**Regional Operational Plan SF.3F.2014.13**

# Copper River Chinook Salmon Smolt Abundance Feasibility Study, 2014

**by**

**James W. Savereide**

**May 2015**

**Alaska Department of Fish and Game** **Divisions of Sport Fish and Commercial Fisheries**

## Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

**Weights and measures (metric)**

| | |
|---|---|
| centimeter | cm |
| deciliter | dL |
| gram | g |
| hectare | ha |
| kilogram | kg |
| kilometer | km |
| liter | L |
| meter | m |
| milliliter | mL |
| millimeter | mm |

**Weights and measures (English)**

| | |
|---|---|
| cubic feet per second | $ft^3/s$ |
| foot | ft |
| gallon | gal |
| inch | in |
| mile | mi |
| nautical mile | nmi |
| ounce | oz |
| pound | lb |
| quart | qt |
| yard | yd |

**Time and temperature**

| | |
|---|---|
| day | d |
| degrees Celsius | °C |
| degrees Fahrenheit | °F |
| degrees kelvin | K |
| hour | h |
| minute | min |
| second | s |

**Physics and chemistry**

| | |
|---|---|
| all atomic symbols | |
| alternating current | AC |
| ampere | A |
| calorie | cal |
| direct current | DC |
| hertz | Hz |
| horsepower | hp |
| hydrogen ion activity (negative log of) | pH |
| parts per million | ppm |
| parts per thousand | ppt, ‰ |
| volts | V |
| watts | W |

**General**

| | |
|---|---|
| Alaska Administrative Code | AAC |
| all commonly accepted abbreviations | e.g., Mr., Mrs., AM, PM, etc. |
| all commonly accepted professional titles | e.g., Dr., Ph.D., R.N., etc. |
| at | @ |
| compass directions: | |
| east | E |
| north | N |
| south | S |
| west | W |
| copyright | © |
| corporate suffixes: | |
| Company | Co. |
| Corporation | Corp. |
| Incorporated | Inc. |
| Limited | Ltd. |
| District of Columbia | D.C. |
| et alii (and others) | et al. |
| et cetera (and so forth) | etc. |
| exempli gratia (for example) | e.g. |
| Federal Information Code | FIC |
| id est (that is) | i.e. |
| latitude or longitude | lat. or long. |
| monetary symbols (U.S.) | $, ¢ |
| months (tables and figures): first three letters | Jan,...,Dec |
| registered trademark | ® |
| trademark | ™ |
| United States (adjective) | U.S. |
| United States of America (noun) | USA |
| U.S.C. | United States Code |
| U.S. state | use two-letter abbreviations (e.g., AK, WA) |

**Measures (fisheries)**

| | |
|---|---|
| fork length | FL |
| mideye-to-fork | MEF |
| mideye-to-tail-fork | METF |
| standard length | SL |
| total length | TL |

**Mathematics, statistics**

| | |
|---|---|
| *all standard mathematical signs, symbols and abbreviations* | |
| alternate hypothesis | $H_A$ |
| base of natural logarithm | $e$ |
| catch per unit effort | CPUE |
| coefficient of variation | CV |
| common test statistics | (F, t, $\chi^2$, etc.) |
| confidence interval | CI |
| correlation coefficient (multiple) | R |
| correlation coefficient (simple) | r |
| covariance | cov |
| degree (angular ) | ° |
| degrees of freedom | df |
| expected value | $E$ |
| greater than | > |
| greater than or equal to | ≥ |
| harvest per unit effort | HPUE |
| less than | < |
| less than or equal to | ≤ |
| logarithm (natural) | ln |
| logarithm (base 10) | log |
| logarithm (specify base) | $\log_2$, etc. |
| minute (angular) | ' |
| not significant | NS |
| null hypothesis | $H_O$ |
| percent | % |
| probability | P |
| probability of a type I error (rejection of the null hypothesis when true) | α |
| probability of a type II error (acceptance of the null hypothesis when false) | β |
| second (angular) | " |
| standard deviation | SD |
| standard error | SE |
| variance | |
| population | Var |
| sample | var |

