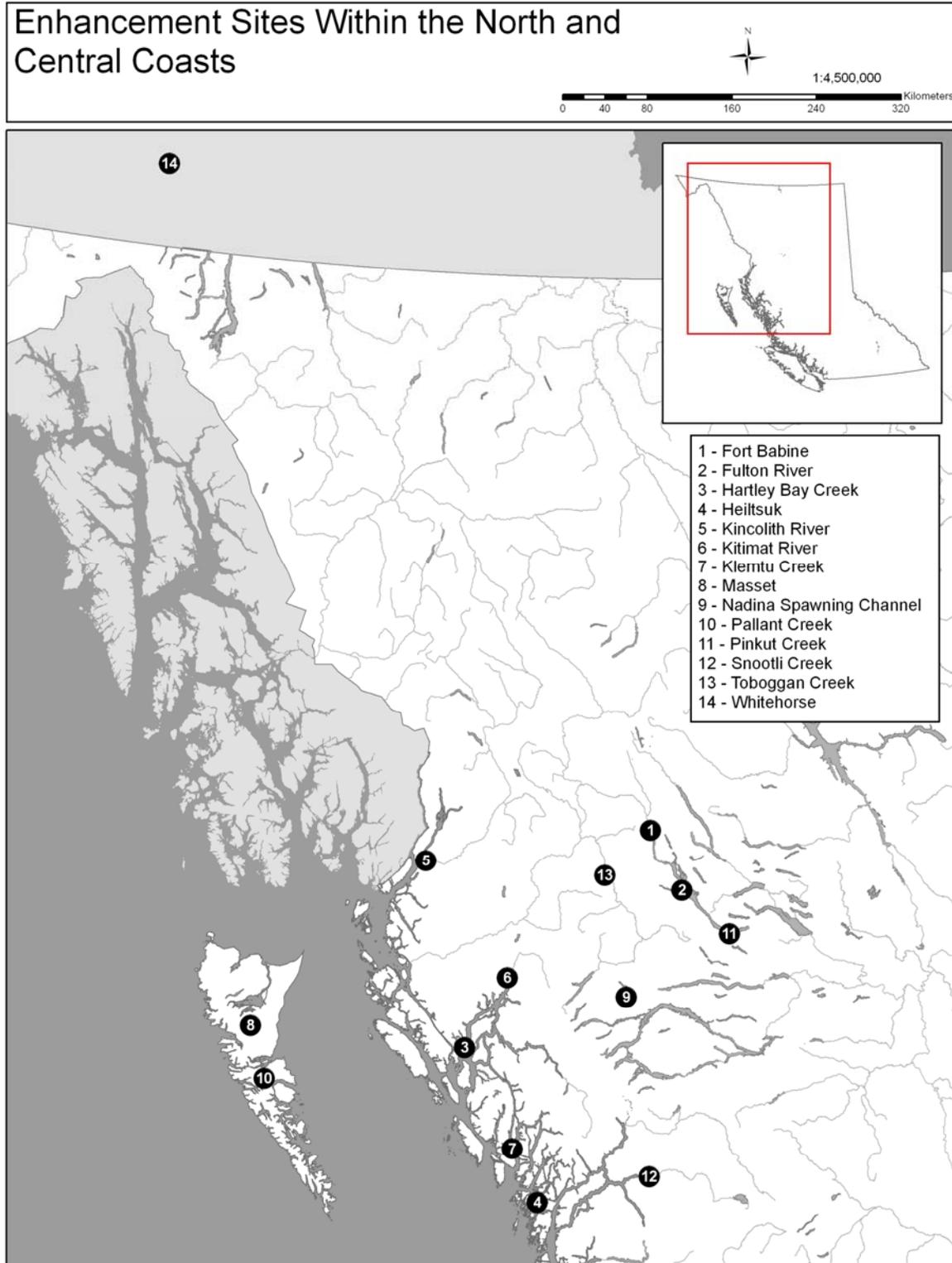


Figure 1c Locations of hatcheries and manned spawning channels operated by OHEB staff or contracted to community and native groups within British Columbia's Strait of Georgia and Vancouver Island

