TERMINAL ABUNDANCE OF WCVI CHINOOK SALMON

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INTRODUCTION

BACKGROUND

Chinook salmon stocks originating from the West Coast of Vancouver Island (WCVI) contribute significantly to the ocean harvests in fisheries in Southeast Alaska (SEAK) and Northern British Columbia (NBC) as well as being of prime importance to near-shore fisheries along the WCVI itself. Consequently, commercial and sport fishermen in SEAK and NBC as well as First Nations, commercial, and sport fishermen in WCVI have a vested interest in the status of WCVI chinook salmon. Management agencies and organizations responsible for fisheries in SEAK, NBC, and along the WCVI have need of stock status information concerning WCVI chinook salmon.

The terminal abundance (or run size) of West Coast Vancouver Island (WCVI) chinook is the sum of the catch of WCVI chinook in WCVI area fisheries and the number of spawners in WCVI rivers. Since 1980, the terminal abundance of WCVI chinook has averaged about 150,000 fish; a large portion of this abundance is hatchery origin fish. The terminal abundance (hatchery and wild) is indexed through run reconstruction techniques and is an annual input to the CTC model that forecasts Abundances Indices that determine the TACs for AABM fisheries. Data sources used to generate the terminal abundance index are of variable quality; ranging from high quality passage counts and fishery sample data for the Robertson Creek Hatchery CWT stock and Area 23 and offshore fisheries to generally lower quality escapement estimates and fishery sample data for other stocks and terminal areas.

Given the uncertainty in some the of the data inputs and the increasing concern with the performance of the CTC model that relies on estimates of the terminal abundance of the WCVI 'driver' stock, one focus of the CTC Sentinel Stock Program was exploring methods to improve the estimation of the aggregate abundance of the terminal WCVI chinook stock. This study was designed to significantly increase the sampling of terminal fisheries and escapement in the WCVI area. The resulting samples are then used to develop more precise estimates of terminal run abundance through both standard run reconstruction methods and also using distant fishery index methods (Korman et al. 2011, Brisco et al. *in prep*). The comprehensive sampling also improves the precision of terminal harvest rate estimates, allows for further evaluation of straying among WCVI chinook populations, and helps build better understanding of the biological variability among WCVI chinook populations.

This report is part of a multi-year study and, as such, presents preliminary results from the 2015 return year. Further and more detailed analysis is anticipated as 2016 results are compiled.

STUDY AREA AND PROBLEM

Production of WCVI-origin chinook salmon is from natural spawning that occurs in 100 or so streams and from hatchery programs. Major production facilities like Robertson Creek, Conuma, and Nitnat hatcheries; medium-sized supplemental programs such as occurs in the Burman and Sarita rivers; and smaller enhancement programs have produced in excess of 80% of the annual production of WCVI chinook salmon. In recent years nearly 100% of hatchery releases have thermally marked otoliths.

High quality information is focused on the return to Robertson Creek Hatchery Indicator Stock. Annual releases of chinook salmon with coded-wire tags (CWTs) from Robertson Creek Hatchery are used to indirectly estimate fishery contributions of the WCVI stock group through cohort analysis. Estimates of natural and hatchery escapement along the rest of the WCVI are of lower quality. Assessment of spawning escapement of WCVI chinook salmon into WCVI rivers is difficult and expensive. Rivers supporting spawning populations are small and typically remote. Due to frequent storms and steep terrain, rivers on the WCVI are "flashy". Chinook salmon often stage below a river mouth or within pools in the lower river at times of low discharge, then quickly migrate upstream when the river levels increase with fall rains. Following spawning, moribund and dead chinook salmon are often quickly removed by predators and flash flooding.

Since the mid-1990s, field personnel have surveyed about 15% of WCVI river systems with spawning populations by swimming downstream and counting salmon. Swims of the surveyed areas are attempted every few days but missed when high water makes surveys unsafe. Counts are used with area-under-the-curve (AUC) models to estimate spawning abundance in a river. Besides counts, knowledge of stream life for fish being counted and knowledge of observer efficiency in the counting are required to use AUC models. Programs to scientifically estimate stream life are expensive and typically involve radio tagging. Programs to scientifically estimate observer efficiency are also expensive and typically involve tagging of fish. Existing base level funding for the ongoing stock assessment program is insufficient to annually estimate these important parameters necessary to produce accurate and precise estimates for WCVI stocks with AUC methods.

Since 1999 terminal fisheries along WCVI involving First Nations, net and tidal sport fishermen have annually harvested from about 5,000 to 110,000 chinook salmon. Hatchery produced salmon are targeted in these inshore fisheries. Canada annually releases CWT smolts from Robertson Creek Hatchery and, from sampling to recover these tagged fish as adults, produces annual estimates of the return of chinook salmon to terminal Area 23 (Barkley Sound/ Alberni Inlet) including returns to the Stamp River (natural and hatchery-produced salmon) as well as escapement to the Nahmint and Sarita rivers. Genetic stock identification (GSI) is also used to directly estimate WCVI contributions (landed catches) in SEAK and NBC fisheries.

Estimates of the terminal return of tagged chinook salmon from Robertson Creek in combination with sampling data from ocean fisheries subsequently results in estimates of exploitation rates and ocean cohort sizes for the entire WCVI complex of natural and hatchery origin chinook salmon.

Crucial to the accuracy of these aggregate estimates is the condition that harvest rates and maturation rates of tagged Robertson Creek Hatchery fish provide applicable proxy data for the entire WCVI complex of natural and hatchery origin Chinook salmon. While the Robertson Creek data may provide reasonable approximations for open ocean fisheries, the various stocks of WCVI origin chinook undoubtedly are susceptible to very different harvest patterns in near shore fisheries that take place along the WCVI.

However, monitoring of near shore fisheries and of escapements in areas other than Area 23 is less intensive. Outside of Area 23 the estimated catch by stock group is based on limited

opportunistic sampling pooled across years to apportion WCVI from non-WCVI catch. The result is lack of recognition of the inter-annual variability of production between WCVI areas. Recent variations in productivity amongst components of the WCVI chinook salmon stock group amplify the problem associated with the existing sparsely funded terminal assessment program for the WCVI chinook salmon stock. From 1999 to 2011, the Robertson Creek stock complex (Area 23) accounted for the majority of the WCVI Chinook production, roughly 60%. However, since 2012 the return to that complex is less than 20% of the overall return whereas returns to Area 25 accounted for more than half. As a result, forecasts of abundance of WCVI origin chinook salmon that are used as part of the information to regulate distant fisheries have greater uncertainty given divergent survival patterns and the differential level of monitoring that occurs for the overall complex.

PROJECT OBJECTIVES

The specific objectives of this project are to:

- Improve the precision of estimates of terminal hatchery and wild chinook returns by conducting a comprehensive catch and escapement sampling program in 'key' terminal production areas along the WCVI (e.g. Barkley-Alberni, Nootka-Esperanza, Nitinat-San Juan, Clayoquot, Kyuquot). This includes DNA and otolith sampling of terminal fisheries, as well as escapement sampling for otoliths (hatchery contribution) and scales (age composition).

- Estimate the portions of WCVI origin chinook salmon in non-terminal fisheries in aggregate as well as those of WCVI hatchery and natural origin and the portions of each that originated from 'key' areas as identified in 1 above through standard run reconstruction methods.

- Adapt or modify the existing 'distant-fishery' index approach to estimating total WCVI chinook returns by age as well as the portions therein comprised of natural and hatchery origin fish based upon existing information and the augmented information described above. This approach may provide a cost effective long term solution to estimate the aggregate wild and hatchery chinook salmon production from the WCVI.

The primary activities in this study were to increase the size and improve the representation of terminal fishery and escapement stock and age composition samples.

METHODS

This assessment builds on ongoing DFO programs such as the WCVI Creel Survey, Recreational Guide Logbook Program, CWT Mark-Recovery Program, and extensive escapement monitoring. The primary activities of this project were increasing the size and improving the representation of terminal fishery and escapement stock and age composition samples in order to improve the precision of WCVI terminal stock and fishery assessment. The resulting samples inform two subsequent analyses of the terminal abundance of WCVI chinook salmon. The first is the estimation of the terminal abundance through standard run reconstruction methods. The second is the estimation of terminal abundance through 'distant fishery' indices.

RUN RECONSTRUCTION MODEL

The run reconstruction technique used to estimate the WCVI terminal chinook run size is a simple deterministic model. That is, the WCVI terminal run size is estimated by summing the catch in the terminal area associated with WCVI stocks and the indexed escapement estimate for WCVI populations. It is essentially an accounting exercise. The fundamental assumptions of the method are that accurate estimates of catch and escapement are available and that representative age and stock composition estimates can be associated with the catch and escapement data.

To account for the large number of spawning populations and variation in terminal recreational fishing opportunities and regulations, all source data are stratified by area (PFMA), sub-area and time (month) and spawning population. When samples are not available for particular stratum and/or the available number of samples is low, then stratums are combined. All commercial fishery openings are sampled separately.

Although the run reconstruction model that is used is conceptually simple, the number of strata, varying types of data that are used, varying quality of data (even within data source type), and different outputs, makes the accounting exercise complex. In practice, there has been no attempt to quantify the uncertainty of the overall estimates because of the varying level and types of measurement and estimation errors associated with the different data sources.

Data Sources

There 4 types of data used in the terminal run reconstruction; including estimates of escapement, terminal catch, and age and stock composition of the terminal catch and escapement. Each data source is described in detail below.

Escapement

Escapement estimates are not available for all WCVI populations. The quality of escapement data ranges from high quality passage counts at Stamp Falls or rack counts at hatcheries to relatively lower quality estimates generated mostly from periodic visual surveys of spawners in extensive indicator populations.

Catch

First Nation, Recreational and Commercial fisheries catch chinook in terminal WCVI area fisheries. Fishing opportunities are directed toward the more abundant hatchery stocks and restricted in areas where wild stocks are dominant.

Recreational catch statistics for WCVI terminal areas are generated through data collected by the South Coast Creel Survey. The survey combines angler surveys and aerial boat counts to estimate recreational catch. Anglers are interviewed at the end of fishing trips to provide both average catch by species and average fishing times, while the aerial counts from chartered aircraft capture 'instantaneous' snapshots of the number of recreational boats fishing at the time of the flight. In the most basic sense, the estimate of the number of boats fishing is multiplied by the average catch by species to estimate the total catch by species on that day. However, the actual calculations are more complex: stratifying within the survey area and periods and expanding instantaneous effort counts based on activity profiles generated for each area and period from angler surveys. Details of the creel survey method and analysis are described in English et al. (2002).

Information from the regular creel survey is supplemented by logbook and/or catch manifests submitted by guides and more recently by an internet survey system, "IREC", whereby all licenced fishers (including guides) are directly prompted to report their catch (Houtman et al. *in prep*, O'Brien et al. *in prep*.). This supplemental information is important to account for catch in periods when the creel survey is not operating and also to gather more representative data for areas where landing sites may not fully represent effort within an area. The latter situation is most problematic for those areas where recreational lodge-based effort accounts for the larger portion of the effort.

For all commercial openings, harvesters are required to report their catch directly to DFO as a condition of licence. This information is compiled and stored in the DFO's Fishery Operating System (FOS) database. For any given opening, catch is estimated by summing the individual vessel reports supplied by licenced harvesters. Fishery managers may use verification information (e.g. from compliance surveys, observer data, sales slips, etc.) to adjust catch estimates associated with openings.

First Nation fishery, monitoring and reporting programs vary considerably across WCVI terminal areas. Most First Nation fisheries are for either Treaty or Food, Social and Ceremonial (FSC) purposes and catch reporting may not be complete. However, the level of catch in these subsistence-type fisheries is very low compared to WCVI recreational and commercial terminal area fisheries. Higher catches occur in areas where First Nations participate in commercial fisheries and/or ESSR fisheries. In these cases, the catch data are more complete and similar methods of monitoring and reporting are applied as with commercial fisheries.

Age composition

Age is determined from the analysis of scales collected from escapement and catch samples. In cases when brood year marks are unique, age of samples can also be inferred from thermally marked otolith and coded-wire-tag specimens.

Stock composition

Stock composition of samples collected from catch was determined by the presence of coded-wire-tags (CWTs), thermally-marked otoliths and/or via DNA analysis. CWTs identify hatchery marked fish originating from CWT indicator stocks. Thermally-marked otoliths identify non-CWT hatchery production. DNA analysis is used to identify the origin of fish for which no other mark was present. Otolith samples were also from collected spawning populations to determine whether or not the specimen was hatchery or natural origin.

Sampling Methodology

Catch Sampling

The primary activities in this study were to increase the size and improve the representation of terminal fishery and escapement stock and age composition samples.

For catch strata, information that was collected from sample specimens included: catch location; date and time fish was caught; length; sex; adipose fin clip mark (AFC) presence/absence. Tissues retrieved from catch specimens for subsequent age and stock composition analysis included scales (for age and DNA stock composition) and heads (for either subsequent CWT analysis and/or otolith analysis).

