Hatchery-Wild Interactions Study: Sitka Sound Science Center 2021 Field Summary

Alex McCarrel- Research Coordinator, Chance Gray- Operations Manager, Ron Heintz- Research Director

INTRODUCTION

The Alaska Department of Fish & Game (ADF&G), along with private-non-profit hatchery corporations, have engaged in research studies addressing concerns about straying and the genetic and ecological interactions between hatchery and wild salmon. These concerns relate to the value of hatchery-origin and wild stocks to Alaska salmon fisheries and the state mandate that hatchery production be compatible with sustainable productivity of wild stocks. The Hatchery-Wild Interactions Project began in 2011 to address these concerns. Initially, ADF&G convened a science panel that prioritized three major questions in Southeast Alaska and Prince William Sound:

1) What is the genetic stock structure of chum salmon in Southeast Alaska (SEAK)?
2) What is the extent and annual variability in straying of hatchery chum salmon in SEAK?
3) What is the impact on fitness (productivity) of wild chum salmon due to straying of hatchery chum salmon?

The Sitka Sound Science Center (SSSC) was contracted by the ADF&G to collect genetic and life history samples from post-spawned summer chum salmon in three streams in Northern Southeast region of Alaska beginning in 2017. This report details the field summary and survey findings of those streams in the 2021 field season. The raw data are available and were submitted via the Hatchery Wild Application.

METHODS

SSSC was contracted to sample three streams (Figure 1) for post-spawned summer chum salmon (*Oncorhynchus keta*) in Northern Southeast Alaska in 2021. Two Juneau-based field crews conducted surveys on Fish Creek (North Douglas Island) and Sawmill Creek (Berner's Bay) while a third crew focused on Prospect Creek (Port Snettisham) in a remote field camp. One four-person crew was tasked with conducting surveys on Fish Creek (AWC 111-50-10690) on Douglas Island and another four-person crew was tasked with conducting surveys on Sawmill Creek (AWC 115-20-10520) in Berner's Bay. Fish Creek is the only study site accessible by the road system on Douglas Island, and Sawmill Creek is accessible by skiff from the Echo Cove boat launch 8 miles North to Berner's Bay. This year was the first year a remote field camp was developed in Port Snettisham to allow a four-person crew, consisting of three fisheries technicians and one bear guard, to access Prospect Creek (AWC 111-33-10100) through a short 10-minute skiff ride.

SSSC crews are contracted to collect otolith and tissue samples and morphological information from post-spawned chum salmon. This year chum carcass retrieval on all three streams were aided by carcass weirs, used to capture chum carcasses as they drifted downstream. Crews also conducted mark-recapture studies in all three streams to produce escapement estimates that could be used to estimate the proportion of the run that is sampled. In addition, crews record a daily live, dead, and previously sampled count for all chum salmon observed in each stream. Crews also take weekly live counts of pink salmon in each stream and documents any other Pacific salmon species seen.

Figure 1. Location of streams sampled by SSSC field crews in 2021.

1. Training and Field Preparation:

SSSC field crews spent 10 days of training prior to conducting field work. Training consisted of field safety, sampling protocols, and quality control. Measures were taken to protect crew members, SSSC staff, and the Sitka and Juneau communities from COVID-19. Due to COVID-19, traditional access to the University of Alaska Southeast was not available for the Juneau-based crew and alternative housing near Auke Bay was obtained. For the crew assigned to Prospect Creek, a remote field camp was constructed in Port Snettisham, less than a mile south from the creek, to allow easy access to the stream.

Numerous policies and procedures were developed to minimize COVID-19 risk and ensure data was collected effectively and safely. Minor alterations to training and field preparation included conducting training when applicable outside and wearing masks for all indoor training activities. Community interactions were minimized while in Sitka and Juneau by discouraging eat-in dining and wearing masks in all indoor facilities.

2. Pedigree Sample Collection and Reporting:

The quality and integrity of the data was further enhanced in 2021 through updates to the field technician training. Crews primarily focused on sampling chum salmon carcasses for pedigree analysis. To obtain more samples while conducting carcass surveys, crews included sampling of live post-spawned chum salmon in the absence of more readily available carcasses. This method was especially relevant for crew assigned at Prospect Creek, which dealt with low dead chum salmon counts. Crews used snagging equipment and nets to target post-spawned live individuals. However, special care had to be taken to not unnecessary capture pre-spawned individuals.

Carcasses were sampled as they were encountered. However in locations when large numbers of carcasses were observed they were hapharzardly subsampled in order to allow time for processing carcasses in other sections of the stream. The goal was to examine the entire length of the stream on each carcass survey. Complete carcass surveys were conducted every other day except for Sawmill Creek, which allowed for daily carcass surveys. On the intervening days, carcasses were recovered from the carcass weirs and locations near the mark and release areas. Carcasses were sampled for length (mideye to hypural plate length mm), tissues for genetic analysis, two scales, otoliths, and sex. In addition we recorded the date, latitude, longitude, and the quality of the carcass. Data were recorded electronically in the field using a specially developed application.

