Regional Operational Plan No. ROP.SF.2A.2022.10

Operational Plan: Deshka River Salmon Weir, 2021–2025

by

Daryl Lescanec

January 2022

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)

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, χ^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 NO. ROP.SF.2A.2022.10

OPERATIONAL PLAN: DESHKA RIVER SALMON WEIR, 2021–2025

by
Daryl Lescanec
Alaska Department of Fish and Game, Division of Sport Fish, Palmer

Alaska Department of Fish and Game
Division of Sport Fish
333 Raspberry Road, Anchorage, Alaska, 99518-1565

January 2022

The Regional Operational Plan Series was established in 2012 to archive and provide public access to operational plans for fisheries projects of the Divisions of Commercial Fisheries and Sport Fish, as per joint-divisional Operational Planning Policy. Documents in this series are planning documents that may contain raw data, preliminary data analyses and results, and describe operational aspects of fisheries projects that may not actually be implemented. All documents in this series are subject to a technical review process and receive varying degrees of regional, divisional, and biometric approval, but do not generally receive editorial review. Results from the implementation of the operational plan described in this series may be subsequently finalized and published in a different department reporting series or in the formal literature. Please contact the author if you have any questions regarding the information provided in this plan. Regional Operational Plans are available on the Internet at: http://www.adfg.alaska.gov/sf/publications/.

Product names used in this publication are included for completeness and do not constitute product endorsement. The Alaska Department of Fish and Game does not endorse or recommend any specific company or their products.

Daryl Lescanec,
Alaska Department of Fish and Game, Division of Sport Fish,
1801 S. Margaret Dr., Palmer, AK 99645-6736, USA

This document should be cited as follows:
Lescanec, D. 2022. Operational Plan: Deshka River weir, 2021–2025. Alaska Department of Fish and Game, Division of Sport Fish, Regional Operational Plan No. ROP.SF.2A.2022.10, Anchorage.

SIGNATURE PAGE

Project Title:	Deshka River Salmon Weir
Project leader(s):	Daryl Lescanec
Division, Region, and Area	Division of Sport Fish, Region II, Palmer
Project Nomenclature:	
Period Covered	May 2021–September 2025
Field Dates:	May–September 2021–2025
Plan Type:	Category II

Approval

Title	Name	Signature	Date
Project leader	Daryl Lescanec		4/2/21
Biometrician	Adam Reimer		4/2/21
Research Coordinator	Tim McKinley		1/17/21

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

The Deshka River is the largest producer and has the largest sport fishery of Chinook salmon in the North Cook Inlet Management Area. The Deshka River weir has operated seasonally since 1995. A floating, resistance-board-weir is used at river mile (RM) 7 to enumerate Chinook and coho salmon and to collect age, sex, and length data from these species. The Deshka River sustainable escapement goal (SEG) range is currently 9,000–18,000 fish for Chinook salmon and 10,200–24,100 fish for coho salmon. Data collected at this weir are used to manage sport and commercial fisheries inseason and to develop and evaluate escapement goals. This project is also used as a platform to collect harvest data upstream of RM 7, passage data of other fish species, environmental data, and it provides recapture data for the greater Susitna River drainage Chinook salmon mark–recapture project.

Keywords: Deshka River, Chinook salmon, *Onchorynchus tshawytscha*, coho salmon, *Onchorynchus kisutch*, ASL, resistance-board weir, escapement, age and sex composition, mark–recapture, Susitna River

INTRODUCTION

PURPOSE

The Deshka River is one of the Northern Cook Inlet Management Area's (NCIMA) most popular fishing locations. This project will monitor Chinook and coho salmon weir passage for inseason management decisions and collect unbiased Chinook salmon age data to be used in the development of spawner–recruit and sibling relationship models. Additionally, mark–recapture estimates of Susitna River drainage Chinook salmon abundance will be made using the Deshka River weir as one of the recapture locations.

BACKGROUND

During 1977–2019, sport anglers spent an average of 19,558 angler-days per year fishing the Deshka River for all species combined, and fishing effort for the Deshka River has exceeded 10,000 angler-days in 36 of the last 43 years (Table 1). Anglers fish the Deshka River primarily for Chinook salmon (*Oncorhynchus tshawytscha*), but also for coho salmon (*O. kisutch*), pink salmon (*O. gorbuscha*), rainbow trout (*O. mykiss*), Arctic grayling (*Thymallus arcticus*), and northern pike (*Esox lucius*).

Chinook Salmon

The Deshka River (Figure 1), a tributary of the Susitna River, supports the largest Chinook salmon run in the NCIMA (Oslund et al. 2020). Prior to 1995, the Deshka River Chinook salmon fishery was managed based on indices of escapement from a single aerial survey conducted yearly after the sport fishery had taken place. Due to the popularity of the fishery and declining escapement indices, a weir was installed in 1995 to give Alaska Department of Fish and Game (ADF&G) managers inseason information about run size and biological composition of the run. Since that time, the Deshka River weir has been successfully operated for 26 Chinook salmon seasons with weir counts ranging from 7,533 to 57,934 fish (Table 2, Figure 2). Information gathered from the operation of this weir, in conjunction with historical escapement indices and sport harvest data, are used to construct spawner–recruit models for the Deshka River Chinook salmon stock. Based on these models, in 2001, ADF&G developed a sustainable escapement goal (SEG) range of 13,000–28,000 Chinook salmon counted at the weir (Bue and Hasbrouck, unpublished[1]), which was implemented in 2002. In 2020, the Deshka River Chinook escapement goal was lowered to

[1] Bue, B. G. and J. J. Hasbrouck. Unpublished. Escapement goal review of salmon stocks of Upper Cook Inlet. Alaska Department of Fish and Game, Report to the Alaska Board of Fisheries, November 2001 (and February 2002), Anchorage.

9,000–18,000 fish to better attain escapements to produce desired yields. The Deshka River weir allows ADF&G to manage the Deshka River Chinook salmon fishery commensurate with the size of the run by providing inseason run strength information, refinement of the spawner–recruit relationship for this stock, and a preseason run outlook.