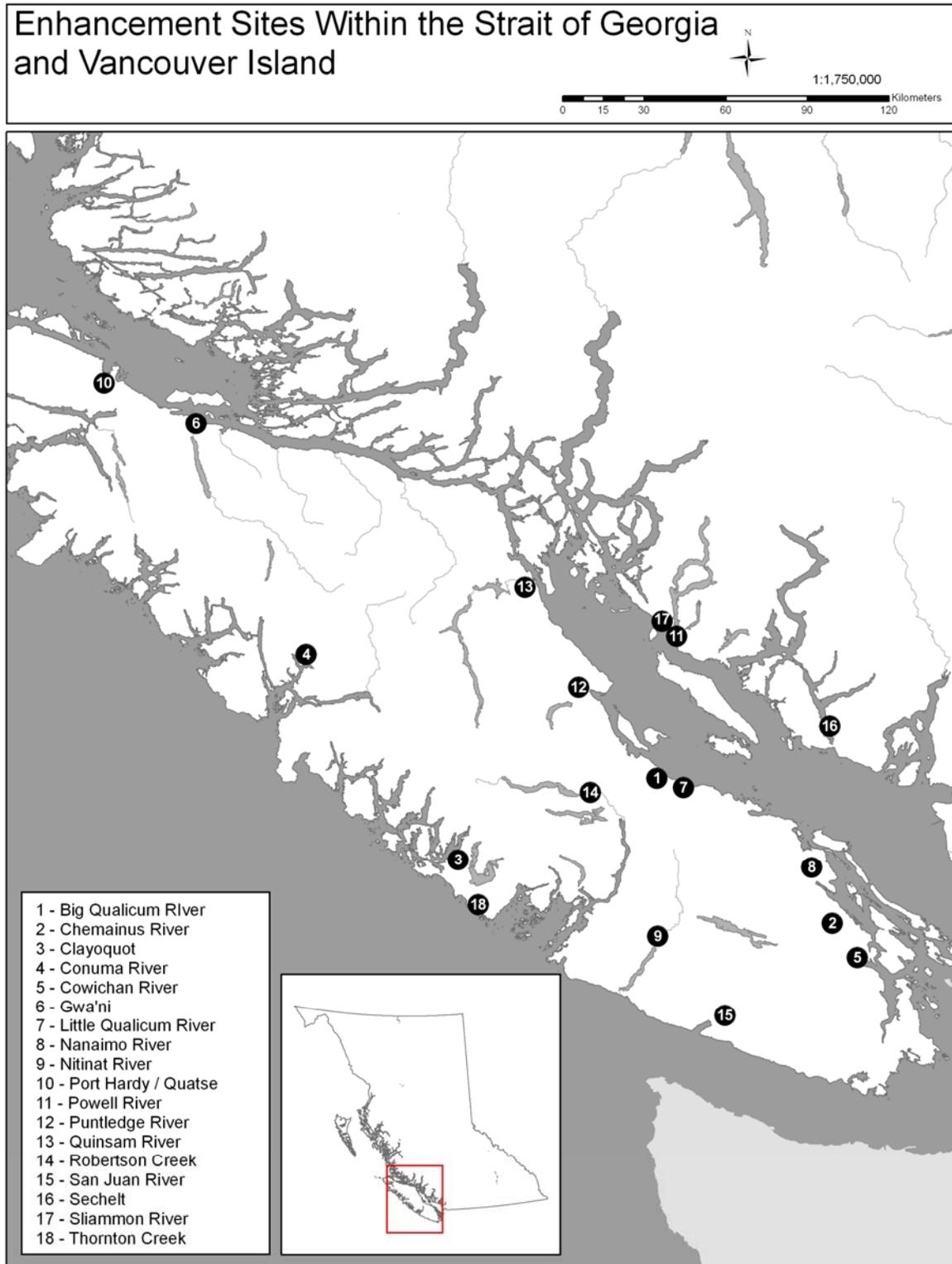


Table 1. Juvenile salmon releases by brood year from OHEB hatcheries and manned channels in British Columbia and the Yukon, Canada