The laptop application allowed for easy review of all field data and data were submitted after returning to base camp. Prior to data transmission, the laptop application prompted a complete review of the samples collected and required the identification of milestone cells (missing otolith, last specimen, etc.). Once these checks were complete, the surveys were transmitted to the Hatchery-Wild Database via the internet. Data were backed up on multiple storage devices daily by all field crews. The Prospect Creek-based crew had limited internet access and transmitted surveys as service was available, typically occurring every two weeks during crew transfers. The Hatchery-Wild Database was critical to acquisition of error-free data and was used by project personnel throughout the season to produce reports, conduct data checks, and confirm survey transmission. The database was also used during the season to conduct final quality assurance checks prior to delivering otolith and DNA samples to the ADF&G MTA Lab and scales to the Douglas Island Pink & Chum lab in Juneau.

3. Proportion of Run Sampled:

A mark-recapture study was incorporated into the sampling to provide precise estimates of chum salmon run size and estimate the proportion of the run sampled for pedigree analysis. The mark-recapture study consisted of periodic sampling of live chum entering Fish Creek, Sawmill Creek, and Prospect Creek, double marking them, and releasing them. The recapture phase coincided with carcass sampling. Live fish for tagging and release were captured at fixed locations in each stream using beach seines and/or dip nets. Release locations were far enough upstream to minimize the number of probing fish that might emigrate the stream after tagging. Once captured, fish were given uniquely numbered Floy tags and opercular punches that corresponded to the week of release. Genetic samples, scales, sex, and morphometric data were taken for each fish and they were released back into the stream. For Fish Creek and Prospect Creek, mark-recapture sampling was conducted every other day, which prevented full length stream surveys on those days due to the long survey lengths for the two creeks. Sawmill Creek's shorter survey length allowed for daily carcass surveys, with mark-recapture sampling conducted every other day. All chum marking ceased the third week of August due to the incoming fall chum run and to allow all tagged salmon sufficient time to spawn. Carcasses were sampled, tallied, and examined for floy tags and opercular marks. All carcasses were subjected to our pedigree sampling protocols.

Release data were recorded in the field using the computer application. A "Survey Type" field allowed us to distinguish release samples from recapture samples. Recorded data included the Floy tag number, opercular punch location, in addition to the data typical of carcass surveys. Lengths of tagged fish were recorded at tip-of-snout to fork-of- tail (SFL) to minimize handling. The lengths of subsequent recaptures

were recorded as MEHL. The lengths of all tagged and released fish were converted to MEHL using a linear regression of the MEHL on FL for the recaptures.

3.1 Estimation of the Proportion Sampled

The proportion of the run sampled for each of the streams was calculated the ratio of the number of unique samples collected to the estimated run size. The number of unique samples (N_u) is the sum of the number of tagged fish released and the observed number unmarked carcasses. Run size ($\widehat{N}$) was estimated using Chapman's modification of the Peterson estimate: .

$$\widehat{N} = \left(\frac{(M+1)(C+1)}{R+1}\right) + 1 \qquad \text{equation 1}$$

Where *M* = is the total number of marks released, *C* is the number of carcasses inspected, and *R* is the number of recaptured fish. The the variance estimator is given by:

$$V_{\widehat{N}} = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)} \qquad \text{equation 2}$$

The proportion of the population sampled (p) is estimated as:

$$P = \frac{N_u}{\widehat{N}} \qquad \text{equation 3}$$

Where N_u is the number of unique samples collected from the stream. The 95% confidence interval for the run size was estimated as

$$\text{C.I.} = 1.96 * \sqrt{V_{\widehat{N}}} \qquad \text{equation 4}$$

There are a number of important assumptions underlying the Peterson estimator that must be examined to understand the potential for bias in the estimates. Specifically, these include:

1) Marking does not effect the catchability of a fish. This includes no mortality associated with handling.
2) Fish do not lose marks between sampling events.
3) Recruitment and death of fish cannot occur between sampling events

These assumptions were met in our study by holding marked fish briefly to ensure they recovered from the marking event. We double marked the fish to determine if the fish lost marks and finally marking and recovery occurred throughout the run which minimizes the possibility for recruitment into the stream during the study. There is some potential for emigration from the study, but we located our marking area above the high tide line to minimize any marking of fish probing the system. Removal by predators are another source of emigration, but our carcass surveys also examined areas along stream bank.

In addition, it is important that at least one of these three criteria are also met in order to minimize bias:

1. Every fish has an equal probability of being marked and released alive during the first sampling event.
2. Every fish has an equal probability of being captured during the second sampling event.
3. Marked fish mix completely with unmarked fish between sampling events.

We examined these criteria by examining the proportion of males and females and the size distributions of fish collected in the marking and recovery events. Comparisons of the proportion of males and females employed Chi-square analysis of the proportion of Marked and Recaptured fractions of the data set. Rejection of the null hypothesis led to the conclusion c samples were biased with result to sex in the recovery data (Failure of criterion 2). Comparisons of the sex ratios in the Captured and Recaptured fractions that rejected the null hypothesis led to the conclusion that sampling was biased in the marking event (Failure of criterion 1). Comparisons of the ratios in the Marked and Captured fractions were used to examine criterion 3. A similar process was used to compare lengths relative to criteria 1 through 3, but a Kolmogorov Smirnov test was used instead of the Chi-square. Critical values for hypothesis testing relied on $\alpha = 0.05$.