*REGIONAL OPERATIONAL PLAN SF.3F.2014.13*

# COPPER RIVER CHINOOK SALMON SMOLT ABUNDNACE FEASIBILITY STUDY, 2014

by

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## SIGNATURE/TITLE PAGE

| | |
|---|---|
| Project Title: | Copper River Chinook Salmon Smolt Abundance Feasibility Study, 2014 |
| Project leader(s): | James W. Savereide Fishery Biologist III |
| Division, Region and Area | Sport Fish, Region III, Fairbanks |
| Project Nomenclature: | Project ; Study |
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| Plan Type: | Category III |

**Approval**

| Title | Name | Signature | Date |
|---|---|---|---|
| Project leader | James Savereide | | 3/17/14 |
| Biometrician | Jiaqi Huang | | 3/18/14 |
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| Regional Supervisor | Don Roach | | 3/17/14 |
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# PURPOSE

The Copper River is 1 of 12 indicator stocks chosen by the ADF&G in the *Chinook Salmon Stock Assessment and Research Plan* (ADFG Chinook Research Team 2013) as a stock for which additional information on stock productivity is desired, and the lack of estimates of juvenile abundance and survival for this stock has been identified as an information gap. Furthermore, age-structured production models that are widely used to understand a stock's dynamics require information about processes like recruitment and mortality. To better understand these processes, Region III Sport Fish Division would like to conduct a coded wire tag (CWT) study to estimate the annual abundance of Chinook salmon smolt emigrating from the Copper River and their subsequent marine survival. However, before a project of this magnitude is funded, it is prudent to assess the feasibility of capturing emigrating smolts from the Copper River to gain a better understanding of suitable capture sites, potential catch rates, and outmigration timing.

# BACKGROUND

The Copper River Chinook salmon population supports significant commercial, subsistence, personal use, and sport fisheries. The average annual Chinook salmon harvest from 2003–2012 was 25,071 fish in the commercial fishery, 3,532 fish in the subsistence fisheries, 2,513 fish in the personal use fisheries, and 3,139 fish in the sport fisheries (Somerville *In prep*). Since 1999, the Copper River drainage has sustained an average run of ~ 71,000 Chinook salmon; however, in recent years the run has declined to an average of ~ 54,000 Chinook salmon. A drainage-wide sustainable escapement goal of >24,000 Chinook salmon was established in 2002 based on the average of escapement estimates from 1980-1998 derived from a catch-age model (Savereide 2004). A mainstem mark-recapture project has been in place since 1999 that along with harvest estimates is used to generate annual estimates of escapement and total run size. These estimates will ultimately be used to construct a spawner recruit model to derive a more biologically-based spawning escapement goal, but to date, the data are insufficient.

The Copper River Chinook stock is composed of 6 major spawning stocks (Upper Copper, Gulkana, Tazlina, Klutina, Tonsina, and Chitina), and six years of radiotelemetry studies suggest there is no spawning that occurs downstream of the Chitina River which is located approximately 170 km upstream from the mouth of the Copper River (Savereide 2005). Although it is unknown whether juvenile Chinook salmon overwinter in the mainstem Copper River prior to smolting, it is reasonable to assume that all waters downstream of the Chitina River confluence contain a mixture of fish from all spawning stocks. Ice-out in the Copper River progresses from upstream to downstream such that the stretch of river immediately downstream from the Chitina River is ice free approximately a week to ten days before the channels in the Copper River Delta. Because it is logistically simpler and cheaper to conduct sampling in the Chitina area than in the Delta area, sampling in both the Copper River Delta (CRD) and in the mainstem Copper River (MCR) near Chitina (Figure 1) is warranted.

