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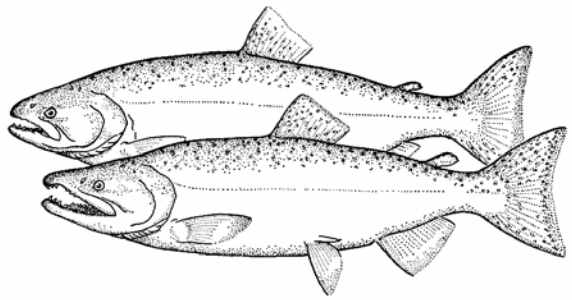
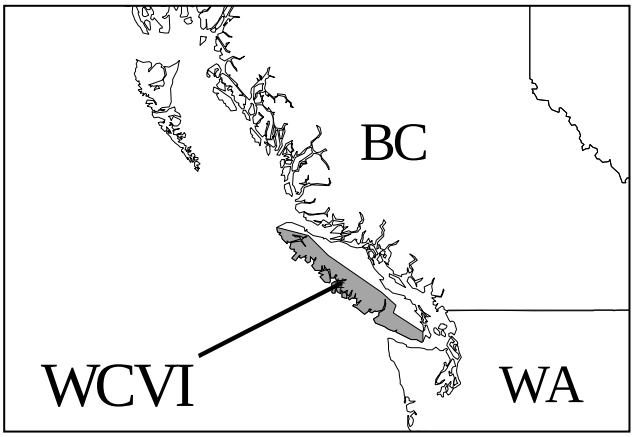
Pacific Region
Canadian Science Advisory Secretariat
Science Advisory Report 2012/032

ASSESSMENT OF WEST COAST VANCOUVER ISLAND CHINOOK AND 2010 FORECAST



Chinook Salmon (Oncorhynchus tshawytscha)



The west coast of Vancouver Island (WCVI).

Context

Chinook (Oncorhynchus tshawytscha) from the west coast of Vancouver Island (WCVI) are one of British Columbia's most important natural resources. These stocks have long been major contributors to First Nations, commercial troll, and sport catches, from Alaska to southern Vancouver Island. WCVI Chinook salmon inhabit over 100 rivers, with 60 rivers supporting populations exceeding 100 spawners. Spawning population sizes can range from less than 100 to more than 100,000 Chinook in rivers with major hatcheries. Twenty of the 60 rivers have some form of enhancement to supplement natural spawning; including major hatcheries on the Stamp, Conuma, and Nitinat rivers. Together, these hatcheries contribute an average of about 90% of the annual WCVI Chinook production.

WCVI wild Chinook are a stock of concern. Most populations remain at low levels showing no signs of rebuilding despite management actions over the last 15 years and some populations in south-west Vancouver Island continue to decline. There are likely many factors contributing to the low abundance and continued declines of WCVI wild Chinook.

The far northerly distribution of WCVI Chinook limits Canada's ability to conserve WCVI Chinook, since a large proportion of the catch occurs in Alaska. Allowable harvest impacts in areas under joint Canada-US Aggregate Abundance-Based Management (AABM) are determined by provisions in the Pacific Salmon Treaty (PST. In Canada, fisheries are also subject to domestic considerations, such as conservation and allocation. In recent years, concern for low status natural origin WCVI Chinook has constrained harvest in mixed-stock Canadian fisheries, including North-Central BC and WCVI AABM fisheries.

The Stamp River/Robertson Creek Hatchery (RCH) Chinook salmon stock is a key indicator stock for exploitation rate and distribution pattern of west coast Vancouver Island (WCVI) populations. Intensive assessments of the WCVI hatchery and natural population aggregates and abundance forecast for the Stamp River/RCH are undertaken annually for indication of stock status and management of ocean and terminal fisheries. The forecasts are key inputs to the annual PSC Chinook Technical Committee annual model calibration which calculates abundance indices and associated allowable catch levels for the WCVI and North-Central BC AABM fisheries. The forecasts also contribute to the management of other Canadian and US fisheries.

SUMMARY

- The status of wild WCVI Chinook remains poor. Over the last 15 years wild populations in south-west Vancouver Island have continued to decline despite management actions. Wild populations from north-west Vancouver Island are more stable; however they are only stable at low levels and show no signs of rebuilding.
- Many of the other index systems, which have not declined, are dependent on hatchery supplementation to maintain current spawner levels. Sampling of escapement for hatchery marks indicates that a high proportion of spawners in some systems in some years are hatchery origin fish.
- Of particular concern, are wild populations originating from the south-west area of Vancouver Island. Wild spawner populations in Area 24 (Clayoquot Sound) have declined an average of 53% over the last three generations despite relatively pristine freshwater habitat and harvest reductions.
- Currently, a few productive (or enhanced) systems and hatcheries contribute to the bulk of WCVI Chinook production (i.e 90%). A consequence of the current management system is the mass production from WCVI hatcheries increases the allowable harvest rate in PST-regulated AABM fisheries where hatchery and wild stocks are treated similarly.
- From 1995 to 2009, the average estimated annual fishing mortality was 18% in US AABM (Southeast Alaska) fisheries; 11.5% in Canadian ocean (AABM) fisheries and the average terminal (ISBM) exploitation rate was 22%, based on an analysis of coded wire tags (CWTs). From 1997 to 2007, the management objective for WCVI Chinook was a 10% to 15% maximum mortality in Canadian AABM fisheries. From 2008, the management objective has been a 10% maximum mortality in Canadian AABM fisheries.
- With the exception of terminal fisheries targeting hatchery surpluses (e.g. Alberni Inlet, Barkely Sound, Tlupana Inlet and Nitinat Lake) ISBM fishing mortality is assumed low (i.e. <5%) because fishing opportunities in areas where wild WCVI Chinook are vulnerable are severely restricted.
- Stakeholders are concerned about the potential impact of near-shore activities (e.g. aquaculture) on WCVI Chinook populations, particularly in Nootka Sound (Area 25) and Clayoquot Sound (Area 24). However, there is uncertainty in level of harvest in some areas and the role additional harvest among other factors, such as marine mammal predation, may play in the decline of populations there.
- The 2009 terminal return to the Stamp River/RCH indicator stock was estimated at about 43,200 adults and 5000 jacks (age-2 males), approximately 8% less than forecast.
- The 2010 forecast total return of Stamp River/RCH Chinook to Canada is 48,700. After Canadian ocean fisheries, the forecast return of adult Stamp/RCH Chinook to the terminal area of Barkley Sound and Alberni Inlet is 42,900, similar to levels observed in 2009.
- In 2010, the age-4 component is forecast to comprise 41% of the terminal run (27% age-3, 41% age-4, and 31% age-5), with an expected sex ratio of 46% female.
- For 2010, expectations for WCVI natural stocks are similar to the 2009 observed return. However, the outlook for SWVI populations is below recent average abundance whereas the outlook for NWVI is about recent average levels.

