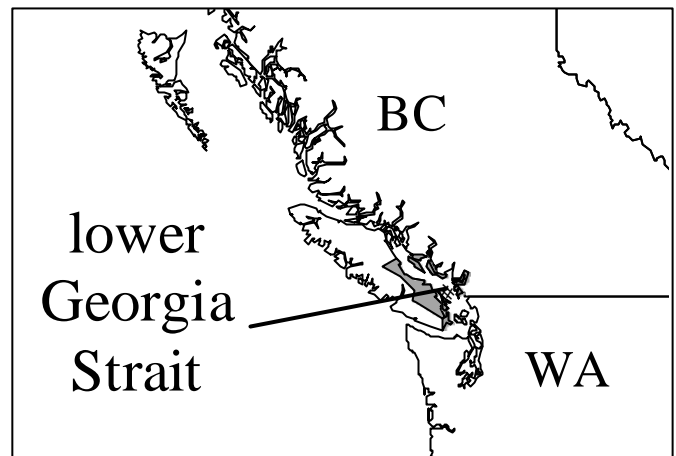


CHINOOK (King)
Oncorhynchus tshawytscha

Lower Strait of Georgia Chinook Salmon



Background

Groupings of chinook salmon populations in British Columbia are distinguished by geographic location, run timing of the spawning migration, distribution of catch in the ocean, and age at maturity. Five major groups of Canadian-origin chinook salmon are recognized around the Strait of Georgia; including upper Fraser River spring and summer chinook, lower Fraser River white fall chinook of Harrison River origin, mainland inlet summer chinook, far-north migrating fall chinook in the upper Strait, and the Lower Strait of Georgia chinook group. The latter is defined by limited northward migration along the Pacific coast, relatively young age-at-maturity (few fish at age 5 or older), and adult migration timing predominantly in the late summer and fall.

This group was over-fished through the 1970s and early 1980s, and extensive hatchery programs were initiated to rebuild production but in recent years production has been limited by poor marine survival. This group of chinook salmon is considered to be very important to local communities and fisheries within the Strait.

Lower Strait of Georgia (LGS) chinook reproduce and rear in small and medium sized rivers from the Puntledge River, east coast of Vancouver Island, south to the Saanich Peninsula and along the southern mainland. Production results from major hatchery programs, such as the Big Qualicum, Puntledge, and Capilano hatcheries and numerous smaller

enhancement programs intended to supplement production from naturally spawning adults. The largest remaining naturally spawning populations exist in the Cowichan and Nanaimo rivers but these populations are also supplemented through hatchery production. The vast majority of LGS chinook production is from fall chinook salmon but a small spring chinook population exists in the Nanaimo River and a summer chinook population persists in the Puntledge River. In some past assessments, the Squamish River and Tenderfoot Hatchery production has been included in LGS reports. These chinook have a similar catch distribution to the LGS fall chinook but are summer run-timing and will now be included in the mainland inlet summer chinook group.

Management of the LGS stock involves a complex interaction of habitat changes and urban development, historical over-fishing, extensive hatchery development, and competing user groups and social values (Walters and Riddell 1986). In the past five years, however, extensive reductions in fishery impacts have been able to sustain the naturally spawning component of this important stock group, even during periods of poor marine survival.

The Fishery

The LGS chinook group is vulnerable to fisheries from northern B.C. and Alaska south to local fisheries within the Strait of Georgia, the latter being the principle fisheries on these chinook. Catches in net, troll, and sport fisheries in Johnstone Strait and the Strait of Georgia averaged over 500,000 chinook annually during the 1970s but have been reduced to less than one-tenth of that value between 1994-1998. This reduction reflects management actions to conserve LGS chinook and reduced fishing. For example, a large portion of the catch in the 1970s was of small age-2 chinook (Argue et al. 1985); increases in size limits during the 1980s reduced the catch retained but also increased the incidental mortality associated with fishing. Seine net fisheries are now required to release chinook landed and the Strait of Georgia troll fishery, which has been very restricted in recent years. A major reason for the magnitude of decline in catch, however, has been the poor marine survival of chinook and coho salmon from recent brood years and the resulting decline in sport fishing effort within the Strait.