# OBJECTIVES

The objectives for 2014 are:

1. capture emigrating Chinook salmon smolt from mid May to mid June using minnow traps and beach seines on the CRD near 25-Mile Bridge outside of Cordova and on the MCR downstream from the confluence of the Chitina and Copper rivers; and
2. evaluate catch per unit effort, total catches, and run timing of Chinook salmon smolt in each area and determine what level of accuracy and precision could potentially be achieved for future abundance estimates and what level, timing, and location of sampling would be required.

# METHODS

## Study Area and Design

The Copper River is a glacially dominated system located in Southcentral Alaska and is the second largest river in Alaska in terms of average discharge. Ice and/or snow conditions during the spring salmon smolt outmigration may preclude effective sampling of Chinook smolts due to the impracticality of sampling through the ice and/or safety concerns during periods with large ice- flows. Currently, there is no concrete information on the outmigration timing of Chinook salmon smolts from the Copper River. Studies on the Unalakleet River have shown that Chinook salmon smolt begin their emigration under the ice (P. Joy, ADFG-SF, personal communication); however, studies on the Taku and Stikine rivers in Southeast Alaska have not encountered this situation and consistently produce relatively precise estimates of abundance (Pahlke et al. 2010). To increase the probability of sampling smolts on the Copper River in these conditions, 1 crew of 4 people will sample emigrating Chinook salmon smolt in each of 2 areas on the Copper River (Figure 1). The first area will be on the MCR downstream from the confluence of the Chitina and Copper rivers to Obrien Creek, where previous radiotelemetry studies have been conducted during this time of the year (Savereide 2005). The second area will be on the CRD approximately 2 to 3 miles upstream and downstream from the 25-Mile Bridge, where a study assessed early run salmon with DIDSON sonar techniques (Degan et al. 2005).

Sampling will be conducted for approximately 4 weeks in each area, and sampling will commence once river conditions are safe for short-distance boat travel. It is believed that the MCR section will be ice free approximately a week to ten days earlier than the CRD section; therefore, sampling will begin and finish earlier there. Ice-out date varies from year-to-year, but it is expected that the MCR section will be open by approximately May 10 and the CRD section will be open by May 1. Ice conditions will be monitored throughout the spring and start dates will be adjusted accordingly.

Crews will be cross-trained by 'veteran' technicians from Southeast CWT programs that have a lot of experience trapping smolts during their emigration in glacial braided rivers. Each crew will deploy 50 to 75 minnow traps (style G-40) baited with salmon roe each day throughout their respective area, depending on time and weather. Traps will be deployed along multiple channel banks and in backwater areas. Areas of woody debris will be targeted when present and traps will be checked and rebaited daily and moved to a new location if catches are low.

Beach seines will also be used to capture emigrating Chinook salmon smolts just as Southeast Alaska smolt studies have done since 2002 (Richards et al. 2008). Seines are 60 to 80 ft long

