

**Genetic Changes Associated with In-basin Supplementation of Sockeye
Salmon (NOAA Component). Year 11
NF-2019-I-12
Final Report for 2019-2020**

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Abstract/Executive Summary

This project is evaluating the long term fitness of hatchery and wild sockeye salmon within a small watershed in Southeast Alaska. Concern about sockeye salmon fitness has been expressed in the case of both the Pacific Salmon Commission (PSC) Transboundary River enhancement on the Taku and Stikine Rivers and the PSC Northern Boundary Treaty Area of Southern Southeast Alaska (Hugh Smith and MacDonald Lakes). Measuring the fitness effects and potential impact of such enhancement projects (e.g. the lake stocking of fry or smolt using local or native stocks) is desirable to avoid long term undesirable effects on wild stocks. We will set out to evaluate the fitness of wild and hatchery progeny over multiple generations to understand and measure these impacts. Initial genetic sampling in 2008, 2009, and 2010 shows potential for utilizing microsatellite and single nucleotide polymorphism (SNP) markers to assess the parentage of Auke Lake sockeye and identify the progeny of wild and enhanced fish. We then will be able to evaluate the survival and introgression, if any, of the enhanced fish into the wild population. Additionally, we have demonstrated the ability to sample very close to 100% of both the juvenile and adult sockeye leaving/entering the system and provided a low impact design for sampling, capturing, maturing and spawning small numbers for use as brood stocking in three different brood years this study. During the summers of 2011-13, we captured and held adult sockeye in the Auke Creek Research Station Hatchery. We conducted experimental matings in all years and have incubated, cultured and released approximately 50,000 sockeye salmon into Auke Lake in the springs of 2012, 2013 and 2014. The culture and enhancement portions of this study are completed and all major objectives for culture and stocking have been met with high success. During 2013 through 2019 funding cycles, we have assessed

both smolt and adult production with virtually 100% sampling and accounting of fish leaving and entering the Auke Lake Watershed. A complete sampling of genetic, scale and age structured daily counts of upstream migrating adult sockeye salmon has occurred from 2008 through 2020.

Introduction

The project supports both the Stikine River Enhancement Production Plan (SEPP) and Taku River Enhancement Production Plan (TEPP), the two enhancement plans governing enhancement and harvest shares of sockeye salmon on important Transboundary rivers. It will also benefit the understanding of impacts to Alaska lakes that provide important sockeye harvest in the Northern Boundary Treaty Area of Southern Southeast Alaska. By utilizing technology and enhancement strategies currently in use for sockeye enhancement in Alaska, the project will help address and manage long term concerns about the impact of such enhancement on native populations. The work may also directly benefit the sockeye population at Auke Lake which has been noted in the Juneau Watershed Plan as declining in the face of increased watercraft use and upland development.

We have an opportunity through ongoing collaboration between UAF, ADF&G, and NOAA to conduct this important research at the NOAA Auke Creek Research Station hatchery and fish counting weir. This station affords the best experimental control and evaluation possible in Alaska. This is due to the presence of a small research hatchery and the two way counting weir which allows the capture, and observation of both juvenile and adult salmon migrating out and into Auke Lake. Prior work by NOAA Fisheries has demonstrated methodology to accomplish genetic and age structure sampling; as well as the capture, maturing and spawning of sockeye salmon at the facility have been highly successful.

NOAA, UAF, and ADF&G partner to undertake this long term project. Each organization brings significant resources to the project. NOAA provides the operational framework for the sampling, enhancement and evaluation that takes place at the Auke Creek Research Station and expertise in enhancement technology, experimental design and evaluation of long term enhancement impacts. UAF will provide expertise in the proper sampling, storage and analysis of genetic samples; and in the experimental design, statistical analysis of genetic data and the evaluation of long term impacts. The ADF&G will provide permit support, advice in experimental design and sampling as well as genetic analysis.

Objectives

All Project objectives have been met and accomplished successfully in a timely manner; the specific objectives are listed below;

1. Operate the juvenile and adult capture weir at Auke Creek on/about March 1 through October 31 in order to capture all sockeye salmon leaving and returning to the system. Based on prior year smolt escapement and average marine survival we expect approximately 2,000 adults and a few dozen jacks.
2. Subsample downstream migrating sockeye smolts for length, scales, and genetic samples.
3. Subsample downstream migrating coho smolts for length, scales, and genetic samples.
4. Coded wire tag all migrating coho salmon smolts
5. Sample all adult sockeye (axillary process) for DNA microsatellite and SNP analysis.
6. Subsample adult sockeye for Age Sex Length (ASL) data.
7. Count and examine all migrating coho salmon for external marks and sub sample for ASL.

