

## **PSC Northern Fund Final Report**

Project Number: NF-2015-I-10

Project Title: Genetic Stock Identification of District 111 sockeye salmon, 2015

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### **Abstract:**

The Taku River in Southeast Alaska supports sockeye salmon runs important for various commercial and aboriginal fisheries in both Alaska and Canada. This project continues the use of mark- and age-enhanced genetic stock identification (GSI) of sockeye salmon harvested in the 2015 gillnet fishery in District 111 by screening 96 single nucleotide polymorphic genetic markers in 1,479 salmon. Advances in mixed stock analysis methodologies allowed the incorporation of hatchery-marked fish and age composition into genetic-based fishery estimates. The mixed stock analysis model indicated that the *Stikine/Taku Mainstem* reporting group was the largest contributor in the District 111 fisheries in 2015, followed by the *Taku Lakes* reporting group. The *Taku Lakes* group was more prevalent early in the season, while the *Stikine/Taku Mainstem* group dominated nearly every week. The *Enhanced Snettisham* group started to become more dominant beginning in statistical week 30. The most common age group was 1.3, followed by age-0.x. The *Stikine/Taku Mainstem* reporting group was dominated by ages-1.2, 1.3 and 0.x fish, while the *Taku Lakes* and *Enhanced Snettisham* reporting groups were primarily comprised of age-1.3 fish.

### **Introduction:**

The Taku River in Southeast Alaska (SEAK) supports sockeye salmon runs important for various commercial and aboriginal fisheries in both the United States (U.S.) and Canada. Taku River sockeye salmon are harvested by commercial gillnet fisheries in U.S. District 111, by Alaska personal use fisheries in the river, by Canadian commercial gillnet fisheries, by Canadian recreational fisheries, and by Canadian aboriginal fisheries.

The U.S. District 111 gillnet fishery harvests wild stocks of sockeye salmon primarily bound for several systems in the Taku River or to Crescent and Speel lakes in Port Snettisham, Alaska. Significant numbers of enhanced sockeye salmon bound for release sites in the Taku River or to Snettisham Hatchery are also caught in the fishery. Catches of Taku River sockeye salmon stocks in District 111 gillnet fishery are subject to a harvest sharing agreement, in which the U.S. is allowed to harvest a variable proportion of the Total Allowable Catch of Taku River sockeye salmon depending on the return of enhanced fish. Stock contribution estimates are used to document compliance with the harvest-sharing agreements, reconstruct runs of wild stocks, estimate the return of enhanced fish, forecast upcoming returns, and support sustainable management.

This project completed GSI analysis of sockeye salmon tissue samples collected from commercial gillnet fisheries in areas near the Taku River in 2015. The analysis focused on tissue samples collected in U.S. District 111. Estimates are provided over the entire season for all age groups, for 9 time strata for all age groups, and over the entire season for 6 age groups. Estimates are reported as proportions of 8 reporting groups consisting of 4 groups of Taku-area wild fish (*Stikine/Taku Mainstem*, *Taku Lakes*, *Tatsamenie Wild*, and *Speel Wild*), 2 groups of Taku-area hatchery-origin fish (*Enhanced Tatsamenie* and *Enhanced Snettisham*), one group of Stikine hatchery-origin fish (*Enhanced Stikine*), and one group that includes all other fish in the baseline (*Other*).

### **Objectives:**

The objective of this project is to estimate the stock composition of Southeast Alaska sockeye fisheries near the Taku River in 2015 using genetic stock identification for 9 reporting groups including: 4 reporting groups of Taku area wild fish (*Taku/Stikine Mainstem*, *Taku Lakes*, *Tatsamenie Wild*, and *Speel Wild*), 3 reporting groups of Taku area hatchery-origin fish (*Enhanced Tatsamenie*, *Enhanced Trapper*, and *Enhanced Snettisham*), one reporting group of Stikine hatchery-origin fish (*Enhanced Stikine*), and one reporting group that includes all other fish in the baseline (*Other*) such that the estimates are within 10% of the true value 90% of the time. This will be accomplished through the following tasks:

- Determine the stock composition of sockeye harvests from the District 111 drift gillnet fishery. For 2015, provide estimates for:
  - District 111
    - Total season, all age groups combined;
    - Total season, by age groups including ages-1.2, -1.3, -2.2, -2.3, 0-checks, and other;
    - At least 5 time strata, all age groups combined.

