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**Enhanced Salmon Production in British Columbia, Canada
1977 – 2000 Brood Years**

by

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ABSTRACT

Enhancement Support and Assessment Unit. An assessment of Canadian enhanced salmon production, 1977-2000 brood years. (NPAFC Doc. No.). p. Dept. of Fisheries and Oceans, Habitat and Enhancement Branch, Vancouver, B.C. V6C 3S4.

The Salmonid Enhancement Program 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 (*Salmo 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 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 which had 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 (*Salmo clarki*).

Projects include hatcheries, fishways, spawning and rearing channels, and small classroom incubators, ranging in size from spawning channels releasing nearly 100 million juveniles annually to school classroom incubators releasing fewer than one thousand juveniles. Projects are operated by HEB staff or contracted community and native groups, as well as by volunteers with some HEB support. As many as 10,000 volunteers may participate in the program in any given year. 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 salmon 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.

Methods

Juvenile salmonids are reared to various release stages depending on the species and enhancement technology employed. Chum and pinks are released either unfed after emergence from channels or incubation boxes or as fed fry after one month of feeding. Coho are released as fry, either at emergence or after 3 to 5 months of rearing, or as smolts after one year of rearing. The majority of sockeye are released as unfed fry after emergence from channels, although a small number are hatchery incubated and short-term reared. Sockeye are also enhanced through lake fertilization programs, migrating from the lake after one year of rearing. For chinook, coastal stocks are released after 3 to 4 months of rearing, while interior stocks are frequently reared for one year to the yearling stage. The latter are a very small part of the chinook program and releases are not tabulated separately in this report. Releases from hatcheries are usually enumerated by subtracting egg and fry mortalities from the egg number while releases from manned channels are estimated through proportional sampling of the outmigrants.

Annual egg and release targets for hatcheries are set pre-season for each stock, in consultation with project managers, stock assessment biologists and harvest management biologists. Factors such as potential adult production (based on previous average survival rates), species interactions, effect on existing stocks, harvest concerns, habitat capacity and project capacity are taken into account.

Estimates of enhanced contribution and survival rates of chinook, coho, and chum salmon are based on marking a portion of the fry released and recovery of these marks in the fisheries and escapement. Although marked in the past, pink are not currently being marked. Marking occurs at the project prior to release, while recovery takes place through coastwide sampling programs in the sport and commercial fisheries (Kuhn, 1988; Kuhn et al., 1988) and through recovery programs on the spawning grounds or at the project. Mark type is dependent on the species, with coded wire tags used for chinook, coho and some chum stocks, and finclips for other chum stocks. Beginning in 1996, coho from southern B.C. production facilities were marked with a fin clip to allow for the possibility of a selective hatchery mark fishery.

Attempts are made to assess all stocks routinely but some enhancement projects and species are rarely or never assessed directly because of their small size or logistical constraints. Certain stocks have been identified as indicator stocks, and their production is marked annually. These sites conduct rigorous escapement sampling and estimation programs. Survival and exploitation rate estimates for these projects are used to represent parameters for other stocks, both wild and enhanced, and to show trends over time.

There are fewer projects enhancing sockeye. Production is estimated using run reconstruction or average predicted survival rates. Experimental groups of reared sockeye may be marked with finclips. Recovery occurs on the spawning grounds or at the project.

Selected species and stocks are identified with an otolith mark for estimation of enhanced contribution to terminal areas. Thermal marking is coordinated through the Stock Assessment Branch at the Pacific Biological Station. Additionally, a limited number of stocks, mainly sockeye, have been marked with strontium chloride, a naturally occurring salt. Until recently, no other agencies used strontium chloride and there was no formal reporting system. A coordinated marking and reporting system needs to be developed for both thermal and strontium chloride marking.

Results

Table 1 shows releases for 1977 - 2000 brood years from hatcheries and manned spawning channels operated by HEB staff or contracted community and native groups. Estimates of production from unmanned channels, overwintering ponds, lake enrichment programs and other habitat restoration projects are not included. Steelhead and cutthroat data are not included as their assessment is a provincial responsibility. Releases from facilities which are not under the direction of HEB are also not included. Locations of facilities included in Table 1 are shown in Figures 1a, 1b and 1c.

