## Gitksan Watershed Authorities

# Slamgeesh Lake
# Smolt Sampling Project
# 2009

**Report to Skeena Watershed Initiative**

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## ABSTRACT

After a gap of three years, we reinitiated smolt sampling for sockeye and coho at Slamgeesh Lake. A novel design velocity barrier fyke trap was fabricated and installed at the outlet of Slamgeesh Lake. It was attached to two trusses of the adult weir constructed in 2007. The sockeye smolt catch was 20% of the total run. This run is estimated as 30,254 ± 1567. This is a median value for the six years of record. The coho smolt catch was 5% of the total run. The coho smolt run is estimated as 51,046 ± 10,927, a relatively high value. Rigourous freshwater productivity estimates as smolts/female spawner will require one more year of data collection because smolts of both species leave after one and two years of residence. However since in the years we have sampled no more than a few percent of the sockeye are two year smolts, we can make a minimum estimate for sockeye production of 146 smolts/female. This is the highest value of five years for Slamgeesh Lake and relatively high compared to other sockeye lakes in BC. It appears that Slamgeesh sockeye have highly productive freshwater habitat and the serious declines in adult returns of the past decade are due to problems in the marine realm.

# TABLE OF CONTENTS

## LIST OF FIGURES



## LIST OF TABLES

# INTRODUCTION

For the past ten years the Gitksan Watershed Authorities (GWA) have been collecting information on adult and juvenile sockeye and coho in Slamgeesh Lake in the northern part of the Skeena watershed. Because of the long migration distance to this site, it is likely that both sockeye and coho populations are relatively more sensitive to fishing pressure and environmental disturbance (Holtby *et al.*. 1999, Gottesfeld & Rabnett 2009).

Sockeye salmon show extraordinary high levels of specialization to their rearing habitats. In the Skeena, sockeye from each rearing lake have a genetically unique character that separates them from sockeye in other rearing lakes. As a consequence, most of the salmon conservation units (CUs) developed under the Wild Salmon Policy are for sockeye salmon. Evaluation of the status of the sockeye CUs is dependent on comparing the productivity of the rearing habitat with its theoretical potential.

It appears that many of the small lake sockeye CUs are in serious decline. The first question to be raised about these stocks is "Is the problem in the freshwater or the marine part of the salmon life cycle?" The data we report here and data from previous studies is critical for answering this question. This report will focus on the relevant smolt studies that were made possible with a grant from the Skeena Watershed Initiative.