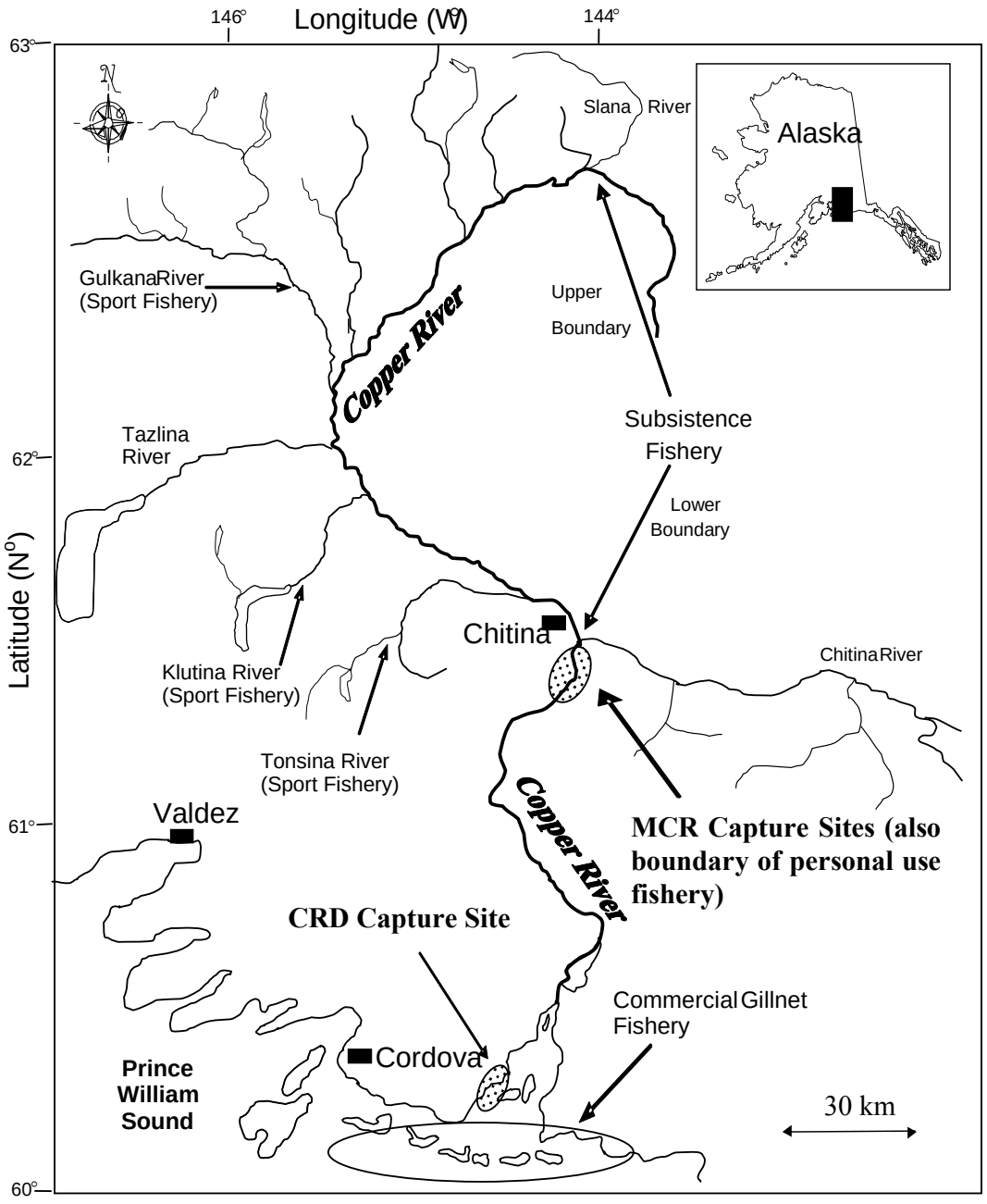


**Figure 1.**-Map of the Copper River drainage demarcating the capture sites, major tributaries, and the commercial, sport, subsistence and personal use fisheries.

and 6 ft deep with ¼" knotless mesh dyed "fish green". Seines will be deployed by hand along multiple channel banks within each area each day after minnow traps have been checked, baited, and redeployed. Beach seines will be fished a set amount of time each day once it is determined how long it takes to check, bait, and redeploy the minnow traps.

During this feasibility study no CWT's will be applied to Chinook salmon smolt because the money required to purchase tagging equipment for each area was not available at this time.

If spring sampling is deemed successful then a fall juvenile sampling program would be instituted to increase the marked fraction on each brood. Fall sampling programs have been used for many years in the CWT programs throughout Southeast Alaska and should also work well in the Copper River drainage.

## Data Collection

The following data will be collected and recorded for each minnow trap and each beach seine set:

Trap number (or seine set number);

Set date and time (and pull date and time for minnow traps);

GPS coordinates of each trap or set;

Total catch of Chinook salmon;

Total catch of other species (listed individually).