Coho Salmon

The Deshka River is an important early-run Susitna River coho salmon fishery. A weir-based coho salmon escapement goal (SEG of 10,200–24,100 fish) was adopted for the first time for this stock in 2017 (McKinley et al. 2020). The coho salmon sport harvest from the Deshka River has been estimated through the Statewide Harvest Survey (SWHS) since 1977. Coho salmon harvest from the Deshka River has been variable, ranging from 559 coho salmon in 1977 to 8,947 coho salmon in 1989 (Table 1, Figure 3). Deshka River coho salmon are also harvested in Cook Inlet commercial fisheries in both the Central District drift fishery and the Northern District set gillnet fishery to an unknown degree. Because of the potential for overexploitation of the Deshka River coho salmon stock, ADF&G initiated the Deshka River weir program for coho salmon in 1995. High water can be a problem during the coho salmon season; the weir has been submerged for parts of the season for 8 of the last 21 years (Table 3). The Deshka River coho salmon counts, during years with complete counts, has varied dramatically from year to year, from a low of 5,368 coho salmon in 2020 to a high of 62,940 in 2004 (Table 3). The weir site was moved from RM 17 to RM 7 in 1997 because it was somewhat less susceptible to flood damage and easier to access. The 1997–2020 average number of coho salmon escaping to the weir at RM 7 is 20,017 coho salmon.

OBJECTIVES

PRIMARY OBJECTIVES

The objectives for the Deshka River Chinook salmon weir project are as follows:

1) Count the number of adult Chinook salmon in the Deshka River that pass through the weir at river mile (RM) 7 from late May through late August.
2) Estimate the age composition and sex composition of the adult Chinook salmon run to the Deshka River upstream of RM 7 from late May through late August such that the estimates are within ±7 percentage points of the true values 95% of the time.

The objectives for the Deshka River coho salmon weir project are as follows:

1) Count the number of adult coho salmon in the Deshka River that pass through the weir at RM 7 from July 1 through mid-September.
2) Estimate the sex composition of the coho salmon counted at the Deshka River weir site upstream of RM 7 from July 1 through mid-September such that the estimates are within ±12 percentage points of the true values 90% of the time.

SECONDARY OBJECTIVES

1) Interview anglers sport fishing for Chinook and coho salmon upstream of the weir for harvest information.
2) Identify and count all species of fish that move through the live trap from weir installation until weir removal.

3) Estimate mean length-at-age and age-by-sex composition for Deshka River Chinook salmon run.
4) Record sex and length from the Deshka River coho salmon run.
5) Record water temperature twice daily and water stage once daily for inseason management purposes.

METHODS

STUDY DESIGN

Weir Counts

A resistance-board weir like those described in Ivey (2014) and Lescanec (2017) will be located on the Deshka River at RM 7 to count salmon from the third week in May until early September. This weir is operated primarily to count Chinook and coho salmon, but pink salmon, sockeye salmon (*O. nerka*), chum salmon (*O. keta*), northern pike, rainbow trout, Arctic grayling, Pacific lamprey (*Lampetra tridentata*), humpback whitefish (*Coregonus pidschian*), and longnose sucker (*Catostomus catostomus*) will also be counted.

Spaces between adjacent pickets on the weir and live trap are less than or equal to 38 mm (1.5 in); this spacing will prevent all but the smallest ocean-age-0 (jack) coho salmon and small pink salmon from passing between pickets. The picket spacing is not designed for pink salmon, although the majority pass through the live trap. Technicians will count fish passing through the live trap; fish that pass through the pickets will not be recorded. All species of fish will be counted through the live trap during daylight hours. The trap will be closed at night, during breaks, and while boats pass.

The majority of the Chinook salmon run passes through the weir from late May to the middle of July. Coho, pink, sockeye, and chum salmon are expected to migrate past the weir from early July until early September. Pink salmon will be counted individually unless numbers are likely to exceed 30,000 per day. When this happens, the crew will estimate the daily number of pink salmon by counting the number that pass through the weir in 1 minute and multiplying that number by 15 after the first 15-minute period has elapsed. After expanding the count, a new 1-minute count will be performed and expanded the same way. This process will continue for the remainder of the day while fish are passing.

High water events have partially submerged the weir during 12 of 26 coho salmon runs (1996–1999, 2002, 2005–2006, 2011, 2013–2014, 2016, and 2018; Table 3). When the weir is partially submerged, it is possible that salmon pass over the weir undetected. Technicians will attempt to keep the weir floating during high water events by removing debris that is submerging the panels. However, if this is no longer possible, technicians will record the time and date that the weir is submerged and details about how much of the weir is submerged. When water stage drops, and the water turbidity decreases enough so that salmon can be positively identified and counted, the date and time will be recorded when counting has resumed.

Age and Sex Compositions

Chinook Salmon

The Chinook salmon age, sex, and length (ASL) sample size goal was calculated using the procedures outlined by Thompson (1987) without adjusting for a finite population and assuming a nonreadable scale rate of 20%. The sample size goal for the objective criterion of ±7 percentage points of the true value 95% of the time is 325 fish.

Sampling crews achieved the sample size goal in 2015–2016 and 2020 but failed to achieve the goal in 2013–2014 and 2017–2019 (Table 4). Sampling goals will be more reliably reached in future years by increasing the sampling rate soon after inseason run projections indicate a run size below 9,000 fish. Precision objectives were still met for most age and sex classes in years when the sample size goal was not achieved partially because greater than 80% of scales were successfully aged and also because of conservative assumptions made about the age composition in the Thompson (1987) sample size calculations.

Proportional sampling will be used to obtain the 325 ASL samples per year. Each year, the sampling rate will begin as 1 ASL sample taken for every 30 fish passed through the weir unless an addendum is attached to this operational plan. This sampling rate was derived using an expected inriver run size of 9,000 fish. The lower end of the escapement goal range was used as a conservative measure because managers will attempt to manage the harvest so that an escapement within the SEG goal range is achieved. However, if a preseason forecast based on sibling relationship is lower than 9,000 Chinook salmon, then it will be used to determine the sampling rate.

The sampling target for each day will be derived by dividing the previous day's total Chinook salmon count by the number 30. If, on any day, the sample size goal cannot be achieved, additional fish will be sampled the following day to make up the difference. Proportional sampling will be periodically reviewed and adjusted if obtaining too small or too large of a sample seems likely.

Coho Salmon

The sample size goal for estimation of length and sex composition of coho salmon is set at 50 coho salmon per sample period (7 days) with a total of 6 sample periods over the run yielding 300 samples per year. The 6 sample periods of 7 days each will begin on July 16 and end August 26. During the 2012–2015 seasons, 88–99% of the coho salmon run passed the weir between these 2 dates. Based on a binomial model (Cochran 1977) to estimate sex composition within each temporal stratum, this level of sampling effort will be sufficient to meet the precision criteria even if the entire run passes through the weir in just 1 week, providing only 50 samples. Actual run timing will likely be more dispersed, and our estimates will be more precise. This strategy sacrifices proportional sampling because coho salmon run timing can occur in extreme pulses and be difficult to sample at a constant rate. By sampling a fixed number of fish every week, we ensure samples are taken from all portions of the run, and we rely on postseason stratification to address bias from nonproportional sampling.