Results

During the summer of 2011/12, 13 we captured and held adult sockeye in the Auke Creek Research Station Hatchery. We conducted experimental matings in both years and have incubated, cultured and released 50,000 sockeye salmon into Auke Lake in the spring of 2012, 13, 14. Detailed summary follows;

Table 1. Summary of Auke Creek Sockeye Returns to Auke Creek Year 2008-2020

Year	Males	Females	Jacks	Total Return
2008	Not allocated by sex		37	1243
2009	1794	2207	47	4001
2010	968	1050	45	2018
2011	1010	1299	118	2309
2012	611	905	53	1516
2013	910	1043	107	1953
2014	1583	1762	98	3345
2015	2082	2507	131	4720
2016	1220	1281	18	2519
2017	1612	2012	42	3666
2018	465	446	12	923
2019	466	615	23	1104
2020	332	370	4	706

Results – 2013 Funding Project Activity

The Auke Creek weir was converted to upstream capture mode on June 24, 2013. The first adult sockeye salmon were observed and captured on June 28. Between June 28 and Sept 3, all individual sockeye salmon were sampled by excision of an axillary process as they passed the weir upstream to Auke Lake. A total of 1953 adult sockeye salmon samples were collected (910 male, 1043 female and 107 jack) – fewer than five mortalities occurred during the capture and sampling process and fewer than three adults escaped sampling.

On July 7th, the project review committee members met and developed an operational plan to capture and hold sockeye for maturation, spawning, incubation and eventual release of fry into Auke in the spring of 2014. The fish were captured and transferred from the weir into holding tanks in the Auke Creek Research Station on July 10th and July 11th. A total of 30 females and 20 males were captured and held. The tanks were filled with Auke lake water collected from a 2.3 meter deep intake in Auke Lake which delivers water to the research station. The tanks were covered to prevent escape and minimize light and disturbance to the maturing fish. On August 26, 2013 eggs were collected from 22 females and fertilized with milt from 11 males. Three additional males were crossed with 3 females on September 2nd. Crosses were performed according to the breeding design set forward by the committee; on the 26th each male was crossed with least two and on the 2nd 1:1 crosses were made. Viable eggs were obtained from all females. Standard ADF&G procedures were followed during the spawning process including external disinfection and idophore egg hardening to mitigate infectious hematopoietic necrosis virus (IHN) issues.

Tissue samples were collected from kidneys and ovarian fluid to screen for bacterial kidney disease (BKD) and IHN.

Incubating embryos have reached the eyed egg stage and fertilization rates appear good. Eyed egg fertilization rates averaged 75%. Intake water is being taken from the deep lake intake in Auke Lake and is mechanically filtered and ultraviolet (UV) light treated prior to introduction to the incubator trays.

Results – 2014 Funding Project Activity

Approximately 75,000 sockeye fry from the 2013 Brood were incubated in vertical flow incubators at Auke Creek. Water flow and temperature were monitored 24/7 and influent water was filtered and treated with a new UV treatment system in order to minimize risk to IHN and other infectious agents. Fry were transferred to ponding units on at an average size of . They were fed at manufactures recommended levels for approximately 4 weeks. At that time the average size was .31 g and 50,000 fry were transported in 5 gallon buckets the short distance to Auke Lake. The fish were planted along the Auke Lake Margin in three locations on April 31, 2014 and May1, 2014. The experimental development committee arrived at the 50,000 fry release as optimal to accomplish project goals.

The Auke Creek Fry and Smolt weir was installed on February 27, 2014 .The first sockeye was captured on May 3rd, the last on June 13th, and a total of 21,029 sockeye smolt were capture in the spring of 2014. Daily counts and periodic age length samples and genetic samples were taken to ascertain year class of smolts and growth rate as well as genetic samples for possible analysis of hatchery and wild components.