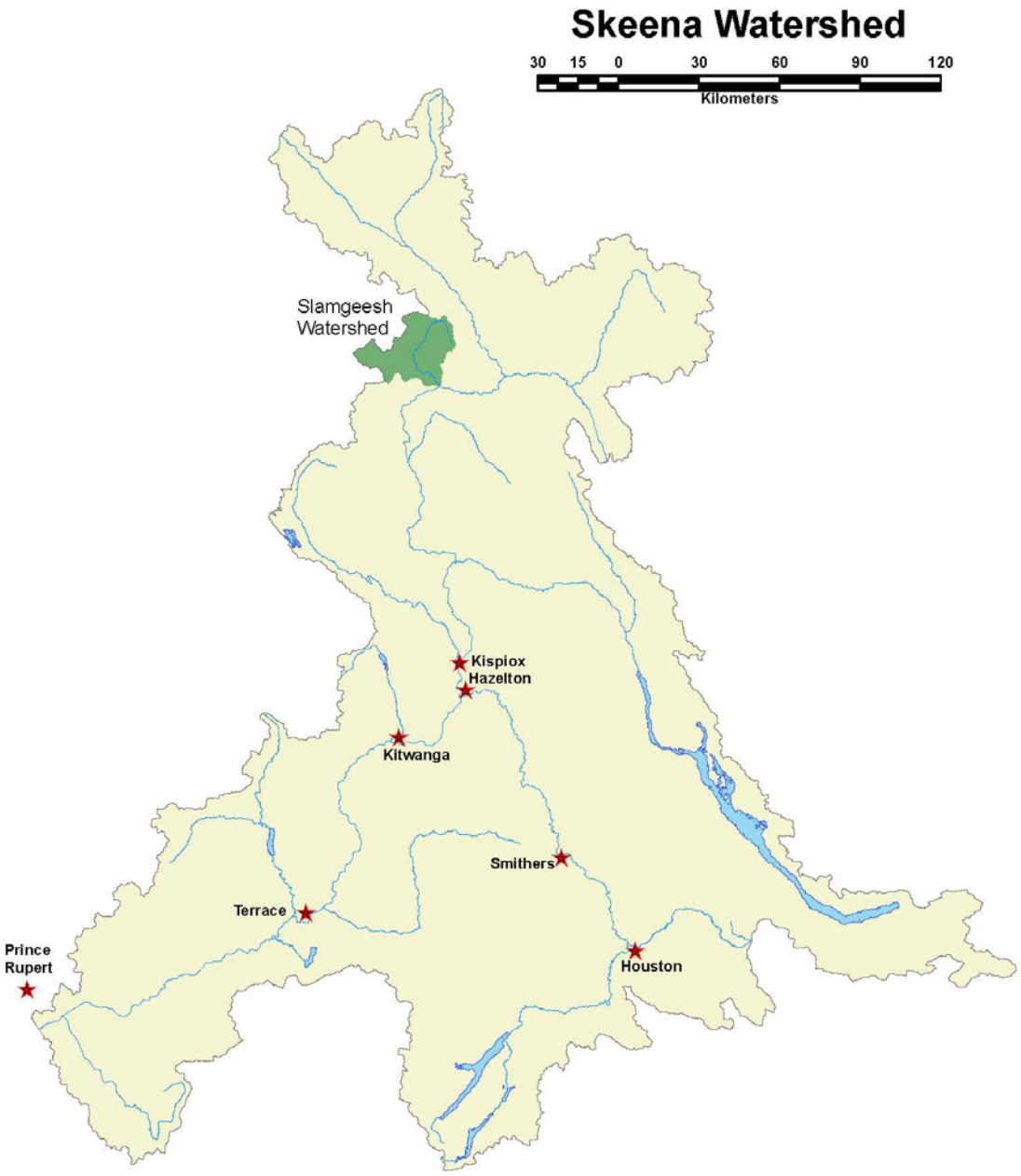


**Figure 1. Index Map of Skeena Watershed**

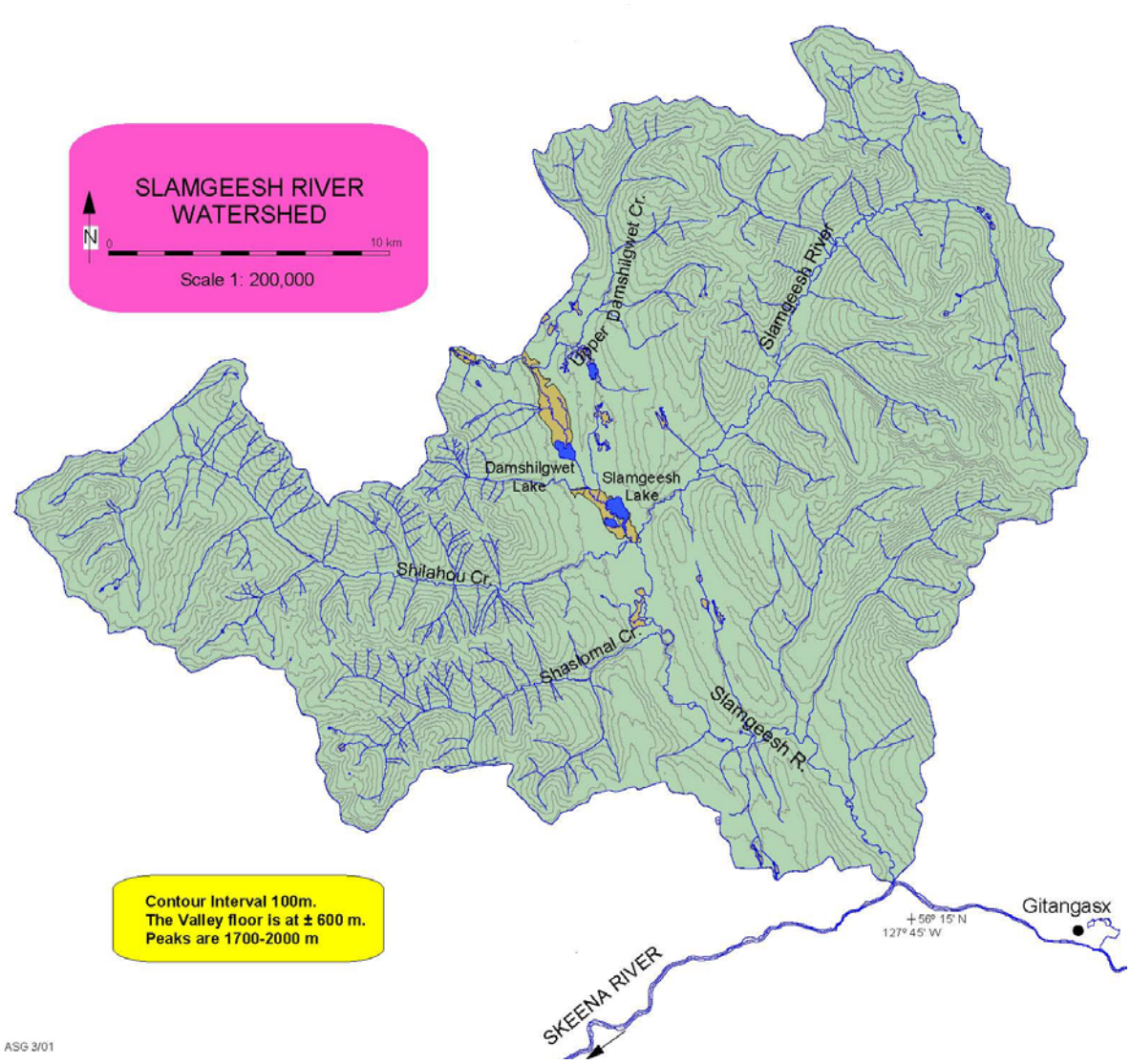


**Figure 2.Map of Slamgeesh Watershed**

# METHODS

Damshilgwet Creek a tributary of the Slamgeesh River, flows through two shallow, productive lakes: Damshilgwet Lake (34.6 ha) and Slamgeesh Lake (60.0 ha). Most of the sockeye and coho spawning occurs in the portion of Damshilgwet Creek between the two lakes. In the 2009 field season, studies were carried out on adult salmon of the five species that migrate to Damshilgwet Creek, smolts leaving Slamgeesh Lake, and fish habitat in the lakes and streams drained by Damshilgwet Creek.

## Smolt Trapping Summary

Between 2000 and 2005 Gitksan Watershed Authorities trapped emigrating sockeye and coho smolts at the outlet of Slamgeesh Lake. During these years a fyke trap of varying design and a 2x2 m inclined plane trap (IPT) were used to collect juveniles. Between 9% and 26% of the migrating smolts were trapped successfully (Hall and Gottesfeld, 2006). However, each trap had variable efficiencies during the season. This was mitigated somewhat by the complementary behavior of the two traps, as the fyke worked best at high flows and the IPT at low flows. Smolt trapping was not attempted in 2006 and 2007 because of budget constraints. Meanwhile, channel changes in the lower tributaries in 2006 and 2007 eliminated the possibility of fishing an IPT. This turned our focus to a weir-based system to trap and count smolts. We constructed a weir of perforated aluminum with three inclined plane fan traps and fished it for two weeks in 2008. The weir was of necessity a light weight structure since all components and construction equipment needed to be flown in. The rapid onset of the snowmelt flood removed the weir. It was apparent that the structure of the weir was too weak to support the three fan traps which required backing up Slamgeesh Lake by 1m for sufficient flow depth. In 2009 we installed a simplified mesh fyke trap and were successful in fishing a complete smolt season. This is the report of that activity.

## 2009 Smolt Trap Design

In April 2009 we were able to modify a smolt fyke trap to function at the Slamgeesh adult weir site with funds provided by the Skeena Watershed Initiative. The smolt trap (Figure 3) is 1.8 m wide and covered with 3/8" and 1/2" stainless steel hardware cloth mesh. The upstream end was adjusted to fit between two trusses of the adult trap structure. A floating live box was connected downstream of the fyke with 6" stainless steel ducting. Custom fabricated stainless steel screw jacks were mounted to each side of the trap outflow end to stabilize the trap at the desired height. The jacks were bolted to cement block bases with a hinged attachment. We installed a 3 m long steel fence with 5 cm mesh approximately 10m above the trap to minimize weeds and ice blocking the trap entrance,

The trap was fished close to the right bank approximately at the point of highest water velocity. A highline cable system permits the easy movement of the trap from a storage shed to the fishing position and removal for service and maintenance.

The smolt trap acts as a velocity trap. When smolts enter the trap (Figure 4) they cannot leave it because the velocity at the fyke openings exceeds their peak swimming speed. Ultimately the smolts explore the downstream end of the trap and accumulate in the live box. As larger fish such as bull trout can enter and leave the trap, we inserted a screen with 5 cm openings in the fyke entrance to exclude predatory fish and mammals.

