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Stock Assessment Study of Chilkat Lake and River Sockeye Salmon, 2017–2020

by

Shane R. Ransbury

Nicole L. Zeiser

Julie A. Bednarski

Steve C. Heinl

Chase S. Jalbert

and

Sara E. Miller

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

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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

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by
Shane R. Ransbury and Nicole L. Zeiser
Alaska Department of Fish and Game, Division of Commercial Fisheries, Haines

Julie A. Bednarski
Alaska Department of Fish and Game, Division of Commercial Fisheries, Douglas

Steven C. Heinl
Alaska Department of Fish and Game, Division of Commercial Fisheries, Ketchikan

Chase S. Jalbert
Alaska Department of Fish and Game, Gene Conservation Laboratory, Anchorage

Sara E. Miller
Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau

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

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Shane R. Ransbury and Nicole L. Zeiser,
Alaska Department of Fish and Game, Division of Commercial Fisheries,
Mile 1 Haines Highway, Haines, Alaska 99827, USA

Julie A. Bednarski
Alaska Department of Fish and Game, Division of Commercial Fisheries,
802 Third Street, Douglas, Alaska 99824, USA

Steven C. Heinl
Alaska Department of Fish and Game, Division of Commercial Fisheries,
2030 Sea Level Drive, Suite 205, Ketchikan Alaska 99901, USA

Chase S. Jalbert
Alaska Department of Fish and Game, Division of Commercial Fisheries,
333 Raspberry Road, Anchorage, AK 99518

Sara E. Miller
Alaska Department of Fish and Game, Division of Commercial Fisheries,
1255 W. 8th Street, Juneau, AK 99801

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ABSTRACT

From 2017 to 2020, the Alaska Department of Fish and Game, Division of Commercial Fisheries, conducted stock assessment programs to estimate the escapement and harvest of Chilkat Lake sockeye salmon (*Oncorhynchus nerka*). Escapement was estimated with a Dual-frequency Identification Sonar (DIDSON) and weir near the outlet of Chilkat Lake, and age, length, and sex data were collected and analyzed each year. Sockeye salmon escapements, based on expanded DIDSON counts, were 88,197 fish in 2017, 108,047 fish in 2018, 136,091 fish in 2019, and 50,746 fish in 2020. Estimated escapements fell within the biological escapement goal range of 70,000–150,000 sockeye salmon in all but one year (2020). A pair of fish wheels were operated on the Chilkat River to provide inseason information on Chilkat sockeye salmon run strength to assist in management of the District 15 commercial drift gillnet fishery. Genetic stock identification was conducted to determine the stock composition of sockeye salmon harvested annually in the District 15 commercial drift gillnet fishery. Estimated commercial harvests of Chilkat Lake sockeye salmon were 5,698 fish in 2017, 19,235 fish in 2018, 40,935 fish in 2019, and 8,776 fish in 2020. Estimated annual harvest rates (not including subsistence or sport harvests) ranged from 6.1% (2017) to 23.1% (2019), and Chilkat Lake sockeye salmon accounted for an estimated 14.3% (2017) to 23.5% (2018) of the annual commercial sockeye salmon harvest in District 15. Zooplankton populations at Chilkat Lake have improved steadily since the late 2000s; historical peaks in the abundance of copepods and cladocerans (particularly *Daphnia*), the preferred prey of juvenile sockeye salmon, were observed in 2020 and 2019, respectively.

Keywords: Chilkat Lake, Chilkat River mainstem, commercial harvest, DIDSON, District 15 commercial drift gillnet fishery, fish wheel, escapement, expanded counts, zooplankton, *Oncorhynchus nerka*, genetic stock identification, sockeye salmon, limnology

INTRODUCTION

The Chilkoot and Chilkat sockeye salmon (*Oncorhynchus nerka*) runs in northern Southeast Alaska, near the town of Haines, are two of the largest in Southeast Alaska (Figure 1). Between 1900 and 1920, the annual commercial harvest of sockeye salmon in northern Southeast Alaska averaged 1.5 million fish, the majority of which were believed to be Chilkat and Chilkoot sockeye salmon (Rich and Ball 1933). Historically, Chilkat sockeye salmon were harvested in the large fish trap and purse seine fisheries in Icy and northern Chatham Straits as well as in terminal drift gillnet areas of Lynn Canal. Fish traps were eliminated with Alaska statehood in 1959 and Lynn Canal was developed into a designated drift gillnet fishing area (District 15) where most of the commercial harvest of Chilkat sockeye salmon takes place (Figure 1). The annual harvest of sockeye salmon in the District 15 commercial drift gillnet fishery averaged 187,426 fish from 1985 to 2016, of which an average 76,631 fish originated from Chilkat Lake, 88,379 fish originated from Chilkoot Lake, and the remainder were of mixed stock origin. A smaller portion of the Chilkat run is harvested in the commercial purse seine fisheries that target pink salmon (*O. gorbuscha*) in Icy and northern Chatham Straits (Ingledue 1989; Gilk-Baumer et al. 2015). Annual contributions to those fisheries are not known and probably vary annually depending on fishing effort and the strength of pink salmon runs. Chilkat sockeye salmon are also harvested annually in subsistence fisheries in Chilkat Inlet and the Chilkat River, where reported harvest for the period 1985–2016 averaged approximately 4,324 fish per year (Appendix A).

