

Canadian Enhanced Salmonid Production  
During 1978-2010 (1977 – 2009 Brood Years)

by

J. Wilkinson<sup>1</sup>, C. Lynch<sup>1</sup> and J. R. Irvine<sup>2</sup>

<sup>1</sup>Fisheries and Oceans Canada  
Ecosystem Management Branch  
401 Burrard Street  
Vancouver, B.C. V6C 3S4  
CANADA

<sup>2</sup>Fisheries and Oceans Canada  
Science Branch  
Pacific Biological Station  
Nanaimo BC V9T 6N7  
CANADA

Submitted to the

**North Pacific Anadromous Fish Commission**

by

CANADA

September 2011

THIS PAPER MAY BE CITED IN THE FOLLOWING MANNER:

Wilkinson, J., C. Lynch, and J. R. Irvine. 2011. Canadian enhanced salmonid production during 1978-2010 (1977-2009 brood years). NPAFC Doc. 1339. 10 p. (Available at <http://www.npafc.org>).

## **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 currently comprises approximately 150 projects which produce chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), chum (*O. keta*), pink (*O. gorbuscha*), and sockeye (*O. nerka*) salmon, as well as small numbers of steelhead (*O. mykiss*) and cutthroat trout (*O. clarki*). Projects include hatcheries, fishways, spawning and rearing channels, 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 hundred. 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 Planning and Assessment Unit of the Salmonid Enhancement Program (SEP) within the Ecosystem Management Branch (EMB, formerly known as the Oceans, Habitat and Enhancement Branch) of Fisheries and Oceans Canada.

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 currently comprises approximately 150 projects, which include 175 rearing facilities, throughout British Columbia that produce chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), chum (*O. keta*), pink (*O. gorbuscha*), and sockeye (*O. nerka*) salmon, as well as small numbers of steelhead (*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 hundred juveniles. Projects are operated by EMB staff or contracted to community and native groups, as well as by volunteers with some EMB support. Up to 5,000 volunteers participate annually in salmon enhancement and habitat restoration and improvement projects. EMB works with First Nations, industry, community groups and other government agencies to design and implement habitat restoration projects. Fish produced from these restoration projects are not estimated here.

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

## **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) targeting a specific enhancement objective such as conservation or rebuilding, harvest and/or assessment, species interactions, effects on natural stocks, harvest concerns, habitat capacity and project capacity are all considered when developing targets. The proposed targets are included in the Integrated Fisheries Management Plan, which is available to industry, the public and other interested groups.

Enhanced contributions and survivals of chinook, coho, and chum salmon are normally estimated by marking a portion of the fish released and subsequently recovering these marked fish in fisheries and the escapement. Pink and most sockeye and chum salmon are not 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 pink salmon 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.