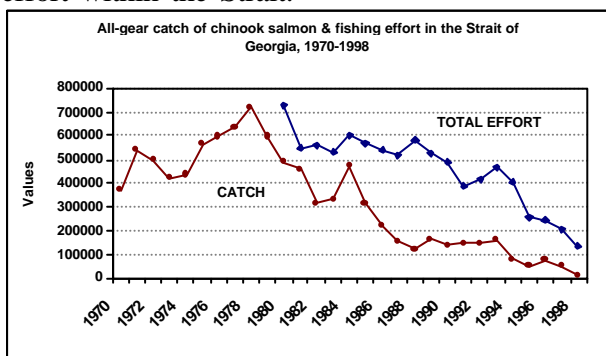


Figure 1

Although more poorly documented, LGS chinook are also subject to freshwater harvest. Sport fisheries for age-2 male chinook exists in some systems and Native fishers harvest chinook for food and ceremonial purposes. In total, however, these fisheries are considered to have minimal effect compared to the ocean fisheries.

Life History

Mature LGS chinooks normally return to natal rivers from late August through October, and spawn through mid to late fall. Peak spawning normally occurs in mid to late October. The timing of up-stream migration varies substantially depending on temperature and flow conditions in these rivers. Differences in these timings occur in two populations. Spring chinook returning to the Nanaimo River arrive in the early summer but spawning occurs in the fall. Summer chinooks returning to the Puntledge River arrive in mid-summer and again spawn in mid-fall.

Juvenile emergence occurs early in the following spring and within 1 to 3 months the juveniles migrate to the ocean (“ocean-type” life history). Some migrate at the early feeding stage (fry) shortly after emergence. The relative importance of this behaviour to adult production, compared to the larger, older migrants (smolts), is not well known. However, production resulting from fry migrants is believed to be relatively small. Hatchery programs for LGS chinook typically feed juveniles for three months and then release these “90-day smolts” (migration normally occurring in late-May and June). Juveniles entering the marine environment utilize estuaries and near-shore areas to feed for a few months before beginning a northward movement. LGS chinook may remain within the Strait of Georgia for their entire marine growth phase but some smaller portion migrate to more northerly waters of central and northern B.C. and to a lesser extent Alaska.

An exception to this life history is the Nanaimo spring chinook population. Spring chinook that spawn and rear in the natural environment spend one year in freshwater before emigration (“stream-type chinook”). However, the enhancement strategy used for Nanaimo spring chinook still releases them as “90-day smolts”.

LGS chinook rear in the ocean for 1 to 4 years but the vast majority of the mature fish return after 2.5 or 3.5 years at sea (3 and 4 years after their

spawning or brood year). The fall chinook are considered to be early maturing chinook with approximately 3% of a brood production maturing as 2 year-olds (usually all small males referred to as Jacks), 25% of the remaining brood maturing as 3 year-olds, and 90% of the remaining age-4 fish maturing in that year. The contribution of age-5 and older chinook is very limited. Male chinook generally mature at a younger age than females. Maturation rates are estimated from chinook tagged in hatchery programs (coded-wire tagging for brood years 1975-1992) and analyzed by cohort analysis of recoveries in fisheries and spawning escapements. These rates vary among years and stocks but are quite typical of LGS fall chinook and the Puntledge summer chinook. Maturation rates for the Nanaimo spring chinook are not as well estimated but the age of maturity will not correspond due to the year spent in freshwater.

An important characteristic of this chinook stock is their "residence" within the Strait of Georgia. Typically, chinook populations are distributed northward from their natal streams but some show more localized distributions. Stock distribution is interpreted from recoveries of coded-wire tags in commercial, recreational, and Native catches. Distributions of recoveries among fisheries will, therefore, vary with changes in fisheries over time but the extent and pattern of stock distributions have proven to be very consistent among years and stocks. Tags recovered throughout the year from the Strait of Georgia sport fishery, especially of the younger age-classes, indicate residence of this stock within the Strait. LGS chinooks extensively utilize the northern portion of the Strait of Georgia, but some portion of the production emigrates further north. The timing of migrations out of and into, the Strait is not well documented. The residence of this stock makes it both important to local fisheries and highly vulnerable to exploitation.

