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# **THE CANADIAN SOCIETY OF ENVIRONMENTAL BIOLOGISTS Newsletter / Bulletin**

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# CSEB Newsletter Bulletin SCBE

VOLUME 70, ISSUE 1, 2013

CSEB Website <http://www.cseb-scbe.org>

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**Front Cover:** Environmental Technician Matt MacLean samples benthic invertebrates and intertidal snails on a mud flat, East River estuary, Trenton, Nova Scotia.

**Photo Credits:** Patrick Stewart, CSEB Regional Director.

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•Term of Directorship



## CSEB NEWSLETTER 2013

Vol. 70, Number 1 Spring 2013

The Canadian Society of Environmental Biologists Newsletter is a quarterly publication. The Newsletter keeps members informed of the Society's activities and updates members on the current affairs and advances in the field of environmental biology. This publication draws together the widely diverse group of Canadian environmental biologists through a national exchange of ideas. Members are invited to contribute papers, photos or announcements that are of a national biological and environmental interest. Letters to the editor are welcome. This is a volunteer non-profit organization and we rely on your participation to make the newsletter a productive forum for ideas and discussion.

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## LE BULLETIN de la SCBE 2013

Vol. 70, Numéro 1 Printemps 2013

Le Bulletin de la SCBE est une publication trimestriel de la Société Canadienne des Biologistes de l'Environnement. Le Bulletin informe les membres des activités de la Société sur événements courant ainsi que les progrès qui font en sciences de l'environnement. Par un échange d'idées au niveau national, cette publication intéresse un groupe très diversifié d'environnementalistes Canadien. Les membres sont invités à contribuer des articles, photos (noir et blanc) ou des messages qui sont d'intérêt nationale en sciences biologiques et environnementales. Les lettres à l'éditeur sont bienvenues.

**Tout la correspondance d'affaires, y compris les abonnements, les changements d'adresse, les exemplaires retournés et les formulaires:** CSEB National Office, P.O.Box 962, Station F, Toronto, ON, M4Y 2N9. **Les lettres à l'éditeur:** Gary Ash, Editor, courriel: [gash@golder.com](mailto:gash@golder.com)

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## The Canadian Society of Environmental Biologists



### CSEB OBJECTIVES

The Canadian Society of Environmental Biologists (CSEB) is a national non-profit organization. Its primary objectives are:

- to further the conservation of Canadian natural resources.
- to ensure the prudent management of these resources so as to minimize environmental effects.
- to maintain high professional standards in education, research and management related to natural resources and the environment.

### OBJECTIFS de la SOCIÉTÉ

La Société Canadienne des Biologistes de l'Environnement (SCBE) est une organisation nationale sans but lucratif. Ses objectifs premiers sont:

- de conserver les ressources naturelles canadiennes.
- d'assurer l'aménagement rationnel de ces ressources tout en minimisant les effets sur l'environnement.
- de maintenir des normes professionnels élevés en enseignement, recherche, et aménagement en relation avec la notion de durabilité des ressources naturelles et de l'environnement, et cela pour le bénéfice de la communauté.

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## NATIONAL News

### PRESIDENT'S Report

#### President's Report – Spring 2013

I watched an interesting documentary report last night on the erosion on the east coast of the United States due to higher ocean water levels and storm surges. In the report were heated exchanges between private homeowners and government officials as to what should be done. The homeowners of course thought “they” (the government) should be doing something to keep the ocean at bay! One woman was quoted as saying she can’t sleep at night because of her fear that her million dollar home would be consumed by the relentless ocean, and that “they” were being irresponsible for not doing something to prevent this event! Watching the scene unfold, one government official is quoted as saying, “well ma’am, what would you suggest you have us do?” While in the background, the pounding surf was slowly eating away at what remained of the beach of her oceanfront home.

It was almost comical, because no barrier yet created by man would survive the constant barrage of the ocean, regardless of the ingenuity of designers and civil engineers. This particular government representative seemed to accept the fact that rising ocean levels and more storm surges would be the norm, and was quite prepared to let nature take its course. I actually applauded his stand.

General awareness of climate change has been with us now for more than two decades since the Rio Summit (January 3-14, 1992) where 172 countries participated, with 108 heads of state in attendance; signifying the importance they attributed to environmental issues, including climate change. From this came Agenda 21, the Rio Declaration on Environment and Development, the Statement of Forest Principles, the United Nations Framework Convention on Climate Change and the United Nations Convention on Biological Diversity

“The Earth Summit in Rio de Janeiro was unprecedented for a UN conference, in terms of both its size and the scope of its concerns. Twenty years after the first global environment conference, the UN sought to help Governments rethink economic development and find ways to halt the destruction of irreplaceable natural resources and pollution of the planet. Hundreds of thousands of people from all walks of life were drawn into the Rio process. They persuaded their leaders to go to Rio and join other nations in making the difficult decisions needed to ensure a healthy planet for generations to come.”

The Summit’s message — that nothing less than a transformation of our attitudes and behavior would bring about the necessary changes — was transmitted by almost

10,000 on-site journalists and heard by millions around the world. The message reflected the complexity of the problems facing us: that poverty as well as excessive consumption by affluent populations place damaging stress on the environment. Governments recognized the need to redirect international and national plans and policies to ensure that all economic decisions fully took into account any environmental impact.

What have we learned in twenty years? We have learned that the “transformation of our attitudes and behavior” is still a long way off for some, and only when those individuals are smacked in the face with a real climatological change will they sit up and take notice.

I again applaud that U.S. government official for starting that process.

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## REGIONAL News

### ALBERTA News

Submitted by Joseph Hnatiuk, CSEB Regional Director

Since the last winter CSEB newsletter I have been involved in several activities that included various Provincial and National activities. Regarding the National activity I participated in a Pest Management Advisory Council (PMAC) meeting in Ottawa. The PMAC is intended to advise the Minister of Health Canada, Ms Leona Aglukkaq, on regulatory/legislation matters that deal with Pest Management and Pesticides. Some of the advisory topics included a new fee for cost recovery schedule for licensing of new pesticides, progress on International Regulatory Cooperation, upgrades for Information Management/Information Technology, Pollinator Protection, Incident Reporting and Information Updates. Details will be provided in a future CSEB newsletter when the approved minutes become available.

I attended on behalf of CSEB, an Ambient Air Quality Objectives Stakeholder Advisory Council (AAQO SAC) meeting hosted by Alberta Environment and Sustainable Resource Development (AE&SRD). Topics discussed included Provincial objectives that were recommended for arsenic. Other emission standards discussed included acroline and naphthalene. Health Canada presented their Chemical Management Plan as an information package. Details will be presented when the minutes are approved.

On behalf of CSEB, I attended a one day workshop on "Agricultural Ammonia Emissions and Policy Implications - Where are we Today and What Lies Beyond the Horizon". The workshop was sponsored by Alberta Agriculture and Rural Development (AA&RD). The workshop participants provided advice to AA&RD on ammonia issues and its impact on the environment/ecosystems. I also participated in a two day agriculture workshop hosted by Alberta, Saskatchewan and Manitoba that discussed the effects of manure on local environments and ecosystems. The session involved results of various research. More details will be forthcoming when a summary is available.

## SASKATCHEWAN News

Submitted by Robert Stedwill, CSEB Regional Director

On February 11, 2013 it was announced that the multi-material recycling program aimed at reducing landfill household waste by 40 per cent would be implemented under the Household Packaging and Paper Stewardship Program Regulations. The government is to be commended for its province-wide initiative.

Minister of Environment Cheveldayoff during the announcement indicated that "as Saskatchewan communities continue to grow, reducing the amount of waste going to local landfills will help us maintain the quality of life we enjoy in the province. It is estimated that more than 40 per cent of the household waste going to landfills today can be diverted into recycled products, improving our environment while creating new business and employment opportunities. That amount is equivalent to about 112,000 tonnes."