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. Lower harvest rates for Fraser River chum led to reductions in egg targets for 1999. Full production for chinook and coho smolt releases was reached in the early to mid 1980s. In recent years, increased effort was made to rebuild severely depressed stocks, including upper Skeena and Thompson 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 British Columbia. Projects are cooperative programs in partnership with other governmental and non-governmental agencies and include constructing side-channels, increasing water flows, stabilizing stream banks, enriching nutrient poor lakes and rivers, and rebuilding estuary marshes.

Since 1998, concern for Upper Skeena and Thompson River wild coho stocks has constrained the harvest of all species. The entire coast was managed on the basis of Upper Skeena and Thompson River coho. No fishing was permitted in areas and times where these stocks were prevalent and selective fishing gear was required in all fisheries. Fishing for other species was permitted in areas and times where these stocks were not prevalent, with retention of coho permitted only in extreme terminal areas on hatchery stocks. Many of the fisheries which did occur were focussed on enhanced stocks.

Summary

Data are presented for releases by brood year, species and release stage for Enhancement Operations and Community Involvement Division facilities. Since 1998, Fisheries & Oceans Canada has implemented more conservation based management of salmon fisheries. Many fisheries are being directed towards enhanced stocks.

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

Upper and Lower Fraser River and Thompson River Sites

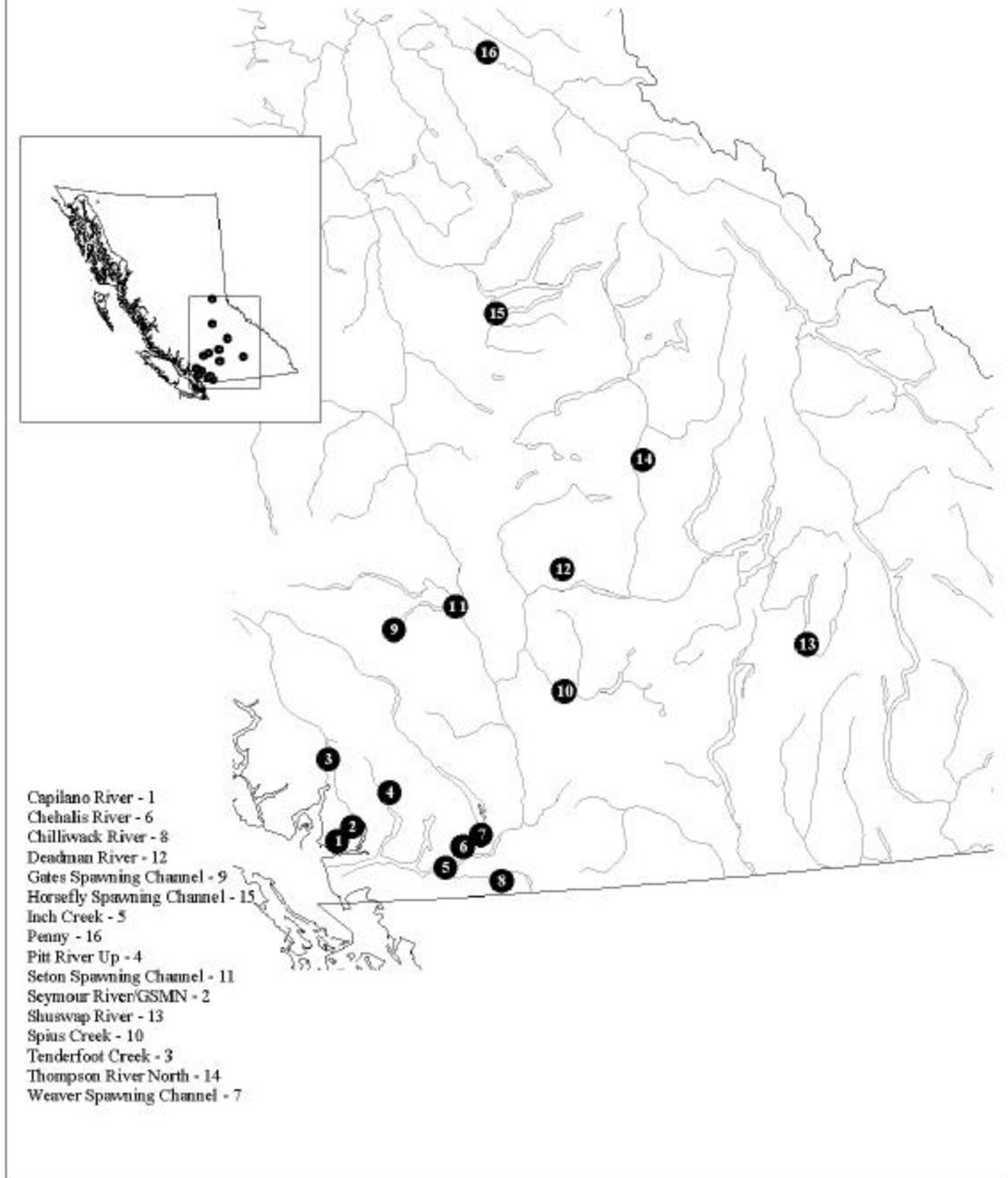


Figure 1b Locations of selected British Columbia, Canada enhancement facilities.

