Moyeha River Chinook Salmon (*Oncorhynchus tshawytscha*) 2011 Escapement Estimation Feasibility Study

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EXECUTIVE SUMMARY

Moyeha River chinook contribute to the southeast Alaska, northern British Columbia and west coast of Vancouver Island (WCVI) Aggregate Abundance Based Management (AABM) fisheries which are regulated in part by the Pacific Salmon Treaty. The Moyeha River is located in Strathcona Park, Clayoquot Sound, on the West Coast Vancouver Island (WCVI). The Moyeha River was chosen as a Sentinel Stock candidate for the following four reasons:

1. Habitat in the Moyeha River watershed is pristine and untouched by development.
2. The population has never been targeted by hatchery supplementation.
3. The stock contributes to the PSC fourteen-stream WCVI chinook salmon escapement index.
4. Moyeha chinook belong to the South West Vancouver Island (SWVI) chinook Conservation Unit (CU). Other WCVI Sentinel Stock projects on the Burman and Kaouk River populations belong to the Nootka & Kyuquot CU (Holtby and Ciruna 2007).

Prior to the Sentinel Stocks program, area-under-the curve (AUC) estimates from 2000 to 2009 indicate an escapement average of 130 individuals (Figure 1).

The 2011 project objective was to measure catch per unit of effort (CPUE) for various capture methods including beach seining, tangle netting, angling, and carcass recovery and to determine if catch rates were sufficient to provide a defensible mark-recapture estimate in future years. Additional objectives were to obtain samples to estimate age, sex, size and origin composition of the escapement. The escapement estimate was to be compared to the normative AUC escapement estimate developed annually using snorkel survey methods. A very low chinook salmon apparent population size in 2011 resulted in capture rates insufficient to support a mark-recapture estimate with sufficient precision and accuracy to meet the SSP standards.

Summary of Methods

A seine net was deployed in the Moyeha River from RKM 2.25, RKM 2.50, and RKM 3.00 within staging pools using a 4.27m flat-bottom boat powered by a 25hp jet motor or 9.9hp motor. Tangle netting was conducted between RKM 1.50 to RKM 2.50 during the day and night. The tangle net was stretched across the full width of the river to sample salmon swimming up or retreating down the river. Angling with a rod and reel using salmon roe as bait was conducted from RKM 9.00 down to the entrance of the river. Anglers walked the river banks or floated down the river in a rubber raft after being dropped off in the upper section of the river by a helicopter.

All species captured during the seining, tangle netting or angling events were recorded. Carcass surveys were conducted over the entire anadromous reach from RKM 13.5 to the river mouth. Surveyors swam the river and walked the river banks to maximize carcass recovery. Live chinook captured were tagged in both operculum with numbered Kurl-lock tags and a mutilation mark was applied to the operculum. Chinook salmon were also visually identified for gender. For all chinook salmon sampled, the post-orbital hypural (POH) lengths were measured to the nearest 5 mm and scales were obtained for aging. Tissue samples were collected from the operculum and preserved in 95% ethanol to contribute to the coast-wide GSI database. For carcasses, biological samples included otoliths to determine origin. The gender was verified by cutting open the fish and examining its internal organs. Egg retention for females was estimated to assess handling stress.

Summary of Results

Even though we had a low sample size, beach seining was more successful as a method of capture compared to tangle netting and angling. There were three chinook obtained by beach seine on a total of eight days creating a CPUE of 0.375 chinook/day. There were no chinook captured by tangle netting or angling, although other species such as chum, coho and trout were captured by these methods.

There were nine samples obtained from the carcass surveys with no recaptures. The age structure proportions (n = 10) were 0.10 (SE = 0.10, CI = 0.00 – 0.44) age-3, 0.80 (SE = 0.13, CI = 0.45 – 0.97) age-4, and 0.10 (SE = 0.10, CI = 0.00 – 0.44) age-5. The three chinook captured by the seine net were all males. The ratio of males to females sampled during the carcass recoveries was 3.00:1.00. Origin analysis showed that all chinook sampled (n = 9) were considered of wild origin because there were no hatchery marks on the otoliths. The length distributions of chinook captured in the seine net were not significantly different (D, = 0.40, P = 0.313) from the chinook obtained from the carcass recoveries although the samples sizes were small (n = 3 and n = 8 respectively).

Although the intention of this project was not to deliver an escapement estimate, the normative DFO area-under-the curve estimate (AUC) in 2011 from the snorkel surveys provided by DFO was 60 large chinook with a peak observation of 44 individuals. A survey life of 25 days was used and the observer efficiency was estimated on a per section basis ranging between 90% - 95%.

Future Estimates of Escapement/Conclusion

A mark-recapture program is not feasible on this system considering the difficulty in capturing the chinook salmon during low returns. Recommendations for future work include continued non-invasive monitoring of the population, and increasing the frequency of swim surveys to obtain more precise estimates of escapement. Carcass surveys and biological sampling should be continued to monitor potential hatchery stray contributions.

Moyeha Sentinel Stocks Program Financial Summary

The 2011 Moyeha River Sentinel Stocks project was provided funding remaining from the previous FY totaling $64,977.24. The total expenditure for this project was $53,651.65, leaving $11,325.59 unspent.

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INTRODUCTION

The Sentinel Stocks Program (SSP) was established in 2009 in the Pacific Salmon Treaty to improve escapement estimates of chinook salmon (*Oncorhynchus tshawytscha*) from selected indicator stocks located in Washington, Oregon and British Columbia. The Moyeha River Sentinel Stocks Project is one of three projects that were conducted on the west coast of Vancouver Island (WCVI) in 2010 and 2011. This program was intended to determine catch per unit of effort (CPUE) for beach seining, angling and tangle netting and to determine the effectiveness of carcass collections obtained by snorkeling in the river and walking the length of the river. This study was not intended to provide an estimate of escapement. The other two SSP projects on Vancouver Island were the Burman River and Kaouk River, which were intended to provide accurate chinook escapement estimates.

There are four conservations units identified on the WCVI (Nootka & Kyuquot, Northwest Vancouver Island, Southwest Vancouver Island, and Port San Juan). Within these four conservation units, six indicator stocks are identified to provide an index of escapement for wild WCVI stocks. These stocks originate from the Marble (Area 27), Tahsish, Artlish, Kaouk (Area 26), Burman, and Tahsis rivers (Area 25). A second fourteen-stream index includes the six indicator stocks and eight additional streams which are the Colonial/Cayegle Creeks (Area 26), Leiner (Area 25), Megin, Bedwell/Ursus, Moyeha (Area 24), Sarita, Nahmint (Area 23), and San Juan rivers (Area 21). The Moyeha River population belongs to the Southwest Vancouver Island (SWVI) Conservation Unit (Holtby and Ciruna 2007). This population is represented in the fourteen-stream WCVI chinook escapement index reported by the Joint Chinook Technical Committee in the annual catch and escapement reports.

Since 1995, the Department of Fisheries and Oceans (DFO) have estimated escapement by conducting snorkel surveys to obtain an AUC estimate. This natural population is small. The maximum escapement over the past 10 years was estimated at 362 adults and averaged 130 individuals (Figure 1).

This was the second SSP project on the Moyeha River. For the 2011 project, the primary objective was to measure CPUE for seining, angling, tangle netting and for the carcass surveys. If sufficient samples were obtained, then additional objectives included estimating total escapement of age 3.0 and older chinook by age, sex, size and origin and to compare the mark-recapture estimate to the results from the normative DFO AUC snorkel survey result.

Study Area

The Moyeha River is a pristine watershed situated in the middle of the west coast of Vancouver Island in British Columbia, Canada. This river is located in Strathcona Park at the end of Herbert Inlet, Clayoquot Sound (Figure 2). The mouth of Moyeha River is located 49° 25' 16.56"N, 125° 54' 35.01"W. The length of the mainstem is 28 km. A migration barrier to chinook salmon, consisting of a cascade, is located at river km (RKM) 11 according to Brown et al (1979). According to DFO survey records, the impassible falls is located at RKM 13.5 at 49°29'53.01"N, 125°48'34.65"W (D. Palfrey, personal communication, September 2010) (Figure 3). RKM 13.5 was used to identify the upper limit of salmon distribution within the Moyeha River in this report. No roads exist in the watershed so access is limited to foot, boat or helicopter. The Moyeha River hydrograph is largely rain driven in the fall and bank-full flows occur during the late summer through the fall seasons. Very little precipitation occurred in August and up to mid-September (Figure 4). Precipitation increased from mid-September through to November, which made access difficult (Figures 5, 6 and 7).