**Figure 3. Smolt fyke trap in fishing position.**

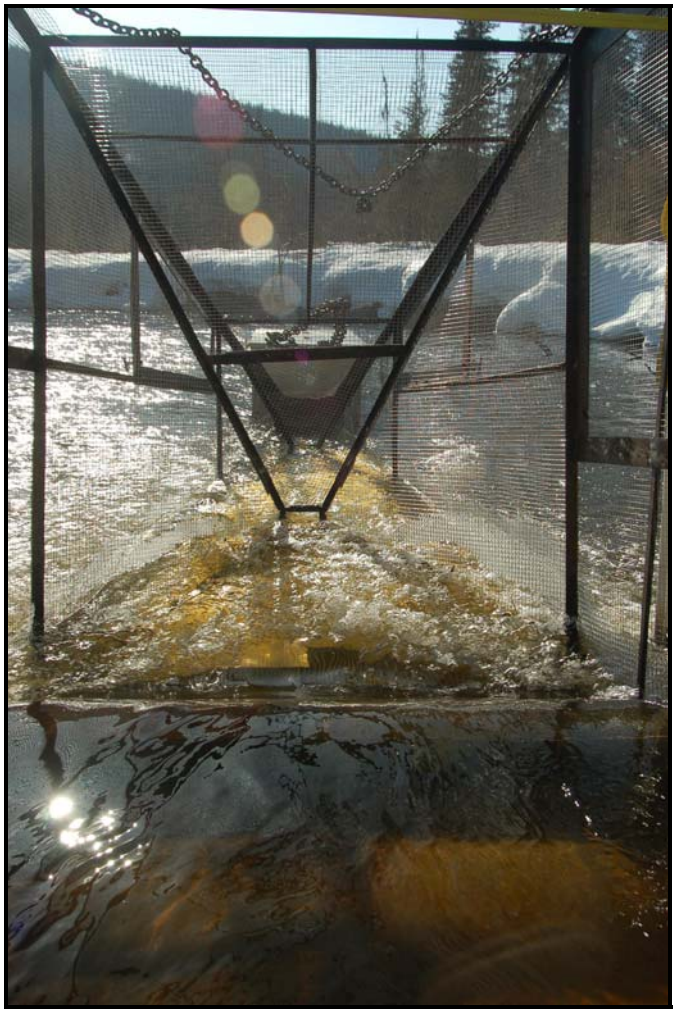

**Figure 4. View upstream of the trap fykes under typical fishing conditions.**

### Smolt Sampling

Smolt sampling occurred between May 2nd to July 11th, throughout the coho and sockeye smolt emigrations. Live-boxes were checked daily and all fish were removed and recorded. We measured lengths (snout-fork) for up to 50 sockeye and coho each day. Other species were counted and lengths recorded. Scale samples were collected from sockeye and coho with a stratified sampling design intended to take scales from 20 fish for each 10 mm length class. All sampled smolts were anesthetized using tricaine methanesulfonate (TMS), to facilitate handling.

### Smolt Mark-Recapture Population Estimation

The marking program is used to estimate the total smolt population of sockeye and coho migrating from Slamgeesh Lake. The modified Petersen equation, adapted from Seber (1982), was used to estimate the total smolt population of each species (Hall and Gottesfeld, 2006).

For the mark-recapture experiment, all marked smolts (sockeye and coho) had their adipose fin clipped. A coded wire tag (CWT) was implanted into the nose of every marked coho smolt using a Mark IV tagging machine (Northwest Marine Technology Ltd.). Oxygen and temperature were maintained by continuously circulating stream water through the holding containers. After marking, the fish were transported via boat approximately 500 m upstream into Slamgeesh Lake and released. Any dead fish upon release were recorded and subtracted from the "marked" count. Smolts that are not marked, dead, or held for a survival experiment and those recaptured were released downstream of the smolt fence in Damshilgwet Creek.

# RESULTS

## Smolt Trapping

### Smolt Trap Capture

In 2009 the newly installed fyke trap caught an estimated 20% of the sockeye smolt run (n=7080). This capture rate is comparable to previous years when two traps were used and combined as shown in Table 1 for years 2000-2005. We calculate that the coho smolt catch of 2,755 fish was approximately 5% of the run.

**Table 1. Total smolt catches and calculated overall capture rate by year and species.**

| Year | Sockeye # Caught | Sockeye % Captured | Coho # Caught | Coho % Captured |
|---|---|---|---|---|
| **2009** | 7,080 | 20% | 2,755 | 5% |
| **2008*** | 633 | - | 292 | - |
| **2005** | 5,294 | 24% | 6,815 | 23% |
| **2004** | 8,301 | 38% | 16,242 | 21% |
| **2003** | 6,945 | 19% | 6,871 | 15% |
| **2002** | 10,448 | 46% | 3,249 | 16% |
| **2001** | 9,126 | 27% | 5,591 | 21% |
| **2000** | 2 | - | 71 | - |

***partial capture for incomplete sampling of 2008 run**

The smolt trap is highly selective for migrating sockeye and coho smolts. About 99% of the total catch were the target species. Other fish species caught are shown in Table 2. The highest catch other than the target species was bull trout.

**Table 2. Total number of non-target species caught by the smolt trap in 2009.**

| Chinook | BT/DV | Rainbow Trout | Prickly Sculpin | Longnose Sucker | Mountain Whitefish |
|---|---|---|---|---|---|
| 0 | 53 | 8 | 43 | 22 | 2 |

**Smolt Migration Timing**

Sockeye smolts were caught over a period of 44 days from May 3rd to June 15h (Table 3). The peak sockeye smolt catch was on May 14th with 2300 sockeye smolts caught. This was the day the last of the ice melted on Slamgeesh Lake. The median day of the sockeye smolt migration was May 15, a date closely comparable to smolt migration peaks in past years.

**Table 3. Sockeye smolt catch timing in 2009 and 2001 – 2005 from combined trap totals.**

| Year | First | Midpoin | Ice Melted | Last | Duratior | Traps Installec | Traps Removed |
|---|---|---|---|---|---|---|---|
| 2009 | May 3 | May 15 | May 14 | June 15 | 44 days | May 2 | July 11 |
| 2005 | May 4 | May 14 | May 7 | June 18 | 46 days | May 3 | June 30 |
| 2004 | May 2 | May 12 | May 5 | June 15 | 45 days | May 1 | June 30 |
| 2003 | May 5 | May 12 | May 11 | June 23 | 49 days | April 25 | July 10 |
| 2002 | May 10 | May 20 | May 19 | June 29 | 51 days | May 3 | July 14 |
| 2001 | May 12 | May 23 | May 23 | July 6 | 56 days | April 30 | July 11 |

Ninety-eight percent of the sockeye smolts were caught over a period of 15 days from May 11th to May 25th (Figure 5). Seventy-eight percent of the sockeye smolt migration occurred over a period of 7 days from May 13th to May 19th.