Angler Interviews

Anglers fishing for Chinook or coho salmon upstream of the weir will be asked, as they pass downstream over the weir, how many Chinook or coho salmon they harvested (Secondary

Objective 1). The number of salmon harvested upstream of the weir will be recorded on the daily report form (Appendix A1).

Nontarget Species

To the extent possible, technicians will identify, count, and record all fish species that move through the live trap while the weir is operational. Fish not readily identifiable will be removed from the water and examined (Secondary Objective 2).

Water Temperature, Depth, and Clarity

A protected glass thermometer will be submerged in the river and attached to the live trap at the beginning of the season. The thermometer will be pulled out of the river daily at 0900 and 1800 hours; temperature will be read to the nearest whole degree Celsius and recorded on the daily report form (Appendix A1).

Water clarity will be judged by the technician as excellent, acceptable, or poor each morning at 0900 hours; this observation will be recorded on the daily report form (Appendix A1). A depth gauge will be installed on the fish trap at the beginning of the season. Water depth in centimeters will be recorded each morning at 0900 hours. Water depth will be measured vertically as the depth in centimeters that can be read on the depth gauge each morning at 0900 hours. Maximum recorded depth will be defined as the bottom of the river at the trap. This observation will be recorded in a waterproof notebook and in the "Stage" tab of the inseason spreadsheet.

DATA COLLECTION

Weir Counts

The following information will be collected each day and reported to the Palmer ADF&G Office before 0800 hours the following day:

1) number of salmon by species counted through the live trap
2) number of salmon by species harvested above the weir
3) number of salmon by species sampled for age, length, and sex
4) number of female Chinook salmon in the age sample
5) number of other fish, by species, that passed through the live trap
6) instantaneous water stage and water temperature
7) number of boats that passed upstream over the weir
8) comments regarding the ability to accurately count salmon through the live trap

The information detailed above will be recorded on the daily report form (Appendix A1). In addition, daily and cumulative values of salmon counted and sampled will be recorded in a waterproof notebook that will be turned into the project biologist at the end of the season.

The crew will clean and inspect the weir for gaps that would allow salmon to pass through the weir undetected at least daily and more frequently if conditions warrant. The crew will monitor the weir closely during daylight hours and pass fish in a timely fashion to minimize impeding the upstream migration of salmon.

Age, Sex, and Length

Sampling events will occur regularly throughout the day when small numbers of fish (approximately 3 Chinook or 10 coho salmon) are captured within the trap. This system minimizes disruption to the upstream migration and reduces handling induced stress that can occur when large numbers of fish are in the trap at the same time. Sampling events will be triggered by considering passage rates and daily sampling goals without regard for the size or condition of migrating fish. All fish in the trap will be sampled to prevent selection bias for fish within the trap.

Sampling crews will attempt to sample Chinook salmon daily to meet the 1:30 ratio as stated in the Study Design section of this operational plan. Varying combinations of water level, water temperature, water clarity, cloud cover, rain, date, run progression, and boat traffic influence the number of fish that can be trapped in a day. If sufficient samples are not obtained on a given day, extra fish will be sampled in subsequent days to maintain sampling goals for the run.

Four scales from each sampled Chinook salmon will be taken from the preferred location on the left side of the body at a point on a diagonal line from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin and 2 rows above the lateral line (Welander 1940; Scarnecchia 1979). If the preferred scales cannot be obtained, another scale will be taken from as close to the preferred scale as possible, always from the first or second row above the lateral line, in order to capture the early life history portion of the age. If no scales are available in the preferred area on the left side of the fish, scales will be collected from the preferred area on the right side of the fish. If scales are not obtainable from a given fish, that fish will not be sampled at all and sampling will continue with the next available fish.

Chinook scales will be mounted on gum cards and impressions made in cellulose acetate as described in Clutter and Whitesel (1956) and Scarnecchia (1979). Date, sampler name, and location will be recorded on the gum card. The impressions will be magnified and viewed on a microfiche reader, and the ages will be determined from the growth patterns of the circuli. Ages will be reported in European notation (Jearld 1983) and recorded in an ASL spreadsheet after the season is over.

Coho salmon do not have to be sampled daily because only 50 sex-length samples are required per 7-day period. Technicians will determine when the 50 samples will be taken so as to take advantage of fish movement while minimizing the disruption to the upstream migration of salmon. In general, sampling will be spread over 3–5 days of 10–20 fish per day.

Sampled fish will be measured from mid eye to tail fork (METF) to the nearest 0.5 cm. Sex will be determined by external physical characteristics, such as kype development or a protruding ovipositor. Length and sex will be recorded in waterproof notebooks while sampling and later transferred to the daily report form (Appendix A1).

DATA REDUCTION AND ANALYSIS

Weir Counts

The field crew will maintain the daily report form (Appendix A1) and a field notebook of daily information (detailed in Data Collection-Weir Counts above) at the weir field camp. Daily information received over the telephone will be entered into the inseason Excel spreadsheet at the Palmer ADF&G office. At the end of the season, the data in the daily report form will be reconciled with the data that was recorded via telephone during the season. If discrepancies occur, the project

biologist and field crew will confer to determine the appropriate values. The fields in the Deshka inseason worksheet will be as follows: date, Chinook salmon daily weir count, cumulative weir count, reported daily Chinook salmon harvest above weir, Chinook salmon run projection (calculated using historical average of complete years), Chinook salmon daily sample, percent of Chinook salmon sample that is female, sample ratio, daily count of coho salmon, cumulative coho salmon count, coho salmon run projection (calculated using historical average of complete years), daily coho salmon sample, daily harvest of coho salmon above the weir, daily count of sockeye salmon, daily count of chum salmon, daily count of pink salmon, daily count of northern pike, daily count of rainbow trout, daily count of longnose sucker, daily count of lamprey, daily water stage, daily morning and evening water temperature and clarity, daily number of boats, rafts, and canoes through the weir, and comments. If floods or weir breakdowns allow fish to pass uncounted, adjustments will be made on a case by case basis, estimating missed fish passage when adequate data exist. When data are inadequate to estimate missed passage, we will used empirical counts and assume the seasonal count is biased low. The Deshka River Chinook salmon passage data will be archived in ASCII format in the Division of Sport Fish's Docushare repository (http://docushare.sf.state.ak.us). A copy of the inseason spreadsheet will also be maintained in the Palmer ADF&G office. Hourly water temperature data will be stored on the Palmer ADF&G local area network, along with past years' records of water temperature data.

Age and Sex Compositions

Field crews will record age (Chinook salmon), sex, and length data in a waterproof notebook while sampling, and then they will transfer the data onto the daily report form (Appendix A1). The project biologist will correct any errors and enter the ages on the forms into an Excel spreadsheet.