The Moyeha River has a gradient of 0.25% to 0.50% from the river mouth up to RKM 6.4 and 0.50% to 0.75% from RKM 6.4 to RKM 11.0 (Brown et al. 1979). The potential spawning habitat for salmon is 264,000 m^2 with a maximum salmon density of 0.026 salmon/m^2 (Reimchen et al. 2002; Brown et al. 1979). According to Brown et al. (1979), the majority of the river accessible to salmon consists of course material (50.9 mm – 256 mm). Chinook salmon are capable of spawning in larger course material compared to other salmon species because of their size and can spawn in gravels up to about 10% of their body length (Kondolf and Wolman 1993). The preferred spawning substrate for chinook salmon ranges from 200 mm to 1060 mm (Raleigh et al. 1986). Salmon, such as chinook, may choose to spawn in smaller gravels which often have to do with spawning habitat availability (Kondolf and Wolman 1993).

Moyeha River chinook salmon are ocean-type fall chinook. Chinook begin to arrive in Clayoquot Sound in late July to early August and move to the head of Herbert Inlet, entering the river during the first elevation of stream discharge in autumn. During the first significant freshet, fish move upstream and distribute themselves throughout the river up to an impassable barrier at RKM 13.5. Peak spawning occurs during the last week of September and first week of October. Small numbers of fish continue to enter the system with each subsequent rainfall until mid to early October. Chinook spawning is usually complete prior to the last week in October or first week of November. Other salmon species observed in this river are coho (*O. kisutch*), sockeye (*O. nerka*), pink (*O. gorbuscha*), chum (*O. keta*) and trout species such as steelhead, rainbow trout (*O. mykiss*) and cutthroat trout (*O. clarki*).

Strathcona Park was established in 1911 and protects some of the last unspoiled wilderness on Vancouver Island, including the Moyeha Valley (Strathcona Park Master Plan 1993). The Moyeha River valley is the only completely protected coastal watershed on Vancouver Island and is 184 km^2 in size (Tripp et al. 2010). Approximately 92% of the forest is classified as old age forest and stand ages range from 141 years to 251+ years (Tripp et al. 2010).

BC Parks relies on zoning that divides the park into logical units to apply uniform and consistent management objectives such as Wilderness Conservation Zones, Recreational Zones, Natural Environment Zones and Special Feature Zones (Strathcona Park Master Plan 1993). Moyeha River Valley is a part of the Wilderness Conservation Zone and Special Feature Zone. The objective of the Wilderness Conservation Zone is to protect a remote, undisturbed natural landscape and to provide unassisted back country recreational opportunities dependant on a pristine environment. The Special Feature Zone has the objective to preserve and protect significant natural or cultural resources, features or processes because of their special character, fragility or heritage value.

The Moyeha River is located within the Ahousaht First Nations traditional territory. It continues to be an important river for the Ahousaht people, both for its salmon and its cultural significance.

METHODS

Effort

Surveys commenced August 25, 2011, and ended November 1, 2011. Beach seining occurred from September 14, 2011 through October 17, 2011. A 50 fathom knotted beach seine, which was 200 meshes deep, was deployed in pools located in sections 3.5, 4.0, and 5.0 (RKM 2.25, RKM 2.50, and RKM 3.00 respectively) from a 4.27 m Jon boat powered by a 25hp jet motor or a 9.9hp motor. The goal was to beach seine in more than one location each day and set more than once in each location if there were chinook observed but missed after the first set to maximize catch. Moving to each location and setting more than once depended on time it took to move to another location, conduct a seine set, and daylight availability.

Tangle netting started September 14, 2011 and ended October 1, 2011. Three tangle nets were used in which two were #19 River Series custom gillnets 12.07 cm x 60 mesh deep and 15.24 m in length and one had similar dimensions but was 17.78 cm in mesh size. Tangle netting was conducted during the day and night between RKM 1.50 and RKM 2.50. The net was stretched out across the width of the river to catch fish swimming up or retreating down the river.

Angling started September 14, 2011 and ended October 1, 2011. Anglers were equipped with a 10’ fibreglass fishing rod and Ambassadeur 7000 reel with 20lb monofilament main line, a 15lb leader, 1/0 barbless black hooks along with swivels, split shot and floats. Bait used was salmon roe cured with ProCure and borax. Anglers would walk the river banks or utilize a canoe to access the lower sections of the river and were dropped off by a helicopter to access the upper sections and waded or floated downstream in a rubber raft.

Carcass surveys were conducted from the migration barrier at RKM 13.5 to the estuary by two crews of two persons. One crew surveyed from RKM 13.5 to RKM 7.0. The second crew would collect carcasses from RKM 7.0 to the estuary. Surveyors used a hook and line to obtain carcasses from deep pools. The banks were also searched for carcasses that may have been pulled from the river by predators or washed ashore.

Catch

All live species captured by each method were recorded then carefully released back into the river. Live captured chinook salmon were marked with individually numbered and coloured Kurl-lock aluminium tags (Ketchum Manufacturing Inc., Brockville, Ontario, Canada K6V 7N5). These tags were applied on both opercula and a secondary mutilation mark, made with a paper-punch, was also applied to the operculum. The permanent mutilation mark permitted identification of tagged chinook that may have lost their Kurl-lock tags.

Biological samples were obtained from all chinook salmon to determine age composition. Samples from carcasses included otoliths for origin composition. Five scales were obtained from the preferred area of each salmon and placed in labelled scale booklets. Genetic samples were obtained by collecting the tissue(s) from the hole-punch that was applied to the operculum. Tissue samples were preserved in vials containing 95% ethanol. The scale and tissue samples were sent to the Pacific Biological Station, Nanaimo, British Columbia, for age and genetic analysis. Post-orbital hypural (POH) length of each salmon was measured to the nearest 5 mm using a fibreglass tape measure. Sex was determined visually from live chinook by assessing the maturity characteristics of the salmon such as kype pronouncement, mouth and abdominal size. For carcasses, sex was identified by dissecting the abdomen and examining the internal organs. Egg retention for females was also recorded (<10%, 25%, 50%, 75%, and 100%) once the carcasses were dissected. Biological samples for carcasses included otoliths. Otoliths were placed in numbered vials and sent to the Uchucklesaht Tribe to be analyzed. Carcasses were cut in half following sampling to prevent double counting.

Catch per unit of effort (CPUE)

CPUE was determined by dividing the chinook catch by the effort of each method:

$$\text{CPUE} = \frac{\text{Catch}}{\text{Effort}} \tag{1}$$

For each capture method, the total number of chinook obtained (catch) was divided by the total number of days fished by that particular method (effort).

Abundance

Chinook salmon abundance was to be determined by using a two-event Petersen closed population mark-recapture experiment (Seber 1982). No marked carcasses were recovered. The population size was too small to mark enough chinook to produce a Peterson estimate.

Age, sex, origin and tag loss proportions

The sample sizes were too small to provide an accurate or precise estimate of proportions of age, sex and origin. Tag loss could not be determined as no marked fish were recaptured.

Area-under-the curve estimation

The normative area-under-the curve (AUC) estimation procedure employed by DFO on the WCVI employs five to six snorkel surveys to estimate the number of spawners over time over a standardized reach. The visual observations are adjusted for the swimmers estimate of observation efficiency and a technician estimates survey life. The number of fish observed on each survey is expanded by the observer efficiency and plotted against the survey date. The AUC estimate is determined by dividing the integral of the escapement curve by the average residence time (survey life) of fish in the survey area (English et al. 1992).

The area under the curve plotted from the adjusted count data was calculated using the trapezoidal approximation:

$$A\hat{U}C = 0.5 * \sum_{i=2}^{n} (t_i - t_{i-1}) * (p_i + p_{i-1}) \qquad (2)$$

where t_i is the time of sampling measured from the day that fish entered the system, p_i is the count of live fish in the system on swim i and n is the number of observations + 2.

Escapement was calculated by division of the AUC by a survey life of 25 days in 2011 for the estimate determined by DFO.

$$\hat{N}_{AUCindex} = \frac{A\hat{U}C}{\hat{S}} \qquad (3)$$

where $\hat{S}$ is the survey life estimate or period the fish were available to be counted in the river counting sections.

Calibration of the AUC estimate

The AUC escapement estimate was to be compared to the Peterson estimate to determine an expansion factor. Since a Peterson estimate was not generated, an expansion factor was not developed.

RESULTS

Effort

A total of eight days of beach seining was conducted on the Moyeha River in the field. Crew members managed to set the seine net three times on one day and move to two locations in a day on a few occasions (Table 1). Tangle netting was conducted on a total of five days throughout the project (Table 2). Three sets were conducted during daylight hours and three sets were done during the night. Eight days were dedicated to angling with at least two anglers fishing (Table 3). A total of four carcass surveys were conducted in the Moyeha River during this project (Table 4).