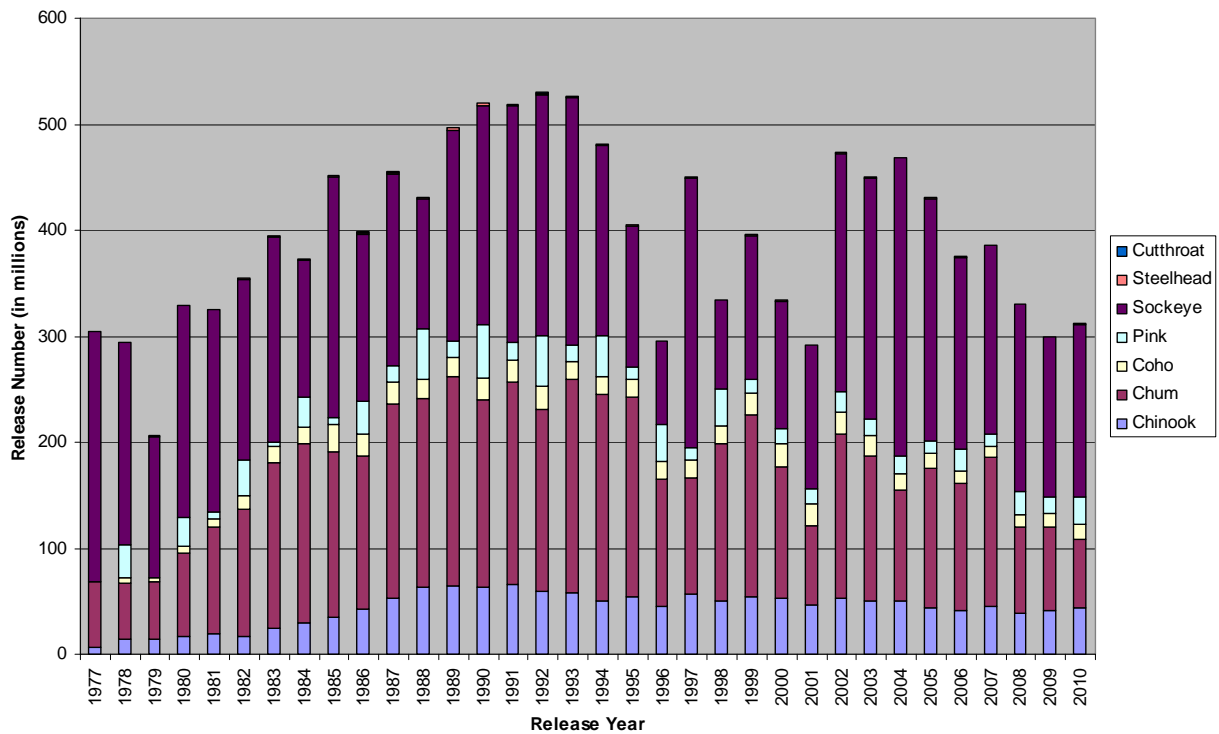
## **Results**

Release numbers are provided by brood (Table 1) and release (Table 2) year. Releases in 2010 are broken down by area (Table 3). Data for the final year presented (2009 brood and 2010 release year) are

preliminary and may be updated in future reports. Similarly, this report updates release numbers provided in earlier reports. Some of the numbers may have changed slightly since the last 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 EMB staff, contracted to community and native groups or operated by volunteer groups under the direction of EMB 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 EMB.

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



Total releases generally increased from 1976 through 1992 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 mid to late 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 returns 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.

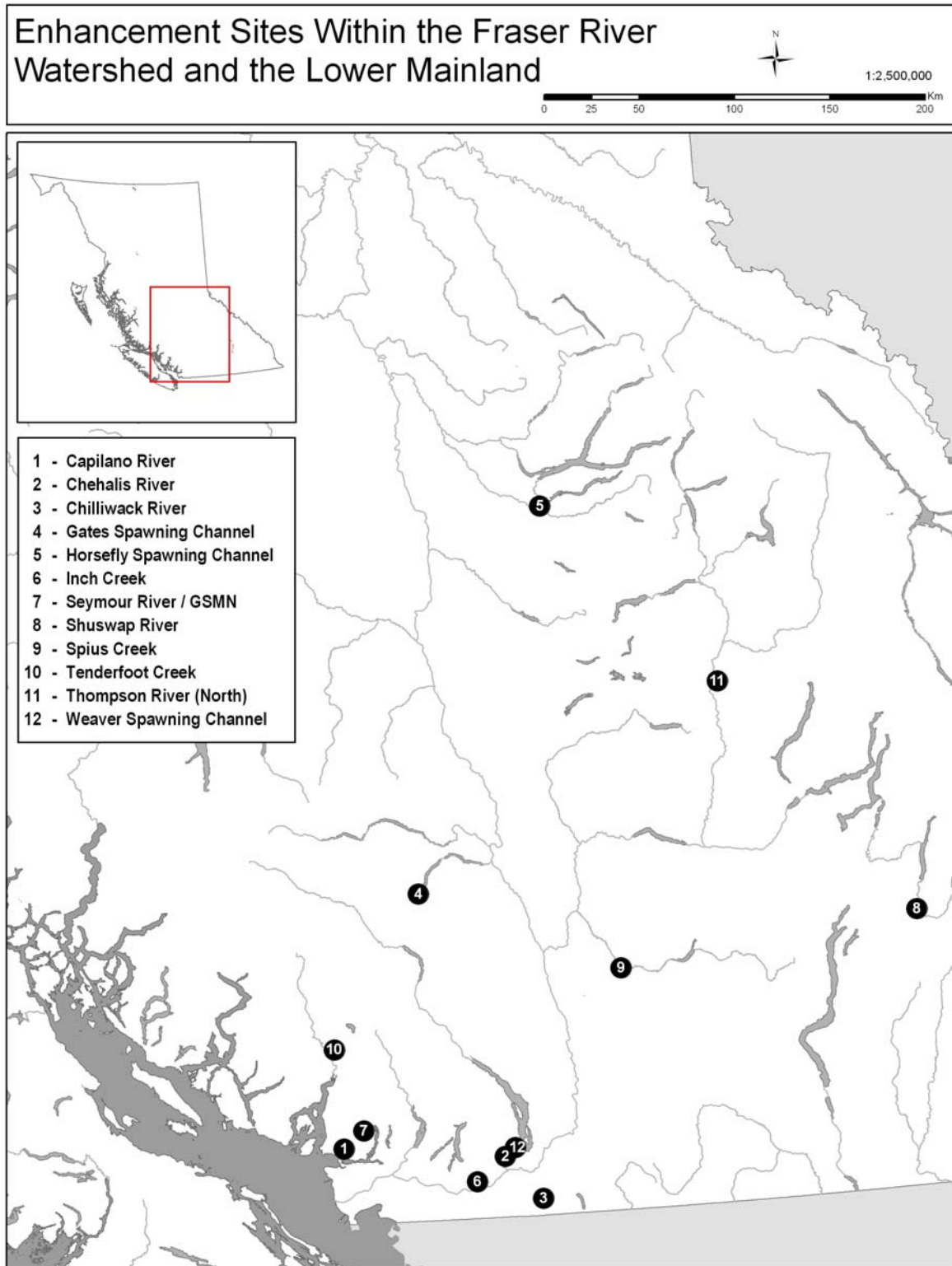
In 2004, (2005 or 2006 release year depending on species), to meet budget constraints, production was reduced where stocks were strong and returns to hatchery locations exceeded spawning requirements. Chinook and coho targets were the most affected. Production was maintained for all stocks enhanced for 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 continue to result in low numbers released from the channels. Weaver Spawning Channel experienced high pre-spawn sockeye mortality, resulting in a very low number of fry migrating out in 2009 but in 2010, numbers of fry migrating out returned to pre-2009 levels. Puntledge River Hatchery stopped producing coho smolts and instead began releasing fry to the upper watershed in 2010 after a mortality event in 2009 caused by lethal rearing water temperatures over the summer. This facility may adjust production levels of coho in coming years.