The age composition of Chinook salmon will be estimated as follows, however sex or age-by-sex composition will be treated similarly with appropriate substitutions. The age proportions of salmon weir passage by sampling stratum will be estimated as

$$\hat{p}_{tz} = \frac{n_{tz}}{n_t} \tag{1}$$

where $\hat{p}_{tz}$ is the estimated proportion of salmon passing the weir during sampling stratum t from age category z, n_{tz} equals the number of fish sampled during sampling stratum t that were classified as age category z, and n_t equals the number of salmon sampled for age determination during sampling stratum t.

The sampling variance of $\hat{p}_{tz}$ will be calculated by

$$\text{var}\left[\hat{p}_{tz}\right] = \left(1 - \frac{n_t}{N_t}\right)\frac{\hat{p}_{tz}\left(1-\hat{p}_{tz}\right)}{n_t - 1} \tag{2}$$

where N_t is the number of Chinook salmon passing the weir during sampling stratum t.

The estimates of weir passage by age categories in each sampling stratum will be calculated as follows:

$$\widehat{N}_{tz} = N_t\hat{p}_{tz} \tag{3}$$

with its variance estimated as

$$\mathrm{var}\left[\hat{N}_{tz}\right] = N_t^2 * \mathrm{var}\left[\hat{p}_{tz}\right] \tag{4}$$

The total weir passage by age category and its variance will then be estimated by summation:

$$\widehat{N}_z = \sum_{t=1}^{L} \widehat{N}_{tz} \tag{5}$$

and

$$\mathrm{var}\left[\hat{N}_z\right] = \sum_{t=1}^{L} \mathrm{var}\left[\hat{N}_{tz}\right] \tag{6}$$

where L equals the number of sampling strata.

Finally, the total proportion of the weir passage by age category and its variance will be estimated as follows:

$$\hat{p}_z = \frac{\widehat{N}_z}{N} \tag{7}$$

and

$$\mathrm{var}\left[\hat{p}_z\right] = \frac{\mathrm{var}\left[\hat{N}_z\right]}{N^2} \tag{8}$$

The sampling protocol for Chinook salmon attempts proportional sampling of the run. If proportional sampling is achieved or age compositions do not change between temporal strata, then samples will be pooled and unstratified estimates will be calculated. To test if a stratified estimator is required, the run will be split into 4 temporal strata based on the daily weir counts such that each stratum represents approximately a quarter of the total run and a likelihood ratio test (G-test, $\alpha = 0.05$) will be applied to age-by-time contingency tables. The likelihood ratio test statistic (G-statistic) will be calculated as follows:

$$G = 2\sum_i f_i \ln\left(\frac{f_i}{\hat{f}_i}\right) \tag{9}$$

where f_i is the observed number of fish in the ith cell of the age-by-time contingency table, and $\hat{f}_i$ is the expected number of fish in the ith cell calculated under the assumption that age proportions don't change over time (Sokal and Rohlf 1995). The G-statistic has an approximate χ^2 distribution with $(r-1)(c-1)$ degrees of freedom, where r is the number of rows and c the number of columns in the table.

If age composition is independent of time, age proportions for the weir passage ($\hat{p}_z$), as well as the number of fish by age ($\widehat{N}_z$) and their estimated variances, will be calculated using Equations 1 through 4 with the pooled data and ignoring subscripts for temporal strata. If not, then the stratified estimates will be calculated as described above.

Mean Length at Age

The mean length by sex for Chinook salmon passing the weir by sampling stratum will be estimated as follows:

$$\bar{x}_{tz} = \frac{\sum_{i=1}^{n_{tz}} x_{tzi}}{n_{tz}} \tag{10}$$

where $\bar{x}_{tz}$ is the estimated mean length of salmon passing the weir during sampling stratum t from sex category z, x_{tzi} is the length of the ith fish sampled of sex z during sampling stratum t.

The sampling variance of $\bar{x}_{tz}$ will be estimated as follows:

$$\hat{var}[\bar{x}_{tz}] = \frac{\sum_{i=1}^{n_{tz}} (x_{tzi} - \bar{x}_{tz})^2}{n_{tz}(n_{tz} - 1)} . \tag{11}$$

The mean length by sex category is then estimated:

$$\bar{x}_z = \sum_{t=1}^{L} \frac{\hat{N}_{tz}}{\hat{N}_z} \bar{x}_{tz} \tag{12}$$

with its variance approximated using a Taylor's series expansion:

$$\hat{var}[\bar{x}_z] \approx \sum_{t=1}^{L} \frac{\hat{N}_{tz}^2}{\hat{N}_z^2} \hat{var}[\bar{x}_{tz}] + \sum_{t=1}^{L} \frac{\left(\bar{x}_{tz} \hat{N}_z - (\sum_{u=1}^{L} \bar{x}_{uz} \hat{N}_{uz}) \right)^2}{\hat{N}_z^4} \hat{var}[\hat{N}_{tz}] . \tag{13}$$

If age composition is independent of time, mean length-at-age age will be calculated using Equations 10 and 11 with the pooled data and ignoring subscripts for temporal strata. If not, then the stratified estimates will be calculated as described above.

SCHEDULE AND DELIVERABLES

Dates of sampling events and other field and office activities are summarized below. Results for 2020 will be published in a Fisheries Management Report (FMR) made available to the Alaska Board of Fisheries in 2021, and data from 2018 and 2019 will be reported in the Fisheries Management Report (FMR) for the recreational fisheries of Northern Cook Inlet for 2019 and 2020. These will continue to alternate as 1- and 2-year reports thereafter. A more detailed Deshka River weir Fisheries Data Series (FDS) report for 2015–2019 will also be published in 2021.

Dates	Activity
Approximately May 21–September 15	Data collection
November 30	Scale reading
December 15	Data analysis
December 31	Data archiving
February 15,	FDS report
March 15	Review operational plan

RESPONSIBILITIES

Daryl Lescanec, Fishery Biologist II, Project Leader
Duties: Oversees project by authoring operational plan, preparing budgets, supervising Fisheries Biologist I, tracking implementation of operational plan, and providing assistance and direction when needed.

Adam Reimer, Biometrician III
Duties: Provides statistical supervision and shares design and writing of the operational plan with the project leader. Reviews and provides statistical support for the data analysis.

Steve Dotomain, Fishery Biologist I
Duties: Establishes safe field camp and coordinates weir installation and removal. Maintains daily contact with the field crew, routinely visits with the crew to observe activities, provides assistance and discusses weir operation with the field crew. Ages scales, edits forms, performs data analysis, and assists project biologist with fisheries data series reports.