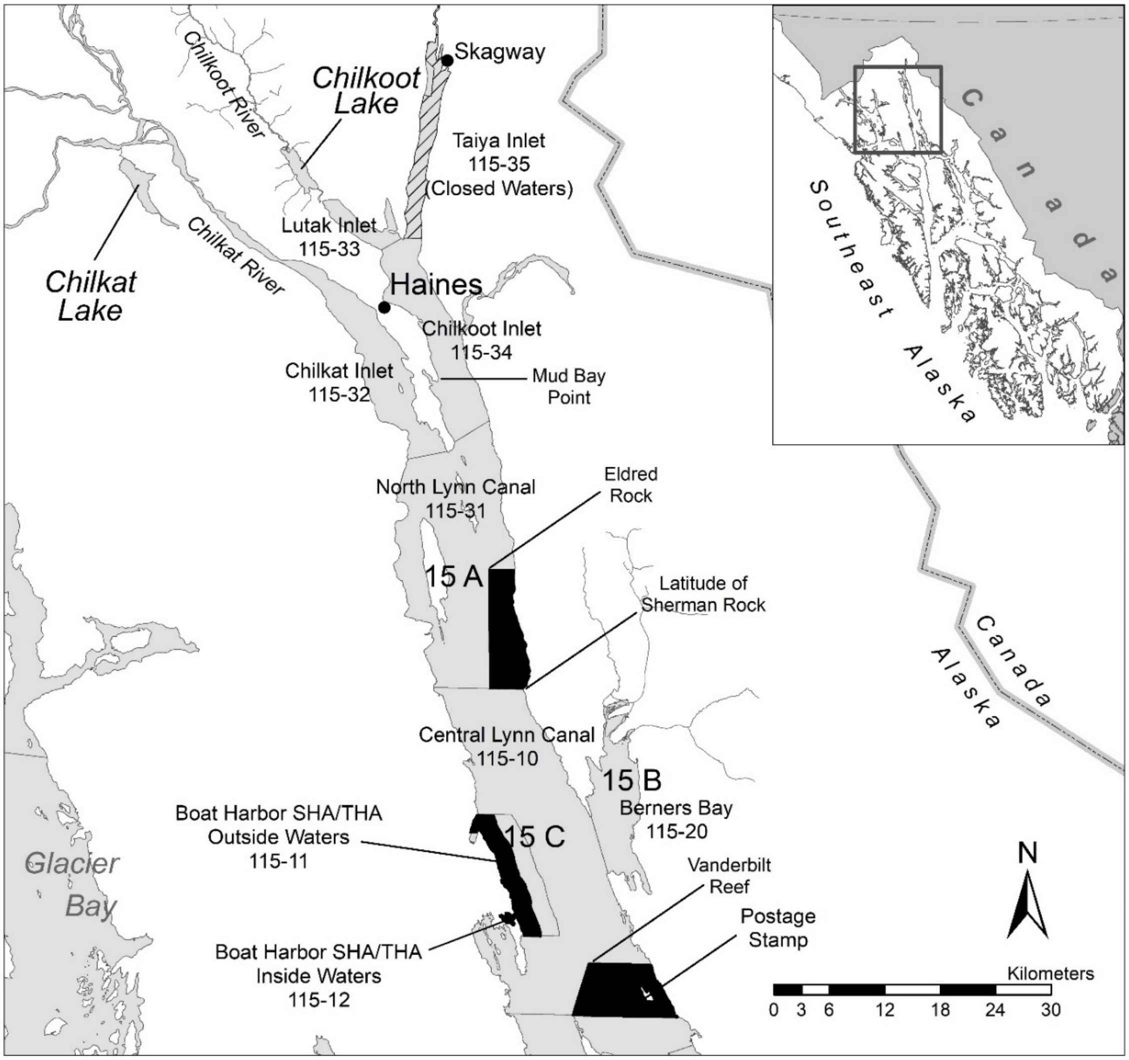

Figure 1.–Haines Management Area with sections and statistical areas for the District 15 commercial drift gillnet fishery. Early in the 2018–2020 seasons, the fishery was restricted to the black shaded areas in accordance with management actions implemented in the 2018 Chilkat River Chinook salmon action plan (Lum and Fair 2018) and the 2019 Southeast Alaska drift gillnet fishery management plan (Gray et al. 2019) that were designed to reduce commercial harvest of Chilkat River Chinook salmon.

Stock composition of the sockeye salmon harvest in the mixed stock District 15 commercial drift gillnet fishery was estimated using scale pattern analysis through 2016 and genetic stock identification since 2017 (Bednarski et al. 2017). The Alaska Department of Fish and Game (ADF&G) initiated a scale pattern analysis program in 1980 (McPherson 1990; McPherson et al. 1992) to estimate contributions of Chilkat and Chilkoot sockeye salmon stocks based on consistent differences in freshwater scale patterns (Stockley 1950; Bergander 1974). Accurate scale pattern analysis required highly skilled personnel trained in very specific pattern recognition, which could take years to master, and required intensive field sampling and inseason analysis of a very large number of scale samples (Bednarski et al. 2017), whereas genetic stock identification methods are standardized and used widely throughout the state (Shedd et al. 2016). Multiple blind tests conducted by the Northern Boundary Technical Committee of the Pacific Salmon Commission (years 2003, 2009) and by ADF&G (Lynn Canal, years 2015–2016) indicated that the 2 methods offered similar estimates of salmon stock contribution but that the genetic techniques were able to discriminate stocks at a finer resolution in less time compared to scale pattern analysis (Anne Reynolds-Manney, ADF&G fisheries biologist, unpublished data[1]). As a result, stock composition of sockeye salmon harvests in the District 15 commercial drift gillnet fishery have been estimated solely through genetic stock identification since 2017 (Bednarski et al. 2017).

Chilkat Lake sockeye salmon escapements have historically been estimated from expanded visual weir counts from 1967 to 1995 and 1999 to 2007 and Dual-frequency Identification Sonar (DIDSON) counts from 2008 to 2020 (Eggers et al. 2010; Sogge and Bachman 2014; Bednarski et al. 2017). The switch to DIDSON allowed for more accurate counts of sockeye salmon passage. Periodic flooding of the silty Tsirku River into Chilkat Lake (Bergander et al. 1988) required opening the weir, sometimes for extended periods, and increased boat traffic in and out of the lake required frequent lowering of a boat gate in the center of the weir through which fish could pass uncounted (Kelley and Bachman 2000). The DIDSON allowed fish passage to continue to be monitored during periods when fish could otherwise avoid the gaze of an observer seated on the weir. In addition to the direct counts, mark–recapture studies were conducted in conjunction with operation of fish wheels in the lower Chilkat River from 1994 to 2016 to estimate Chilkat Lake and mainstem river sockeye salmon escapements; however, concerns regarding mark–recapture as a reliable measure of abundance lead to elimination of mark–recapture studies in 2017 (Bednarski et al. 2017). Biological data have been collected annually at the Chilkat Lake weir and Chilkat River fish wheels to estimate age, size, and sex composition of sockeye salmon escapements.

The Chilkat River fish wheels are used to provide fishery managers with timelier information on inriver abundance than can be obtained from Chilkat Lake weir counts alone (Kelley and Bachman 2000). It is thought to take sockeye salmon a month to travel between the commercial fishery and the Chilkat Lake weir (McPherson 1990), whereas it took an average of 16 days for radiotagged Chilkat Lake sockeye salmon to travel between the fish wheels and the weir in a study conducted in 2003 and 2004 (Brian Elliott, ADF&G Fishery Biologist, personal communication, unpublished data). The fish wheels also provide sampling platforms for assessment projects on Chilkat River chum (*O. keta*), coho (*O. kisutch*), and Chinook (*O. tshawytscha*) salmon.