All captured Chinook salmon smolt will be measured (FL) to the nearest mm. If catch rates are so high that measuring all smolt becomes impractical then a subset of Chinook salmon smolt will be sampled for length composition.

In addition, water temperature and level will be recorded each day.

## Data Reduction

During the fieldwork, all data will be recorded into all-weather field notebooks or on data forms printed on all-weather paper. Following the fieldwork, data will be transcribed into an Excel workbook spreadsheet from which all data analysis will be referenced and performed. The electronic files will be submitted upon completion of the final report and placed into the Division's Intranet Docushare website – the file name and directory location will be presented in the final report. The spreadsheet will also be archived with the ADF&G Research and Technical Service (333 Raspberry Road, Anchorage, AK 99518) when completed.

## Data Analysis

CPUE summary statistics will be calculated for each area and each gear type for the following categories:

1. by entire sampling period;
2. by day to examine for temporal patterns; and,
3. by bank/channel (east/west or middle/side) to examine spatial patterns.

CPUE will be estimated as a ratio (Cochran 1977) by the desired time period (e.g., hour, day, week, or entire period), gear type, and bank/channel as:

$$CPUE_{i,g,t,l} = \sum_{d=1}^{n_{g,t,l}} c_{i,g,t,l,d} \Big/ \sum_{d=1}^{n_{g,t,l}} s_{g,t,l,d} \tag{1}$$

with variance:

$$\hat{V}(CPUE_{i,g,t,l}) = \frac{n_{g,t,l} \sum_{d=1}^{n_{g,t,l}} \left( c_{i,g,t,l,d}^2 - 2CPUE_{i,g,t,l} c_{i,g,t,l,d} s_{g,t,l,d} + CPUE_{i,g,t,l}^2 s_{g,t,l,d}^2 \right)}{(n_{g,t,l} - 1) \left( \sum_{d=1}^{n_{g,t,l}} s_{g,t,l,d} \right)^2} \tag{2}$$

where:

$c_{i,g,t,l,d}$ = catch $i$ using gear $g$ during time period $t$ at location $l$ for observation $d$ ($d$=1 to $n_{g,t,l}$);

$s_{g,t,l,d}$ = fishing time using gear $g$ during time period $t$ at location $l$ for observation $d$; and,

$n_{g,t,l}$ = number of observations for gear $g$ during time period $t$ at location $l$ .

CPUE statistics will be examined graphically and compared by inspection to evaluate logistical similarities and differences between gear and temporal periods. CPUE statistics for combinations of catch categories or temporal periods will be calculated using equations 1 and 2 and substituting the appropriate sample size for $n_{g,t,l}$. Comparisons of CPUE statistics between gear or time periods will be performed using a t-test with appropriate variance formulas for non-independent ratio estimates (Cochran 1977).

CPUE estimates over the 4-week sampling schedule will be expanded over a number of plausible run timing and effort scenarios to determine the level of accuracy and precision of any future smolt abundance estimates. The Stikine River drainage, which is smaller in size but relatively similar in flow and escapements to the Copper River, supports a Chinook salmon population that averaged 112 smolts per spawner from 1998 through 2002 (Pahlke et al. 2010). Assuming 100 smolts per spawner and an average escapement of 30,000, the number of smolts annually emigrating from the Copper River would be 3,000,000. Over 2,000 adult Chinook salmon from all cohorts are examined each year for commercial ASL composition and inriver abundance estimates. This level of sampling effort each year over the entire brood year return (age .2 through age .6) will likely equate to 7,500 individuals from a particular brood year being examined for tags. Under this sampling scenario, to obtain smolt abundance estimates with relative precision of 25% at 90% confidence, a total of 18,162 smolts would have to be successfully tagged during emigration. Therefore, the likelihood of obtaining this level of precision and accuracy with future abundance estimates will be determined by expanding the total number of smolt captured using the plausible run-timing and effort scenarios.