Catch

Three chinook were captured by beach seining (Table 1). Two chinook were caught on September 29, 2011 at section 4 (RKM 2.50) after the large rainfall near the end of that month. Snorkel surveyors observed these two tagged salmon the following day and counted a total of 44 chinook salmon in the system. One tagged salmon was observed in the same pool from which it was tagged and the second was observed between sections 16 and 17 or RKM 8.50 to RKM 9.00 (Figure 8). The third chinook salmon was tagged on October 17, 2011 in section 4 and a tagged salmon was observed by snorkel surveyors on October 27, 2011 between sections 14 and 15 (RKM 7.50 – RKM 8.00). Other species captured by beach seine included chum salmon (n = 1850), coho salmon (n = 86), and trout (n = 4). The majority of chum salmon were caught near the end of September and beginning of October just after the peak migration of chinook salmon were observed by snorkel surveyors (Table 1).

There were no chinook salmon captured by tangle netting although other species of salmon were obtained (Table 2). A total of 30 chum salmon were caught in the tangle nets of which 23 were captured at night. Five coho salmon were caught in total of which two were caught at night as was one pink salmon (Table 2).

No chinook salmon were caught by angling. Other species captured by angling included chum salmon (n = 1), coho salmon (n = 9), and trout (n = 8) (Table 3). All of the coho salmon were caught on the last three days of angling from September 29 to October 1, 2011.

A total of nine carcasses were obtained during the carcass surveys (Table 4). Capture varied from one to three chinook per carcass survey. One carcass was obtained during the snorkel survey by DFO contractors.

Catch per unit of effort (CPUE)

Catch per unit of effort (CPUE) was determined for each of the capture methods and the carcass recoveries. CPUE for seining was 0.375 chinook per day or 0.273 chinook per pool fished (Table 1). There was no CPUE for tangle netting or angling because no chinook were caught with these methods of capture although other species were obtained (Tables 2 and 3). CPUE for carcass recoveries in 2011 was 2.25 chinook per day (Table 4).

Abundance

Sample size was too low and there were no recaptures during the carcass surveys to produce a Peterson estimate.

Age composition

Five scales were collected from each of the 12 chinook salmon sampled to determine the age composition. The samples include the three samples obtained during seining and the nine samples obtained from the carcasses. All scale samples were successfully read but one sample was regenerated and the age-2 jack salmon was removed from the final results (83.3%). The partially aged, regenerated sample was removed because one stream-type chinook was found. Out of the 12 samples collected, 10 were used in the final results (n = 10). The proportion of age-3 chinook salmon were 0.10 (SE = 0.10, CI = 0.00 – 0.44), age-4 was 0.80 (SE = 0.13, CI = 0.45 – 0.97), and age-5 was 0.10 (SE = 0.10, CI = 0.00 – 0.44) (Table 5). The age 5_2 chinook salmon was caught in the seine net and was larger than the other two chinook salmon captured by seine with a post-orbital hypural length of 756 mm compared to 630 mm and 670 mm respectively.

Sex

Sex was determined from 11 of the 12 chinook salmon sampled. Only male chinook salmon were obtained from seining. The ratio of males to females obtained from the carcass recoveries was 3.00:1.00. Too few carcasses were obtained to verify the visual gender assessments by dissection (Table 6). Gender bias in the recovery samples was apparent but could not be statistically compared due to the sparse data.

Origin

Nine otoliths were recovered out of the ten carcasses sampled to assess the proportions of wild and hatchery strays. All samples were successfully read. All sampled carcases were unmarked and assumed to be of wild origin (n = 9). Genetic samples had not been analyzed at the time of writing this report and the data will be added to the coast wide GSI baseline when analysis is completed.

Lengths

The length distributions of chinook captured in the seine net were not significantly different (D, = 0.40, P = 0.313) from the chinook obtained from the carcass recoveries although the samples sizes were small (n = 3 and n = 8 respectively). The average POH length for chinook captured in the seine net (n = 3) was 685 mm (SE = 30; 95% CI = 555 – 816) and ranged from 630 mm to 800 mm (Figure 9). Those recovered during carcass surveys ranged from 410 mm to 830 mm (Figure 9). Over half of the chinook obtained in the carcass surveys were over 650 mm in POH length (Figure 10). The average POH length for adult chinook salmon obtained from the carcass recoveries (n = 8) was 672 mm (SE = 46; 95% CI = 563 – 781). The sample size was too small to compare lengths by sex and there were no marked recaptures during the carcass surveys.

Area under the curve estimation

The AUC escapement result for the snorkel surveys conducted by the Department of Fisheries and Oceans was 60 adult chinook salmon with a peak observation of 44 individuals. The survey life used was 25 days and observer efficiency was estimated on a per section basis ranging between 90% - 95% (Figure 11). On average, the river was surveyed every 12 days with the largest gap between surveys being 18 days. A total of six surveys were conducted by DFO on the Moyeha River.

Calibration of AUC estimate

A Peterson estimate was not developed to compare with the AUC estimate in order to determine an expansion factor.

DISCUSSION

August and early September were relatively dry which made access to the river easy (Figure 4). The first large rainfall of 90 mm occurred on September 21, 2011 (Figure 5). This prevented field work for seven days. Field work resumed on September 29, 2011 after water levels subsided. There was a total of 250 mm of precipitation in September with the majority of rainfall at the end of the month. Crew members were able to effectively seine, tangle net, and angle during this month.

In October 2011, precipitation was variable throughout the month (Figure 6). Seining, tangle netting, and angling was conducted on October 1, 2011 after which angling and tangle netting were discontinued. This was the last day of tangle netting and angling due to a lack of success using these methods. Total precipitation for October was approximately 300 mm throughout the month. Along with the other capture methods, carcass surveys started in October and crew members managed one half river swim and two full river swims. October was the last month of effort to tag chinook salmon.

Precipitation in November 2011 increased throughout the month compared to October (Figure 7). No effort was anticipated in tagging and focus was on carcass recoveries. Total precipitation for November was approximately 370 mm and only one carcass recovery was conducted on November 1, 2011.

Beach seining, tangle netting and angling was conducted before chinook salmon were observed in the river in case some salmon were present that may have been missed by crew members. Beach seining appears to be the better method of capture compared to tangle netting and angling although the CPUE is low. Because of the low CPUE obtained, a mark-recapture experiment would not be feasible on this system.

Tangle netting at night was more effective in obtaining salmon species compared to during the day although no chinook salmon were caught. Most fish managed to avoid the tangle net during the daylight hours. Removing salmon from the tangle net was more difficult compared to the beach seine net. With the tangle net, crew members had to untangle each fish which could be time consuming especially for the large mature male chum salmon whose pronounced kype and teeth would become severely tangled in the net. This would also happen with the seine net but the knotted net prevented severe wrapping and entanglement. Overall, salmon took less time to remove from the seine net compared to the tangle net.

Angling effort was conducted throughout the river system to maximize river coverage and was conducted by at least two anglers. Angling was also conducted for a day on the Burman River to compare capture efficiency on the Moyeha River. One angler managed to capture three chinook on the Burman River in only an hour and a half compared to no captures during the entire field project on the Moyeha River.

Low chinook salmon abundance played a vital role in catch efficiency for all methods. Catch proved to be problematic with an estimated 60 adult chinook with a peak observation of 44 individuals in this system. During the peak migration, only a few salmon would stage within our seining locations and only for a short duration of time. The low return of chinook salmon also contributed to zero catch for tangle netting and angling considering other species with higher abundance such as coho and chum were obtained.

Carcass surveys covered the entire river and more effort was put towards walking the river banks to check for carcasses than was done in 2010. Our CPUE for 2011 (2.25) was higher compared to the previous year's CPUE (1.27). Increasing our bank coverage may have contributed to increasing our CPUE for carcass recoveries.

We obtained some partial information for age, sex, origin, and lengths. Moyeha chinook age compositions for age-3 and age-4 (10% age-3, 80% age-4) were also similar to the Burman chinook age-3 and age-4 composition (7.7% age-3, 88.4% age-4) for 2011 (Dunlop, personal communication). One aged sample had stream-type characteristics. According to Healey (1983), there is a distinct difference in distribution and behaviour of the two life history types of ocean-type and stream-type chinook. Approximately 1% of WCVI chinook, based on Nitinat Lake samples, are stream-type (Healey 1983). Nitinat and Moyeha chinook contribute to the Southwest Vancouver Island conservation unit and along with other Vancouver Island chinook populations, are predominately ocean-type chinook.

The otoliths analyzed for the 2011 study were all unmarked and assumed to be of wild origin. This differs significantly from our findings in 2010 where 46% were hatchery strays from Conuma hatchery. Hatchery fish tend to have lower fitness in natural environments than wild fish which could be caused by a number of factors including domestication selection in which positive selection for adaptation to the hatchery environment comes at the expense of adaptation to the natural environment (Araki et al. 2008). Overall, the sample sizes obtained from the chinook in both study years were small (n = 11 in 2010 and n = 9 in 2011) and annual sampling of this system would be required to get a better indication of hatchery contribution. Further investigation of hatchery contribution would be valuable in order to determine whether or not Moyeha River chinook are being impacted by hatchery strays.