The Auke Creek Weir was converted to upstream capture mode on June 13, 2014. The first adult sockeye salmon were observed and captured on June 14. Between June 14 and September 7 all individual sockeye salmon were sampled by excision of an axillary process as they passed the weir en route to Auke Lake. A total of 3,345 adult sockeye salmon samples were collected (1583 male, 1762 female and 98 jack) – fewer than five mortalities occurred during the capture and sampling process and fewer than three adults escaped sampling. The timing of sockeye into Auke Creek was earlier than most other years reflecting a general shift in migratory timing earlier, matching with other adult and juvenile salmon, presumable as a response to changing water temperatures and flow patterns. Periodic collections of age sex length data were collected to examine brood year strength and determine marine survival and growth.

Results – 2015 Funding Project Activity

The Auke Creek Fry and Smolt weir was installed on February 26, 2015. The first sockeye was captured on May 5th, the last on June 16th, and a total of 12,112 sockeye smolt were capture in the spring of 2015. Daily counts and periodic age length samples and genetic samples were taken to ascertain year class of smolts and growth rate as well as genetic samples for possible analysis of hatchery and wild components.

The Auke Creek Weir was converted to upstream capture mode on June 26th, 2015. The first adult sockeye salmon were observed and captured on June 26. Between June 26 and September 3, all individual sockeye salmon were sampled by excision of an axillary process as they passed the weir en route to Auke Lake. A total of 4,720 adult sockeye salmon samples were collected (2082 male, 2507 female and 131jack) –fewer than five mortalities occurred during the capture and sampling process and fewer than two adults escaped sampling. The timing of sockeye into Auke Creek was earlier than most other years reflecting a general shift in migratory timing earlier, matching with other adult and juvenile salmon,

presumable as a response to changing water temperatures and flow patterns. Periodic collections of age sex length data were collected to examine brood year strength and determine marine survival and growth.

Results – 2016 Funding Project Activity

The Auke Creek Fry and Smolt weir was installed on February 22, 2016. This is more than a week earlier than normal. The rationale for early installation was a) long term trend toward earlier migration of both juveniles and adults and b) normal than warmer water temperatures in the watershed during the fall and winter. The first sockeye was captured on April 25th, the last on June 17th, and a total of 19,045 sockeye smolt were capture in the spring of 2016. Daily counts and periodic age length samples and genetic samples were taken to ascertain year class of smolts and growth rate as well as genetic samples for possible analysis of hatchery and wild components.

The Auke Creek Weir was converted to upstream capture mode on June 17, 2016. The first adult sockeye salmon were observed and captured on July 1. Between July 1 and September 17, all individual sockeye salmon were sampled by excision of an axillary process as they passed the weir en route to Auke Lake. A total of 2,519 adult sockeye salmon samples were collected (1,220 male, 1,281 female and 18 jack) – fewer than five mortalities occurred during the capture and sampling process and no adults escaped sampling.

Additional funding was requested in 2016 to help support smolt sampling operations and coded wire tagging (CWT) of coho smolt at Auke Creek. Auke Creek coho serve as one of four indicator stocks used by ADF&G in Southeast Alaska to inform management decisions. The high tagging rate at Auke Creek (~100% marking), along with thorough commercial and recreational fishery sampling by ADF&G helps create a time series of marine survival, harvest, and productivity that is invaluable for area management biologists and researchers. In 2016, a total of 9,283 coho smolt were injected with CWTs. Tagged smolt are held for 24 hours to check for mortality and tag retention. Only 20 (0.2%) mortalities occurred and no fish required re-tagging. A total of 9,263 tagged and clipped coho smolt were released.

Results – 2017 Funding Project Activity

The Auke Creek Fry and Smolt weir was installed on February 24, 2017. This is more than a week earlier than normal. The rationale for early installation was a) long term trend toward earlier migration of both juveniles and adults and b) normal than warmer water temperatures in the watershed during the fall and winter. The first sockeye was captured on May 5, the last on June 19, and a total of 13,665 sockeye smolt were capture in the spring of 2017. Daily counts and periodic age length samples and genetic samples were taken to ascertain year class of smolts and growth rate, as well as genetic samples for possible analysis of hatchery and wild components.

The weir was converted to downstream capture mode on June 19, 2017. The first adult sockeye were passed upstream on June 21 and the last fish migrated on September 10. A total of 3,624 large adult and 42 jack sockeye were counted in 2017. Genetic samples were taken from every returning sockeye and there was no holding or handling mortality. In addition to genetic sampling, periodic length and scale samples were taken to allow estimation of length and age structure. The weir was removed for the winter season on October 27, 2017.