Stratified estimates of the proportion sampled were calculated as:

$$\text{C.I.} = 1.96 * \frac{\sum N_u}{\sum \hat{N}} \qquad \text{equation 5}$$

Sampling Equipment Summary:

Most sampling equipment worked well in 2021. We had issues using the seine nets for the mark-recapture study due to a lack of adequate staging areas where chum salmon were gathering in sufficient numbers, as well as the nets themselves being too lightweight to hold up against strong currents. We also had issues with clickers freezing.

Several pieces of equipment were upgraded or new this year, including new waterproof backpacks and the equipment used to tag chum for the mark-recapture study. One major addition to this year's field equipment was the installation of ADF&G carcass weirs in all three streams to aid in chum salmon carcass retrieval. The carcass weirs worked poorly for chum salmon, though they had a high catch rate for pink salmon. Despite these equipment setbacks, crew members felt well prepared and satisfied with the equipment used in the field.

Communication between field crews and project coordinators was effective and frequent. The use of both cell phones and Garmin InReach SE Satellite texting devices allowed crews to remain in contact with the SSSC project coordinator and field support staff throughout the season. Sample numbers, field logistics, schedule revisions, field crew requests, and other challenges were discussed throughout the season. The project coordinators also maintained communication with ADF&G Area Management Biologists in Juneau and Haines with updates on fish numbers, as well as stream and sampling conditions. Updates were also communicated to ADF&G project supervisors and the HWI science panel.

RESULTS

Survey timing and coverage:

All three study streams were surveyed throughout the 37-day field season in 2021. Sampling lasted from July 22nd to August 27th for Fish Creek, July 21st to August 26th for Sawmill Creek, and July 25th to August 26th for Prospect Creek. Fish Creek had 29 unique stream visits, Sawmill Creek had 33 unique stream visits, and Prospect Creek had 25 unique stream visits. Crew members recorded lengths, identified sex, and collected DNA samples, scales, and otoliths from over 1,100 samples representing 980 chum carcasses and 408 live chum salmon (Table 1). The 2021 field season yielded a low to moderate number

of carcass samples compared with the median number of samples collected over the previous seven years. The previous medians were 266, 1017 and 473 samples in Sawmill Creek, Fish Creek, and Prospect Creek, respectively. The number of carcasses sampled from Sawmill Creek is nearly equal to the median (Table 1) while Fish Creek and Prospect Creek were well below the median.

Table 1. Starting and ending dates from chum salmon streams surveys and gross counts of live chum, dead chum sampled, live chum sampled, the number of otolith samples collected, and the number of scale samples collected.

	Start Date	End Date	Total Live Observed	Number carcasses sampled	Number live fish sampled	Number otolith samples	Number scale samples
Sawmill Creek	7/21/2021	8/26/2021	2240	230	72	222	301
Fish Creek	7/22/2021	8/27/2021	2481	659	163	643	822
Prospect Creek	7/25/2021	8/26/2021	1123	91	23	85	114

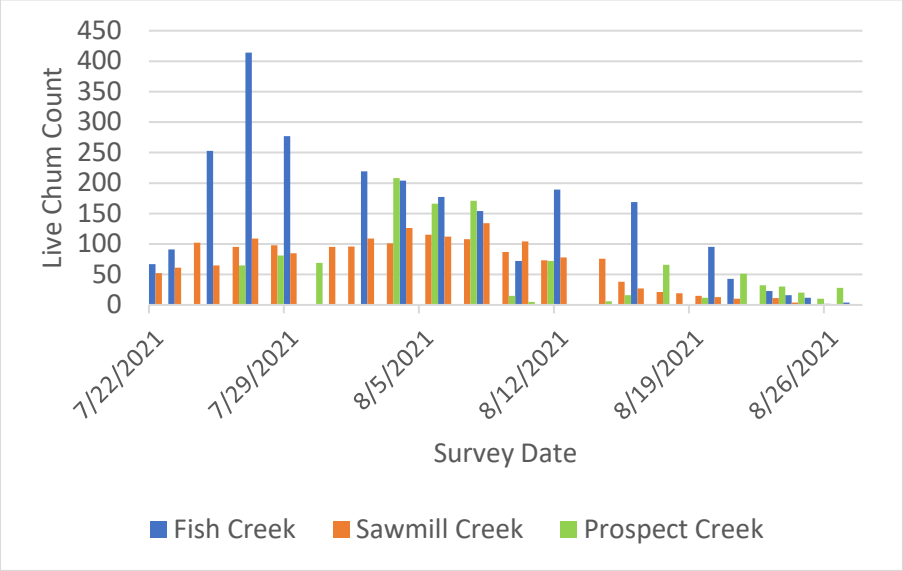

Figure 2. Live chum counts for Fish Creek, Sawmill Creek, and Prospect Creek over the 2021 survey season. Notes the differences in scale and distribution of peak live chum counts between each stream.

