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**Enhanced Salmonid Production in British Columbia, Canada  
During 1978-2002 (1977 – 2001 Brood Years)**

by

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## **ABSTRACT**

Lehmann,S. 2003. Canadian Enhanced Salmonid Production During 1978-2002 (1977-2001 brood years). (NPAFC Doc. 710). 10p.+i. Department of 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. SEP was combined with Habitat Management in 1995 to form the Habitat and Enhancement Branch (HEB). The program is now comprised of nearly 300 projects and produces 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 releasing fewer than one thousand. Steelhead and cutthroat data are not included in this report as their assessment is a provincial responsibility. Data from facilities which operate outside the direction of HEB are also not included.

## **Introduction**

The Salmonid Enhancement Program (SEP) in British Columbia, Canada was undertaken in 1977 primarily to rebuild 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 to form the Habitat and Enhancement Branch (HEB). The program is now comprised of nearly 300 projects throughout British Columbia and produces 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 HEB staff or contracted to community and native groups, as well as by volunteers with some HEB support. Up to 10,000 volunteers participate in the program annually. The focus is also on restoring and improving fish habitat. HEB 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. HEB developed educational packages to teach children about salmon and the need to protect habitat and watersheds. HEB staff also provide technical advice to enhancement activities, including hatcheries, which operate outside HEB.

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, 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 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 coastwide sampling programs in the sport and commercial fisheries and through recovery programs on the spawning grounds or at the project. 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 HEB staff, contracted to community and native groups or operated by volunteer groups under the direction of HEB staff are provided by brood (Table 1) and release (Table 2) year. Releases for 2002 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 Province 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. Some inconsistencies in reporting of releases from restoration projects were corrected from previous reports. Releases from some facilities funded through the Aboriginal Fisheries Strategy which receive significant technical support from HEB are included.

Total releases approximately doubled between 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.

HEB 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 has 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 Habitat & Enhancement Branch. 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