Crew Leaders, Fish and Wildlife Technician III
Duties: Collects all field data as outlined in the operational plan, including capture and biological sampling of fish. Trains the crew members in how to operate the weir, operate boats safely, record data, identify fish, and perform biological sampling. Decides when and how to modify field sampling in response to water conditions and fish movements. Ensures that they or crew they assign report to the Palmer office daily, perform daily maintenance of the weir, routine maintenance of the field camp and all equipment assigned to the project, purchase all routine and unexpected supplies, provide the office administrator receipts for purchases, and turn in completed timesheets on the 1st and 16th of each month. Lead the inventory, organizing, repair, and storage of all gear at the completion of the season.

Crew Members, Fish and Wildlife Technician II
Duties: Collects all field data as outlined in the operational plan and demonstrated by crew leaders. The crew is responsible for reporting to the Palmer office daily, daily maintenance of the weir, routine maintenance of the field camp and all equipment assigned to the project, purchasing all routine and unexpected supplies, providing the office administrator receipts for purchases, and turning in completed timesheets on the 1st and 16th of each month.

BUDGET SUMMARY

FY 21 Chinook salmon request

Line item	Category	Budget ($K)
100	Personal Services	72.6
200	Travel	0.0
300	Contractual	8.2
400	Commodities	24.3
500	Equipment	0
Total		105.2

FY 22 coho salmon request (Susitna River coho salmon abundance; allocation is shared).

Line item	Category	Budget ($K)
100	Personal Services	47.3
200	Travel	0.0
300	Contractual	3.5
400	Commodities	9.5
500	Equipment	0.0
Total		60.3

REFERENCES CITED

Clutter, R., and L. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. International Pacific Salmon Commission, Bulletin 9. Westminster, British Columbia, Canada.

Cochran, W. G. 1977. Sampling techniques. 3rd edition. John Wiley and Sons, New York.

Howe, A. L., G. Fidler, A. E. Bingham, and M. J. Mills. 1996. Harvest, catch, and participation in Alaska sport fisheries during 1995. Alaska Department of Fish and Game, Fishery Data Series No. 96-32, Anchorage. http://www.adfg.alaska.gov/FedAidPDFs/fds96-32.pdf

Howe, A. L., G. Fidler, and M. J. Mills. 1995. Harvest, catch, and participation in Alaska sport fisheries during 1994. Alaska Department of Fish and Game, Fishery Data Series No. 95-24, Anchorage. http://www.adfg.alaska.gov/FedAidPDFs/fds95-24.pdf

Ivey, S. S. 2014. Deshka River Chinook and coho salmon escapement studies, 1995–2004. Alaska Department of Fish and Game, Fishery Data Series No. 14-24, Anchorage. http://www.adfg.alaska.gov/FedAidPDFs/FDS14-24.pdf

Jearld, A., Jr. 1983. Age determination. Pages 301-324 *in* L. A. Nielsen, editors. Fisheries techniques. The American Fisheries Society, Bethesda, Maryland

Lescanec, D. 2017. Deshka River Chinook and coho salmon escapement studies, 2005–2014. Alaska Department of Fish and Game, Fishery Data Series No. 17-10, Anchorage. http://www.adfg.alaska.gov/FedAidPDFs/FDS17-10.pdf

McKinley, T., N. DeCovich, J. W. Erickson, T. Hamazaki, R. Begich, and T. L. Vincent. 2020. Review of salmon escapement goals in Upper Cook Inlet, Alaska, 2019. Alaska Department of Fish and Game, Fishery Manuscript No. 20-02, Anchorage. http://www.adfg.alaska.gov/FedAidPDFs/FMS20-02.pdf

Mills, M. J. 1979. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1978-1979, Project F-9-11(20)SW-I-A, Juneau. http://www.adfg.alaska.gov/FedAidPDFs/FREDf-9-11(20)SW-I-A.pdf

Mills, M. J. 1980. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1979-1980, Project F-9-12(21) SW-I-A, Juneau. http://www.adfg.alaska.gov/FedAidPDFs/FREDf-9-12(21)SW-I-A.pdf

Mills, M. J. 1981a. Alaska statewide sport fish harvest studies. 1979 data. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1980-1981, Project F-9-13(22a)SW-I-A, Juneau. http://www.adfg.alaska.gov/FedAidPDFs/FREDf-9-13(22a)SW-I-A.pdf

Mills, M. J. 1981b. Alaska statewide sport fish harvest studies. 1980 data. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1980-1981, Project F-9-13(22b)SW-I-A, Juneau. http://www.adfg.alaska.gov/FedAidPDFs/FREDf-9-13(22b)SW-I-A.pdf

Mills, M. J. 1982. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1981-1982, Project F-9-14(23)SW-I-A, Juneau. http://www.adfg.alaska.gov/FedAidPDFs/FREDf-9-14(23)SW-I-A.pdf

REFERENCES CITED (Continued)

Mills, M. J. 1983. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1982-1983, Project F-9-15(24)SW-I-A, Juneau. http://www.adfg.alaska.gov/FedAidPDFs/FREDf-9-15(24)SW-I-A.pdf

Mills, M. J. 1984. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1983-1984, Project F-9-16(25)SW-I-A, Juneau. http://www.adfg.alaska.gov/FedAidPDFs/FREDf-9-16(25)SW-I-A.pdf

Mills, M. J. 1985. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1984-1985, Project F-9-17(26)SW-I-A, Juneau. http://www.adfg.alaska.gov/FedAidPDFs/FREDf-9-17(26)SW-I-A.pdf

Mills, M. J. 1986. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1985-1986, Project F-10-1(27)RT-2, Juneau. http://www.adfg.alaska.gov/FedAidPDFs/FREDf-10-1(27)RT-2.pdf

Mills, M. J. 1987. Alaska statewide sport fisheries harvest report, 1986. Alaska Department of Fish and Game, Fishery Data Series No. 2, Juneau. http://www.adfg.alaska.gov/FedAidPDFs/fds-002.pdf

Mills, M. J. 1988. Alaska statewide sport fisheries harvest report, 1987. Alaska Department of Fish and Game, Fishery Data Series No. 52, Juneau. http://www.adfg.alaska.gov/FedAidPDFs/fds-052.pdf

Mills, M. J. 1989. Alaska statewide sport fisheries harvest report, 1988. Alaska Department of Fish and Game, Fishery Data Series No. 122, Juneau. http://www.adfg.alaska.gov/FedAidPDFs/fds-122.pdf

Mills, M. J. 1990. Harvest and participation in Alaska sport fisheries during 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-44, Anchorage. http://www.adfg.alaska.gov/FedAidPDFs/fds90-44.pdf