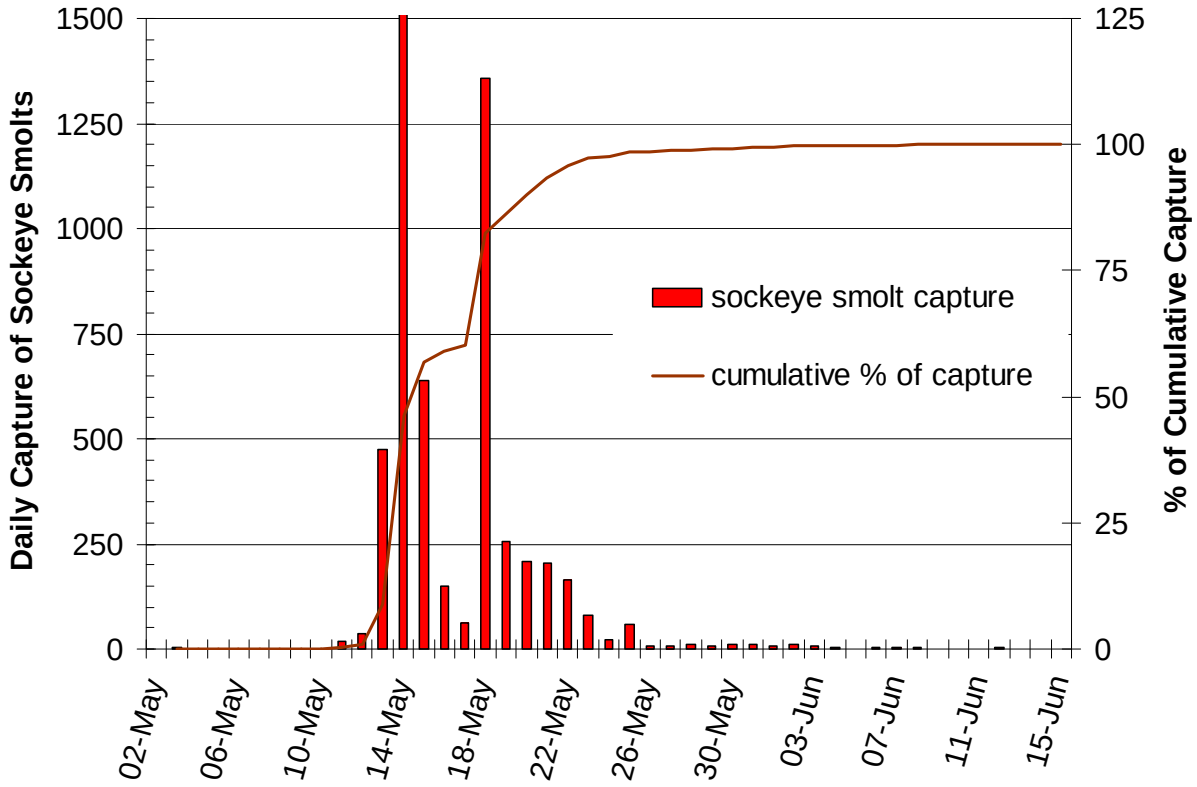


**Figure 5. Sockeye smolt catch presented as daily catch and a cumulative catch.**

Coho smolts were caught by the fyke trap over a period of 57 days from May 3rd to July 8th (Table 4). In all years, coho smolts have been caught within one day of when the traps were installed. Trapping continued until the coho catches reached or approached zero. The 2009 midpoint of the coho smolt migration was June 5th, which was similar to 2004 and 2005 runs.

**Table 4. Coho smolt catch timing from combined trap totals 2001 – 2005.**

| Year | First | Midpoint | Peak | Last | Duration | Traps Installed | Traps Removed |
|---|---|---|---|---|---|---|---|
| 2009 | May 3 | June 5 | May 18 | July 8 | 67 days | May 2 | July 11 |
| 2005 | May 3 | June 9 | June 11 | June 28 | 57 days | May 3 | June 30 |
| 2004 | May 1 | June 9 | June 16 | June 27 | 58 days | May 1 | June 30 |
| 2003 | April 25 | May 29 | May 14 | July 10 | 77 days | April 25 | July 10 |
| 2002 | May 4 | June 14 | June 29 | July 14 | 72 days | May 3 | July 14 |
| 2001 | April 30 | June 14 | June 18 | July 10 | 72 days | April 30 | July 11 |

Consistent with the previous years, the duration of coho migration was much greater than the sockeye migration with 97% of the migration occurring over 40 days (Figure 6). The peak daily coho catch was 114 on May 18th and the second highest daily catch of 93 was on June 27th. These peak catches were lower than all previous years of smolt trapping, probably because of lower trap efficiency.

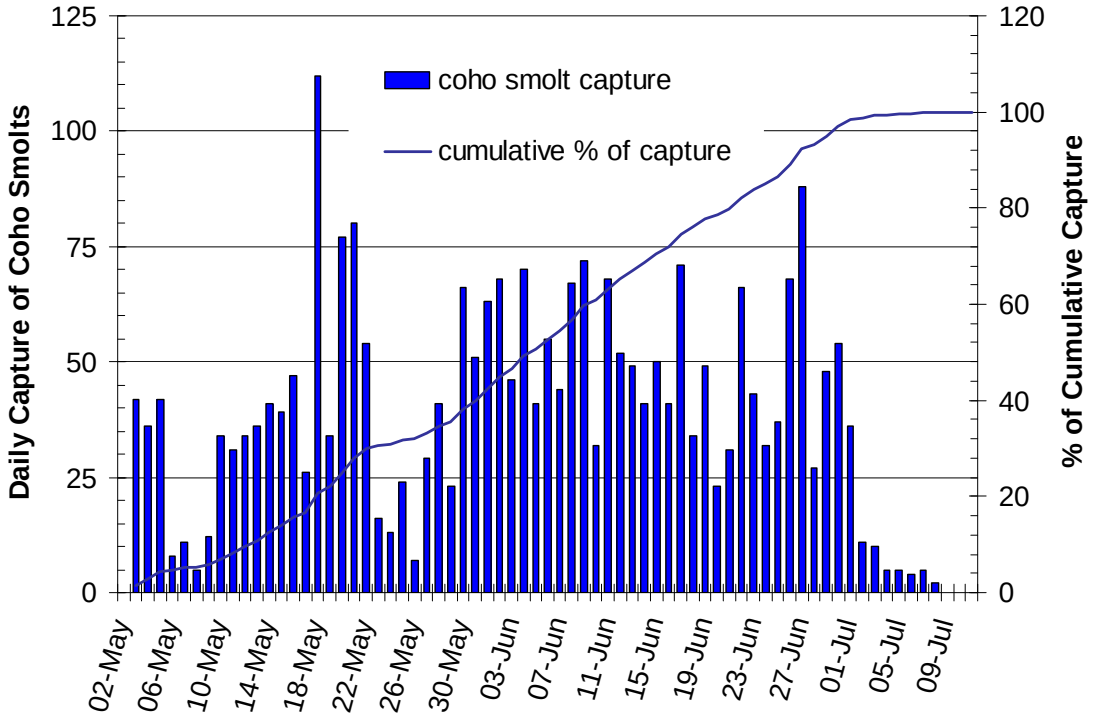


**Figure 6.Coho smolt catch presented as daily counts and as a cumulative curve**

**Smolt Size**

The mean length of the sockeye smolts in 2009 was 104.8 mm, about in the middle of the range of previous years' values (Table 5). Weights were not taken this year. Sockeye smolt sampling from five previous years give an overall mean of 10.22g.

