



Howe Sound Chinook Smolt Outmigration Pilot Study

Interim Report August 2011

Prepared for:
Squamish River Watershed Society &
Fisheries and Oceans Canada

Prepared by:
Kendra Morgan
Simon Fraser University Co-op
Department of Fisheries & Oceans Canada
Resource Restoration Biology Student

With Funding from:
Pacific Salmon Foundation





Abstract:

This interim report summarizes data collected between April 19th and July 28th, 2011 from 60 beach seine surveys to highlight any emerging patterns in juvenile Chinook distribution and habitat preferences. A total of 38 fish species, 18 invertebrate orders and 9 macroalgae genera were identified. Though no obvious migration patterns for Chinook were determined at this time, this study will provide the basis for future analysis of migratory patterns as well as determining near shore habitat preferences of this species. In addition, this study allowed researchers to interact with interested community members and educate these individuals on the importance of healthy nearshore habitats for fishery resources. The study may be used as a basis for future fish surveys of Howe Sound and to inform hatchery and development management decisions in this area.

Introduction:

Chinook salmon populations returning to the Squamish River have been declining in recent years along with many other salmon populations in North America (DFO Science 1999). Howe Sound supported a major commercial fishery for chum, pink and Chinook salmon until declining returns resulted in the closure of the fishery in 1968. Since that time there have been significant efforts to limit exploitation and increase escapement through hatchery programs, especially for Squamish River Chinook. Despite these efforts this population is still struggling (Levings and Riddell 1992) for unknown reasons though poor marine survival could be a major contributing factor (DFO Science 1999, Wada and Sander 2005).

Natural populations of salmon have differing life histories with variable timing of juvenile migration. This may result in greater survival rates due to less pressure on limited food and space resources (Beamish *et al* 2003) and a decreased likelihood that chance oceanic events will wipe out an entire brood year (Bottom *et al* 2005). Results from this study can be used to guide the establishment of hatchery release times that limit potential competition between wild and hatchery juveniles while also increasing our limited knowledge how hatchery programs effect wild salmon (Bottom *et al* 2005).

Howe Sound is a necessary travel corridor for salmon returning to the Squamish River and its tributaries and may also play an important role for juvenile salmon during their outmigration and transition to the marine environment. 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). In addition, no broad scale juvenile fish sampling has occurred in Howe Sound since 1998 when a sampling methodology was established (Grout et al1998), through there have been many changes to the local environment. The primary objectives of this study are to better understand the spatial and temporal distribution of juvenile Chinook in Howe Sound and to identify key habitats or community assemblages preferred by these fish.

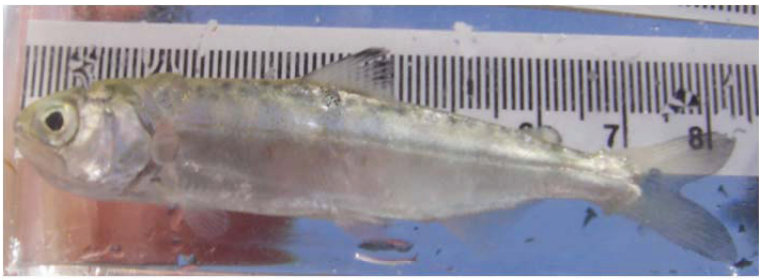

Figure 1: Juvenile Chinook salmon in a viewing box.

Methods:

A grant from the Pacific Salmon Foundation was obtained by the Squamish Watershed Society to conduct a beach seine survey of Howe Sound in 2011. From April 19 to July 28, 2011, a crew of three conducted beach seine surveys at 22 sites located throughout Howe Sound (Figure 1). Each site, or sites in close proximity, was visited approximately once a month totaling 2-4 visits. Further sampling occurred in August. The sites were chosen based on accessibility and presence of a substrate conducive to pulling the beach seine onshore without catching the net on submerged logs or boulders.

Figure 2: Map of Howe Sound depicting sampling sites.