BACKGROUND

Species Biology

Chinook salmon (*Oncorhynchus tshawytscha)* are one of seven Pacific salmon species. Populations are broadly distributed from California to Alaska. Those originating from the West Coast of Vancouver Island (WCVI) are among the middle end of the species range in North America.

The return migration to their streams of origin occurs from July through September. The peak of migration into the terminal WCVI areas is usually late August. However, populations originating from more northern areas of Vancouver Island, such as the Conuma River stock, return about 3 weeks earlier.

Peak spawning for WCVI Chinook occurs from late September to mid-October. Timing of the peak varies by up to a week or two depending on the immigration rate into the river and water conditions. Emergence from the spawning gravel occurs early in the spring of the following spawning. Within 1 to 3 months the fry migrate to the ocean and these Chinook are referred to as 'ocean type'. There are very few "stream type" Chinook (i.e., stay in river for one year after emergence) in the WCVI region. Surveys in the Barkley Sound area suggest that the young-of-the-year Chinook may reside in near-shore waters until August before beginning a northerly migration. This early marine phase is critical to the survival of the cohort, which depends on ocean conditions, predation and food abundance.

WCVI Chinook migrate north into northern BC and southeast Alaska waters to rear for 2 to 7 years. As they become sexually mature they migrate south back to their natal rivers and streams. Under average exploitation rates, 2-3 % of each cohort mature and head south at age 2, another 15 % mature at age 3, with 55 % maturing at age 4, and 25 % at age 5. Less than 2 % are left to mature at age 6. Some populations, such as Nahmint River, have a higher population of older age 5 to 6 year old fish returning. Generally, male Chinook mature at a younger age than female Chinook. Few or no mature 2-year-old Chinook are female, only 5 % of mature 3-year-olds are female, 50 % of mature 4-year-olds are female; and about 75% of mature 5-year-olds are female. It is important to ensure enough of older Chinook age classes escape fisheries, since they are mostly females and typically more fecund than younger maturing females.

Stock Structure

DFO's Wild Salmon Policy (WSP) requires identification of Conservation Units (CUs) for salmon. In the policy, a CU is defined as "a group of wild salmon sufficiently isolated from other groups that, if extirpated, is very unlikely to re-colonize naturally within an acceptable timeframe." The CU is the scale at which the DFO aims to maintain biodiversity and at which benchmarks (LRPs and TRPs) will be defined. It is also the scale at which depleted species may be legislatively protected (e.g. through the Canada Species at Risk Act, SARA).

Conservation Units are determined based on the genetic, morphological, behavioral and ecological similarity of populations. Four Chinook Conservation Units (CUs) are designated for WCVI area; including San Juan (Area 20), South West Vancouver Island (Areas 23, 24), Nootka-Kyoquot (Areas 25, 26) and North West Vancouver Island (Area 27) (Holtby and Ciruna 2007).

Stock Enhancement

Twenty WCVI rivers have some form of enhancement to supplement natural spawning. Annual releases of Chinook smolts from WCVI enhancement facilities have totaled about 21 million per year. About 17 million of these releases come from the three major hatcheries located on the Stamp, Nitinat, and Conuma rivers. There is also enhancement of Chinook populations in surrounding systems such as the Sarita, Nahmint, Tlupana, and Toquart rivers. Hatchery fish also stray into streams, such as Canton Creek and Sucwoa, which are near the Conuma River facility. About 3 million Chinook smolts are released annually from the smaller hatchery facilities, including volunteer public involvement projects such as those on the Marble, Zeballos, Tahsis, Leiner, Burman, Tranquil, and Cypre rivers. Also, federally-funded community development projects exist on the San Juan, and Kennedy rivers and at Thornton Creek.

Fishery

WCVI Chinook may be harvested in fisheries from Alaska to the WCVI rivers. Northern fisheries harvest WCVI Chinook stocks as both immature fish feeding in the area and as mature adults during their return migration to their natal stream. Southern fisheries harvest only maturing Chinook en route to their natal stream. The far northerly distribution of WCVI Chinook limits Canada's ability to conserve WCVI Chinook, since a large proportion of the catch occurs in Alaska. In fact, WCVI origin Chinook stocks comprise about 20% on average of the South-East Alaskan (SEAK) catch (Table 1). Currently, most WCVI origin Chinook are harvested in the AABM fishing areas north of Vancouver Island, including the SEAK fisheries and commercial and recreational fisheries in Northern BC (NBC).