EMB 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, improving fish passage, stabilizing stream banks, enriching nutrient poor lakes and rivers, and rebuilding estuary marshes.

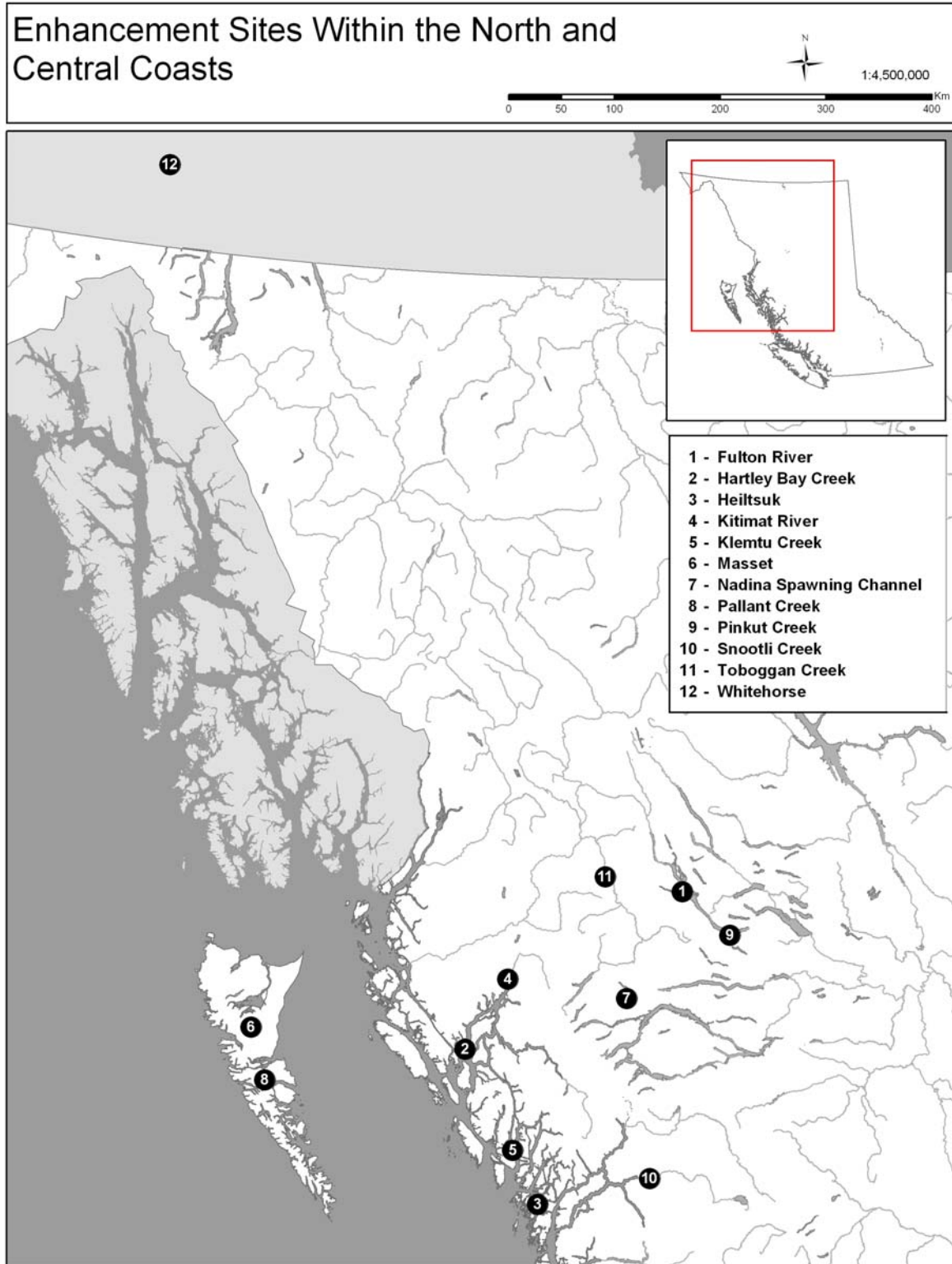
## **Summary**

Data are presented for releases by brood and release year, species and release stage for facilities under