Auke Creek coho serve as one of four indicator stocks used by ADF&G in Southeast Alaska to inform management decisions. The high tagging rate at Auke Creek (~100% marking), along with thorough

commercial and recreational fishery sampling by ADF&G helps create a time series of marine survival, harvest, and productivity that is invaluable for area management biologists and researchers. In 2017, a total of 4,149 coho smolt were injected with CWTs. Tagged smolt are held for 24 hours to check for mortality and tag retention. Only 31 (0.7%) mortalities occurred and no fish required re-tagging. A total of 4,118 tagged and clipped coho smolt were released.

Results – 2018 Funding Project Activity

The Auke Creek Fry and Smolt weir was installed on March 3, 2018. The first sockeye was captured on May 2, the last on June 15, and a total of 12,680 sockeye smolt were captured in the spring of 2018. Daily counts and periodic age length samples and genetic samples were taken to ascertain year class of smolts and growth rate, as well as genetic samples for possible analysis of hatchery and wild components.

The weir was converted to downstream capture mode on June 15, 2018. The first adult sockeye were not passed upstream until July 16 due to low water, and the last fish migrated on September 3. A total of only 911 large adult and 12 jack sockeye were counted in 2018. Genetic samples were taken from every returning sockeye and there was no holding or handling mortality. In addition to genetic sampling, periodic length and scale samples were taken to allow estimation of length and age structure. The weir was removed for the winter season on October 24, 2018.

Auke Creek coho serve as one of four indicator stocks used by ADF&G in Southeast Alaska to inform management decisions. The high tagging rate at Auke Creek (~100% marking), along with thorough commercial and recreational fishery sampling by ADF&G helps create a time series of marine survival, harvest, and productivity that is invaluable for area management biologists and researchers. In 2018, a total of 4,731 coho smolt were injected with CWTs. Tagged smolt are held for 24 hours to check for mortality and tag retention. Only 16 (0.3%) mortalities occurred and no fish required re-tagging. A total of 4,715 tagged and clipped coho smolt were released.

Results – 2019 Funding Project Activity

The Auke Creek Fry and Smolt weir was installed on February 12, 2019. This is more than two weeks earlier than normal. The rationale for early installation was a) long term trend toward earlier migration of both juveniles and adults and b) normal than warmer water temperatures in the watershed during the fall and winter. The first sockeye was captured on May 5, the last on June 13, and a total of only 4,726 sockeye smolt were captured in the spring of 2019. Daily counts and periodic age length samples and genetic samples were taken to ascertain year class of smolts and growth rate, as well as genetic samples for possible analysis of hatchery and wild components.

The weir was converted to downstream capture mode on June 13, 2019. The first adult sockeye were passed upstream on June 17, and the last fish migrated on August 30. A total of only 1,081 large adult and 23 jack sockeye were counted in 2019. Genetic samples were taken from every returning sockeye and there was no holding or handling mortality. In addition to genetic sampling, periodic length and scale samples were taken to allow estimation of length and age structure. The weir was removed for the winter season on October 22, 2019.

Auke Creek coho serve as one of four indicator stocks used by ADF&G in Southeast Alaska to inform management decisions. The high tagging rate at Auke Creek (~100% marking), along with thorough commercial and recreational fishery sampling by ADF&G helps create a time series of marine survival,

harvest, and productivity that is invaluable for area management biologists and researchers. In 2019, a total of 3,226 coho smolt were injected with CWTs. Tagged smolt are held for 24 hours to check for mortality and tag retention. Only 25 (0.8%) mortalities occurred and no fish required re-tagging. A total of 3,201 tagged and clipped coho smolt were released.

Results – 2020 Funding Project Activity

The Auke Creek Fry and Smolt weir was installed on February 13, 2020. The rationale for early installation was a) long term trend toward earlier migration of both juveniles and adults and b) normal than warmer water temperatures in the watershed during the fall and winter. The abundance of downstream migrant sockeye salmon smolt during 2020 (7,347) was below the 1980-2020 average (16,343). A total of 6,570 smolt migrated downstream in May, and 777 migrated in June. Daily counts and periodic age length samples and genetic samples were taken to ascertain year class of smolts and growth rate, as well as genetic samples for possible analysis of hatchery and wild components.

