2017 TERMINAL ABUNDANCE OF WCVI CHINOOK SALMON

Report to the Northern Endowment Fund, Pacific Salmon Commission

March 2019 Report

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SUMMARY

Chinook salmon stocks originating from the West Coast of Vancouver Island (WCVI) contribute significantly to ocean harvests from the Gulf of Alaska to the Strait of Juan de Fuca. Much of the current production of WCVI chinook comes from hatcheries; natural (wild) chinook from the WCVI are a stock of concern in Canada. Fishery management actions to protect wild WCVI origin chinook as they migrate along the WCVI are complex and difficult to assess.

This project provides improved accuracy and precision of abundance estimates along with improved spatial, temporal resolution of biological catch and escapement data to improve the assessment and forecast of WCVI hatchery and wild chinook abundance used in the fishery management in the PST AABM fisheries and in the terminal ISBM areas of the WCVI.

This project supports the application of the 'distant fishery index' methodology (also called 'driver stock method'). Distant fishery catch ratios such as 'total WCVI abundance/ Robertson Creek Hatchery abundance' can be combined with known terminal abundance of Robertson Creek Hatchery stock to estimate total terminal abundance of WCVI chinook. There is significant potential for such 'distant fishery indices' to improve assessment and management of such complex stock aggregates such as WCVI chinook.

This report summarizes sampling results from 2017. For sample results from 2015 and 2016 see the previous versions of this report on the Pacific Salmon Commission website.

WCVI terminal/near shore fisheries and spawning escapements were sampled at a much higher sample rate than normal. From 2015 to 2017 almost 40,000 samples were obtained from fisheries and escapement. Almost 21,000 of those samples were resolved to complete biological profile consisting of catch location, date, length, age, sex, and stock origin. This includes 9,129 samples in 2017; an increase of approximately 35% relative to 2015 and 2016 levels.

Year	Sample Type	Total Samples	Sample w/ Resolved Age	Samples w/ Resolved Stock
2015	Sport	4,586	3,799	3,541
	Commercial Gillnet	352	339	165
	Escapement (Hatchery Brood)	6,688	3,212	1,749
	Escapement (Extensive)	744	583	306
2015 Totals		**12,370**	**7,933**	**5,761**
2016	Sport	4,188	3,602	2,726
	Brooks Troll Test	713	353	462
	Commercial Gillnet	363	340	358
	Escapement (Hatchery Brood)	5,848	3,186	2,327
	Escapement (Extensive)	174	94	69
2016 Totals		**11,286**	**7,575**	**5,942**
2017	Sport	6,761	5,662	4,688
	Brooks Troll Test	952	909	943
	Commercial Gillnet	710	792	691
	Escapement (Hatchery Brood)	6,325	4,031	2,497
	Escapement (Extensive)	488	443	180
	Maa-nulth Treaty	296	353	231
2017 Totals		**15,532**	**12,190**	**9,230**
	Grand Total	**39,188**	**27,698**	**20,933**

Note: Sport totals include samples collected from 1-5 nm offshore (see Tables 11-12 for terminal only sport samples)

Note: Total samples includes all samples taken with at least a catch location some bio data. The second category of 'resolved bio' includes samples with complete biological information, including length/sex/age/CWT. Not all these had readable DNA or otoliths, mostly escapement samples where otoliths and DNA were subsampled, or samples rejected in the labs. The third category 'resolved stock' includes fish with complete location, biological, and stock info.

These sample data, along with catch and escapement data along the WCVI, were the basis for reconstructing the total terminal returns for individual rivers (e.g. Stamp/Robertson Creek Hatchery) and associated sounds along the WCVI (e.g. Nitinat/San Juan, Barkley, Clayoquot, Nootka/Esperanza, Kyuquot, and Quatsino sounds) and total terminal return of hatchery and natural origin chinook to the total WCVI. The results are presented in the following table. The total terminal return of WCVI origin chinook to the WCVI was estimated at 190,071 adult chinook in 2017 compared to 172,857 in 2016 and 209,376 in 2015. In 2017, the total terminal return along the WCVI consisted of 156,247 hatchery origin chinook and 33,824 natural origin chinook.

Stock Aggregate	**2015**	**2016**	**2017**
Total Robertson/Stamp River return	73,645	73,621	88,908
CWT based return of Robertson Hatchery	33,558	41,368	57,494
WCVI total terminal return, adults (age 3-6)	209,376	172,857	190,071
WCVI total hatchery return, adults (age 3-6)	186,484	158,577	156,247
WCVI total natural production, adults (age 3-6)	22,891	14,280	33,824
WCVI jack (age 2) return, hatchery and wild	3,900	9,064	11,445

Application of the distant fishery index methodology will occur once the 2018 WCVI data and the associated SEAK and northern BC troll data are finalized in the next couple of months.

This project is also assessing the utility of a distant fishery index at Brooks Peninsula. The 2017 test fishery catch composition is shown in the following table. In 2016, the proportion of WCVI chinook, especially Robertson/Stamp and Nitinat chinook, was unexpectedly low during August, presumably due to the influence of the remnant 'warm water blob', El Nino conditions, and a massive abundance of juvenile rockfish along the WCVI on chinook migration behavior, which affected fisheries along the WCVI, including this test fishery. In 2017, the proportion of WCVI chinook averaged 38% (and ranged from 38% to 51%; see table below). As we had expected to see in 2016, the incidence of Conuma chinook increased to the end of July then dropped off. Both Robertson and Nitinat increased over the first five weeks and peaked in the third week of August. The utility of the Brooks test fishery as a distant fishery index appears to be worth pursuing, and may again be conducted in 2019.

Stat Week	***n***	**Stat Week**							
		73	**74**	**75**	**81**	**82**	**83**	**84**	**Total**
CONUMA	*136*	19%	18%	26%	18%	3%	1%	0%	**14%**
ROBERTSON	*186*	14%	19%	21%	25%	26%	28%	27%	**20%**
NITINAT	*27*	1%	1%	0%	1%	3%	8%	3%	**3%**
WCVI	*85*	8%	11%	3%	7%	8%	12%	8%	**9%**
Other BC	*165*	16%	16%	5%	11%	26%	25%	8%	**17%**
SUS	*344*	41%	36%	45%	38%	33%	25%	54%	**36%**

The data collected in 2017 over all fisheries and escapements provided significant insight into the terminal fisheries along the WCVI, including terminal fishery harvest rates, detailed distribution and timing information through the sounds, hatchery straying to wild rivers, genetic composition of spawning populations, comparison of CWT and otolith based estimates of hatchery contribution, and more. The results are being used in other analyses including assessment of hatchery straying along the WCVI and genetic impact of hatcheries on WCVI wild populations (Withler et al.). The results are also helping to redefine management along the WCVI (e.g. changes in the WCVI Chinook Management Corridor and changes in the release strategies for Conuma Hatchery).

The project was completed on time and within the allocated budget. A summary of expenditures is provided in Tables 60-61. A total of $212,653 was spent in fiscal year 2017-2018, less than the total available amount of $231,300. A total of $18,647 was returned to the PSC in March 2018 in error due to confusion about funding type: it was assumed that the funding was in S&W (salary and wages) and therefore that approximately $18,000 needed to be retained for the conversion of S&W to O&M, when in fact that wasn't the case.

Results from the 2018 sampling year (Year 4 of the Project) will be ready by the summer/fall of 2019 and will be reported on in early 2020.

TABLE OF CONTENTS

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 2017 return year. The results from 2015 and 2016 were provided in 2017 and 2018, respectively. Further and more detailed analysis is anticipated as 2018 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 Nitinat 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 the 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 stated overall goal is to estimate the aggregate abundance of hatchery and especially wild WCVI Chinook using the distant fishery index / driver stock approach. This will be accomplished by:

Objective 1. Improve the precision and discrimination of run reconstruction estimates of terminal hatchery and wild Chinook returns by expanding the catch and escapement sampling program in 'key' terminal production areas along the WCVI (e.g. Nitinat-San Juan, Barkley-Alberni, Clayoquot, Nootka-Esperanza, Kyuquot, Quatsino).

Objective 2. From these improved run reconstructions, estimate key proportions 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 or 'key' indicator stocks.

Objective 3. Adapt or modify the existing Bayesian analytical framework (Korman etal. 2011 and 2013) to estimate aggregate returns of natural and hatchery origin WCVI Chinook salmon, from distant fishery DNA/otolith/CWT/scale data.

The distant fishery index will include ratios such as RBT / total WCVI. In combination with known values from the terminal run reconstructions, these distant fishery indices could be valuable tools in assessing total WCVI aggregate abundance, or total WCVI natural production.

This report focuses on objective 1, including data and resulting reconstructed terminal returns of each major river and sound along the WCVI. These data and results are critical to completing Objectives 2 and 3; the data tables required for applying the Bayesian analytical framework are provided. Additional tables using various other ratios will be developed in conjunction with Josh Korman. An interim report using 2015 to 2017 results in the analytical framework will be available in 2019/20.

This report also focuses on the assessment and evaluation of current chinook fishery management along the WCVI, such as determination of harvest rates of various fisheries.

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, about 80 populations with historic observations are not regularly assessed. However, these populations are assumed to account for only a small proportion of the total production. 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 interviews and aerial boat counts to estimate recreational catch. Anglers are interviewed at the end of fishing trips to provide catch by species and location, and fishing times. 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 guide logbook and lodge catch manifests. More recently an email based system called "IREC" surveys licenced fishers 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 observed from catch at processing plants. Typically, most of the landed commercially caught chinook in WCVI terminal area fisheries are processed at only 1-2 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 (with the exception of the Maa-nulth Domestic fishery in Area 23 in 2016). 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 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 (DRIVER STOCK APPROACH)

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 ratio of this indicator stock group in a distant ocean fishery (using mark information such as CWT, otolith, DNA) relative to the total aggregate in the same distant fishery would have the same ratio as the abundance of the indicator stock group in the terminal area to the total aggregate abundance (or other important group such as natural spawners).

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 test these assumptions 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 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 21 WCVI terminal indicator stocks for the 2017 return year was 108,206 (Table 1). Of this total, 79,800 (or about 81%) was associated with the three major hatchery facilities located on the WCVI; including production from the Robertson Creek Hatchery and Somass River (41,474), the Conuma Hatchery (24,109) and Nitinat Hatchery (22,059). The remaining escapement (20,564) 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 2017 was 58,627 (Table 2). Most of this catch was associated with hatchery-directed fisheries in Area 23 (Barkley, Alberni Inlet – 21,683) and Area 25 (Nootka Sound – 16,877). There was also a significant amount of recreational catch in Area 20/21 (Port Renfrew, San Juan – 10,225). 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 WCVI terminal area catch generated from the IREC survey in 2017 for periods outside the creel survey was 2,213 (K. Hein, DFO, pers. comm.).

The total estimated catch in terminal WCVI area commercial net fisheries in 2017 was 29,025 (Table 3). Similar to the terminal recreational fisheries, this catch is associated with those areas with surplus hatchery production including Area 23 (Alberni Inlet – 9,872) and Area 25 (Tlupana Inlet – 19,153). 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.

The total estimated catch in terminal WCVI area First Nation fisheries in 2016 was 58,912 (Table 4). The catch of 4,739 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 was relatively low compared to the 13,158 caught in First Nation commercial fisheries (Economic Opportunity and Demonstration). Like commercial fisheries, First Nation ESSR opportunities are directed at those areas where hatchery surpluses exits namely Area 23 (Alberni Inlet, Somass R., catch – 29,554; Thornton Creek, catch - 240), Area 22 (Nitinat Lake, catch – 1,036) and Area 25 (Conuma R., catch – 10,185). All of these fisheries occurred proximate to the river area in order to avoid non-target local natural origin stocks.

SAMPLES

WCVI Escapement

There were 1,739 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. The majority of spawners in 2017 were 4-year olds from the 2013 brood year.

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

There were also 1,254 otoliths collected from WCVI spawning populations, not including hatchery rack samples. Identification of thermally marked otoliths allows for evaluation of the hatchery contribution (Table 9) and the extent of straying of hatchery origin fish among WCVI populations (Table 10).

WCVI Terminal Area Fisheries

Recreational Fisheries

There were 4,784 samples collected from WCVI area terminal recreational fisheries for which either scale or other mark data are available (Table 11). Of these samples 2,984 are complete samples for which age and stock identification information, either through CWT, otolith or DNA analysis, are known (Table 12).

Age and sex 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 (grouped to Conuma Hatchery, Robertson Creek Hatchery, Nitinat Hatchery, Other WCVI, and Non-WCVI) of the 4,233 biological samples with stock identification data is tabulated in Table 17. The origin (hatchery, natural) 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 702 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 2017 was 4-year olds from the 2013 brood year.

There were also 634 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).

Mquqwin-Brooks Test Fishery

A total of 943 biological samples collected from the Mquqwin-Brooks Test Fishery over 8 weeks (Table 26). These samples were used to estimate age composition of test fishery catch (Table 27). The majority of the test fishery catch in 2017 was 3-year olds from the 2014 brood year.

Identification of the thermally marked otoliths allows for evaluation of the hatchery contribution (Table 28) and stock composition (Table 29, 30) in the test fishery catch.

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 31 through Table 37 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 (Kyuquot 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 (Kyuquot), 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, Kyuquot).

The total estimated terminal aggregate return of WCVI chinook in 2017 is summarized in Table 38. The return of WCVI origin chinook (hatchery and wild) to the WCVI terminal area in 2017 was 201,516 including 190,071 adults. The vast majority (167,166 or 83%) of the return was associated with WCVI area hatchery production. The average age composition of the hatchery origin return was 7%, 29%, 52%, 13% 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 2%, 17%, 62%, 19% 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 2017 was 192,231 including 180,388 adults with an estimated age composition of 6%, 27%, 52%, 14% and <0.1% of age 2, 3, 4, 5 and 6 year-old fish, respectively (Table 39). 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 unaccounted for bycatch of natural origin fish. The distribution of catch of natural origin WCVI chinook by terminal area is summarized in Table 40. About 66% of this catch was associated with terminal areas 23 and 25 where recreational fishing opportunities are less restrictive due to hatchery surpluses there. About 22% 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. 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 41. Of the total return, 52,075 fish were associated with Area 25, the terminal area where Conuma Hatchery is located. An additional 4,436 fish were accounted for in catch and straying. There were 1,958 Conuma Hatchery spawners observed in other WCVI systems. Many of these strays were observed in other systems within Area 25, but there were also strays observed in Area 23, and most significantly, Area 26 (Table 45). The straying rate, estimated as the number of Conuma Hatchery chinook spawning in other systems relative to the Conuma River/Hatchery was approximately 4%.