The Multi-material Recycling Programs (MMRP) will provide the framework to fund the collection and recycling of household materials including printed paper, newsprint, cardboard, plastic, metal and glass packaging in the province. With the regulations now in place, Multi-Material Stewardship Western Inc. (MMSW), representing industry, will work with municipalities and other stakeholders to develop the recycling program. MMSW is similar to those organizations that have been developed for waste paint, used oil, scrap tires and e-waste. Industry has the legal responsibility under the regulations to manage and fund the MMRP.

Within 180 days (on or before August 6, 2013) MMSW will present to the Minister of Environment for his approval a product management plan on how the recycling program will be structured, funded and managed. Once the product management plan has been approved, implementation of MMRP can proceed.

"As an advocate of environmentally-sound waste reduction programs, the Saskatchewan Waste Reduction Council (SWRC) applauds industry, municipalities and government

in the development of these regulations," SWRC Executive Director Joanne Fedyk said. "We look forward to the implementation of the multi-material recycling program for Saskatchewan."

The responsibility of managing and financing recycling programs for these materials is being transferred from the taxpayer to industry and consumers. Municipalities that currently collect recycling are covering 100 per cent of the cost. Once the MMRP is established, industry will contribute up to 75 per cent of the costs to deliver an effective and efficient program. Municipalities that choose to participate in MMRP will be responsible for the remainder of the cost to operate a recycling program in their community. Municipalities will also be able to decide the type of collection system for their community – curbside pickup or a central depot, depending on the size of their community and the associated costs.

The actual cost to industry will be determined in the plan; however, it is expected that the financial implications to industry will be minimal and most likely charged back to the consumer. For example, in other Canadian jurisdictions with similar recycling programs, the costs to newspapers range from less than one-quarter of a cent to one cent per paper produced. Depending on the size of the newspapers' distribution, some may be exempt from paying fees entirely.

"This is a significant step in meeting our government's commitment to provide more recycling opportunities for Saskatchewan residents," Cheveldayoff added. "Supporting the province of Saskatchewan's Plan for Growth, this new recycling program will help us keep pace with our increased growth while ensuring the protection of our environment." \*

The city of Regina has recently launched its curbside recycling program to begin in July of 2013, the cost of which is less than the city originally anticipated, and will certainly be less than that which was provided by the private sector. Recyclables will be collected every second week, which if the program works, as it should, it should significantly reduce other household garbage, thereby reducing the need to pick it up as frequently (perhaps every other week as well), especially during the winter month when organic waste typically freezes and emits no odours. Hopefully, as the city's waste reduction plans moves forward, green kitchen wastes along with leaf and yard wastes can be composted at source, or composted at a centrally located composting facility.

No doubt it will take some getting used to for some residents as they learn the ways of a more sustainable City and province.

\*Some Extracts taken from the Ministry of Environment Website  
Robert Stedwill, Chair  
Saskatchewan CSEB Chapter

## TERRITORIES News

### Nunavut Spring 2013 Update

Submitted by Paula Smith, CSEB Regional Director

In the mining sector, a global downturn in commodity prices has affected some of the proposed projects but overall the economic forecast for the territory is strong and projects will likely continue through the environmental assessment process. Bill C-47, which includes the Nunavut Jobs and Growth Act, formerly known as the *Nunavut Planning and Project Assessment Act*, is currently before senate. This legislation is a requirement of the Nunavut Land Claims Agreement and its goal is to improve predictability in the regulatory regime. Boards in the North are concerned about having the resources to implement the Act and we'll see if this one makes it through.

Nunavut has a number of active projects either in the environmental assessment stage or regulatory stage, including gold and iron ore projects. For information on these, the Nunavut Impact Review Board public registry can be accessed at <http://www.nirb.ca/PublicRegistry.html> (see reviews) and the Nunavut Water Board files can be found at <http://www.nunavutwaterboard.org/en/publicregistry>.

In other Arctic development news, the federal government has opened a call for bids for exploration licenses for oil and gas discovery licenses located in the Arctic Islands of Nunavut. Cameron. The Bent Horn Oil Field was the site of exploration and production in the 80's and 90's and is within the region that is now open for potential oil and gas exploration.

In non-development news, the United States' proposal to ban trade in polar bear parts was defeated at the Convention on International Trade in Endangered Species (CITES) meetings in early March. This topic is highly contentious, especially in the North where such a ban would have socioeconomic impacts on the communities that benefit from hunting of the species.

With spring on the horizon across Canada, don't forget to submit your observations on eBird. This online checklist program allows recreational and professional birders to enter their sightings, ultimately creating a vast data resource accessible to anybody, and contributing to international biodiversity data systems. Go online to submit your sightings at <http://ebird.org/content/canada>

Have a good spring!

### NWT Regional 2013 Update

Submitted by Anne Wilson, CSEB Regional Director

The big news in the North this Spring is the reaching of a Final Devolution Agreement between the Territorial Government, the Gwich'in Tribal Council, the Sahtu Secretariat Inc., the Tłıchǫ Government, the NWT Metis Nation, the Inuvialuit Regional Council, and the Federal Government. This will have broad-reaching implications for environmental management as the responsibility for lands and resources transfers to the territorial level. For information, visit <http://devolution.gov.nt.ca/>.

My work continues to focus on the Northern files, mostly in the realm of environmental assessment (although I am now based in Edmonton) and I love the opportunity to travel North for various hearings and meetings periodically. There is something about the crisp, dry cold and sparkling white landscape on a bright bluesky day that lifts the spirits! This month I am looking very much forward to a trip to Pond Inlet to participate in the Baffinland water licence hearings. The Nunavut processes are well-run, constructive and respectful – and it is always wonderful to see the people!

#### Mining news

Things have been busy on the mining front, with a number of projects moving through the assessment processes. Here's an update on the current activity:

- The Fortune Minerals Ltd. NICO proposed cobalt-gold-bismuth mine project successfully completed the environmental assessment (EA) process, pending acceptance of the EA report by the federal Minister. We anticipate the regulatory process will begin shortly, with another round of public hearings for the water licence.
- The Avalon Rare Metals Inc. Thor Lake Rare Earth Element Project involves a proposed mine located on the north side of Great Slave Lake, with processing to be done at a hydrometallurgical facility sited at the old Pine Point Mine. Public Hearings are ran the week of February 18<sup>th</sup>, 2013, with the public registry closing March 21<sup>st</sup>. The EA Decision Report is expected to be released in late spring.
- The Tyhee Yellowknife Gold Project review has seen more promises of information to come, but no actual progress. It is still in the "Information Request" (IR) stage; but project details seem to be continually changing, with predictions not necessarily keeping up. Ideally, the Board would send the Proponent back to the drawing board to re-do (thoroughly this time) the Developer's Assessment Report.
- The Giant Mine Remediation Project EA hearings wound up in October, and it has been 10 years since



the closure method was initially identified. There are project changes occurring (water treatment) as well as cost controversy arising even as we await the EA Decision Report. The project includes the containment of 237,000 tonnes of arsenic trioxide dust currently stored underground, generated over 6 decades of mine production. Concerns have been raised with the geotechnical stability of overlying historic open pits, and with some of the surface structures such that work included in the EA is being done on an emergency basis. Public concern has led to further investment in water treatment being proposed, with a reduction in arsenic concentrations at end of pipe from 200 to 10 ug/L.

- The DeBeers Canada Inc. Gahcho Kue Diamond Project EIR completed public hearings in December 2012 and a decision is anticipated to be released in July of 2013. Work is underway on the Aquatic Effects Monitoring Program and other initiatives.

Full details for current environmental assessments are available on the Board's web site at <http://www.reviewboard.ca/registry/>.