Live chum counts for all three streams for the 2021 season differed in respect to scale and peak timing (Figure 2). Peak live counts were the highest and occurred the earliest in Fish Creek compared to the other streams, during the last week of July with 414 fish observed on 7/27/2021 (Figure 3). Peak live counts were the smallest for Sawmill Creek, occurring the first week of August with 134 fish on

8/8/2021, with live counts having a more even distribution across the 2021 survey season (Figure 4). Prospect Creek had a peak live count of 208 fish on 8/3/2021 (Figure 5).

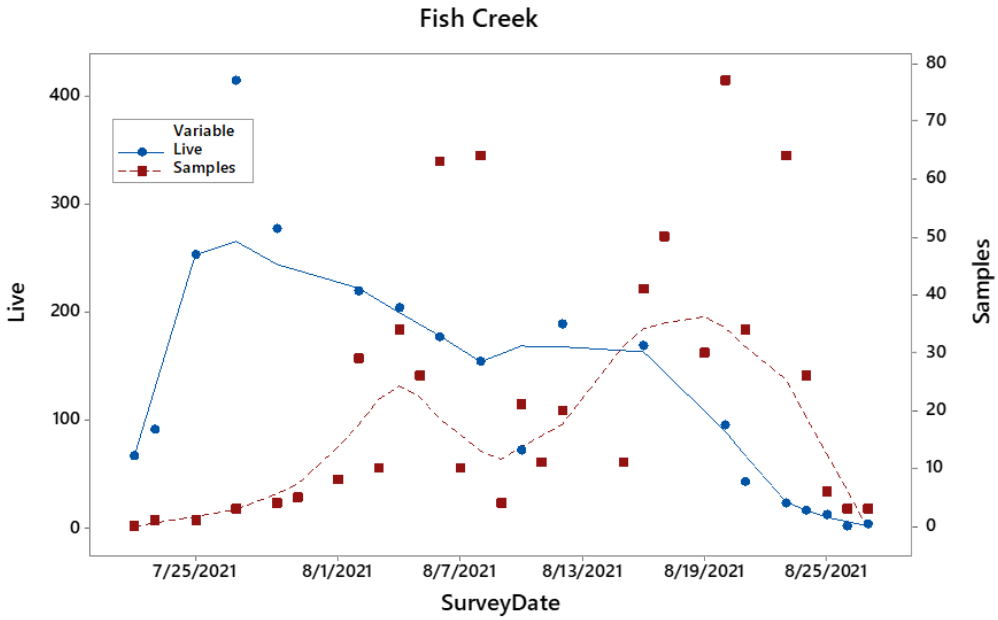

Figure 3. Daily live counts and sample numbers for Fish Creek chum salmon as a function of survey date. Lines show Lowess smoother drawn through data points. Note sample numbers track the daily dead counts.

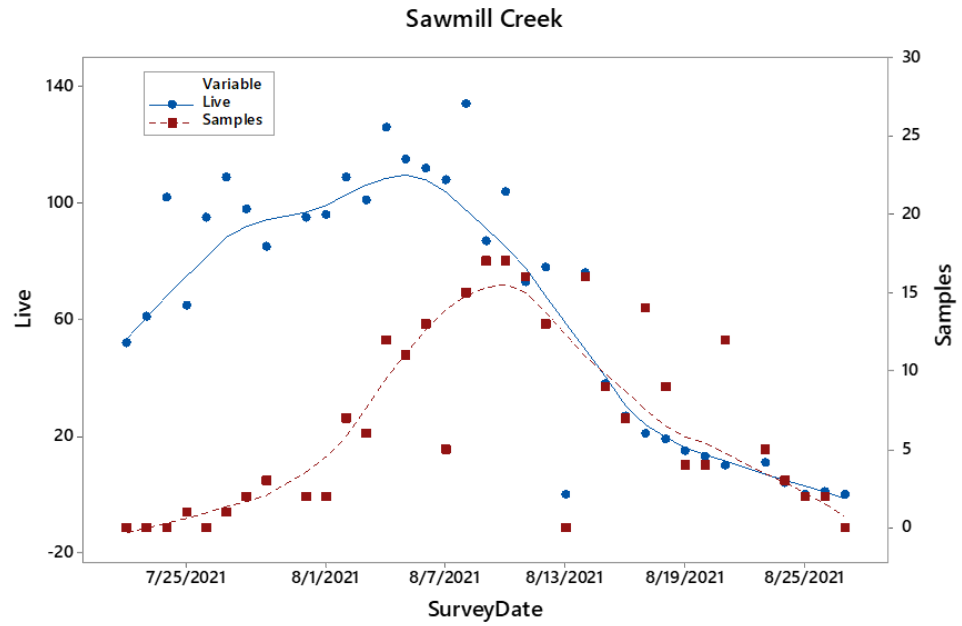

Figure 4. Daily live counts and sample numbers for Sawmill Creek Chum Salmon as a function of survey date. Lines show Lowess smoother drawn through data points. Sample numbers track the daily dead counts. Note differences in scales relative to Figures 3 and 5.