Stock Distribution

The ocean catch distribution for this stock group is well known through extensive coded-wire

tagging programs in many of the hatchery populations. The exploitation pattern of this stock group is highly repeatable between years and populations. Over half of the exploitation on these chinook occurs within the Strait of Georgia plus the Johnstone Strait net fisheries, a much more restricted northward distribution than amongst most other chinook stocks (Table 1).

Table 1. Average annual distribution (%) of the total fishing mortality on three LGS populations for the 1987-1991 brood years. These distributions are contrasted with a far-north migrating fall chinook from the Quinsam/Campbell River (Upper Strait of Georgia).

FISHERIES*	BIG QUALICUM R. FALL CHINOOK	COWICHAN R. FALL CHINOOK	PUNTLEDGE R. SUMMER CHINOOK	QUINSAM / CAMPBELL R. FALL CHINOOK
S.E. ALASKA (all gear)	14.4	1.7	15.3	42.2
NCBC TROLL + SPORT	11.7	3.0	17.1	24.7
NCBC NETS	6.1	2.5	11.6	15.4
WCVI TROLL + SPORT	5.8	4.1	2.0	1.3
ST. GEORGIA TROLL	4.9	17.1	3.0	0.6
JOHNSTONE STRAIT NET	8.7	9.8	5.2	8.9
ST. GEORGIA SPORT	45.9	49.3	45.8	6.5
OTHER BC	0.4	2.4	0.0	0.1
WASHINGTON	2.0	10.1	0.0	0.1

* Fishery designations: NCBC is north and central B.C. (statistical areas 1-11,30), WCVI is west coast of Vancouver Island (areas 21-27). Strait of Georgia includes Johnstone Strait for troll and sport fisheries, Other BC includes other minor fisheries plus freshwater recoveries, and Washington includes all recoveries in Washington State fisheries.

The years 1987-1991 were used in this comparison to reduce variation introduced by fishery management changes and for inclusion of the Cowichan River data. The table presents the average distribution of recoveries over all ages within a calendar year. However, younger ages would show a more southerly and "inside" (Strait of Georgia) distribution than older ages. Inclusion of earlier years would also increase the portion estimated in Strait of Georgia fisheries due to higher exploitation rates and smaller size limits before 1987.

Fishery Exploitation Rates

The exploitation rate on a chinook population is the portion of the production from a brood year that was caught (reported catch) or killed (total fishing mortality due to catch plus non-reported fishery-related mortality) by fishing. These rates have been measured on coded-wire tagged

hatchery populations since the early 1970s for the Big Qualicum falls and the Puntledge summer chinook, and since the late 1980s for the Cowichan River falls. Management of this stock relies heavily on these data and assumes that exploitation rates measured on hatchery populations are representative of local natural populations also. Average exploitation rates by time periods and populations (total fishing mortality) are summarized in Table 2.

Table 2. Average total exploitation rates (over all fisheries) by time periods (Brood years) for 3 coded-wire tagged indicator stocks in the Strait of Georgia

TIME PERIODS	BIG QUALICUM	PUNTLEDGE	COWICHAN
1975-1984	82.3%	77.6%	NODATA
1985-1990	75.7%	56.7%	85.6%
1991-1993	62.8%	45.4%	66.5%

In each stock, the total exploitation rate has been decreased over time. However, for each stock, the proportion of the mortality attributed to non-reported incidental mortality has increased from an estimated 15% during 1975-1984 to about 35% recently, largely due to increases in size limits in hook-and-line fisheries. The rates also do not account for any unsampled mortality; for example, fish that drop out of gillnets or losses in terminal areas. This will increase the exploitation for Puntledge summer chinook due to seal predation in the river mouth, and slightly increase the rate on Cowichan chinook due to a small Native fishery.