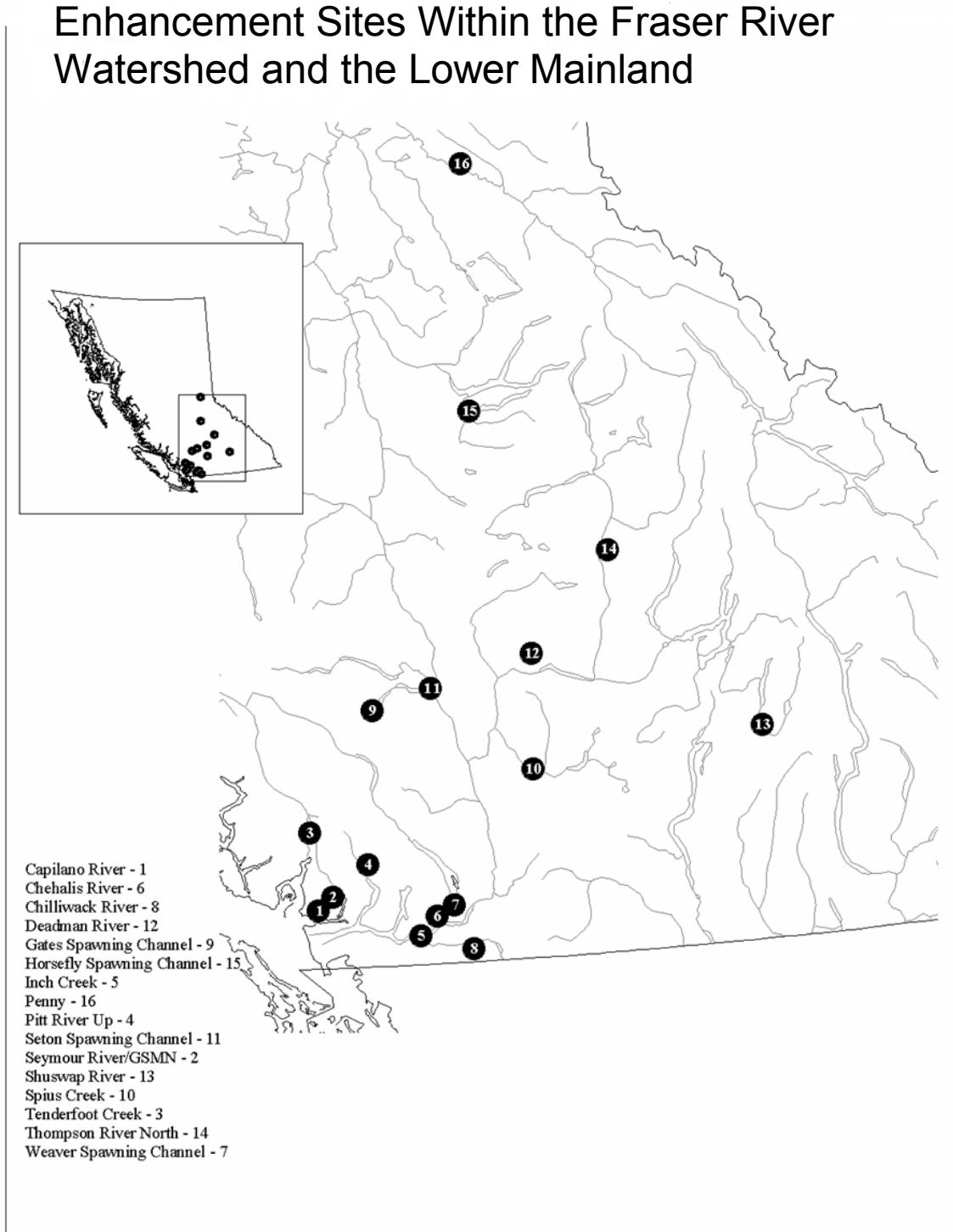


Figure 1b Locations of selected British Columbia, Canada enhancement facilities.