Mills, M. J. 1991. Harvest, catch, and participation in Alaska sport fisheries during 1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-58, Anchorage. http://www.adfg.alaska.gov/FedAidPDFs/fds91-58.pdf

Mills, M. J. 1992a. Alaska sport fishing in the aftermath of the Exxon Valdez oil spill. Alaska Department of Fish and Game, Special Publication No. 92-5., Anchorage. http://www.adfg.alaska.gov/FedAidPDFs/sp92-05.pdf

Mills, M. J. 1992b. Harvest, catch, and participation in Alaska sport fisheries during 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-40, Anchorage. http://www.adfg.alaska.gov/FedAidPDFs/fds92-40.pdf

Mills, M. J. 1993. Harvest, catch, and participation in Alaska sport fisheries during 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-42, Anchorage. http://www.adfg.alaska.gov/FedAidPDFs/fds93-42.pdf

Mills, M. J. 1994. Harvest, catch, and participation in Alaska sport fisheries during 1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-28, Anchorage. http://www.adfg.alaska.gov/FedAidPDFs/fds94-28.pdf

Oslund, S., S. Ivey, and D. Lescanec. 2020. Area Management Report for the sport fisheries of northern Cook Inlet, 2017–2018. Alaska Department of Fish and Game, Fishery Management Report No. 20-04, Anchorage. http://www.adfg.alaska.gov/FedAidPDFs/FMR20-04.pdf

Scarnecchia, D. L. 1979. Variation of scale characteristics of coho salmon with sampling location on the body. Progressive Fish Culturist 41(3):132-135.

Sokal, R. R., and F. J. Rohlf. 1995. Biometry. 3rd edition. Freeman, San Francisco.

Thompson, S. K. 1987. Sample size for estimating multinomial proportions. The American Statistician 41(1):42-46.

Welander, A. D. 1940. A study of the development of the scale of Chinook salmon *Oncorhynchus tshawytscha*. Master's thesis. University of Washington, Seattle.

TABLES

Table 1.–Statewide Harvest Survey estimates of Deshka River angler effort and sport harvest by species, 1977–2019.

Year	Angler days	Chinook salmon	Coho salmon	Pink salmon	Rainbow trout	Arctic grayling	Northern pike
1977	3,852	1,017	559	391	1,556	631	0
1978	9,111	850	1,789	697	3,634	579	0
1979	13,236	2,811	973	109	3,182	1,463	0
1980	19,364	3,685	2,290	689	4,305	1,817	0
1981	13,248	2,769	632	19	3,631	1,255	0
1982	18,391	4,307	2,463	377	3,804	1,457	0
1983	23,174	4,889	1,036	21	2,434	1,280	0
1984	20,561	5,699	1,646	748	2,120	1,110	0
1985	29,322	6,407	2,637	87	3,104	1,335	0
1986	29,739	6,490	4,256	882	3,038	938	0
1987	30,008	5,632	2,789	652	3,006	942	0
1988	32,160	5,474	7,458	800	4075	1,164	0
1989	39,432	8,062	8,947	152	1,676	457	0
1990	32,082	6,161	4,959	297	707	152	0
1991	38,011	9,306	8,111	98	1,275	333	0
1992	37,056	7,256	7,110	513	459	105	0
1993	30,643	5,682	6,530	84	452	89	0
1994	19,267	624	5,511	564	415	61	78
1995	4,808	0	2,275	77	183	0	0
1996	5,246	11	4,615	236	321	97	161
1997	5,110	42	1,169	11	264	68	137
1998	11,574	3,384	3,630	702	218	8	18
1999	20,088	3,496	4,034	67	561	11	283
2000	30,997	7,076	8,687	799	205	122	462
2001	23,734	5,007	6,556	291	270	139	400
2002	20,362	4,508	3,616	185	417	60	226
2003	24,904	6,605	4,946	24	368	35	143
2004	28,653	9,050	4,440	249	938	79	336
2005	26,638	7,332	3,616	77	60	0	240
2006	30,958	7,753	6,042	76	523	0	505
2007	34,726	5,696	2,550	70	185	172	277
2008	15,514	2,036	3,426	78	419	268	168
2009	10,532	723	4,060	23	562	35	455
2010	17,867	3,381	5,690	77	122	67	1,120
2011	13,206	3,139	2,282	56	0	0	258
2012	11,050	1,650	1,358	100	61	0	64
2013	10,315	1,087	2,658	15	103	0	998
2014	10,947	1,329	2,598	128	29	0	164
2015	10,330	1,835	2,180	0	166	115	186
2016	12,693	2,890	1,517	59	28	43	45
2017	10,748	1,392	2,825	0	0	0	249
2018	7,629	0	3,169	15	26	0	177
2019	3,728	0	1,578	70	0	0	67

-continued-

Table 1.–Page 2 of 2.

Year	Angler days	Chinook salmon	Coho salmon	Pink salmon	Rainbow trout	Arctic grayling	Northern pike
Average 1977–2018	19,558	3,873	3,703	248	1,137	383	168

Source: Mills (1979-1980, 1981a, 1981b, 1982-1991, 1992a, 1992b, 1993, 1994); Howe et al. (1995, 1996); Alaska Sport Fishing Survey database [Internet]. 1996–present. Anchorage, AK: Alaska Department of Fish and Game, Division of Sport Fish (accessed December 2020). Available from: http://www.adfg.alaska.gov/sf/sportfishingsurvey/.

Table 2.–Chinook salmon counts, installations, and interruptions to the Deshka River weir, 1995–2020.

Year	Location	Season total	Date weir installed	Dates partially submerged or flooded May 15 to July 15
1995	RM 17	10,048	21 May	25–29 May
1996	RM 17	14,349	21 May	None
1997	RM 7	35,587	21 May	None
1998	RM 7	15,409	21 May	None
1999	RM 7	29,649	21 May	None
2000	RM 7	35,242	21 May	None
2001	RM 7	29,004	21 May	None
2002	RM 7	29,428	21 May	None
2003	RM 7	40,069	21 May	None
2004	RM 7	57,934	21 May	None
2005	RM 7	37,725	27 May	None
2006	RM 7	31,150	26 May	None
2007	RM 7	18,714	18 May	None
2008	RM 7	7,533	28 May	None
2009	RM 7	11,960	21 May	None
2010	RM 7	18,594	20 May	None
2011	RM 7	19,026	24 May	None
2012	RM 7	14,096	24 May	None
2013	RM 7	18,531	7 Jun	None
2014	RM 7	16,335	15 May	28–29 June
2015	RM 7	24,316	20 May	None
2016	RM 7	22,874	12 May	None
2017	RM 7	11,383	17 May	None
2018	RM 7	8,549	29 May	None
2019	RM 7	9,705	19 May	None
2020	RM 7	10,638	2 Jun	None

Source: Lescanec (2017); ADF&G, Palmer, unpublished data.