The weir was converted to downstream capture mode on June 15, 2020. The first adult sockeye were passed upstream on June 17, and the last fish migrated on August 30. The 2020 sockeye upstream migration abundance (706) was the lowest on record and well below the 1980-2020 average (2,641). The 2020 sockeye run consisted of 702 large adults and 4 jacks. Genetic samples were taken from every returning sockeye and there was no holding or handling mortality. In addition to genetic sampling, periodic length and scale samples were taken to allow estimation of length and age structure. The weir was removed for the winter season on October 27, 2020.

Auke Creek coho serve as one of four indicator stocks used by ADF&G in Southeast Alaska to inform management decisions. The high tagging rate at Auke Creek (~100% marking), along with thorough commercial and recreational fishery sampling by ADF&G helps create a time series of marine survival, harvest, and productivity that is invaluable for area management biologists and researchers. In 2020, a total of 4,387 coho smolt were injected with CWTs. Tagged smolt are held for 24 hours to check for mortality and tag retention. Only 23 (0.5%) mortalities occurred and no fish required re-tagging. A total of 4,364 tagged and clipped coho smolt were released.

Monitoring and Evaluation

Monitoring and Evaluation of this project is ongoing and is principally accomplished thru the annual operations of the NOAA Auke Creek Weir and Research Station. The weir traps, enumerates, and allows sampling of all juvenile and adult salmon migrating to and from the Auke Lake Watershed. PSC funding is critical for this important data set to move forward, principally by the monitoring of sockeye juveniles and adults in this system, the periodic collection of basic biological parameter data, as well as DNA pedigree information and scales is the means by which the long term goals of this project can be accomplished.

Discussion/ Conclusion

Good planning and good fortune continued and resulted in all project objectives being accomplished during 2013, 14 and 15. We were successful in sampling virtually every adult migrant, capturing and holding sufficient adult sockeye salmon for the hatchery component. We conducted maturation and spawning activity that resulted in a relatively high rate of egg and fry survival and had no issues with disease or water quality. Each of the three years we were successful in incubating and culturing fry, and eventually meeting stocking goal numbers of fry into Auke Lake. We had some serious logistical challenges with floods and unplanned sampling issues but all challenges were met and the project goals for these time periods are complete. We have completed three years of full cycle sampling, spawning and stocking. Operations during calendar years 2015-2020 have provided the structural framework for sampling and evaluation of the experimental releases of hatchery and wild sockeye salmon and were also accomplished with great success.

Benefits

Benefits include increased knowledge of the fitness of hatchery and wild sockeye salmon reared in the same watershed. This will assist fisheries enhancement scientists and managers within the state and federal agencies that would increase their knowledge base of the potential and direct impacts of enhanced sockeye salmon on wild populations within the same basin. Direct knowledge of the genetic structure of this population will add to the general knowledge of sockeye salmon genetic variation in Southeast Alaska. Ultimately, the knowledge gained from this study will help to provide direction to expanding the contribution and lowering the risk of sockeye enhancement projects in the US and US/Canada Transboundary rivers such as the Taku and Stikine. This could allow for the increased commercial, sport and subsistence catch and direct economic benefit while protecting wild salmon stocks

Budget Narrative

Spending was accomplished along budget plans, with primary spending going to contracted services. Supplies monies were allocated, but no travel occurred. In FY19, \$41,235.75 was spent on contract services and \$823 on AGO service fees/overhead associated with the contract. In FY20, \$5,191.25 was spent on supplies and travel.

Line Item	Projected	Spent	Difference
Subcontractors and Consultants			
Contract Services FY19		\$41,235.75	
Total Contractor Costs	\$41,153.00	\$41,235.75	(\$82.75)
Site/Project Costs			
Supplies FY20	\$2,250.00	\$3,300.88	
SOEM Travel FY20	\$3,024.00	\$1,890.37	
Total Site/Project Costs	\$5,274.00	\$5,191.25	\$82.75
Overhead/Indirect Costs			
AGO overhead fee for contract	\$823.00	\$823.00	
Total Overhead/Indirect Costs	\$823.00	\$823.00	\$0.00
Total Project Costs	\$47,250.00	\$47,250.00	\$0.00