Brood Year	Chinook	Chum		Coho		Pink		Sockeye	Trout	
		Unfed	Fed	Fry	Smolt	Unfed	Fed		Cutthroat	Steelhead
1977	13,620,370	52,127,027	1,904,625	2,020,264	2,985,263	31,029,220		191,179,000		127,810
1978	14,259,873	48,218,296	5,535,566	1,012,721	3,741,951	750		133,739,000		268,833
1979	16,379,080	69,550,228	9,191,947	3,656,819	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	17,443,149	50,709,042	68,980,710	7,293,522	4,907,184	33,113,088	492,034	170,814,370	9,732	711,136
1982	24,854,529	86,930,258	69,365,130	10,767,984	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	13,150,827	12,077,417	3,783,368	2,296,285	226,572,635	72,347	1,311,591
1985	42,729,073	41,608,091	102,464,677	9,270,847	9,771,560	25,432,597	5,057,021	157,434,930	109,045	1,501,462
1986	53,614,372	96,273,382	85,842,800	11,744,760	10,116,999	11,585,712	4,509,098	180,106,075	157,749	2,073,374
1987	63,693,543	101,661,170	75,979,591	8,170,803	9,555,691	43,221,480	4,807,689	122,471,589	179,737	1,896,518
1988	64,570,975	110,287,223	88,028,664	7,833,404	11,260,130	13,504,123	2,827,349	198,689,081	193,793	1,924,706
1989	63,647,832	84,537,150	92,214,006	9,877,022	11,772,691	47,373,147	2,884,163	206,752,792	164,027	1,826,304
1990	66,630,752	95,715,249	94,759,699	8,834,612	12,445,245	16,102,839	1,023,076	223,080,058	181,781	1,841,700
1991	59,573,429	76,557,826	96,839,355	9,350,809	10,959,542	46,709,818	1,584,525	227,135,058	178,076	1,642,679
1992	57,857,725	113,382,987	89,286,432	6,468,538	11,098,333	12,982,461	1,781,339	233,649,779	159,793	1,198,027
1993	50,726,909	101,495,532	93,399,435	6,571,925	10,867,764	36,575,827	1,576,168	179,704,118	172,851	1,060,477
1994	53,994,291	85,189,766	103,998,196	6,379,202	10,772,307	8,576,269	1,981,042	133,196,977	120,128	1,008,292
1995	45,148,414	33,223,512	87,665,283	6,980,359	11,719,718	32,317,111	2,001,615	78,186,811	128,428	958,327
1996	57,387,231	16,662,042	93,102,003	5,798,723	11,912,953	1	1,472,567	255,261,453	138,214	709,573
1997	50,515,716	45,104,033	104,106,311	5,212,022	11,774,958	33,090,03	1,640,496	83,807,632	85,676	994,208

1998	54,371,639	80,420,855	91,556,525	9,104,197	14,560,240	13,643,609	150,482	135,638,928	127,234	647,171
1999	53,669,216	45,515,245	78,593,285	8,367,707	13,035,509	10,588,053	3,198,637	120,547,649	93,977	668,944
2000	46,321,761	16,468,059	59,351,149	8,734,094	12,816,870	12,193,240	999,207	135,650,027	76,387	685,784
2001	53,040,570	73,981,946	81,394,064	7,866,302	13,795,760	16,885,480	2,550,411	225,112,415	52,844	781,534
2002	50,664,691	55,510,125	82,166,643	5,574,418	10,527,153	14,589,187	1,161,483	227,528,947	79,746	703,061
2003	50,262,808	50,478,858	54,680,148	4,666,462	10,825,237	15,624,437	1,423,758	281,420,261	74,097	643,066
2004	43,603,651	60,027,600	71,759,170	4,598,708	8,680,425	10,521,438	998,000	228,275,927	40,205	734,646
2005	41,038,994	35,651,427	85,529,443	2,953,632	8,035,621	17,066,080	3,064,252	181,141,578	32,253	495,461
2006	44,097,495	70,431,961	71,580,217	2,886,543	7,803,032	10,130,010	1,419,281	177,111,050	42,098	484,531
2007	38,746,667	47,633,200	34,298,452	3,355,748	9,082,892	18,876,850	3,264,501	176,621,514	44,801	524,401
2008	40,791,400	36,224,062	42,673,265	4,102,872		11,960,274	2,937,687	150,900,526	16,225	557,458