It would have been beneficial for DFO to start the snorkel surveys sooner to obtain a zero count and ensure that we had minimal, if any, earlier migrants as the first survey identified 42 chinook salmon. Chinook salmon may have been entering the river earlier or may have arrived in the river all at once due to dry August-early September conditions followed by heavy rainfall but since no snorkel surveys were conducted until September 19, 2011, we simply don't know. An earlier snorkel survey would also have given us a better indication of run timing within this system. More frequent surveys and a survey conducted before the count of 42 individuals would have provided a better representation of the run size.

CONCLUSION AND RECOMMENDATIONS

The catch rates identified in 2011 do not support future mark-recapture efforts on the Moyeha River until escapements increase substantially from current levels. The two years of SSP research on the Moyeha River demonstrated that working with a small population in a mark-recapture experiment is difficult, particularly given the unpredictable stream flows on the WCVI in autumn. The 2011 research that focused on capture methodologies demonstrated that seining in this system has the most success in terms of CPUE, though small run size limits its effectiveness overall.

Efforts on this system should focus on AUC method swims. The DFO snorkel surveys are essential for determining escapement within this system. We also recommend increasing the frequency of the surveys to get more precise estimates of escapement. In an unpublished report prepared for the Department of Fisheries and Oceans, Labelle (2011) recommended eight to ten swims for more accurate AUC estimates.

Carcass surveys should be conducted annually in order to better understand hatchery contributions to natural stocks such as Moyeha River chinook. The DFO snorkel surveyors collected one carcass in 2011, but their CPUE was much lower compared to the carcass surveys. This is probably associated with the fact that they are focusing on live fish in the deeper parts of the river, whereas many of our carcasses were found on the river edges. For this reason we also recommend carcass surveys to continue annually so essential biological information such as origin can be determined.

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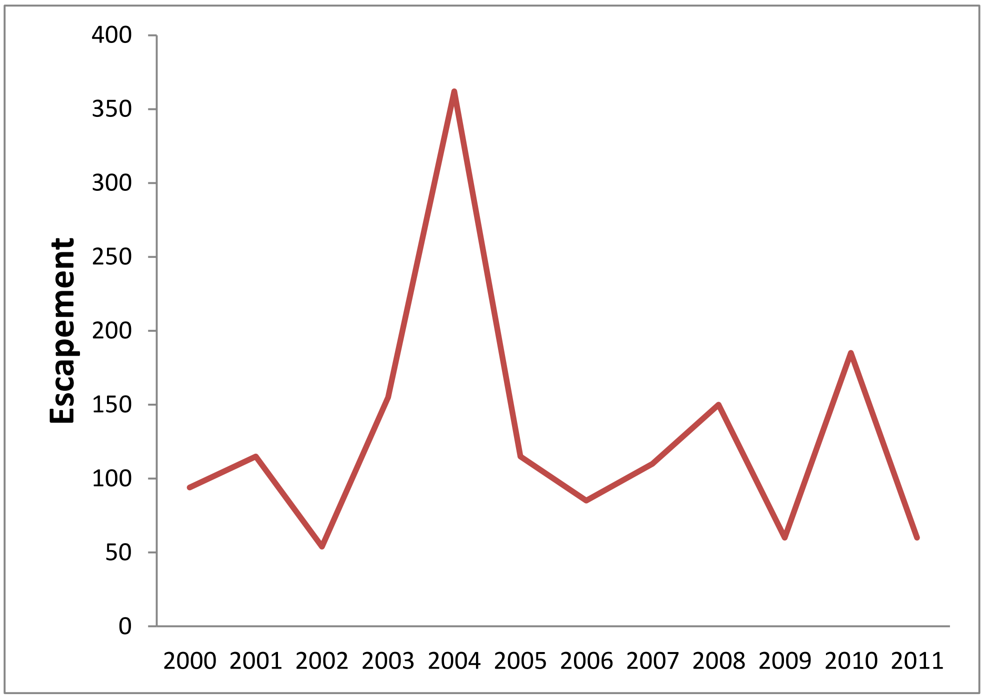
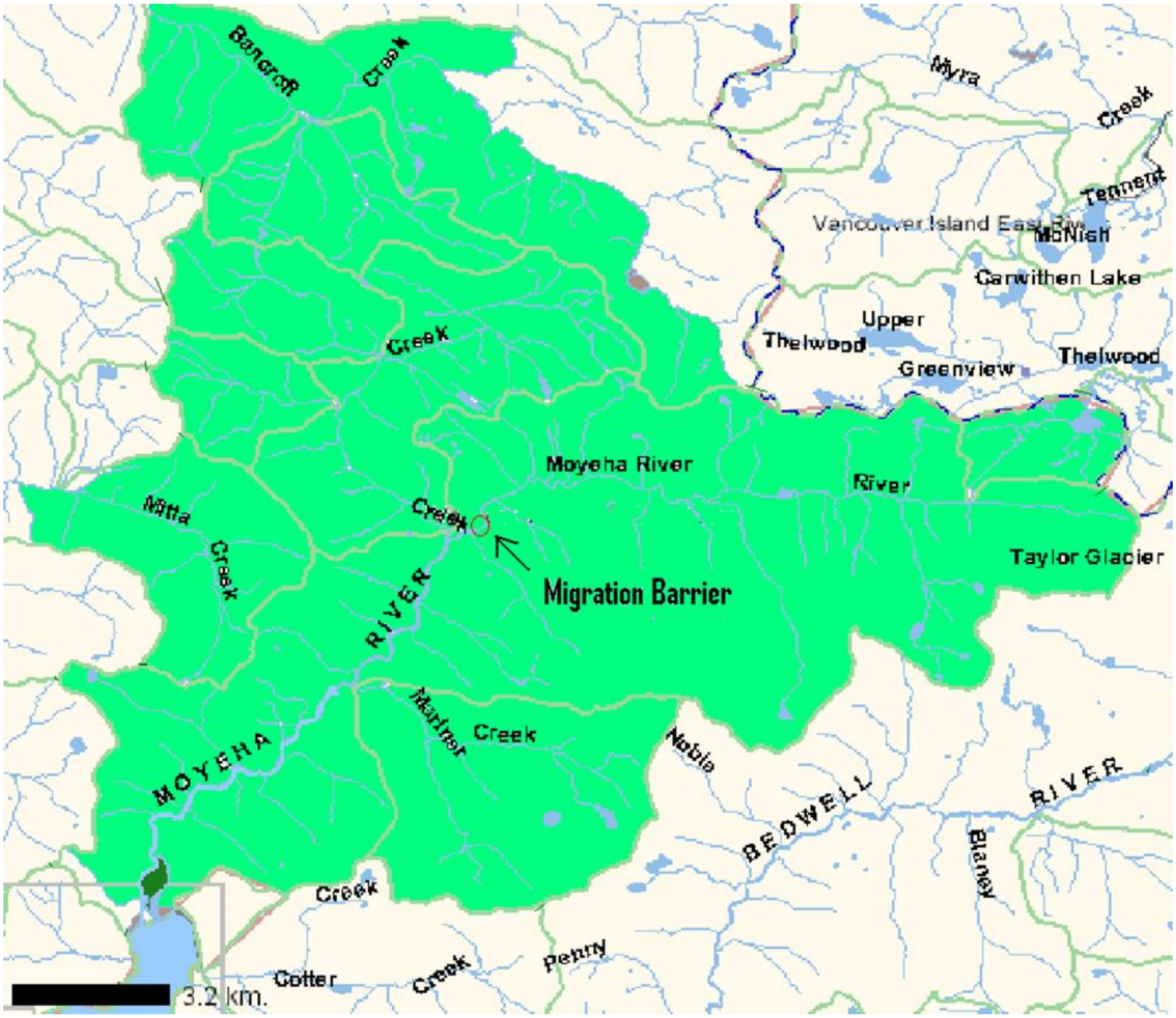


Figure 1. Moyeha River chinook AUC escapement estimates from 2000 to 2011.