#### Regulatory stage projects:

- Following public hearings for the Prairie Creek Mine Project at the end of January, the Mackenzie Valley Land and Water Board has issued draft effluent quality criteria for the water licence. Because of the proximity to the Nahanni National Park (think of the mine as the doughnut hole, surrounded by the Park) and discharging into a stream 6 km upstream of the park, setting appropriate water quality objectives and effluent limits is a priority topic. The proponent has proposed a load-based approach (which involves being on top of a number of moving variables at any given time) while some of the stakeholders proposed fixed limits for discharges. The Board has come up with an innovative compromise – fixed discharge limits until it can be demonstrated with real-world data that load-based could be managed.
- The Ekati Diamond Mine water licence is up for renewal, with the draft water licence out for review. The mine has done some excellent work on deriving site-specific water quality objectives.

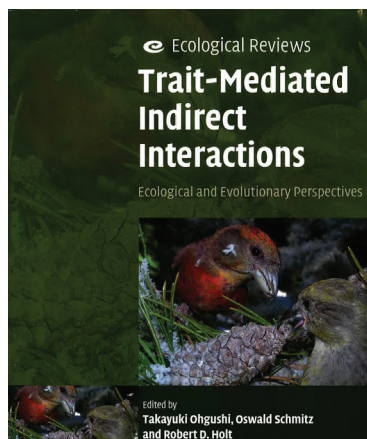
#### Closing:

Best wishes to all for Spring, wherever you may be! If you are doing work north of 60 that you would like to highlight in the newsletter, or running some seminars or other training opportunities, please let us know. The CSEB provides a valuable networking and communication forum, and a voice for biologists if there are any issues to be raised. There is also the option of instigating other CSEB activities – both of the fun and/or of the educational variety - with colleagues in the North. Please email your thoughts to [anne.wilson@ec.gc.ca](mailto:anne.wilson@ec.gc.ca) or [paula.c.smith@ec.gc.ca](mailto:paula.c.smith@ec.gc.ca).

### How You Can Help the CSEB

- **Contribute to the quarterly newsletter and/or website.** Give us an article on something you are interested in
- **Write a short paragraph about what you have been doing, articles or reports you have written**
- **Provide us with points of views on issues.** Your Executive is always interested in learning what issues concern you
- **Write a book review for the newsletter**
- **Become a Chapter Chair, or offer to join the Board of Directors**
- **Promote CSEB - put up a poster, distribute membership forms - download from our website**
- **Set up a Chapter - contact any Director for help**
- **Organize a CSEB event - contact any Director for help**
- **Attend the annual conference and maybe present a paper on your work.**

### BOOKS FOR Review



#### Trait-Mediated Indirect Interactions. Ecological and Evolutionary Perspectives.

Edited by Takayuki Ohgushi, Oswald Schmitz and Robert D. Holt. Cambridge University Press.

There is increasing evidence that the structure and functioning of ecological communities and ecosystems are

strongly influenced by flexible traits of individuals within species. A deep understanding of how trait flexibility alters direct and indirect species interactions is crucial for addressing key issues in basic and applied ecology. This book provides an integrated perspective on the ecological and evolutionary consequences of interaction mediated by flexible species traits across a wide range of systems. It is the first volume synthesizing the rapidly expanding research field of trait-mediated indirect effects, and highlights how the conceptual framework of these effects can aid the understanding of evolutionary processes, population dynamics, community structure and stability, and ecosystem function. It not only brings out the importance of this emerging field for basic ecological questions, but also explores the implications of trait-mediated interactions for the conservation of biodiversity and the response of ecosystems to anthropogenic environmental changes.

## 2012 Howe Sound Juvenile Chinook Outmigration Study Squamish River Watershed Society

Submitted by Edith B. Tobe, R.P.Bio., Squamish River Watershed Society, and  
Sandra Warren, MRM, Fisheries and Oceans Summer Student

### Acknowledgements

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### Overview

This document is the final draft of a two year study on Chinook salmon (*Oncorhynchus tshawytscha*) smolt outmigration in Howe Sound. The study was spearheaded by the Squamish River Watershed Society (SRWS), in collaboration with Fisheries and Oceans Canada as well as Squamish Nation and numerous local stewardship organizations and with funding support from Pacific Salmon Foundation. The overarching goal of the study was to obtain baseline information on the movements of Chinook smolts as they migrate from freshwater habitats into the estuarine and marine environment of Howe Sound. Genetic analysis was used to identify population specific migration patterns (e.g., Fraser River Chinook versus Squamish Origin) and near shore habitat characterization was employed to provide insight into habitat use and preferences of juvenile Chinook.

### 1.0 Introduction

Chinook salmon (*Oncorhynchus tshawytscha*) populations returning to the Squamish River, British Columbia, have been declining in recent years (DFO Science 1999). Escapement estimates generated from the Squamish River Salmon Enumeration Program indicate Chinook have remained well below 500 individuals since 1997 (Golder 2008). Significant efforts have been made to limit exploitation of wild salmon through reduced fishing pressures and increased escapement through hatchery programs (US Salish Sea Technical Team 2012). The Tenderfoot Hatchery has enhanced Chinook populations as part of the Department of Fisheries and Oceans Salmon Enhancement Program since 1981. Over the past three decades, the number of smolts released each year has

steadily increased and in 2012 approximately one million Chinook juveniles were released into the Squamish River and its tributaries (DFO 2012) from Tenderfoot Hatchery. The continued decline of Squamish River Chinook is of concern both at the Federal level and the local recreational fisheries level given the ongoing enhancement efforts.

Chinook salmon are the least abundant of the six major Pacific salmon species (Golder 2005). Prior to 1968, Squamish River Chinook, along with Chum and Pink salmon, supported a healthy commercial fishery in Howe Sound (the basin into which the Squamish River drains and a part of the Salish Sea); however, declining returns forced its closure by the late 1970s (Golder 2005). Nevertheless, Chinook are still highly valued in commercial, recreational, and aboriginal fisheries and are caught in fisheries outside Howe Sound. The species is also culturally important to First Nations (O'Neill et al. 2011). Furthermore, Chinook play a key role in maintaining the ecological health of local systems. After spawning, individuals die and release nutrients and energy into the ecosystem providing food for both aquatic and terrestrial species (Schindler et al. 2003). Efforts to recover Chinook populations would likely produce benefits that extend beyond the species to the local ecosystems and food webs (O'Neill's et al. 2011).

Our lack of understanding of the survival and behaviors of Chinook – particularly during the early marine phases – limits our ability to identify the factors currently limiting Chinook production (Riddell et al. 2009). Most studies of salmon distribution and survival are limited to freshwater life stages and consequently relatively little is known about survival and behaviour in marine waters (Beamish et al 2003). The majority of Squamish River Chinook are known to follow an “ocean-type” life history whereby juveniles largely depend on estuaries and coastal areas and typically migrate to sea within their first year (Levy and Levings 1978). During this period, the marine nearshore environment is thought to be of particular importance for the associated abundant food resources, refuge from predators and also acts as a physiological transition zone (Shaffer et al 2008). Little is known about the use of nearshore habitat by Chinook juveniles during their emigration from the Squamish River and through Howe Sound. Furthermore, no study has examined the habitat utilization patterns of the various stocks (e.g., hatchery versus wild) migrating through Howe Sound towards the Georgia Basin.

The Howe Sound Juvenile Chinook Outmigration Study (henceforward referred to as the Study) aimed to assess the temporal and spatial distribution of juvenile Chinook in the nearshore environment of Howe Sound and identify



key habitats or preferred community assemblages. More specifically, the Study aimed to (1) establish the migratory patterns of juvenile Chinook salmon in Howe Sound; (2) identify habitats used by juvenile Chinook salmon and associated fish densities along the foreshore of Howe Sound; (3) identify the potential for competition between hatchery and wild Chinook populations; and (4) identify natal watersheds of juvenile Chinook populations found in Howe Sound.