Samples from terminal recreational fisheries were collected directly by creel survey observers from catch landed at WCVI creel survey sites. Samples were also collected from catch landed on guided boats or at lodges by guides participating in a volunteer logbook and catch sampling program. All samples were associated with creel sub-areas within each terminal PFMA. Additional CWT samples from recreational catch were also recovered through the regular volunteer head recovery program operated by DFO's CWT Mark Recovery Program (MRP). Where possible (e.g. enough samples retrieved) samples within an area were sub-sampled based on the catch associated with creel sub-areas within the PFMA by month.

Samples from terminal commercial fisheries were collected directly by observes from catch at processing plants. (Typically, most of the landed commercially caught chinook in WCVI terminal area fisheries are processed at between 2 to 4 plants on Vancouver Island.) In order to ensure the sample is representative of the overall catch, fish sampled at plants are selected from across totes and across landing sites. All samples were associated with the commercial opening area and time. Commercial openings are typically 1 to 3 subsequent days within a week within a PFMA sub-area adjacent to either the Conuma or Somass Rivers and most catch is processed within a day or two at plants. The sample target was 100 samples per commercial fishery opening.

First Nation Treaty or FSC fisheries were not directly sampled. First Nation commercial-type fisheries were sampled at landing sites by fishery monitors as part of the CWT MRP program. In some cases, additional scales were collected for age composition analysis. Stock composition of First Nation commercial-type fisheries was assumed similar to regular commercial fisheries operating in the same time and areas. All First Nation ESSR type fisheries occurring at hatchery racks were directly sampled for age and stock composition.

Escapement Sampling

For escapement, information that was collected from sample specimens included length and sex (if possible) and adipose fin clip mark (AFC) presence/absence. Tissues retrieved from catch specimens for subsequent age and stock composition analysis included scales (for age composition) and heads (for either subsequent CWT analysis and/or otolith analysis to identify hatchery origin fish). For escapement sampling, the method of collection was directly at the rack for the larger hatchery systems with samples augmented for river spawners either through 'dead-pitch' sampling or beach seining in holding pools.

Quality Control

A significant amount of effort was put into training observers and surveyors and raising the awareness of recreational guides prior to the fishing season. Operational procedures and protocols for sample collection and flow were developed and communicated in surveyor training sessions. Field surveyors were audited throughout the season to ensure that they collected the required information and properly sampled and referenced specimens.

DISTANT FISHERY INDEX

The distant fishery index is based on the assumption that an indicator stock (or stock group) experiences the same exploitation and maturation rates as the aggregate. If the assumption holds, the incidence of this indicator stock group in an ocean fishery (using mark information such as CWT, otolith, DNA) and in its terminal area would have the same ratio as the catch of the indicator stock group in the same ocean fishery to its terminal run size. When using a single CWT stock, estimating terminal run size is a matter of simple algebra.

Through previous SSP and Southern Endowment (SF) work, this method was applied by Korman et al. (2011) and Briscoe et al. (*in prep*.) to the WCVI aggregate using DNA and CWT information from the SEAK and NTR ocean fisheries and WCVI terminal fisheries. However, given the complexity of the WCVI stock aggregate and terminal WCVI fisheries, the key assumptions of the method – i.e. that maturation rates and exploitation rates are constant across the WCVI aggregate were not met, impacting results of the previous work.

To alleviate these risks an 'assessment' or test fishery at Brooks Peninsula was planned. This area is thought to be a 'pinch point' for WCVI chinook migration. It is a location where i) there is a high proportion WCVI origin chinook, ii) the WCVI origin chinook are all mature, and iii) all the WCVI stock groups are equally vulnerable. The purpose of the Brooks Peninsula test fishery was to 1) estimate a 'near terminal' distant fishery index of WCVI terminal aggregate abundance using the same method applied earlier for SEAK and NTR fishery samples; and 2) examine the variation in run timing and other factors among WCVI populations that affect the validity of the assumptions of the distant fishery index method.

Data Sources

South-East Alaska (SEAK) fishery samples

Samples collected from SEAK are through regular ADFG mark recovery programs and also additional projects (i.e. the related NEF project to collect thermal mark and GSI data to support the SEAK distant-fishery index project).

Terminal area catch and escapement samples

The additional samples collected in the terminal area provide a more precise estimate of marked fish and age of those fish in terminal area fisheries and escapement using the distant-fishery index method. Moreover, the additional samples mean the distant-fishery index of WCVI aggregate abundance can be generated using different and more types of marks. That is, the results of otolith sampling to identify WCVI hatchery stocks including and other than Robertson Creek Hatchery are used in addition to the CWT data that is available for Robertson Creek Hatchery only.

Brooks Peninsula Test Fishery

The 'assessment troll fishery' was planned to collect and sample mature WCVI origin chinook salmon migrating down the coast to the WCVI rivers of origin over a 6 to 8 week period. The fishery was to collect up to 200 WCVI origin DNA/otolith/scale samples per week during the period from early July to the end of August. One test vessel was to fish up to 4 days/week in a defined area in the vicinity of Solander Rocks near the tip of Brooks Peninsula with an on-board observer to collect samples and record associated information.

RESULTS

ESCAPEMENT

The total estimated escapement to 22 WCVI terminal indicator stocks for the 2015 return year was 148,604 (Table 1). Of this total, 121,166 (or about 82%) was associated with the three major hatchery facilities located on the WCVI; including production from the Robertson Creek Hatchery and Somass River (57,258), the Conuma Hatchery (40,144) and Nitinat Hatchery (23,794). The remaining escapement (27,438) was estimated from extensive WCVI area indicator stocks. Many of these index stocks are either directly enhanced or are influenced by WCVI area hatcheries through straying.

The estimated escapement does not include all spawning populations of the WCVI area. Based on the historical record, chinook salmon inhabit over 100 rivers of the WCVI area, with 60 rivers supporting populations exceeding 100 spawners. However, the extensive indicator populations include most of the spawning populations that historically accounted for the majority of the natural production and over the last 30 years or so hatchery production has significantly exceeded natural production overall.

CATCH

The total estimated catch in terminal WCVI area recreational fisheries in 2015 was 49,900 (Table 2). Most of this catch was associated with hatchery-directed fisheries in Area 23 (Barkley, Alberni Inlet – 15,495) and Area 25 (Nootka Sound - 19,643). There was also a significant amount of recreational catch in Area 20/21 (Port Renfrew, San Juan – 19,643). Recreational catch estimates are based on the WCVI creel survey which operates from June to September. Therefore, these estimates do not include catch landed outside that period. However, effort during the off-season is very low relative to the summer period. The estimate of terminal area catch generated from the IREC survey in 2015 for periods outside the creel survey was 2650 (K. Hein, DFO, pers. comm.).

The total estimated catch in terminal WCVI area commercial net fisheries in 2015 was 10,611. Similar to the terminal recreational fisheries, this catch is associated with those areas with surplus hatchery production including Area 23 (Alberni Inlet – 382) and Area 25 (Tlupana Inlet – 10,229). These commercial fisheries occur in ‘near-terminal areas’ close to the hatchery in order to avoid locations where natural origin WCVI chinook are likely to aggregate. In 2015, selective net gear was used in some openings to selectively target the abundant return of smaller, 3-year old chinook.

The total estimated catch in terminal WCVI area First Nation fisheries in 2015 was 10,342. The catch of 2,618 associated with ‘food, social and ceremonial’ (FSC) and Treaty fisheries occurred across the WCVI area and with mixed gear. Although the specific time and location of catch was often not reported, the overall catch associated with FSC and Treaty fisheries (x) was relatively low compared to the 7,724 caught First Nation commercial fisheries (Economic Opportunity and Demonstration). Like commercial fisheries, First Nation commercial opportunities are directed at those areas where hatchery surpluses exits namely Area 23 (Alberni Inlet, Somass R., catch - 6692) and Area 25 (Matchlee Inlet, Burman R., catch – 1032).

Both of these fisheries occurred proximate to the river area in order to avoid non-target local natural origin stocks.

SAMPLES

WCVI Escapement

There were 1489 scale samples collected from WCVI spawning populations, not including hatchery rack samples (Table 5). These samples were used to estimate age composition of WCVI chinook spawners. With few exceptions (notably populations in Area 27, Quatsino Sound), the majority of spawners in 2015 were 3-year olds from the 2012 brood year.

From WCVI spawning populations, sample data were also collected for sex ratio (Table 6), length allowing for evaluation of the variation in average size by age across WCVI populations (Table 7, Table 8).

There were also 647 otoliths collected from WCVI spawning populations, not including hatchery rack samples. Identification of thermally marked otoliths allows for evaluation of the hatchery contribution to spawning populations (Table 9) and the extent of straying of hatchery origin fish among WCVI populations (Table 10).

WCVI Terminal Area Fisheries

Recreational Fisheries

There were 2,356 samples collected from WCVI area terminal recreational fisheries for which either scale or other mark data are available (Table 11). Of these samples 1760 are full samples for which age and stock identification information, either through CWT, otolith or DNA analysis, are known (Table 12).

Age and data compiled across fishing times and areas allows for examination of selectivity in fisheries (Table 13, Table 15). Tabulating sample results allows for evaluation of the variation in average size or sex ratio associated with age of fish caught across WCVI terminal fishing areas (Table 14, Table 16).

The origin (Conuma Hatchery, Robertson Creek Hatchery, Nitinat Hatchery, Other WCVI, Non-WCVI and Unknown) of the 1760 samples with stock identification data is tabulated in Table 17. Most of the ‘unknown’ samples are associated with either destroyed, or unreadable, otoliths or lost CWTs. The origin (hatchery, natural, unknown) of the samples is tabulated in Table 18. In this case, natural origin fish were classified as those fish without an AFC, CWT, or thermal mark. Some of these fish may be associated with unmarked hatchery production. However, that hatchery production is unlikely to originate from WCVI facilities as the vast majority of WCVI hatchery production is thermally marked.

Interesting results emerge when comparing biological characteristics of hatchery and natural origin fish. For example, hatchery fish appear to be on average smaller than the natural origin fish landed (Table 19), which may result from the observation that the natural fish landed were generally older (Table 20, Table 21).

Commercial Fisheries

There were 480 scale samples collected from WCVI commercial fisheries (Table 22). These samples were used to estimate age composition of WCVI commercial catch. The majority of the commercial catch in 2015 was 3-year olds from the 2012 brood year.

There were also 499 otoliths collected from WCVI commercial fisheries (Table 23). Identification of thermally marked otoliths allows for evaluation of the hatchery contribution to the commercial fisheries (Table 23). Other biological data collected from commercial fishery samples include average length of fish (Table 24, Table 25).

With the exception of the first opening in Area 25 most of the chinook landed in WCVI terminal area fisheries is associated with the target stock (i.e. Somass and Robertson Creek Hatchery origin fish in Area 23 and Conuma Hatchery origin fish in Area 25). Interestingly, a large portion of the sample from the first opening in Area 25 was associated with Robertson Creek Hatchery production (Table 23). In previous years when this fishery has sampled this result has not been observed, although strays from Robertson Creek Hatchery are typically observed in Gold River, which is also in Area 25.

ANALYSIS

WCVI Chinook Terminal Run Reconstruction

The source data from the sample results were compiled to generate a terminal run reconstruction by associating the sample results with catch and escapement strata across the WCVI terminal area. It should be emphasized that this exercise is completed at a much finer scale of resolution than the summary tables presented in this report, particularly for recreational fisheries but also the Robertson Creek Hatchery/Somass Indicator stock and other rack sampling. That is, samples and associated catch are further stratified by fishing or survey areas and sample gear. The results presented in this report are 'rolled up' for clarity and interpretation.

In the case of the recreational fishery, samples are associated with monthly catch in creel sub-areas within each PFMA, or terminal WCVI area. Stratification of samples and catch allows for more accurate representation of the landed catch, which is not random with respect to stock throughout the area. In the case of escapement of the RCH/Somass Indicator stock (and other hatchery stocks) samples are associated with source, either from river or rack counts or, in some cases, ESSR fisheries. Escapement and samples from hatcheries are also stratified by time to account for sampling events that occur over the duration of the run. Quite often older, more mature fish migrate to the river earlier than younger age classes.

Table 26 through Table 32 present run reconstructions for each WCVI terminal fishing area; Area 20/21 (Port Renfrew); Area 22 (Nitinat); Area 23 (Barkley Sound, Alberni Inlet); Area 24 (Clayoquot Sound); Area 25 (Nootka Sound, Esperanza Inlet); Area 26 (Kyoquot Sound); Area 27 (Quatsino Sound). Estimated catch at age of WCVI origin chinook is summarized for First Nation FSC/Treaty, First Nation Commercial (Economic Opportunity, Demonstration); Recreational, Commercial gill-net, and Commercial seine net. Estimated escapement by age for indicator stocks within each terminal area is summed across the stocks. The total terminal

return of WCVI origin chinook in each area is estimated as well as the portion of the terminal return associated with hatchery origin fish. For areas, such as 22 (Nitinat), 24 (Clayoquot), 26 (Kyoquot), and 27 (Quatsino), the lack of catch reflects lack of effort because either the area is relatively isolated (Nitinat, Quatsino) or because fishing opportunities there are restricted due to the low status of local chinook stocks (Clayoquot, Kyoquot).