### **Approach:**

#### *Fishery Sampling*

Landings from drift gillnet fisheries in District 111 were sampled by ADF&G at fish processing facilities in Juneau and by observers on tenders. Sampling protocols ensured that the fish sampled were as representative of catches as possible. Axillary processes were excised and placed into individually labeled vials and preserved in ethanol. Associated data for each sample including fishery and capture date were recorded, and the tissue sample for each fish was paired with age, sex, and length (ASL) information and with otolith samples.

#### *Laboratory Analysis*

A single nucleotide polymorphism (SNP) baseline for SEAK and British Columbia (BC) including 45 markers was first completed in 2007. The baseline included all major sockeye salmon-producing systems in SEAK and in BC north of and including the Skeena River and from representative sockeye salmon-producing systems in BC south of the Skeena River. A cooperative project between ADF&G and DFO in 2007-2009 added several collections to the baseline for transboundary rivers (Northern Fund project no. NF-2008-I-15A). In addition, these and existing collections have been analyzed at a total of 96 SNP markers in order to further enhance the baseline for fishery applications. The current genetic baseline includes 171 populations and 96 markers (Table 1; Rogers Olive et al. *in review*).

Samples were analyzed for 96 SNP loci. Genomic DNA was extracted using a DNeasy® 96 Tissue Kit by QIAGEN®, (Valencia, CA). All SNPs were detected using a TaqMAN SNP Genotyping Assay (Life Technologies). SNP assays were generally performed using the BioMark 96.96 Dynamic Array (Fluidigm). Re-analyses of failed assays was performed on the QuantStudio™ 12K Flex Real-Time PCR System (Life Technologies). Genotype data are stored in an *Oracle* database (*LOKI*) on a network drive maintained by ADF&G computer services. Quality control measures included reanalysis from DNA extraction from 8% of each collection for all markers to ensure that genotypes are reproducible and to identify laboratory errors and measure rates of inconsistencies during repeated analyses.

### *Mixture Analysis*

Mixture analyses included additional available data to help inform the genetic estimates; specifically, ages from matched scales and hatchery marks on matched otoliths. In this method (“mark- and age-enhanced GSI”), two sets of parameters are required: 1) a vector of stock compositions, summing to one, with a proportion for each of the wild and hatchery stocks weighted by harvest per stratum; and 2) a matrix of age composition, with a row for each of the wild and hatchery stocks (summing to one), and a column for each age class. This information is “completed” iteratively by stochastically assigning each wild fish to a population, then estimating the stock proportions based on summaries of assignments from each iteration. In this process, all available information is used to assign individuals to stock of origin based on age, genotype, and/or otolith information. For this method, only genotypes from wild fish are necessary to complete stock composition estimates; thus only wild fish were genotyped for 2015 fisheries.

This algorithm was run for 40,000 repetitions, discarding the first 20,000 repetitions to eliminate the effect of the initial state. The point estimates and credibility intervals for the stock proportions and age composition are simple summary statistics of the output.

Results are given for 8 reporting groups consisting of 4 groups of Taku-area wild fish (*Stikine/Taku Mainstem*, *Taku Lakes*, *Tatsamenie Wild*, and *Speel Wild*), 2 groups of Taku-area hatchery-origin fish (*Enhanced Tatsamenie* and *Enhanced Snettisham*), one group of Stikine hatchery-origin fish (*Enhanced Stikine*), and one group that includes all other fish in the baseline (*Other*). A total of 14 separate estimates were made for the 2015 fisheries.

## **Results/Findings:**

### *Fishery sampling*

A total of 3,430 sockeye salmon were sampled in the gillnet fisheries in District 111 during 2015 (Table 2). These fish were sampled from statistical weeks 26 through 33.

### *Laboratory analyses*

Of the samples collected in District 111, 1,479 samples were genotyped at 96 SNP genetic markers. During quality control procedures a total of 123 fish were reanalyzed at all 96 markers for a total of 11,808 comparisons. The average failure rate was 1.8%. Few inconsistencies were found (0.5% across all comparisons).