The Chilkat Lake sockeye salmon run has been managed for at least 5 different escapement goals since 1976. Informal goals of 60,000–70,000 fish (1976–1980) and 70,000–90,000 fish (1981–1989; Bergander et al. 1988) were replaced in 1990 with a biological escapement goal of 52,000–106,000 sockeye salmon, based on a stock-recruit analysis by McPherson (1990). Efforts to update the escapement goal were hindered by lake stocking in the 1990s and concerns regarding accuracy of weir counts (Geiger et al. 2005). Geiger et al. (2005) converted the weir-based goal to mark–recapture units and the goal was revised to a sustainable escapement goal of 80,000–200,000 sockeye salmon from 2006 to 2008. In 2009, the Chilkat Lake escapement goal was revised again to a biological escapement goal of 70,000–150,000 sockeye salmon, based on weir counts converted to mark–recapture units (Eggers et al. 2008, 2010). After the introduction of the DIDSON to the site in 2008, Eggers et al. (2010) further recommended that escapement continue to be assessed using DIDSON counts at the Chilkat Lake weir site. After a comprehensive review of historical stock assessment data (Bednarski et al. 2017), the escapement goal analysis was most recently updated in 2018 using age-structured state-space stock-recruit models to better account

[1] Reynolds Manney, A. M. Lynn Canal sockeye stock identification. Saltonstall-Kennedy final performance report, July 1, 2015 through June 30, 2017, NOAA Cooperative Agreement No. NA15NMF4270274, September 22, 2017.

for multiple overlapping methods of escapement enumeration (mark–recapture, weir counts, DIDSON counts) and missing data (Miller and Heinl 2018; brood years 1976–2012). The resulting parameter estimates from the analysis were very similar to those estimated by Eggers et al. (2010) and, as a result, the current biological escapement goal of 70,000–150,000 sockeye salmon, counted with the DIDSON system at the Chilkat Lake weir site (Heinl et al. 2017), remained unchanged. Escapement goals have not been established for Chilkat mainstem sockeye salmon populations due to lack of reliable estimates of escapement and historical harvest (Bednarski et al. 2017).

The primary purpose of the Chilkat sockeye salmon stock assessment program was to estimate the escapement and commercial harvest of Chilkat Lake sockeye salmon. Information provided by this project, in conjunction with stock assessment projects on the adjacent Chilkoot River (Zeiser et al. 2019), was used inseason to manage the District 15 commercial drift gillnet fishery to ensure escapement goals were met while maximizing the sustainable harvest of sockeye salmon from the 2 watersheds. Information on age-at-return will be used in reconstruction of brood-year returns and escapement goal evaluations. In addition, limnological surveys of Chilkat Lake were conducted to collect information on zooplankton abundance, light penetration, and water temperature profiles.

STUDY SITE

Chilkat Lake (ADF&G Anadromous Waters Catalogue No. 115-32-10250-2067-3001-0010; 59.32577° N, 135.89436° W) is located approximately 27 river miles upstream from the city of Haines, Alaska (Figures 1 and 2). It is a relatively large clear lake with a surface area of 9.8×10^6 m^2 (2,432 acres), mean depth of 32.5 m, maximum depth of 57 m, and volume of 319×10^6 m^3. The lake drains through Clear Creek, a 0.5 km long channel where the weir is located, and into the Chilkat River by way of the Tsirku River. Resident fish species include sockeye salmon, coho salmon, Dolly Varden (*Salvelinus malma*), cutthroat trout (*Salmo clarki*), Pacific lamprey (*Entosphenus tridentatus*), threespine stickleback (*Gasterosteus aculeatus*), sculpin (*Cottus* sp.), and round whitefish (*Prosopium cylindraceum*; Johnson and Daigneault 2013). Very small numbers of adult pink and chum salmon have been observed moving through the Chilkat Lake weir, but the spawning location of these fish is unknown. Despite the remoteness of Chilkat Lake, there is moderate to heavy boat traffic, due to the numerous private cabins on the lake (50 to 100 cabins). Summer access is limited to jet boats and floatplanes only.

The Chilkat River (ADF&G Anadromous Waters Catalogue No. 115-32-10250) drains a large watershed stretching from British Columbia, Canada, to the northern end of Lynn Canal, near Haines, Alaska (Figure 2). The watershed is characterized by rugged, highly dissected mountains with steep-gradient streams and braided rivers that flow through glaciated valleys. The watershed encompasses approximately 1,600 km^2, and the main river and tributaries comprise approximately 350 km of river channels. Principle tributaries include the Tahkin, Tsirku, Klehini, Kelsall, and Tahini Rivers. Chilkat River discharge rates range from 80 to 20,400 ft^3/s (Bugliosi 1988). The river supports large runs of sockeye, coho, chum, Chinook, and pink salmon. The Chilkat River receives input from several glaciers, and heavy silt loads in the main river impair visual salmon stock assessment methods.