The total estimated terminal aggregate return of WCVI chinook in 2015 is summarized in Table 33. The return of WCVI origin chinook (hatchery and wild) to the WCVI terminal area in 2015 was 213,276 including 209,376 adults. The vast majority of 186,484 (or 89%) of the return was associated with WCVI area hatchery production. The average age composition of the hatchery origin return was 2%, 59%, 32%, 8% and < 0.1% of age 2, 3, 4, 5 and 6 year-old fish, respectively. The average age composition of the natural origin return was 1%, 36%, 46%, 17% and 0.2% of age 2, 3, 4, 5 and 6 year-old fish, respectively.

The previously estimated terminal aggregate return of WCVI chinook in 2015 was 192,812 including 190,925 adults with an estimated age composition of 1%, 57%, 33%, 9% and <0.1% of age 2, 3, 4, 5 and 6 year-old fish, respectively (Table 34). The key difference between the two estimates is the use of additional stock composition samples from terminal area fisheries. When the previous estimate was generated most of the age data were available for inclusion in the terminal run reconstruction. However, not all of the stock composition data were available. The additional return is mostly from previously unaccounted for WCVI hatchery origin fish caught in WCVI terminal areas, but a significant amount is also previously accounted for by catch of natural origin fish (Table 35). The distribution of catch of natural origin WCVI chinook by terminal area is summarized in Table 36. About 62% of this catch was associated with terminal areas 23 and 25 where recreational fishing opportunities are less restrictive due to hatchery surpluses there. Only about 4.5% of this catch was associated with terminal areas 24 and 26 where opportunities are severely restricted due to low status of local populations.

WCVI Hatchery Terminal Run Reconstruction

The run reconstruction results above account for all WCVI origin chinook (hatchery and wild) associated with terminal area catch and escapement. However, the specific results of the reconstruction of marked hatchery stocks (CWT or otolith) can be used to better understand the overall contribution of WCVI hatcheries to WCVI fisheries and escapement and also to generate area-specific terminal harvest rates. Moreover, for the RCH CWT indicator stock for which both CWT and thermal (otolith) marks are recovered, the hatchery contribution estimated from both types of marks can be compared.

The return of Conuma Hatchery chinook to the WCVI terminal area is summarized in Table 40. Of the total return, 66,029 fish were associated with Area 25, the terminal area where Conuma Hatchery is located. An additional 7244 fish were accounted for in catch and straying. Of the additional catch of 4039, only 317 fish were associated with Area 25. The rest of the catch was accounted for in other WCVI terminal areas (Table 41). There were 3522 Conuma Hatchery spawners observed in other WCVI systems. Most of these strays were observed in other systems within Area 25, but there were also strays observed in Areas 23, 24 and 26 (Table 41). The straying rate, estimated as the number of Conuma Hatchery chinook spawning in other systems relative to the Conuma River/Hatchery was approximately 9%.

The return of Nitnat Hatchery chinook to the terminal area is summarized in Table 37. Of the total return, 25,081 fish were associated with Areas 21 and 22, the terminal areas near where Nitinat Hatchery is located. An additional 2034 fish were accounted for in catch and straying. Of the additional catch of 1890, none were associated with Areas 21 or 22. The rest of the catch was accounted for in other WCVI terminal areas (Table 41). There were only 65 Nitinat Hatchery spawners observed in other WCVI systems. All of these strays were observed in Area 23 systems (Table 41). The straying rate, estimated as the number of Nitinat Hatchery chinook spawning in other systems relative to the Nitinat River/Hatchery was less than 0.5%.

The return of Robertson Creek Hatchery chinook to the WCVI terminal area is summarized in Table 38. Of the total return, 73,645 fish were associated with Area 23, the terminal area where Robertson Creek Hatchery is located. An additional 5699 fish were accounted for in catch and escapement. Of the additional catch of 5643, only 582 fish were associated with Area 23. The rest of the catch was accounted for in other WCVI terminal areas (Table 41). There were 607 Robertson Creek Hatchery spawners observed in other WCVI systems. Most of these strays were observed in the Gold River (Area 25) samples, but there were also strays observed in Areas 23 and 26 (Table 41). The straying rate, estimated as the number of Robertson Creek Hatchery chinook spawning in other systems relative to the Somass River/Hatchery was approximately 1%.

CWT versus 'All mark sample' Terminal Return

The return of CWT-associated Robertson Creek Hatchery chinook to the WCVI terminal area is summarized in Table 39. Overall, the CWT associated return is about half of the return estimated from marked otolith samples. CWTs were associated with only about 43% of the escapement of Robertson Creek Hatchery chinook that was associated with marked RCH otoliths. Even lower, CWT-associated terminal catch was only 29% of the catch associated with marked RCH otoliths.

In all years since Robertson Creek Hatchery chinook have been thermally marked, the contribution of hatchery origin fish as estimated by CWT recoveries has been lower than the contribution estimated through marked otolith associated samples. It is not known whether or not there is a constant bias relative to escapement in fishery recovered samples, but this question should obviously be key area of investigation given the dependency of the CTC chinook model on CWT data. Clearly, a major source uncertainty is the 'awareness factor' used to approximate catch-sample ratios of CWT recoveries for recreational fisheries dependent on volunteer recovery programs. The results here suggest these ratios have been over-estimated in 2015 for WCVI terminal area fisheries, but that bias may not be consistent across recreational fisheries or years.

WCVI Terminal Harvest Rates

Note: The harvest rates reported below are for terminal fisheries only. Therefore, they are not comparable to estimates of annual exploitation rates for the same fisheries, which incorporate all catch in terminal as well as distant fisheries. (By incorporating the entire return, annual exploitation rates are lower than harvest rates for a particular sub-set of fisheries.)

Robertson Creek Hatchery

The estimated harvest rates by age class of Robertson Creek Hatchery chinook in WCVI terminal area fisheries are summarized in Table 42. The overall harvest rate ranged from 6.1 % to 48.5%, depending on the age class. For the younger age classes (Age 2 and 3) most of the harvest was in Area 23. However, for the older age 4 and 5-year old age classes, most of the harvest (58% and 66%, respectively) was in other WCVI areas. In Area 23, additional size and gear restrictions in recreational and net fisheries contributed to catch selectivity in relation to size and age of landed fish. That is, in 2015 restrictions were placed on Area 23 fisheries to specifically reduce interception of older, larger fish given the low forecast of those components while allowing opportunity to harvest the abundant 3-year old age class.

Although natural origin fish are intercepted in Area 23 fisheries (Table 36), the total harvest rate on Robertson Creek Hatchery origin chinook in Area 23 does not represent the harvest rate on natural origin fish from Area 23. About half of the terminal Area 23 harvest is associated with 'near-terminal' First Nation and commercial net fisheries that occur proximate to the Somass River estuary, the outlet of the watershed where Robertson Creek Hatchery is located. If these fisheries are discounted, the maximum estimated harvest rate on natural origin chinook in terminal area 23 fisheries ranges between 0% and 12%, depending on the age class (Table 43). These estimates of harvest rate are a maximum (and likely high) because there are additional time and area closures in areas proximate to rivers with naturally spawning chinook populations (e.g. proximate to the Nahmint River).

Similarly, the total harvest rate of Robertson Creek Hatchery chinook estimated in other WCVI terminal fisheries is likely higher than the harvest rate on natural origin chinook stocks from Area 23. The key factor in this consideration is the propensity for Robertson Creek Hatchery chinook to stray into the Gold River. As a result, Robertson Creek Hatchery chinook are frequently intercepted in Area 25 fisheries. For example, 2076 of the chinook caught in the 2015 Area 25 commercial gillnet fishery in Tluplana Inlet were associated with Robertson Creek Hatchery. Still, if Area 25 fisheries are discounted and other migration patterns are assumed similar, the terminal harvest rate of natural origin chinook from Area 23 may have ranged from 1.5% to about 16% not including the 2 and 6 year old age classes (Table 43).

Conuma Hatchery

The estimated harvest rates by age class of Conuma Hatchery chinook in WCVI terminal area fisheries are summarized in Table 43. The overall harvest rate ranged from 2.9 % to 48.3%, depending on the age class and not including 6 year olds. For all age classes most of the harvest was in Area 25. Additional gear restrictions in commercial net fisheries contributed to catch selectivity in relation to size and age of landed fish. That is, in 2015 restrictions were placed on Area 25 commercial net fisheries to specifically reduce interception of older, larger fish given the low forecast of those components while allowing opportunity to harvest the abundant 3-year old age class.

Although natural origin fish are intercepted in Area 25 fisheries (Table 36), the total harvest rate on Conuma Hatchery origin chinook in Area 25 does not represent the harvest rate on natural origin fish from Area 25. About three quarters of the terminal Area 25 harvest is associated with 'near-terminal' First Nation and commercial net fisheries that occur in Nootka Sound and

Tlupana Inlet in areas approaching the Conuma River. If these fisheries are discounted, the estimated harvest rate on natural origin chinook in terminal area 25 fisheries ranges between 6.5% and about 12%, not including 2-year olds (Table 45). Like Area 23, these estimates of harvest rate may be high because there are additional time and area closures in areas proximate to rivers with naturally spawning chinook populations.

Similarly, the harvest rate of Conuma chinook estimated in other WCVI terminal fisheries is likely higher than the harvest rate on natural origin chinook stocks from Area 25. Like Robertson Creek Hatchery, the key factor consideration is the propensity of Conuma Hatchery fish to stray. If south-west Vancouver Island fisheries are discounted, the harvest rate of natural origin chinook from Area 25 in other WCVI area terminal fisheries likely ranged between 0.8% to about 3.5%, not including the 2 and 6 year old age classes (Table 45).

WCVI Fishery Stock Composition

The stock composition of catch in terminal area fisheries, including non-WCVI origin fish, was estimated from fishery samples based on the stratification of catch and samples applied in the terminal run reconstruction and using all available mark data (CWT, otolith, and DNA). Table 44 to Table 50 summarize the estimated stock composition of catch in each terminal area.

The contribution of non-WCVI origin chinook to terminal fishing areas is quite variable, ranging from 0 (Area 22, Nitinat Lake, not including Area 21) to 57% (Area 20/21, Port Renfrew and area). Overall, the contribution of non-WCVI origin chinook to catch in WCVI terminal fishing area catch was 13.5% or 9505 pieces (Table 51). This assessment includes periods within terminal areas that are classified as both AABM and ISBM fisheries. About 54% of the non-WCVI origin catch was associated with Area 20 and the vast majority of the rest was caught in either Area 21 (17%) or Area 23 (20%) (Table 52). There was very little catch associated with non-WCVI stocks in north-west Vancouver Island terminal fishing areas. About 94% of the non-WCVI chinook catch occurred in June/July and August and was evenly distributed between those months. Much less (6%) non-WCVI chinook fish were caught in September. Although more work is required to reconcile the individual stock identification with the run reconstruction strata in order to accurately estimate contribution, about 70% or greater of the non-WCVI origin samples collected were associated with US origin stocks.

The contribution of natural origin WCVI chinook to terminal fishing areas is also variable, ranging from 2% (Area 22, Nitinat Lake, not including Area 21) to 19% (Area 24, Clayoquot Sound). Overall, the contribution of WCVI origin chinook to terminal area catch was about 9% or 6231pieces. The contribution of WCVI hatchery origin fish was about 78% or 54,615 pieces (Table 51).

Terminal fishery samples for the Distant Fishery Indices

SEAK Index

The SEAK distant fishery index of the WCVI terminal aggregate hatchery and natural chinook abundance is being developed through a related ADFG project. The additional terminal mark and age samples collected in this project should increase the precision and accuracy of that estimate, which is not yet available.

Observed coded-wire-tag (CWT) terminal area recoveries of Robertson Creek Hatchery (RCH) CWT indicator stock tags were compiled across 6 WCVI terminal area strata as well as the estimated sample rates associated each stratum. These data together with the estimated age composition of the aggregate WVVI area escapement were provided as an input file for the SEAK distant fishery index estimation of WCVI terminal aggregate return (Table 53).

Observed thermal (otolith) mark terminal area recoveries of Robertson Creek Hatchery (RCH), Conuma Hatchery and Nitinat Hatchery were compiled across 13 WCVI terminal area strata as well as the estimated sample rates associated each stratum. These data together with the estimated age composition of the aggregate WVVI area escapement were provided as an alternate input file for the SEAK distant fishery index estimation of WCVI terminal aggregate return (Table 56).

The major benefit of this project is the increased terminal sample size associated with age samples in escapement and otolith samples in both terminal catch and escapement. In previous years, sample data were only available for CWT recoveries. This means there are often very few 'observed' (i.e. actual, tag-in-hand) samples because 1) there are few CWT tags available for recovery (only about 2% or less of WCVI hatchery production is CWT-tagged) and 2) most of the catch is associated with recreational fisheries for which samples are retrieved via the voluntary head-recovery program. As a result of these factors, the number of recovered tags is often very low and the catch-sample ratios applied to recreational fisheries are very uncertain.