Table 3.–Operational periods, coho salmon counts, and interruptions for the Deshka River weir during 1995–2020.

Year	Location	Season total	Date weir removed	Days of operation (1 Jul–15 Sep)	Down days	Dates partially submerged or flooded
1995	RM 17	12,824	1 Sep	63	0	None
1996	RM 17	1,394 [a]	28 Jul	28	>40	Most of coho season
1997	RM 7	8,063	8 Sep	70	2	1–2 Sep
1998	RM 7	6,773 [a]	6 Sep	60	8	8–12 Aug, 23–25 Aug
1999	RM 7	4,563 [a]	27 Aug	50	8	31 Jul–2 Aug, 14–17 Aug
2000	RM 7	26,387	13 Sep	75	0	None
2001	RM 7	29,927	13 Sep	75	0	None
2002	RM 7	24,612 [a]	9 Sep	72	0	9–15 Aug, 22–24 Aug
2003	RM 7	17,305	8 Sep	70	0	None
2004	RM 7	62,940	9 Sep	70	0	None
2005	RM 7	47,887	22 Sep	68	0	6–22 Sep
2006	RM 7	59,419 [a]	7 Sep	46	>20	Flooded 16 Aug
2007	RM 7	10,575	5 Sep	67	0	None
2008	RM 7	12,724	8 Sep	70	0	None
2009	RM 7	27,348	7 Sep	69	0	None
2010	RM 7	10,393	6 Sep	68	0	None
2011	RM 7	7,508 [a]	6 Sep	61	6	9–14 Aug
2012	RM 7	6,825	4 Sep	67	0	None
2013	RM 7	22,341	17 Sep	66	12	9–15 Sep
2014	RM 7	11,578	3 Sep	64	3	28–30 Jun
2015	RM 7	10,775	8 Sep	69	0	None
2016	RM 7	6,820 [a]	5 Sep	66	8	9-12, 25-28 Aug
2017	RM 7	36,869	6 Sep	67	0	None
2018	RM 7	12,962 [a]	29 Aug	59	3	26-28 Aug
2019	RM 7	10,445	9 Sep	70	0	None
2020	RM 7	5,368	13 Aug	43	0	None

Source: Lescanec (2017); Oslund et al. (2020); ADF&G, Palmer, unpublished data.

Table 4.–Number of Chinook salmon scale samples obtained and percent of samples that were unreadable, Deshka River weir, 2013–2015.

Year	Number of samples obtained	Nonreadable scale rate
2013	281	11%
2014	296	18%
2015	430	22%
2016	564	23%
2017	283	16%
2018	244	28%
2019	271	13%
2020	345	11%

Source: Lescanec (2017); Oslund et al. (2020); ADF&G, Palmer, unpublished data.

FIGURES

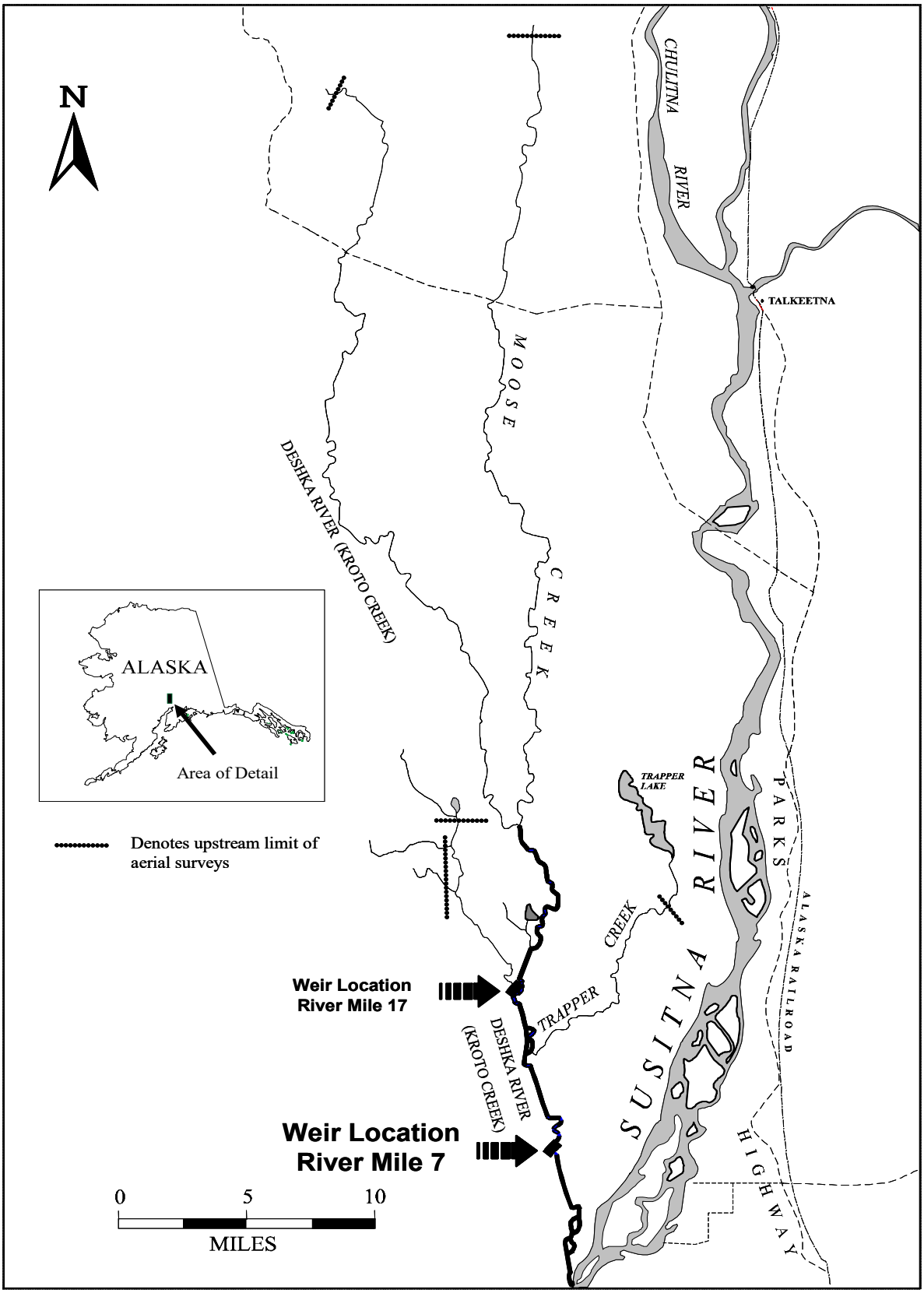

Figure 1.–Deshka River drainage and weir locations.