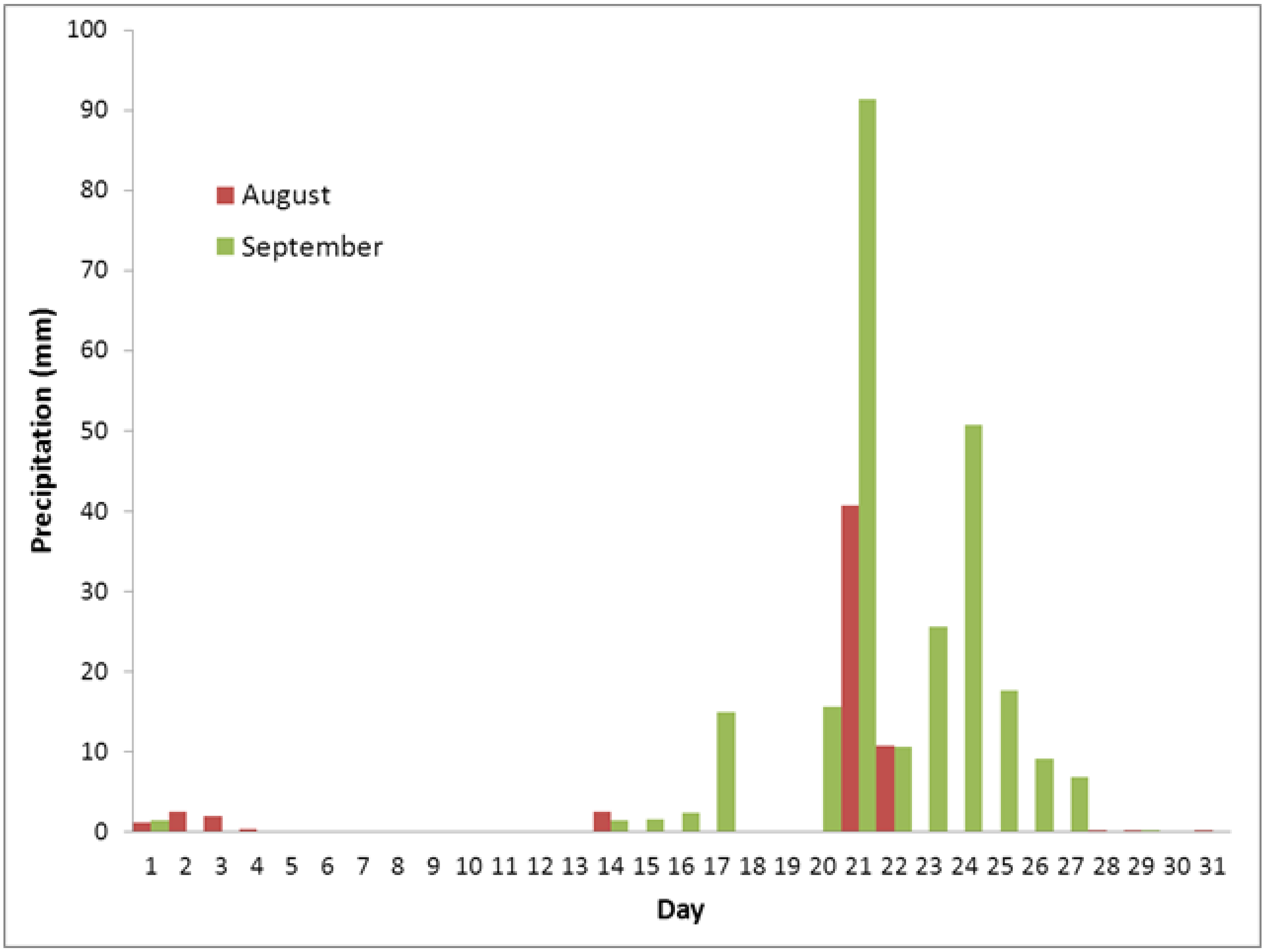
Made on mapster: http://www.pac.dfo-mpo.gc.ca/gis-sig/maps-cartes-eng.htm

Figure 2. Moyeha River location on Vancouver Island in Strathcona Park.



Made on mapster: http://www.pac.dfo-mpo.gc.ca/gis-sig/maps-cartes-eng.htm

Figure 3. Moyeha River watershed and approximate location of migration barrier.



Precipitation information available at: http://www.climate.weatheroffice.gc.ca

Figure 4. Precipitation from Tofino station A from August to September, 2011.

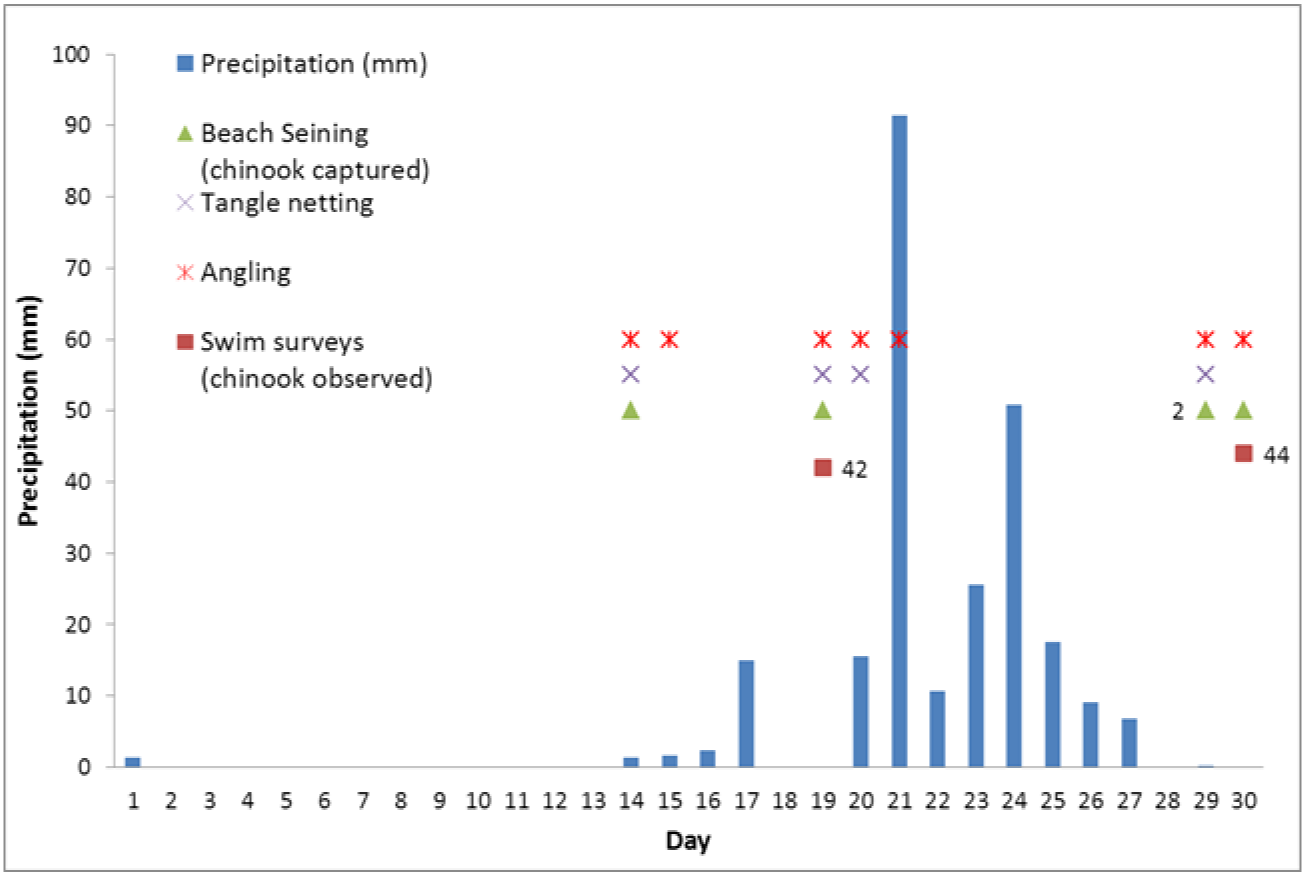


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Figure 5. Precipitation from Tofino station A and effort in the Moyeha River during September, 2011.