North and Central Coast, Skeena, Nass, Rivers Inlet, and Queen Charlotte Sites

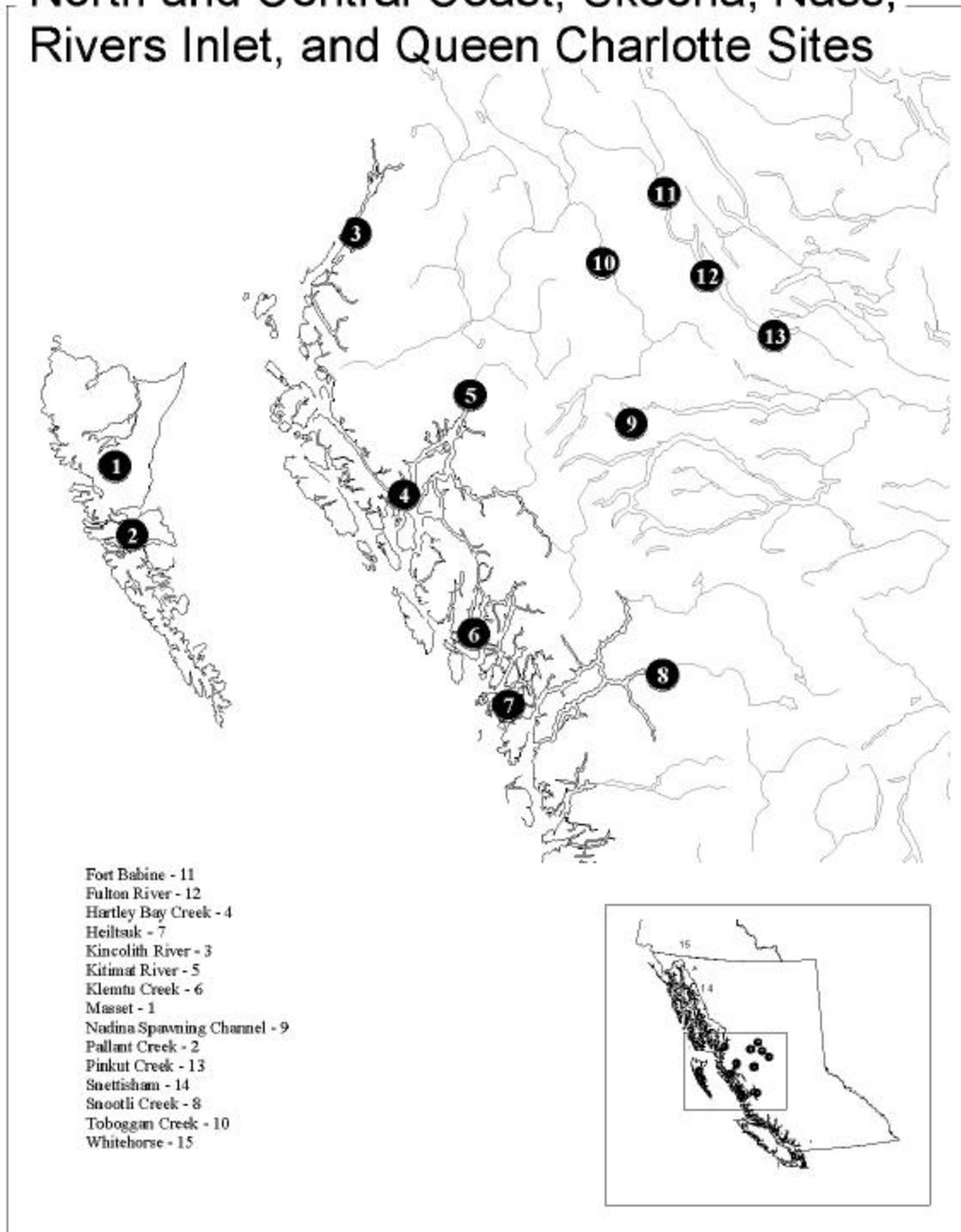


Figure 1c Locations of selected British Columbia, Canada enhancement facilities.