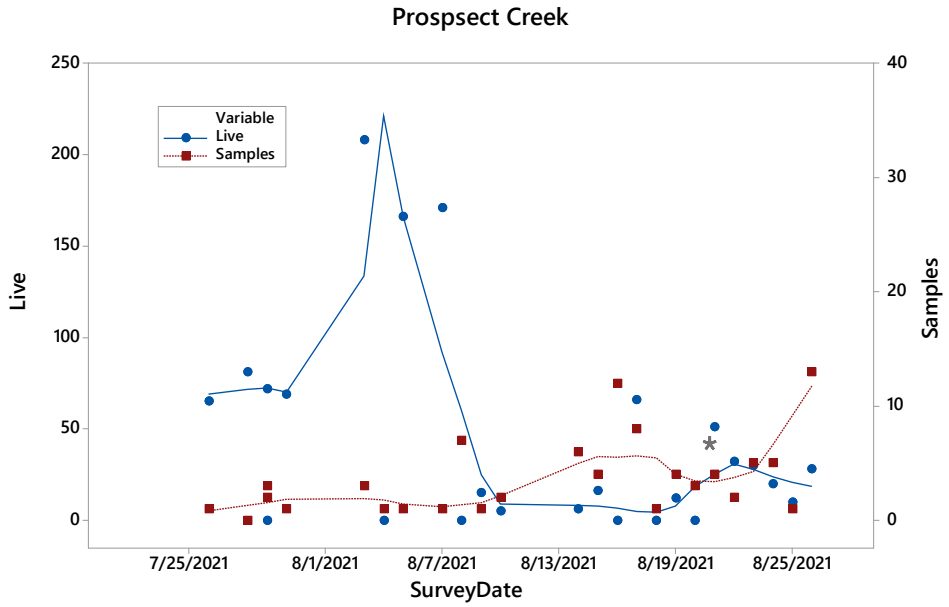

Figure 5. Daily live counts and sample numbers for Prospect Creek Chum Salmon as a function of survey date. Lines show Lowess smoother drawn through data points. Sample numbers track the daily dead counts note differences in scale relative Figures 3 and 4.

Weather became challenging during the middle of the 2021 field season, with numerous surveys being cancelled or curtailed. In Fish Creek, three carcass surveys were cut short due to high water (8/10, 8/12, and 8/15) and three surveys were cancelled altogether (8/13, 8/14, and 8/18). The terrain and nature of Fish Creek, with it being the main drainage for a large portion of North Douglas Island, led to major flooding events that made surveying impossible. In Sawmill Creek only two carcass surveys were cancelled due to high water and/or unsafe skiff conditions (8/13 and 8/27). In Prospect Creek, surveys were the most affected by high water events due to remote terrain and the nature of the stream. Eight carcass surveys were curtailed due to weather (8/9-8/15, 8/18-8/19, 8/25), however, no surveys were cancelled.

Sex Ratio:

When comparing the sex ratios of chum salmon, sex ratios were heavily skewed towards female in 2021. In Fish Creek, 60.20% of chum carcasses were female, with similar results seen in Prospect Creek with 61.50% being female. In Sawmill Creek 63.5% were female. These ratios differed slightly from our eight-year average for these streams (Figure 6).

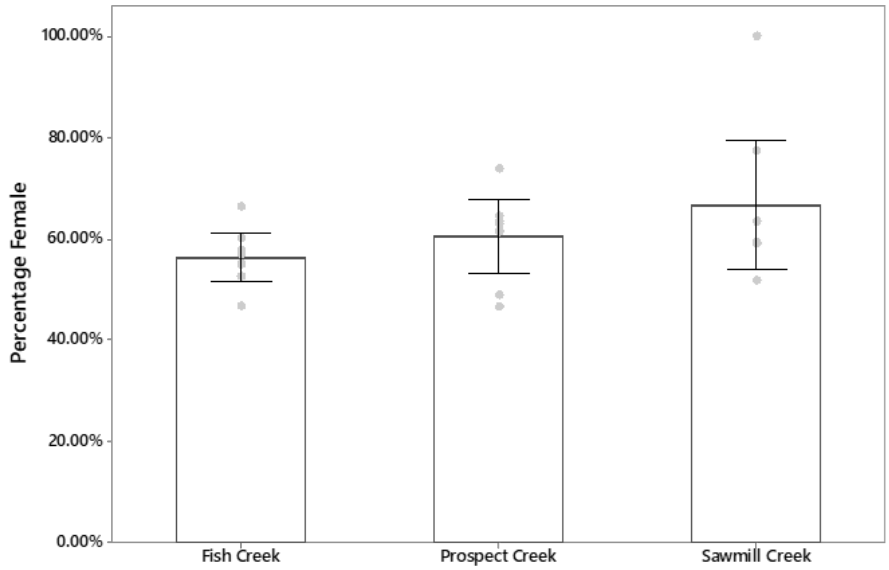

Figure 6. Percentage of females in chum salmon streams sampled between 2013 and 2021. Error bars depict the 95% confidence interval of the mean. Points show observed values for each stream.

Size:

Two types of length measurements were taken for the 2021 season. The length from mid-eye to hypural plate (MEHL) was used to measure chum carcasses, while the length from the snout to the caudal fork (SFL) was used to measure live chum salmon. SFL measurements for all fish were corrected to MEHL by regressing the MEHL observed for the recaptured fish on their SFL ($r^2 = 0.871$, $p < 0.001$) recorded at tagging. The resulting model was applied to all tagged fish (Table 2). Comparing the average corrected MEHL of tagged live chum to the average MEHL of carcasses, live females were larger than carcass females for Fish Creek and live males were larger than carcass males. For Sawmill Creek, both live females and males were smaller than carcass females and males. Like Sawmill Creek, Prospect Creek's live females were smaller than carcass females, while live males were larger than carcass males.

