Canadian Enhanced Salmonid Production

by

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\textbf{THIS PAPER MAY BE CITED IN THE FOLLOWING MANNER:}
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 nearly 300 projects that produce chinook (\textit{Oncorhynchus tshawytscha}), coho (\textit{O. kisutch}), chum (\textit{O. keta}), pink (\textit{O. gorbuscha}), and sockeye salmon (\textit{O. nerka}), as well as small numbers of steelhead salmon (\textit{O. mykiss}) and cutthroat trout (\textit{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 summarise 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 nearly 300 projects throughout British Columbia that produce chinook (\textit{Oncorhynchus tshawytscha}), coho (\textit{O. kisutch}), chum (\textit{O. keta}), pink (\textit{O. gorbuscha}), and sockeye salmon (\textit{O. nerka}), as well as small numbers of steelhead salmon (\textit{O. mykiss}) and cutthroat trout (\textit{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 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.
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.

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 used for other 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 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.

There are relatively few projects that enhance sockeye and pink salmon. Sockeye production is estimated using run reconstruction or historical survivals. Experimental groups of reared sockeye, mainly stock 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 2007 are broken down by area (Table 3). Data for the final year presented (2006 brood and 2007 release year) are preliminary and will be updated in future reports. Similarly, this report updates release numbers provided in earlier reports. Releases have been added for 1985-1996 release years from a small program that was
not included in the past. 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.

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 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. The Doug Little Hatchery at Penny, producing Dome Creek chinook, was closed in 2006 due to structural problems and is proposed for relocation to another upper Fraser River site.

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, Yukon, and Transboundary Area, Canada

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<th>Brood Year</th>
<th>Chinook</th>
<th>Chum</th>
<th>Coho</th>
<th>Pink</th>
<th>Sockeye</th>
<th>Trout</th>
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<td>Fry</td>
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Table 2. Juvenile salmon releases by release year from OHEB hatcheries and manned channels in British Columbia, Yukon, and Transboundary Area, Canada
Table 3. Juvenile salmon releases by area in 2007 from OHEB hatcheries and manned channels in British Columbia, Yukon, and Transboundary Area, Canada

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<th>Pink</th>
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