Run-timing will be described as a time-density function for the entire population (6 stocks mentioned previously), where the relative abundance of all Copper River stocks $j$ that emigrate into the capture area during time interval $t$ is described by (Mundy 1979):

$$f_j(t) = \frac{S_{tj}}{\sum_{t}^{days} S_{tj}} \tag{3}$$

where:

$f_j(t)$ = the empirical temporal probability distribution over the total span of the emigration for all Copper River stocks $j$; and,

$S_{tj}$ = the subset of Chinook salmon smolt ($S$) that would be caught and tagged during day $t$.

The mean date of passage ($\bar{t}_j$) by the capture area for all Copper River stocks $j$ will be estimated as:

$$\bar{t}_j = \sum_t t\, f_j(t), \tag{4}$$

with variance:

$$Var\ (t_j) = \sum_t (t - \bar{t}_j)^2\, f_j(t). \tag{5}$$

Length composition estimates will be calculated as described in Cochran (1977). Stratification will be done post season to evaluate any temporal/spatial differences in composition; however, all strata will be pooled if sample sizes preclude stratification and/or there are no significant differences between stratum estimates. The proportion of smolt in each length category will be estimated by:

$$\hat{p}_{l,i} = \frac{n_{l,i}}{n_i} \tag{6}$$

where:

$n_i$ is the sample size for each time/area stratum $i$;

$n_{l,i}$ is the subset of that sample composed of smolt in length category $l$; and,

$\hat{p}_{l,i}$ is the estimated proportion of the total catch in stratum $i$ composed of fish length $l$.

The variance of will be estimated using Goodman's (1960) formula for the variance of a proportion:

$$\hat{Var}(\hat{p}_{l,i}) = \left( \frac{\hat{p}_{l,i}\left[1 - \hat{p}_{l,i}\right]}{n_i - 1} \right). \tag{7}$$

# SCHEDULE AND DELIVERABLES

Results from this project will be summarized in a Fishery Data Series Report for which a draft will be submitted to the Research Supervisor by 1 March 2015. Probable dates for sampling activities are summarized below.

Sampling = (S), Mobilization = (M), Demobilization = (D), Analysis (A), FDS Report (R)

| Date | CRD/MCR | Data Analysis/Reports |
|---|---|---|
| May 12–18 | M/S | |
| May 19–25 | S | |
| May 26–June 1 | S | |
| June 2–8 | S | |
| June 9–15 | S/D | |
| October–November | | A |
| December–March | | R |

# RESPONSIBILITIES

## Project Staff and Primary Assignments

James Savereide, *Fisheries Biologist III*. Project Leader. Responsible for supervision of all aspects of the Copper River Chinook salmon smolt project, managing the project budget, and writing the final report.

Loren St. Amand, *Fish & Wildlife Technician III*. Crew leader. Mobilization, day-to-day project tasks, all aspects of field work, demobilization.

Mark Schlenker, *Fish & Wildlife Technician III*. Crew leader. Mobilization, day-to-day project tasks, all aspects of field work, demobilization.

Chad Bear, *Fish & Wildlife Technician III*. Mobilization, day-to-day project tasks, all aspects of field work, demobilization.

Mark Roti, *Fish & Wildlife Technician III*. Mobilization, day-to-day project tasks, all aspects of field work, demobilization.

Chloe Johnson, *Fish & Wildlife Technician II* – Mobilization, day-to-day project tasks, all aspects of field work, demobilization.

Allison Martin, *Fish & Wildlife Technician II* – Mobilization, day-to-day project tasks, all aspects of field work, demobilization.

Jiaqi Huang, *Biometrician II*. Assist with project design and data analysis.

Matt Evenson, *Fishery Biologist IV*. Final report editing and project support.

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