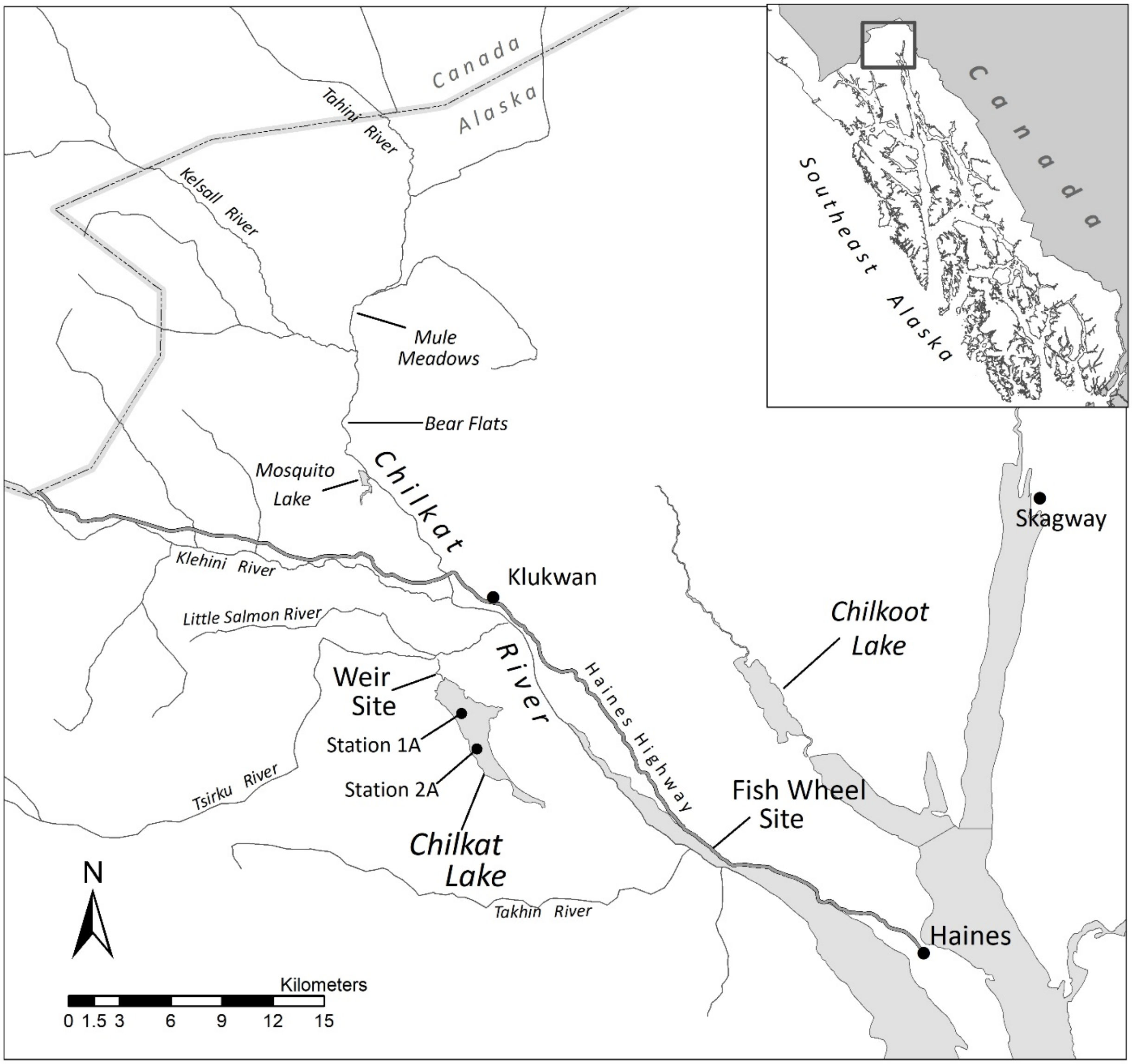

Figure 2.–Chilkat River drainage and locations of Chilkat Lake and limnology sampling stations, the weir site, and fish wheel site.

OBJECTIVES

Primary Objectives:

1. Enumerate the sockeye salmon escapement into Chilkat Lake from 20 June to 10 October.
2. Estimate the seasonal age, sex, and length composition of the Chilkat Lake sockeye salmon escapement such that the estimated proportions are within 5% of the true value with at least 95% probability.
3. Estimate the weekly stock composition of the sockeye salmon harvest in the District 15 commercial drift gillnet fishery using genetic stock identification, such that the estimates are within 7% of the true value with at least 90% probability.

4. Estimate the seasonal age-specific stock composition of the sockeye salmon harvest in the District 15 commercial drift gillnet fishery for major contributing age classes (i.e., those contributing >0.5%; ages 0.3, 1.2, 1.3, 2.2, and 2.3).
5. Enumerate all adult salmon, by species, captured at the Chilkat River fish wheels.

Secondary Objectives:

1. Maintain a standardized beach seine sampling schedule during August–October to ensure accurate species apportionment of DIDSON counts between coho and sockeye salmon.
2. Perform periodic, systematic observer comparison of DIDSON counts to increase precision of the DIDSON count. Inseason disagreement between observers of more than 5% should be flagged for a detailed review.
3. Measure water column temperature, record light penetration profiles, and estimate zooplankton species composition, size, density, and biomass in Chilkat Lake on a monthly basis during the middle of the month, June–October.

METHODS

CHILKAT LAKE ESCAPEMENT ESTIMATION

A DIDSON (manufactured by Sound Metrics Corporation) was used in conjunction with a picket weir to estimate the Chilkat Lake sockeye salmon escapement and determine if the escapement goal was met. The weir and DIDSON were typically installed and operated annually between statistical week 24 (early June) and statistical week 41 (mid-October). ADF&G statistical weeks begin on Sunday at 12:01 a.m. and end the following Saturday at midnight and are numbered sequentially starting from the beginning of the calendar year (Appendix B). Data collected at the weir provided information on run timing, run strength, and age composition.

Chilkat Lake Weir

The Chilkat Lake weir was installed on Clear Creek, approximately 0.4 km downstream of the lake outlet. During 2017–2019, the weir was a semi-removable steel bipod structure approximately 33 m wide. The weir framework consisted of 11 5-cm steel pipe bipods spaced between 2.4 and 2.7 m driven into the bed of the river and connected together with steel stringers of varying lengths. Steel pipe pickets with 2.5 cm outside diameter were inserted through regularly spaced holes in the stringers and extended to the silty stream bed, forming a fence across the lake outlet. The stringer holes were spaced 3.8 cm apart, and the maximum possible space between each picket was 4.1 cm. A 3.6 m wide boat gate was installed in the center of the weir to allow boat traffic to access the lake during the day but completely block fish passage at night. The boat gate was located at the deepest part of the weir site (roughly 3 m in depth) and operated remotely via an electric hoist/winch. Sandbags and fencing were placed as needed along the upstream side of the weir to ensure the weir was fish tight. The integrity of the weir was verified throughout the season by regular underwater inspections.

In 2020, a new weir was built roughly 40 m downstream from the old weir site. A new boat gate apparatus installed in the weir eliminated the need for scuba divers to install the boat gate each spring. The new weir was essentially an aluminum version of the old weir. It was 37 m wide with 2.4 cm pickets, a 4.1 m wide boat gate, bipods spaced an equal 2.9 m apart, and a maximum depth of 2 m during high water.

Periodic flow reversals, caused when glacial water from the flooding Tsirku River backed into Clear Creek and into Chilkat Lake, required keeping the boat gate open to prevent damage to the gate until the reversal subsided. Flow reversals could last from a few hours to several days. Stream height, water temperature, and water clarity (e.g., excellent, fair, poor) were recorded at approximately 6:30 a.m. each day. Stream height (cm) was measured on a stadia rod, and water temperature (°C) was measured with a thermometer installed near the middle of the weir.

Sockeye Salmon Age, Sex, and Length Composition

The seasonal age composition of the Chilkat Lake sockeye salmon escapement (including jack sockeye salmon; i.e., fish <350 mm mid eye to tail fork length) was determined from a minimum sample of 665 fish captured at the weir. This sample size was based on work by Thompson (2002) to estimate proportions of four or more major age classes. A sample of 510 fish would ensure the estimated proportion of each major age class would be within 5% of the true value with at least 95% probability. The sample size was increased to 665 fish to ensure the sampling goal would be met, even if age could not be determined from the scales of 30% of the sampled fish. In addition, 3 scales were sampled from each fish to increase the proportion of readable scales. Up to 10 sockeye salmon were sampled each day for matched scales, sex, and length (70 fish/week). This weekly sample was more than sufficient to meet objective criteria, because the total seasonal sample was more than the 665 samples required. This sample also met seasonal requirements for estimating sex composition, with only 385 samples (assuming no data loss) needed to achieve the precision criteria (within 5% of the true value with 95% probability; Thompson 2002).

Fish were captured for sampling with a beach seine on the downstream side of the weir structure. If fish were present, sampling usually began at 6:00 a.m., early enough for sampling to be completed prior to the start of daily boat traffic on Clear Creek. All sampled fish were measured from mid eye to tail fork, and the sex was determined from examination of external dimorphic sexual maturation characteristics such as snout and kype development, belly shape, and shape of vent opening. Three scales were collected from the "preferred area" of each sampled fish (i.e., the left side of the fish, 2 scale rows above the lateral line on the diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin; INPFC 1963). Sampled fish were then marked with a left operculum punch to prevent resampling. All captured coho salmon were counted, and those counts were used for species apportionment of the DIDSON counts (see below). After sampling, the boat gate was opened, and fish were allowed to travel upstream.