Abundance and species composition sampling was conducted using a 2.4m deep seine net that is 12.8m long with wings of 5mm mesh and center of 2mm nylon mesh. 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 (50 horsepower, welded aluminum, 5m long skiff) out to approximately 2.4 meter deep and released the net. A second crew member was then deposited onshore with a rope attached to the other end of the net. The net was subsequently pulled up onshore using the ropes. Any fish captured were transferred to buckets of seawater. Invertebrate numbers were estimated and the presence of macroalgae, either in the net or onshore, was recorded.

For Chinook salmon, *Oncorhynchus tshawytscha,* fork length measurements were taken using viewing boxes with embedded rulers of millimeter accuracy. A small section of caudal fin was clipped with scissors and preserved in ethanol for later DNA analysis. This DNA data will be analyzed in the fall of 2011 to confirm species and determine the natal watersheds of the captured Chinook. Photographs were also taken with emphasis on any damage and difficult identifications. For all other 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 were taken to establish a rough size range.

Water quality data, including temperature, pH, salinity, and conductivity, was measured either before or after the set. A water quality profile was taken on the first visit to every site with measurements taken at the surface, at 1 meter, and at 2 meters. For subsequent visits, only surface measurements were taken. Tide height and tide direction were estimated from a tide prediction model for Camp Latona, southern sites, or Squamish, northern sites (Pentcheff 2010).

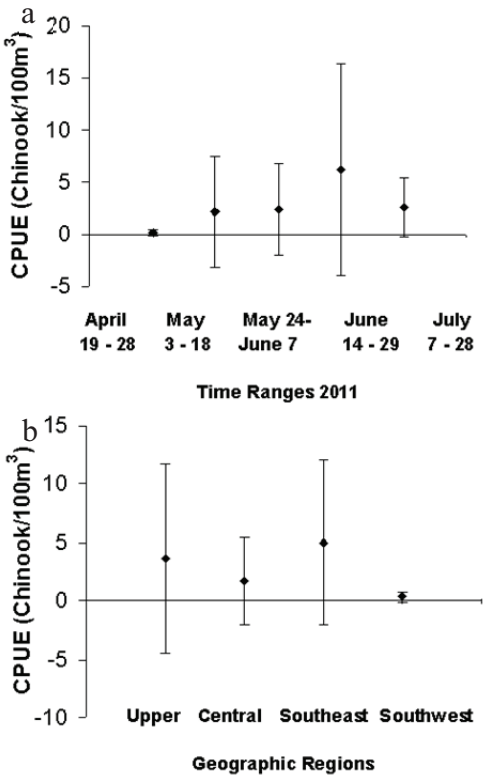

Figure 3: a) Mean CPUE for chinook in each region over the sampling period and b) mean CPUE for chinook in all regions for each time range. Error bars are standard deviation.

Results:

From April 19 to July 28 2011, a total of 60 sets were completed at 22 sites. Three of those sites were nearby replacements for sites inaccessible under certain tide or wind conditions. Over the course of this sampling period 7295 fish of 38 species were captured and identified, 2375 of which were salmonids. 427 Chinook salmon were captured and 268 DNA samples were collected from these fish. In addition, 18 invertebrate orders and 9 macroalgae genera were identified.

The majority of sets caught few or no Chinook while a few sets, especially in June, had higher concentrations of Chinook. There was no significant difference in the mean Catch per Unit Effort (CPUE) for each time range or region though CPUE varied widely. There is a trend for a peak in number of Chinook captured in June (Figure 3).

Species richness calculations indicate that the lowest diversity occurred in the central zone while diversity was higher in the northern and southern regions of Howe Sound (Figure 4b). The abundance of Chinook appeared to increase over the course of the sampling period and varied throughout Howe Sound (Figure 4a). More analysis will be available in the final report once the sampling season is complete including frequency distribution graphs of salmonid lengths and maps showing CPUE in space.