Georgia Strait, Johnstone Strait, and West Coast Vancouver Island Hatcheries

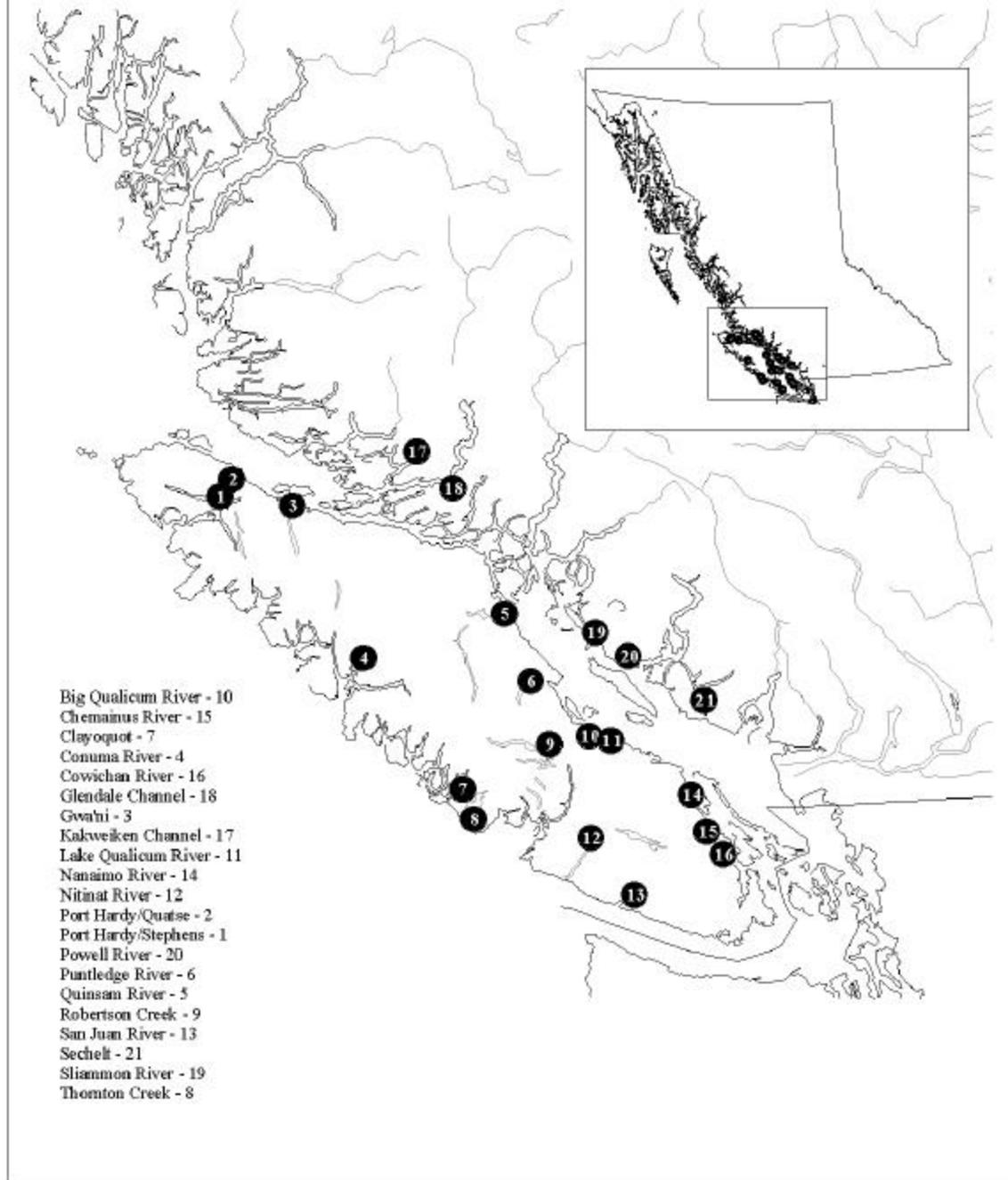


Table 1. Releases of juveniles from HEB hatcheries and manned channels in British Columbia Canada

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	41,614,811	102,464,677	8,852,842	9,720,856	25,432,597	5,057,021	157,434,930	109,045	1,501,462
1986	53,815,001	96,413,382	85,842,800	11,505,565	10,087,259	13,740,312	4,509,098	180,106,075	157,749	2,073,374
1987	63,631,981	101,859,170	75,979,591	8,066,239	9,534,951	43,696,480	4,807,689	122,471,589	179,737	1,896,518
1988	64,254,578	113,649,528	87,928,664	7,701,263	11,168,846	34,245,812	2,827,349	198,725,634	194,543	1,940,636
1989	63,254,499	83,288,150	92,214,006	9,637,576	11,705,728	48,240,457	2,884,163	206,752,792	164,027	1,840,159
1990	66,114,433	94,789,499	94,759,699	8,523,000	12,115,301	87,447,634	1,023,076	223,080,058	181,781	1,841,700
1991	59,326,978	79,481,997	96,839,355	9,421,861	10,700,087	54,216,640	1,584,525	227,135,058	178,076	1,642,679