Large returns of WCVI Chinook in the 1980s and early 1990s resulted in rapid growth of aboriginal, sport, and commercial fisheries along the WCVI. The peak fishing period was August through September for the WCVI stocks. In fact, the local stocks comprised between 90 and 100 % of the catch in WCVI aboriginal, sport, and commercial gillnet fisheries during this period. Since1994, these fisheries were restricted during peak migration periods of WCVI Chinook in response to declines in escapement levels and, later, in response to Interior Fraser coho salmon declines. With the exception of terminal fisheries targeting hatchery surpluses (Alberni Inlet, Barkley Sound and Tlupana Inlet (Area 25)) or mixed stocks (Area 20), the estimated catch of Chinook in ISBM fisheries is relatively low (Table 2).

Table 1. Average contribution of WCVI Chinook to AABM fisheries, 1985 to 2007. (SEAK – Southeast Alaska; NBC – Northern BC; WCVI – West Coast Vancouver Island)

AABM Area (All Gear)	WCVI Contribution*			Treaty Catch*
	Hatchery	Wild	Total	
	1985 to 2006 Average			
SEAK	16.02%	3.45%	**19.47%**	278,000
NBC	5.57%	1.26%	**6.83%**	169,000
WCVI	6.18%	1.36%	**7.54%**	164,000
	2007			
SEAK	20.00%	2.34%	**22.34%**	327,000
NBC	3.45%	0.41%	**3.86%**	168,000
WCVI	4.08%	0.48%	**4.56%**	225,000

** based on CTC JCTWC Report TCCHINOOK 08-02*

Table 2. Average WCVI ISBM area Chinook catch, 2005 to 2009.

ISBM Area	Recreational	Commercial[1]	First Nation
Area 20 (WCVI)	8,689	-	195
Area 21	674	-	-
Nitinat (22)	-	-	194
Alberni Inlet (23)	7,922	32,049	2,335
Barkley Sound (23)	13,269	-	890
Clayoquot (24)[2]	459	-	
Nootka (25)	10,613	4,842	355
Kyoquot (26)	1,368	-	839
Quatsino (27)	1,433	-	-
WCVI	44,427	36,891	4,809

1 includes First Nation Somass Economic Opportunity Fisheries (Area 23)
2 average 1590 FSC reported catch attributed to the AABM (Area 123, 124) fishery although some portion occurs in Area 24

Harvest Management

Allowable harvest impacts in areas under joint Canada-US Aggregate Abundance-Based Management (AABM) are determined by provisions in the Pacific Salmon Treaty (PST) and subject to domestic considerations, such as conservation and allocation. Examples of AABM fisheries are the Alaskan troll, northern BC troll, sport and net, and the WCVI troll and sport. Pass-through fisheries also subject to PST provisions are deemed Individual Stock-Based Management (ISBM) fisheries. Examples of ISBM fisheries include fisheries in the Central Coast and inshore areas of the west coast of Vancouver Island.

AABM Fishery Management

Ocean fisheries in Canada that intercept WCVI wild-origin Chinook have been limited to a 10 to 15% harvest rate since 1997, even if Pacific Salmon Treaty (PST) provisions allow for a higher catch. Measures are in place to reduce the impact of fisheries on WCVI Chinook while still providing harvest opportunities. For WCVI sport fisheries, these include the 'slot limit' (designed to conserve larger egg-bearing females); maximum size limits, closed areas and increased limits in hatchery approach areas. The Northern Troll is restricted to an annual interception limit for WCVI Chinook, which is evaluated bi-weekly through catch composition sampling. Impacts in the WCVI troll have been reduced to near zero through time and area closures.

ISBM Fishery Management

Harvest opportunities for Chinook in terminal fishing areas are severely restricted to allow for conservation of wild populations. Specific areas or time-areas are closed to Chinook retention in order to protect local wild populations. These closed areas are considered to be either migration corridors or holding areas of the populations of concern. More harvest opportunities are permitted in terminal locations where hatchery surpluses may be identified, such as Alberni Inlet (Area 23), Tlupana Inlet (Area 25), or Nitinat Lake (Area 22).

ASSESSMENT

Data and Methods

Stock status for the WCVI Chinook is evaluated using Robertson Creek Hatchery (RCH) Chinook as an indicator of marine survival and exploitation rates and selected rivers as indicators of escapement levels. Other WCVI Chinook populations are assumed to experience similar survival rates and marine distribution. Exploitation rates are also assumed similar with the exception of the very terminal fisheries (e.g. Tlupana Inlet and BarkleySound/Alberni Inlet) where directed fisheries may target hatchery surpluses. However, for AABM fisheries, management actions taken to achieve goals for this stock are assumed to have similar effects on other WCVI stocks. In addition to the RCH Indicator Stock program, spawning levels of 14 other WCVI Chinook escapement indicator stocks are consistently monitored by an extensive spawner survey program. Combined, the results are the basis for the overall stock assessment of WCVI Chinook status.

Cohort Analysis

An annual cohort analysis is conducted using estimated coded-wire-tag (CWT) recoveries in escapement and fisheries to determine survival rates and exploitation patterns for Robertson Creek Hatchery Chinook. The incorporation of in-river tag recoveries provides estimates of the total exploitation rates for this stock. The cohort model used is documented in Appendix 2 of Starr and Argue (1991) and was modified by the Chinook Technical Committee (CTC) of the Pacific Salmon Commission (PSC, TCCHINOOK (98)-1). In determining incidental mortality, only the brood year method was used. The cohort model was modified by the CTC to account for the Chinook non-retention fisheries implemented in Canada during 1996. For each brood year, information used from the cohort analyses include the annual distribution of catch and total fishing mortalities; the survival of CWT groups to age 2 recruitment; and ocean (catch or total fishing mortality) and total exploitation rates by fishery and age. These data are used to determine stock status, forecast production and monitor harvest impacts.