### *Mixture analysis*

Mixtures of fish representing catches by statistical week, age group, and subdistrict from the District 111 gillnet fishery were analyzed. Of the samples extracted and genotyped, genotypes from 1,463 wild fish (no otolith mark present) were used for the genetic analyses in the mark- and age-enhanced GSI method. Stock composition estimates can be found in Figures 1–4. Total season estimates were made for each subdistrict or district by age class and over all ages, and were weighted by harvest in each stratum. In addition, results are given for fish of all age classes over every time stratum sampled, regardless of sample size. All of these estimates met the minimum criteria for precision and accuracy accepted by the Pacific Salmon Commission (PSC) Transboundary Technical Committee (within 10% of the true mixture 90% of the time).

The greatest contributor to the overall harvest in District 111 in 2015 was the *Stikine/Taku Mainstem* reporting group (57%), followed by the *Taku Lakes* reporting group (23%; Figure 1). The *Enhanced Snettisham* reporting group was also an important contributor (12%), followed by the *Other* reporting group (6%). The remaining reporting groups were present at low proportions (<5%).

Stock composition in District 111 was dominated by the *Stikine/Taku Mainstem* group in nearly every statistical week, followed by the *Taku Lakes* reporting group. The largest contributions by the *Enhanced Snettisham* group were in weeks 32 and 33 (20% and 26% respectively). The *Other* group contributed at least 5% in 5 of the 8 statistical weeks, with the highest proportion in week 26 (9%; Figure 2).

The most common age groups throughout the 2015 season in District 111 were age-1.3 and -0.x (49% and 38% of total, respectively; Figure 3). Age 1.3 was the largest component of the *Taku Lakes* (16%), and *Enhanced Snettisham* (10%) reporting groups, while age 0.x was the largest component of the *Stikine/Taku Mainstem* reporting group (35%) followed by age-1.3 (17%; Figure 4). Age-1.2 was present at 9% overall and was comprised primarily of *Stikine/Taku Mainstem* (4%), *Enhanced Snettisham* (2%), and *Taku Lakes* (2%) reporting groups. Ages 2.2 and Other were present at <5% overall.

### **Evaluation:**

We accomplished the following:

- A total of 3,430 sockeye salmon were sampled from District 111 gillnet fisheries during the 2015 season.
- A total of 1,479 samples from District 111 were assayed for genotypes for the 96 SNP loci in the sockeye salmon baseline, and quality control procedures revealed a low rate of inconsistencies.
- Mixture analyses estimated the contributions of 8 reporting groups including Taku-area wild and enhanced sockeye salmon to 88 temporal strata in District 111.
- Mixture analyses estimated the age compositions of harvests over the entire season in District 111 for 8 reporting groups.
- Mixture analyses estimate the seasonal stock composition over all ages for District 111 for 8 reporting groups.
- In total, 14 separate estimates are provided for Taku-area fisheries in 2015.
- The improved methodology (mark- and age-enhanced GSI) has allowed us to combine several sources of data when estimating stock composition in District 111 for Pacific

Salmon Treaty (PST) purposes. In the past, GSI was conducted on only wild fish, and stock composition estimates for enhanced fish were conducted in a separate analysis using otolith and other data. This approach allows us to combine these analyses to provide the most accurate and efficient estimates possible for Taku-area fisheries. Work is currently underway to continue to improve this methodology to provide reliable estimates for statistical weeks where low sample sizes could be an issue.

- Results will be incorporated into harvest estimates for PST purposes by the Transboundary Technical Committee (TTC *in prep*).

**Project Products:**

Results from this project have been presented both to ADF&G Commercial Fisheries management staff and to the bilateral PSC Transboundary Technical Committee. A report published in the ADF&G Fishery Data Series is expected in 2016.

**Date Prepared:** July 11, 2016

**References:**

Rogers Olive, S. D., S. E. Gilk-Baumer, E. K. C. Fox, and C. Habicht. *In review*. Genetic baseline of Southeast Alaska sockeye salmon for mixed stock analyses, 2014. Alaska Department of Fish and Game, Fishery Data Series No. YY-XX, Anchorage.

TTC (Transboundary Technical Committee). *In prep*. Estimates of Transboundary River salmon production, harvest and escapement, and a review of joint enhancement activities in 2015. Pacific Salmon Commission Report TCTR, Vancouver.