Table 2. Juvenile salmon releases by release year from OHEB hatcheries and manned channels in British Columbia and the Yukon, Canada

Release Year	Chinook	Chum		Coho		Pink		Sockeye	Trout	
		Unfed	Fed	Fry	Smolt	Unfed	Fed		Cutthroat	Steelhead
1978	13,601,392	52,127,027	1,904,625	2,020,264	2,741,852	31,029,220		191,179,000		166,856
1979	14,273,266	48,218,296	5,535,566	1,012,721	2,985,263	750		133,739,000	682	290,453
1980	16,370,618	69,550,228	9,191,947	3,656,819	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	17,482,160	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	10,767,984	4,907,184			194,054,919	37,913	1,191,999

1984	29,377,307	83,266,067	85,579,589	8,930,958	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	13,094,103	13,576,282	3,783,368	2,296,285	226,572,635	92,728	1,329,526
1986	42,832,059	41,608,091	102,464,677	9,276,105	12,098,441	25,432,597	5,057,021	157,434,930	110,507	2,201,706
1987	53,503,630	96,273,382	85,842,800	11,796,226	9,775,056	11,585,712	4,509,098	180,077,635	162,435	1,889,935
1988	63,564,731	101,661,170	75,979,591	8,170,803	10,118,075	43,221,480	4,807,689	122,480,753	191,794	1,810,897
1989	64,288,432	110,287,223	88,028,664	7,833,404	9,555,691	13,504,123	2,827,349	198,639,174	180,270	1,775,285
1990	63,440,015	84,537,150	92,214,006	9,877,022	11,260,130	47,373,147	2,884,163	206,749,382	158,512	1,937,098
1991	66,605,831	95,715,249	94,759,699	8,834,612	11,772,691	16,102,839	1,023,076	223,152,651	184,025	1,626,254
1992	59,092,678	76,557,826	96,839,355	9,329,859	12,445,245	46,709,818	1,584,525	227,135,058	180,389	1,305,798
1993	57,893,499	113,382,987	89,286,432	6,489,488	10,959,542	12,982,461	1,781,339	233,649,779	162,443	1,160,008
1994	50,666,759	101,495,532	93,399,435	6,571,925	11,098,333	36,575,827	1,576,168	179,704,118	148,498	1,067,623
1995	54,661,601	85,189,766	103,998,196	6,379,202	10,867,764	8,576,269	1,981,042	133,196,977	116,773	937,798
1996	45,240,596	33,223,512	87,665,283	6,980,359	10,772,307	32,317,111	2,001,615	78,186,811	133,910	704,430
1997	57,146,540	16,662,042	93,102,003	5,798,532	11,719,718	9,804,380	1,472,567	255,261,453	137,033	885,351
1998	50,209,950	45,104,033	104,106,311	5,202,188	11,912,953	33,138,850	1,640,496	83,807,632	85,887	779,410
1999	54,818,107	80,420,855	91,556,525	9,114,222	11,774,958	13,594,789	150,482	135,637,678	126,087	686,211
2000	53,473,201	45,515,245	78,593,285	8,367,707	14,560,240	10,588,053	3,198,637	120,566,525	97,965	650,146
2001	46,453,300	16,468,059	59,351,149	8,734,094	13,035,509	12,193,240	999,207	135,628,510	74,831	657,904
2002	53,229,474	73,981,946	81,394,064	7,866,302	12,816,870	16,885,480	2,550,411	225,113,140	48,488	721,861
2003	50,541,264	55,510,125	82,166,643	5,574,418	13,795,760	14,589,187	1,161,483	227,522,171	81,654	725,279
2004	50,307,62	50,478,858	54,680,148	4,662,462	10,527,15	15,624,43	1,423,758	281,353,125	77,460	687,476