The return of Nitinat Hatchery chinook to the WCVI terminal area is summarized in Table 42. Of the total return, 20,760 fish were associated with Areas 21 and 22, the terminal areas near where Nitinat Hatchery is located. An additional 1,377 fish were accounted for in catch in other WCVI terminal areas. There were 114 Nitinat Hatchery spawners observed in other WCVI systems, mainly in Area 23, and at very low levels in Area 25 (Table 45). The straying rate,

estimated as the number of Nitinat Hatchery chinook spawning in other systems relative to the Nitinat River/Hatchery was 1%.

The return of Robertson Creek Hatchery chinook to the WCVI terminal area is summarized in Table 43. Of the total return, 88,908 fish were associated with Area 23, the terminal area where Robertson Creek Hatchery is located. An additional 5,249 fish were accounted for in catch and escapement to in other WCVI terminal areas. There were 995 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 22 and 23 (Table 45). 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 44. Overall, the CWT associated return is about 65% of the return associated with marked otolith samples. CWTs were associated with only about 67% of the escapement of Robertson Creek Hatchery chinook that was associated with marked RCH otoliths. CWT-associated terminal catch was similar, at 61% 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 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 2016 for WCVI terminal area fisheries, but that apparent bias may not be consistent across recreational fisheries or years. See Appendix 1 for a deeper review of this issue.

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 46. The overall harvest rate ranged from 3% to 56%, depending on the age class, with most of the harvest occurring in Area 23. In 2016, the data suggested that for the younger age classes (Age 2-4) most of the harvest was in Area 23; however, for the older age 5 and 6-year old age classes, most of the harvest (31% and 75%, respectively) was in other WCVI areas. This result was not observed in 2017. Although natural origin fish are intercepted in Area 23 fisheries (Table 40), 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 estimated harvest rate on natural origin chinook in terminal area 23 fisheries ranges between 9% and 37%, depending on the age class (Table 47). 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. 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 9% to about 13% not including the 2 and 6 year old age classes (Table 47).

Conuma Hatchery

The estimated harvest rates by age class of Conuma Hatchery chinook in WCVI terminal area fisheries are summarized in Table 48. The overall harvest rate ranged from 49% to 67%, depending on the age class and not including 2 and 6 year old age classes. For all age classes most of the harvest was in Area 25.

Although natural origin fish are intercepted in Area 25 fisheries (Table 40), 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 about 4% and 8%, not including 2 and 6-year olds (Table 49). 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 Southwest Vancouver Island fisheries are discounted, the harvest rate of natural origin chinook from Area 25 in other WCVI area terminal fisheries likely ranged between about 6% to 10%, not including the 2 and 6 year old age classes (Table 49).

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 50 to Table 56 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 about 3% in Area 25 to 67% in Area 20. Overall, the contribution of non-WCVI origin chinook to catch in WCVI terminal fishing area catch was 16% or 16,374 pieces (Table 57). This assessment includes periods within terminal areas that are classified as both AABM and ISBM fisheries. About 43% of the non-WCVI origin catch was associated with Area 20 and the vast majority of the rest was caught in either Area 23 (26%), Area 27 (10%), or Area 24 (9%). Relative to 2016, more non-WCVI origin chinook were caught in terminal WCVI areas.

The contribution of natural origin WCVI chinook to terminal fishing areas is also variable, ranging from about 1% (Areas 25) to 27% (Area 26). Overall, the contribution of WCVI origin chinook to terminal area catch was about 10% or 10,552 pieces. The contribution of WCVI hatchery origin fish was about 74% or 77,451 pieces (Table 57).

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 58).

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 59).

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 7 times as many thermal mark recoveries as CWT in the terminal area (4765 versus 674). This is significantly higher than was found in 2016, when there were 2.5 times as many thermal mark recoveries as CWT in the terminal area (3661 versus 1487). In 2017 terminal fisheries there were 3 times as many recoveries (2122 versus 664), relative to over 10 times as many recoveries in 2016 (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.

A total of 943 samples were collected over 8 weeks in 2017, from the second week of July through the end of August. Stock composition results are provided in Tables 26-30.

EVALUATION / NEXT STEPS

This report summarizes results from 2017 in the same format as results are reported in 2015 and 2016. Results from 2018 will be available by summer 2019, and reported in early 2020.

More timely reporting will result from the scope of this project, which required refinement of key databases within DFO, and resulted in the on-going creation of a new biological database. The CREST data base now contains almost 40,000 records of individual fish from this project, not including those collected in 2018. Each fish record contains catch location/date/gear, biological characteristics such as length, sex, and age, and stock identification resolved from CWT, otolith thermal marks, or DNA. Inclusion of catch/sample rates for each fish is being developed, which will allow the expansion of each of these sampled fish to total catch they represent. This data format will allow considerable investigation into chinook behavior, distribution, by size or age, maturation rate, etc. The data management from this project is now being used in all other south coast fishery sampling.

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.

The ability to identify the sample origin to finer stock (in some cases population level) and fishery spatial and temporal resolution will result in more precise estimates of terminal harvest rate, and for some of the smaller WCVI hatchery marked stocks not already reported.

The inclusion of additional samples collected in 2018 will allow for evaluation of variability between years. Completing this evaluation is extremely important considering that 2015 and 2016 results appear unusual given the unusual climatic conditions (i.e. the prolonged summer drought in Southern BC, the warm water 'blob' observed off the coast of western North America, El Nino conditions in 2015-16, massive juvenile rockfish abundance in 2016 and 2017, La Nina conditions in 2017). The additional samples will also increase the sample sizes within stocks. The higher sample sizes will allow for statistical evaluation of factors such as the biological differences in maturation or size at age between WCVI stocks and also, potentially, differences among natural and hatchery origin stocks.

In the meantime, the results from this project have already improved our assessment and management 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 detailed catch composition resulted in an increase in the WCVI terminal abundance which would not have been included under the previous methods. From 2015 to 2017, 18,500, 7,100 and 9,700 fish were added, respectively, to the terminal aggregate return.
- 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. A total of 9,230 otoliths were analysed for thermal marks to assess WCVI hatchery contributions in fisheries from 2015 to 2017.

- Collected samples in spawning populations to estimate the extent of hatchery straying among WCVI populations. Notably, about 9%, 3% and 9% of the spawners associated with Conuma River Hatchery spawned in other WCVI area systems in 2015, 2016 and 2017, respectively. For comparison, for Robertson River Hatchery we estimated stray rates of 1%, 3%, and 2% in 2015, 2016 and 2017, respectively, and for Nitinat River Hatchery we estimated stray rates of <1%, 0%, and 1% in 2015, 2016 and 2017, respectively.

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:

- Comparing results from all four years of the project (2015-2018), when available, to evaluate how consistent the observations are. Without doubt, the climate and ocean conditions observed in 2015 and to some extent, 2016, were anomalous. We may be able to relate higher than expected harvest and straying rate of WCVI chinook in terminal areas distributional and migratory changes associated with observed marine and freshwater environmental 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 has 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 (CSAS review July 2019).

- Evaluation of the genetic effects of hatchery straying among WCVI populations (Withler et al.).

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 significant 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, Pat Vek, Eamon Miyagi, Brenda Wright, Jeff Till, Diana McHugh, Erin Porszt.

Special thanks to Kris Hein for refinements to our databases to improve how we manage fishery samples, and Lee Kearey for data coordination with the labs.

Thanks to Kathy Fraser and her staff of the DFO MRP program. Thanks to the various labs that processed our samples including the PBS Age Lab, the PBS Genetics lab, 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 West Coast Fishing Guide Association, the Sport Fishing Institute of BC, and the many WCVI guides that provided samples and catch data.

Thanks to the many First Nations who came on board with sampling, especially the Kyuquot First Nation, who are supporting the Brooks / Mquqwim test fishery.

Thanks to the many external groups that work on WCVI escapement assessment and sampling.

Thanks to the Vancouver Island processing plants who facilitated the sampling of the commercial fishery catch.

Finally, thanks to our colleagues in ADFG who support the project and related analysis.

REFERENCES

Bernard, D. R. 2007. Proposed Application of GSI and Indicator Stock Data: Modification of Appendix C. A paper presented to the PSC GSI Workshop, 11-12 September, 2007 by Jim Packer.

Briscoe, R., S. Gilk-Baumer, D. Evenson, W. Templin, and D. Bernard. *In prep*. Feasibility of Estimating the 2011 Terminal Run Sizes for Chinook Salmon Driver Stocks Harvested in Southeast Alaska Troll and Sport Fisheries. Alaska Department of Fish and Game, Fishery Manuscript Series No. YY-XX, Anchorage.

Chinook Technical Committee (CTC). 2012 Exploitation Rate Analysis and Model Calibration. TCChinook (12)-4. December 2012.

English, K, G.F. Searing and D.A. Nagtegaal. 2002. Review of the Strait of Georgia Recreational Creel Survey, 1983-1999. Canadian Technical Report of Fisheries and Aquatic Sciences 2414. 81p. http://www.dfo-mpo.gc.ca/Library/266177.pdf

Gilk-Baumer, S., W.D. Templin, and L.W. Seeb. *In review*. Genetic stock identification of Chinook salmon harvested in the Southeast Alaska Troll Fishery, 2004-2008. Alaska Department of Fish and Game, Fishery Data Series No. YY-XX, Anchorage.

Houtman, R., D.S. O'Brien, N. Komick, A.H. Rahme, and K. Hein. In Revision. The "iREC" survey, an internet- based survey of recreational fishing effort and catch in British Columbia tidal waters: methodology and preliminary results. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/XXX. ix + 124 p.

Korman, J., C. Parken, and M. Chamberlain, I. Winther, J. Candy, D. Gillespie D. 2012. Estimation of the Escapement of the South Thompson 0.3 Chinook Aggregate in 2010 and 2011 using a Bayesian Model that Combines Data on Coded Wire Tag Recoveries, Genetic Stock Identification, and Scale Age Identification in Distant Fisheries. Pacific Salmon Commission Sentinel Stocks Committee 600-1155 Robson Street, Vancouver, BC.

Korman, J., Parken, C., Chamberlain, M., Winther, I., Candy, J., and D. Gillespie. 2011. Estimating Basin-Wide Salmon Escapements for Chinook Salmon Returning to the West Coast of Vancouver Island and the South Thompson River using a Bayesian Model that Combines Data on Coded Wire Tag Recoveries, Genetic Stock Identification, and Scale Age Identification in Distant Fisheries.

Korman, J., Parken, C., Chamberlain, M., Winther, I., Candy, J., and Gillespie, D. 2010. Estimating Basin-Wide Salmon Escapements using a Bayesian Model that Combines Data on Coded Wire Tag Recoveries, Genetic Stock Identification, and Scale Age Identification in Distant Fisheries. Prepared for Pacific Salmon Commission, Sentinel Stocks Committee; 23pp.

O'Brien, D.S. and R. Houtman. In Revision. Creel survey calibration of the iREC survey estimates: an integrated monitoring plan. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/XXX. vii + 23 p.

Templin, W. D., J. M. Berger, and L. W. Seeb. 2011. Genetic stock identification of Chinook salmon harvested in the Southeast Alaska troll fishery, 1999–2003. Alaska Department of Fish and Game, Fishery Manuscript No. 11-03, Anchorage.

Withler, R.E., Bradford, M.J., Willis, D.M., and Holt, C. 2018. Genetically Based Targets for Enhanced Contributions to Canadian Pacific Chinook Salmon Populations. DFO Can. Sci. Advis. Sec. Res. Doc. 2018/019. xii + 88 p.

FIGURES

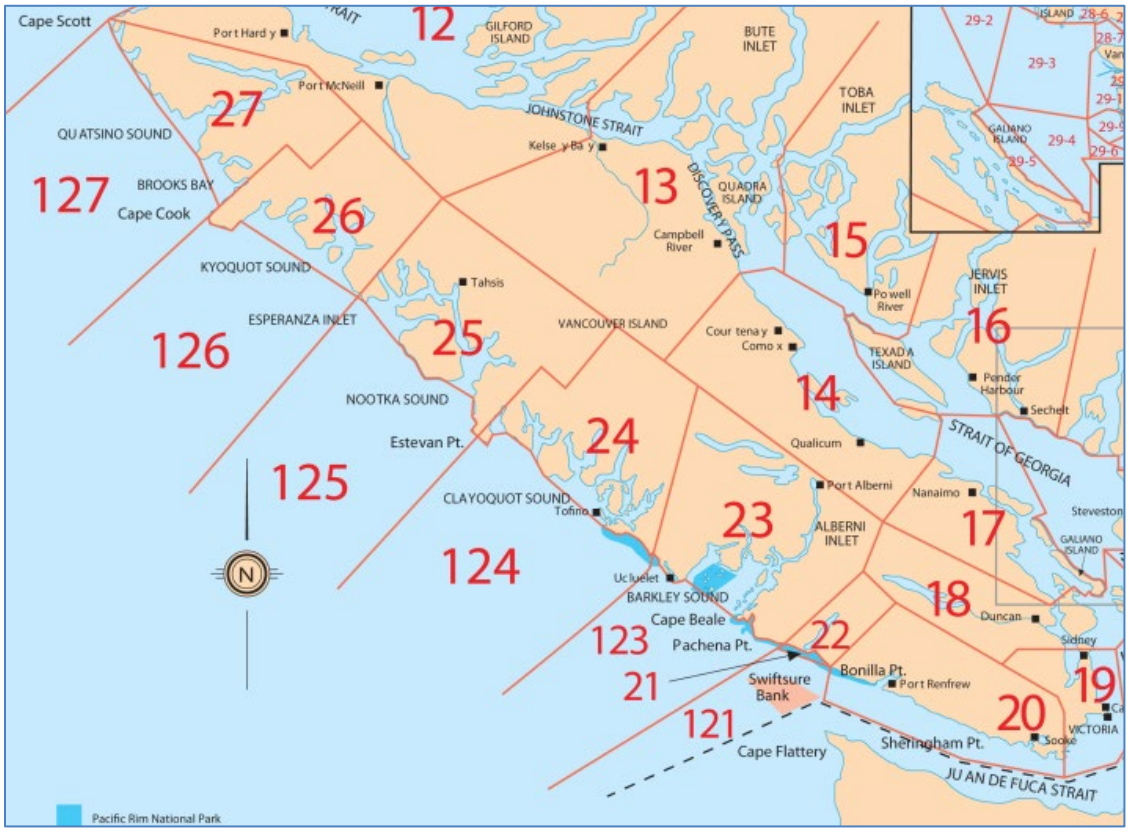


Figure 1. The terminal fishing area of West Coast Vancouver Island includes Pacific Management Fishing Areas (PFMAs) 20 to 27.