Enhancement

Since the 1970s, substantial expansion has occurred in the numbers of LGS chinook released from enhancement programs around the Strait of Georgia (Figure 2). These releases contribute significantly to fisheries in the Strait of Georgia, currently accounting for about 30% of the catch in the recreational, troll, and net fisheries in the Strait and Johnstone Strait (Figure 3).

Enhancement programs vary from major hatcheries such as the Big Qualicum Development Program (Fraser et al. 1983), to smaller hatchery programs in most rivers, and spawning channels

for the Puntledge summer chinook. Objectives of these programs range from increasing chinook catches (Big Qualicum) to supplementing the numbers of chinook spawning naturally in order to rebuild production from naturally spawning populations (Cowichan River and Puntledge summers). Poor marine survival is currently limiting the adult production from these facilities.

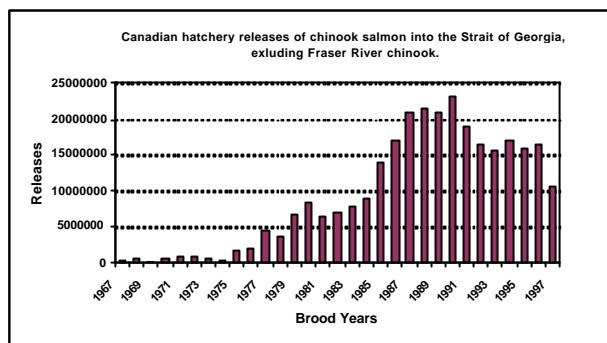


Figure 2

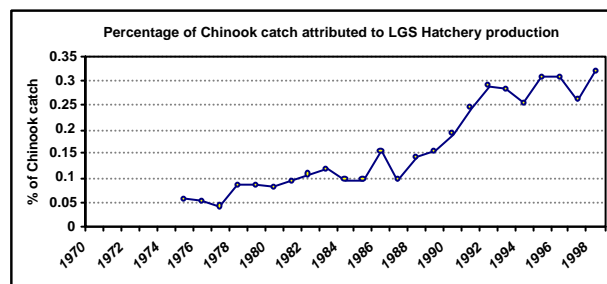


Figure 3

Environmental Factors

The rivers that support LGS chinook are located in a highly developed region. Urban and industrial development has affected availability and temperatures of freshwater, reduced wetlands, and altered estuarine habitats. Loss of available habitat has caused a reduction in the rearing capacity of many rivers (Healey 1982). More recently, studies in the Strait of Georgia have indicated that changes in the marine environment have also contributed to the decline in chinook abundance (Beamish et al. 1995). Estimates of the marine survival for Cowichan River hatchery smolts indicate that survival of the most recent brood years (1991-1995) is only one-third of the average survival through the 1980s. Changes in

the habitat and climatic factors have been compounded by increases in some predator populations; in particular harbour seals in some areas of the Strait. During the late summer and fall in the lower Puntledge River and estuary, harbour seals were estimated to consume 22-47% of the chinook returning to this river (pg. 110, Rice et al. 1997).

Stock Status

The status of LGS chinook has resulted from a complex interaction of their migratory pattern (residency in the Strait), potentially high fishery exploitation rates, expanding production from enhancement programs, and numerous environmental changes. In general, the production from LGS chinook is considered depressed relative to the 1970s when large chinook catches were taken in the Strait of Georgia. Total production from natural and hatchery populations has declined but the spawning populations have been maintained by reducing fishery impacts and through enhancement programs; the notable exception to this generality is the Puntledge summer chinook population (Figure 4a).

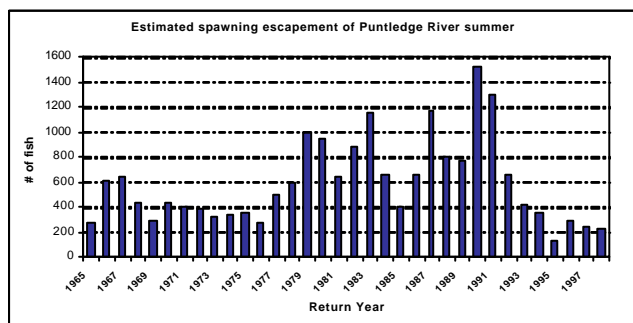


Figure 4a

The numbers of summer chinook returning to spawn in the Puntledge River once numbered about 3,000, but declined following expansion of hydroelectric development during the early 1950s. By 1965, only a few hundred fish returned. Following enhancement efforts, the number of spawners increased to between 800 and 1,200 chinook during the 1980s. However, during the 1990s these escapements have again declined to only a few hundred spawners, and most spawning