Table 2. Live chum salmon lengths by sex compared to carcass survey chum salmon lengths by sex for each survey stream. Standard errors for each value are in parentheses..

Stream	Average Female Carcass Survey MEHL (SE)	Average Male Carcass Survey MEHL (SE)	Average Female Tagging Survey Corrected MEHL (SE)	Average Male Tagging Survey Corrected MEHL (SE)
Fish Creek	483.1 (±1.6)	493.9 (±2.5)	487.9 (±2.6)	502.38 (±3.4)
Sawmill Creek	478.2 (±2.96)	490.7 (±4.92)	460.5 (±5.2)	488.9 (±6.6)
Prospect Creek	487.68 (±3.7)	497.7 (±6.8)	473.5 (±6.6)	506.9 (±7.4)

Age:

Scales were collected from both chum carcasses and live chum, providing information on the age structure of the runs. We recently received the age data from the DIPAC fish ageing lab. Our initial review indicates a scale loss rate of 2% for Fish Creek, 3.5% for Sawmill Creek, and 11.5% for Prospect Creek. The high level of scale loss seen for Prospect Creek is likely due to scale cards getting wet during the atmospheric river event that happened 8/13/2021-8/15/2021, as well as periods of heavy rainfall the week following the atmospheric river event and damp living conditions throughout the 2021 season.

Origin:

Otolith samples were submitted to the ADF&G Mark Tag and Aging Lab at the end of the field season. We have not yet received results back from the lab.

Proportion of Run Sampled:

Marking began on the first day of sampling in each creek and ended approximately one week before the end of sampling (Figure 7). Initially the plan called for marking to be conducted every other day until the beginning of the last week of August. Fish were to be captured at fixed locations (“staging areas”) in each stream using beach seines or dip nets. These locations were located near or just beyond the tidal influence in these streams. This was problematic for Prospect Creek because flows were sufficiently fast and water level deep enough to impede use of the seine nets and limited visibility for dip net capture. Similarly in Fish Creek, fish did not appear to stage in the intertidal prior to moving upstream. Dip netting was effective, but it appears that catchability was highest for fish intending to spawn in the lowest spawning area. Capture using beach seines in Sawmill Creek worked as planned, though the seine nets primarily caught pink salmon, not chum salmon, due to a lack of chum salmon congregating in high numbers. Table 3 summarizes the number of tagged fish released (M in equation 1), the number of recaptures (R in equation 1) and the number of carcasses examined for tags (C in equation 1).