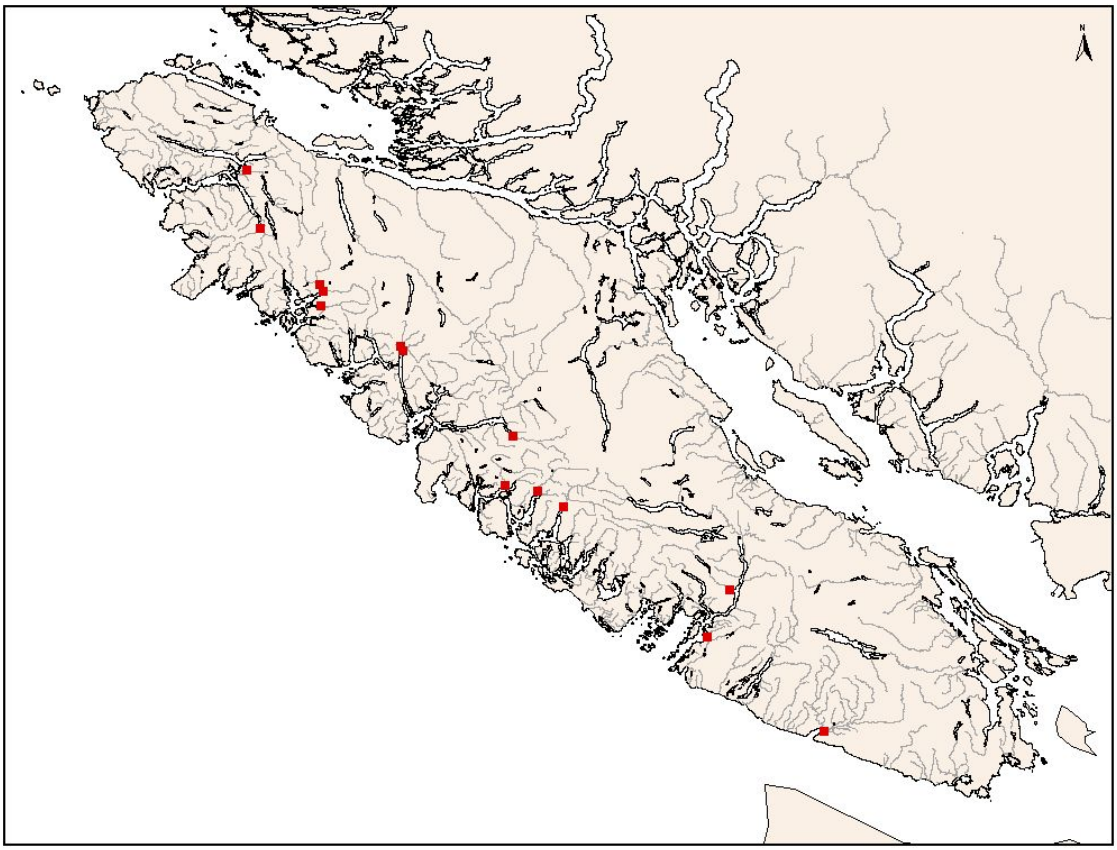


Figure 2. Location of WCVI Extensive Indicator Stocks.

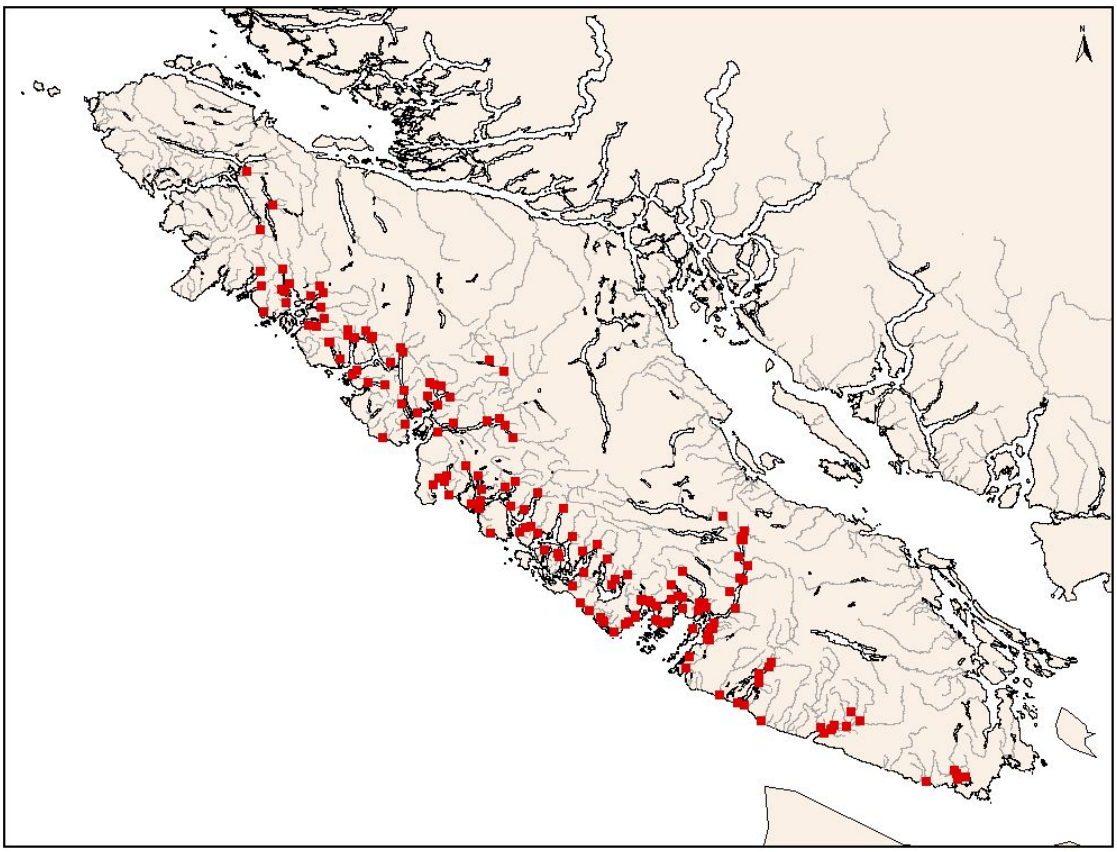


Figure 3. WCVI river systems that have spawner observations of chinook for at least one year during the period of record (1953-2012).

TABLES

Escapement

Table 1. Estimated escapement of chinook to WCVI index stocks in 2017.

		2017		
AREA	**STOCK**	**ESTIMATE**	**TYPE**	**12 Year Average**
21	SAN JUAN RIVER	1,422	PL+D	1,660
22	NITITAT AREA/HATCHERY	22,059	AUC	9,800
23	NAHMINT RIVER	208	AUC	300
23	SARITA RIVER	2,380	AUC	1,450
23	SOMASS RIVER/RCH HATCHERY	41,474	COUNT/RACK	33,100
23	TOQUART RIVER	191	PL+D	330
24	BEDWELL RIVER	796	AUC	300
24	CYPRE RIVER	219	PL+D	1,110
24	MEGIN RIVER	61	AUC	50
24	MOYEHA RIVER	136	PL+D	100
24	TRANQUIL RIVER	141	AUC	320
25	BURMAN RIVER	1,380	AUC	3,090
25	CONUMA R/HATCHERY	24,109	AUC	21,340
25	GOLD RIVER	1,764	PL+D	1,400
25	TAHSIS RIVER	635	AUC	310
25	LEINER RIVER	1,860	AUC	600
25	ZEBALLOS RIVER	500	PL+D	260
26	KAOUK RIVER	605	AUC	320
26	ARTLISH RIVER	274	AUC	260
26	TAHSISH RIVER	1,561	AUC	460
27	MARBLE RIVER	5,638	AUC	2,900
27	COLONIAL CREEK	793	AUC	340
	WCVI TOTAL	108,206		79,800

Catch

Table 2. Estimated 2017 catch of chinook in terminal area WCVI recreational fisheries.

2017 Terminal Area Catch	Month				Total	Average 2012-2016
	6	7	8	9		
Area 20 Renfrew	240	1819	6758	1408	10,225	7,060
Area 21/22 Nitinat	181	250	195		626	880
Area 23 - Barkley	2,477	1,268	13,599	4,340	21,683	15,510
Area 24 - Clayoquot	807	813	453	226	2,299	1,580
Area 25 - Nootka/Esperanza	1,802	7,161	7,706	208	16,877	13,870
Area 26 - Kyuquot	384	2,043	488	490	3,404	740
Area 27 - Quatsino	432	1,762	811	508	3,513	2,400
Total	6,323	15,115	30,010	7,179	58,627	42,040

Table 3. Estimated catch of chinook in 2017 terminal area WCVI commercial net fisheries.

Area 25 - Nootka/Esperanza	Tlupana	Week 81	Gillnet	6,986
Area 25 - Nootka/Esperanza	Tlupana	Week 82	Gillnet	948
Area 25 - Nootka/Esperanza	Tlupana	Week 83	Gillnet	4,245
Area 25 - Nootka/Esperanza	Tlupana	Week 84	Gillnet	1,049
Area 25 - Nootka/Esperanza	Tlupana	Week 91	Gillnet	5,517
Area 25 - Nootka/Esperanza	Tlupana	Week 92	Gillnet	408
Area 25 Total				19,153
Area 23 - Barkley	Alberni Inlet	Week 83	Gillnet	2,504
Area 23 - Barkley	Alberni Inlet	Week 84	Gillnet	2,491
Area 23 - Barkley	Alberni Inlet	Week 91	Gillnet	2,243
Area 23 - Barkley	Alberni Inlet	Week 91	Seine	2,322
Area 23 - Barkley	Alberni Inlet	Week 92	Seine	283
Area 23 - Barkley	Alberni Inlet	Week 93	Seine	29
Area 23 Total				9,872
2017 Total				**29,025**

Table 4. Estimated catch of chinook in 2017 First Nation Treaty, FSC (food, social, ceremonial) and Commercial (Economic Opportunity and Demonstration) fisheries.

		2017		
Terminal Area	**Sub-Area**	**Opening**	**Gear**	**Catch**
Area 21 - San Juan	San Juan R.	FSC	Mixed	236
Area 22 - Nitinat	Nitinat L.	FSC	Gillnet	341
Area 22 - Nitinat	Nitinat L.	ESSR	Seine	1,036
Area 23 - Barkley	Barkley S.	Treaty	Mixed	1,223
Area 23 - Barkley	Alberni Inlet	FSC	Mixed	2,076
Area 23 - Barkley	Alberni Inlet	EO	Gillnet	11,560
Area 23 - Barkley	Robertson Hatchery	ESSR	Gillnet	29,554
Area 23 - Barkley	Thornton Ck.	ESSR	Net	240
Area 24 - Clayoquot Sound		FSC	Mixed	345
Area 25 - Nootka/Esperanza		FSC	Mixed	518
Area 25 - Nootka/Esperanza	Friendly Cove	Demo	Rod	7
Area 25 - Nootka/Esperanza	Burman R.	Demo	Mixed	1,591
Area 25 - Nootka/Esperanza	Conuma River	ESSR	Gillnet	10,185
Area 26 - Kyuquot				-
Area 27 - Quatsino				-
Total				58,912
			Total FSC/Treaty	4,739
			Total EO/Demo	13,158
			Total ESSR	41,015

Sampling Results

WCVI Escapement

Table 5. Age composition of samples collected from WCVI chinook spawning populations in 2017, including samples collected at WCVI Major Hatcheries.

Terminal Area	Population	*n*	Age				
			2	**3**	**4**	**5**	**6**
Area 20 - Juan de Fuca	San Juan River	*98*	0%	27%	56%	16%	1%
	Sooke River	*104*	2%	43%	49%	6%	0%
Area 22 - Nitinat	Nitinat R (HATCHERY)	*815*	1%	18%	68%	13%	0%
Area 23 - Barkley	Effingham River	*4*	0%	50%	50%	0%	0%
	Nahmint R	*94*	13%	15%	57%	15%	0%
	Robertson Cr (HATCHERY)	*1,943*	10%	34%	42%	14%	0%
	Sarita R	*326*	2%	10%	50%	37%	1%
	Sproat River	*24*	13%	8%	58%	21%	0%
Area 24 - Clayoquot	Systems Combined	*50*	4%	12%	70%	14%	0%
	Bedwell River	*5*					
	Cypre River	*5*					
	Megin River	*2*					
	Moheya River	*7*					
	Tranquil Creek	*30*					
	Warn Bay Creek	*1*					
Area 25 - Nootka/Esperanza	Burman River	*198*	0%	6%	70%	24%	0%
	Tahsis R	*379*	0%	5%	86%	8%	0%
	Leiner R	*167*	0%	7%	84%	10%	0%
	Gold R	*92*	0%	9%	67%	24%	0%
	Conuma R (HATCHERY)	*74*	13%	18%	60%	8%	0%
Area 26 - Kyuquot	Tahsish River	*48*	6%	19%	71%	4%	0%
Area 27 - Quatsino	Marble River	*259*	0%	1%	67%	31%	0%
	Total Samples	**4,675**	**4%**	**18%**	**63%**	**15%**	**0%**
	Total not incl. Hatcheries:	**1,739**	**3%**	**14%**	**66%**	**17%**	**0%**

Table 6. Adult sex composition of samples collected from WCVI chinook spawning populations in 2017, including samples collected at WCVI Major Hatcheries.