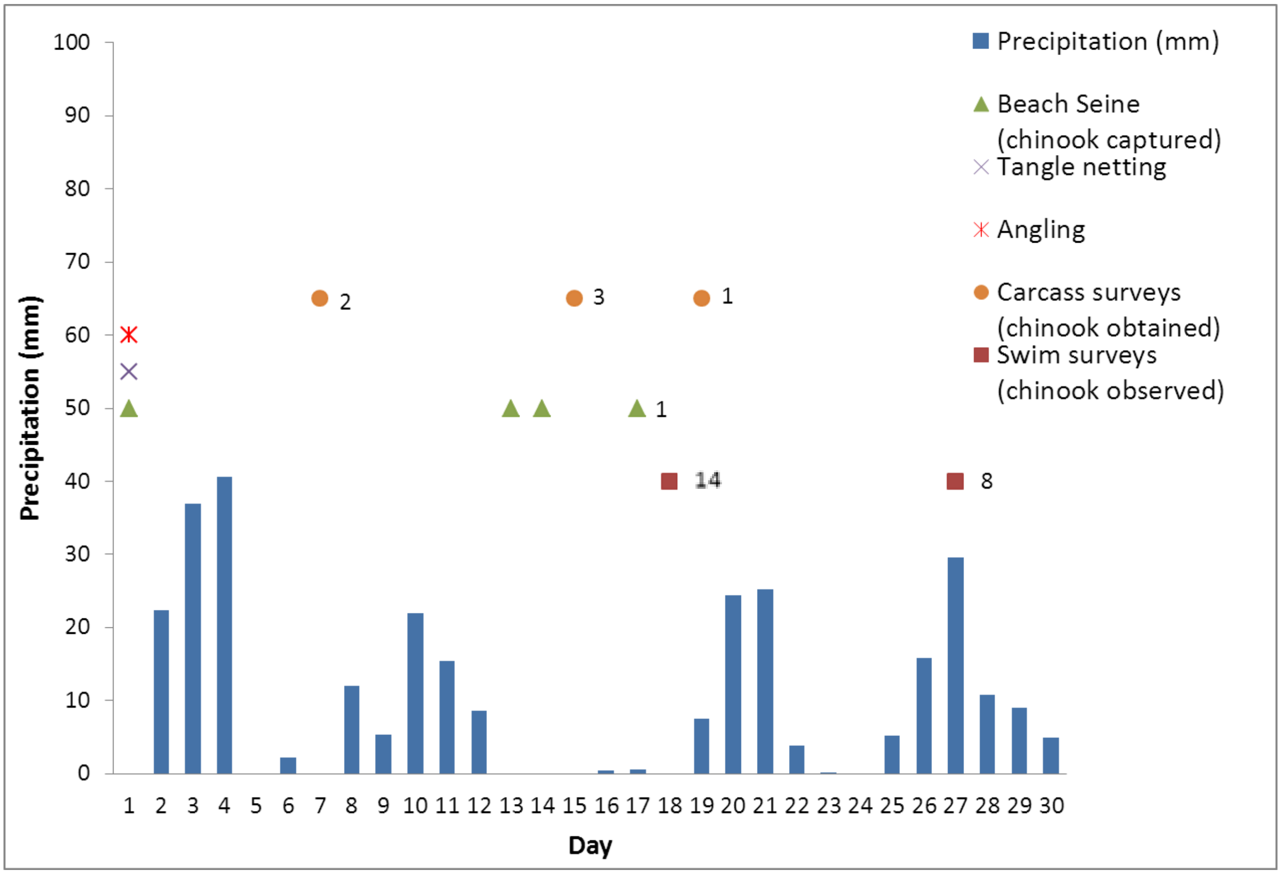

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Figure 6. Precipitation from Tofino station A and effort in the Moyeha River during October, 2011.

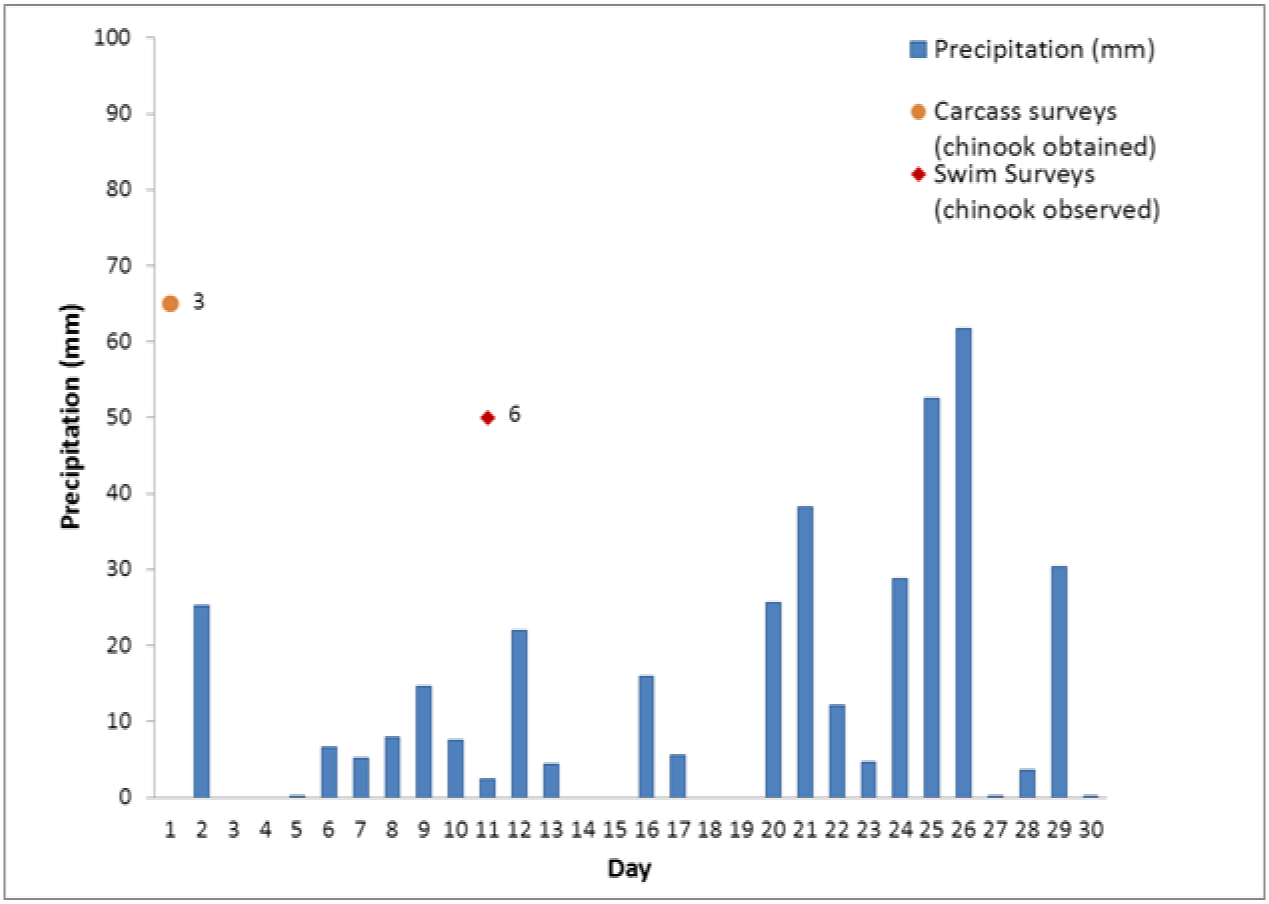

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Figure 7. Precipitation from Tofino station A and effort in the Moyeha River during November, 2011.