Table 1. Reporting groups and collection locations defined for use in genetic stock identification of sockeye salmon caught in gillnet fisheries in District 111 in 2015. Wild collections are ordered north to south and followed by enhanced collections.

| Reporting Group               | Collection Location         | Reporting Group                                  | Collection Location          |                               |
|-------------------------------|-----------------------------|--|------------------------------|-------------------------------|
| <i>Other</i>                  | Bainbridge Lake             | <i>Other (cont.)</i>                             | Chilkat River - Mule Meadows |                               |
|                               | Coghill Lake                |  | Chilkoot Lake - Beaches      |                               |
|                               | Eshamy Lake                 |  | Chilkoot Lake - Bear Creek   |                               |
|                               | Main Bay                    |  | Chilkoot River               |                               |
|                               | Miners Lake                 |  | Berners Bay                  |                               |
|                               | Bering Lake                 |  | Lace River                   |                               |
|                               | Clear Creek at 40 Mile      |  | Steep Creek                  |                               |
|                               | Eyak - Hatchery Creek       |  | Windfall Lake                |                               |
|                               | Eyak - Middle Arm           |  | Lake Creek - Auke Creek Weir |                               |
|                               | Eyak - South beaches        |  | Crescent Lake                |                               |
|                               | Gulkana - Fish Creek        |  | <i>Speel Wild</i>            | Speel Lake                    |
|                               | Gulkana - East Fork         |  |                              | Snettisham                    |
|                               | Klutina Lake - inlet        |  | <i>Other (cont.)</i>         | Vivid Lake                    |
|                               | Klutina - Mainstem          |  |                              | Bartlett River - Creel survey |
|                               | Klutina - Banana Lake       |  |                              | North Berg Bay Inlet          |
|                               | Klutina - Bear Hole         |  |                              | Hoktaheen Lake                |
|                               | Kushtaka Lake               |  |                              | Neva Lake                     |
|                               | Long Lake weir              | Sitkoh Lake                                      |                              |                               |
|                               | Mahlo River                 | Lake Eva   |                              |                               |
|                               | Martin Lake                 | Kook Lake  |                              |                               |
|                               | Martin River Slough         | Pavlof Lake                                      |                              |                               |
|                               | McKinley Lake 2007          | Hasselborg Lake                                  |                              |                               |
|                               | McKinley Lake 2008          | Kanalku Lake <sup>1</sup>                        |                              |                               |
|                               | McKinley Lake 1991          | Kutlaku Lake                                     |                              |                               |
|                               | Salmon Creek - Bremner      | Falls Lake                                       |                              |                               |
|                               | Mendeltna Creek             | Ford Arm Creek                                   |                              |                               |
|                               | Mentasta Lake               | Klag Bay Stream outlet                           |                              |                               |
|                               | Paxson Lake - outlet        | Redfish Lake Beaches                             |                              |                               |
|                               | St. Anne Creek              | Salmon Lake weir                                 |                              |                               |
|                               | Steamboat Lake - Bremner    | Redoubt Lake - outlet                            |                              |                               |
|                               | Swede Lake                  | Benzeman Lake                                    |                              |                               |
|                               | Tanada Creek weir           | <i>Taku Lakes</i>                                | King Salmon Lake             |                               |
|                               | Tanada Lk - lower outlet    |  | Little Tatsamenie            |                               |
|                               | Tanada Lk - shore           |  | Little Trapper Lake          |                               |
|                               | Tebay River - Outlet        | <i>Tatsamenie Wild<br/>Stikine/Taku Mainstem</i> | Kuthai Lake                  |                               |
|                               | Tokun Lake                  |  | Tatsamenie Lake              |                               |
|                               | Tonsina Lake                |  | Hackett River                |                               |
|                               | Ahrnklin River              |  | Nahlin River                 |                               |
|                               | Akwe River                  |  | Tulsequah River              |                               |
|                               | Dangerous River             |  | Yellow Bluff Slough          |                               |
|                               | East Alsek River            |  | Sustahine Slough             |                               |
|                               | Lost/Tahwah Rivers          |  | Taku River                   |                               |
|                               | Old Situk River             |  | Takwahoni/Sinwa Creek        |                               |
|                               | Mountain Stream             |  | Tuskwa/Chunk/Bear Slough     |                               |
|                               | Situk Lake                  |  | Fish Creek                   |                               |
|                               | Blanchard River             |  | Yehring Creek                |                               |
|                               | Border Slough               |  | Shakes Slough                |                               |
| Klukshu River                 | Iskut River                 |  |                              |                               |
| Upper Tatshenshini/Kudwat     | Verrett River               |  |                              |                               |
| Tatshenshini - Kwatini River  | Scud River                  |  |                              |                               |
| Neskataheen Lake              | Andy Smith/Porcupine/Fowler |  |                              |                               |
| Tweedsmuir River              | Devil's Elbow               |  |                              |                               |
| Vern Ritchie                  | Chutine River               |  |                              |                               |
| Chilkat Lake                  | Chutine Lake                |  |                              |                               |
| Chilkat River - Mosquito Lake | Christina Lake              |  |                              |                               |
| Chilkat River - Bear Flats    | <i>Other (cont.)</i>        | Little Tahltan River                             |                              |                               |