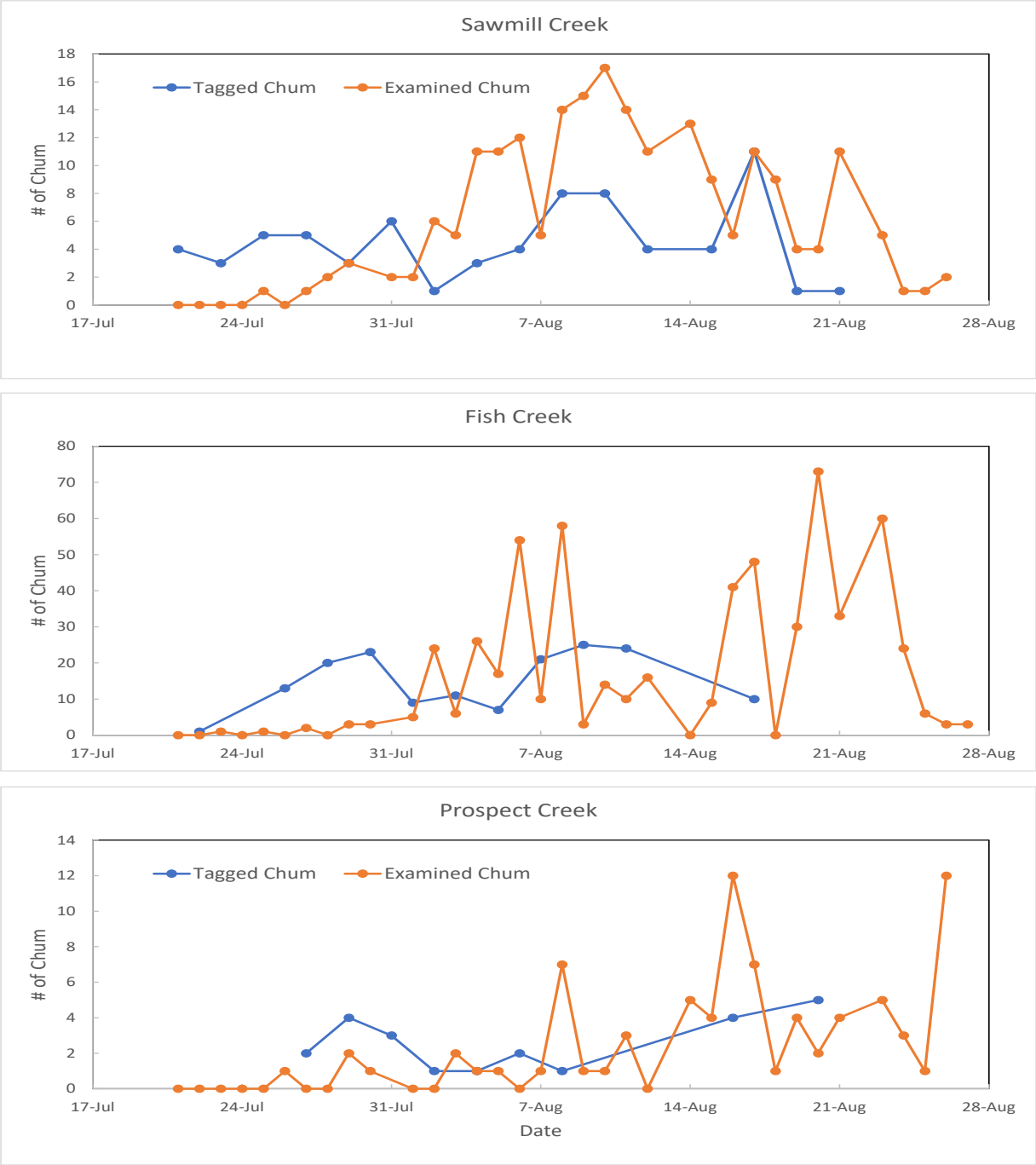

Figure 7. Daily numbers of fish marked and released and the number carcasses surveyed for each of the three study streams. Note differences in ordinate scales.

Table 3. Marks released (M), recaptures (R) and the number of carcasses inspected C) in each of the three study streams. Recaptures include all fish with mutilated opercula. % lost tags is the percentage of R for which no floy tag was observed. Numbers in parentheses are females and males. Fish with unknown sex are included in totals.

	M	R	% Lost Tags	C
Fish Creek	164 (82, 82)	75 (45, 29)	16 (18, 10)	659 (397, 249)
Sawmill Creek	72 (28, 43)	26 (11, 15)	19 (18, 20)	230 (146, 82)
Prospect Creek	23 (11, 12)	10 (4, 3)	30 (20, 40)	91 (56, 34)

Examination of the sex ratios observed in the different fractions (Table 4) indicated the presence of bias with respect to sex in the Fish Creek sample as indicated by the rejection of the null hypothesis for the comparison of the sex ratios in M vs. R and M vs. C. In contrast there was some evidence of a sex bias in the second event for Sawmill Creek indicated by the significant difference between M vs. C. No bias was detected in the Prospect sample. Similarly analysis of the lengths (Table 5) indicated evidence of size bias in Sawmill Creek. Consequently, population estimates were mad for all the fish combined in each stream and broken down by sex in Fish Creek and size in Sawmill Creek. Size was partitioned into "small" and "large" fish using the median length (486 mm) of the recaptures as the break point.

Table 4. Results of χ2 testing of sex ratios in different fraction of the mark-recapture data set. M is the Marked and released fraction, R is the recaptured fraction, and C is fraction representing the second sampling event.

Comparison	Sawmill Crk	Fish Crk	Prospect Crk
M vs. R	Accept H_0	**Reject H_0**	Accept H_0[1]
C vs. R	**Reject H_0**	Accept H_0	Accept H_0
M vs. C	**Reject H_0**	**Reject H_0**	Accept H_0
Conclusion	No bias in second event, but there is in the first	Bias in the second event, bias unknown in first event	No bias evident

Table 5. Results of Kolmogorov Smirnov tests on length frequency distributions in different fractions of the mark-recapture data sets for each stream. M is the marked and released fraction, R is the recaptured fraction and C is fraction representing the second sampling event.

Comparison	Sawmill Crk	Fish Crk	Prospect Crk
M & R	**Reject H_0**	Accept H_0	Accept H_0
C & R	**Reject H_0**	Accept H_0	Accept H_0
M & C	**Reject H_0**	**Reject H_0**	Accept H_0
Conclusion	Size bias in the second event, bias unknown in first event	No bias in second event but there is in the first	No bias

The estimated proportion sampled in each stream exceeded 40% of the run. Estimated run sizes, the number of unique samples and the 95% confidence intervals for the proportion sampled are given in Table 6. Unstratified estimates for the proportion sampled ranged from 40% in Sawmill Creek to 52% in Fish Creek and Sawmill Creek. Stratified estimates for Sawmill Creek and Fish Creek were nearly equal to the estimates made without stratification.

Table 6. Run size estimates, the number of unique samples and the estimated percentage of the run sampled in each of the study streams.