During the spring and summers of 2011 and 2012, beach seining was conducted at various sites and biological and physical data were collected. Genetic analysis was used to identify the different Chinook populations using nearshore beach habitat in Howe Sound.



**Figure 1. Map of Howe Sound.**

## 2.0 Background

The estuarine ecosystem and nearshore environment of Howe Sound consists of a diverse mix of habitats that juvenile salmon can potentially use. The most recent study of juvenile salmon occupying the foreshore of Howe Sound occurred in 1997 when a beach seine survey was conducted by Grout et al. (1998). Juvenile Chinook were found utilizing the foreshore from mid-April to the end of August. While this study highlights the importance of nearshore habitats, it only assessed sites in the upper reaches of Howe Sound (excluding the Squamish River estuary) and did not conduct any genetic analysis.

Further evidence of the importance of nearshore and estuarine habitats for multiple Chinook populations are

presented by studies conducted in other regions of the Salish Sea. Shaeffer et al. (2008) reported juvenile Chinook in nearshore and brackish areas of central and western Juan de Fuca Strait between June and September. The study used genetic analysis and identified various Chinook populations occupying the nearshore environment. A similar result was found by a study of juvenile Chinook in Puget Sound in 2001 and 2002 (Fresh et al. 2006). Juveniles from both local populations and juveniles from populations significantly outside the study area were found sharing the same nearshore habitats. Both studies indicate that the foreshore environment may play a crucial role for rearing populations that originate not only from the immediate area and hence, alterations to the environment may have widespread effects that affect multiple salmon populations. Uncovering which populations use Howe Sound will not only increase our understanding of juvenile migration but may also have important ramifications for habitat management decisions in this area.

## 3.0 Rationale and Significance

The Study was initiated following the development of the Squamish River Watershed Salmon Recovery Plan in 2005 (Golder 2005) and the Squamish Salmon Recovery Assessment Framework in 2006 (Golder 2006). These plans identified Chinook salmon as a priority species for recovery given their current population size, lack of knowledge, economic importance, and potential to be the largest population in the Lower Strait of Georgia aggregate. Specific recommendations for their recovery included increasing our limited knowledge of the current population status and habitat use of the estuary (Golder 2005). Based on this recommendation, the Study investigated juvenile Chinook use of the Squamish River estuary and extended the study area to also examine outmigration patterns as smolts continue their migration to the Strait of Georgia through Howe Sound. New information on the distribution and potential competition among juvenile salmon in Howe Sound will assist DFO Stock Assessment and Habitat and Enhancement to improve upon their knowledge base for better program delivery with the objective to reestablish a healthy and robust Chinook salmon return to the Squamish watershed. Information will be linked with data from other studies being undertaken in the Lower Strait of Georgia (i.e., Cowichan River, Quinsam River, Little Qualicum River, etc.) with the intention to improve knowledge and recovery of Chinook salmon populations in Howe Sound.

Identifying the spatial and temporal use of nearshore habitats by Chinook populations may influence land development decisions and shoreline management. Industrial and commercial developments continue to alter the aquatic environment of the Squamish River estuary and Howe Sound (Golder 2005). In recent years, the closure of Woodfibre Pulp Mill and the development of a water treatment plant for Britannia mines runoff have significantly reduced contamination of Howe Sound (Epcor 2011); however, the long-term impact on fish has not been well studied. The Study will provide an indication of whether nearshore habitats in

and around Britannia mines have recovered and may provide support to protect nearshore beaches utilized by Chinook. With genetic analysis, the results of the Study will provide an indication of the distribution of hatchery versus wild Chinook throughout Howe Sound. Hatchery-produced fish often differ from their wild counterparts in their behavior, appearance, and physiology. Competition for food and space can occur between wild and hatchery produced fish, especially when they are the same species and rely on the same resources (NOAA 2006). The results of the Study may provide an indication of the potential for competition. Furthermore, local hatcheries, such as Tenderfoot and Capilano, may use the results from this report to guide their rearing programs (e.g., such as the length to which individuals are reared before release) and release dates to limit competition with wild fish.

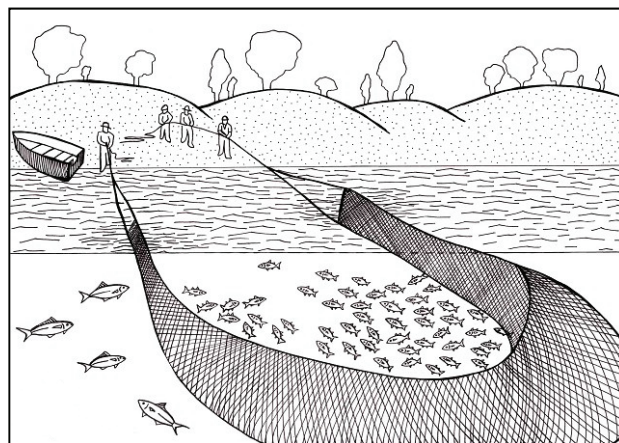
#### 4.0 Methods

Beach seining was utilized to examine fish species composition in selected locations within Howe Sound. Seining locations were selected based on an initial survey conducted in February 2011 by SRWS and DFO, however, additional sites identified by the survey crew were also sampled. Seining sites were chosen based on their geographic location, ease of accessibility, and bottom substrate that would not snag or obstruct the seine net. Some of the sites sampled previously in a 1998 beach seining study by Grout et.al. (1998) were duplicated in the Study in an effort to maintain continuity and allow for some basic comparisons. Habitat types represented can be broadly described as sandy shorelines, rocky shorelines, and estuarine areas. On three occasions in 2012, cliff seining at a nearby rock bluff was performed instead of beach seining due to high tides and little exposed beach area.

A total of 40 sites, or sites in close proximity, were sampled throughout Howe Sound. Ten sites were visited in Northern Howe Sound (seven in the Squamish River estuary), 12 sites in Central Howe Sound (separated into east and west coast), and 11 sites in southern Howe Sound (separated into east and west coast). Weekly sampling began in late April 2011 and continued through early September 2011. Sampling resumed in March 2012 and continued through mid-September 2012. In 2012, a relatively greater effort was put into sampling the Squamish River estuary (Northern Howe Sound) compared to 2011 based on input from the Fisheries Technical Team (DFO). On some occasions, weather conditions prevented some weekly sampling at some sites. However, the sampling crew aimed to visit each site at least one time per month.

Sampling for the abundance and species composition of fish present in the nearshore waters of Howe Sound was carried out using a 2.4 m deep seine net that is 12.8 m long with wings of 5 mm mesh and a center of 2 mm nylon mesh. Doug Swanson (Seacology), an independent fisheries consultant, was hired along with his skiff – the MV Tritonia (50 hp, welded aluminum, 5 m long), to conduct the weekly surveys and oversee the ocean sampling program. On average two to three people assisted Swanson on the weekly surveys so a minimum team of three was maintained at all times (support

crew provided by SRWS and DFO) To deploy the net, one person stood onshore with a rope attached to the net while the other two crew members took the MV Tritonia skiff out to approximately 2.4 m depth and deployed the net parallel to shore. A second crew member was then deposited onshore with a rope attached to the other end of the net. The net was subsequently pulled onshore using the ropes and captured fish were transferred to buckets of seawater. Any macroalgae or invertebrates caught in the net were identified and a rough estimate of invertebrates was recorded (Figure 2).