**Table 5. Sockeye smolt lengths by year.**

| Year | Length (mm) | | | |
|---|---|---|---|---|
| | Mean | Min. | Max. | N |
| 2009 | 104.8 | 74 | 201 | 664 |
| 2005 | 107.3 | 78 | 274* | 704 |
| 2004 | 112.8 | 86 | 190* | 1129 |
| 2003 | 100.1 | 72 | 150 | 627 |
| 2002 | 99.9 | 71 | 193 | 761 |
| 2001 | 103.9 | 74 | 140 | 2233 |

*Not included in average due to non-random sampling

**Table 6. Sockeye smolt lengths (mm) by age class and year.**

| Year | Age 1.0 | | | Age 2.0 | | |
|---|---|---|---|---|---|---|
| | Mean | N | Rank | Mean | N | Rank |
| 2009 | 107.2 | 148 | 2 | 155.8 | 10 | 3 |
| 2005 | 107.1 | 704 | 3 | 200.0 | 1 | 1 |
| 2004 | 112.4 | 1,111 | 1 | 136.4 | 18 | 5 |
| 2003 | 99.7 | 620 | 5 | 140.5 | 7 | 4 |
| 2002 | 99.7 | 759 | 5 | 178.3 | 3 | 2 |
| 2001 | 103.9 | 2,233 | 4 | n/a | 0 | n/a |

The mean coho smolt length was 115.6 mm (Table 7). This is the lowest of the six years sampled. Weights were not taken this year because we have a large set of previous measurements and see little year-to-year difference. Based on the regression for 2003 data the most similar size set, a coho of 115.6 mm weighs 15.6 g. Coho smolt sampling from five previous years have mean weights ranging from 17.9g to 26.1g.

In 2009 there were some age 0 coho (fry) collected. These 209 coho fry range from 23 to 70 mm in length. These data were kept separate from the smolt enumeration and sampling analysis. Sixty-seven of the presumed fry cohort 40-57 mm long were aged by scale reading and shown to be all age 0. Two fish within this size range in the non-stratified length sample for smolts were removed from the sample.

**Table 7. Coho smolt lengths (mm) by year.**

| Year | Length (mm) | | | |
|---|---|---|---|---|
| | Mean | Min. | Max. | N |
| 2009 | 115.6 | 50 | 182 | 1898 |
| 2005 | 129.6 | 83 | 320* | 1674 |
| 2004 | 126.8 | 62 | 180 | 2054 |
| 2003 | 117.9 | 56 | 200* | 2182 |
| 2002 | 120.4 | 72 | 277* | 2363 |
| 2001 | 131.4 | 71 | 299 | 2644 |

Note: Min. and max lengths and weights may not correspond to the same fish.
*Not included in average due to non-random sampling

Since scale samples for ageing are not taken randomly, the proportions by age class are applied to the sample of coho smolt lengths to get mean lengths for each age class (Table 8). A single age 3.0 coho smolt was in the stratified sample group. Only three age 3.0 smolts have been recorded in the past.

**Table 8. Coho smolt lengths (mm) by age class and year.**

| Year | Age 1.0 | | | Age 2.0 | | |
|---|---|---|---|---|---|---|
| | Mean | N | Rank | Mean | N | Rank |
| 2009 | 107.2 | 806 | 6 | 132.3 | 1076 | 3 |
| 2005 | 124.9 | 933 | 1 | 135.5 | 741 | 2 |
| 2004 | 122.1 | 1096 | 2 | 132.1 | 958 | 4 |
| 2003 | 112.6 | 1249 | 5 | 125.1 | 933 | 6 |
| 2002 | 113.9 | 1257 | 4 | 127.5 | 1104 | 5 |
| 2001 | 117.9 | 819 | 3 | 137.5 | 1823 | 1 |

**Smolt Length Frequencies**

Of the 664 sockeye smolts measured for length (non-stratified sample), the modal length category was 98 to 100 mm (Figure 7). This is consistent with samples from 2001-2004. The year 2005 had the highest mode of 105 to 106 mm.

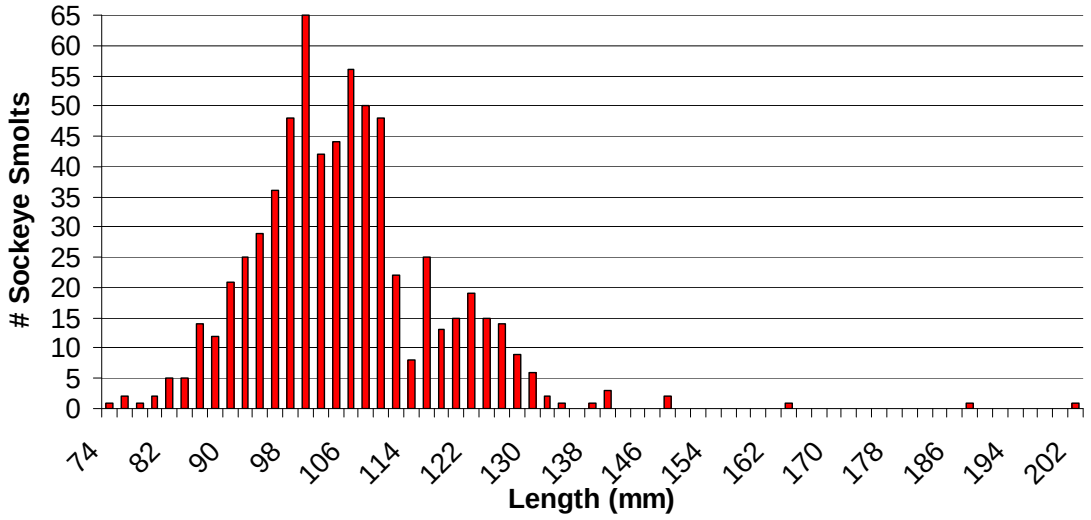


**Figure 7. Sockeye smolt fork length frequency (N = 664).**

There were 1898 coho smolts measured for length over the entire trap capture period. The most frequent length category (modal length) was 116 to 118 mm. This is consistent with samples from 2001-2005. The length frequency distribution of coho in 2009 was not strongly bi-modal similar to what was found in previous years (2002 to 2004).

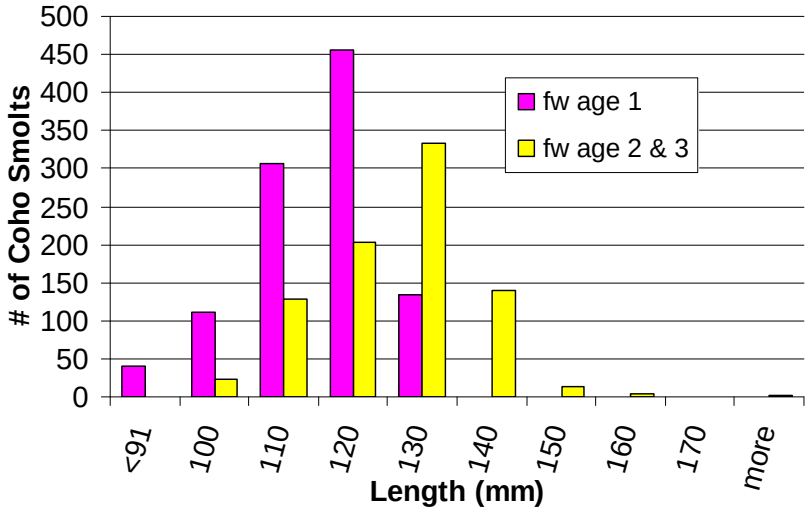


**Figure 8.Coho smolt fork length frequency (N =1898).**

**Sockeye Smolt Ages**

In 2009 a sample of 160 sockeye smolts with lengths ranging from 78 to 200 mm had scales collected for age determination. Of these smolt scale samples, 158 were successfully aged. Ten of the 155 (6.3%) were aged 2.0 while the rest were aged 1.0. Age 1.0 sockeye smolts ranged in length from 75 to 138 mm while age 2.0 sockeye ranged in length from 120 to 195 mm resulting in a significant overlap.