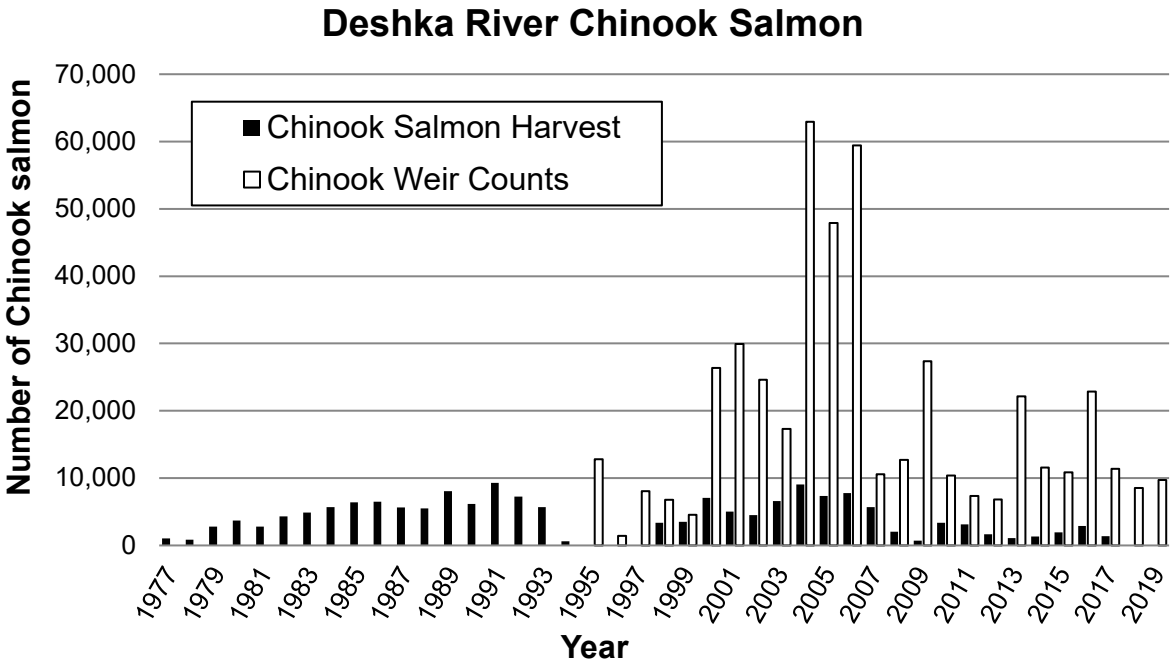

Figure 2.–Deshka River Chinook salmon sport harvest and weir counts.

Source: Lescanec (2017); ADF&G, Palmer, unpublished data; Alaska Sport Fishing Survey database [Internet]. 1996–present. Anchorage, AK: Alaska Department of Fish and Game, Division of Sport Fish (cited October 14, 2015). Available from: http://www.adfg.alaska.gov/sf/sportfishingsurvey/.

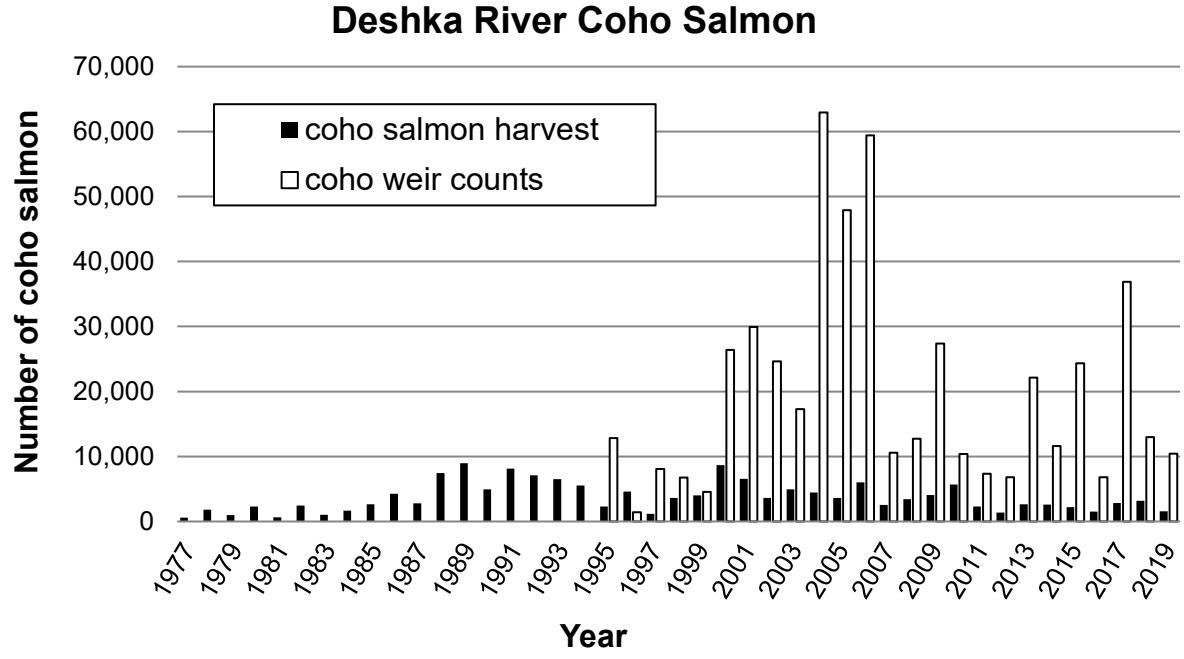

Figure 3.–Deshka River coho salmon sport harvest and weir counts.

Source: Lescanec (2017); ADF&G, Palmer, unpublished data; Alaska Sport Fishing Survey database [Internet]. 1996–present. Anchorage, AK: Alaska Department of Fish and Game, Division of Sport Fish (cited October 14, 2015). Available from: http://www.adfg.alaska.gov/sf/sportfishingsurvey/.

APPENDIX A: DESHKA WEIR DAILY REPORT FORM

Appendix A1.–Deshka weir daily report form.

DESHKA RIVER WEIR DAILY REPORT FORM PAGE _____OF_____

Date		Chinook Salmon				Coho Salmon			Pink Salmon		Chum	Sockeye	NP	RBT	LNS	WF	Stream Conditions				Boats	Notes
Day	Date	Count	Harvest	Scales	# F	Count	Harvest	# Sampled	Count	Count method	Counts		Counts				Stg.	AM Temp	PM Temp	Clarity	Count	