Terminal Area	Population	*n*	Sex	
			Female	Male
Area 20 - Juan de Fuca	San Juan River	*102*	47%	53%
	Sooke River	*112*	48%	52%
Area 22 - Nitinat	Nitinat R (HATCHERY)	*937*	47%	44%
Area 23 - Barkley	Effingham River	*7*	57%	43%
	Nahmint R	*96*	45%	55%
	Robertson Cr (HATCHERY)	*4,703*	37%	46%
	Sarita R	*350*	52%	47%
	Sproat River	*25*	40%	60%
Area 24 - Clayoquot	Bedwell River	*49*	47%	53%
	Cypre River	*6*	83%	17%
	Megin River	*3*	33%	67%
	Moheya River	*7*	43%	57%
	Tranquil Creek	*47*	51%	49%
	Warn Bay Creek	*4*	0%	100%
Area 25 - Nootka/Esperanza	Burman River	*206*	48%	51%
	Tahsis R	*79*	44%	56%
	Leiner R	*102*	49%	51%
	Gold R	*170*	47%	53%
	Conuma R (HATCHERY)	*390*	44%	44%
Area 26 - Kyuquot	Kaouk River	*1*	0%	100%
	Tahsish River	*65*	46%	54%
Area 27 - Quatsino	Marble River	*259*	72%	28%
	Total Samples	***7,720***	**45%**	**54%**
	Total not incl. Hatcheries:	***1,578***	**45%**	**55%**

Table 7. Average, minimum and maximum length of samples collected from WCVI chinook spawning populations in 2017, including samples collected at WCVI Major Hatcheries.

Terminal Area	Population	*n*	Average Length (FL, mm)	Minimum Length (FL, mm)	Maximum Length (FL, mm)
Area 20 - Juan de Fuca	San Juan River	*102*	824	630	1020
	Sooke River	*122*	761	480	940
Area 22 - Nitinat	Nitinat R (HATCHERY)	*854*	803	508	1004
Area 23 - Barkley	Effingham River	*7*	794	715	840
	Nahmint R	*96*	788	395	1019
	Robertson Cr (HATCHERY)	*3902*	789	500	1050
	Sarita R	*346*	826	503	1010
	Sproat River	*25*	778	385	965
Area 24 - Clayoquot	Bedwell River	*9*	817	700	880
	Cypre River	*6*	835	740	940
	Megin River	*3*	805	725	860
	Moheya River	*7*	797	480	990
	Tranquil Creek	*47*	831	538	1010
	Warn Bay Creek	*4*	658	500	870
Area 25 - Nootka/Esperanza	Burman River	*205*	846	653	1023
	Tahsis R	*79*	839	703	1010
	Leiner R	*102*	837	684	985
	Gold R	*170*	868	678	1060
	Conuma R (HATCHERY)	*320*	820	633	984
Area 26 - Kyuquot	Kaouk River	*1*	950	950	950
	Tahsish River	*65*	790	470	1040
Area 27 - Quatsino	Marble River	*259*	881	616	1084
	Total/Avg	***6,731***	**815**	**599**	**979**
	Total not incl. Hatcheries:	***1,533***	**820**	**615**	**975**

Table 8. Average fork-length (mm) by age from samples collected from WCVI spawning populations in 2017, including samples collected at WCVI Major Hatcheries.

Terminal Area	Population	*n*	Age				
			2	**3**	**4**	**5**	**6**
Area 20 - Juan de Fuca	San Juan River	*98*		746	841	876	1000
	Sooke River	*104*	670	684	805	867	
Area 22 - Nitinat	Nitinat R (HATCHERY)	*815*	523	704	819	867	
Area 23 - Barkley	Effingham River	*4*		743	823		
	Nahmint R	*94*	490	701	837	925	
	Robertson Cr (HATCHERY)	*1,732*		734	833	880	910
	Sarita R	*322*	560	705	815	889	891
	Sproat River	*24*	436	705	831	876	
Area 24 - Clayoquot	Systems Combined	*45*	548	768	834	896	
	Bedwell River	*0*					
	Cypre River	*5*					
	Megin River	*2*					
	Moheya River	*7*					
	Tranquil Creek	*30*					
	Warn Bay Creek	*1*					
Area 25 - Nootka/Esperanza	Burman R	*197*		744	830	916	
	Tahsis R	*74*		744	838	884	
	Leiner R	*92*		721	840	905	
	Gold R	*167*		762	858	935	
	Conuma R (HATCHERY)	*310*		727	841	893	
Area 26 - Kyuquot	Tahsish River	*48*	480	693	830	885	
Area 27 - Quatsino	Marble River	*259*		876	863	921	966
	Total/Avg	***4,430***	**529**	**735**	**834**	**894**	**942**
	Total/Avg. not incl. Hatcheries:	***1,469***	**503**	**742**	**837**	**901**	**952**

Table 9. Stock origin (natural or hatchery) as estimated from otolith samples collected from WCVI spawning populations in 2017, including samples collected at WCVI Major Hatcheries.

Terminal Area	Population	*n*	Stock Origin	
			Natural	Hatchery
Area 20 - Juan de Fuca	San Juan River	*102*	39%	61%
	Sooke River	*141*	26%	74%
Area 22 - Nitinat	Nitinat R (Hatchery)	*855*	18%	82%
Area 23 - Barkley	Nahmint R	*96*	57%	43%
	Robertson Cr (Hatchery)	*3,903*	65%	35%
	Sarita R	*346*	20%	80%
	Sproat River	*25*	100%	0%
Area 24 - Clayoquot	Bedwell River	*19*	37%	63%
	Cypre River	*6*	100%	0%
	Moheya River	*7*	86%	14%
	Tranquil Creek	*27*	96%	4%
	Warn Bay Creek	*4*	50%	50%
Area 25 - Nootka/Esperanz	Burman R	*205*	26%	74%
	Tahsis R	*79*	44%	56%
	Leiner R	*102*	28%	72%
	Gold R	*170*	28%	72%
	Conuma R (Hatchery)	*340*	4%	96%
Area 26 - Kyuquot	Kaouk River	*1*	100%	0%
	Tahsish River	*65*	100%	0%
Area 27 - Quatsino	Marble River	*Data not available*		
	Total/Avg	***6,493***	**54%**	**46%**
	Total not incl. Hatcheries:	***1,254***	**61%**	**39%**

Table 10. Origin of thermally marked otoliths collected from WCVI spawning populations in 2017.

Terminal Area	Population	n	Stock Origin							
			Natural	Conuma	Robertson	Nitinat	San Juan	Area 25 Other *	Nahmint	Sarita
Area 20 - Juan de Fuca	San Juan River	*98*	39%	0%	0%	0%	61%	0%	0%	0%
	Sooke River **	*141*	26%	0%	0%	74%	0%	0%	0%	0%
Area 22 - Nitinat	Nitinat R	*691*	0%	0%	1%	97%	0%	0%	0%	2%
Area 23 - Barkley	Effingham River	*7*	100%	0%	0%	0%	0%	0%	0%	0%
	Nahmint R	*39*	0%	5%	3%	0%	0%	0%	90%	3%
	Robertson Cr	*564*	8%	0%	91%	0%	0%	0%	0%	0%
	Sarita R	*286*	0%	0%	0%	1%	0%	0%	0%	98%
	Sproat River	*20*	80%	0%	15%	0%	0%	5%	0%	0%
Area 24 - Clayoquot	Bedwell River	*11*	91%	0%	0%	0%	0%	9%	0%	0%
	Cypre River	*6*	100%	0%	0%	0%	0%	0%	0%	0%
	Megin River	*2*	50%	50%	0%	0%	0%	0%	0%	0%
	Moheya River	*2*	100%	0%	0%	0%	0%	0%	0%	0%
	Tranquil Creek	*43*	100%	0%	0%	0%	0%	0%	0%	0%
	Warn Bay Creek	*2*	100%	0%	0%	0%	0%	0%	0%	0%
Area 25 - Nootka/Esperanza	Burman R	*150*	0%	12%	2%	0%	0%	86%	0%	0%
	Tahsis R	*45*	0%	20%	2%	2%	0%	73%	0%	2%
	Leiner R	*73*	0%	49%	0%	0%	0%	51%	0%	0%
	Gold R	*120*	0%	1%	60%	0%	0%	38%	0%	1%
	Conuma R	*327*	0%	98%	1%	0%	0%	1%	0%	0%
Area 26 - Kyuquot	Kaouk River	*1*	100%	0%	0%	0%	0%	0%	0%	0%
	Tahsish River	*65*	29%	68%	0%	0%	0%	3%	0%	0%
Area 27 - Quatsino	Marble River ***	*260*	Data not available							
	Total/Avg	***2953***	**44%**	**14%**	**8%**	**8%**	**3%**	**13%**	**4%**	**5%**

* Sucwoa, Burman, Gold, Leiner, Tahsis

** Sooke River is enhanced with Nitinat River stock.

*** Marble River otoliths were not processed.

WCVI Terminal Area Recreational Fisheries

Table 11. Total number of biological samples collected from terminal area WCVI recreational fisheries in 2017 (by area and month). This table does not include additional samples collected from 1-5 nm offshore.

Terminal Area	Month					
	May	June	July	August	September	Total
Area 20/21 - Renfrew		35	134	267	53	489
Area 23 - Barkley	4	72	99	624	177	976
Area 24 - Clayoquot		90	142	106	1	339
Area 25 - Nootka/Esperanza	6	140	799	541	4	1490
Area 26 - Kyuquot		37	315	515		867
Area 27 - Quatsino	7	154	320	141	1	623
Total	**17**	**528**	**1809**	**2194**	**236**	**4784**

Table 12. The total number of 'complete' biological samples collected for terminal area WCVI recreational fisheries in 2017 (i.e. specimens for which there are stock identification + age composition data). This table does not include additional samples collected from 1-5 nm offshore.

Terminal Area	Month					
	May	June	July	August	September	Total
Area 20/21 - Renfrew		31	80	162	44	317
Area 23 - Barkley		8	34	489	135	666
Area 24 - Clayoquot		50	99	75	1	225
Area 25 - Nootka/Esperanza		56	636	486		1178
Area 26 - Kyuquot		7	25	38		70
Area 27 - Quatsino		122	283	123		528
Total		**274**	**1157**	**1373**	**180**	**2984**

Table 13. Age composition of samples collected in terminal area WCVI recreational fisheries in 2017 (by area and month).

Terminal Area	Month	*n*	Age				
			2	**3**	**4**	**5**	**6**
Area 20/21 - Renfrew	July	*95*	0%	32%	57%	12%	0%
	August	*189*	0%	20%	68%	13%	0%
	September	*44*	0%	32%	59%	9%	0%
Area 23 - Barkley	July	*64*	2%	33%	45%	20%	0%
	August	*547*	1%	36%	42%	21%	0%
	September	*156*	3%	44%	43%	10%	0%
Area 24 - Clayoquot	July	*105*	8%	73%	14%	5%	0%
	August	*70*	0%	37%	51%	11%	0%
Area 25 - Nootka/Esperanza	July	*654*	0%	18%	63%	19%	0%
	August	*501*	2%	30%	59%	9%	0%
Area 26 - Kyuquot	July	*285*	0%	20%	66%	14%	0%
	August	*432*	0%	36%	51%	13%	0%
Area 27 - Quatsino	July	*278*	0%	32%	51%	16%	1%
	August	*126*	2%	44%	48%	6%	0%
	Total	**3546**					

Table 14. Average fork length (mm) by age of samples collected from terminal area WCVI recreational fisheries in 2017 (by area, month and age).

Terminal Area	Month	*n*	Age				
			2	**3**	**4**	**5**	**6**
Area 20/21 - Renfrew	July	*87*		720	812	883	
	August	*180*		722	788	864	
	September	*44*		739	780	865	
Area 23 - Barkley	July	*54*	1190	717	825	849	
	August	*427*	498	722	823	865	
	September	*114*	523	701	805	887	
Area 24 - Clayoquot	July	*102*	535	674	1396	778	
	August	*69*		743	815	891	
Area 25 - Nootka/Esperanza	July	*638*	475	689	803	858	
	August	*484*	553	706	801	874	
Area 26 - Kyuquot	July	*283*	680	699	793	835	
	August	*430*	484	698	781	845	
Area 27 - Quatsino	July	*270*		670	783	855	864
	August	*125*	497	654	780	873	
	Total	**3307**					

Table 15. Average sex ratio by age and area of samples collected from terminal area WCVI recreational fisheries in 2017.

Terminal Area	Age	*n*	Sex	
			Female	Male
Area 20/21 - Renfrew	3	*61*	28%	72%
	4	*155*	54%	46%
	5	*29*	66%	34%
	6	*1*	100%	0%
Renfrew Total		***246***	**62%**	**38%**
Area 23 - Barkley	2	*8*	13%	88%
	3	*212*	19%	81%
	4	*261*	64%	36%
	5	*119*	82%	18%
Barkley Total		***600***	**44%**	**56%**
Area 24 - Clayoquot	2	*2*	50%	50%
	3	*79*	37%	63%
	4	*60*	63%	37%
	5	*15*	80%	20%
Clayoquot Total		***156***	**58%**	**42%**
Area 25 - Nootka/Esperar	2	*8*	13%	88%
	3	*267*	24%	76%
	4	*677*	50%	50%
	5	*167*	74%	26%
Nootka/Esp. Total		***1119***	**40%**	**60%**
Area 26 - Kyuquot	3	*48*	19%	81%
	4	*81*	48%	52%
	5	*21*	81%	19%
Kyuquot Total		***150***	**49%**	**51%**
Area 27 - Quatsino	3	*20*	25%	75%
	4	*37*	51%	49%
	5	*7*	86%	14%
Quatsino Total		***64***	**54%**	**46%**
WCVI Total/Avg		***2335***	**51%**	**49%**

Table 16. Average sex ratio by age and month of samples collected from Area 23 terminal fisheries in 2017.

Month	Age	*n*	Sex	
			Female	Male
July	3	*11*	9%	91%
	4	*24*	67%	33%
	5	*10*	90%	10%
July Total		***45***	**55%**	**45%**
August	2	*4*	25%	75%
	3	*151*	19%	81%
	4	*175*	65%	35%
	5	*94*	80%	20%
August Total		***424***	**47%**	**53%**
September	2	*4*	0%	100%
	3	*42*	19%	81%
	4	*55*	58%	42%
	5	*13*	85%	15%
September Total		***114***	**40%**	**60%**
Area 23 Total		***583***	**48%**	**52%**

Table 17. Origin of samples collected from 2017 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).