Sockeye smolts sampled for age determination were grouped into size classes (length ranges) of 20 mm. The proportion of age 1.0 sockeye smolts is shown in Table 9. These proportions were then applied to the sockeye length distribution from randomly sampled smolts to determine the contribution of each age class to the overall smolt population. This resulted in a 2.2% age 2.0 contribution for 2009 is similar to the previously sampled years which ranged from 0 to 2.9%.

**Table 9. Percentage age 1.0 sockeye smolts by fork length range (mm).**

| Year | | < 80 | 81-100 | 101-120 | 121-140 | 141-160 | 161-180 | > 181 | Total N |
|---|---|---|---|---|---|---|---|---|---|
| 2009 | % | 100% | 100% | 99% | 94% | 0% | 0% | 0% | 158 |
| | n | 4 | 42 | 73 | 32 | 3 | 2 | 2 | |
| 2005 | % | 100% | 100% | 100% | 100% | 100% | 0% | 0% | 65 |
| | n | 1 | 11 | 31 | 16 | 4 | 1 | 1 | |
| 2004 | % | n/a | 100% | 100% | 95% | 33% | 0% | 0% | 134 |
| | n | 0 | 9 | 73 | 37 | 3 | 10 | 2 | |
| 2003 | % | 100% | 100% | 100% | 89% | 0% | n/a | n/a | 44 |
| | n | 1 | 10 | 17 | 9 | 7 | 0 | 0 | |
| 2002 | % | 100% | 100% | 100% | 100% | 100% | 0% | 0% | 97 |
| | n | 2 | 32 | 31 | 29 | 1 | 1 | 1 | |
| 2001 | % | n/a | 100 | 100 | 100 | n/a | n/a | n/a | 54 |
| | n | 0 | 17 | 27 | 10 | 0 | 0 | 0 | |

**Coho Smolt Ages**

Scales were sampled from a total of 137 coho smolts. Of these 120 were successfully aged, 15 were damaged and 2 were not readable. The aged coho smolts are grouped into size classes (length ranges) of 10 mm. The proportion of age 1.0 coho smolts is shown in Table 10. These proportions were applied to the coho length distribution from randomly sampled smolts to determine the contribution of each age class to the overall smolt population. There was only a single fresh water age 3 coho in the scale samples. When the age proportions are applied to the stratified length samples (n=1898) the 2009 age 2.0 contribution is 55.3% which is slightly greater than previous years. In 2005 there was 44% age 2.0 contribution, 47% in 2004, 46% in 2003, 47% in 2002 and 69% in 2001.

**Table 10. Percentage of age 1.0 coho smolts by fork length range (mm).**

| Year | | < 91 | 91-100 | 101-110 | 111-120 | 121-130 | 131-140 | 141-150 | 151-160 | 161-170 | >170 | Total n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2009 | % | 100% | 83% | 71% | 69% | 29% | 0% | 6% | 0% | 0% | 0% | 120 |
| | n | 0 | 9 | 6 | 17 | 26 | 21 | 20 | 17 | 3 | 1 | |
| 2005 | % | 100% | 100% | 88% | 75% | 65% | 40% | 41% | 15% | 0% | 0% | 139 |
| | n | 1 | 3 | 8 | 8 | 26 | 40 | 17 | 13 | 5 | 18 | |
| 2004 | % | 100% | 100% | 93% | 81% | 64% | 23% | 6% | 0% | 0% | n/a | 134 |
| | n | 1 | 4 | 15 | 27 | 33 | 30 | 18 | 5 | 1 | 0 | |
| 2003 | % | 100% | 100% | 78% | 60% | 52% | 17% | 13% | 11% | n/a | 0% | 108 |
| | n | 6 | 6 | 9 | 15 | 23 | 23 | 16 | 9 | 0 | 1 | |
| 2002 | % | 100% | 100% | 77% | 59% | 47% | 23% | 0% | 0% | 0% | 0% | 121 |
| | n | 6 | 13 | 13 | 22 | 15 | 22 | 15 | 7 | 4 | 4 | |
| 2001 | % | n/a | 71% | 48% | 41% | 60% | 24% | 6% | 0% | 0% | 0% | 193 |
| | n | 0 | 7 | 21 | 17 | 15 | 21 | 33 | 48 | 19 | 12 | |

## Sockeye Smolt Parasite Frequency

*Salmincola californiensis* an external copepod parasite, has been observed on sockeye smolts in each year since 2002. In 2009 0.5% of the sampled sockeye smolts were recorded as having this parasite, the lowest observed prevalence observed. In 2003 to 2005 prevalence ranged between 1.4 and 4.5% (Hall et al., 2006).

## Tagging Mortalities (24 hour)

In 2009, 183 coho smolts that were sampled, adipose fin clipped and coded wire tagged were held for 24 hours with only one post mortality. The live box survival studies gave a tag retention rate of 99%. In 2009 there were 256 sockeye sampled and adipose fin clipped. They were held for 24 hours and experienced a single mortality. Table 11 shows the results of mortality studies for both species by year. The 24 hour mortality rates were incorporated into the population estimates by reducing the number of marked fish available for recapture by the associated mortality rate.

**Table 11. 24 handling/tagging mortality rates by species and year.**

| Year | Sockeye | | Coho | |
|---|---|---|---|---|
| | Mortality Rate | N | Mortality Rate | N |
| 2009 | 0.3% | 256 | 0.5% | 183 |
| 2005 | n/a | 0 | 0.0% | 250 |
| 2004 | 0.0% | 303 | 0.2% | 484 |
| 2003 | 0.0% | 250 | 1.0% | 399 |
| 2002 | 2.0% | 150 | 1.1% | 183 |
| 2001 | 3.9% | 203 | n/a | 0 |

**Sockeye Smolt Mark/Recapture Population Estimates**

A total of 4769 sockeye smolts were marked and released upstream of the traps over a period of 12 days from May 8th to May 19th. The fyke trap recaptured 961 of these fish. The peak recaptures for the fyke trap were on May 18th (435). May 14th had the largest daily release of marked sockeye smolts (1964) and the second highest release was on May 18th (1254). After both releases, peaks in recaptures occurred four days later (Figure 9).