the direction of the Ecosystem Management 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.

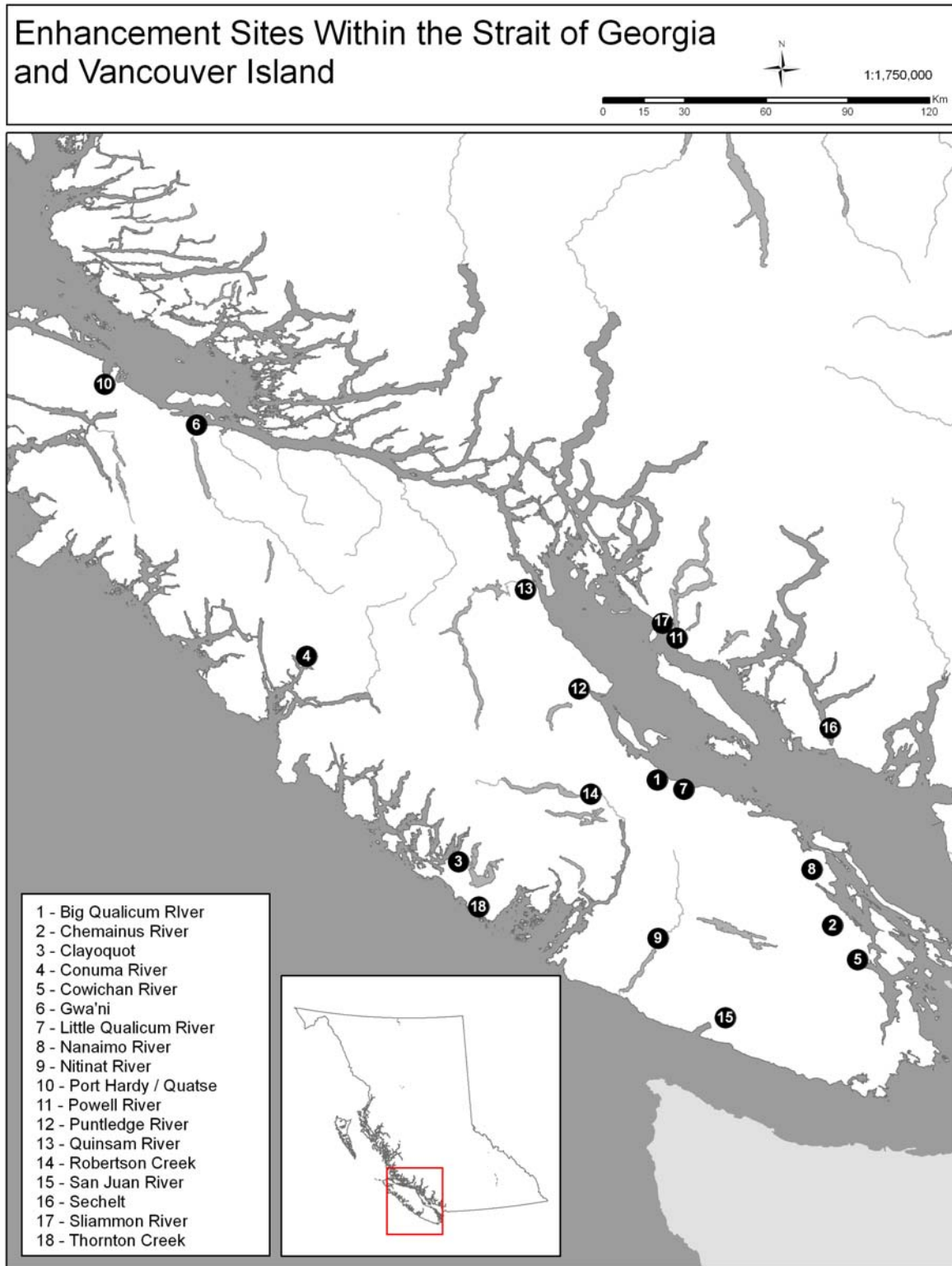
**Figure 1a** Locations of hatcheries and manned spawning channels operated by EMB staff or contracted to community and native groups within British Columbia's Fraser River watershed and lower mainland