-continued-

Table 1 (cont.)

| Reporting Group      | Collection Location           | Reporting Group            | Collection Location          |
|----------------------|-------------------------------|----------------------------|------------------------------|
| <i>Other (cont.)</i> | Tahltan Lake                  | <i>Other (cont.)</i>       | Alastair Lake                |
|                      | Hugh Smith Lake               |                            | Four Mile Creek/Pierre Creek |
|                      | McDonald Lake                 |                            | Fulton River/Morrison Creek  |
|                      | Hatchery Creek - Sweetwater   |                            | Kitsumkalum Lake             |
|                      | Kah Sheets Lake               |                            | Lower Tahlo River            |
|                      | Kunk Lake                     |                            | McDonell Lake - Zymoetz R    |
|                      | Luck Lake                     |                            | Nangeese River               |
|                      | Big Lake                      |                            | Nanika River                 |
|                      | Mill Creek Weir               |                            | Slamgeesh River              |
|                      | Petersburg Lake               |                            | Sustut River - Johanson Lake |
|                      | Red Bay Lake                  |                            | Swan Lake                    |
|                      | Salmon Bay Lake               |                            | Upper Babine River           |
|                      | Shiple Lake                   |                            | Naden River                  |
|                      | Thoms Lake                    |                            | Kitlope Lake                 |
|                      | Sarkar Lakes                  |                            | Baker Lake                   |
|                      | Heckman Lake                  |                            | Issaquah Creek               |
|                      | Helm Lake                     |                            | Cedar River                  |
|                      | Karta River/McGilvery Creek   |                            | Adams R - Shuswap Lake       |
|                      | Kegan Lake                    |                            | Birkenhead River             |
|                      | Mahoney Creek                 |                            | Chilko Lake                  |
|                      | Unuk River - Gene's Lake      |                            | Gates Creek                  |
|                      | Fillmore Lake - Hoffman Creek |                            | Harrison River               |
|                      | Klakas Lake                   |                            | Horsefly River               |
|                      | Bar Creek - Essowah Lake      |                            | Raft River                   |
|                      | Eek Creek                     |                            | Stellako River               |
|                      | Hetta Creek - Middle run      |                            | Enhanced - Burnett Inlet     |
|                      | Hetta Creek - Early run       |                            | Enhanced - Main Bay          |
|                      | Hetta Lake                    |                            | Enhanced - McDonald          |
|                      | Klawock River                 | <i>Enhanced Tatsamenie</i> | Enhanced - Sweetheart        |
|                      | Bowser Lake                   | <i>Enhanced Snettisham</i> | Enhanced - Tatsamenie        |
|                      | Damdochax Creek               | <i>Enhanced Stikine</i>    | Enhanced - Speel Arm         |
|                      | Meziadin Lake                 |                            | Enhanced - Tahltan           |
|                      | Tintina Creek                 |                            | Enhanced - Tuya              |
|                      | Weaver Creek                  |                            |                              |

Table 2. Number of sockeye salmon sampled from District 111 sockeye gillnet harvests during each statistical week in 2015, genotyped samples used in analysis, and otolith-marked or aged samples not genotyped (or failed genotyping) for each statistical week.

| District | Statistical Week | Total Samples Collected | Genotypes Used in Analysis | Not Genotyped (otolith-marked or aged or both) |
|----------|------------------|-------------------------|----------------------------|--|
| 111      | 26               | 337                     | 135                        | 202  |
|          | 27               | 400                     | 66                         | 334  |
|          | 28               | 473                     | 136                        | 337  |
|          | 29               | 220                     | 95                         | 125  |
|          | 30               | 600                     | 324                        | 276  |
|          | 31               | 430                     | 304                        | 126  |
|          | 32               | 440                     | 229                        | 211  |
|          | 33               | 530                     | 174                        | 356  |
| Totals   |                  | 3,430                   | 1,463                      | 1,967  |