**Figure 2. Depiction of a crew beach seining (adapted from WWF 2010).**

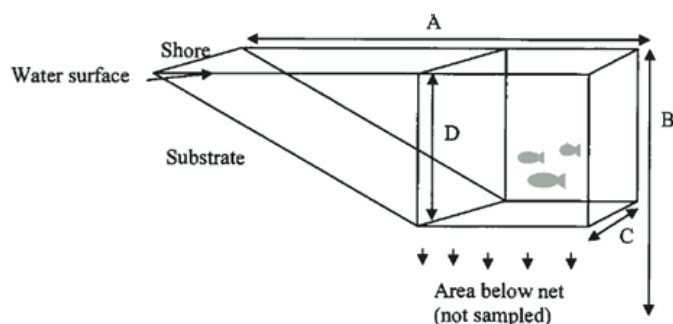
Chinook salmon captured in each set were measured (fork length) to the nearest millimeter using viewing boxes with embedded rulers. A small section of the caudal fin was clipped with scissors for DNA analysis to confirm species and identify the natal watershed. Each clipping was placed in individual vials with lab grade ethyl alcohol and the vial labeled with a unique identification number. Photographs were also taken to assist with difficult identifications or to record any damage to the fish (e.g., bite marks). For large catches (> 30 Chinook), sub-sampling was performed by selecting individuals that were representative of the size range caught. Individuals not selected for DNA sampling and measurement were simply counted and released immediately. For all other captured salmonids, a maximum of 30 fork length measurements were taken and any surplus fish were enumerated. Non-salmonid fish were enumerated by species and a few length measurements (either fork length or total length depending on the species) were taken to establish a rough size range.

For each site visit, a number of physical parameters were recorded. Nearshore substrate composition was characterized visually using the following criteria: Bedrock (>4 m); Boulder (4 m - 0.25 m); Cobble (0.24 m - 0.08 m); Pebble (0.07 m - 0.03 m); gravel (0.02 m - 0.005 m); Sand (0.005 m - 0.001 m); silt (>0.001 m). In addition, water quality data was taken either before or after each seine at the surface, 1 m, and 2 m depths. An alcohol thermometer was used to measure air and water temperature (°C). A Hanna Combo Meter or Oakton pHTestr 30 was used to measure



pH. A YSI Model 85 Handheld Unit was used to measure dissolved oxygen (percent saturation and mg/L), conductivity (mS/cm), conductance (mS/cm at 25°C), and salinity (ppt). Tide height and tide direction were estimated from a tide prediction model for a nearby reference point (Camp Latona for central and southern sites and Squamish for northern sites [Pentcheff 2010]) and weather data – air temperature, precipitation, wave height, wind speed – was recorded for every sample since these parameters can affect the spatial distribution of fish within the water column.

To obtain an estimate of the volume of water sampled per seine, three parameters were recorded: the distance at which the net was deployed offshore (measured perpendicular to shore), the maximum width of the net, as well as the water depth upon net deployment. Water depth was measured using a weighted 50-m measuring tape or by the onboard Eagle Cuda 168 depth reader. Assuming a constant slope, an estimate of the volume of water sampled was calculated (Figure 3). For seines where this information was not recorded, an average was calculated using data from other seines performed at the site during the same sampling year.



**Figure 3. Schematic diagram illustrating parameters estimated for calculation of volume of water sampled**

A = Distance at which net was deployed offshore (m); B = Depth at which net was deployed (m); C = Width of net when pulled in (m); D = Maximum depth of net (2.4 m); Volume of water sampled =  $(1/2) * (2.4) * (C) * (2.4 * \tan(\arctan(A/B))) + (2.4) * (C) * (A - \tan(\arctan(A/B)))$ .

## 5.0 Results

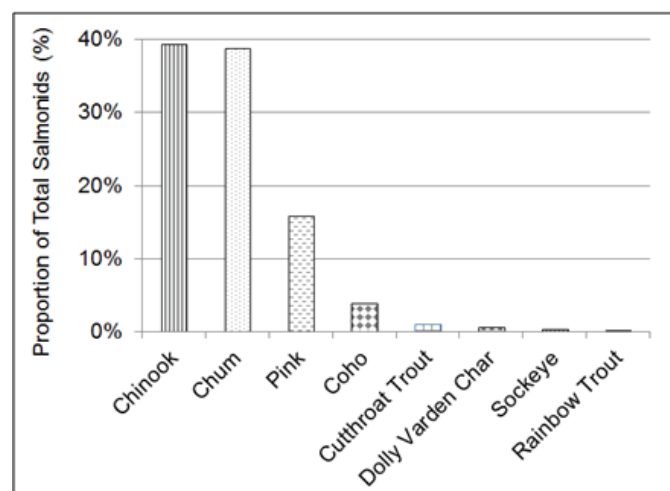
Over the two sampling periods, a total of 47 days were spent seining and 198 beach and three cliff sets were completed at 40 sites in Howe Sound. Slightly less than one third of all sets (31%) were completed in Northern Howe Sound, one quarter (26%) in Central Howe Sound West, one fifth (21%) in Southeast Howe Sound, 15% in Central Howe Sound East, and one fifteenth (7%) in Southwest Howe Sound. A total of 10,889 fish belonging to 52 species were caught over the two year sampling period. An additional 2109 fish were caught but only identified to the family or genus level; small individuals or larval stages made it difficult to identify to species. The most common species captured in Howe Sound were Shiner Perch (*Cymatogaster aggregata*), followed by Herring (*Clupea pallasii*), Chinook, and Chum. Eighteen

invertebrate orders and nine macroalgae genera were also identified. A detailed summary of all the data recorded can be found in the digital file: "Howe Sound Database Jan 24".

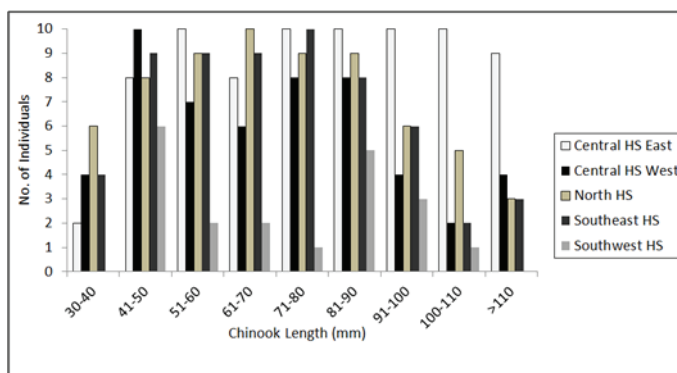
## 5.1 Chinook Catch

A total of 3392 salmonids belonging to eight different species were captured in Howe Sound. Chinook and Chum were the two most common species (Figure 4). All cliff seines (100%) and the majority of beach seines (72%) captured at least one salmonid. More than half of all sets (58%) caught at least one Chinook.

**Figure 4. Frequency distribution of salmonids caught over the two sampling periods**



The average fork length of Chinook in Howe Sound was 72 mm. One quarter (24%) of Chinook were over 90 mm, 5% were below 40 mm, and the remaining 69% were between 41 mm and 90 mm. Figure 8 provides the distribution of fork lengths for the two sampling periods. While Chinook were found to reside in nearshore beach habitats from early April through to September, juveniles did not show any noticeable increase in length beyond 100 mm, suggesting that as individuals grow they move away from nearshore habitats.