Terminal Area	Month	*n*	Stock Origin				
			CON	RCH	NIT	OTHER WCVI	NON-WCVI
Area 20/21 - Renfrew	July	*134*	3%	7%	1%	7%	83%
	August	*267*	0%	21%	3%	5%	71%
	September	*53*	0%	43%	11%	9%	36%
Renfrew Total		***454***	**1%**	**24%**	**5%**	**7%**	**63%**
Area 23 - Barkley	July	*99*	4%	6%	0%	35%	54%
	August	*624*	1%	76%	8%	9%	6%
	September	*177*	0%	81%	7%	7%	5%
Barkley Total		***900***	**2%**	**54%**	**5%**	**17%**	**22%**
Area 24 - Clayoquot	July	*142*	0%	10%	0%	10%	81%
	August	*106*	3%	64%	18%	5%	10%
Clayoquot Total		***248***	**1%**	**37%**	**9%**	**8%**	**45%**
Area 25 - Nootka/Esperanza	July	*799*	68%	5%	1%	11%	15%
	August	*541*	65%	16%	3%	11%	6%
Nootka-Esperanza Total		***1340***	**67%**	**10%**	**2%**	**11%**	**10%**
Area 26 - Kyuquot	July	*315*	54%	11%	4%	11%	20%
	August	*515*	19%	33%	9%	21%	18%
Kyuquot Total		***830***	**37%**	**22%**	**6%**	**16%**	**19%**
Area 27 - Quatsino	July	*320*	25%	8%	2%	12%	52%
	August	*141*	12%	13%	4%	20%	51%
Quatsino Total		***461***	**19%**	**11%**	**3%**	**16%**	**52%**
WCVI Total		**4,233**	**21%**	**26%**	**5%**	**12%**	**35%**

Table 18. Origin of production (hatchery, natural) of samples collected in 2017 terminal area WCVI recreational fisheries (by area and month).

Terminal Area	Month	*n*	Production Type	
			Hatchery	Natural
Area 20/21 - Renfrew	July	*133*	39%	61%
	August	*267*	35%	65%
	September	*53*	62%	38%
Renfrew Total		***453***	**45%**	**55%**
Area 23 - Barkley	July	*97*	38%	62%
	August	*556*	54%	46%
	September	*170*	56%	44%
Barkley Total		***823***	**49%**	**51%**
Area 24 - Clayoquot	July	*139*	59%	41%
	August	*106*	56%	44%
Clayoquot Total		***245***	**57%**	**43%**
Area 25 - Nootka/Esperanza	July	*787*	47%	53%
	August	*539*	60%	40%
Nootka-Esperanza Total		***1326***	**53%**	**47%**
Area 26 - Kyuquot	July	*315*	12%	88%
	August	*515*	10%	90%
Kyuquot Total		***830***	**11%**	**89%**
Area 27 - Quatsino	July	*320*	52%	48%
	August	*141*	47%	53%
Quatsino Total		***461***	**49%**	**51%**
WCVI Total		***4138***	**44%**	**56%**

Table 19. Average fork length (mm) of samples collected in 2017 terminal area WCVI recreational fisheries by production type, area and month.

Terminal Area	Month	*n*	Average Fork Length (mm)	
			Hatchery	Natural
Area 20/21 - Renfrew	July	*133*	751	800
	August	*267*	764	798
	September	*53*	774	778
Renfrew Total		***453***	**763**	**792**
Area 23 - Barkley	July	*97*	770	810
	August	*556*	789	796
	September	*170*	756	766
Barkley Total		***823***	**772**	**791**
Area 24 - Clayoquot	July	*139*	653	870
	August	*106*	801	794
Clayoquot Total		***245***	**727**	**832**
Area 25 - Nootka/Esperanza	July	*787*	790	803
	August	*539*	775	774
Nootka-Esperanza Total		***1326***	**783**	**788**
Area 26 - Kyuquot	July	*315*	746	783
	August	*515*	737	762
Kyuquot Total		***830***	**741**	**773**
Area 27 - Quatsino	July	*320*	748	766
	August	*141*	690	757
Quatsino Total		***461***	**719**	**762**
WCVI Total		***4138***	**751**	**789**

Table 20. Age composition of samples collected in 2017 terminal area WCVI recreational fisheries by production type, area, and month.

Terminal Area	Month	*n*	Production Type	Average Fork Length (mm)				
				2	3	4	5	6
Area 20/21 - Renfrew	Jul	40	Hatchery	0%	48%	53%	0%	0%
		55	Natural	0%	20%	60%	20%	0%
	Aug	64	Hatchery	0%	39%	50%	11%	0%
		125	Natural	0%	10%	77%	14%	0%
	Sep	29	Hatchery	0%	38%	48%	14%	0%
		15	Natural	0%	20%	80%	0%	0%
Renfrew Total		***328***		**0%**	**29%**	**61%**	**10%**	**0%**
Area 23 - Barkley	Jul	23	Hatchery	4%	57%	30%	9%	0%
		40	Natural	0%	20%	55%	25%	0%
	Aug	290	Hatchery	1%	37%	42%	20%	0%
		191	Natural	2%	31%	43%	24%	0%
	Sep	94	Hatchery	2%	48%	41%	9%	0%
		56	Natural	5%	36%	45%	14%	0%
Barkley Total		***694***		**2%**	**38%**	**43%**	**17%**	**0%**
Area 24 - Clayoquot	Jul	64	Hatchery	11%	81%	6%	2%	0%
		40	Natural	3%	60%	28%	10%	0%
	Aug	52	Hatchery	0%	42%	48%	10%	0%
		18	Natural	0%	22%	61%	17%	0%
Clayoquot Total		***174***		**3%**	**51%**	**36%**	**9%**	**0%**
Area 25 - Nootka/Esperanza	Jul	333	Hatchery	1%	18%	65%	16%	0%
		311	Natural	0%	18%	60%	22%	0%
	Aug	312	Hatchery	2%	29%	60%	9%	0%
		189	Natural	1%	32%	56%	11%	0%
Nootka/Esperanza Total		***1145***		**1%**	**24%**	**60%**	**14%**	**0%**
Area 26 - Kyuquot	Jul	35	Hatchery	3%	46%	43%	9%	0%
		250	Natural	0%	16%	69%	15%	0%
	Aug	45	Hatchery	0%	58%	36%	7%	0%
		387	Natural	0%	34%	53%	13%	0%
Kyuquot Total		***717***		**1%**	**38%**	**50%**	**11%**	**0%**
Area 27 - Quatsino	Jul	142	Hatchery	0%	42%	44%	13%	1%
		136	Natural	0%	21%	60%	18%	1%
	Aug	64	Hatchery	5%	56%	38%	2%	0%
		62	Natural	0%	32%	58%	10%	0%
Quatsino Total		***404***		**1%**	**38%**	**50%**	**11%**	**1%**
WCVI Total		***3462***		**1%**	**37%**	**50%**	**12%**	**0%**

Table 21. Average fork length (mm) by age of hatchery and natural origin fish caught in 2017 terminal area WCVI recreational fisheries.

Terminal Area	Month	*n*	Production Type	Age				
				2	3	4	5	6
Area 20/21 - Renfrew	Jul	40	Hatchery		721	790		
		55	Natural		717	829	883	
	Aug	64	Hatchery		717	798	880	
		125	Natural		734	785	857	
	Sep	29	Hatchery		737	778	865	
		15	Natural		747	782		
Renfrew Total		***328***			**729**	**794**	**871**	
Area 23 - Barkley	Jul	23	Hatchery	1190	710	820	815	
		40	Natural		728	827	853	
	Aug	290	Hatchery	503	724	821	861	
		191	Natural	492	715	823	868	
	Sep	94	Hatchery	495	700	807	874	
		56	Natural	580	717	790	923	
Barkley Total		***694***		**652**	**716**	**814**	**866**	
Area 24 - Clayoquot	Jul	64	Hatchery	520	666	834	710	
		40	Natural	640	683	1601	795	
	Aug	52	Hatchery		753	819	899	
		18	Natural		690	808	878	
Clayoquot Total		***174***		**580**	**698**	**1015**	**821**	
Area 25 - Nootka/Esper	Jul	333	Hatchery	475	680	802	862	
		311	Natural		707	804	858	
	Aug	312	Hatchery	524	706	804	869	
		189	Natural	655	705	796	882	
Nootka/Esperanza Total		***1145***		**551**	**700**	**801**	**868**	
Area 26 - Kyuquot	Jul	35	Hatchery	680	699	790	784	
		250	Natural		700	794	839	
	Aug	45	Hatchery		685	795	789	
		387	Natural	484	701	780	848	
Kyuquot Total		***717***		**582**	**696**	**790**	**815**	
Area 27 - Quatsino	Jul	142	Hatchery		668	795	845	785
		136	Natural		674	773	861	904
	Aug	64	Hatchery	497	656	763	910	
		62	Natural		651	792	867	
Quatsino Total		***404***		**497**	**662**	**781**	**871**	**845**
WCVI Total		***3462***		**572**	**700**	**833**	**852**	**845**

WCVI Terminal Area Commercial Fisheries

Table 22. Age composition of samples collected in 2017 terminal area WCVI commercial fisheries (by area and opening).

Terminal Area	Sub-Area	Stat Week	*n*	Age		
				3	4	5
Area 23 - Barkley	Alberni Inlet	83	*100*	23%	47%	31%
		84	*65*	42%	43%	15%
		91	*45*	49%	44%	7%
	Alberni Total/Avg		***210***	**38%**	**45%**	**18%**
Area 25 - Nootka/Esperanza	Tlupana Inlet	81	*100*	16%	73%	11%
		82	*100*	22%	72%	6%
		83	*100*	23%	61%	16%
		84	*99*	16%	75%	9%
		91	*93*	9%	71%	20%
	Nootka Total/Avg		***492***	**17%**	**70%**	**13%**

Table 23. Stock composition of samples collected in 2017 terminal area WCVI commercial fisheries (by area and opening).

Terminal Area	Sub-Area	Stat Week	*n*	Stock Origin				
				Natural	Robertson	Conuma	Sucwoa	Burman
Area 23 - Barkley	Alberni Inlet	83	89	3%	97%	0%	0%	0%
		84	58	9%	91%	0%	0%	0%
		91	46	13%	87%	0%	0%	0%
	Alberni Total/Avg		***193***	**8%**	**92%**	**0%**	**0%**	**0%**
Area 25 - Nootka/Esperanza	Tlupana Inlet	81	49	2%	18%	78%	2%	0%
		82	100	0%	1%	99%	0%	0%
		83	100	0%	6%	88%	3%	3%
		84	99	0%	1%	97%	2%	0%
		91	93	0%	0%	99%	1%	0%
	Nootka Total/Avg		***441***	**0%**	**5%**	**92%**	**2%**	**1%**

Table 24. Average length of fish (FL) by age sampled in 2017 Area 23 commercial fisheries.

Terminal Area	Sub-Area	*n*	Age		
			3	4	5
Area 23 - Barkley	Alberni Inlet	*210*	665	731	789

Table 25. Average length of fish (POF) by age sampled in 2017 Area 25 commercial fisheries.

Terminal Area	Sub-Area	*n*	Age		
			3	4	5
Area 25 - Nootka/Esperanza	Tlupana Inlet	*492*	650	742	811

WCVI Mquqwin-Brooks Test Fishery

Table 26. Number of samples collected in the 2017 Mquqwin-Brooks Test Fishery by sample date and statistical week.

Stat Week	Date	*n*
72	7/10/2017	*45*
	7/11/2017	*45*
	7/12/2017	*46*
	7/13/2017	*30*
73	7/17/2017	*24*
	7/18/2017	*37*
	7/19/2017	*37*
	7/20/2017	*42*
	7/22/2017	*30*
74	7/23/2017	*22*
	7/27/2017	*97*
	7/28/2017	*47*
	7/29/2017	*13*
75	7/30/2017	*35*
	7/31/2017	*3*
81	8/6/2017	*47*
	8/7/2017	*34*
	8/8/2017	*21*
82	8/14/2017	*1*
	8/17/2017	*34*
	8/18/2017	*35*
	8/19/2017	*47*
83	8/22/2017	*37*
	8/23/2017	*55*
	8/24/2017	*42*
84	8/28/2017	*12*
	8/29/2017	*25*
Total		***943***

Table 27. Age composition of samples collected in the 2017 Mquqwin-Brooks Test Fishery by statistical week.

Stat Week	*n*	Age			
		3	**4**	**5**	**6**
72	*157*	44%	50%	6%	0%
73	*159*	46%	48%	6%	0%
74	*171*	43%	47%	9%	0%
75	*37*	68%	19%	14%	0%
81	*97*	67%	30%	2%	1%
82	*115*	51%	42%	7%	0%
83	*129*	37%	52%	10%	1%
84	*35*	63%	29%	9%	0%
Total	**900**	**52%**	**39%**	**8%**	**0%**

Table 28. Origin of production (hatchery, natural, unknown) of samples collected in the 2017 Mquqwin-Brooks Test Fishery by statistical week.

Stat Week	*n*	Production Type	
		Hatchery	**Natural**
72	*157*	54%	46%
73	*159*	58%	42%
74	*171*	55%	45%
75	*37*	84%	16%
81	*97*	68%	32%
82	*115*	47%	53%
83	*129*	40%	60%
84	*35*	49%	51%
Total	**900**	**57%**	**43%**

Table 29. Stock origin rollup of samples collected in the 2017 Mquqwin-Brooks Test Fishery by statistical week.

Stat Week	*n*	Stock Origin						
		Robertson	Conuma	Nitinat	Other WCVI	NON-WCVI	Unknown	Total WCVI
72	*166*	9%	22%	4%	10%	55%	0%	45%
73	*170*	14%	19%	1%	8%	56%	1%	43%
74	*179*	19%	18%	1%	11%	51%	0%	49%
75	*38*	21%	26%	0%	3%	50%	0%	50%
81	*102*	25%	18%	1%	7%	49%	0%	51%
82	*117*	26%	3%	3%	8%	59%	0%	41%
83	*134*	28%	1%	8%	12%	50%	0%	50%
84	*37*	27%	0%	3%	8%	62%	0%	38%
Total	***943***	21%	14%	3%	8%	54%	0%	46%

Table 30. Detailed stock origin of samples collected in the 2017 Mquqwin-Brooks Test Fishery by statistical week.