	6				3	7				
2005	43,620,154	60,027,600	71,759,170	4,584,708	10,825,237	10,521,438	998,000	228,273,931	39,476	723,286
2006	41,061,485	35,651,427	85,529,443	3,071,687	8,680,425	17,066,080	3,064,252	181,140,066	35,135	527,777
2007	44,442,462	70,431,961	71,580,217	2,871,080	8,035,621	10,130,010	1,419,281	177,139,733	41,890	424,057
2008	38,388,329	47,633,200	34,298,452	3,270,256	7,803,032	18,876,850	3,264,501	176,627,221	38,111	555,020
2009	41,631,455	36,224,062	42,673,265	4,103,772	9,082,892	11,960,274	2,937,687	150,900,526	21,123	542,773

Table 3. Juvenile salmon releases by area in 2009 from OHEB hatcheries and manned channels in British Columbia and the Yukon, Canada

Area	Stat Area	Chinook	Chum	Coho	Pink	Sockeye	Trout
Yukon	120	48,580	975				
	Total	48,580	975				
Nass R	03			195			
	Total			195			
Skeena R	04	388,206		90,196		136,771,462	
	Total	388,206		90,196		136,771,462	
North Coast	03			80			
	04	13,879		27,298			
	05		920				
	06	1,429,140	1,457,826	560,730			57,808
	Total	1,443,019	1,458,746	588,108			57,808
Queen Charlotte Is	01			42,098			
	02E		9,939,147	857,091	6,087		
	Total		9,939,147	899,189	6,087		
Central Coast	07		3,124,448	68,899		115,590	
	08	2,071,229	7,513,065	59,490		80,705	
	09	226,881		17,545		187,802	
	Total	2,298,110	10,637,513	145,934		384,097	
West Coast Vancouver Is	22	3,053,623	7,631,058	242,949			
	23	7,200,773	234,173	580,223			136,777
	24	480,120		215,492			
	25	3,250,669	1,977,552	144,144			
	27	319,095		196,708			
	Total	14,304,280	9,842,783	1,379,516			136,777
Johnstone Strait	11	10,604	1,543,364	437,053	726,984		33,968
	12			23,433			
	Total	10,604	1,543,364	460,486	726,984		33,968
Strait of Georgia	13	4,243,064	103,755	1,025,134	6,290,910	688,290	24,463
	14	7,936,330	24,953,841	2,335,504	6,650,904		1,218
	15	882,501	1,772,415	285,845			
	16	211,660	178,797	250,648		727,376	
	17	697,564	860,482	240,059	1,063,076		
	18	1,763,345	458,268		160,000		
	19	331,468	341,919	63,942			
	20	1,431,586		274,821			
	28	1,126,169	1,564,903	1,599,143			57,175
	29C		31,979	8,597			
	Total	18,623,687	30,266,359	6,083,693	14,164,890	1,415,666	82,856
Lower Fraser R	29B	184,890	138,000	164,351			
	29C	234,800	592,248	367,012			43,437
	29D	995,965	11,224,585	1,426,138		3,912,756	84,188
	29E	1,726,288	3,253,607	1,194,580		51,645	124,862
	Total	3,141,943	15,208,440	3,152,081		3,964,401	252,487
Upper Fraser R	29F	375,681		129,678		1,650,000	
	29G	1,700					
	29I					5,100,000	
	29J			60,834			
	29K	995,645		196,204			
	Total	1,373,026		386,716		6,750,000	
Okanagan	31					1,614,600	
	Total					1,614,600	
Kootenay	29K					300	
	Total					300	
Total All Areas		41,631,455	78,897,327	13,186,114	14,897,961	150,900,526	563,896