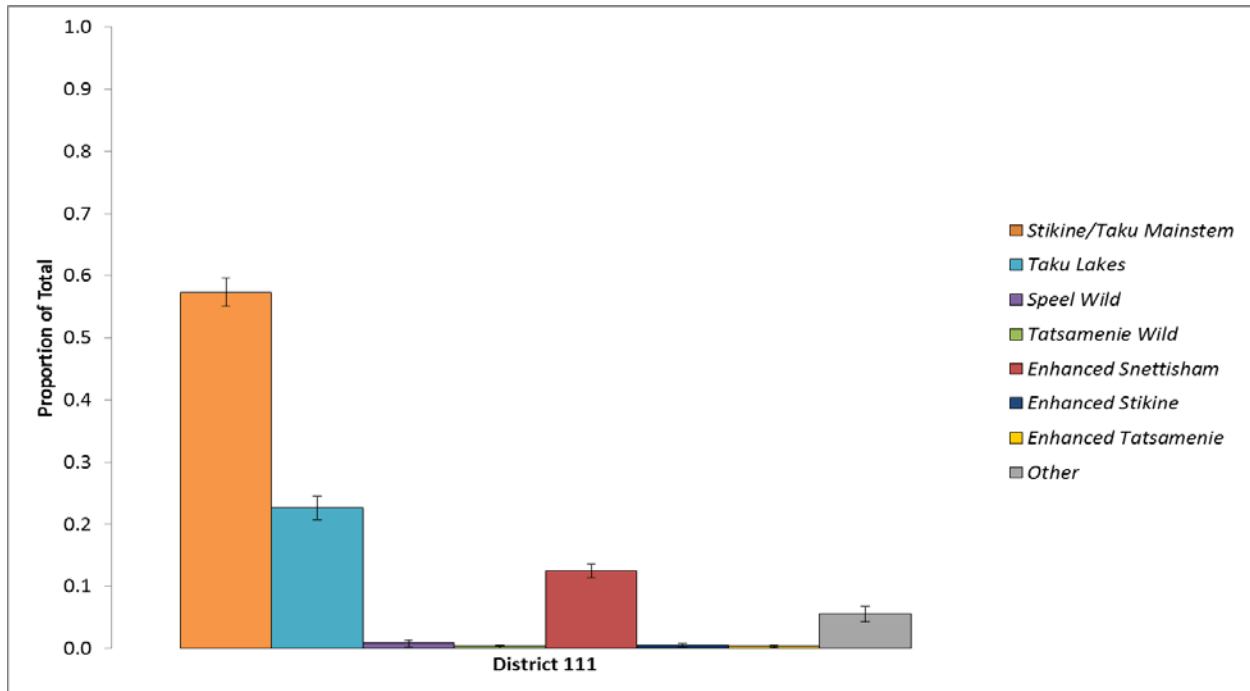


Figure 1. Total season stock composition estimates for Taku River area gillnet fisheries in 2015. Estimates were weighted by harvest per stratum. Error bars are upper and lower bounds of 90% credibility intervals.