Stock Trends

Escapement

Several WCVI rivers have been surveyed consistently enough to serve as indicators of natural spawning abundance. Escapement estimates to 6 of these rivers, including the Marble, Artlish, Kaouk, Tahsish, Burman and Tahsis Rivers, are summed to generate a ‘PSC Index’ of naturally spawning Chinook for PST evaluation. The trend in number of spawners in these systems is relatively stable near the 1979-1982 base (indicated by the line) through most of the period (Figure 1). However, populations have not achieved the provisional doubling rebuilding target established under the PST in 1984. In addition, three of these systems are dependent on some level of hatchery supplementation (Tahsis, Leiner and Burman Rivers) and the Marble River (Area 27) contributes a disproportionate amount to the index relative to historical levels.

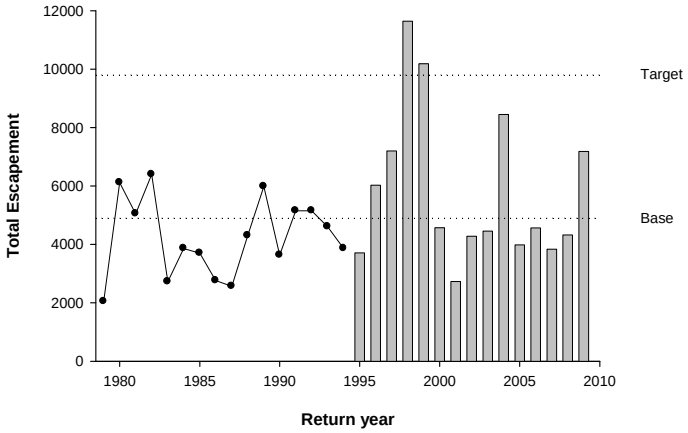


Figure 1. 6-system PSC-Index of naturally spawning Chinook, 1979 to 2009. The break from line to bar graph indicates a change in survey methods. Estimates after 1994 are more reliable.

The PSC Index only includes Chinook populations originating from the north-west Vancouver Island (Areas 25, 26 and 27). A larger PSC 14-system index also includes systems originating from the south-west of Vancouver Island, although some of these escapement estimates are less reliable. The trend for the larger index is similar to the smaller index: WCVI populations have generally not achieved their provisional 1984 rebuilding target and many of the index systems are dependent on supplementation to maintain spawner levels (e.g. the San Juan, Sarita and Tlupana Rivers in addition to those described above Figure 2).

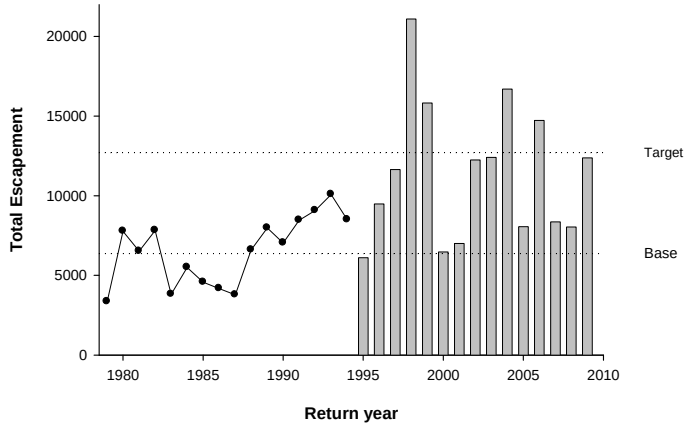


Figure 2. 14-system PSC-Index of naturally spawning Chinook, 1979 to 2009. The break from line to bar graph indicates a change in survey methods. Estimates after 1994 are more reliable.

When trends from only wild populations are examined, of particular concern are populations originating from Clayoquot Sound (Area 24). Over the last three generations, wild population escapement levels within Area 24 have declined at an average rate of 53% (Figure 3). These populations in Area 24 make up the bulk of the SWVI Conservation Unit in addition to some mostly enhanced populations in Area 23, some of which are also of concern (e.g. Nahmint River Chinook). Escapement levels of wild populations originating from more northerly portions of WCVI (e.g. Area 26, Kyoquot Sound) appear more stable (Figure 3). However, those populations are only stable at low levels and have not achieved provisional rebuilding targets.

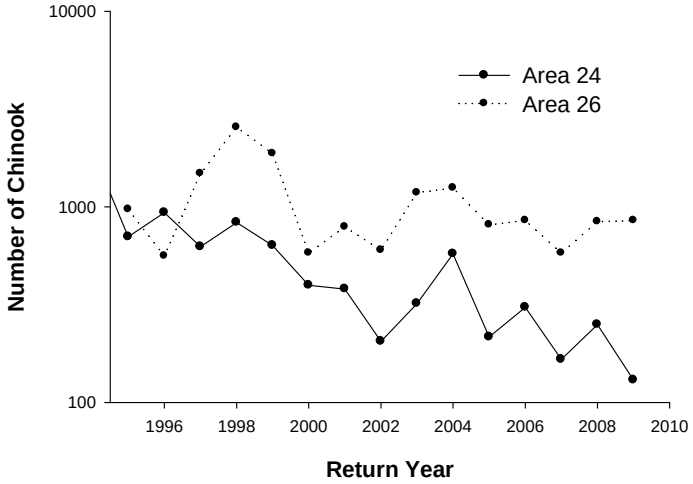


Figure 3. Indices of WCVI Chinook escapement for wild spawning populations, Area 24 (Clayoquot) and Area 26 (Kyoquot); 1995 to 2009. Note log-scale on the y-axis.

Marine survival

The marine survival rate trend for Robertson Creek Hatchery Chinook is displayed in Figure 4. Recent survival rates are variable, but generally lower than the long-term average. Over the last 5 brood years, the estimated survival to age 2 is approximately 2.3%, about half of the long-term average marine survival rate for the longer period.