In contrast, because of the direct sampling approach used in this study and the fact that most (about 98%) of the WCVI hatchery production is thermally marked, the number of hatchery marked samples available for analysis using the distant fishery index approach is much higher and the sample rate can be estimated with more certainty. Overall there were about 2.5 times as many thermal mark recoveries as CWT in the terminal area (3661 versus 1487). In terminal fisheries there were over 10 times as many recoveries (1269 versus 118).

Brooks Peninsula 'near terminal' Index

This study aspired to conduct a test troll fishery in the Brooks Peninsula area off the WCVI area to collect additional samples to 1) estimate a 'near terminal' distant fishery index of WCVI terminal aggregate abundance using the same method applied for SEAK fishery samples; and 2) examine the variation in run timing among WCVI populations.

Unfortunately, due to a number of operational difficulties, including approvals for licencing, the test fishery was not implemented as planned 2015. Therefore, few samples were collected and the analysis is not possible. However, the test fishery was successfully implemented in 2016 (Year 2 of this project) and the desired analysis will be conducted with the resulting data set.

EVALUATION / NEXT STEPS

This report summarizes results from Year 1 of a 2 (potentially 3) year project. Therefore, it is important to emphasize that the analysis presented herein is preliminary and incomplete.

On the one hand, the data set is extremely large and informative and much more detailed analyses are possible. For this analysis, stock groupings have been rolled up to various WCVI hatcheries, WCVI natural origin and Non-WCVI hatchery and Non-WCVI natural origin. However, stock identification information is available at a much finer scale for all the samples: CWTs and otoliths results identify the sample origin to the population level and DNA results can also identify the sample origin to finer resolution, in some cases population level. Therefore, with further analysis, more precise estimates of terminal harvest rate can be developed for some of the smaller WCVI hatchery marked stocks not already reported. Also, the stock identification data can be further evaluated to better understand the distribution and amount of impacts for non-WCVI origin stocks.

On the other hand, inclusion of additional samples collected in 2016 (and, potentially, 2017) will allow for evaluation of how consistent the results observed in 2015 in subsequent years. Completing this evaluation is extremely important considering that 2015 results may be anomalous given the unusual climatic conditions observed in 2015 (i.e. the prolonged summer drought in Southern BC and warm water 'blob' observed off the coast of western North America). The additional samples over the next year (or two) will also increase the sample sizes within stocks. The higher sample sizes will allow for statistical evaluation of factors such as the biological differences between WCVI stocks (and also, potentially, differences among natural and hatchery origin stocks such as maturation rates and size-at-age).

In the meantime, the preliminary results of the 2015 'Terminal Abundance of WCVI Chinook Salmon' project have already improved our stock assessment of WCVI chinook populations and fisheries. Specifically, we have:

- Developed a more precise estimate of the WCVI terminal abundance through the standard run reconstruction method; including the age composition of the run and the contribution from hatchery stocks. Notably, the additional terminal samples resulted in an increase of over 18,000 adults to the WCVI terminal abundance index through the standard run reconstruction method.

- Developed more precise estimates of the impact of WCVI terminal area fisheries on WCVI stocks (and also non-WCVI origin stocks). Terminal harvest rates were higher than previously estimated due to increased amount of the catch associated with WCVI stocks.

- Increased the terminal sample size to support more precise estimates of WCVI terminal abundance using the SEAK distant fishery index of abundance. Altogether, there are 3661 thermally-marked otolith samples from the terminal area representing all the three major hatcheries.

- Collected samples in spawning populations to estimate the extent of hatchery straying among WCVI populations. Notably, about 9% of the spawners associated with Conuma River Hatchery spawned in other WCVI area systems.

This information significantly enhances the WCVI stock assessment program by supporting improved forecasting, stock status assessments, fishery impact assessments, and the evaluation of hatchery impacts on wild stocks.

There are many interesting avenues of evaluation to pursue in future project reports as the analysis are expanded with the inclusion of additional samples collected in 2016 (and potentially 2017):

- Comparing 2015 results versus subsequent years to evaluate how consistent the observations are. Without doubt, the climate and ocean conditions observed in 2015 were anomalous. It may turn out that the higher than expected harvest and straying rate of WCVI chinook in terminal areas was related to distributional and migratory changes associated with these conditions.

- Expanding the run reconstruction to other fishery areas (e.g. WCVI AABM) for which similar data are available will be informative.

- Testing the use of distant fishery indices of terminal abundance using the sampling results of not only CWT recoveries, but also more abundant otolith mark recoveries. Complete a detailed comparison and evaluation of these estimates in relation to the standard run reconstruction methods of terminal WCVI chinook abundance.

- Evaluating sources of uncertainty in the sampling rates associated with the CWT recovery program for recreational fisheries and the effect this uncertainty on subsequent analyses (e.g. exploitation rate estimates in recreational fisheries, terminal run size estimates, etc.).

- Evaluating biological differences in characteristics such as age and size among WCVI populations, including between hatchery and wild components.

- Evaluating the level of selectivity (for size, age) in terminal area fisheries.

- Further evaluation of the extent and magnitude of hatchery straying among WCVI populations.

- Evaluation of the genetic effects of hatchery straying among WCVI populations.

As these analysis are completed, the improved knowledge of WCVI chinook populations and WCVI area fisheries will inform (and potentially significantly change) our current status assessments and assessment programs, the determination of biological and management objectives for stocks and fisheries, fishery assessment models, and hatchery management (and mitigation).

ACKNOWLEDGEMENTS

The primary activity of this project was to collect additional samples from WCVI area chinook fisheries and escapement. At first take, a relatively simple task. However, implementation requires a signficant amount of work and cooperation on behalf of many people to coordinate programs, train observer and sampling staff and volunteers, raise awareness and educate harvesters, manage large amounts of samples and sample processing and the resulting data, etc. To this end, many people and groups both within and outside DFO deserve acknowledgement for their efforts. Thanks to South Coast area stock assessment staff including Carmen McConnell, Andrew Day, Pat Vek, Eamon Miyagi, Jeff Till, Andrew Pereboom, Brenda Wright, Kris Hein, Lee Kearey Diana McHugh, Erin Porszt. Thanks to Kathy Fraser and her staff of the DFO MRP program. Thanks to the various labs that processed our samples including Nora Crosby and the PBS Age Lab, John Candy and PBS Genetics lab, Sue Di Novo and the NTC Thermal Mark Lab, and the CWT lab at J.O. Thomas and Associates. Thanks to our external groups and partners including WCVI area Harvest Committee champions, the WCVI Guide Association and the Sport Fish Institute. Finally, thanks to our colleagues in ADFG who support the project and related analysis.

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FIGURES

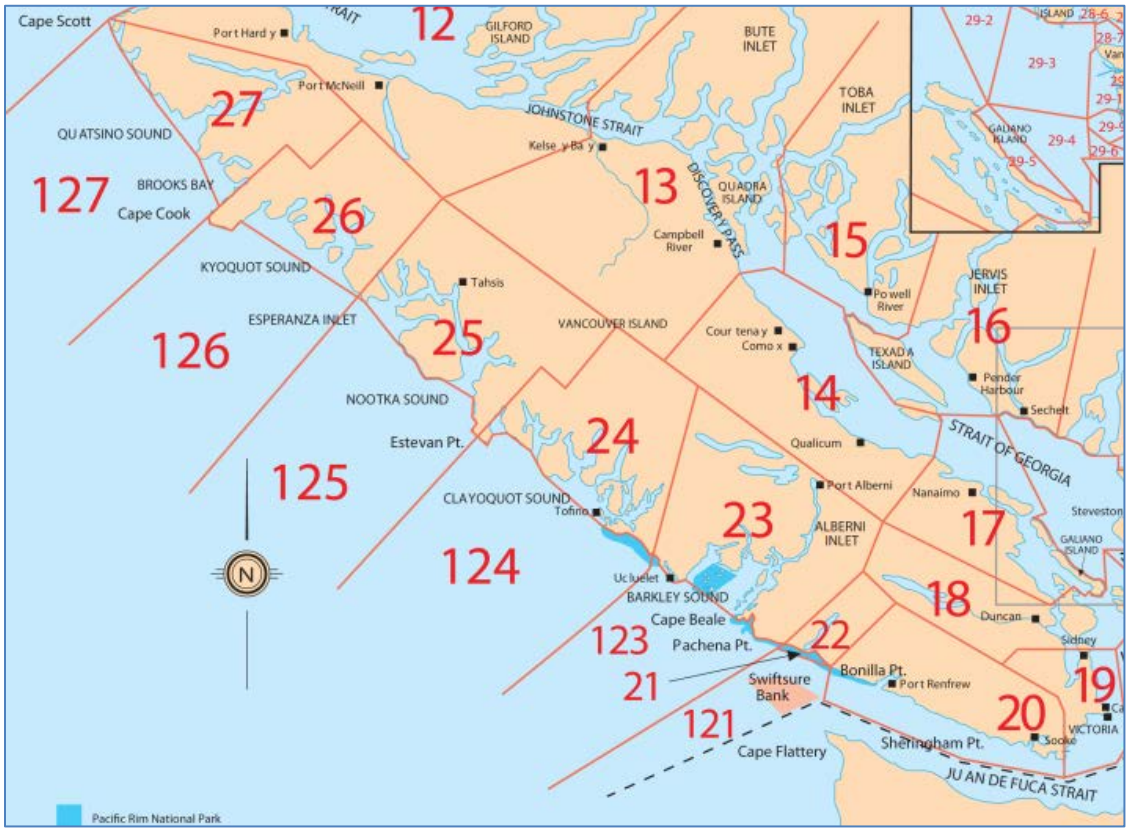

Figure 1. The terminal fishing area of West Coast Vancouver Island includes Pacific Management Fishing Areas (PFMAs) 20 to 27.

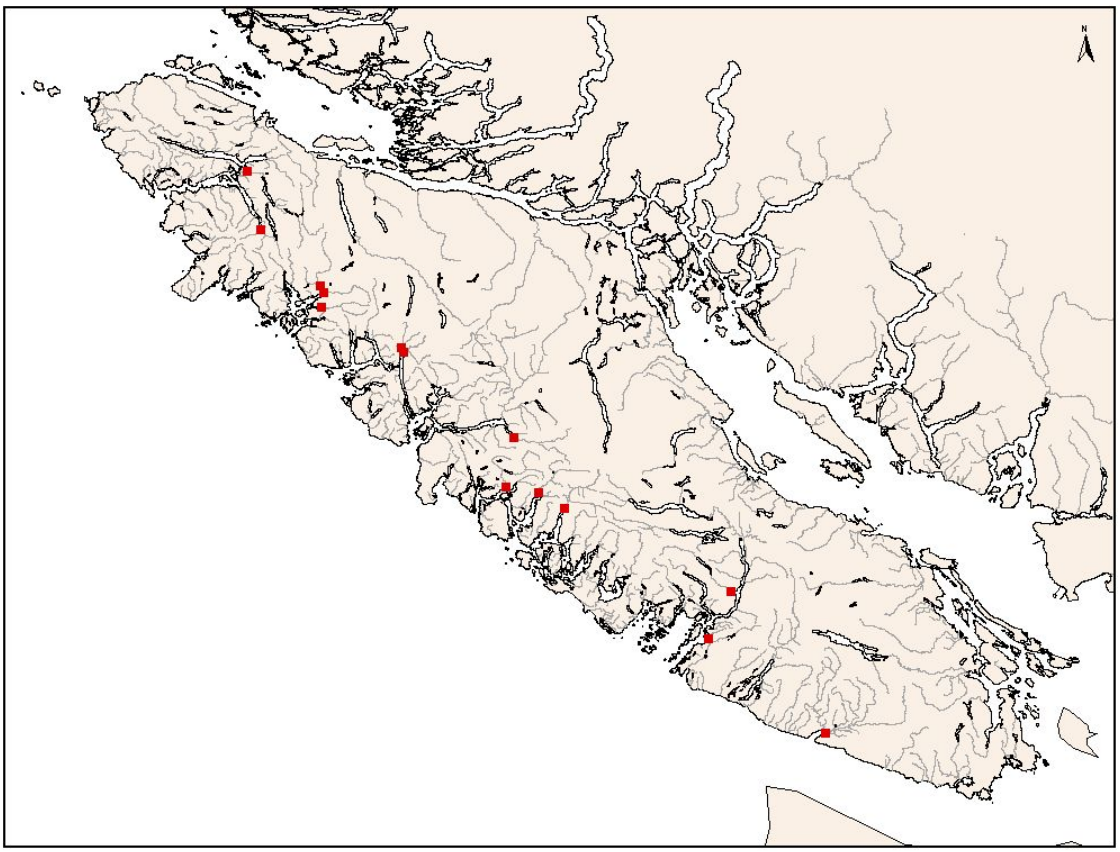

Figure 2. Location of WCVI Extensive Indicator Stocks.