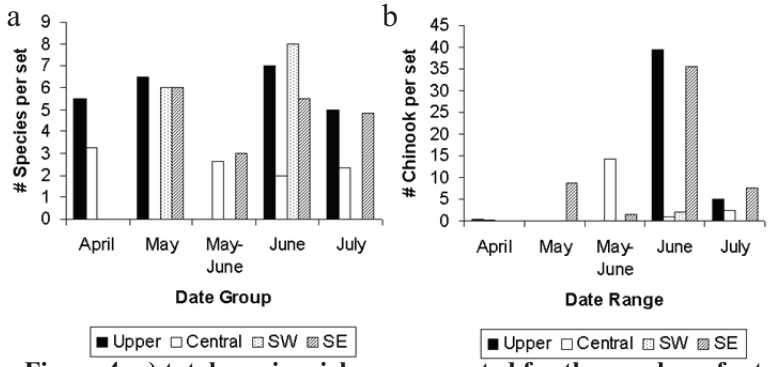

Figure 4: a) total species richness corrected for the number of sets in each region per time range and b) abundance of chinook caught per set for the four regions and five time ranges.

Discussion:

Objective 1: Identify juvenile salmon (focus being mainly but not limited to Chinook) migration patterns (through time and space) as they move through Howe Sound towards the Georgia Basin.

Over the sampling period 8 species of salmonids were identified: Chinook, Chum, Coho, Pink, Sockeye, Cutthroat trout, Rainbow trout and Dolly Varden Char. The CPUE of Chinook varied with highest catches occurring in June (Figure 3a). This corresponds with migration timing 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). Though the mean CPUE for each time range did not differ significantly there was a trend for a maximum spike in June (Figure 3b) which may indicate a pulse of Chinook moving out of the Squamish River. The pattern of larger catches of salmonids in the southeast zone may indicate that this region is a migration route for salmonids moving into the Strait of Georgia (Figure 4a).

Objective 2: Identify which habitats are being utilized by Chinook juvenile salmonids and their densities along the intertidal zone through nearshore sampling techniques and ortho-imagery (Google Earth and air photos, etc.).

Over this sampling period, Chinook were captured at all of the sites except for Avalon Bay and Wood Fibre which were visited once and twice respectively. There was also no significant difference in the mean CPUE for the four geographic regions though the mean CPUE was slightly larger in the upper and the southeast regions (Figure 3b). However, species richness of the sampling sites varied throughout Howe Sound. The central region of Howe Sound had the lowest species richness (Figure 4b). This may be a result of the influence of freshwater discharge from the Squamish River, upper region, and Fraser River, southern regions. The final report will include regression analyses to study whether Chinook are found more often at sites with a specific species assemblage or at certain water quality levels.

Objective 3: Identify the potential for competition between hatchery production and natural production for juvenile Chinook salmon in Howe Sound.

Sampling at Porteau Cove found 63 Chinook on May 30th, 2011 which could be the hatchery fish released from net pens near this location. Despite sampling at this location on April 20th, June 23rd, and August 5th, the only other time Chinook were found at this site was July 21st when 5 Chinook were caught (Figure 5). The final report will contain the hatchery release data including dates of release, number released, and size of the fish released. This data as well as DNA data will be used to estimate which fish caught are hatchery fish and from this determine whether there are any interactions between wild and hatchery juveniles.

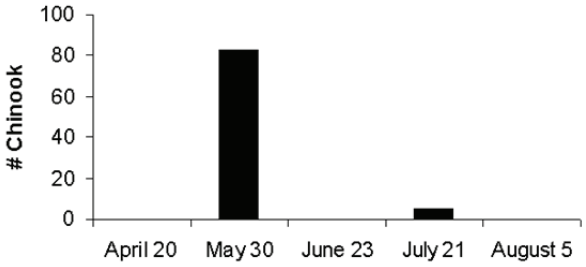

Figure 5: Number of Chinook caught at Porteau Cove over the summer of 2011.