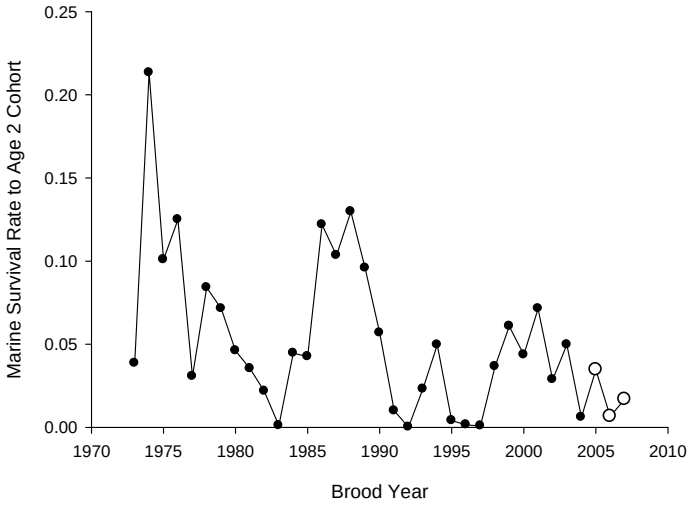


Figure 4. Estimated marine survival rate of WCVI Chinook based on the RCH indicator, brood years 1973 to 2007. Assessment of brood years 2005 to 2007 is incomplete, pending maturation of the full brood.

Exploitation

The estimated mortality rates in fisheries coast wide (i.e. from Alaska south) are summarized in Table 3. The trend in annual mortality in AABM fisheries is displayed in Figure 5. These estimates are generated from the CTC cohort model described above.

Annual AABM ocean exploitation rates, including Alaskan fisheries, have averaged about 30% since conservation action were first taken in Canadian fisheries in 1995, compared to 42% prior to 1995. Prior to implementation of the PST in 1985, the annual AABM mortality rate averaged about 53%. In 2009, the estimated total fishing mortality of RCH Chinook in AABM fisheries was estimated at 41%, including 19% in Canada and 22% in Alaskan fisheries.

The estimated ISBM annual mortality rate for RCH hatchery Chinook averages about 23% since 1995. Much of this mortality is associated in with commercial net fisheries occurring near the Somass (RCH) River. In addition, recreational fishery regulations are more relaxed in Area 23 compared to other WCVI terminal areas given the abundance of RCH Chinook there. In 2009, the estimated fishing mortality of RCH Chinook in ISBM fisheries was estimated at 19.6%.

For other WCVI terminal areas, (ISBM) mortality rates will vary depending on the fishing effort and catch in each area. However, with the exception of Tlupana Inlet fisheries targeting Conuma hatchery surplus, fishing opportunities in terminal area locations where WCVI Chinook are vulnerable are severely restricted. For areas other than Area 23, ISBM related mortality probably averages much less than 5% therefore the AABM fishery impacts far exceed ISBM impacts. (Area 23 commercial net fisheries typically contribute to over half of the RCH ISBM mortality; the remaining mortality is associated with the recreational fishery in Area 23, which has far greater retention opportunities than other WCVI areas.)

Table 3. Distribution of the total fishing mortality of RCH Chinook by fishing area, 2007 to 2009. Long term average mortality also shown for three periods: 1979 – 1984 (prior to the Pacific Salmon Treaty); 1985 to 1994 (prior to implementation of increased fishery restrictions); and after 1995 .

FISHERY				2009	2008	2007	AVG 95-09	AVG 85-94	AVG 79-84
AABM	**ALASKA**	SEAK	All Gear	**22%**	**12%**	**23%**	**18%**	**23%**	**34%**
	CANADA	NBC	Troll	2.1%	2.6%	5.3%	3.0%	9.2%	12.3%
			Sport	12.4%	5.3%	7.6%	5.6%	0.9%	0.2%
		WCVI	Troll	0.0%	0.0%	0.1%	0.2%	6.5%	6.7%
			Sport	4.7%	1.3%	4.3%	2.6%	1.9%	0.3%
		Canada AABM		**19.1%**	**9.2%**	**17.3%**	**11.5%**	**18.6%**	**19.5%**
	AABM TOTAL			**41%**	**21%**	**41%**	**30%**	**42%**	**53%**
ISBM		Area 23 Terminal		19%	34%	39%	22%	21%	17%
		Other		0.6%	1.9%	0.8%	1.5%	5.3%	14.4%
TOTAL MORTALITY				**61%**	**57%**	**80%**	**53%**	**68%**	**85%**

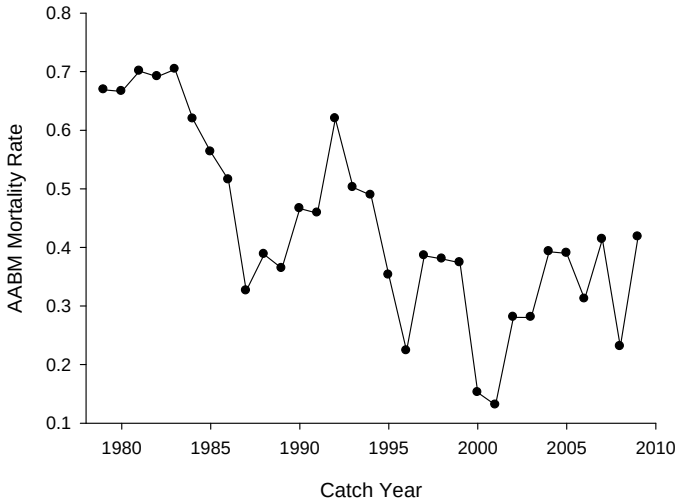


Figure 5. Estimated mortality rate of WCVI origin Chinook in AABM fisheries, catch year 1979 to 2009.