Stat Week	*n*	Stat Week							
		73	**74**	**75**	**81**	**82**	**83**	**84**	**Total**
ROBERTSON	*186*	14%	19%	21%	25%	26%	28%	27%	**20%**
CONUMA	*136*	19%	18%	26%	18%	3%	1%	0%	**14%**
NITINAT	*27*	1%	1%	0%	1%	3%	8%	3%	**3%**
MARBLE	*29*	2%	6%	3%	2%	3%	2%	5%	**3%**
KAOUK	*1*	0%	0%	0%	0%	0%	0%	0%	**0%**
MOYEHA	*1*	0%	0%	0%	0%	0%	0%	0%	**0%**
LEINER	*6*	1%	1%	0%	2%	0%	1%	0%	**1%**
GOLD	*17*	0%	1%	0%	1%	0%	5%	3%	**2%**
BURMAN	*9*	2%	1%	0%	0%	0%	0%	0%	**1%**
SUCWOA	*1*	0%	1%	0%	0%	0%	0%	0%	**0%**
TLUPANA	*1*	0%	1%	0%	0%	0%	0%	0%	**0%**
BEDWELL	*2*	0%	0%	0%	1%	1%	0%	0%	**0%**
THORNTON	*12*	2%	1%	0%	0%	4%	1%	0%	**1%**
NAHMINT	*2*	0%	0%	0%	1%	0%	1%	0%	**0%**
SARITA	*1*	0%	0%	0%	0%	0%	1%	0%	**0%**
SAN JUAN	*3*	0%	1%	0%	0%	0%	1%	0%	**0%**
NORTH/CENTRAL	*1*	0%	0%	3%	0%	0%	0%	0%	**0%**
GEORGIA STRAIT	*49*	8%	2%	0%	3%	9%	8%	0%	**5%**
FRASER	*115*	8%	14%	3%	8%	16%	17%	8%	**12%**
PUGET SOUND	*176*	21%	17%	37%	27%	16%	7%	27%	**19%**
COASTAL WA	*10*	1%	1%	0%	0%	0%	1%	5%	**1%**
COLUMBIA	*127*	16%	13%	3%	11%	16%	14%	19%	**13%**
OREGON/CA	*11*	3%	0%	5%	0%	1%	1%	3%	**1%**
SNAKE	*14*	1%	3%	0%	0%	0%	0%	0%	**1%**
UNKNOWN	*1*	1%	0%	0%	0%	0%	0%	0%	**0%**
US MASS MARK	*5*	0%	2%	0%	0%	0%	0%	0%	**1%**
	943								**100%**

WCVI Terminal Area Chinook Run Reconstruction 2017

Table 31. Terminal return of WCVI origin chinook to Area 20 (Port Renfrew).

Fishery/Location	Age					Total
	2	3	4	5	6	
FSC	-	14	55	19	-	87
First Nation EO	-	-	-	-	-	-
Recreational	-	479	2,128	779	-	3,386
Commercial GN	-	-	-	-	-	-
Commercial SN	-	-	-	-	-	-
Escapement	-	366	806	235	15	1,422
Total Terminal Return	**-**	**859**	**2,989**	**1,032**	**15**	**4,895**
Hatchery Origin	**-**	**632**	**2,116**	**687**	**15**	**3,449**

Table 32. Terminal return of WCVI origin chinook to Area 21/22 (Nitinat).

Fishery/Location	Age					Total
	2	3	4	5	6	
FSC	-	72	229	40	-	341
First Nation EO	-	219	695	122	-	1,036
Recreational	-	211	671	118	-	1,000
Commercial GN						-
Commercial SN						-
Total Escapement	510	3,828	12,153	2,133	-	18,623
Total Terminal Return	**510**	**4,330**	**13,748**	**2,412**	**-**	**21,000**
Hatchery Origin	**510**	**4,150**	**10,248**	**2,318**	**-**	**17,225**

Table 33. Terminal return of WCVI origin chinook to Area 23 (Barkley Sound, Alberni Inlet).

Fishery/Location	Age					Total
	2	3	4	5	6	
FSC/Treaty	-	1,485	1,339	476	-	3,299
First Nation Comm	-	4,276	5,150	2,135	-	11,560
Recreational	305	6,116	7,499	3,243	-	17,162
Commercial GN	-	2,647	3,174	1,237	-	7,059
Commercial SN	34	1,509	1,107	503	-	3,152
Escapement	9,355	18,836	19,198	6,617	29	54,035
Total Terminal Return	**9,693**	**34,868**	**37,467**	**14,211**	**29**	**96,268**
Hatchery Origin	**9,368**	**31,730**	**32,288**	**12,104**	**-**	**85,490**

Table 34. Terminal return of WCVI origin chinook to Area 24 (Clayoquot Sound).

Fishery/Location	Age					Total
	2	3	4	5	6	
FSC	2	13	96	-	-	111
First Nation Comm	-	-	-	-	-	-
Recreational	15	283	393	100	-	791
Commercial GN	-	-	-	-	-	-
Commercial SN	-	-	-	-	-	-
Escapement	60	180	932	180	-	1,353
Total Terminal Return	**78**	**476**	**1,421**	**281**	**-**	**2,255**
Hatchery Origin	**24**	**268**	**606**	**103**	**-**	**1,001**

Table 35. Terminal return of WCVI origin chinook to Area 25 (Nootka Sound, Esperanza Inlet).

Fishery/Location	Age					Total
	2	3	4	5	6	
FSC	-	81	313	64	-	458
First Nation EO	0	69	1,181	345	-	1,596
Recreational	163	2,798	8,869	1,874	-	13,705
Commercial GN	-	2,982	13,291	2,880	-	19,153
Commercial SN						-
Escapement	812	5,442	19,463	2,914	-	28,630
Total Terminal Return	**975**	**11,372**	**43,118**	**8,077**	**-**	**63,542**
Hatchery Origin	**921**	**10,068**	**37,362**	**6,403**	**-**	**54,754**

Table 36. Terminal return of WCVI origin chinook to Area 26 (Kyuquot Sound).

Fishery/Location	Age					Total
	2	3	4	5	6	
FSC	-	-	-	-	-	-
First Nation Comm	-	-	-	-	-	-
Recreational	-	416	1,560	324	-	2,300
Commercial GN	-	-	-	-	-	-
Commercial SN	-	-	-	-	-	-
Escapement	153	458	1,728	102	-	2,440
Total Terminal Return	**153**	**873**	**3,288**	**426**	**-**	**4,740**
Hatchery Origin	**69**	**457**	**1,874**	**215**	**-**	**2,615**

Table 37. 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	13	351	901	176	-	1,442
Commercial GN	-	-	-	-	-	-
Commercial SN	-	-	-	-	-	-
Escapement	24	512	4,826	1,988	25	7,374
Total Terminal Return	**37**	**863**	**5,727**	**2,164**	**25**	**8,816**
Hatchery Origin	**27**	**491**	**1,918**	**196**	**-**	**2,631**

Table 38. TOTAL terminal return of WCVI chinook to the WCVI terminal area.

	Return	Age					Total
		2	3	4	5	6	
WCVI	Total Terminal Return	11,445	53,642	107,757	28,603	68	201,516
	Hatchery Origin	10,919	47,795	86,412	22,025	15	167,166
	Natural Origin	526	5,847	21,345	6,579	54	34,350
	Hatchery Origin	7%	29%	52%	13%	0.0%	83%
	Natural Origin	2%	17%	62%	19%	0.2%	17%

Table 39. Comparison of current 2017 estimate of WCVI terminal chinook abundance (RR) with the initial 2017 estimate of WCVI terminal chinook abundance.

Estimate	Age					Total	Adult
	2	3	4	5	6		
2017 RR	11,445	53,642	107,757	28,603	68	201,516	190,071
2017 OLD	11,843	52,625	100,212	27,489	62	192,231	180,388
Difference	- 398	1,017	7,545	1,114	6	9,285	9,682
% Difference	-3%	2%	8%	4%	10%	4.8%	5.4%

Table 40. Location of terminal area WCVI natural origin catch.

Terminal Area	Age					Total	Adult
	2	3	4	5	6		
Area 20	-	-	110	28	-	138	138
Area 21/22	-	-	-	-	-	-	-
Area 23	21	581	663	288	-	1,553	1,532
Area 24	14	30	93	38	-	175	161
Area 25	0	13	77	13	-	103	103
Area 26	-	59	230	100	-	389	389
Area 27	-	29	122	20	-	171	171
Total	35	712	1,295	487	-	2,529	2,494

WCVI Hatchery Terminal Run Reconstruction (Major Facilities)

Table 41. Return of Conuma Hatchery origin chinook to the WCVI terminal area in 2017. 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	-	54	232	47	-	332
	First Nation Comm	0	0	149	1	-	150
	Recreational	107	1,862	7,219	1,370	-	10,558
	Commercial GN	-	2,668	12,797	2,753	-	18,218
	Commercial SN	-	-	-	-	-	-
	Escapement	812	4,946	15,034	2,026	-	22,817
	Total	**918**	**9,530**	**35,430**	**6,196**	**-**	**52,075**
Other WCVI Areas	Catch	17	447	1,723	292	-	2,478
	Escapement	75	269	1,441	173	-	1,958
	Total Terminal Return	**1,011**	**10,246**	**38,593**	**6,661**	**-**	**56,511**

Table 42. Return of Nitinat Hatchery chinook to the WCVI terminal area in 2017. 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	-	71	227	40	-	337
	First Nation EO	-	214	689	121	-	1,024
	Recreational	-	207	665	117	-	988
	Commercial GN	-	-	-	-	-	-
	Commercial SN	-	-	-	-	-	-
	Escapement	510	3,748	12,042	2,112	-	18,411
	Total	**510**	**4,240**	**13,622**	**2,389**	**-**	**20,760**
Other WCVI Areas	Catch	26	497	781	287		1,592
	Escapement	18	38	43	15	0	114
	Total Terminal Return	**554**	**4,775**	**14,446**	**2,691**	**0**	**22,465**

Table 43. Return of Somass/Robertson Creek Hatchery chinook to the WCVI terminal area in 2017. 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	-	1,438	1,273	442	-	3,153
	First Nation Comm	-	4,276	5,150	2,135	-	11,560
	Recreational	223	4,645	5,686	2,496	-	13,050
	Commercial GN	-	2,647	3,174	1,237	-	7,059
	Commercial SN	34	1,509	1,107	503	-	3,152
	Escapement	9,352	18,418	17,601	5,534	29	50,934
	Total	**9,609**	**32,932**	**33,991**	**12,347**	**29**	**88,908**
Other WCVI Areas	Catch	61	1,408	2,180	606	-	4,255
	Escapement	16	137	659	182	-	995
	Total Terminal Return	**9,686**	**34,478**	**36,830**	**13,135**	**29**	**94,157**

Table 44. Terminal return of CWT-associated Robertson Creek Hatchery fish to Area 23 in 2017 (Barkley Sound and Alberni Inlet).

Terminal Area	Fishery Location	Age					Total
		2	3	4	5	6	
Barkley, Alberni - Area 23	FSC/Treaty		160	475	423		1,057
	First Nation Comm	181	2,091	3,001	1,893		7,165
	Recreational		4,317	3,024	1,415		8,756
	Commercial GN		1,684	3,926	629		6,239
	Commercial SN						-
	Escapement	6,126	13,125	11,294	3,731	-	34,276
		6,307	**21,377**	**21,719**	**8,091**	**-**	**57,494**
Other WCVI Areas	Catch	159	841	681	589		2,270
	Escapement	-	-	-	-	-	-
	Total Terminal Return	**6,466**	**22,218**	**22,399**	**8,681**	**-**	**59,764**

Table 45. Terminal areas for which additional catch and escapement was associated with hatchery stocks based on mark recoveries in 2017. (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	-	-	-	28	-
		Nitinat	-	41	153	51	-
		RCH	-	328	1,274	332	-
	Area 21/22	Conuma	-	-	145	25	-
		Nitinat					
		RCH	-	10	15	3	-
	Area 23	Conuma	4	91	111	49	-
		Nitinat	21	266	358	139	-
		RCH					
	Area 24	Conuma	-	13	27	-	-
		Nitinat	0	27	37	10	-
		RCH	3	154	212	24	-
	Area 25	Conuma					
		Nitinat	1	38	68	24	-
		RCH	51	712	479	165	-
	Area 26	Conuma	-	170	974	127	-
		Nitinat	-	1	2	3	4
		RCH	-	80	108	32	-
	Area 27	Conuma	7	103	371	29	-
		Nitinat	-	-	25	-	-
		RCH	7	124	92	49	-
ESC	Area 20	Conuma	-	-	-	-	-
		Nitinat	-	-	-	-	-
		RCH	-	-	-	-	-
	Area 21/22	Conuma	-	-	-	-	-
		Nitinat	-	-	-	-	-
		RCH	6	43	137	24	-
	Area 23	Conuma	0	1	3	1	-
		Nitinat	18	37	39	14	0
		RCH	0	2	6	4	-
	Area 24	Conuma	-	-	-	-	-
		Nitinat	-	-	-	-	-
		RCH	-	-	-	-	-
	Area 25	Conuma	-	42	586	122	-
		Nitinat	-	0	4	0	-
		RCH	10	92	516	155	-
	Area 26	Conuma	75	226	852	50	-
		Nitinat	-	-	-	-	-
		RCH	-	-	-	-	-
	Area 27	Conuma	-	-	-	-	-
		Nitinat	-	-	-	-	-
		RCH	-	-	-	-	-