**Figure 5. Distribution of Chinook fork length for all 2011 and 2012 data**



### 5.1.1. Spatial Trends

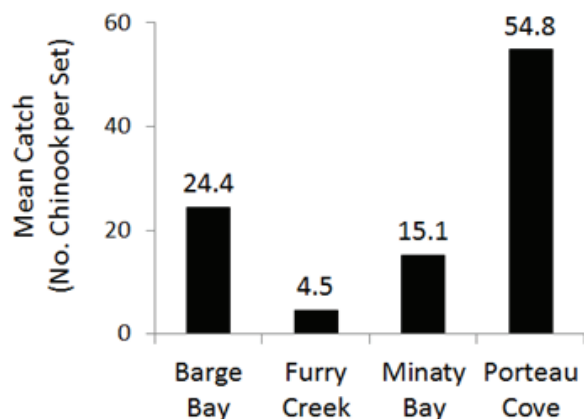
Chinook juveniles were found to reside in the nearshore beach habitats of 28 sites throughout North, Central, and Southern Howe Sound. Table 1 provides the mean catch per set as well as CPUE for each geographic area in Howe Sound.

**Table 1. Number of Chinook per set and CPUE by geographic location in Howe Sound**

Location in Howe Sound	Total # Chinook Recorded	# Sets	# Chinook per Set	CPUE (# Chinook per 100 m <sup>3</sup> )
North*	258	60	4.3	0.4
Central East*	756	29	26.1	1.6
Central West	76	50	1.5	0.1
South East	186	40	4.7	0.5
South West	25	14	1.8	0.3
<b>Total</b>	<b>1301</b>	<b>193</b>		

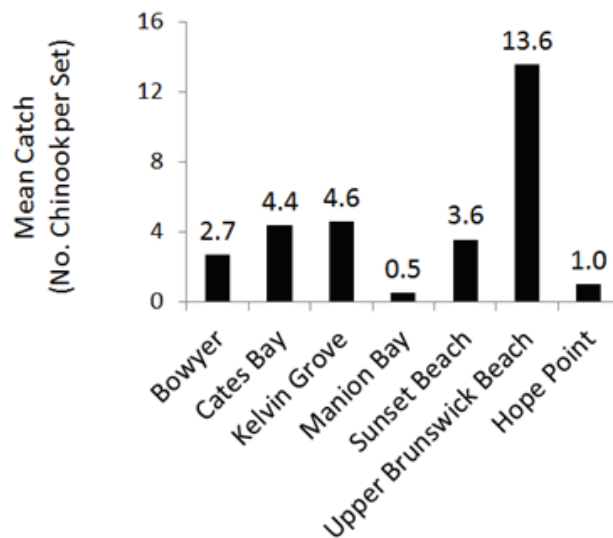
\*Includes the large catches on May 25, 2012; June 14, 2011; and May 17, 2012

Chinook were caught in relatively greater numbers in the Eastern portion of Central Howe Sound ( $\bar{x}$  = 26.1/set or CPUE = 1.6 Chinook/100 m<sup>3</sup>). Chinook were caught at all four sites and catch was highest at Porteau Cove, followed by Barge Bay, Minaty Bay, and Furry Creek (Figure 6). The comparatively large number of Chinook captured in Central Howe Sound East is likely due to greater than average catches at Porteau Cove and Barge Bay. On May 17, 2012, 399 individuals were caught Porteau Cove, while a week later, 119 individuals were caught at Barge Bay, located 9 km north of Porteau Cove. It was later noted through communication with Tenderfoot hatchery staff that release of Chinook from the Porteau Cove fish pen a few days prior to sampling (May 15, 2012) was likely the cause of the large catches. Some individuals had not yet dispersed away from the net pen while others had traveled in a large group north along the coastline. Even when these two catches are excluded from the total catch in Central Howe Sound East – dropping the mean number of Chinook per set to 9 individuals – mean catch remains the largest in this area of Howe Sound.



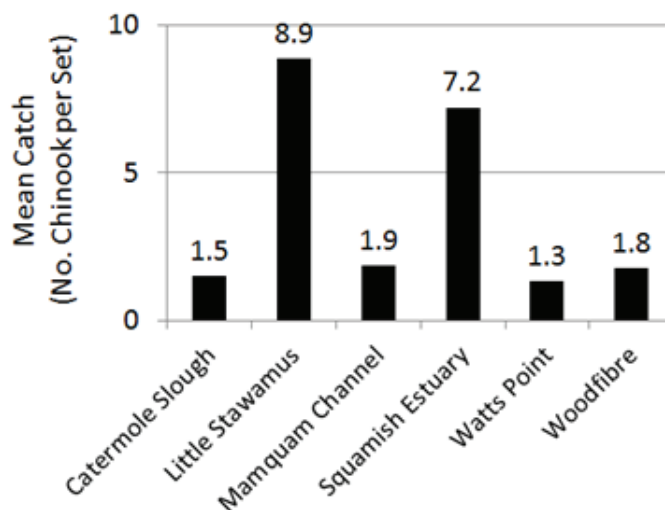
**Figure 6. Mean catch at sites in Central Howe Sound East**

In the Eastern portion of Southern Howe Sound, Chinook were caught at seven out of eight sites. Mean catch was 4.7 individuals/set or 0.5 Chinook/100 m<sup>3</sup>. Upper Brunswick Beach had the highest catch, followed by Cates Bay, Sunset Beach, and Kelvin Grove. The majority of individuals (72%) sampled at Upper Brunswick Beach were caught on June 29, 2011. Manion Bay had the lowest catch ( $\bar{x}$  = 0.5/set); such low numbers may be due to the relatively lower number of times this site was visited (Figure 7).



**Figure 7. Mean Catch at sites in Southeast Howe Sound**

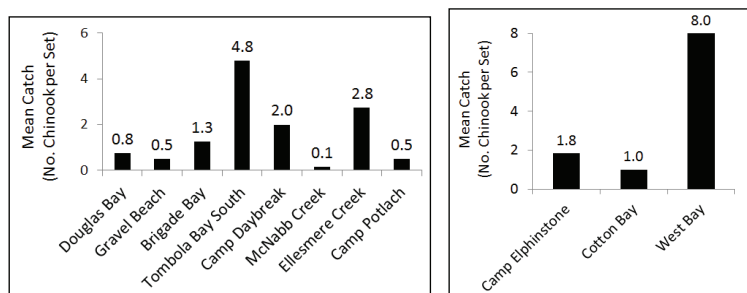
In Northern Howe Sound Chinook were captured at all six sites and a mean of 4.3 Chinook were caught per set or 0.4 Chinook/100 m<sup>3</sup>. Little Stawamus had the highest catch followed by the Squamish Estuary, Mamquam Channel, Woodfibre, Cattermole Slough and Watts Point (Figure 8). The majority of Chinook captured in the Squamish Estuary (90%) were caught at the Squamish Terminal on June 14, 2011, while 80% of Chinook sampled in Little Stawamus were caught on April 25, 2012.



**Figure 8. Mean catch for sites in Northern Howe Sound**

In the Central and Southern portions of Western Howe Sound, Chinook were caught in relatively low numbers ( $\bar{x} = 1.5/\text{set}$  and  $\bar{x} = 1.8/\text{set}$ , respectively). While sampling effort may be a factor behind the low catch in southwest Howe Sound; the same cannot be said for Central Howe Sound West as the second highest number of sets was completed in this region. Figure 9 provides a summary of mean catch for the Central and Southern portion of western Howe Sound. Chinook were captured at all sites in both regions. Highest catch occurred at West Bay ( $\bar{x} = 8/\text{set}$ ) despite being visited only once, followed by Tombola Bay South ( $\bar{x} = 4.8/\text{set}$ ). Lowest catch occurred at McNabb Creek ( $\bar{x} = 0.1/\text{set}$ ). The majority of Chinook caught at Tombola Bay South (70%) were caught on May 3, 2012.