Terminal Returns: hatchery + wild

The trend in total estimated annual return of WCVI Chinook is displayed in Figure 6. The hatchery component includes production from Robertson Creek (RCH), Conuma and Nitinatl hatcheries. The wild component only includes systems with annual estimates of escapement. However, the indexed systems probably include the bulk of WCVI natural production. As described above, some of these systems also receive supplementation by hatcheries. Recently, most releases to these systems are marked using thermal (otolith marking) techniques. Sampling of escapement for marked otoliths indicates that greater than 80% of spawners in some systems in some years are hatchery origin fish (Till 2010). Not including these fish, the estimated contribution of the major hatcheries to WCVI Chinook production averages about 90% since they were built. A consequence of the current management system is the mass production from WCVI hatcheries increases the allowable catches in PST-regulated AABM fisheries. This increases the harvest pressure on wild WCVI Chinook in mixed-stock fisheries because hatchery and wild stocks are treated similarly under the current PST regime.

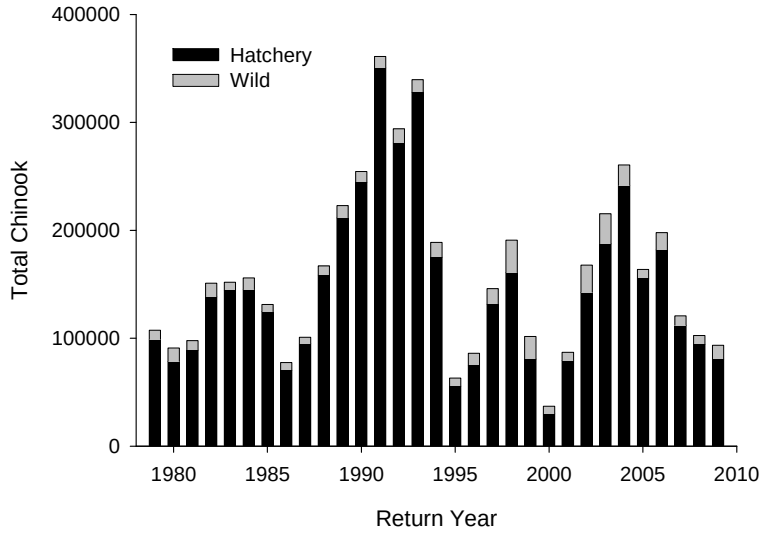


Figure 6. Total estimated annual terminal return of WCVI Chinook, 1979 to 2009.

Terminal Hatchery Returns

Stamp River/Robertson Creek Hatchery

The terminal return to the Stamp River/RCH system is defined as catch of Stamp River/RCH Chinook in Area 23, including native, sport, and commercial fisheries, plus spawning escapement to the RCH and Stamp River. Results from intensive catch monitoring and escapement monitoring programs estimate the 2009 terminal run at about 48,300 (*Table 4*).

Table 4. Summary of the 2009 terminal run of Stamp River Chinook, including jacks (age-2) and adults (ages 3-6).

Fishery/Location	Age					Total	Total Adult
	2	3	4	5	6		
Alberni Inlet Sport	135	1,156	1,880	273	0	3,444	3,309
First Nation	0	3,684	3,009	226	0	6,919	6,919
Commercial GN	0	1,094	2,341	146	0	3,581	3,581
Commercial SN	27	568	1,755	248	0	2,598	2,571
Barkley Sound Sport	0	1,797	4,043	0	0	5,839	5,839
Hatchery Return	1,643	1,041	2,306	87	7	5,085	3,442
River Escapement	3,261	3,669	12,581	1,242	83	20,837	17,576
Total Terminal Return	**5,065**	**13,009**	**27,915**	**2,223**	**91**	**48,304**	**43,238**
Percent at age	10.5%	26.9%	57.8%	4.6%	0.2%		

Since 1985, the average combined harvest in the Area 23 terminal area is about 45,000 fish, ranging from 0 to a peak of 160,000 in 1991 (Figure 7). Over the same period, the average annual terminal harvest rate on Stamp/RCH Chinook is about 37%.

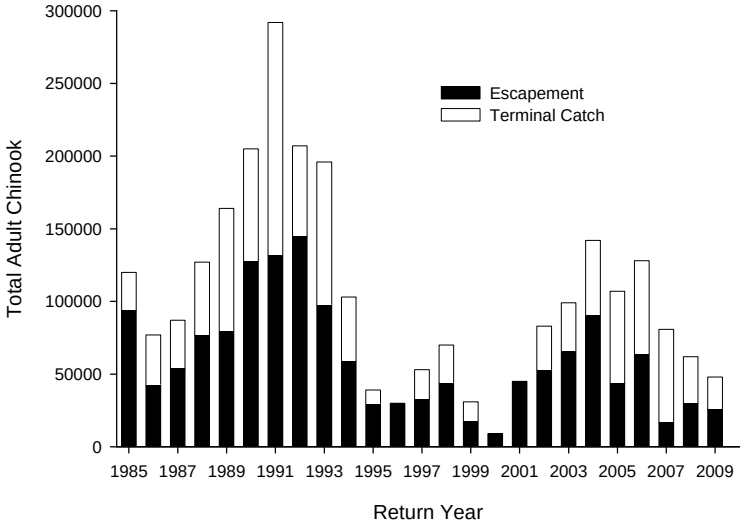


Figure 7. Terminal return of Stamp River/RCH Chinook, 1985 to 2009.

Conuma River/Hatchery

The terminal return to the Conuma River/Hatchery system is defined as catch of Conuma Chinook in Area 25, including native, recreational and commercial fisheries, plus spawning escapement to the Conuma Hatchery and River. Results from catch and escapement monitoring programs estimate the 2009 terminal run at about 26,500 Chinook; including 17,000 escapement and 7600 and 4200 recreational and commercial catch, respectively. Since 1992,

the terminal return of Conuma River and Hatchery Chinook has averaged about 35,200 and the annual average terminal harvest rate about 41%.