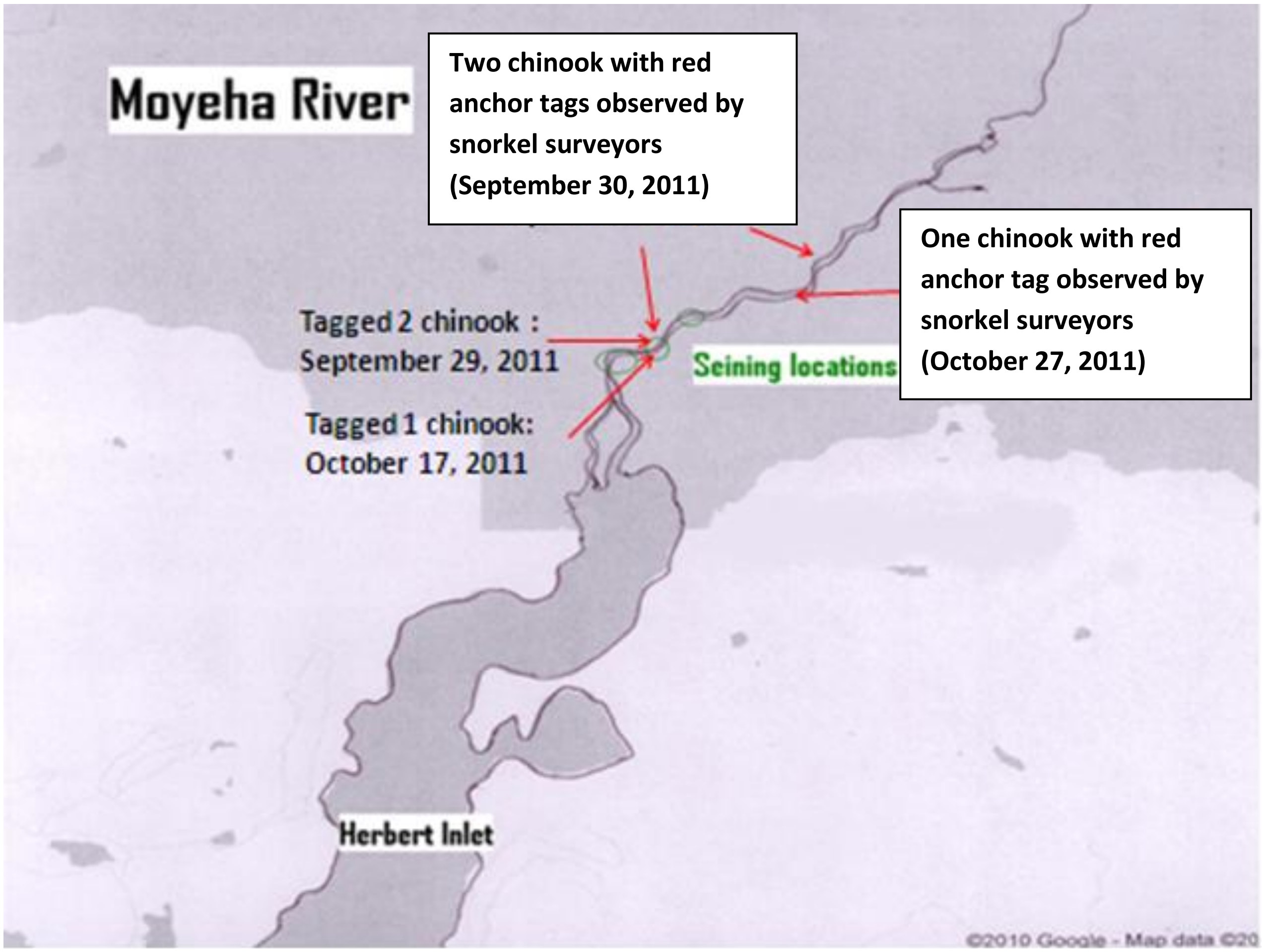

Figure 8. Locations of tagged and observed chinook salmon.

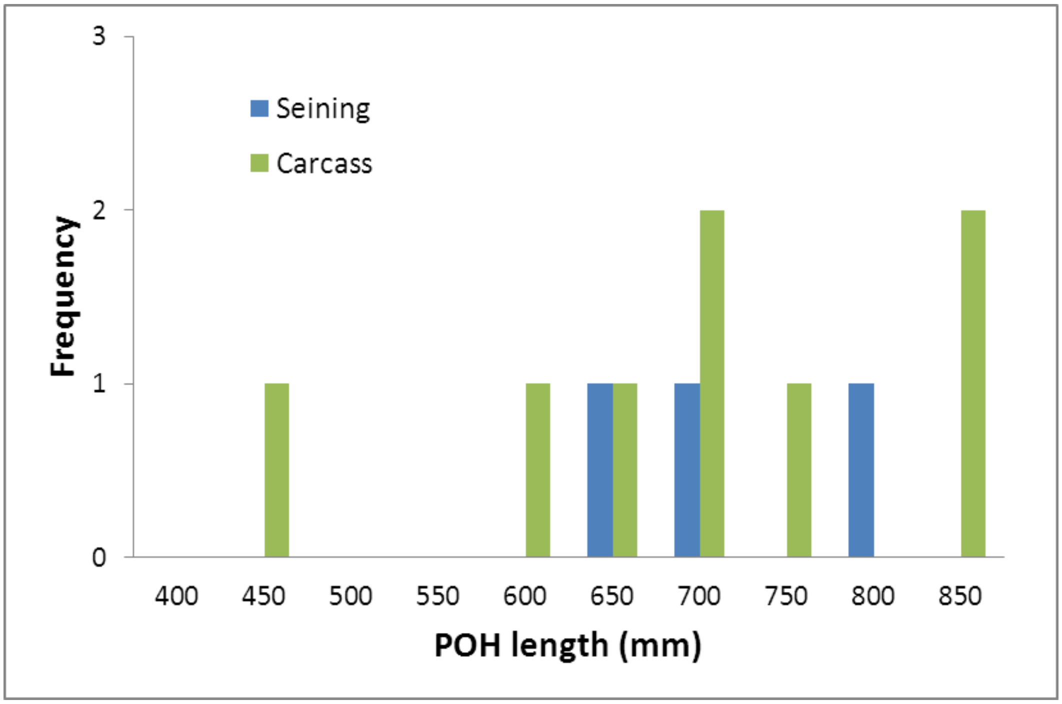

Figure 9. Length frequency of chinook salmon obtained during the beach seining and carcass events.

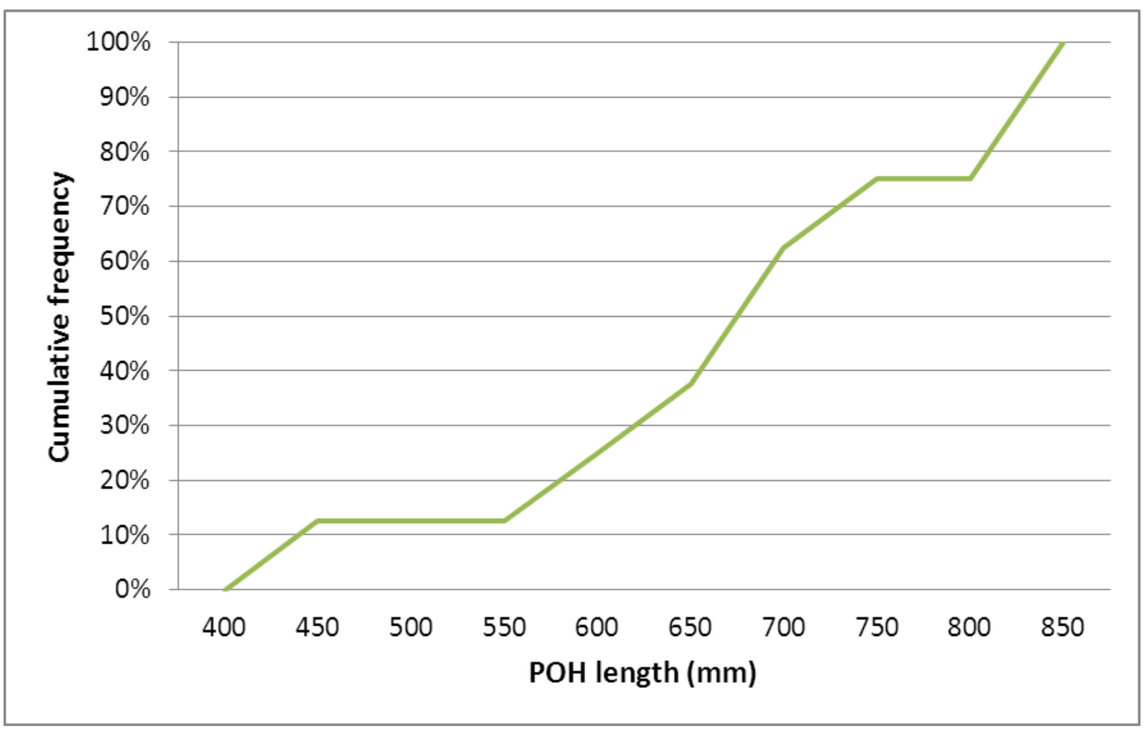

Figure 10. Cumulative length frequency of chinook salmon obtained during the carcass surveys.