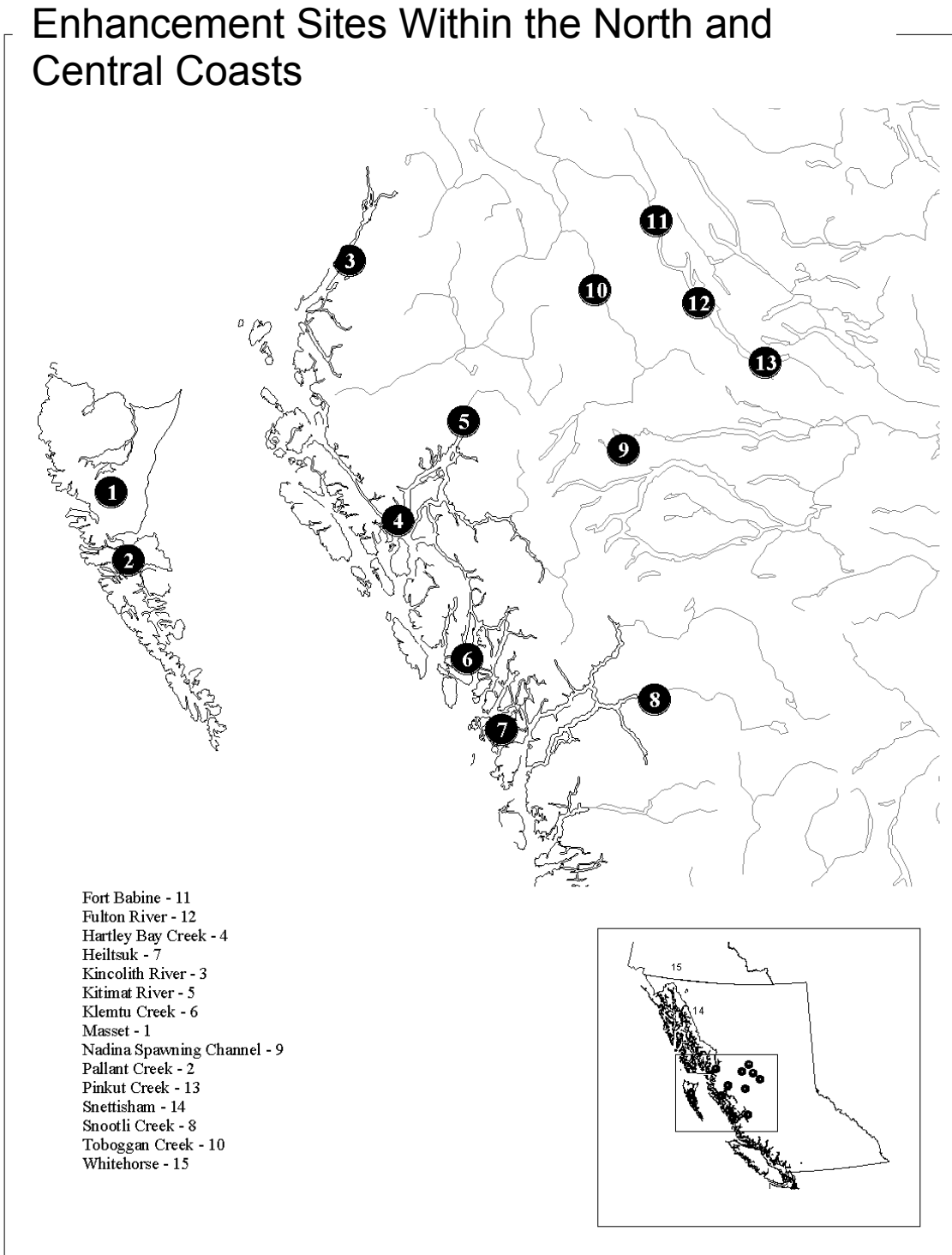


Figure 1c Locations of selected British Columbia, Canada enhancement facilities.