WCVI Terminal Area Harvest Rates

Table 46. 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	0.0%	3.2%	2.2%	1.5%	0.0%
	FN EO	Alberni Inlet	0.0%	12.4%	14.0%	16.4%	0.0%
	Treaty	Inner Barkley Sound	0.0%	0.6%	0.8%	1.2%	0.0%
	Commercial GN	Alberni Inlet	0.0%	7.7%	8.7%	9.5%	0.0%
	Commercial SN	Alberni Inlet	0.3%	4.4%	3.0%	3.9%	0.0%
23	Recreational	Outer Barkley Sound	0.4%	2.1%	2.4%	2.7%	0.0%
		Barkley Corridor	0.8%	3.2%	4.0%	4.5%	0.0%
		Inner Barkley Sound	0.8%	2.9%	3.7%	4.1%	0.0%
		Alberni Inlet	0.3%	5.3%	5.5%	7.8%	0.0%
		Total	2.3%	13.5%	15.5%	19.1%	0.0%
23	Total		**2.7%**	**41.9%**	**44.3%**	**51.5%**	**0.0%**
20 - 27		Other WCVI terminal areas	0.6%	4.1%	5.9%	4.6%	0.0%
Total			**3.3%**	**46.0%**	**50.2%**	**56.2%**	**0.0%**

Table 47. 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	2.0%	8.9%	10.9%	12.5%	0.0%
Other WCVI Areas	0.1%	0.6%	0.5%	0.6%	0.0%
Total	2.1%	9.5%	11.4%	13.2%	0.0%

Table 48. 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	0.0%	0.5%	0.6%	0.7%	-
	FN EO		0.0%	0.0%	0.4%	0.0%	-
25	Commercial GN	Tluplana Inlet	0.0%	26.2%	33.2%	41.5%	-
25	Recreational	Inner Nootka	10.3%	13.6%	13.6%	12.5%	-
		Outer Nootka	0.1%	1.2%	1.9%	3.9%	-
		Inner Esperanza	0.0%	1.1%	1.2%	1.4%	-
		Esperanza Corridor	0.2%	0.9%	0.8%	2.0%	-
		Tlupana (25D)	0.0%	1.5%	1.2%	0.9%	-
		Matchlee Bay	-	-	-	-	-
		Total	10.6%	18.3%	18.8%	20.7%	-
25	Total		**10.6%**	**45.0%**	**52.6%**	**62.9%**	-
20 - 27	Other WCVI terminal areas		1.1%	3.7%	4.2%	3.9%	-
Total			**11.7%**	**48.7%**	**56.8%**	**66.8%**	**0.0%**

Table 49. 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	0.3%	3.7%	4.6%	8.0%	-
Other WCVI Areas	0.7%	2.7%	3.5%	2.4%	-
Total	1.0%	6.4%	8.1%	10.3%	0.0%

WCVI Terminal Area Catch Stock Composition

Table 50. Stock composition of Area 20 (Port Renfrew) terminal area catch.

Stock	Age					Total	
	2	3	4	5	6		
SAN_JUAN_H	-	82	110	106	-	298	3%
NIT_H	-	41	153	51	-	244	2%
OTHER WCVI_H	-	328	1,317	461	-	2,106	20%
WCVI_NAT	-	41	603	180	-	824	8%
NON-WCVI_H	-	1,533	833	28	-	2,393	23%
NON-WCVI_NAT	-	489	3,612	494	-	4,594	44%
Total	-	2,514	6,628	1,319	-	10,461	

Table 51. Stock composition of Area 21/22 (Nitinat) terminal area catch.

Stock	Age					Total	
	2	3	4	5	6		
NIT_H	-	481	1,189	269	-	1,939	65%
NIT_NAT	-	10	391	8	-	410	14%
OTHER WCVI_H	-	52	290	51	-	393	13%
WCVI_NAT	-	-	-	-	-	-	0%
NON-WCVI_H	-	91	145	25	-	261	9%
NON-WCVI_NAT	-	-	-	-	-	-	0%
Total	-	635	2,015	354	-	3,003	

Table 52. Stock composition of Area 23 (Barkley Sound, Alberni Inlet) catch.

Stock	Age					Total	
	2	3	4	5	6		
RCH_H	199	12,725	14,278	5,920	-	33,123	71%
SOMASS_NAT	58	1,789	2,112	893	-	4,851	10%
OTHER WCVI_H	35	599	767	316	-	1,717	4%
WCVI_NAT	46	919	1,112	464	-	2,541	5%
NON-WCVI_H	25	1,385	1,248	504	-	3,163	7%
NON-WCVI_NAT	16	365	436	189	-	1,006	2%
Total	379	17,783	19,953	8,286		46,401	

Table 53. Stock composition of Area 24 (Clayoquot Sound) terminal area catch.

Stock	Age					Total	
	2	3	4	5	6		
LOCAL_H	-	-	-	-	-	-	0%
OTHER WCVI_H	3	208	289	42	-	542	22%
WCVI_NAT	14	88	199	58	-	360	15%
NON-WCVI_H	87	726	160	28	-	1,001	41%
NON-WCVI_NAT	-	244	187	84	-	514	21%
Total	105	1,266	835	212	-	2,418	

Table 54. Stock composition of Area 25 (Nootka-Esperanza) terminal area catch.

Stock	Age					Total	
	2	3	4	5	6		
CON_H	107	4,584	20,396	4,171	-	29,257	81.0%
OTHER_LOCAL_H	2	468	2,440	726	-	3,637	10.1%
OTHER WCVI_H	53	790	598	189	-	1,630	4.5%
WCVI_NAT	1	88	221	78	-	387	1.1%
NON-WCVI_H	8	424	84	26	-	541	1.5%
NON-WCVI_NAT	5	318	200	160	-	683	1.9%
Total	176	6,672	23,939	5,349	-	36,136	

Table 55. Stock composition of Area 26 (Kyuquot Sound) terminal area catch.

Stock	Age					Total	
	2	3	4	5	6		
OTHER WCVI_H	-	249	1,089	169	-	1,507	52%
WCVI_NAT	-	167	471	155	-	793	27%
NON-WCVI_H	-	183	114	31	-	329	11%
NON-WCVI_NAT	-	81	156	49	-	285	10%
Total	-	681	1,830	403	-	2,914	

Table 56. Stock composition of Area 27 (Quatsino Sound) terminal area catch.

Stock	Age					Total	
	2	3	4	5	6		
LOCAL_H	-	-	99	18	-	117	4%
OTHER WCVI_H	13	264	566	96	-	940	31%
WCVI_NAT	-	87	235	63	-	385	13%
NON-WCVI_H	7	490	161	41	5	704	23%
NON-WCVI_NAT	-	292	468	129	11	900	30%
Total	20	1,133	1,529	347	16	3,045	

Table 57. Overall stock composition of WCVI terminal area catch.

Stock	Age					Total
	2	3	4	5	6	
WCVI Hatchery	414	20,872	43,581	12,584	-	77,451
WCVI Natural	119	3,189	5,345	1,900	-	10,552
Non-WCVI Hatchery	127	4,833	2,744	682	5	8,392
Non-WCVI Natural	21	1,789	5,058	1,104	11	7,982
Total	680	30,683	56,727	16,270	16	104,377
WCVI Hatchery	61%	68%	77%	77%	0%	74.2%
WCVI Natural	17%	10%	9%	12%	0%	10.1%
Non-WCVI Hatchery	19%	16%	5%	4%	33%	8.0%
Non-WCVI Natural	3%	6%	9%	7%	67%	7.6%

Terminal fishery sample for the Distant Fishery Index

Table 58. 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	
6	21		ACSPT	Alberni Canal Sport
15	81	2	AI NET	Alberni Canal Net (Comm, EO, FSC)
10	16		BARK	Barkley Catch (Sport, FSC)
1	24	1	WSPT	Other terminal WCVI Sport
7	28	0	ESC River	Stamp River
839	651	0	ESC Hatchery	Rack, RCH

Sampling rate and uncertainty in sampling rate for each strata

#e:			N
0.23	40%	ACSPT	2,152
0.19	5%	AI NET	15,893
0.12	40%	BARK	13,180
0.20	40%	WSPT	19,406
0.03	5%	ESC River	22,206
1	5%	ESC Hatche	30,947

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

773	2579	208

Scale sample

Table 59. Input file for terminal otolith samples for distant fishery index calculations. WCVI area supplied data in green cells.

TERMINAL OTOLITH SAMPLES (all WCVI origin)

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

4	3

#Nestrata

13

#me				Description	
13	31	1		Area 20/21/22	SWVI REC + FSC
64	184	5		Area 23	Alberni/Barkley REC, Barkley FSC
1	6	1		Area 24	Clayoquot REC and FSC
109	413	42		Area 25	Area 25 REC and FSC
72	195	8		Area 26	Area 26/27 REC
27	108	4		Area 27	Area 26/27 REC
9	72			Area 23 NET, EO, FSC	Alberni Inlet Comm Net, EO, and Somass FSC
39	165	32		Area 25 NET	Tlupana Inlet Comm Net
59	184	31		CON ESC River/Hatchery	Conuma Hatchery and River
29	176	13		Burman R. ESC/Demo	Burman River ESC and First Nation Comm
153	465	51		NIT ESC River/Hatchery	Nitinat Hatchery and River
96	175	1		Stamp ESC River	Stamp River deadpitch
92	220	1		RBT ESC Hatchery	Rack, RCH
101	619	20		OTHER WCVI ESC	Seine, deadpitch sampling, index streams only
			4,087		

Sampling rate and uncertainty in sampling rate for each strat			Catch/ESC sampled	Total Samples	
#e:			*N*	*n*	
0.8%	10%	Area 20/21/22	8,687	*71*	8,687
2.2%	10%	Area 23	15,332	*344*	
2.4%	10%	Area 24	1,088	*26*	
9.1%	10%	Area 25	6,810	*619*	
35.8%	10%	Area 26	1,443	*517*	
9.3%	10%	Area 27	2,332	*218*	
0.6%	5%	Area 23 NET, EO, FSC	15,893	*96*	
7.1%	5%	Area 25 NET	3,451	*244*	
0.8%	15%	CON ESC River/Hatchery	37,074	290	
2.2%	15%	Burman R. ESC/Demo	9,765	218	
3.6%	15%	NIT ESC River/Hatchery	20,600	735	
1.5%	5%	Stamp ESC River	22,206	338	
1.1%	5%	RBT ESC Hatchery	30,947	326	
8.8%	30%	OTHER WCVI ESC	14,210	*1248*	

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

773	2579	208

Scale sample

Financial Summary

Table 60. Project expenditures by type (sample collection and sample analysis) and WCVI area (specific terminal area or all WCVI areas combined) for Year 3 (2017-2019) of the WCVI Terminal Chinook Run Reconstruction Project. Expenditures do not include the 10% hold back amount.

		Expenditure Source		
Area		**Analysis**	**Collection**	**Total**
21/121	O&M to Salary Transfer		$ 7,808.05	$ 7,808.05
23/123	Automobile Rental		$ 1,295.90	$ 1,295.90
	Boat Fuel		$ 247.67	$ 247.67
	O&M to Salary Transfer		$ 12,525.88	$ 12,525.88
24/124	O&M to Salary Transfer		$ 17,014.12	$ 17,014.12
25/125	Automobile Rental		$ 1,304.23	$ 1,304.23
	O&M to Salary Transfer		$ 25,788.73	$ 25,788.73
	Vehicle Fuel		$ 115.93	$ 115.93
26/126	Boat Fuel		$ 46.17	$ 46.17
	Services (i.e. contract labour, scientific, fees, informatics)		$ 20,778.20	$ 20,778.20
WCVI	Computer Software, Computer Parts	$ 355.93		$ 355.93
	Non-professional personal service contracts		$ 3,246.18	$ 3,246.18
	O&M to Salary Transfer		$ 19,177.64	$ 19,177.64
	Other Fuel		$ 21.00	$ 21.00
	Postage, Courier, Freight		$ 61.24	$ 61.24
	Services (i.e. contract labour, scientific, fees, informatics)	$ 67,548.80	$ 105.52	$ 67,654.32
	Travel		$ 20.00	$ 20.00
	Materials and Supplies	$ 34,477.26		$ 34,477.26
	Office Stationary and Supplies	166.81	198.33	365.14
	Training and Educational Services		350	350
Total		**$ 102,548.80**	**$ 110,104.80**	**$ 212,653.60**

Table 61. Project expenditures by type (sample collection and sample analysis) and WCVI area (specific terminal area or all WCVI areas combined), for the 10% hold back amount, for Year 3 (2017-2019) of the WCVI Terminal Chinook Run Reconstruction Project.

		Expenditure Source		
Area		**Analysis**	**Collection**	**Total**
WCVI	Non-professional personal service contracts	$ 5,700.00		$ 5,700.00
	Repair and Maintenance to Machinery Equipment and Vehicles	$ 20,000.00		$ 20,000.00
Total		**$ 25,700.00**	**$ -**	**$ 25,700.00**

APPENDIX 1.

Response letter summarizing additional information requested regarding discrepancies between CWT based and otolith based estimates of Robertson Creek Hatchery (RCH) contributions to fisheries and escapement from 2015 to 2017.

Fisheries and Oceans Canada | Pêches et Océans Canada

Original sent September 24, 2018
Updated March 12, 2019

To: Angus Mackay, Northern Fund Committee

Re: Terminal Abundance of WCVI Chinook Salmon 2018 and discrepancies between otolith and CWT based estimates of Robertson Creek Hatchery (RCH) contributions to fisheries and escapement.

This note is in response to the February 22, 2018 letter requesting additional info regarding discrepancies between CWT based and otolith based estimates of hatchery contributions in 2015 and 2016 (the request is excerpted below). This note has been updated as of March 2019 to include data collected during the 2017 return year.

> *… as a component of the 2017 report the proponent is requested to provide a specific explanation for the discrepancies observed (see 2016 annual report – page 20 (bottom)). For example, are these differences due to sample design, inadequate tagging rates, bias from CWT awareness factors, or some combination of these or other factors? The underlying interest is to ensure that the Robertson Creek run reconstructions are based on the best possible information and are producing reliable estimates. This is particularly important given the dependency of the PSC's CTC model on CWT data for this important "driver" stock of Chinook salmon.*

The tables (2015 tables 39 and 40, 2016 tables 44 and 45) and related to this request are attached and summarized in the following Table 1. These tables indicate that, in these 2 years, CWT significantly underestimated (by about 50%) the catch and escapement of RCH chinook (45% underestimate in 2016 and 57% underestimate in 2015). Catch along the WCVI was underestimated by 66% and 61% respectively for 2016 and 2015. Escapement of RCH chinook was underestimated by 34% and 55% in 2016 and 2015 respectively.