Scale samples were analyzed at the ADF&G Region I Scale Aging Laboratory in Douglas, Alaska. Scale impressions were made in cellulose acetate and prepared for analysis as described by Clutter and Whitesel (1956). Scales were examined under moderate (70×) magnification to determine age. Age classes were designated by the European aging system where freshwater and saltwater years were separated by a period (e.g., age 1.3 denoted a fish with 1 freshwater and 3 ocean years; Koo 1962). Age, length, and sex data were entered into the Region I Commercial Fisheries Database by Douglas staff. The weekly age distribution, the seasonal age distribution weighted by week, and the mean length by age and sex weighted by week were calculated using standard sampling summary statistics from Cochran (1977; Appendix C).

Chilkat Lake DIDSON

The DIDSON system was used to enumerate fish as they passed through the boat gate opening in the weir and was deployed just upstream of the weir approximately 3–5 m from the left bank of the river. The DIDSON transducer was attached to an aluminum pod and oriented perpendicular to the current. The wide axis of the beam was oriented horizontally and positioned close to the river bottom to maximize residence time of targets in the beam. The DIDSON was operated at 1.8 MHz (high frequency 96 beams) with a viewing angle of 29° × 14°. A 30 m cable was used to transmit power and data between the DIDSON and a "topside box" located inside the camp cabin, and an Ethernet cable was used to route data to a laptop computer. Playback of files to enumerate fish was controlled on the laptop computer running the latest version of DIDSON software. A small gasoline-powered generator, in later years supplemented by a small photovoltaic system (Zeiser et al. 2020a), provided power for all equipment. Daily visual inspections were conducted to confirm proper placement and orientation of the transducer to accommodate varying water levels.

The DIDSON was operated 24 hours a day for the first 5 days with the boat gate closed at night. If any fish were observed passing through the weir at night while the gate was closed, the opening was found and patched as soon as possible. This process was extended past the first 5 days if fish continued to be observed passing through the weir when the gate was closed. Acoustic sampling then began each morning around 6:00 a.m. and continued until 10:00 p.m., when the boat gate was closed for the night. Closing the gate at 10:00 p.m. allowed fish to build up behind the weir, where they could be easily sampled in the morning. In the rare event that a boat required passage through the weir between 10:00 p.m. and 6:00 a.m., the period of time the gate was open was limited as much as possible, but some fish may have passed without being counted. If the boat gate remained open after 10:00 p.m. due to a flow reversal or a mechanical issue with the gate, the DIDSON was operated 24 hours a day until the boat gate could be closed. Periodically throughout the season, the DIDSON was run 24 hours a day to confirm the weir was fish-tight. If a breach in the weir was discovered, the weir was patched to rectify the problem.

The DIDSON was set to record data onto the hard drive in 60-minute increments, creating a separate date- and time-stamped file for each recording period. The weir crew identified and tallied fish traces from the playback of recorded files. All fish determined to be salmon were counted. Although it was possible to count salmon at the same time new files were being recorded, during normal operation the files were viewed sometime after the initial recording, often the next day. Viewing a file later allowed for the recording to be sped up, increasing efficiency. Files were viewed at speeds below 60 frames per second to prevent the computer from dropping frames during review, thus decreasing the likelihood of missing fish. Files could be initially screened with the playback speed set at 60 frames per second to facilitate quicker viewing when there were long periods without any observed fish passage. When a moving object was observed, part of the recording could be replayed backwards and forwards at a lower speed to evaluate the nature of the object (relative size, swimming pattern, etc.). Technicians familiarized themselves with behaviors typical of various fish species through intensive observation. Fish that displayed feeding or milling behavior known to be associated with cutthroat trout or whitefish were not counted. Fish that exhibited the size and behavior identified with salmon (directional migration, no milling) were assumed to be salmon and were counted manually with tally counters. In the beginning of the season, all salmon were assumed to be sockeye salmon.

DIDSON Observer Training

The use of the DIDSON to count fish has limitations that need to be accounted for during operations or addressed preseason, including species apportionment (see below), shadowing effects, and observer bias from species nondetection or misclassification (e.g., cutthroat trout and whitefish identification versus salmon species) (Keefer et al. 2017). Observer fatigue or interruptions in viewing can also bias observations between operators (Cronkite et al. 2006). Acoustic shadowing effects can be a problem when fish are present in high densities—fish nearer to the DIDSON mask or "shadow" fish passing farther away—which leads to undercounting. In studies conducted elsewhere, problems associated with shadowing occurred when fish densities were greater than 1,000 fish an hour (Holmes et al. 2006; Maxwell and Gove 2007; Westerman and Willette 2012). Hourly fish counts at Chilkat Lake have usually been well below 1,000 fish. Event nondetection bias or perception bias occurs in field observation studies when animals are visible but not observed and typically results in underestimates of abundance (Nichols et al. 2000). Misclassification biases occur when species are misidentified, also inducing bias in abundance estimates (Conn et al. 2013). These biases can be reduced by training observers in the preseason and by routinely conducting inseason observer comparisons to maintain quality control and ensure accuracy. Early and inseason observer training has not been consistently performed at Chilkat Lake since recommended by Bednarski et al. (2017) but continues to be important for accurate DIDSON counts.

DIDSON Species Apportionment

The DIDSON cannot be used to identify salmon to species when 2 or more species of similar size and shape are present (Martignac et al. 2015). Although on some river systems apportionment of sonar counts by species requires separate, intensive net or fish wheel sampling programs (Bromaghin 2005; Lozori and McIntosh 2014), species identification at the Chilkat Lake weir involved only 2 species (coho and sockeye salmon) and was not an issue until coho salmon started arriving in late August or early September. Historically, pink and chum salmon were also counted at the weir; however, historical counts of these species were extremely low (the 1981–2007 average annual weir count was 10 chum salmon and 1 pink salmon). It was assumed that abundance of these 2 species was negligible, and species apportionment was based only on the ratio of coho and sockeye salmon.

Species apportionment started on the first day a coho salmon was observed at the weir or captured in morning beach seine sampling events in conjunction with sockeye salmon scale sampling (Zeiser et al. 2020a). Thereafter, a standardized beach seine sampling schedule was maintained through the end of the season to ensure accurate species apportionment. The crew strived to sample at least 68 fish (coho and sockeye salmon in combination) captured in beach seine sets each morning. The sample of 68 fish was sufficient to estimate the proportion of each species within 10% of the true value with 90% probability, with the assumption that the proportion sampled in morning beach seine sets was representative of the proportion of coho and sockeye salmon present throughout the day. The number of fish captured by species was recorded for each beach seine set conducted. To avoid duplicate counting, all captured fish were marked with a hole punch on the upper left operculum. If at least 68 fish were sampled, the proportion of coho and sockeye salmon was applied to that day's DIDSON counts. If, however, fewer than 68 fish were sampled on day X, the total sample on that day was added to samples from previous days until the combined total equaled at least 68 fish. The apportionment from the combined total was then applied to the DIDSON counts on day X (Zeiser et al. 2020a).