1992	57,818,691	113,799,377	89,286,432	6,367,148	10,370,043	14,074,137	1,781,339	233,579,579	159,793	1,200,172
1993	50,834,933	101,859,532	93,399,435	6,477,421	10,735,588	36,840,352	1,576,168	179,045,418	154,936	1,061,360
1994	53,344,098	85,693,766	103,998,196	10,546,670	10,646,445	8,794,240	1,981,042	132,539,077	120,128	1,008,803
1995	45,205,507	33,590,212	87,665,283	8,200,503	11,311,460	32,476,878	2,001,615	77,980,811	128,428	960,635
1996	57,580,439	16,928,042	93,094,003	5,769,716	11,804,961	11,255,228	1,472,567	254,967,453	138,214	711,072
1997	49,797,448	45,470,998	104,038,311	5,212,183	11,558,341	34,741,905	1,640,496	84,204,632	85,676	995,164
1998	54,075,107	80,298,805	91,425,525	9,097,619	14,312,424	13,643,600	150,482	135,058,928	127,234	647,365
1999	54,199,157	18,858,989	78,593,285	8,139,340	12,721,759	11,505,870	3,198,637	148,912,649	105,283	670,415
2000	44,589,168	9,304,415	58,238,149	7,983,579	10,069,588	16,792,058	999,207	178,410,655	76,387	673,426

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