Objective 4: Through genetic sampling, determine the population of origin (i.e. Fraser River or Squamish River) of the juvenile Chinook encountered in the Howe Sound Sampling (non-destructive sampling).

Analysis of the DNA samples should help to clarify juvenile migration patterns. Though 268 DNA samples were taken, a subset of these samples will be analyzed in the fall of 2011 in order to achieve an overall picture of population origin in Howe Sound. Determining natal watersheds of the fish captured in Howe Sound will give an indication of what populations are using this area and at what sizes these populations are found in the nearshore waters studied.

Objective 5: Work with local stewardship groups raising awareness of the importance of the nearshore habitat for a healthy ecosystem in which Chinook and other salmonids and wildlife can exist.

This study provided a unique opportunity for fisheries biologists to connect with community groups and local landowners. These interactions increased awareness of salmonid research and restoration efforts in Howe Sound. Over the sampling period the crew interacted with interested parties, both young and old, 11 times at various sampling sites. Several individuals participated in salvaging fish from the net and identifying fish while also contributing local knowledge of marine life. Most of the in field community outreach occurred in July when more people were out on the water and beaches. On June 4th, 2011 DG Blair and Edith Tobe set up a table at Camp Elphenstone's Open House. Approximately 30 people participated in activities including beach seining and a beach "scavenger hunt" bingo game. Additional sampling in co-operation with local community groups is planned for August and September.

Conclusions and Recommendations:

Though no trends in juvenile Chinook migration through Howe Sound were obvious in this initial phase of the study, analysis of the data from August as well as the DNA samples may help to elucidate the movements of Chinook in this region. This initial phase of the study has set up sampling locations and methodology for the continued study of juvenile salmon movements in Howe Sound. Overall, large variations made patterns in juvenile movement difficult to determine. This emphasizes the need to continue this study for several years in order to best understand how Howe Sound is utilized by juvenile salmon and in this way enable protection of critical habitat. Repeating this study in another year and sampling the sites more frequently could help clarify patterns of fish movement and habitat preference. This study was also limited to beaches that were accessible with a seine net. Linking to data from deeper water sampling in Howe Sound would give a broader picture of juvenile migration through this water body.

References:

Beamish, R.J., I.A. Pearsall, and M.C. Healey. (2003). A history of the research on the early marine life of Pacific salmon off Canada's Pacific coast. N. Pac. Anadr. Fish Comm. Bull. 3: 1-40.

Bottom, D.L., K.K. Jones, T.J. Cornwell, A. Gray, and C.A. Simenstad. (2005). Patterns of Chinook salmon migration and residency in the Salmon River estuary (Oregon). Estuarine, Coastal and Shelf Science 64: 79-93.

DFO Science Stock Status Report D6-12 (1999). Lower Strait of Georgia Chinook Salmon. Accessed July 4, 2011 (http://www.dfo-mpo.gc.ca/csas/Csas/status/1999/D6-12e.pdf).

Grout, J.A., C.D. Levings, B. Nidle, B. Piercey, and D. Marsden. (1998). Beach Seine Data from Near Britannia Mines and in Howe Sound, British Columbia, during 1997. Canadian Data Report of Fisheries and Aquatic Sciences 1044: iii + 83p.

Levings, C.D., and B.E. Riddell. (1992). Salmonids and their habitats in Howe Sound basin: status of knowledge, p. 65-81. In**:** Levings, C.D., R.B. Turner, and B. Ricketts [Ed.]. Proceedings of the Howe Sound environmental science workshop. Canadian Technical Report of Fisheries and Aquatic Sciences 1879.

Pentcheff, D. (2010). WWW Tide and Current Predictor. University of South Carolina. Accessed July 4, 2011 (http://tbone.biol.sc.edu/tide).

Wada, G., and B. Sander. (2005). Squamish River Watershed Salmon Recovery Plan. Golder Associates. Pg i-xi; 40-45.