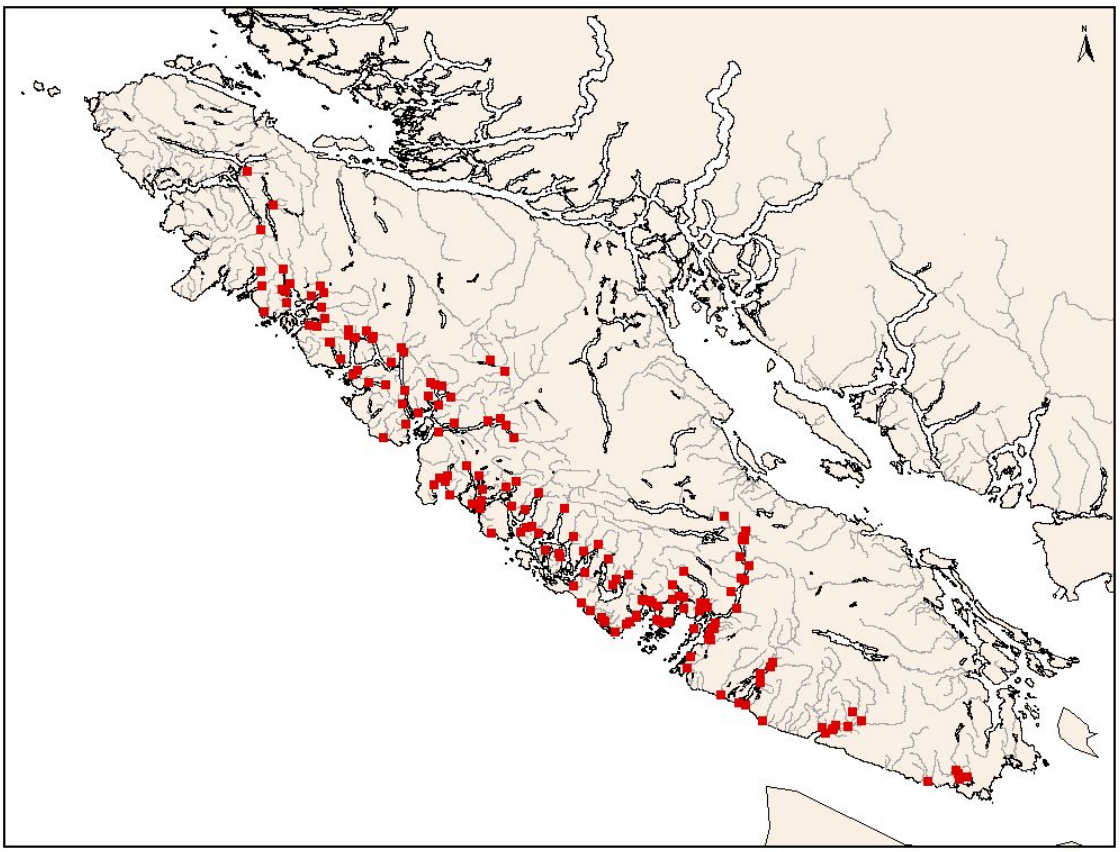

Figure 3. WCVI river systems that have spawner observations of chinook for at least one year during the period of record (1953-2012).

TABLES

Escapement

Table 1. Estimated escapement of chinook to WCVI index stocks.

AREA	STOCK	ESTIMATE	TYPE
21	SAN JUAN RIVER	2,197	AUC
22	NITITAT AREA/HATCHERY	23,794	RACK/ESSR
23	NAHMINT RIVER	476	AUC
23	SARITA RIVER	2,777	AUC
23	SOMASS RIVER	18,511	COUNT
23	RBT HATCHERY	38,747	RACK
24	BEDWELL RIVER	740	AUC
24	CYPRE RIVER	2,621	AUC
24	MEGIN RIVER	50	AUC
24	MOYEHA RIVER	252	AUC
24	TRANQUIL RIVER	199	AUC
25	BURMAN RIVER	6,444	AUC
25	CONUMA R/HATCHERY	40,114	RACK/AUC
25	GOLD RIVER	892	AUC
25	KAOUK RIVER	331	AUC
25	TAHSIS RIVER	310	AUC
25	LEINER RIVER	900	AUC
25	ZEBALLOS RIVER	266	AUC
26	ARTLISH RIVER	1,113	AUC
26	TAHSISH RIVER	768	AUC
27	MARBLE RIVER	6,516	AUC
27	COLONIAL CREEK	586	AUC
WCVI	TOTAL	148,604	

Catch

Table 2. Estimated catch of chinook in terminal area WCVI recreational fisheries.

Terminal Area	Month				Total
	6	7	8	9	
Area 20 Renfrew	624	2,148	4,608	1,614	8,994
Area 21/22 Nitinat	479	133	1,771	431	2,815
Area 23 - Barkley	2,097	2,969	6,495	3,933	15,495
Area 24 - Clayoquot	278	358	72	2	710
Area 25 - Nootka/Esperanza		7,510	12,133		19,643
Area 26 - Kyuquot	146	286	86		518
Area 27 - Quatsino		1,339	387		1,726
Total	3,625	14,743	25,552	5,980	49,900

Table 3. Estimated catch of chinook in terminal area WCVI commercial net fisheries.

Terminal Area	Sub-Area	Opening	Gear	Catch
Area 25 - Nootka/Esperanza	Tlupana	Week 82	Gillnet	4,237
Area 25 - Nootka/Esperanza	Tlupana	Week 83	Gillnet	4,441
Area 25 - Nootka/Esperanza	Tlupana	Week 83	Gillnet	
Area 25 - Nootka/Esperanza	Tlupana	Week 84	Gillnet	1,154
Area 25 - Nootka/Esperanza	Tlupana	Week 91	Gillnet	397
Total				10,229
Area 23 - Barkley	Alberni Inlet	Week 92	Gillnet	329
Area 23 - Barkley	Alberni Inlet	Week 93	Gillnet	53
Total				382
WCVI Total				10,611

Table 4. Estimated catch of chinook in First Nation Treaty, FSC (food, social, ceremonial) and Commercial (Economic Opportunity and Demonstration) fisheries.

Terminal Area	Sub-Area	Opening	Gear	Catch
Area 21 - San Juan	San Juan R.	FSC	Mixed	
Area 22 - Nitinat	Nitinat L.	FSC	Mixed	550
Area 23 - Barkley	Barkley S.	Treaty	Mixed	434
Area 23 - Barkley	Alberni Inlet	FSC	Mixed net	1,051
Area 23 - Barkley	Alberni Inlet	EO	Mixed net	6,692
Area 24 - Clayoquot Sound		FSC	Mixed	128
Area 25 - Nootka/Esperanza	Tlupana	FSC	Gillnet	455
Area 25 - Nootka/Esperanza	Burman R.	Demo	Mixed	1,032
Area 26 - Kyoquot				
Area 27 - Quatsino				
Total				10,342

Sampling Results

WCVI Escapement

Table 5. Age composition of samples collected from WCVI chinook spawning populations.

Terminal Area	Population	*n*	Age				
			2	**3**	**4**	**5**	**6**
Area 20 - Juan de Fuca	Sooke River	*38*	0%	34%	63%	3%	0%
Area 20/21 - Renfrew	San Juan River	*90*	0%	27%	40%	33%	0%
Area 23 - Barkley	Ash River	*27*	0%	85%	11%	4%	0%
	GCL Fishway	*42*	5%	86%	7%	2%	0%
	Toquart River	*29*	0%	62%	24%	14%	0%
	Nahmint River	*70*	1%	66%	16%	16%	1%
	Sarita River	*266*	9%	45%	26%	20%	0%
Area 24 - Clayoquot	Cypre River	*50*	0%	46%	54%	0%	0%
	Kennedy River Lower	*77*	0%	29%	60%	12%	0%
	Megin River	*8*	0%	50%	38%	13%	0%
	Bedwell/Ursus	*29*	0%	62%	21%	17%	0%
Area 25 - Nootka/Esperanza	Burman River	*326*	0%	48%	26%	25%	0%
	Tahsis River	*50*	0%	46%	26%	28%	0%
	Leiner River	*123*	0%	42%	37%	21%	0%
	Gold River	*87*	0%	92%	7%	1%	0%
Area 26 - Kyuquot	Artlish River	*36*	3%	36%	19%	42%	0%
	Kaouk River	*29*	7%	38%	38%	17%	0%
	Tahsish R.	*41*	12%	32%	12%	44%	0%
Area 27 - Quatsino	Colonial/Cayegle R.	*21*	0%	24%	43%	33%	0%
	Marble R.	*50*	0%	2%	86%	12%	0%
Total Samples		*1489*					

Table 6. Sex composition of samples collected from WCVI chinook spawning populations.

Terminal Area	Population	*n*	Sex		
			Female	Male	Jack
Area 20 - Juan de Fuca	Sooke River	*83*	54%	46%	0%
Area 20/21 - Renfrew	San Juan River	*95*	48%	52%	0%
Area 23 - Barkley	Ash River	*31*	10%	90%	0%
	GCL Fishway	*42*	7%	93%	0%
	Thornton Creek	*100*	41%	59%	0%
	Toquart River	*30*	37%	63%	0%
	Nahmint River	*80*	30%	70%	0%
	Sarita River	*285*	44%	47%	9%
Area 24 - Clayoquot	Cypre River	*57*	82%	18%	0%
	Kennedy River Lower	*119*	56%	44%	0%
	Megin River	*16*	19%	81%	0%
	Bedwell/Ursus	*37*	59%	41%	0%
Area 25 - Nootka/Esperanza	Burman River	*448*	37%	63%	0%
	Tahsis River	*53*	28%	72%	0%
	Leiner River	*126*	37%	63%	0%
	Gold River	*91*	21%	79%	0%
Area 26 - Kyuquot	Artlish River	*37*	57%	43%	0%
	Kaouk River	*29*	28%	72%	0%
	Tahsish R.	*41*	44%	56%	0%
Area 27 - Quatsino	Colonial/Cayegle R.	*23*	48%	52%	0%
	Marble R.	*50*	66%	34%	0%
Total Samples		*1873*			

Table 7. Average length of samples collected from WCVI chinook spawning populations.

Terminal Area	Population	*n (FL)*	Avg. Length (FL mm)	*n (POH)*	Avg. Length (POH mm)
Area 20 - Juan de Fuca	Sooke River	*126*	833		
Area 20/21 - Renfrew	San Juan River	*94*	812		
Area 23 - Barkley	Ash River			*30*	600
	GCL Fishway	*42*	720		
	Thornton Creek				
	Toquart River			*29*	652
	Nahmint River	*80*	629		
	Sarita River	*285*	602		
Area 24 - Clayoquot	Cypre River			*26*	671
	Kennedy River Lower	*119*	851	*57*	680
	Megin River			*119*	604
	Bedwell/Ursus			*16*	654
Area 25 - Nootka/Esperanza	Burman River			*36*	659
	Tahsis River	*53*	660		
	Leiner River	*126*	658		
	Gold River	*91*	590		
Area 26 - Kyuquot	Artlish River	*38*	778	*38*	655
	Kaouk River	*29*	726	*29*	597
	Tahsish R.	*42*	705	*41*	642
Area 27 - Quatsino	Colonial /Cayegle R	*23*	769	*23*	682
	Marble R.	*50*	842	*45*	676

Table 8. Average fork-length (mm) by age from samples collected from WCVI spawning populations.

Terminal Area	Populatin	*n*	Age				
			2	**3**	**4**	**5**	**6**
Area 20 - Juan de Fuca	Sooke River	*38*		808	800	940	
Area 20/21 - Renfrew	San Juan River	*89*		690	831	887	
Area 23 - Barkley	GCL Fishway	*42*	465	717	872	880	
	Lowry Creek	*3*		645		780	
	Taylor River	*2*		653			
	Nahmint River	*70*	452	594	650	745	727
	Sarita River	*266*	353	575	660	702	
Area 24 - Clayoquot	Kennedy River	*77*		785	880	900	
Area 25 - Nootka/Esperanza	Tahsis River	*50*		585	678	765	
	Leiner River	*123*		602	682	723	
	Gold River	*87*		581	667	785	
Area 26 - Kyuquot	Artlish River	*36*		687	778	870	
	Kaouk River	*29*	434	688	784	829	
	Kauwinch River	*5*		770	830	850	
	Tahsish R.	*41*	438	702	798	851	
Area 27 - Quatsino	Colonial / Cayegle	*21*		688	771	812	
	Marble R.	*50*			833	897	

Table 9. Stock origin (natural or hatchery) as estimated from otolith samples collected from WCVI spawning populations.

Terminal Area	Population	*n*	Stock Origin	
			Natural	Hatchery
Area 20 - Juan de Fuca	Sooke River	*125*	26%	74%
Area 20/21 - Renfrew	San Juan River	*94*	18%	82%
Area 23 - Barkley	Toquart River	*29*	93%	7%
	Nahmint River	*77*	44%	56%
	Sarita River	*282*	20%	80%
Area 24 - Clayoquot	Cypre River	*57*	100%	0%
	Kennedy River Lower	*113*	100%	0%
	Megin River	*15*	33%	67%
	Bedwell/Ursus	*36*	39%	61%
Area 25 - Nootka/Esperanza	Burman River	*424*	15%	85%
	Tahsis River	*45*	40%	60%
	Leiner River	*125*	37%	63%
	Gold River	*91*	26%	74%
Area 26 - Kyuquot	Artlish River	*36*	47%	53%
	Kaouk River	*28*	96%	4%
	Tahsish R.	*40*	55%	45%
Area 27 - Quatsino	Colonial R at Cayegle R	*23*	100%	0%
	Marble R.	*50*	100%	0%

Table 10. Origin of thermally marked otoliths collected from WCVI spawning populations.