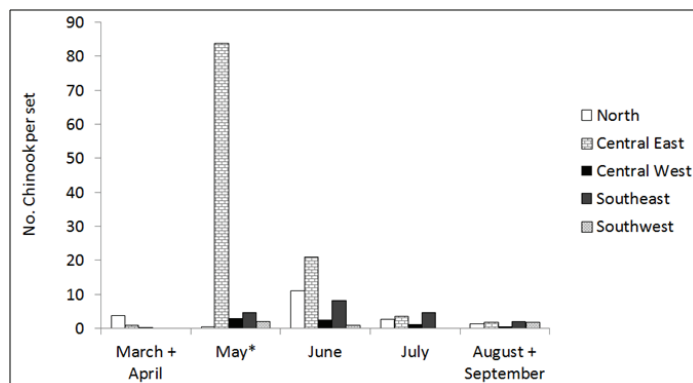
**Figure 9. Mean catch for sites in Central Howe Sound West (left) and Southwest Howe Sound (right).**



### 5.1.2. Temporal Trends

Chinook juveniles were caught throughout Howe Sound from March to August/September of both sampling years (Figure 10). In 2011 no Chinook were recorded in September while in 2012 only five Chinook were captured. In general, catch increased from the beginning of the sampling period (March or April) to a peak in late May and June, and then gradually decreased thereafter. This trend is consistent for both the 2011 and 2012 sampling years. Only 16% of all captured Chinook were sampled in July and 9% in August or September, suggesting that juveniles gradually move to deeper waters within Howe Sound or migrate seaward as the summer progresses.

**Figure 10. Chinook catch by region for both the 2011 and 2012 sampling periods**



\*The large catch of 399 individuals on May 17, 2012 and 119 individuals on May 25, 2012 are not included in this graph for better comparison.

At the beginning of the sampling period (March and April), Chinook were captured primarily in Northern Howe Sound, despite sampling at sites as far south as Douglas Bay (Central Howe Sound West). In May, juveniles were caught in relatively greater densities in Central Howe Sound East, which can be attributed to one large catch of 84 individuals on May 30, 2011. Similarly, Chinook were caught in greater densities in the Central Eastern portion of Howe Sound in June, even though only 13% of all sets were completed in this region. During this month, Chinook were also found in higher densities in Northern Howe Sound, where 37% of all sets were completed, and in Southeastern Howe Sound, where 16% of all sets were completed. Chinook densities in July were highest in Southeast and Central Howe Sound, where 50% of all sets were completed. In August and September, juvenile densities were similar for all regions, approaching 2.0 Chinook per set, except for Central Howe Sound West, where densities were only 0.6 Chinook per set.

### 5.2 Stock Specific Migration Patterns

Genetic analysis was used to identify the different Chinook populations utilizing Howe Sound and to track stock specific migration patterns. Presently, only DNA samples from fish caught in 2011 have been analysed. This section will discuss the results of these samples.

A total of 215 DNA samples were sent for genetic analysis and 165 samples were analysed. Chinook with 11 different genetic signatures were caught in Howe Sound and were grouped into five aggregate stocks based on geographic location: South Thompson, Lower Fraser River – Fall, Middle/Upper Fraser River, East Coast Vancouver Island, and Southern Mainland. South Thompson aggregate consists of Chinook populations originating from southeastern British Columbia, specifically from the lower reaches of the Thompson River, Little River, and Shuswap River. The Lower Fraser River – Fall aggregate consists of populations from South Central BC, specifically the Harrison and Chilliwack Rivers (as well as the Chilliwack hatcheries), while the Middle/Upper Fraser River grouping consists of populations from central BC, including the Baezaeko River. East Coast Vancouver Island aggregate consists of populations originating from the Puntledge River and Qualicum River. It should be noted that these individuals did not travel across the Strait of Georgia into Howe Sound, but were rather brought to the region as brood stock for hatcheries around the mainland (i.e. Capilano). The Southern Mainland grouping is composed of Chinook originating from southeast BC, notably the Cheakamus River and Squamish River. Chinook reared by Tenderfoot hatchery and released at Porteau Cove are also included in this aggregate.

Of the 165 DNA samples analysed, over one third (35%) belonged to Chinook of the South Thompson Aggregate (SOTH), 28% to the Lower Fraser River – Fall Chinook

Aggregate (LWFR-F), 26% to the East Coast Vancouver Island Aggregate (ECVI), 10% to the Southern Mainland Aggregate (SOMN), and less than 1% to the Middle/Upper Fraser River Aggregate (MUFR).

The five identified stock aggregates occupied different regions of Howe Sound throughout the sampling period. At the beginning of the sampling period in late April 2011, two individuals belonging to the SOMN aggregate (representing 16% of the total CPUE for SOMN) were recorded at Minaty Bay, located on the eastern shore of central Howe Sound. Both individuals were of Squamish River origin. Since these two individuals were recorded on the very first day of sampling, the question as to how much earlier these populations occupy Howe Sound arises. This question may be answered using the 2012 data as sampling began one month earlier.

During the month of May, the eastern beaches of south and central Howe Sound supported juveniles primarily from the LWFR-F Aggregate. The majority of these individuals were from the Harrison River while the remaining were from the Chilliwack Hatchery Fall run populations that were derived from the Harrison stock. Two Chilliwack origin juveniles captured on May 10 2011 were 59 and 60 mm fork length; the early timing and small size suggests these were natural origin fry and not produced by the Chilliwack hatchery. One individual belonging to the Middle/Upper Fraser River was recorded at Sunset Beach on May 24, 2011. This was the only individual of this aggregate recorded during the two sampling periods, suggesting that the waters of Howe Sound are relatively less important rearing habitats for Chinook originating from tributaries of the Middle and Upper Fraser River.

In early June, the beaches of Central Howe Sound East in the vicinity of Tombola Bay South and Minaty Bay were dominated by ECVI juveniles originating from Puntledge Falls (70%), LWFR-F juveniles from Chilliwack River (7%), and SOMN juveniles of Squamish River origin (23%). From mid to late June, beaches in northern Howe Sound in the vicinity of Squamish Estuary and Watts Points supported ECVI juveniles (Puntledge and Cowichan) and Squamish origin Chinook. ECVI aggregates were also recorded in Central Howe Sound West near Camp Potlach and McNabb Creek. Four individuals of the LWFR-F aggregate (three of Harrison origin and one Chilliwack) were recorded in the southern half of Howe Sound, in the vicinity of Gravel Beach, Camp Elphinstone, and Sunset Beach. One individual of South Thompson River was recorded at Sunset Beach on June 29 2011.

During the month of July, beaches in the eastern portion of Howe Sound from Ellesmere creek south to Sunset Beach were dominated by South Thompson Chinook. Juveniles from LWFR-F were also recorded at the same sites, as well as in the Squamish Estuary but in much smaller densities. Beaches in upper half of Howe Sound in the vicinity of Little Stawamus, Ellesmere Creek, and Furry Creek supported

ECVI individuals primarily from the Puntledge River while two individuals of Squamish origin were recorded in Central Howe Sound at Furry Creek and Ellesmere Creek.

From August through the completion of the study, all beaches sampled in Southern and Central Howe Sound were dominated by South Thompson Chinook (80%) with the remaining 20% composed equally of Harrison/Chilliwack and Puntledge populations.

### 5.3 Habitat Characteristics

The 28 sites where Chinook were recorded differed in water quality and substrate composition. Table 2 provides a basic summary of the mean and standard deviation for the seven water quality parameters averaged across all sites in Howe Sound. While the mean provides a broad picture of overall water quality, it is clear from the standard deviation that each parameter is quite variable. Further analysis at a smaller scale is needed to identify the differences between each site. That being said, Table 3 does indicate that Chinook occupy nearshore beach habitat where waters can range in temperature, salinity, dissolved oxygen, pH, and conductivity. Similarly, Chinook were recorded at sites where the substrate ranged from silt to large boulders and bedrock, furthering the notion that juveniles can occupy a variety of nearshore beach habitats.