Count Expansions

In 2018, the DIDSON was inoperable for brief periods of time that allowed fish to move upstream past the weir uncounted. Fish passage was assumed to be zero if it was likely to be negligible based on inseason data. Otherwise, estimates for missed passage were calculated using a method similar to the one described in Zeiser et al. (2019).

In some years, weir and DIDSON operations did not encompass the entire sockeye salmon run, because the project was started later and/or ended earlier than average due to budget constraints, flooding, low water, or other problems. Linear regression methods were used to expand counts in years with shortened seasons to account for the missing escapement counts (Appendices D and E).

CHILKAT RIVER FISH WHEELS

During 2017–2020, 2 three-basket-configured fish wheels were operated in the lower Chilkat River between miles 7.5 and 10 on the Haines Highway, where the main flow was constrained primarily to the eastern side of the floodplain (Figure 2). Dates of operation have varied depending on the focus of the project, but since 1997 the fish wheels have typically been operated from statistical week 24 (about mid-June) to statistical week 41 (about early October; Appendix F) and between miles 7 and 10 on the Haines Highway.

The best operating locations were determined at the beginning of each season based on river conditions. The fish wheels were launched from the Haines Highway and, depending on location, lowered into the river with a crane, tractor, excavator, or front loader, then drifted downstream or pushed upstream with jet boats to the pre-determined site. The fish wheels were anchored to the highway guardrail with 0.95 cm steel cable and a 2.7 cm diameter polyethylene rope bridle, and held out from and parallel to the shoreline with an adjustable boom log system (Kelley and Bachman 2000). An average river depth of at least 1.5 m was required for the aluminum fish wheels to maintain revolution speeds adequate to capture migrating salmon (approximately 1.5–4 rpm; Bachman and McGregor 2001). Seasonal changes in water flow (particularly from late August through early October, when water levels subsided) required minor changes in fishing location in order to maintain adequate rotation speed; e.g., fish wheels were moved farther from shore into faster current or to a nearby (<1.5 kilometer) alternate location.

The fish wheel design (used since 1997) consisted of 2 aluminum pontoons, measuring approximately 12 m (length) × 6 m (width) and filled with closed-cell Styrofoam for flotation. The pontoons supported a 6 m wide structure consisting of an adjustable height axle, 3 catch baskets, wooden slides, and enclosed fabric chutes, along with 2 live boxes per wheel to hold captured fish. A plywood deck spanning the full width between the pontoons provided a fish sampling area. The aluminum baskets were 3.1 m (width) × 3.7 m (depth), covered with nylon seine mesh (5.1 × 5.1 cm openings), and bolted to a metal axle that spins in a pillow-block bearing assembly. The 3 catch baskets were rotated about the axle by the force of the water current and were adjusted vertically in the water column by moving the axle up or down within tower support channels. Migrating salmon were captured in the rotating baskets as they swam under the structure. V-shaped, foam-padded wooden slides were bolted to the rib midsection of each basket to direct fish through fabric chutes into the lidded aluminum live boxes bolted to the sides of the pontoons. The live boxes were perforated to allow constant flow of fresh river water (Zeiser et al. 2020b).

The fish wheels were operated 24 hours a day throughout the season, including during sampling periods. The fishing “day” started at 4:00 p.m. and ended the following day at 3:59 p.m. Live boxes were inspected a minimum of twice each day, once early in the morning and again in the afternoon, with the end of the fishing day corresponding to the end of the last fish wheel inspection. The first fish wheel inspection of the day was expected to be longer because it encompassed a longer fishing period and sockeye salmon tend to migrate more at night (Bentley et al. 2014). Fish were removed with a dip net and counted by species. The fish wheels were checked more often during periods of peak fish movement. All fish were counted by species, and sex and length data were collected daily from the first 10 (2020) or 20 (2017–2019) sockeye salmon counted out of the live boxes (Zeiser et al. 2020b). The length of each sampled fish was measured from mid eye to tail fork to the nearest 5 mm and identified to sex. Data recorded on standard optical scan forms included the date, sex, length, and condition of each fish. Other information recorded daily included water temperature (°C), fish wheel rotation speed (rpm), and fish wheel start and stop times. River water level (cm) was measured at an established staff gauge located near milepost 8.5 on the Haines Highway. If river conditions made it difficult to navigate to the river gauge, water levels were retrieved from USGS gage site #15056500 at the Wells Bridge on the Chilkat River, near Klukwan (data available at https://waterdata.usgs.gov/nwis/uv?site_no=15056500).

The total hours fished by each fish wheel was recorded each day. When a fish wheel was stopped for any reason, the total catch of all fish wheels was expanded to compensate for the reduction in fishing effort using

$$C_a = \frac{24N_w(\sum c_i)}{\sum E_i}, \tag{1}$$

where C_a was the effort-adjusted catch for both fish wheels, N_w was the number of fish wheels used, c_i was the sockeye salmon catch of fish wheel i, and E_i was the effort of fish wheel i in hours. Although the effort-adjustment provided better estimates of sockeye salmon escapement than raw catch, equation 1 assumed that both fish wheels would have caught the same number of fish in a given 24 hour period, which is known to be false.

COMMERCIAL HARVEST ESTIMATE

Stock composition of the sockeye salmon harvest in the District 15 commercial drift gillnet fishery was estimated annually through genetic stock identification. Laboratory analysis, including quality control, was performed by the ADF&G Gene Conservation Laboratory following methods outlined in Dann et al. (2012). Sockeye salmon were identified to 7 reporting groups: Chilkat Lake, Chilkat mainstem, Chilkoot Lake, Juneau Mainland, Snettisham, Taku River/Stikine mainstem, and Other (Zeiser et al. 2019); however, reporting groups were reduced to Chilkat Lake, Chilkoot Lake, and Other for postseason reporting. Stock composition was estimated for each statistical week using a Bayesian mixed stock analysis approach as implemented in the R package *rubias*[2] (Moran and Anderson 2019), which compared fishery samples against the genetic baseline described in Rogers Olive et al. (2018). Postseason, samples were reanalyzed with age composition data from the harvest using Mark and Age-enhanced Genetic Mixture Analysis (MAGMA), an extension of the Pella-Masuda genetic stock identification model (Pella and Masuda 2001) that incorporates ages from matched scale samples to provide age-specific stock composition estimates for all major contributing age classes (i.e., those contributing >0.5%). MAGMA was used to analyze stock composition in the first 10 statistical weeks of the sockeye salmon fishery. The stock proportions in the last sampled statistical week were used to estimate contribution for the final weeks of the fishery, generally statistical weeks 35–40, which accounted for an average 8% (range 3–15%) of the sockeye salmon harvest during 2017–2020.

[2] R Development Core Team. 2019. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

The District 15 commercial drift gillnet fishery opens by regulation at 12:00 noon on the third Sunday of June. Each week typically begins with a 48 hour opening, with the possibility of an extension depending on fishery performance. Commercial harvest data for District 15, stratified by statistical week, were obtained through the ADF&G Region I Commercial Fisheries Database.