Terminal Area	Population	*n*	Stock Origin											
			Natural	**Sooke**	**San Juan**	**Nitinat**	**Sarita**	**Nahmint**	**Robertson**	**Bedwell**	**Conuma**	**Burman**	**Gold**	**Tahsis/Leiner**
Area 20 - Juan de Fuca	Sooke River	*125*	32	59		34								
Area 20/21 - Renfrew	San Juan River	*94*	17		76						1			
	Toquart River	*29*	27								2			
Area 23 - Barkley	Nahmint River	*77*	34			1	1	35			4		2	
	Sarita River	*282*	56			6	215	1	1		3			
	Cypre River	*57*	57											
Area 24 - Clayoquot	Kennedy River Lower	*113*	113											
	Megin River	*15*	5								10			
	Bedwell/Ursus	*36*	14							19			3	
	Burman River	*424*	65						6		137	188	27	1
Area 25 - Nootka/Esperanza	Tahsis River	*45*	18								9		2	16
	Leiner River	*125*	46						1		46	1		31
	Gold River	*91*	24						50				17	
	Artlish River	*36*	17						1		18			
Area 26 - Kyuquot	Kaouk River	*28*	27									1		
	Tahsish R.	*40*	22								15	3		
Area 27 - Quatsino	Colonial R at Cayegle R	*23*	23											
	Marble R.	*50*	50											

WCVI Terminal Area Recreational Fisheries

Table 11. Total number of biological samples collected from terminal area WCVI recreational fisheries (by area and month).

Terminal Area	Month			
	July	August	September	Total
Area 20/21 - Renfrew	52	136	35	223
Area 23 - Barkley	105	253	112	470
Area 24 - Clayoquot	66	4	-	70
Area 25 - Nootka/Esperanza	724	693	-	1,417
Area 26 - Kyuquot	24	1	-	25
Area 27 - Quatsino	94	57	-	151
Total	1,065	1,144	147	2,356

Table 12. The total number of 'full' biological samples collected for terminal area WCVI recreational fisheries (i.e. those for which specimens were collected for stock identification + age composition).

Terminal Area	Month			
	July	August	September	Total
Area 20/21 - Renfrew	41	128	34	203
Area 23 - Barkley	82	214	100	396
Area 24 - Clayoquot	39	4	-	43
Area 25 - Nootka/Esperanza	524	554	-	1,078
Area 26 - Kyuquot	22	1	-	23
Area 27 - Quatsino	11	6	-	17
Total	719	907	134	1,760

Table 13. Age composition of samples collected in terminal area WCVI recreational fisheries (by area and month).

Terminal Area	Month	*n*	Age				
			2	3	4	5	6
Area 20/21 - Renfrew	July	*51*	0%	18%	65%	18%	0%
	August	*130*	0%	32%	57%	11%	0%
	September	*32*	0%	66%	31%	3%	0%
Area 23 - Barkley	July	*52*	0%	35%	54%	12%	0%
	August	*139*	1%	90%	6%	3%	0%
	September	*52*	0%	85%	15%	0%	0%
Area 24 - Clayoquot	July	*51*	2%	47%	41%	10%	0%
Area 25 - Nootka/Esperanza	July	*629*	0%	27%	57%	17%	0%
	August	*642*	0%	45%	42%	13%	0%
Area 26 - Kyuquot	July/Aug	*24*	0%	42%	46%	13%	0%
Area 27 - Quatsino	July	*84*	0%	23%	49%	29%	0%
	August	*48*	0%	23%	56%	21%	0%

Table 14. Average fork length (mm) by age of samples collected from terminal area WCVI recreational fisheries (by area, month and age).

Terminal Area	Month	*n*	Age				
			2	3	4	5	6
Area 20/21 - Renfrew	July	*51*	-	701	788	873	-
	August	*128*	-	713	801	849	-
	September	*32*	-	708	775	810	-
Area 23 - Barkley	July	*48*	-	702	804	858	-
	August	*133*	650	694	716	703	-
	September	*48*	-	702	792	-	-
Area 24 - Clayoquot	July	*50*	510	664	815	885	-
Area 25 - Nootka/Esperanza	July	*618*	610	700	819	875	-
	August	*640*	-	735	816	862	916
Area 26 - Kyuquot	July	*24*	-	712	810	875	-
Area 27 - Quatsino	July	*84*	-	806	834	873	-
	August	*48*	-	692	839	856	-

Table 15. Average sex ratio by age and area of samples collected from terminal area WCVI recreational fisheries.

Terminal Area	*Age*	*n*	Sex	
			Female	Male
Area 20/21 - Renfrew	*3*	*18*	16.67%	83.33%
	4	*48*	62.50%	37.50%
	5	*8*	62.50%	37.50%
Area 20/21 - Renfrew Total		*74*	51.35%	48.65%
Area 23 - Barkley	*2*	*1*	0.00%	100.00%
	3	*129*	10.08%	89.92%
	4	*25*	60.00%	40.00%
	5	*6*	50.00%	50.00%
Area 23 - Barkley Total		*161*	19.25%	80.75%
Area 24 - Clayoquot	*2*	*1*	0.00%	100.00%
	3	*9*	11.11%	88.89%
	4	*13*	46.15%	53.85%
	5	*2*	50.00%	50.00%
Area 24 - Clayoquot Total		*25*	32.00%	68.00%
Area 25 - Nootka/Esperanza	*2*	*2*	0.00%	100.00%
	3	*376*	23.67%	76.33%
	4	*524*	50.00%	50.00%
	5	*165*	69.09%	30.91%
	6	*1*	100.00%	0.00%
Area 25 - Nootka/Esperanza Total		*1068*	43.63%	56.37%
Area 26 - Kyuquot	*3*	*7*	57.14%	42.86%
	4	*11*	45.45%	54.55%
	5	*3*	66.67%	33.33%
Area 26 - Kyuquot Total		*21*	52.38%	47.62%
Area 27 - Quatsino	*3*	*5*	60.00%	40.00%
	4	*28*	50.00%	50.00%
	5	*8*	75.00%	25.00%
Area 27 - Quatsino Total		*41*	56.10%	43.90%

Table 16. Average sex ratio by age and month of samples collected from Area 23 terminal fisheries.

Month	Age	*n*	Sex	
			Female	Male
July	3	*7*	14%	86%
	4	*13*	77%	23%
	5	*3*	100%	0%
July Total		*23*	61%	39%
August	2	*1*	0%	100%
	3	*94*	12%	88%
	4	*6*	17%	83%
	5	*3*	0%	100%
August Total		*104*	12%	88%
September	3	*28*	4%	96%
	4	*6*	67%	33%
September Total		*34*	15%	85%
Area 23 Total		*161*	19%	81%

Table 17. Origin of samples collected from terminal area WCVI recreational fisheries (by area and month). (CON = Conuma Hatchery, RCH = Robertson Creek Hatchery, NIT = Nitinat Hatchery, OTHER WCVI = Other WCVI (hatchery and non-hatchery), NON- WCVI (Canada, US hatchery and non-hatchery), UNK = Unknown).

Terminal Area	Month	*n*	Origin					
			CON	RCH	NIT	OTHER WCVI	NON-WCVI	UNK
Area 20/21 - Renfrew	July	*41*	7.3%	7.3%	0.0%	9.8%	75.6%	0.0%
	August	*128*	3.1%	23.4%	8.6%	6.3%	56.3%	2.3%
	September	*34*	0.0%	61.8%	8.8%	5.9%	23.5%	0.0%
Area 23 - Barkley	July	*82*	26.8%	14.6%	9.8%	13.4%	29.3%	6.1%
	August	*214*	8.9%	72.4%	7.0%	7.5%	2.8%	1.4%
	September	*100*	3.0%	59.0%	12.0%	20.0%	5.0%	1.0%
Area 24 - Clayoquot	July	*43*	30.2%	20.9%	7.0%	14.0%	20.9%	7.0%
Area 25 - Nootka/Esperanza	July	*524*	85.3%	1.9%	1.0%	3.1%	2.3%	6.5%
	August	*554*	85.2%	3.1%	0.9%	9.4%	0.7%	0.7%
Area 26 - Kyuquot	July	*23*	60.9%	8.7%	0.0%	13.0%	17.4%	0.0%

Table 18. Origin of production (hatchery, natural, unknown) of samples collected in terminal area WCVI recreational fisheries (by area and month).

Terminal Area	Month	*n*	Production Type		
			Hatchery	Natural	Unknown
Area 20/21 - Renfrew	July	*41*	39%	51%	10%
	August	*128*	36%	61%	3%
	September	*34*	74%	26%	0%
Area 23 - Barkley	July	*82*	60%	40%	0%
	August	*214*	77%	19%	4%
	September	*100*	73%	26%	1%
Area 24 - Clayoquot	July	*43*	65%	30%	5%
Area 25 - Nootka/Esperanza	July	*524*	88%	7%	5%
	August	*554*	91%	6%	3%
Area 26 - Kyuquot	July	*23*	65%	30%	4%

Table 19. Average size of samples collected in terminal area WCVI recreational fisheries by production type, area and month.

Terminal Area	Month	*n*	Production Type	
			Hatchery	Natural
Area 20/21 - Renfrew	July	*41*	758	797
	August	*128*	746	795
	September	*34*	720	751
Area 23 - Barkley	July	*82*	763	732
	August	*214*	689	702
	September	*100*	723	694
Area 24 - Clayoquot	July	*43*	716	757
Area 25 - Nootka/Esperanza	July	*524*	799	807
	August	*554*	780	815
Area 26 - Kyuquot	July	*23*	791	758

Table 20. Age composition of samples collected in terminal area WCVI recreational fisheries by production type, area, and month.

Terminal Area	Month	*n*	Production Type	Age		
				3	4	5
Area 20/21 - Renfrew	July	*17*	Hatchery	24%	71%	6%
		21	Natural	14%	71%	14%
	August	*45*	Hatchery	60%	33%	7%
		74	Natural	16%	72%	12%
Area 23 - Barkley	July	*24*	Hatchery	33%	58%	8%
		24	Natural	42%	42%	17%
	August	*91*	Hatchery	91%	5%	3%
		19	Natural	79%	16%	5%
Area 24 - Clayoquot	July	*24*	Hatchery	54%	46%	0%
		12	Natural	33%	50%	17%
Area 25 - Nootka/Esperanza	July	*438*	Hatchery	26%	60%	14%
		35	Natural	23%	29%	49%
	August	*476*	Hatchery	46%	42%	12%
		31	Natural	39%	29%	32%
Area 26 - Kyuquot	July	*14*	Hatchery	21%	71%	7%
		7	Natural	71%	0%	29%

Table 21. Average size by age of hatchery and natural origin fish caught in terminal area WCVI recreational fisheries.

Terminal Area	Month	*n*	Production Type	Age		
				3	4	5
Area 20/21 - Renfrew	July	17	H	665	772	900
		21	NAT	740	799	843
	August	45	H	710	798	823
		72	NAT	724	804	843
Area 23 - Barkley	July	23	H	726	800	840
		24	NAT	683	824	866
	August	85	H	694	708	717
		19	NAT	703	705	660
Area 24 - Clayoquot	July	24	H	662	823	
		11	NAT	645	820	830
Area 25 - Nootka/Esperanza	July	435	H	699	824	877
		34	NAT	652	817	892
	August	474	H	727	817	861
		31	NAT	740	826	894
Area 26 - Kyuquot	July	14	H	727	808	835
		7	NAT	704		895

WCVI Terminal Area Commercial Fisheries

Table 22. Age composition of samples collected in terminal area WCVI commercial fisheries (by area and opening).

Terminal Area	Sub-Area	Opening	*n*	Age				
				2	3	4	5	6
Area 23 - Barkley	Alberni Inlet	92	*105*	2.9%	90.5%	6.7%	0.0%	0.0%
		93	*100*	5.0%	87.0%	8.0%	0.0%	0.0%
Area 25 - Nootka/ Esperanza	Tlupana Inlet	83	*140*	0.0%	50.0%	42.9%	7.1%	0.0%
		84	*97*	0.0%	52.6%	39.2%	8.2%	0.0%
		91	*38*	0.0%	39.5%	47.4%	13.2%	0.0%

Table 23. Stock composition of samples collected in terminal area WCVI commercial fisheries (by area and opening).

Terminal Area	Sub-Area	Opening	*n*	Otolith Thermal Mark					
				Unmarked	Robertson	Nahmint	Conuma	Burman	Leiner
Area 23 - Barkley	Alberni Inlet	92	*111*	7.1%	89.3%	3.6%	-	-	-
		93	*100*	0.0%	75.0%	25.0%	-	-	-
Area 25 - Nootka/ Esperanza	Tlupana Inlet	83	*150*	2.0%	49.5%	-	48.5%	-	-
		84	*100*	-	-	-	98.0%	-	2.0%
		91	*38*	-	-	-	97.3%	2.7%	-

Table 24. Average length of fish (FL) by age sampled in Area 23 commercial fisheries.