**Table 2. Water quality in Howe Sound**

Water Quality Parameter	Mean	SD
<i>Temperature (°C)</i>		
Surface	14.5	4.0
One Metre	13.0	2.8
Two Metres	13.1	2.5
<i>Dissolved Oxygen (mg/L)</i>		
Surface	11.1	3.2
One Metre	10.7	1.6
Two Metres	10.6	1.9
<i>Dissolved Oxygen (% DO)</i>		
Surface	103.6	6.8
One Metre	103.6	9.6
Two Metres	105.3	8.9
<i>pH</i>		
Surface (pH Units)	6.96	0.62
<i>Conductivity (mS/cm)</i>		
Surface	681.5	672.2
One Metre	610.5	669.0
Two Metres	437.4	484.39
<i>Conductivity (mS/cm) at 25°C</i>		
Surface	744.2	859.2
One Metre	597.1	660.83
Two Metres	400.6	446.7
<i>Salinity (ppt)</i>		
Surface	6.76	4.1
One Metre	9.2	4.2
Two Metres	10.8	4.0



## 6.0 Discussion

### **Objective 1: identify juvenile salmon (focus being mainly but not limited to Chinook) migration patterns as they migrate seaward**

A total of 3392 salmonids belonging to eight different species were captured in Howe Sound: Chinook, Chum, Pink, Coho, Sockeye, Cutthroat trout, Rainbow trout, and Dolly Varden Char. Over the two sampling periods Chinook densities varied both spatially and temporally, with the highest densities occurring in the Central region of Eastern Howe Sound, in the vicinities of Porteau Cove, Minaty Bay, Furry Creek, and Barge Bay. The lowest densities were recorded in Central Howe Sound West. Chinook densities gradually rose from the beginning of the sampling period (March/April), peaked in June, and then gradually decreased to a low in August/September. This corresponds to the migration timing noted in the literature indicating that Chinook juveniles migrate downstream from mid-March to late June when they are found rearing in estuaries for several weeks (Wada and Sander 2005). Throughout the sampling period, several larger pulses of Chinook interspersed with smaller catches were recorded, suggesting that Chinook may on occasion migrate downstream in larger groups.

### **Objective 2: use genetic analysis to identify Chinook stocks occupying the nearshore beaches of Howe Sound**

In 2011, 165 DNA samples were analysed, revealing 11 different genetic signatures in Howe Sound. Based on geographic origin, these signatures were grouped into five aggregate stocks: South Thompson (SOTH), Lower Fraser River – Fall (LWFR-F), Middle/Upper Fraser River (MUFR), East Coast Vancouver Island (ECVI), and Southern Mainland (SOMN). The most common aggregate recorded in Howe Sound was the SOTH, followed by the LWFR-F, ECVI, and SOMN. Only one individual belonging to the MUFR was sampled in southern Howe Sound at Sunset Beach.

The spatial and temporal distribution of each stock varied over the sampling period. SOTH were primarily captured in the Eastern portion of Howe Sound, with only three individuals caught on the west coast at Watts Point and Ellesmere Creek. Juveniles were recorded late in the sampling period, from end of June through the end of August. The LWFR-F aggregate was recorded at 41% of all sites belonging to all five regions of Howe Sound. The highest density occurred in early May at Kelvin Grove; however, individuals from this aggregate were consistently caught in smaller densities throughout the entire sampling period. In contrast, Chinook belonging to the ECVI aggregate were only recorded in the upper half of Howe Sound at 34% of all sites. Individuals were recorded from the end of May through August on both the east and west coasts, with the highest CPUE recorded at Little Stawamus in early July. Similar to the ECVI group, juvenile Chinook of the SOMN aggregate were only recorded in the upper half of Howe Sound at 15% of all sites. SOMN Chinook were the earliest to be recorded in Howe Sound, with individuals captured on the very first

sampling day (April 19 2011) at Minaty Bay. Juveniles were recorded earlier in the sampling period; no individuals were recorded in August or September.

### **Objective 3: identify the potential for competition between hatchery production and natural production for juvenile Chinook salmon in Howe Sound**

On three separate occasions in 2011 and 2012, a greater than average number of Chinook were captured in the vicinity of Porteau Cove. This particular site is of interest because Tenderfoot hatchery Chinook are partially reared to a length of 120 mm in large net pens just south of the sample site, thereby creating the potential for resource scarcity and competition with wild salmon immediately following their release. In 2011, 84 Chinook were recorded at Porteau Cove on May 30<sup>th</sup>. This catch is relatively greater than any other catch completed at this site in 2011 (five individuals on July 21, 0 on April 20, June 23, and August 5). Additionally, approximately one-third of individuals (35%) were over 80 mm in length. On average, these fish are larger than other juveniles recorded at sites throughout Howe Sound during the same time frame, suggesting that the larger fish are of hatchery origin. Of the DNA samples sent for analysis, only two were processed, indicating one individual was likely a hatchery release due to its large size (108 mm) and genetic signature whereas the other individual was much smaller – 55 mm – and was of Harrison origin. The final report will contain the hatchery release data – release date, number of Chinook released, and size of fish released – and will be used to better assess the potential for competition between hatchery and wild salmon in Howe Sound.

In 2012, two relatively large catches were recorded in the vicinity of Porteau Cove. On May 17, 2012, 399 individuals were caught at Porteau Cove and an additional 119 individuals were recorded one week later at Barge Bay, located just 9 km north. After talking with Tenderfoot hatchery staff, it was noted that net penned Chinook were released on May 15, 2012 – just two days before sampling at Porteau Cove. These two catches are relatively greater than any catch recorded at either sample sites, suggesting that hatchery released Chinook influenced the number of juveniles recorded. The results from this preliminary analysis suggests that there is the potential for competition between wild and hatchery fish at nearshore beaches in the vicinity of Porteau Cove, particularly after the release of the net penned Chinook. DNA analysis of the samples taken in 2012 coupled with fork length data may further clarify this phenomenon.

### **Objective 4: identify the habitat characteristics of nearshore beaches used by Chinook salmon**

A preliminary assessment of the water quality and substrate composition data of nearshore beach habitats occupied by Chinook suggests that juveniles occupy a variety of habitats during the rearing stages. Further analysis is needed to identify trends and relationships between water quality and catch, particularly the effects of salinity and water temperature on Chinook density.

### Objective 5: work with local stewardship groups raising awareness on the importance of the nearshore habitat for a healthy ecosystem in which salmon and other species can exist.

This study provided a unique opportunity for fisheries biologists to connect with community groups and local landowners. Such interactions increased awareness of salmonid release and restoration efforts in Howe Sound. Over the sampling period the crew interacted with interested people – both young and old – on 22 occasions (11 in 2011 and 11 in 2012). Several individuals participated in salvaging fish from the net and identifying fish while contributing to local knowledge of marine life. The majority of individuals were encountered while they were walking on the beach or playing by the water.

### 7.0 Conclusions and Future Research

Juvenile Chinook were recorded on the majority of all nearshore beaches sampled throughout Howe Sound. Juveniles were found to occupy beaches that varied significantly in water quality and substrate, making it difficult to assess the effects of such parameters on Chinook catch. Density was highest in eastern region of central Howe Sound and peaked in mid-June. On three separate occasions, larger than average catches in the vicinity of Porteau Cove – the same location as Tenderfoot hatchery net pens – suggest the potential for competition between wild and hatchery Chinook. Through DNA analysis, it was possible to identify five different Chinook stock aggregates that occupy the various regions of Howe Sound from March/April to September. Once all DNA samples taken in 2012 have been processed, further analysis can be performed to identify stock specific trends.

While only a few patterns in juvenile Chinook migration were revealed in this study, it did allow for the identification of suitable sample sites and methodology for nearshore beach seining in Howe Sound. This is important for future research on the study of juvenile salmon in Howe Sound and other regions.

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