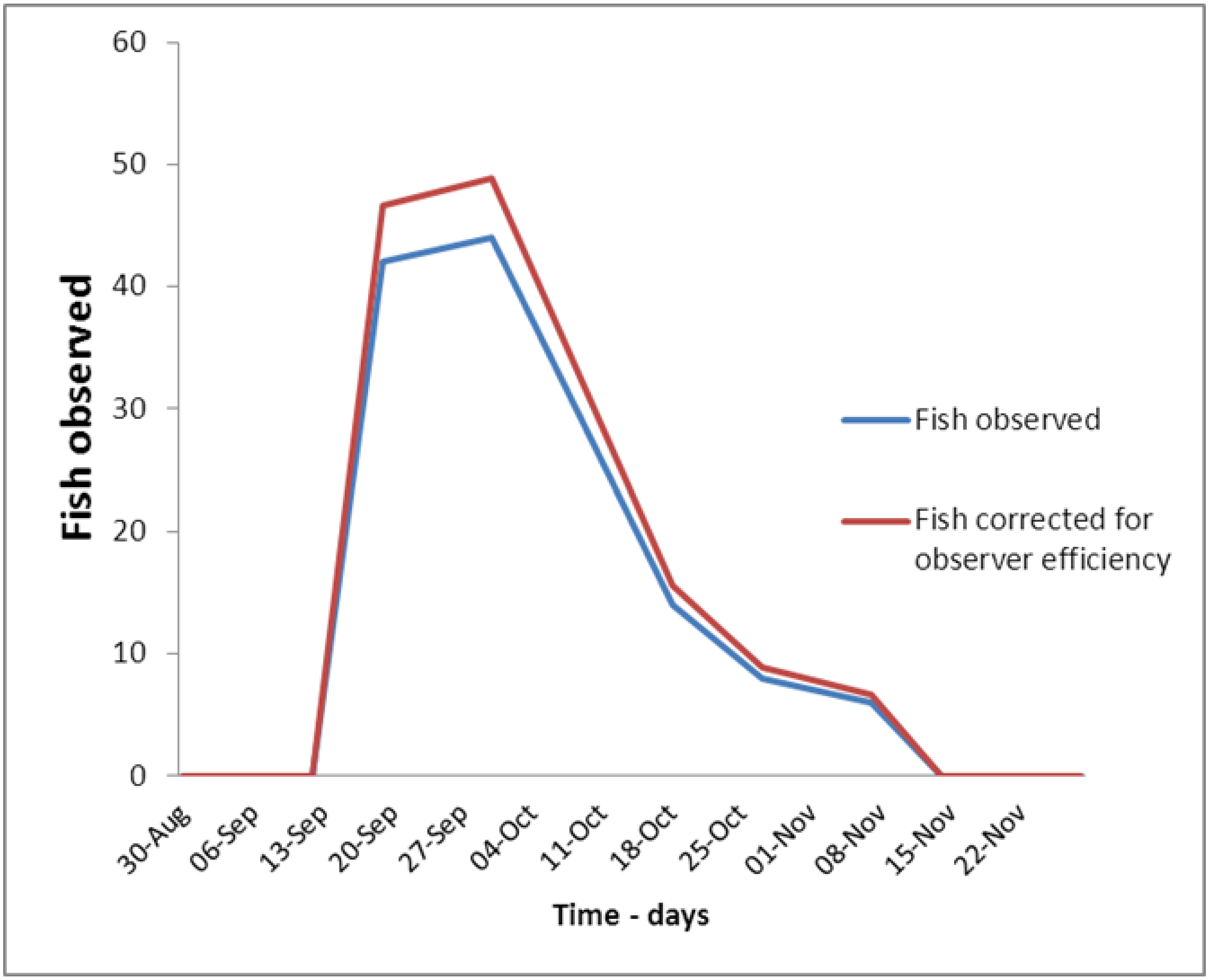

Figure 11. Number of adult chinook observed in the Moyeha River during 2011 snorkel surveys.

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Table 1. Catch per unit of effort using beach seining as a method of capture.

Date	RKM	Total Pools fished	Set(s)/pool	Live Captures			
				Chum	Coho	Trout	Chinook
14/09/2011	2.25	1	2	0	0	0	0
19/09/2011	2.50	1	3	32	26	1	0
29/09/2011	2.50	1	1	451	10	3	2
30/09/2011	2.50, 3.00	2	2	420	11	0	0
01/10/2011	2.50, 3.00	2	1	130	5	0	0
13/10/2011	2.50	1	1	314	15	0	0
14/10/2011	2.50, 3.00	2	1	384	18	0	0
17/10/2011	2.50	1	1	119	1	0	1
Total		**11**	**12**	**1850**	**86**	**4**	**3**
CPUE/day							**0.375**
CPUE/pool							**0.273**

Table 2. Catch per unit of effort using tangle netting as a method of capture.

Date	RKM	Soak time (hrs.min)	Number of sets	Night/Day	Live Captures		
					Chum	Coho	Pink
14/09/2011	2.25	2.00	1	Night	12	2	0
19/09/2011	2.50	0.20	2	Day	2	3	0
20/09/2011	2.25	3.00	1	Night	11	0	0
29/09/2011	2.25	2.00	1	Night	0	0	1
01/10/2011	2.00	1.00	1	Day	5	0	0
Total (night sets)					**23**	**2**	**1**
Total (day sets)					**7**	**3**	**0**
Total					**30**	**5**	**1**

Table 3. Catch per unit of effort using angling as a method of capture.

			Live Captures		
Date	RKM	Anglers	Chum	Coho	Trout
14/09/2011		2	0	0	0
15/09/2011	2.25 - 3.50	2	0	0	0
19/09/2011	2.50 - 5.50	3	0	0	3
20/09/2011	2.25 - 5.50	2	0	0	0
21/09/2011	2.25	2	0	0	0
29/09/2011	2.25 - 9.00	2	0	4	5
30/09/2011	1.00 - 2.50	2	1	3	0
01/10/2011	2.25	3	0	2	0
Total			**1**	**9**	**8**

Table 4. Catch per unit of effort for carcass recoveries.

Date	RKM surveyed	Chinook
07/10/2011	0.00 - 7.00	2
15/10/2011	0.00 - 13.50	3
19/10/2011	0.00 - 13.50	1
01/11/2011	0.00 - 13.50	3
Total		**9**
CPUE/day		**2.25**

Table 5. Age proportion obtained from scale samples collected during beach seining and carcass recoveries.

		Age 3.1	Age 4.1	Age 5.2	Total
Seine	Males	0	2	1	3
	proportion	0	0.67	0.33	1.00
Total					3
Carcass	Males	1	4	0	5
	proportion	0.14	0.57	0.00	0.71
	Females	0	2	0	2
	Proportion	0.00	0.29	0.00	0.29
Total					7
Total Males		1	6	1	8
Proportion		0.13	0.75	0.13	
SE		0.13	0.16	0.13	
CI		0.00 - 0.53	0.35 - 0.97	0.00 - 0.53	
Total Females		0	2	0	2
Proportion		0.00	1.00	0.00	
SE		0.00	0.00	0.00	
CI		0.00 - 0.84	0.16 - 1.00	0.00 - 0.84	
Total		1	8	1	10
Proportion		0.10	0.80	0.10	
SE		0.10	0.13	0.10	
CI		0.00 - 0.44	0.45 - 0.97	0.00 - 0.44	

Table 6. Male and female chinook obtained during the seining events and carcass recoveries.

	Seine	**Carcass**	**Total**
Male	3	6	**9**
Female	0	2	**2**
Unknown	0	1	**1**
Total	**3**	**9**	**12**

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APPENDIX 1. Seining days and chinook salmon captured and tagged.

Date	Section	Sex	Recapture	Tag # 1	Tag # 2	Punch location	Anchor tag	Adipose clip	POH length (mm)	Scale booklet	Scale #	Genetic Vial	Release condition	Comments
14/09/2011														No chinook caught
19/09/2011														No chinook caught
29/09/2011	4.0	m	n	470	471	right operculum	200600575	n	630	87101	1,41	321	good	
29/09/2011	4.0	m	n	466	467	right operculum	200600572	n	670	87101	2,42	322	good	
30/09/2011														No chinook caught
01/10/2011														No chinook caught
13/10/2011														No chinook caught
14/10/2011														No chinook caught
17/10/2011	4.0	m	n	460			200050065	n	756	87104	7-47		healthy	

Note: POH = Post orbital hypural

APPENDIX 2. Chinook salmon obtained during the carcass recovery surveys

Date	Section	Sex	Tagged	Fork Length	POH length (mm)	Scale booklet	Scale #	Adipose clipped	% Eggs retained	Otolith box	Otolith vial	Genetic vial(s)	Comments
07/10/2011	lower river	m			830	87106	1-41	no		143	11	354	missing 1 scale
07/10/2011	lower river	m			830	87106	2-42	no		143	18	325	missing 2 scales
15/10/2011	7km				840	87108	1-41					374; 356	No head. Half eaten by a predator.
15/10/2011	up-mid	m		723	565	87104	1-41	no		143	19	357	
15/10/2011	up-mid	m		910	735	87104	2-42	no		143	15	388	
19/10/2011	upper river	f	no	875	690	87107	1-41	no	0	143	4	378	
01/11/2011	upper river	m	no	530	410	87102	1-41			143	13	391	
01/11/2011	upper river	f	no	830	640	67342	1-21		0	143	2	373	
01/11/2011	upper river	m	no	840	675	87102	5-45			143	1	381	

Note: POH = Post orbital hypural

APPENDIX 3. Chinook salmon origin in the Moyeha River

Fish #	Date	Method of capture	Gender	Adipose clipped	Otolith box	Otolith vial #	Origin	% Eggs retained	Comments
1	07/10/2011	carcass recovery	male	no	143	11	wild		
2	07/10/2011	carcass recovery	male	no	143	18	wild		
3	15/10/2011	carcass recovery	unknown	unknown					No otolith recovered
4	15/10/2011	carcass recovery	male	no	143	19	wild		
5	15/10/2011	carcass recovery	male	no	143	15	wild		
6	19/10/2011	carcass recovery	female	no	143	4	wild	<10	
7	27/10/2011	snorkel survey			envelope		wild		
8	01/11/2011	carcass recovery	male	no	143	13	wild		Age 2
9	01/11/2011	carcass recovery	female	no	143	2	wild	<10	
10	01/11/2011	carcass recovery	male	no	143	1	wild		