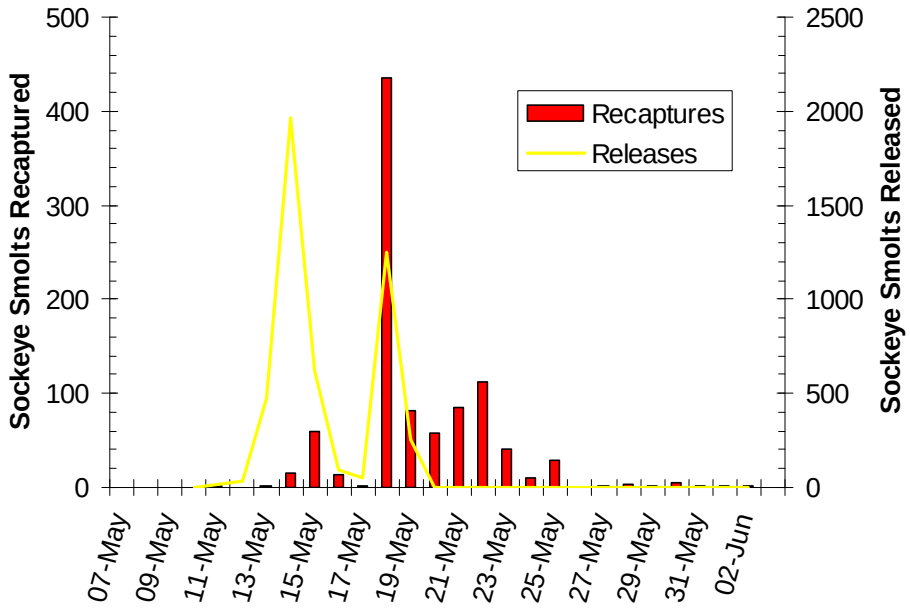


**Figure 9. Sockeye smolt recaptures (columns) and releases (line) 2009.**

Smolt population estimates were obtained by mark/recapture calculations (Seber 1982). The sockeye population estimate was 30,245 sockeye smolts with a 95% confidence interval of ±1567 (Table 12).

**Table 12. Sockeye smolt mark/recapture summary 2009.**

| Caught | Marked* | Recaptured | Recapture Rate | Pop. Est. | 95% C.I. |
|---|---|---|---|---|---|
| 6119 | 4,755 | 961 | 20.21% | 30,254 | 28,687 – 31,821 |

*Reduced by 0.3% to factor in mortality

Sockeye smolt population estimates for previous years are shown in Table 13.

**Table 13. Total sockeye smolt catches and average population estimates 2001-2005.**

| Year | Caught | Marked | Recaptured | Avg. Pop. Estimate | Total Trap Efficiency |
|---|---|---|---|---|---|
| 2005 | 2,084 | 1,635 | 386 | 10,326 | 24% |
| 2004 | 8,301 | 5,432 | 2,053 | 18,938 | 38% |
| 2003 | 6,945 | 5,319 | 992 | 37,672 | 19% |
| 2002 | 10,096 | 4,966 | 2,264 | 19,369 | 46% |
| 2001 | 9,125 | 4,198 | 1,134 | 34,567 | 27% |

**Coho Smolt Mark/Recapture Population Estimates**

In 2009, a total of 1,473 coded wire tagged coho smolts were released to Slamgeesh Lake with their adipose fin clipped. In total the fyke trap recaptured 76 of these fish. Mark and recapture population estimates are presented in two forms. First a pooled Petersen estimate in which all marked and recaptured fish are evaluated without regard to the date of release and then an estimate made with an experimental design that separated the coho migration into three intervals.

The pooled Petersen population estimate (Seber 1982) that results is 51,046 coho smolts with a 95% confidence interval of ±10,927 (Table 14).

**Table 14. Coho smolt mark/recapture summary 2009.**

| Caught | Marked* | Recaptured | Pop. Est. | 95% C.I. | Trap Efficiency |
|---|---|---|---|---|---|
| 2,626 | 1,465 | 76 | 51,046 | 40,175 – 61,916 | 5.19 % |

*Reduced by 0.5% to factor in mortality

Multiple mark and recapture experiments for coho are possible due to the length of the coho run. It appears that most released smolts migrate promptly and are recaptured within a day or two, but some of the smolts delay a week or more before attempting a second emigration. In the triple marking experiment, releases were made over 7 to 18 days and collections of marked fish made during days of releases and for 8 days after releases stopped during which recaptures dropped to zero.

The first experiment had a small sample size (163 releases) and a high recapture rate (9.8%). The following two experiments had larger release sizes (770 and 540) and had very similar but lower capture rates (4.7% and 4.4%). Release periods and subsequent recaptures are shown below (Figure 10). Between the experiments, an additional 908 sockeye were clipped and released directly to Shilahou Creek, at least 100 m below the trap.

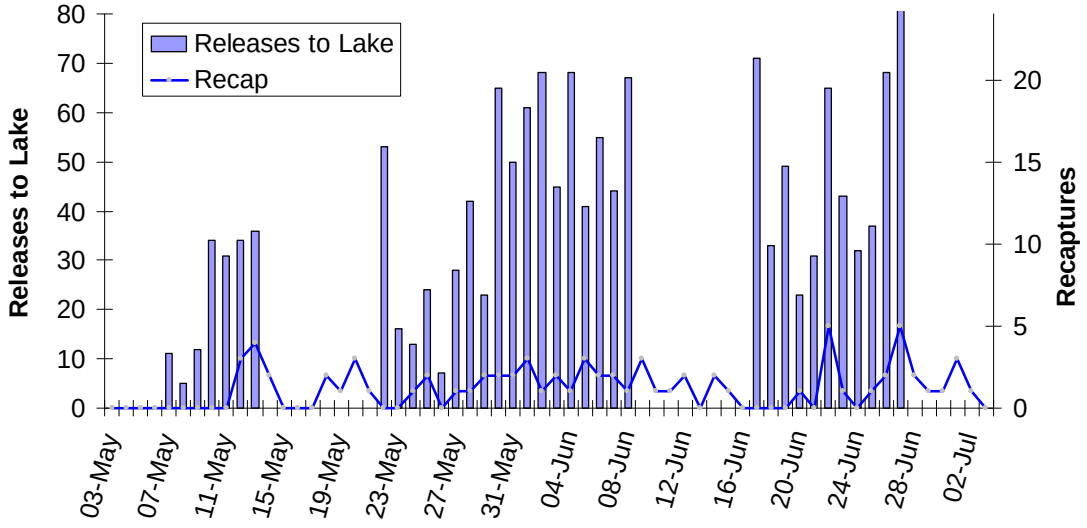


**Figure 10. Coho smolt recaptures (columns) and releases (line) 2009.**

**Table 15. Coho Smolt Mark and Recapture Experiments**

| Experiment | Released | Recap'd | Recap Rate | Caught | Population Estimate |
|---|---|---|---|---|---|
| 1 | 163 | 16 | 0.098 | 619 | 5980 |
| 2 | 770 | 36 | 0.047 | 1183 | 24671 |
| 3 | 540 | 24 | 0.044 | 747 | 16837 |
| | | | | **Total** | **46837** |

The three mark and recapture experiments yielded independent population estimates. The sum of the escapement estimate is 46,837 about 10% smaller than the pooled estimate (51,046) but well within the confidence limits of that estimate.