**Figure 1b** Locations of hatcheries and manned spawning channels operated by EMB 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 EMB 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 EMB hatcheries and manned channels in British Columbia and the Yukon, 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	2,020,264	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	11,752,760	10,116,999	11,585,712	4,509,098	180,106,075	157,749	2,073,374
1987	63,693,543	101,661,010	75,979,751	8,177,303	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	7,836,404	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	9,878,700	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	16,427,839	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	101,494,402	93,400,165	6,571,925	10,870,824	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	10,772,207	8,576,269	1,981,042	133,196,977	120,128	1,008,292
1995	45,148,414	33,223,312	87,665,483	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	9,804,380	1,472,567	255,261,453	138,214	701,832
1997	50,515,716	45,104,033	104,106,311	5,212,022	11,774,958	33,090,039	1,640,496	83,807,632	85,676	994,208
1998	54,371,139	80,420,855	91,590,252	9,104,197	14,560,240	13,643,600	150,482	135,638,928	127,234	647,171
1999	53,643,883	45,515,245	78,461,142	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	59,336,149	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	81,389,064	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	10,822,437	15,624,437	1,423,758	281,420,261	74,097	643,066
2004	43,607,951	60,027,487	71,727,783	4,598,333	8,710,425	10,521,438	998,000	228,275,927	40,205	734,646
2005	41,038,994	35,582,315	85,574,610	2,894,372	8,108,041	17,066,080	3,064,252	181,141,578	32,253	495,461
2006	44,363,064	70,431,961	71,287,217	2,953,181	7,892,867	10,130,010	1,419,281	177,287,752	42,098	484,531
2007	38,831,579	47,526,845	34,233,178	3,506,295	9,088,594	18,966,850	3,264,501	177,013,231	44,801	524,451
2008	42,004,640	36,064,862	42,664,672	4,467,836	9,085,946	12,173,274	2,724,687	150,854,330	41,310	560,913
2009	43,798,247	29,730,394	34,611,664	5,798,989	7,333,194	20,635,440	5,049,262	162,962,389	13,164	546,551