Nitinat River/Hatchery

The terminal return to the Nitinat River/Hatchery system is defined as catch of Nitinat Chinook in Area 22 (Nitinat Lake), including native, recreational, and commercial fisheries, plus spawning escapement to the Nitinat River. Results from catch and escapement monitoring programs estimate the 2009 terminal run at about 8400 Chinook; including 6400 escapement and about 900 each caught in both the native and recreational fisheries. Since 1985, the terminal return of Nitinat River and Hatchery Chinook has averaged about 24,000 and the annual average terminal harvest rate is about 14%.

Current Status

The status of the stock is determined by the trend in abundance of the contributing populations over time, the abundance of populations relative to a target and the distribution of production among populations within the stock.

For wild WCVI Chinook the current status is poor: populations continue to decline despite harvest restrictions; all populations are well below provisional rebuilding targets; and there is a disproportionate contribution from a few productive stocks relative to historic levels.

Given harvest restrictions in terminal areas, the average fishing mortality for wild WCVI Chinook populations is assumed to be about the level of ocean (AABM) mortality for the Stamp/RCH Indicator Stock. This mortality rate of 30% is generally below the level of sustainable exploitation for coastal Chinook stocks; however there is some uncertainty in the level of terminal fishery harvest levels and some may be subject to higher exploitation rates.

For hatchery returns, production has remained relatively constant, yet observed marine survival rates have been lower than average for many of the brood years contributing to recent returns. Therefore, returns of hatchery stocks have declined over the last four years and as a result opportunities for harvest have also declined.

2010 Forecast

Detailed assessments and forecasts of the Stamp/RCH indicator stock are required annually for management and as an indicator of the status and expected returns to the naturally spawning WCVI populations. Assessment and forecasting requires accurate information for the Stamp River/RCH indicator stock. Sampling of ocean fisheries provides CWT data to determine exploitation rates. Intensive assessment programs, including catch and escapement monitoring and sampling, are conducted in Area 23 to determine the terminal catch and escapement of the indicator stock.

An abundance forecast by age is calculated for the Stamp River/RCH indicator stock as well as the minimum escapement required to reach the egg targets for RCH brood-stock and Stamp River spawners. The annual assessment program includes monitoring escapement and providing an outlook for the WCVI natural escapement indicator stocks.

Riddell et al. (PSARC X96-01) outlined the analytical framework for forecasting returns of Stamp River/RCH Chinook. This forecast follows those same procedures. The total cohort size available to ocean fisheries is presented in Table 4 as “Pre-fishery abundance”. In order to determine fishery impacts on WCVI stocks, management scalars were applied to 1984 to 1990 brood year average exploitation rates in Alaskan fisheries, based on an expected 170,000 total

allowable catch (PSC Chinook Model Calibration 0807, SEAK Abundance Index =1.07). Assuming no fisheries in Canada and based on recent average maturation rates (0.17 for Age 3, and 0.60 for Age 4), the remaining cohort was assigned either to the expected terminal run or to the surviving cohort remaining at sea.

The 2010 return to Canada in the absence of Canadian fisheries is forecast to be 48,700 adult Chinook, comprised of 46% females (Table 5). The forecast return to the Barkley Sound/Alberni Inlet terminal area after Canadian ocean fisheries is approximately 42,900 Chinook. For the Somass River/Robertson Creek hatchery stock, the current escapement target is an egg target of 50 million eggs for the river and 7.2 million eggs for brood-stock collection. Given the expected age composition of the 2010 return, approximately 34,000 are required to meet this target.

Table 5. Summary of the 2010 forecast abundance and terminal run size of Stamp River/Robertson Creek Hatchery Chinook salmon.

Model	Pre-Fishery Abundance[1]	Return to Canada[2]	Terminal Return[3]	Age Composition
2. Terminal return versus Total Production				
2007 brood	77,496	12,240	11,758	24%
2006 brood	45,939	24,995	22,491	45%
2005 brood	23,103	19,141	15,325	31%
Total	146,537	56,376	49,574	
3. Total Production versus Total Production				
2007 brood	42,014	6,636	6,374	21%
2006 brood	26,136	14,220	12,796	42%
2005 brood	17,546	14,538	11,639	38%
Total	85,696	35,394	30,810	
Average of both models (2006 brood based on Model 2 only)				
2007 brood	77,496	12,240	**11,758**	**27%**
2006 brood	36,037	19,608	**17,644**	**41%**
2005 brood	20,325	16,839	**13,482**	**31%**
Total	133,858	48,687	**42,884**	

1. Forecast total production from the respective brood years.
2. Forecast return to Canada prior to fisheries.
3. Forecast return to Barkley Sound/Alberni Inlet.

Sources of Uncertainty

There is greater uncertainty in escapement estimates generated from 'extensive' indexing programs (i.e. Area-under-curve estimates of spawner abundance) than through intensive indicator stock programs (i.e. Stamp/RCH indicator). Some observers suggest that AUC estimates are typically biased low. Currently, the PST is supporting the 'Sentinel Stock Program' an intensive program to estimate spawner abundance and quantify the uncertainty of the estimates using mark-recapture studies. The results will be used to explore the potential biases of AUC methods. Estimates of extensive escapement prior to 1995 are particularly uncertain as the methods used to generate them are poorly documented.

There is uncertainty in the estimates of ISBM catch in WCVI terminal areas. The WCVI creel survey only operates from June 1 to about September 15, in some areas it does not begin until July 1. Although the bulk of the fishing effort occurs through June to early September, there is some additional recreational catch in other periods. Similarly, there is significant variation in the quality of reporting of First Nation catch among areas. While some areas are fairly well monitored and reported (e.g. Area 23), there is considerable uncertainty in of the quantity of terminal catch in other areas (e.g. Area 24). Annual catches may be reported, although the time and location of catch is often not and the catch is often not sampled for coded wire tags (CWTs).