occurs in the spawning channel. Exploitation rates on this population have been decreased and predator control programs have been implemented in the river. Conservation actions will continue to be needed to sustain this population particularly during this period of poor marine survival.

The majority of the production from the LGS chinook stock results from the fall run-timing component of these chinook salmon. The natural population monitored to assess this component is in the Cowichan River. Before 1975, the number of spawners returning to the Cowichan River was usually assessed between 5,000 and 10,000 chinook. Even during the decade 1975-1984 the return to the Cowichan River remained between 4,000 and 9,000 chinook, in spite of the large catches within the Strait. However, the numbers of naturally spawning chinook decreased substantially during 1986 and 1987. The precise cause of the decline was not known but severe low water conditions during the fall of those years likely contributed to the loss of adults. To conserve and restore the population, fishery management actions were taken to reduce the exploitation rates and the level of enhancement in the river increased. Returns to the Cowichan River have subsequently improved and have consistently exceeded 6,000 chinook since 1988 (Figure 4b). However, approximately one-half of the returns are now from the hatchery program and harvest rates have remained reduced to compensate for reduced marine survival. While fall chinook populations of the LGS stock are not at risk, their production is presently limited by poor marine survival conditions.

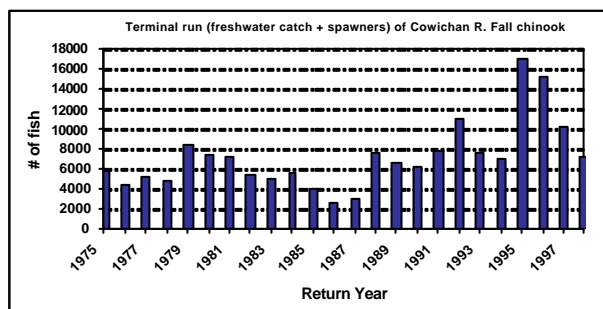


Figure 4b

Spawning escapements of the Nanaimo river spring chinook have also increased recently but the assessment of this population is uncertain. Records of the spawning numbers are sparse before the enhancement program began in 1979 but the numbers of spawners were believed to be only a few hundred or less (based on Fishery Officer reports). Following enhancement programs and reduced early season fisheries, the recorded number of spawners has varied between 200 and 750 chinook annually. While the status of this population relative to earlier years is uncertain, the numbers of spawners do not indicate any consistent decline (Figure 4c).

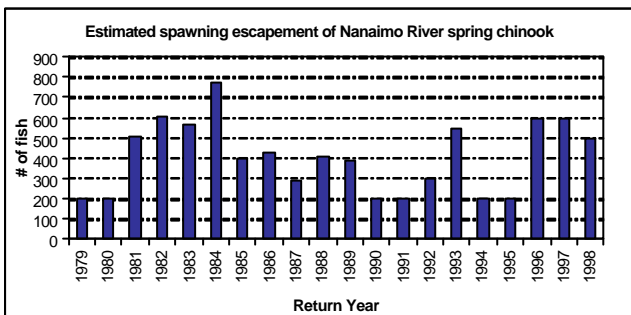


Figure 4c

Outlook

At current levels of marine survival, conservation actions should be maintained to sustain the natural-spawning component of this important chinook group. Both natural and enhanced productions from this stock contribute to one of Canada's most important recreational fisheries within the Strait of Georgia. Assessment of these populations will continue in order to monitor changes in marine survival and the productivity of these chinook populations. Further reductions in the productivity of these chinooks may require further management actions to limit fishery impacts and sustain escapements to rivers. Water management and/or habitat programs may also be required to conserve these populations.

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