Table 1. Summary of RCH contributions to fisheries and escapement along the WCVI from 2015 to 2017.

	All Fisheries/locations			Catch Only			Escapement Only		
Year	**2015**	**2016**	**2017**	**2015**	**2016**	**2017**	**2015**	**2016**	**2017**
Total abundance based on otoliths/CWT/DNA	73,645	73,621	88,908	16,387	24,521	37,974	57,258	49,101	50,934
Total abundance based on expanded CWT only	33,558	41,368	57,494	7,804	8,228	23,217	25,754	33,140	34,276
Difference of CWT based minus Otolith based	-40,087	-32,253	-31,414	-8,583	-16,293	-14,757	-31,504	-15,961	-16,658
Percent difference relative to Otolith based	-54%	-44%	-35%	-52%	-66%	-39%	-55%	-33%	-33%

It is not clear at this time what the cause or origin of these differences between otolith based and CWT based estimates is. Some potential possibilities include:

Adult salmon stage

- Sample design
- Sampling biases during implementation
- Bias from CWT awareness factors
- Differential homing (straying) of CWT'ed and unmarked chinook

Juvenile salmon stage

- Inadequate tagging rates
- Errors in the estimation of releases of both CWT'ed and unmarked chinook
- Differential mortality or loss of CWT'ed vs unmarked chinook

At this time we don't have an answer but recognize it is a significant issue which we are investigating (e.g. stray rates for WCVI chinook are being assessed). But we are able to provide the following insights. First, the letter indicates an underlying intent of producing reliable numbers, to which we agree. Reliability can be described based on the level and consistency of sampling effort and consistency of results. To this end, 2 separate sample groups have operated in the same manner over many years, with relatively high sample rates, with the objective of estimating contribution to escapement of RCH into the Stamp River: 1) swim-ins into the hatchery, and 2) river spawners. About 100% of hatchery swim-ins are observed for adipose clips (and so CWT) and 400 randomly sampled for otoliths. In the river dead pitch the average sample rate has been 16% since 2000 ranging between 5-33%. The results are for the complete brood year returns from 1998 to 2013.

These two sampling groups have the same result, CWT underestimate RCH contribution by about 30%. For swim-ins the CWT underestimated the RCH contribution to the total abundance by on average 30.2% (n=16 years, 1 st dev= 12.9%, range 13%-63% difference). For the river deadpitch the CWT underestimated the RCH contribution to the total abundance by on average 32.3% (n=16 years, 1 st dev= 13.9%, range 5%-56% underestimate). The following graphs show the estimated return

abundance of RCH chinook from the two methods and the level of bias. Figure 1 includes the swim-in sample and Figure 2 the Stamp River deadpitch.

Figure 1a. Abundance of RCH chinook in the swim-in population for brood years 1998-2013. Over these years CWT estimate of hatchery contribution was on average 30% lower than otolith based estimates.

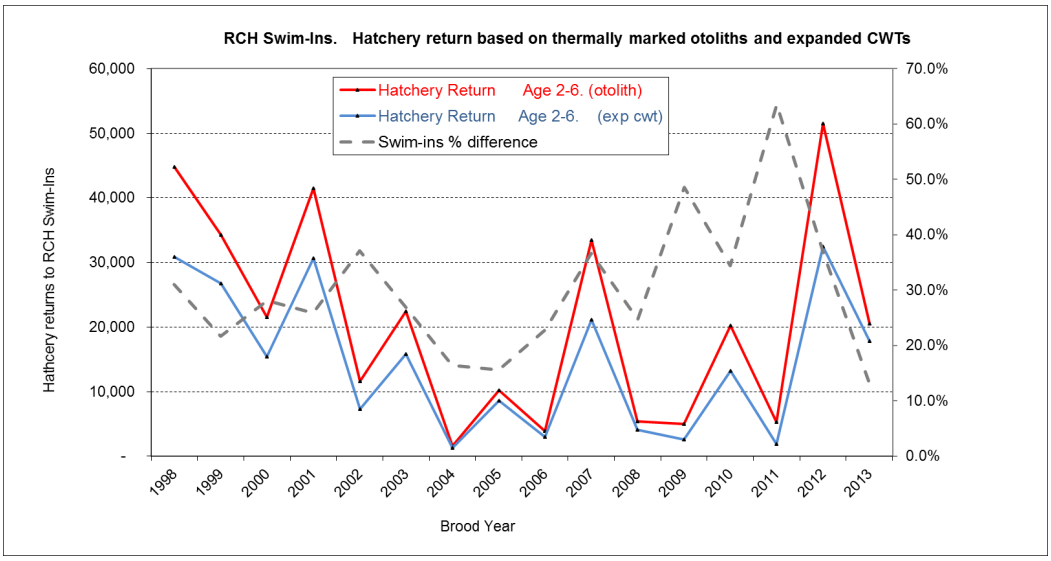


Figure 1b. Relationship between otolith and CWT based estimates of abundance of RCH chinook in the swim-in population for brood years 1998-2013.

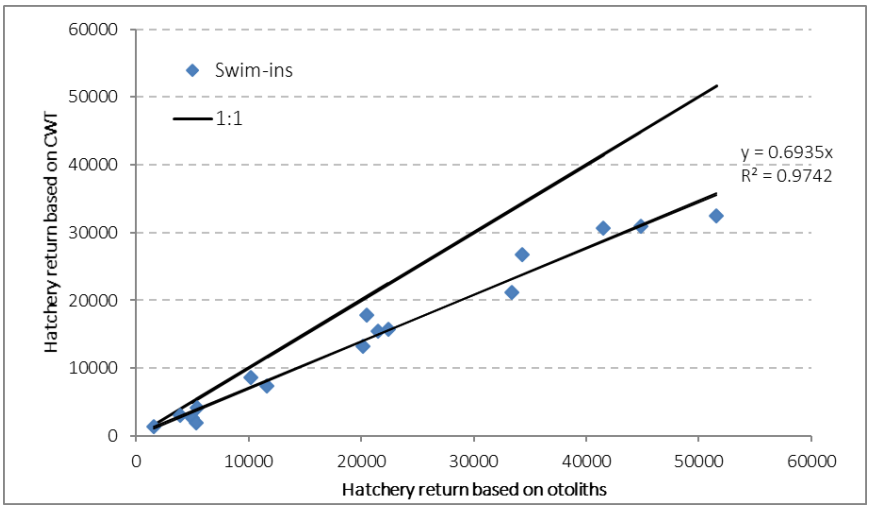


Figure 2a. Abundance of RCH chinook in the Stamp River for brood years 1998-2013 based on CWT and otolith. Over these years CWT estimate of hatchery contribution was on average 32% lower than otolith based estimates.

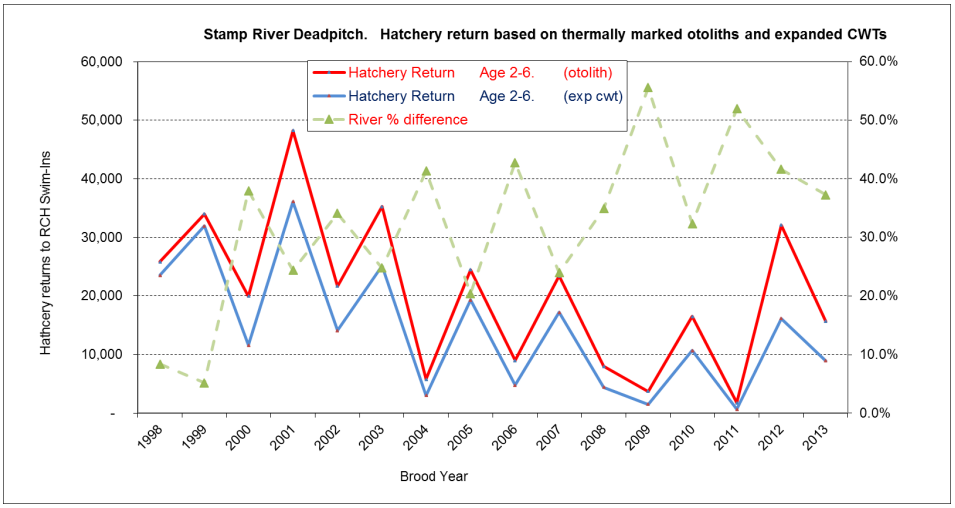
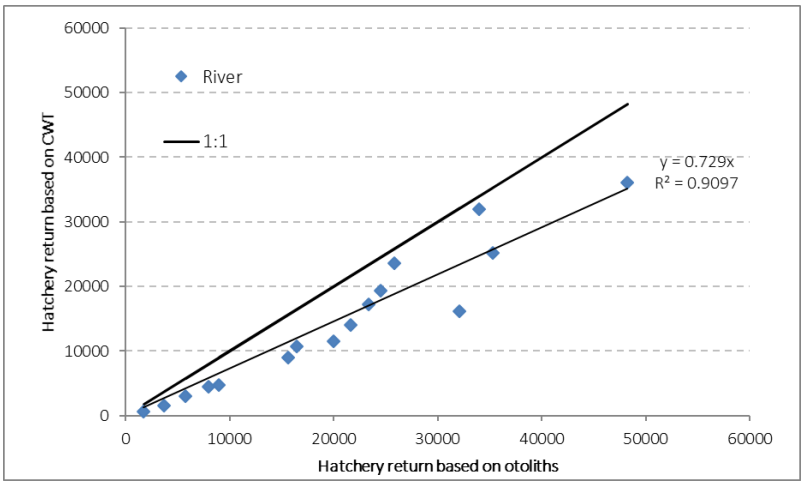


Figure 2b. Relationship between otolith and CWT based estimates of abundance of RCH chinook in the Stamp River dead pitch sample for brood years 1998-2013.



Due to lack of otolith sampling in ocean salmon fisheries outside this project we are not able to assess the extent of this bias in the fisheries. We expect there to be increased uncertainty in the fishery results due to factors such as lower sample rates and increased uncertainty in CWT expansion factors in the fishery. We do not expect higher bias in the fishery relative to the escapement samples. The limited data from 2015-2017 (Table 1) do show higher differences in the catch for one of the three years. In 2016 the difference in catch samples is higher (66%) compared to escapement samples (33%). The 2015

and 2017 years however suggest that differences in catch and escapements are similar (52% vs. 55% for 2015, and 35% vs 33% for 2017).

We do note that there appears to be a negative bias in CWT based estimates for other chinook indicator stocks, but the extent of the bias appears inconsistent between hatcheries. These results will be prepared for the straying report expected in early 2019.

The relative consistency in the bias suggests that the causal factors are likely working at the juvenile life stage. We are testing this hypothesis with Cowichan chinook. The Cowichan River hatchery began marking otoliths about 5 years ago and also CWT and Adipose Fin Clipping almost 100% of their production.

TABLES

2015 report Table 62. Return of Somass/Robertson Creek Hatchery chinook to the WCVI terminal area in 2015. 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**

2015 report Table 63. Terminal return of CWT-associated Robertson Creek Hatchery fish to Area 23 (Barkley Sound and Alberni Inlet) in 2015.

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**

2016 report Table 64. Return of Somass/Robertson Creek Hatchery chinook to the WCVI terminal area in 2016. 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	-	189	2,222	-	-	2,411
	First Nation Comm	231	3,403	8,250	-	-	11,885
	Recreational	626	2,445	5,645	201	-	8,917
	Commercial GN	55	489	764	-	-	1,307
	Commercial SN	-	-	-	-	-	-
	Escapement	6,528	17,751	24,665	157	-	49,101
	Total	**7,441**	**24,277**	**41,546**	**358**	**-**	**73,621**
Other WCVI Areas	Catch	106	735	1,932	179	0	2,952
	Escapement	0	298	959	34	0	1,291
	Total Terminal Return	**7,547**	**25,310**	**44,437**	**570**	**0**	**77,865**

2016 report Table 65. Terminal return of CWT-associated Robertson Creek Hatchery fish to Area 23 (Barkley Sound and Alberni Inlet) in 2016.

Terminal Area	Fishery Location	Age					Total
		2	3	4	5	6	
Barkley, Alberni - Area 23	FSC/Treaty						-
	First Nation Comm	107	668	3,660	136		4,471
	Recreational	13	985	2,571	-		3,333
	Commercial GN						-
	Commercial SN						-
	Escapement	4,355	13,098	15,687	-	-	33,140
		4,475	**14,750**	**21,918**	**136**	**-**	**40,944**
Other WCVI Areas	Catch	108	137	1,307	103		1,654
	Escapement						
	Total Terminal Return	**4,583**	**14,887**	**23,225**	**239**	**-**	**42,598**

2017 report Table 663. Return of Somass/Robertson Creek Hatchery chinook to the WCVI terminal area in 2017. 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	-	1,438	1,273	442	-	3,153
	First Nation Comm	-	4,276	5,150	2,135	-	11,560
	Recreational	223	4,645	5,686	2,496	-	13,050
	Commercial GN	-	2,647	3,174	1,237	-	7,059
	Commercial SN	34	1,509	1,107	503	-	3,152
	Escapement	9,352	18,418	17,601	5,534	29	50,934
	Total	**9,609**	**32,932**	**33,991**	**12,347**	**29**	**88,908**
Other WCVI Areas	Catch	61	1,408	2,180	606	-	4,255
	Escapement	16	137	659	182	-	995
	Total Terminal Return	**9,686**	**34,478**	**36,830**	**13,135**	**29**	**94,157**

2017 report Table 44. Terminal return of CWT-associated Robertson Creek Hatchery fish to Area 23 (Barkley Sound and Alberni Inlet) in 2017.

Terminal Area	Fishery Location	Age					Total
		2	3	4	5	6	
Barkley, Alberni - Area 23	FSC/Treaty		160	475	423		1,057
	First Nation Comm	181	2,091	3,001	1,893		7,165
	Recreational		4,317	3,024	1,415		8,756
	Commercial GN		1,684	3,926	629		6,239
	Commercial SN						-
	Escapement	6,126	13,125	11,294	3,731	-	34,276
		6,307	**21,377**	**21,719**	**8,091**	**-**	**57,494**
Other WCVI Areas	Catch	159	841	681	589		2,270
	Escapement	-	-	-	-	-	-
	Total Terminal Return	**6,466**	**22,218**	**22,399**	**8,681**	**-**	**59,764**