Terminal Area	Sub-Area	*n*	Age		
			2	3	4
Area 23 - Barkley	Alberni Inlet	*205*	509	676	741

Table 25. Average length of fish (POF) by age sampled in Area 25 commercial fisheries.

Terminal Area	Sub-Area	*n*	Age		
			3	4	5
Area 25 - Nootka/ Esperanza	Tlupana Inlet	*275*	637	736	791

WCVI Terminal Area Chinook Run Reconstruction

Table 26. Terminal return of WCVI origin chinook to Area 20 (Port Renfrew).

Fishery/Location	Age					Total
	2	3	4	5	6	
FSC	-	-	-	-	-	-
First Nation EO	-	-	-	-	-	-
Recreational	-	1,627	1,929	322	-	3,878
Commercial GN	-	-	-	-	-	-
Commercial SN	-	-	-	-	-	-
Escapement	-	586	879	732	-	2,197
Total Terminal Return	**-**	**2,213**	**2,808**	**1,054**	**-**	**6,075**
Hatchery Origin	**-**	**1,729**	**2,050**	**858**	**-**	**4,637**

Table 27. Terminal return of WCVI origin chinook to Area 21/22 (Nitinat).

Fishery/Location	Age					Total
	2	3	4	5	6	
FSC	-	171	315	63	1	550
First Nation Comm	-	174	321	65	1	561
Recreational	-	570	1,052	212	3	1,835
Commercial GN	-	-	-	-	-	-
Commercial SN	-	-	-	-	-	-
Escapement	639	7,108	13,314	2,705	28	23,794
Total Terminal Return	**639**	**8,023**	**15,002**	**3,044**	**32**	**26,740**
Hatchery Origin	**634**	**7,643**	**13,974**	**2,830**	**0**	**25,081**

Table 28. Terminal return of WCVI origin chinook to Area 23 (Barkley Sound, Alberni Inlet).

Fishery/Location	Age					Total
	2	3	4	5	6	
FSC/Treaty	55	1,256	129	27	-	1,467
First Nation Comm	45	5,794	764	90	-	6,692
Recreational	33	10,076	2,530	414	-	13,053
Commercial GN	5	413	20	-	-	438
Commercial SN	-	-	-	-	-	-
Escapement	2,088	52,070	5,150	1,540	7	60,856
Total Terminal Return	**2,227**	**69,609**	**8,593**	**2,070**	**7**	**82,506**
Hatchery Origin	**2,123**	**64,118**	**7,740**	**1,707**	**2**	**75,691**

Table 29. Terminal return of WCVI origin chinook to Area 24 (Clayoquot Sound).

Fishery/Location	Age					Total
	2	3	4	5	6	
FSC	-	60	46	21	1	128
First Nation Comm	-	-	-	-	-	-
Recreational	-	189	146	68	4	406
Commercial GN	-	-	-	-	-	-
Commercial SN	-	-	-	-	-	-
Escapement	-	1,533	1,892	263	-	3,689
Total Terminal Return	**-**	**1,782**	**2,085**	**352**	**5**	**4,223**
Hatchery Origin	**-**	**1,456**	**1,673**	**220**	**4**	**3,353**

Table 30. Terminal return of WCVI origin chinook to Area 25 (Nootka Sound, Esperanza Inlet).

Fishery/Location	Age					Total
	2	3	4	5	6	
FSC	1	162	209	69	1	441
First Nation Comm	2	588	245	193	5	1,034
Recreational	24	6,935	9,290	3,073	23	19,345
Commercial GN	-	4,661	4,650	881	37	10,229
Commercial SN	-	-	-	-	-	-
Escapement	860	23,699	19,724	5,510	-	49,793
Total Terminal Return	**887**	**36,046**	**34,118**	**9,726**	**65**	**80,841**
Hatchery Origin	**886**	**35,509**	**33,258**	**8,585**	**59**	**78,297**

Table 31. Terminal return of WCVI origin chinook to Area 26 (Kyoquot Sound).

Fishery/Location	Age					Total
	2	3	4	5	6	
FSC	-	-	-	-	-	-
First Nation Comm	-	-	-	-	-	-
Recreational	-	195	151	70	4	419
Commercial GN	-	-	-	-	-	-
Commercial SN	-	-	-	-	-	-
Escapement	147	771	436	858	-	2,212
Total Terminal Return	**147**	**966**	**586**	**928**	**4**	**2,631**
Hatchery Origin	**59**	**448**	**254**	**443**	**2**	**1,206**

Table 32. Terminal return of WCVI origin chinook to Area 27 (Quatsino Sound).

Fishery/Location	Age					Total
	2	3	4	5	6	
FSC	-	-	-	-	-	-
First Nation Comm	-	-	-	-	-	-
Recreational	-	284	728	419	-	1,431
Commercial GN	-	-	-	-	-	-
Commercial SN	-	-	-	-	-	-
Escapement	-	608	6,730	1,490	-	8,828
Total Terminal Return	**-**	**892**	**7,458**	**1,909**	**-**	**10,259**
Hatchery Origin	**-**	**381**	**977**	**562**	**-**	**1,920**

Table 33. TOTAL terminal return of WCVI chinook to the WCVI terminal area.

Return	Age					Total	Adult
	2	3	4	5	6		
Total Terminal Return	3,900	119,529	70,650	19,084	112	213,276	209,376
Hatchery Origin	3,702	111,285	59,927	15,205	68	190,187	186,484
Natural Origin	198	8,245	10,724	3,879	44	23,089	22,891
Hatchery Origin	2%	59%	32%	8%	0.0%	89%	89%
Natural Origin	1%	36%	46%	17%	0.2%	11%	11%

Table 34. Comparison of current 2015 estimate of WCVI terminal chinook abundance (RR) with the initial 2015 estimate of WCVI terminal chinook abundance.

Estimate	Age					Total	Adult
	2	3	4	5	6		
2015 RR	3,900	119,529	70,650	19,084	112	213,276	209,376
2015 OLD	1,887	110,393	63,586	16,895	50	192,812	190,925
Difference	2,013	9,136	7,064	2,188	62	20,464	18,451
% Difference	107%	8%	11%	13%	125%	10.6%	9.7%

Table 35. Origin of additional WCVI chinook associated with the re-calculated terminal run size.

Stock	Catch
Conuma H	4,039
Nitinat H	2,935
Robertson Cr. H	5,643
Other WCVI H	1,672
WCVI Natural	6,174
Total	**20,464**

Table 36. Location of terminal area WCVI natural origin catch. (1597 of the catch in Area 23 is associated with the Somass River stock.)

Terminal Area	Age					Total
	2	3	4	5	6	
Area 20	-	432	563	98	-	1,094
Area 21/22	-	112	214	43	1	370
Area 23	18	2,568	559	107	-	3,252
Area 24	-	62	48	22	1	134
Area 25	0	93	270	195	1	559
Area 26	-	69	53	25	1	148
Area 27	-	123	315	181	-	618
Total	**18**	**3,458**	**2,022**	**672**	**5**	**6,174**

WCVI Hatchery Terminal Run Reconstruction (Major Facilities)

Table 37. Return of Conuma Hatchery origin chinook to the WCVI terminal area. Note: hatchery origin fish are determined by otolith and DNA.

Terminal Area	Fishery/Location	Age					Total
		2	3	4	5	6	
Nootka, Esperanza - Area 25	FSC	1	154	204	64	0	424
	First Nation Comm	-	-	-	-	-	-
	Recreational	21	6,145	9,022	2,814	21	18,022
	Commercial GN	-	3,593	3,606	698	37	7,934
	Commercial SN	-	-	-	-	-	-
	Escapement	834	18,516	16,605	3,694	-	39,648
	Total	**855**	**28,408**	**29,437**	**7,270**	**58**	**66,029**
Other WCVI Areas	Catch	6	1,656	1,574	482	4	3,722
	Escapement	71	1,368	1,426	658	-	3,522
	Total Terminal Return	**932**	**31,433**	**32,437**	**8,409**	**62**	**73,273**

Table 38. Return of Nitinat Hatchery chinook to the WCVI terminal area – catch and escapement. Note: hatchery origin fish are determined by otolith and DNA.

Terminal Area	Fishery/Location	Age					Total
		2	3	4	5	6	
Nitinat Area - 21/22	FSC	-	169	306	61	-	537
	First Nation EO	-	173	312	63	-	547
	Recreational	-	242	438	88	0	768
	Commercial GN	-	-	-	-	-	-
	Commercial SN	-	-	-	-	-	-
	Escapement	634	7,059	12,918	2,618	-	23,230
	Total	**634**	**7,643**	**13,974**	**2,830**	**0**	**25,081**
Other WCVI Areas	Catch	0	1,206	626	135		1,968
	Escapement	6	32	16	12	-	65
	Total Terminal Return	**640**	**8,881**	**14,616**	**2,977**	**0**	**27,115**

Table 39. Return of Somass/Robertson Creek Hatchery chinook to the WCVI terminal area. Note: hatchery origin fish are determined by otolith, DNA and CWT marks.

Terminal Area	Fishery/Location	Age					Total
		2	3	4	5	6	
Barkley, Alberni - Area 23	FSC/Treaty	51	1,090	111	19	-	1,271
	First Nation Comm	42	5,372	708	83	-	6,205
	Recreational	31	7,172	1,133	169	-	8,504
	Commercial GN	5	383	19	-	-	406
	Commercial SN	-	-	-	-	-	-
	Escapement	1,782	50,295	4,288	887	7	57,258
	Total	**1,910**	**64,312**	**6,258**	**1,158**	**7**	**73,645**
Other WCVI Areas	Catch	1	2,121	2,491	447	2	5,062
	Escapement	2	483	88	35	-	607
	Total Terminal Return	**1,912**	**66,915**	**8,837**	**1,639**	**9**	**79,314**

Table 40. Terminal return of CWT-associated Robertson Creek Hatchery fish to Area 23 (Barkley Sound and Alberni Inlet).

Terminal Area	Fishery Location	Age					Total
		2	3	4	5	6	
Barkley, Alberni - Area 23	FSC/Treaty						-
	First Nation Comm	103	4,368				4,471
	Recreational		3,249	44	41		3,333
	Commercial GN						-
	Commercial SN						-
	Escapement	1,501	22,753	1,018	482	-	25,754
		1,603	30,370	1,062	523	-	33,558
Other WCVI Areas	Catch	-	553	44	-		597
	Escapement	-	-	-	-	-	
	Total Terminal Return	**1,603**	**30,923**	**1,106**	**523**	**-**	**34,155**

Table 41. Terminal areas for which additional catch and escapement was associated with hatchery stocks based on mark recoveries. (n.b. Escapement was accounted for initially, however it was not associated with the hatchery stock.)

Type	Terminal Area	Stock	Age				
			2	3	4	5	6
Catch	**Area 20**	Conuma	-	101	202	46	-
		Nitinat	-	199	140	46	-
		RCH	-	777	765	115	-
	Area 21/22	Conuma	-	33	61	12	0
		Nitinat					
		RCH	-	165	306	61	1
	Area 23	Conuma	6	1,160	764	128	-
		Nitinat	-	905	429	67	-
		RCH					
	Area 24	Conuma	-	97	75	35	2
		Nitinat	-	21	16	7	0
		RCH	-	62	48	22	1
	Area 25	Conuma					
		Nitinat	0	81	42	15	0
		RCH	1	1,116	1,047	248	0
	Area 26	Conuma	-	116	90	42	2
		Nitinat	-	-	-	-	-
		RCH	-	-	-	-	-
	Area 27	Conuma	-	149	382	220	-
		Nitinat	-	-	-	-	-
		RCH	-	-	326	-	-
ESC	**Area 20**	Conuma	-	6	9	8	-
		Nitinat					
		RCH					
	Area 21/22	Conuma	-	-	-	-	-
		Nitinat					
		RCH	-	-	-	-	-
	Area 23	Conuma	5	42	17	14	-
		Nitinat	6	32	16	12	-
		RCH	1	5	3	2	-
	Area 24	Conuma	-	3	3	1	-
		Nitinat					
		RCH					
	Area 25	Conuma	15	1,024	1,253	277	-
		Nitinat					
		RCH	-	467	79	20	-
	Area 26	Conuma	51	292	143	358	-
		Nitinat					
		RCH	1	11	6	13	-
	Area 27	Conuma					
		Nitinat					
		RCH					

WCVI Terminal Area Harvest Rates

Table 42. Estimated harvest rate of Somass/Robertson Creek Hatchery origin chinook in terminal WCVI area fisheries. (Note: this is a terminal harvest rate only; it is not comparable to an annual exploitation rate for the same fisheries, which incorporates all RCH catch in terminal as well as distant fisheries.)