Compared to previous coho smolt sampling (Table 16) the coho run in 2009 was of moderate to large size. Previous trap efficiencies for just the fyke style trap, which was located in previous smolt surveys at the outlet of the lake, ranged from 6.4 to 14. 2%. In past years the mark recapture estimates were temporally stratified and used combined results of both traps to obtain population estimates. The combined trap efficiencies ranged from 15% to 23% (Table 16).

**Table 16. Total coho smolt catches and average population estimates 2001 - 2005.**

| Year | Caught | Marked | Recaptured | Avg. Pop. Estimate | Total Trap Efficiency |
|---|---|---|---|---|---|
| 2005 | 6,815 | 4,998 | 1,145 | 33,757 | 23% |
| 2004 | 16,242 | 11,739 | 2,451 | 66,494 | 21% |
| 2003 | 6,871 | 5,104 | 753 | 46,000 | 15% |
| 2002 | 3,249 | 1,372 | 226 | 23,871 | 16% |
| 2001 | 5,591 | 1,952 | 413 | 25,875 | 21% |

### Coded-Wire Tagged Coho Smolt Survival and Tag Retention

In 2009 a total of 2,497 coho smolts were coded-wire tagged, adipose fin clipped and released using tag code 08/15/09. Short-term tagging mortality was assessed by holding 183 tagged and marked coho smolts in a live box for 24 hours during which one died resulting in a 99.5% survival rate. The Coded-wire tag (CWT) retention rate from the livebox studies was 98.9%. CWT retention was also measured at the fence site by passing the recaptured smolts through the Quality Control Device (QCD). Seventy-four recaptured smolts were assessed through the QCD with 11 having lost their tags resulting in an average tag retention rate of 85.1%. In previous years, tag retention ranged from 92.3% to 99.4%. This retention was used to adjust the total clipped coho smolts released alive with coded wire tags retained. A summary for past years can be found in Hall and Gottesfeld 2006.

### Sockeye Smolt Production

The average sockeye smolt population estimate and the average sockeye smolt weight can be used to calculate the estimated sockeye smolt biomass for each year. The estimated sockeye smolt biomass has ranged from a maximum of 324 kg in 2003 to a minimum of 110 kg in 2005

(Table 17). In all years except 2002 and 2005, the estimated sockeye smolt biomass has exceeded the predicted maximum ($R_{max}$) based on the Photosynthetic Rate Model (PR Model) for Slamgeesh Lake alone (Cox-Rogers *et al.* 2004). However, sockeye smolts caught in the smolt traps downstream of Slamgeesh Lake may also be rearing in Damshilgwet Lake upstream of Slamgeesh Lake. The presence of sockeye fry in Damshilgwet Lake was confirmed through capture by "Swedish" gillnets in 2003 (Hall *et al.* 2004). The maximum smolt biomass production for Damshilgwet Lake was estimated by applying the same value on a per hectare basis from Slamgeesh Lake to Damshilgwet Lake. Thus the total maximum biomass estimate for the Slamgeesh watershed is the sum of the $R_{max}$ for each lake (Table 17). Slamgeesh sockeye smolt production has not exceeded the $R_{max}$ for the watershed in any year. In 2009, the biomass reached approximately 78% of the watershed $R_{max}$.

**Table 17. Slamgeesh sockeye smolt production by year.**

| Year | Average Pop. Est. | Average Weight (g) | Est. Biomass (kg) | Slamgeesh Lake Rmax (kg) | Slamgeesh Watershed Rmax (kg) | % Watershed Rmax Used |
|---|---|---|---|---|---|---|
| 2009 | $3.02 \times 10^4$ | 10.2 [α] | 309 | 200* | 394 | 78% |
| 2005 | $1.03 \times 10^4$ | 10.7 | 110 | | | 28% |
| 2004 | $1.89 \times 10^4$ | 12.6 | 238 | | | 60% |
| 2003 | $3.77 \times 10^4$ | 8.6 | 324 | | | 82% |
| 2002 | $1.94 \times 10^4$ | 9.2 | 178 | | | 45% |
| 2001 | $3.46 \times 10^4$ | 10.0 | 346 | | | 88% |
| Avg. | $2.52 \times 10^4$ | 10.2 [α] | 251 | | | 64% |

*Revised $R_{max}$ subsequent to Cox-Rogers *et al.* 2004 (pers. comm. J. Hume 2004)
Note the Slamgeesh Watershed $R_{max}$ is the sum of the potential production from Slamgeesh Lake and Damshilgwet Lake.
[α] Used average weight of past years.

## Stock Recruitment

### Sockeye smolt production for brood year 2007

Sockeye freshwater production previously calculated for brood years 2000 to 2003 varied from a low of 43 smolts/female to a high of 114 smolts/female (Hall and Hooper, 2008). This range of smolts per female at Slamgeesh appears to be well within the range observed from other BC lake systems from the 1940's and the 1950's (Foerster, 1968). Next year's smolt enumeration will complete the data needed to produce a 2007 brood year output value. However since only 2% of the 2009 smolts are age 2.0 and 3.0, and other years have similar proportions, we can assume that the proportion of age 2.0 smolts in 2010 will be relatively low and can estimate a minimum value for 2007 brood smolts/female. There were 363 female spawners in 2007. The smolts per female spawner are therefore 146, the highest of the five years of record.

### Coho Stock Recruitment

Coho fresh water production of smolts ranged was 49, 93 and 101 smolts/female in the 2000 to 2002 brood years. Since the proportion of age 2.0 smolts varies widely, we will need one more year's smolt data to obtain smolt production levels for the 2007 brood year.

## DISCUSSION

We reinitiated smolt sampling at Slamgeesh after a halt of three years. In April 2009 we built and worked with a new type of smolt trap, a velocity barrier fyke trap. The trap performed adequately throughout the challenges of spring break-up such as avoiding large accumulations of debris and adjusting to changing water levels. The trap worked well for sockeye smolts, capturing approximately 20% of the run. Performance for coho was adequate for a population estimate to be made and to determine stock productivity and lake productivity. However inadequate numbers of coho were collected to produce a coded-wire tagged cohort large enough to assess Alaska coastal fishing rates on this stock. We should work in the next few years to improve the coho catch rate. In 2010 we plan to build a second smolt trap. Whereas it probably will not be as efficient as the first trap due to poorer siting, it should move us toward the goal of 10,000 marked coho smolts.

Reporting both coho and smolt population estimates this year was an important achievement in reactivating this data collection last enumerated in 2005. Our adult fence in 2010 and 2011 will assess how many of these marked smolts return, which will confirm these estimates and also provide data for marine survival calculations. The 2009 emigration estimates correspond in large part to brood year 2007 which had a sockeye escapement of 375 fish. Next year's smolt count will be critical as it corresponds to the lowest escapement we have counted in the past 9 years of operation of only 150 sockeye.

The results presented in this report suggest that the freshwater productivity of Slamgeesh Lake is high and maintaining this level. The poor adult returns we have experienced in the last few years for sockeye and from the 1970s to 2005 for coho are therefore features of poor marine survival and/or excessive fishing pressure.

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