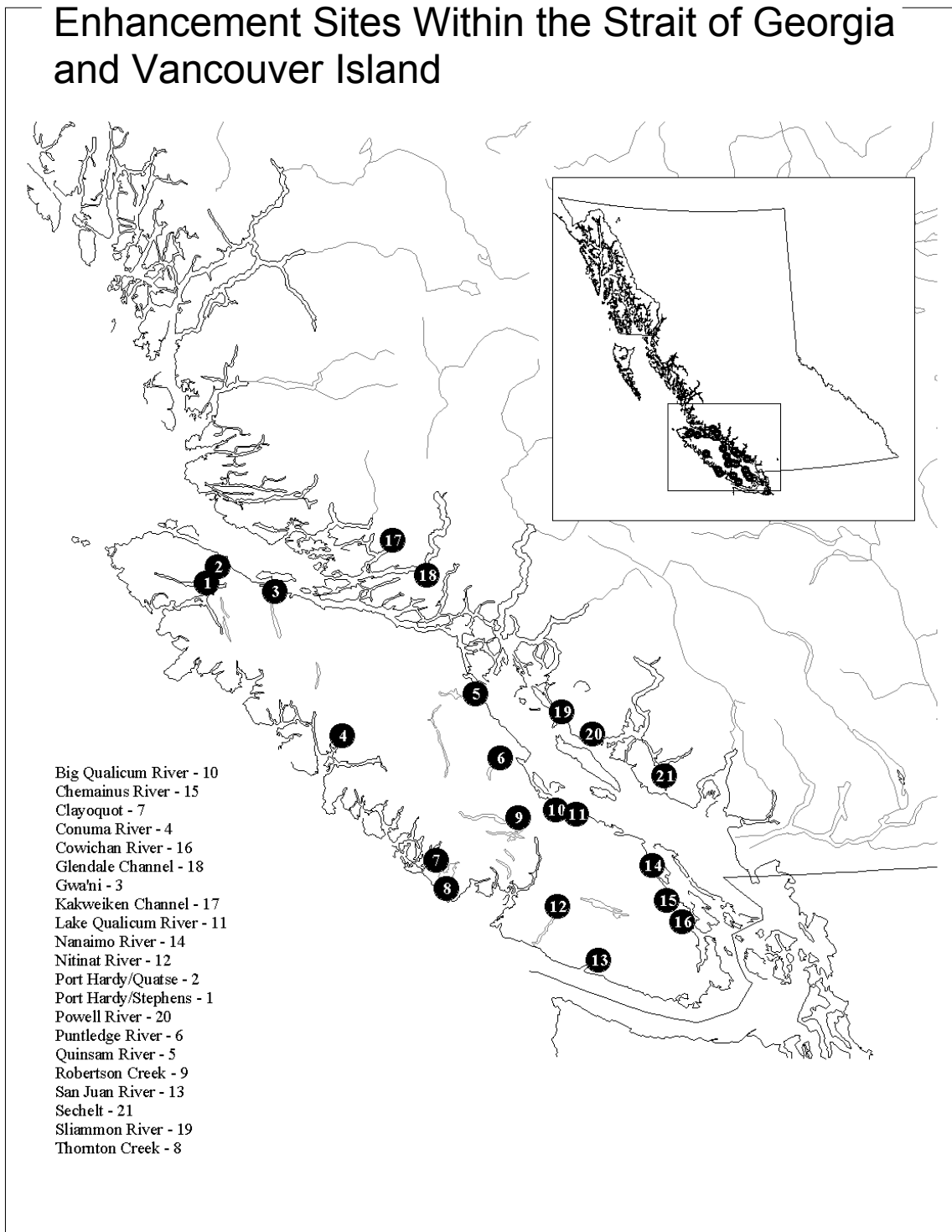




Table 1. Releases of juveniles by brood year from HEB hatcheries and manned channels in British Columbia, Yukon, and Transboundary Area, Canada

Brood Year	Chinook	Chum		Coho		Pink		Sockeye	Cutthroat	Steelhead
		United	Fed	Smolt	United	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	51,965,209	73,957,946	81,394,064	6,820,779	n/a	16,985,480	2,407,411	221,712,036	47,420	650,108

Table 2. Releases of juveniles by release year from HEB 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	52,809,120	73,923,946	81,407,064	6,820,779	12,737,679	16,985,480	2,407,411	221,712,036	48,488	660,795

Table 3. Releases by Area in 2002 from HEB 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	33,034	624			250		
	130	24,168						
	Total	57,202	624			250		
Nass R	03	75,100		80				
	Total	75,100		80				
Skeena R	04A	395,806		545,067		174,700,000		
	Total	395,806		545,067		174,700,000		
North Coast	04			1,275				
	06	1,752,095	4,921,186	562,028			1,288	46566
	Total	1,752,095	4,921,186	563,303			1,288	46566
Queen Charlotte Is	01	135,901		78,003				
	02E	39,689	10,035,396	918,052				
	Total	175,590	10,035,396	996,055				
Central Coast	07		1,848,129	256,037		47,954		
	08	2,310,779	6,860,828	199,181		833,817		
	Total	2,310,779	8,708,957	455,218		881,771		
Rivers & Smith Inlets	09	221,585						
	Total	221,585						
West Coast Vancouver Is	22	3,730,065	30,256,682	350,270				9,823
	23	7,023,974	770,678	1,309,787				71,244
	24	749,236		211,895				
	25	2,408,828	4,152,899	362,969				10,157
	27	1,476,571	28,853	377,732				6,435
	Total	15,388,674	35,209,112	2,612,653				97,659
Johnstone St	11	30,225	15,000	450,000	56,160			
	12	213,277	5,601,872	422,547	1,184,315	100,752		86,750
	Total	243,502	5,616,872	872,547	1,240,475	100,752		86,750
Str of Georgia	13	3,984,627	3,000,000	2,053,385	6,279,294		6,433	14,557
	14	13,044,623	72,712,235	3,220,119	5,909,276			76,497
	15	829,557	1,838,269	332,104				
	16	285,194	429,250	238,577	466,001	32,709		
	17	545,352	597,346	221,162				
	18	3,228,287	616,700	45,875				
	19	381,500	82,000	58,372				
	20	865,000	3,000	446,900				
	28	2,261,174	719,292	1,644,602	1,211,641		1,068	57,347
Total	25,425,314	79,998,092	8,261,096	13,866,212	32,709	7,501	148,401	

Table 3 cont.

Area	Stat	Species						
		Chinook	Chum	Coho	Pink	Sockeye	Cutthroat	Steelhead
Lower Fraser	29A			4,215				
	29B	190,000	97,000	119,803			3,983	7,017
	29C	231,903	370,656	505,817	1,510,542	11,142,175	15,021	25,310
	29D	3,109,005	8,760,558	1,997,212	2,771,662	21,243,014	20,695	108,113
	29E	1,590,378	1,612,557	2,221,017	4,000	3,715		140,979
Total		5,121,286	10,840,771	4,848,064	4,286,204	32,388,904	39,699	281,419
Upper Fraser	29F	371,775		222,421				
	29G	1,820						
	29I	167,481				12850000		
	29J			89,154				
	29K	1,101,111		92,800		757650		
Total		1,642,187		404,375		13607650		
Total All Areas		52,809,120	155,331,010	19,558,458	19,392,891	221712036	48,488	660,795