PFMA	Fishery	Sub-Area	Age 2	Age 3	Age 4	Age 5	Age 6
23	FSC	Alberni Inlet	2.4%	1.1%	0.8%	0.0%	0.0%
	FN EO	Alberni Inlet	2.0%	7.2%	7.2%	4.6%	0.0%
	Treaty	Inner Barkley Sound	0.0%	0.3%	0.3%	0.9%	0.0%
	Commercial GN	Alberni Inlet	0.2%	0.5%	0.2%	0.0%	0.0%
23	Recreational	Outer Barkley Sound	0.0%	1.6%	6.5%	0.0%	0.0%
		Inner Barkley Sound	0.0%	3.8%	2.5%	7.2%	0.0%
		Barkley Corridor	0.0%	1.1%	2.2%	1.6%	0.0%
		Alberni Inlet	1.4%	3.1%	0.5%	0.0%	0.0%
		Total	1.4%	9.7%	11.8%	8.8%	0.0%
23	Total		**6.0%**	**18.9%**	**20.3%**	**14.3%**	**0.0%**
20 - 27		Other WCVI terminal areas	0.0%	3.2%	28.2%	27.3%	25.3%
Total			**6.1%**	**22.1%**	**48.5%**	**41.5%**	**25.3%**

Table 43. Potential harvest rate (likely a maximum) of natural origin Area 23 chinook in WCVI terminal area fisheries. (Note: this is a terminal harvest rate only; it is not comparable to an annual exploitation rate for the same fisheries, which incorporates all Area 23 chinook natural origin catch in terminal as well as distant fisheries.)

Area	Age 2	Age 3	Age 4	Age 5	Age 6
Area 23	1.4%	10.0%	12.0%	9.7%	0.0%
Other WCVI Areas	0.0%	1.5%	16.3%	12.1%	20.3%
Total	1.4%	11.5%	28.4%	21.9%	20.3%

Table 44. Estimated harvest rate of Conuma Hatchery origin chinook in terminal WCVI area fisheries. (Note: this is a terminal harvest rate only; it is not comparable to an annual exploitation rate for the same fisheries, which incorporates all Conuma catch in terminal as well as distant fisheries.)

PFMA	Fishery	Sub-Area	Age 2	Age 3	Age 4	Age 5	Age 6
25	FSC	Nootka/Esperanza	0.1%	0.5%	0.6%	0.8%	0.8%
25	Commercial GN	Tluplana Inlet	0.0%	11.4%	11.1%	8.3%	58.6%
25	Recreational	Inner Nootka	1.6%	13.3%	18.4%	22.2%	22.6%
		Inner Esperanza	0.3%	2.2%	3.7%	3.6%	3.7%
		Outer Nootka	0.2%	1.8%	2.5%	2.9%	3.0%
		Nootka Corridor	0.2%	1.5%	1.9%	2.9%	3.0%
		Outer Esperanza	0.1%	0.5%	0.9%	1.2%	1.3%
		Esperanza Corridor	0.0%	0.1%	0.3%	0.4%	0.4%
		Tlupana (25D)	0.0%	0.2%	0.2%	0.3%	0.0%
		Total	2.3%	19.5%	27.8%	33.5%	33.9%
25	Total		**2.3%**	**31.5%**	**39.6%**	**42.5%**	**93.3%**
20 - 27	Other WCVI terminal areas		0.6%	5.3%	4.9%	5.7%	6.7%
Total			**2.9%**	**36.7%**	**44.4%**	**48.3%**	**100.0%**

Table 45. Potential harvest rate (likely a maximum) of natural origin Area 25 chinook in WCVI terminal area fisheries. (Note: this is a terminal harvest rate only; it is not comparable to an annual exploitation rate for the same fisheries, which incorporates all Area 25 chinook natural origin catch in terminal as well as distant fisheries.)

Area	Age 2	Age 3	Age 4	Age 5	Age 6
Area 25	0.8%	6.5%	9.9%	11.8%	12.1%
Other WCVI Areas	0.0%	0.8%	1.5%	3.1%	3.5%
Total	0.8%	7.4%	11.3%	14.9%	15.6%

WCVI Terminal Area Catch Stock Composition

Table 46. Stock composition of Area 20 (Port Renfrew) terminal area catch.

Stock	Age					Total	
	2	3	4	5	6		
SAN_JUAN_H	-	57	79	13	-	149	2%
NIT_H	-	211	254	39	-	504	6%
OTHER WCVI_H	-	926	1,034	172	-	2,132	24%
WCVI_NAT	-	432	563	98	-	1,094	12%
NON-WCVI_H	-	459	764	162	-	1,385	15%
NON-WCVI_NAT	-	1,271	2,054	406	-	3,731	41%
Total	-	3,356	4,747	890	-	8,994	

Table 47. Stock composition of Area 21/22 (Nitinat) terminal area catch.

Stock	Age					Total	
	2	3	4	5	6		
NIT_H	-	242	438	88	0	768	22%
NIT_NAT	-	5	17	4	1	27	1%
OTHER WCVI_H	-	216	400	80	1	697	20%
WCVI_NAT	-	106	197	40	0	343	10%
NON-WCVI_H	-	120	222	45	1	387	11%
NON-WCVI_NAT	-	370	683	137	2	1,191	35%
Total	-	1,059	1,956	394	5	3,414	

Table 48. Stock composition of Area 23 (Barkley Sound, Alberni Inlet) catch.

Stock	Age					Total	
	2	3	4	5	6		
RCH_H	116	12,647	1,792	234	-	14,790	63%
SOMASS_NAT	13	1,369	178	37	-	1,597	7%
OTHER WCVI_H	5	2,324	1,091	189	-	3,609	15%
WCVI_NAT	5	1,198	381	70	-	1,655	7%
NON-WCVI_H	-	709	306	27	-	1,042	4%
NON-WCVI_NAT	-	443	392	70	-	905	4%
Total	138	18,692	4,140	628		23,598	

Table 49. Stock composition of Area 24 (Clayoquot Sound) terminal area catch.

Stock	Age					Total	
	2	3	4	5	6		
LOCAL_H	-	-	-	-	-	-	0%
OTHER WCVI_H	-	186	144	67	4	401	57%
WCVI_NAT	-	62	48	22	1	134	19%
NON-WCVI_H	-	31	24	11	1	67	10%
NON-WCVI_NAT	-	47	36	17	1	100	14%
Total	-	326	252	117	6	701	

Table 50. Stock composition of Area 25 (Nootka-Esperanza) terminal area catch.

Stock	Age					Total	
	2	3	4	5	6		
CON_H	24	10,031	12,881	3,610	58	26,603	84.9%
OTHER_LOCAL_H	2	1,027	153	149	1	1,331	4.2%
OTHER WCVI_H	1	1,197	1,088	263	1	2,549	8.1%
WCVI_NAT	0	93	270	195	1	559	1.8%
NON-WCVI_H	0	48	75	71	1	195	0.6%
NON-WCVI_NAT	0	12	39	56	0	107	0.3%
Total	27	12,407	14,506	4,343	61	31,344	

Table 51. Stock composition of Area 26 (Kyoquot Sound) terminal area catch.

Stock	Age					Total	
	2	3	4	5	6		
OTHER WCVI_H	-	126	97	45	2	271	52%
WCVI_NAT	-	69	53	25	1	148	29%
NON-WCVI_H	-	23	18	8	0	49	10%
NON-WCVI_NAT	-	23	18	8	0	49	10%
Total	-	240	186	86	5	517	

Table 52. Stock composition of Area 27 terminal area catch.

Stock	Age					Total	
	2	3	4	5	6		
OTHER WCVI_H	-	161	414	238	-	812	47%
WCVI_NAT	-	123	315	181	-	618	36%
NON-WCVI_H	-	29	75	43	-	148	9%
NON-WCVI_NAT	-	29	75	43	-	148	9%
Total	-	342	879	505	-	1,726	

Table 53. Overall stock composition of WCVI terminal area catch.

Stock	Age					Total
	2	3	4	5	6	
WCVI Hatchery	147	29,351	19,864	5,186	66	54,615
WCVI Natural	18	3,458	2,022	672	5	6,174
Non-WCVI Hatchery	0	1,420	1,484	368	2	3,273
Non-WCVI Natural	0	2,194	3,297	737	3	6,231
Total	165	36,422	26,667	6,963	76	70,294
WCVI Hatchery	89%	81%	74%	74%	87%	77.7%
WCVI Natural	11%	9%	8%	10%	6%	8.8%
Non-WCVI Hatchery	0%	4%	6%	5%	3%	4.7%
Non-WCVI Natural	0%	6%	12%	11%	4%	8.9%

Table 54. Terminal area and catch period associated with non-WCVI origin catch (hatchery and natural).

Terminal Area	Stock	Period			Total	%
		June/July	August	September		
Area 20	NON-WCVI_H	748	446	190	1,384	
	NON-WCVI_NAT	1,349	2,193	190	3,731	
	Total	2,097	2,638	380	5,115	54%
Area 21	NON-WCVI_H	165	171	51	387	
	NON-WCVI_NAT	298	843	51	1191	
	Total	463	1014	101	1579	17%
Area 23	NON-WCVI_H	654	334	43	1,032	
	NON-WCVI_NAT	689	168	40	898	
	Total	1,344	503	84	1,930	20%
Area 24	NON-WCVI_H	46	21		67	
	NON-WCVI_NAT	68	32		100	
	Total	114	53		167	2%
					0	
Area 25	NON-WCVI_H	0	195		195	
	NON-WCVI_NAT	76	31		107	
	Total	76	226		302	3%
Area 26	NON-WCVI_H	37	8		45	
	NON-WCVI_NAT	36	7		43	
	Total	73	15	0	88	1%
Area 27	NON-WCVI_H	126	37		163	
	NON-WCVI_NAT	125	36		161	
	Total	251	73	0	324	3%
TOTAL	NON-WCVI_H	1776	1213	284	3273	
	NON-WCVI_NAT	2641	3309	281	6231	
	Total	4418	4522	565	9504	
		46%	48%	6%		

Terminal fishery sample for the Distant Fishery Index

Table 55. Input file for terminal CWT samples for distant fishery index calculations. WCVI area supplied data in green cells.

TERMINAL CWT SAMPLES

#Nages and first age (3-5, with 6 = all streat type + age 6)

4	3

#Nestrata

6

#me				Description	
24				ACSPT	Alberni Canal Sport
20	1			AI NET	Alberni Canal Net (Comm, EO, FSC)
24	1	1		BARK	Barkley Catch (Sport, FSC)
9	1	0		WSPT	Other terminal WCVI Sport
36	1		118	ESC River	Stamp River
1274	63	32		ESC Hatchery	Rack, RCH
			1487		

Sampling rate and uncertainty in sampling rate for each strata

#e:			N
0.28	40%	ACSPT	2304
0.079	5%	AI NET	8076
0.18	40%	BARK	13191
0.27	40%	WSPT	23184
0.12	5%	ESC River	17939
0.84	5%	ESC Hatche	37537

DISTANT FISHERY SAMPLES

#Ncstrata

2

#Lf: Sampling rate for CWTs in fishery

#mf: Captures of CWTS from indicator stock in fishery by age

#NEscScales. #Escapement-weighted number of scales by age for aggregate on spawning grounds

2210	1273	339

Scale sample

Table 56. Input file for terminal otolith samples for distant fishery index calculations. WCVI area supplied data in green cells.

TERMINAL OTOLITH SAMPLES

#Nages and first age (3-5, with 6 = all streat type + age 6)

4 3

#Nestrata

13

#me				Description	
36	13	4		Area 20/21/22	SWVI REC + FSC
106	22	5		Area 23	Alberni/Barkley REC, Barkley FSC
10	8			Area 24	Clayoquot REC and FSC
293	458	110		Area 25	Area 25 REC and FSC
2	7	1		Area 26/27	Area 26/27 REC
23				Area 23 NET, EO, FSC	Alberni Inlet Comm Net, EO, and Somass FSC
78	76	17	1269	Area 25 NET	Tlupana Inlet Comm Net
112	139	32		CON ESC River/Hatchery	Conuma Hatchery and River
102	50	39		Burman R. ESC/Demo	Burman River ESC and First Nation Comm
219	452	78		NIT ESC River/Hatchery	Nitinat Hatchery and River
184	179	83		Stamp ESC River	Stamp River deadpitch
245	118	96		RBT ESC Hatchery	Rack, RCH
121	110	32		OTHER WCVI ESC	Seine, deadpitch sampling, index streams only
			3,661		

Sampling rate and uncertainty in sampling rate for each strat			Catch/ESC sampled	Total Samples
#e:			*N*	*n*
1.4%	10%	Area 20/21/22	11,809	162
1.2%	10%	Area 23	15,929	189
4.2%	10%	Area 24	838	35
4.9%	10%	Area 25	20,098	981
0.8%	10%	Area 26/27	2,244	19
0.3%	5%	Area 23 NET, EO, FSC	8,125	26
2.0%	5%	Area 25 NET	10,229	201
0.7%	15%	CON ESC River/Hatchery	40,694	288
3.2%	15%	Burman R. ESC/Demo	7,476	236
3.5%	15%	NIT ESC River/Hatchery	23,194	809
2.7%	5%	Stamp ESC River	17,939	479
1.4%	5%	RBT ESC Hatchery	37,537	515
4.5%	25%	OTHER WCVI ESC	26,920	1218

DISTANT FISHERY SAMPLES

#Ncstrata

2

#Lf: Sampling rate for otoliths in fishery

#mf: Captures of otoliths from indicator stocks in fishery by age

#NEscScales. #Escapement-weighted number of scales by age for aggregate on spawning grounds

2210	1273	339

Scale sample