Fishery Sampling

Matched sockeye salmon scale and tissue samples were collected from District 15 commercial drift gillnet fishery landings by ADF&G port sampling personnel at fish processing facilities in Excursion Inlet, Juneau, and Petersburg (Buettner et al. 2017). Sampling was stratified by statistical week, and sampling effort spanned the first 10 weeks of the fishery. In 2017, sampling goals were set at 600 fish per week (300 at Excursion Inlet and 300 at Juneau; Buettner et al. 2017). In 2018 through 2020, sampling goals were set at 150 fish each from Juneau and Excursion Inlet, and 100 fish from Petersburg. If Excursion Inlet or Juneau were short of samples in a given week, more were collected at Petersburg. The target sample size for each statistical week was set at a minimum of 200 and a maximum of 300 paired tissues and scales. According to sample theory, under the worst-case scenario (stocks contributing equal proportions) a minimum sample of 200 fish should provide weekly estimates of relative stock composition proportions within 7% of the true value 90% of the time (Thompson 1987).

Starting in 2018, sockeye salmon harvested in the District 15 commercial drift gillnet fishery were sampled regardless of the harvest type and all samples were recorded as traditional harvest (harvest code 11). Previously, sockeye salmon harvested in the Boat Harbor terminal harvest area (THA; statistical area 115-11) were not sampled, including sockeye salmon on tenders with fish mixed from traditional and terminal harvest (harvest code 12) fisheries. The Boat Harbor THA is designated to harvest hatchery chum salmon released inside Boat Harbor; however, the THA encompasses a portion of lower Lynn Canal (Figure 1) through which mixed stocks of sockeye salmon must migrate, and sockeye salmon are harvested incidentally in the fishery. There are no hatchery sockeye salmon released inside Boat Harbor or anywhere else in District 15. Over the 10 years 2008–2017, an average 21% (range: 12–36%) of sockeye salmon harvested in lower Lynn Canal (statistical areas 115-10 and 115-11) were harvested in the Boat Harbor THA. Since 2018, all sockeye salmon samples have been identified as harvest code 11 (traditional fishery).

Sampling protocols were designed to ensure that samples were as representative of harvests as much as possible to account for fluctuations in harvest and effort over the course of a weekly fishery. Deliveries with harvests mixed from more than one gear type or fishing district were not sampled, no more than 40 samples were collected from a single delivery, no more than 200 samples were collected from a single tender delivery, samples were collected without regard to size or sex of fish, and, whenever possible, samples were systematically collected from the entire hold as it was offloaded to ensure they were representative of the entire delivery. A 2.5 cm piece of the pelvic fin was removed from each sampled fish and placed on a Whatman filter paper card for dry preservation. Matched scale, length, and sex data were also collected from each sampled fish as described above for escapement samples. Tissue samples were shipped on a weekly basis to the Region I Scale Aging Laboratory in Douglas, along with matching scale samples and associated data for inventory. Tissue samples were then shipped to the ADF&G Gene Conservation Laboratory in Anchorage for analysis. Scale samples were analyzed at the ADF&G Region I Scale Aging Laboratory in Douglas.

Laboratory Analysis

Genomic DNA was extracted from tissue samples using a NucleoSpin 96 Tissue Kit by Macherey-Nagel (Düren, Germany). A multiplexed preamplification polymerase chain reaction (PCR) of 48 screened single nucleotide polymorphism (SNP) markers was used to increase the concentration of template DNA. Samples were genotyped for 48 screened SNP markers using 2 sets of Fluidigm 192.24 Dynamic Array Integrated Fluidic Circuits, which systematically combined up to 24 assays and 192 samples into 4,608 parallel reactions (https://www.fluidigm.com). The Dynamic Arrays were read on a Fluidigm EP1 System after amplification and scored using Fluidigm SNP Genotyping Analysis software. If necessary, SNPs were rescreened on a QuantStudio 12K Flex Real-Time PCR System (Life Technologies) as a backup method for assaying genotypes. Genotypes were imported and archived in the Gene Conservation Laboratory Oracle database, LOKI.

A quality control analysis (QC) was conducted postseason to identify laboratory errors and to measure the background discrepancy rate of the genotyping process. The QC analyses were performed by staff not involved in the original genotyping as described in detail by Dann et al. (2012). Briefly, the method consisted of re-extracting 8% of project fish and genotyping them for the same SNPs assayed in the original genotyping process. Discrepancy rates were calculated as the number of conflicting genotypes, divided by the total number of genotypes compared. These rates describe the difference between original project data and QC data for all SNPs and can identify extraction, assay plate, and genotyping errors. Assuming that discrepancies among analyses are due equally to errors during the original genotyping and during QC, error rates in the original genotyping were estimated as half the rate of discrepancies. If there were many discrepancies, a duplicate check was performed to determine if the QC fish were a better match to any other project fish. A QC fish matching other project fish would indicate that fish were swapped during the extraction process. This information was used to identify which, and how many, fish should be re-extracted.

Statistical Analysis

Genotypes in the LOKI database were imported into R for analysis. Prior to statistical analysis, 3 quality assurance analyses were performed to ensure high-quality data: 1) individuals missing >20% of their genotype data (markers) were identified and removed from analyses because this is indicative of low-quality DNA (80% rule; Dann et al. 2012); 2) duplicate individuals were identified and removed; and 3) non-sockeye salmon (e.g., chum salmon) were identified and removed.

Inseason, stock composition for each stratum was estimated using the R package *rubias*. Markov Chain Monte Carlo (MCMC) methods, using a single chain with starting values equal among all populations, formed the posterior distribution that described the stock composition of each stratum. Summary statistics were tabulated from these distributions to describe stock compositions. Stock composition estimates of commercial harvest were applied to observed harvest (obtained from fish ticket data) to quantify stock-specific harvests within each week.

Postseason, age-specific stock composition for all major contributing age classes (>5%) was estimated seasonally through a MAGMA model. Weekly and seasonal estimates were provided, by age group, using MAGMA. This method required two sets of parameters: 1) a vector of stock compositions summing to one, weighted by harvest per stratum; and 2) a matrix of age composition, with a row for each stock summing to 1 and a column for each age class. This information was "completed" iteratively by stochastically assigning each fish to a population, then estimating the stock proportions based on summaries of assignment from each iteration. In this process, all available information (i.e., age and genotype) was used to assign individuals to stock of origin.

To initialize the MAGMA algorithm, all fish with unknown origin or age were stochastically assigned to a population or age group, and then proportions for populations and age groups were estimated in the following steps:

1) All age data were summarized by assigned and observed populations for both wild and hatchery individuals;
2) Population and age composition were estimated from previous summaries (accounting for sampling error);
3) Each wild fish with genotypes was stochastically assigned to a wild population of origin based on the product of its genotypic frequency, age frequency, and population proportion;
4) Each wild fish without genotypes was stochastically assigned to a population of origin based on the product of its age frequency and population proportion; and
5) Steps 1–4 were repeated while updating the estimates of the stock proportions and age compositions with each iteration.