Stream	$\widehat{N}$	$V_{\widehat{N}}$	N_u	Percent sampled	95% CI of percent sampled
Sawmill Creek	624	7,752	276	44	35 - 61
Sawmill - small	382	7,238	137	36	25 - 63
Sawmill – large	247	2,537	114	46	33 - 77
Sawmill – stratified	629		251	40	28 - 69
Fish Creek	1431	12,727	748	52	45 – 62
Fish C. – females	717	4,326	434	61	51 – 74
Fish C. – males	691	8,671	302	44	35 – 59
Fish C. – stratified	1408		736	52	43 - 67
Prospect Creek	200	1601	104	52	37 – 86

Discussion:

Despite the impact of weather SSSC surveys collected samples from approximately 40% of the run in each stream. Field crews experienced an atmospheric river event that led to major flooding and unsafe surveying conditions during the second week of August 2021. Approximately 10 cm of rain fell at the Juneau airport during the atmospheric river event. Fish Creek became impassable as water levels rose by more than a meter, wiping out the carcass weir completely and scouring stream banks. Sawmill Creek did not flood as hard, with it being a non-major drainage. However, Sawmill Creek's carcass weir was also dislodged after the heavy rain event. Both Fish Creek and Sawmill Creek had their weirs dislodged on 8/13/2021. Prospect Creek's carcass weir lasted the entire field season, though crews dealt with heavy periods of rain on and off for the whole month of August, including the atmospheric river event. Due to the challenging terrain and long survey stretch for Prospect Creek, surveying the entire stretch was not recommended during periods of heavy rain.

The carcass weirs proved to be unreliable in terms of carcass collecting and tag retrieval. The weirs themselves worked, as they collected high numbers of fish carcasses. However, these carcasses were primarily pink salmon. Time spent clearing debris and pink carcasses from the racks reduced the time available for chum salmon carcass collection. One reason for the lack of chum salmon on the Fish Creek carcass weir is the downstream location of a stocked king salmon pond. Chum salmon spawned on the shoreline of the king pond indicating that some number of chum salmon were spawning below the carcass weir. Sampling in the pond was not feasible. In addition, the carcass weir was installed upstream of a major spawning ground for chum that developed over the 2021 season in Fish Creek. Had we located the carcass weir on Fish Creek to below the king salmon pond it would have been in the intertidally influenced section of the creek and interfered with our planned capture effort.

For the 2021 season, chum salmon returns throughout Southeast Alaska were below average. Preliminary estimates from ADF&G suggest the 2021 harvest at ~7.2 million fish, three-quarters of the ten-year average for SEAK (~10 million fish). Coincidently, the numbers of live chum observed in our surveys were also below our eight-year averages for each of the streams. Consequently, we can expect that the estimated run sizes are relatively small for each of these streams. For example, McConnel et al. reported 854 spawners in Sawmill Creek in 2015 compared with our estimate of 624 spawners. For context, the estimated harvest of chum salmon in Southeast Alaska during 2015 was near 8.5 million fish.

This marks our first attempt to estimate the proportion of the run sampled for pedigree analysis. Coefficients of variation for the run size estimates were 15%, 7% and 20% for Sawmill Creek, Fish Creek and Prospect Creek, respectively. Elevated error likely resulted from inexperience in the marking crew and difficulties in collecting live fish for marking. Prior to the start of the study we identified potential staging areas where we would focus our tagging efforts. We rapidly learned that beach seines were difficult to operate in these areas, particularly in Fish Creek and Prospect Creek. The beach seines were too lightweight to work in fast currents and shallow waters. Dip nets were more effective and crews in Fish Creek and Prospect Creek relied on dip netting to sample fish for marking and releasee. Once the mark-release surveys began, it also became apparent that chum salmon did not stage in these areas. Fish staged below spawning areas and, once tagged, few fish were observed to move upstream of the tagging area. By targeting individual chum that displayed little movement after tagging, crews potentially introduced bias into sampling. Bias relating to sex, and size of chum salmon confirmed the presence of bias in our capture efforts. However, comparisons between the stratified estimates and unstratified estimates indicate little impact of this bias on the overall estimates of the proportion sampled. Prospect Creek's turbid fast-moving waters made dip netting live chum especially difficult. The few fish sampled in Prospect Creek made evaluation of bias difficult because testing often had too few expected values. Consequently, estimates of the proportion sampled in Prospect Creek should be viewed with caution.

Low capture rates for marking led to concern that on scheduled tagging days we would get insufficient genetic samples to maximize collection. Moreover, we believed that allowing carcasses to sit for 24 hours between surveys would further reduce the number of genetic samples. To maximize the number of genetic samples collected for the pedigree analysis, carcasses were sampled even on scheduled tagging days. For Sawmill Creek it was possible to conduct tagging and complete carcass surveys each day. However, on Fish Creek and Prospect Creek carcass surveys on tagging days were limited carcasses observed in the tagging area. No effort was extended beyond those areas and live counts were not

recorded. Consequently, for these two creeks, the number of live, dead, and previously sampled counts were not entered on tagging days.

Survey effort this year was more intensive than in previous years. Previously a single crew was split between Fish Creek and Sawmill Creek. Consequently the number of survey days increased for both streams in 2021. The median number of survey days between 2015 and 2020 was 16 and 17 for Sawmill Creek and Fish Creek, respectively. This is a little more than half of the coverage obtained in 2021. Similarly, the median number of days surveyed in Prospect Creek between 2015 and 2020 was 19 compared with 25 in 2021. It is unknown how this might have influenced the proportion sampled in previous years.