There is uncertainty about the awareness factor of recreational harvesters to submit CWT fish. The coast wide mark-recapture program (MRP) is designed to function with about a 20% sampling/submission rate. However, submission rates in recreational fisheries are often much lower. Lack of awareness or, in some cases deliberate withholding of tags, may contribute to significant bias in CWT estimated mortality rates.

The Stamp/RCH Indicator Stock program is based on the assumption that all WCVI Chinook experience a similar marine distribution, ocean mortality and survival rate to the indicator population. This assumption is probably fairly robust in most years given the similar life history of WCVI Chinook (i.e. ocean type, far north migrating). However, over the last few brood years, NWVI populations (hatchery and wild) apparently have experienced higher survival rates than SWVI populations.

There is uncertainty in understanding the factors contributing to the decline or failed rebuilding of WCVI Chinook populations. There are likely many factors contributing to the low status of these stocks. Among other factors, potential threats include over-harvest, habitat degradation, early marine mortality, near shore habitat use and marine mammal predation.

The performance of pre-season forecasts is evaluated according to the deviation of observed return from forecast return. Expressed as a mean absolute percentage error (MAPE), on average the Somass Chinook forecast performs with a MAPE of 22%. That is, the actual return is typically 22% higher or lower than the pre-season forecast. However, the forecast models predict the return of older age classes with progressively more accuracy as more information is available regarding brood survival rate as the cohort matures. As well, sampling of smaller age 2 (jack) fish in escapement is more difficult. Therefore, the forecast of the 3-year old return is less accurate than the 4 and 5 year old forecasts. In three of the past four years, the average of the two models has under estimated the combined adult return.

CONCLUSIONS AND ADVICE

- Wild WCVI Chinook remain a stock of concern. WCVI Chinook populations were exploited at relatively high rates through the 1980s and early 1990s. The resulting escapements were stable near average levels from 1979 to 1982, but were not rebuilding to provisional goals set in 1984. Decreasing abundance through this period was driven by a declining marine survival rate due to unfavorable ocean conditions and over harvest. Consequently after 1994, harvest restrictions were introduced in Canadian fisheries to reduce their impact on WCVI Chinook. Since then, although many wild WCVI populations are stable at low levels, they have shown no signs of rebuilding.
- Of particular concern, are populations from south-west Vancouver Island (particularly those from Clayoquot -Area 24) that continue to decline despite the fact these populations originate from relatively pristine freshwater habitat. The causes contributing to the further

declines of these populations are not fully understood, although stakeholders suggest terminal harvest and use of near-shore habitat (e.g. aquaculture impacts) may be contributing factors. Other factors, such as continued periods of low ocean productivity, marine mammal predation and over-harvest in AABM fisheries, may also threaten the viability of these populations.

- Currently, a few productive (or enhanced) systems contribute to the bulk of WCVI Chinook production. A consequence of the current management system is that the mass production from WCVI hatcheries increases the allowable catches in PST-regulated AABM fisheries. This increases the harvest pressure on wild WCVI Chinook in mixed-stock fisheries because hatchery and wild stocks are treated similarly under the current PST regime. The creation of a separate management regime for wild and hatchery origin stocks would relieve some of this pressure.
- Time-area closures and in-season catch composition sampling (DNA) have been used to successfully reduce the impact of Canadian commercial AABM fisheries (i.e. NBC and WCVI troll) on WCVI Chinook. Area closures (e.g. the "1-mile" corridor off WCVI) have also reduced the impact of the WCVI AABM recreational fishery on WCVI Chinook.
- The status of WCVI Chinook remains poor and harvest restrictions should be maintained to limit fishery impacts on these populations. However, in 2009 Canadian ocean (AABM) fisheries (excluding terminal fisheries targeting enhanced stocks) had a 19% exploitation rate on WCVI Chinook, which exceeded the 10% maximum mortality objective of the DFO Integrated Fishery Management Plan. The majority of the 2009 impact (12%) was in northern BC AABM recreational fisheries.
- For 2010, the pre-fishery forecast total return of Stamp River/RCH Chinook to Canada is approximately 48,700 based on age-3 forecast from the Prod2 model, and the average forecast of the Prod2 and Prod3 models for age 4 and age 5 fish.
- After Canadian ocean fisheries, the forecast return of adult Stamp/RCH Chinook to the terminal area of Barkley Sound and Alberni Inlet is 42,900, similar to levels observed in 2009.
- The age-4 component is forecast to comprise 41% of the terminal run (27% age-3, 41% age-4, and 31% age-5), with an expected sex ratio of 46% female. The mean absolute percent error in the average forecast is 22%.
- The relative change in the Stamp River/RCH Chinook (by brood) is used as an indication of trends in other stocks along the WCVI. However, over the last two years wild and hatchery populations from NWVI have not experienced the same declines as those from SWVI due to apparently higher marine survival rates experienced by NWVI populations for some recent brood years. For 2010, expectations for WCVI natural stocks are similar to the 2009 observed return. The outlook for SWVI populations is below recent average abundance whereas the outlook for NWVI is about recent average abundance.

SOURCES OF INFORMATION

This Science Advisory Report is from the May 26 & 27, 2010 Cultus Lake Sockeye Stock Status, 2010 Barkley Sound Sockeye Forecast, 2010 West Coast Vancouver Island Chinook Abundance Forecast, and Fraser River Sockeye Spawning Initiative Meeting. Additional publications from this process will be posted as they become available on the Fisheries and Oceans Canada Science Advisory Schedule at *www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm*.

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ISSN 1919-5079 (Print)
ISSN 1919-5087 (Online)

La version française est disponible à l'adresse ci-dessus.

CORRECT CITATION FOR THIS PUBLICATION

DFO. 2012. Assessment of west coast Vancouver Island Chinook and 2010 Forecast. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/032.