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

Release Year	Chinook	Chum		Coho		Pink		Sockeye	Cutthroat	Steelhead
		Unfed	Fed	Fry	Smolt	Unfed	Fed			
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	2,510,301	423,038	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	11,804,226	9,775,056	11,585,712	4,509,098	180,077,635	162,435	1,889,935
1988	63,564,731	101,661,010	75,979,751	8,177,303	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	7,836,404	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	9,878,700	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	16,427,839	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	101,494,402	93,400,165	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	10,870,824	8,576,269	1,981,042	133,196,977	116,773	937,798
1996	45,240,596	33,223,312	87,665,483	6,980,359	10,772,207	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	877,610
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	54,817,607	80,420,855	91,590,252	9,114,222	11,774,958	13,594,789	150,482	135,637,678	126,087	686,211
2000	53,447,868	45,515,245	78,461,142	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	59,336,149	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	81,389,064	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	50,307,626	50,478,858	54,680,148	4,662,462	10,527,153	15,624,437	1,423,758	281,353,125	77,460	687,476
2005	43,624,454	60,027,487	71,727,783	4,584,333	10,822,437	10,521,438	998,000	228,273,931	39,476	723,286
2006	41,061,485	35,582,315	85,574,610	3,012,427	8,768,845	17,066,080	3,064,252	181,140,066	35,135	527,777
2007	44,708,031	70,431,961	71,287,217	2,937,718	8,049,621	10,130,010	1,419,281	177,316,435	41,890	424,057
2008	38,472,785	47,526,845	34,233,178	3,420,803	7,896,667	18,966,850	3,264,501	177,018,938	38,111	555,070
2009	41,816,943	36,064,862	42,664,672	4,409,160	9,091,571	12,173,274	2,724,687	150,900,526	29,208	561,911
2010	44,085,255	29,730,394	34,611,664	5,765,944	9,244,677	20,635,440	5,049,262	162,962,389	30,164	460,593

Table 3. Juvenile salmon releases by area in 2010 from EMB hatcheries and manned channels in British Columbia and the Yukon, Canada

Area	Stat Area	Chinook	Chum	Coho	Pink	Sockeye	Cutthroat	Steelhead
Yukon	120	136,910						
	Total	136,910						
Nass R	03	70,241		140				
	Total	70,241		140				
Skeena R	04	334,184		130,030		114,133,833		
	07			61,783				
	Total	334,184		191,813		114,133,833		
North Coast	03			80				
	04	20,430	5,249	67,715				
	06	1,924,241	3,675,243	857,426			4,580	53,791
	Total	1,944,671	3,680,492	925,221			4,580	53,791
Queen Charlotte Is	01	543,629		2,600				
	02E			846,254				
	Total	543,629		848,854				
Central Coast	07		3,103,529	79,972		150,237		
	08	2,332,480	6,007,921	68,086		70,859		
	09	247,298		24,312				
	Total	2,579,778	9,111,450	172,370		221,096		
West Coast Vancouver Is	22	2,988,792	5,252,749	376,964				
	23	7,105,560	735,219	505,096				96,553
	24	606,947		108,287				
	25	3,650,385	3,924,700	145,382				
	27	709,842	5,932	197,995				
	Total	15,061,526	9,918,600	1,333,724				96,553
Johnstone Strait	11		741,346	614,727	2,271,704			37,958
	12			68,471				
	Total		741,346	683,198	2,271,704			37,958
Strait of Georgia	13	4,365,394	278,375	1,014,091	6,352,956	503,159	8,584	25,263
	14	9,144,212	28,465,709	3,692,789	6,561,657			961
	15	991,406	1,622,418	272,624	84,000			
	16	210,000	544,503	289,425	643,857	328,928		
	17	626,985	373,422	286,485	925,305			
	18	421,329	223,653	4,588	249,450			
	19	244,985	94,888	79,959				
	20	1,566,793		151,076				
	28	1,134,281	983,203	1,419,975	2,737,393			67,746
	Total	18,706,385	32,586,171	7,211,012	17,554,618	832,087	8,584	93,970
Lower Fraser R	29B	150,200	267,500	269,243	50,200			
	29C	574,500	629,100	211,273	1,072,000		17,000	
	29D	1,093,046	6,399,962	1,612,940	4,736,180	36,470,557		58,382
	29E	1,595,457	1,007,437	1,262,447				119,939
	Total	3,413,203	8,303,999	3,355,903	5,858,380	36,470,557	17,000	178,321
Upper Fraser R	29F	265,181		98,232		3,600,000		
	29G					3,287,116		
	29I					3,526,000		
	29J			48,483				
	29K	1,029,547		141,671				
	Total	1,294,728		288,386		10,413,116		
Okanagan	31					891,700		
	Total					891,700		
Total All Areas		44,085,255	64,342,058	15,010,621	25,684,702	162,962,389	30,164	460,593