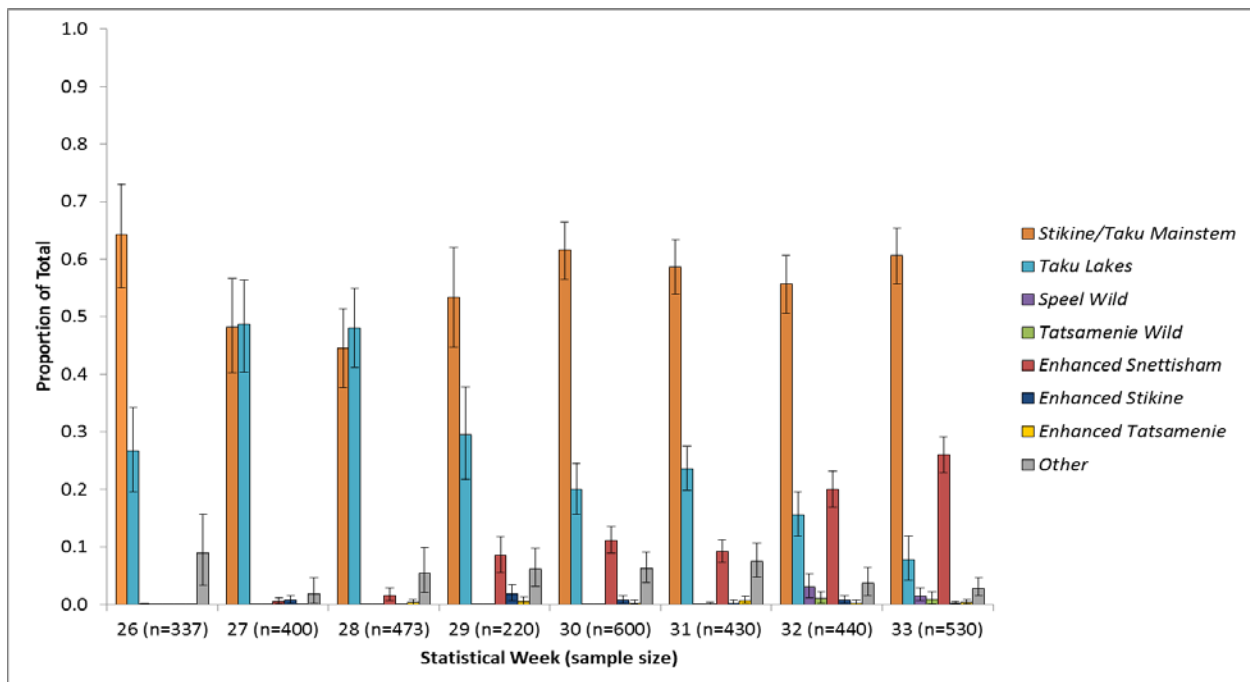


Figure 2. Stock composition estimates of sockeye salmon caught in the District 111 gillnet fishery in 2015. Sample size (n) includes genotyped, aged, and otolith-marked fish. Error bars are upper and lower bounds of 90% credibility intervals.



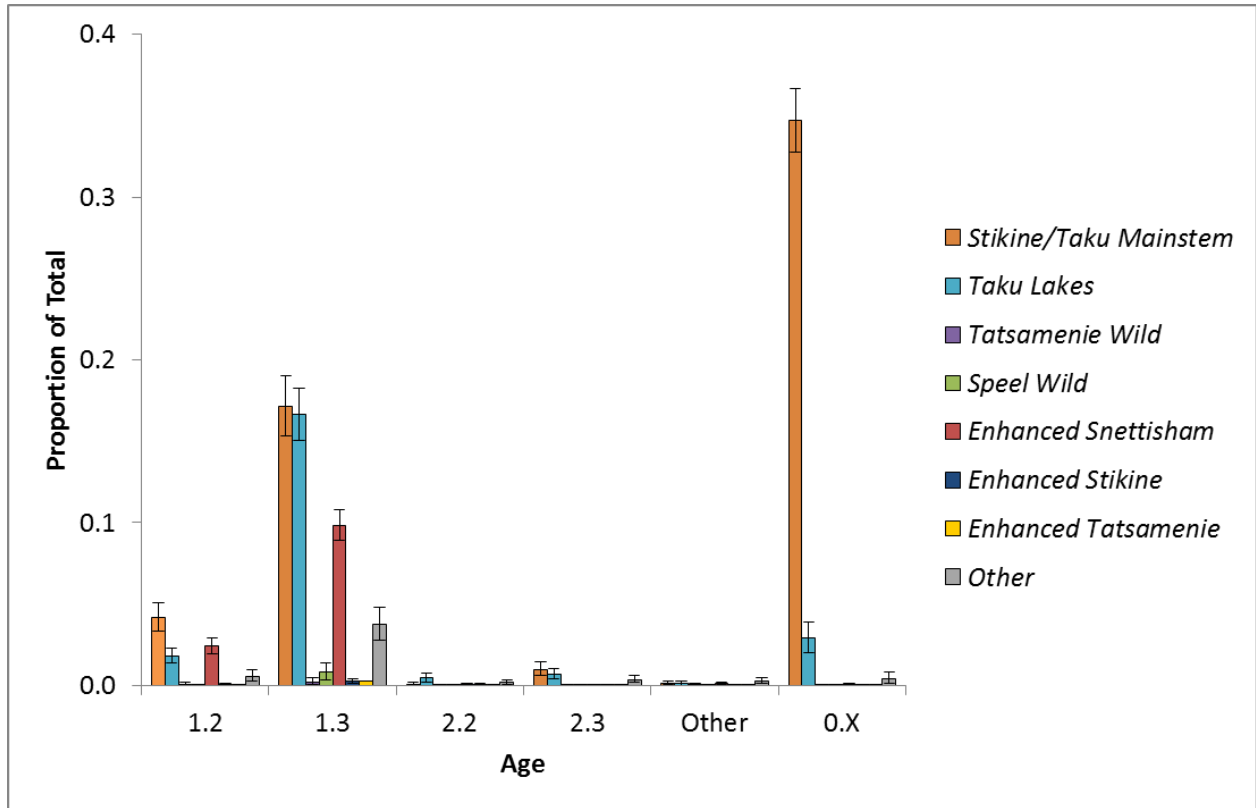


Figure 3. Age composition of sockeye salmon caught in the District 111 gillnet fishery in 2015 over the entire season. Error bars are upper and lower bounds of 90% credibility intervals.

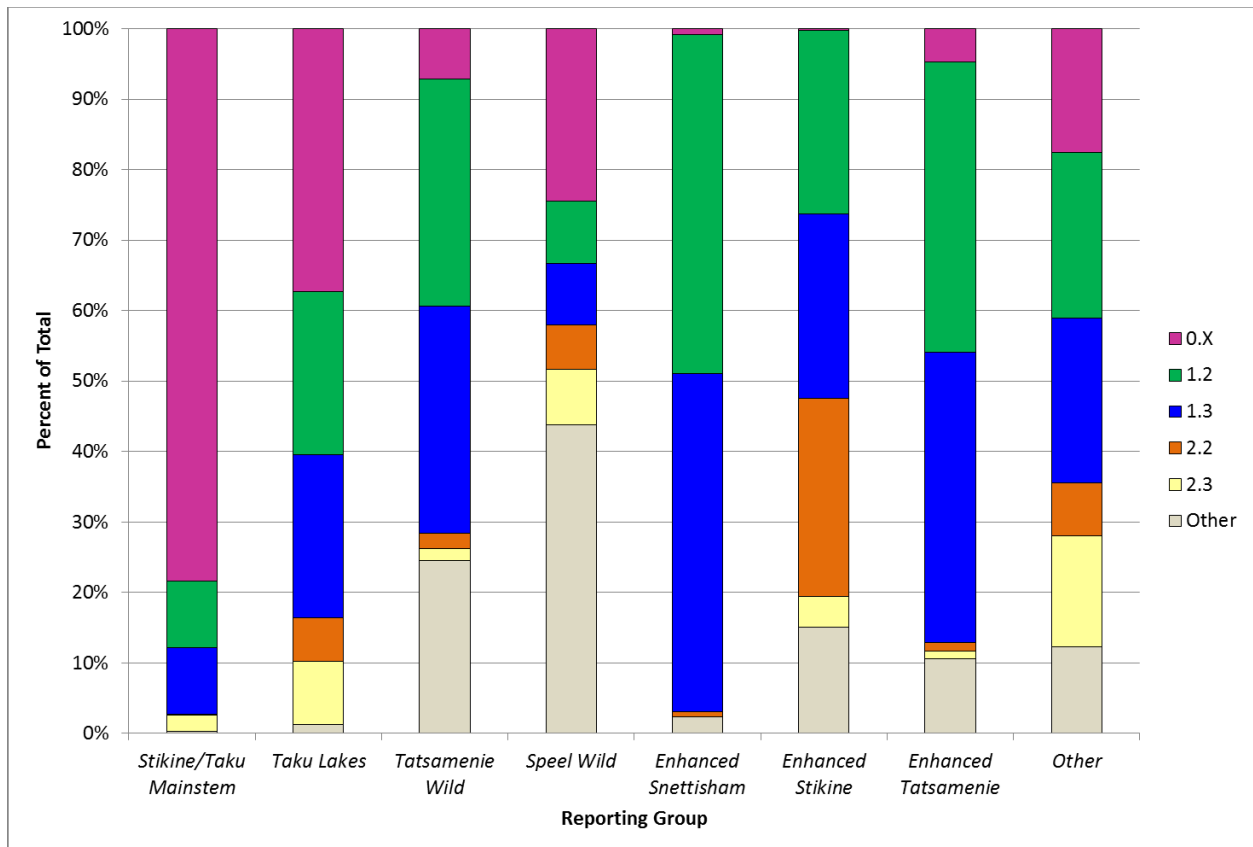


Figure 4. Age composition by reporting group of sockeye salmon caught in the District 111 gillnet fishery in 2015.