The MAGMA algorithm was run for 40,000 repetitions, and the first 20,000 repetitions were discarded to eliminate the effect of the initial state. Five MCMC chains were run and checked for convergence among chains using the Gelman-Rubin convergence diagnostic (Gelman and Rubin 1992; Brooks and Gelman 1998). The point estimates and credible intervals for stock-specific age compositions were summary statistics of the output.

CHILKAT LAKE LIMNOLOGICAL ASSESSMENT

Basic limnological data, including zooplankton, light, and temperature sampling, were collected monthly between June and October. All light and temperature data were collected at 2 primary stations marked by anchored buoys in the lake (station 1A at 59.3420° N, 135.9131° W; station 2A at 59.3263° N, 135.8961° W; Figure 2).

Light and Temperature Profiles

Light penetration measurements were used to estimate the euphotic zone depth of the lake, which is defined as the depth at which light (photosynthetically available radiation at 400–700 nm) is attenuated to 1% of the intensity just below the lake surface (Schindler 1971). Photometric illuminance was recorded as lumens per square meter (lm/m^2) at 0.5 m intervals, from just below the lake surface to the depth at which ambient light level equaled 1% of the subsurface recording, using a Protomatic electronic light meter or ILT 1400 International Light Technologies Photometer. Measurements of underwater light intensity were used to determine vertical light extinction coefficients and algal compensation depths. The natural log (ln) of the ratio of light intensity (I) just below the surface (I_0) to light intensity at depth z, or $\ln(I_0/I_z)$, was calculated for each depth. The vertical light extinction coefficient (K_d), the rate (m^{-1}) at which light dims with increasing depth, was estimated as the slope of regression of $\ln(I_0/I_z)$ versus depth, and euphotic zone depth was calculated as $4.6502/K_d$ (Kirk 1994; Edmundson et al. 2000). Only the measurements recorded from 5 cm below the surface to just below 1% of the subsurface light level were used in calculations, because use of data at depths below 1% of the initial subsurface measurement will skew the estimate of euphotic zone depth. During July and August in 2019, a

Secchi disk was used to estimate the euphotic zone depth using the equation euphotic zone depth = $3.7489(Z_{sd}^{0.7506})$, where Z_{sd} was the depth the Secchi disk disappeared (Luhtala and Tolvanen 2013). Temperature (ºC) was measured with a Yellow Springs Instruments (YSI) Model 57 meter. Measurements were made at 1 m intervals from the surface to a depth of 20 m and then continued in 5 m intervals to a depth of 50 m.

Secondary Production

Zooplankton samples were collected at each sampling station using a 0.5 m diameter, 153 µm mesh conical net. Vertical zooplankton tows were pulled from a depth of 50 m to the surface at a constant speed of 0.5 m/sec. Once the top of the net cleared the surface, the rest of the net was pulled slowly out of the water and rinsed from the outside with lake water to wash organisms into the screened sampling container at the cod end of the net. All specimens in the sampling container were carefully rinsed with tap water into a 500 ml sampling bottle and preserved in buffered 10% formalin. Samples were analyzed at the ADF&G Kodiak Limnology Lab using methods detailed in the ADF&G Limnology Field and Laboratory Manual (Koenings et al. 1987). Results were averaged between stations by month and season.

RESULTS

CHILKAT LAKE ESCAPEMENT

Species Apportionment

Species apportionment of Chilkat Lake DIDSON counts started on the first day a coho salmon was observed at the weir or captured in morning beach seine sampling events in conjunction with sockeye salmon scale sampling. This occurred as early as 16 August in 2018 and as late as 27 August in 2020. During the 2018–2020 sampling seasons, a minimum sample size of 68 total fish (over one or multiple days of seining) and a standardized beach seine sampling schedule was consistently maintained during August–October. The daily sampling ratio (number of sockeye salmon to number of coho salmon captured) over one or multiple days was applied to calculate species apportionment of DIDSON counts between coho and sockeye salmon in years 2018 through 2020 (Appendices I through L).

In 2017, however, beach seining sampling effort was inconsistent and species apportionment had to be estimated using the 10-year (2007–2016) average proportion of coho salmon, by week, starting on 10 September (Appendix I). Although the 10-year average does not capture the year-specific species ratio between coho and sockeye salmon, it provided the best approximation of the general trend in species apportionment at the Chilkat Lake weir.

Escapement Counts

2017

In 2017, 88,197 sockeye and 1,819 coho salmon were enumerated through the weir between 15 June and 10 October (statistical weeks 24–41; Table 1; Figure 3; Appendices D and I). Weekly sockeye salmon escapements were within the weekly escapement goal targets in statistical week 28 and from statistical week 30 on. Escapements built steadily through statistical week 33 before diminishing into statistical week 36. A surge in statistical week 37 propelled the total sockeye salmon escapement over the lower bound of the biological escapement goal range (Table 1; Figure 4).

2018

In 2018, 108,047 sockeye and 3,678 coho salmon were enumerated through the weir between 10 June and 12 October (statistical weeks 24–41; Table 2; Figure 3; Appendices D and J). The DIDSON was not operable for much of 11–13 July and for several hours on both 31 July and 16 August. No interpolation was made for fish passage during 11–13 July because a flow reversal occurred during those days and the boat gate was kept closed; thus, it was assumed that sockeye salmon passage would have been negligible. Interpolated counts for missing hours on 31 July and 16 August totaled 1,349 sockeye salmon (1.2% of the total escapement). Weekly sockeye salmon escapements were slightly below the weekly escapement goal targets during statistical weeks 24–29. In statistical week 30, escapements fell within the weekly escapement goal target range for the first time, but escapements did not rise much above the lower escapement goal target until around statistical week 33. The total sockeye salmon escapement was in the middle of the biological escapement goal range (Table 2; Figure 4).

2019

In 2019, 134,958 sockeye and 6,020 coho salmon were enumerated through the weir between 10 June and 9 October (statistical weeks 24–41; Table 3; Figure 5; Appendices D and K). Weekly sockeye salmon escapements were below weekly escapement goal targets during statistical weeks 25–27. However, the weekly escapement goal targets were met in weeks 28–29, and the upper target boundaries were exceeded in weeks 30–39. The total sockeye salmon count was expanded to 136,091 fish (<1% of the total weir count) to account for removing the weir one day prior to the target end date of 10 October (Appendix D). The total sockeye salmon escapement was slightly below the upper bound of the biological escapement goal range (Table 3; Figure 4).

2020

In 2020, 50,746 sockeye and 3,862 coho salmon were enumerated through the weir between 18 June and 11 October (statistical weeks 25–42; Table 4; Figure 5; Appendices D and L). Weekly sockeye salmon escapements were below the weekly escapement goal targets for the entire season, and the total sockeye salmon escapement missed the lower bound of the biological escapement goal by 19,254 fish (Table 4; Figure 4). The total sockeye salmon escapement was the lowest since 2007 and the 12th lowest since records began in 1971 (Appendix D).

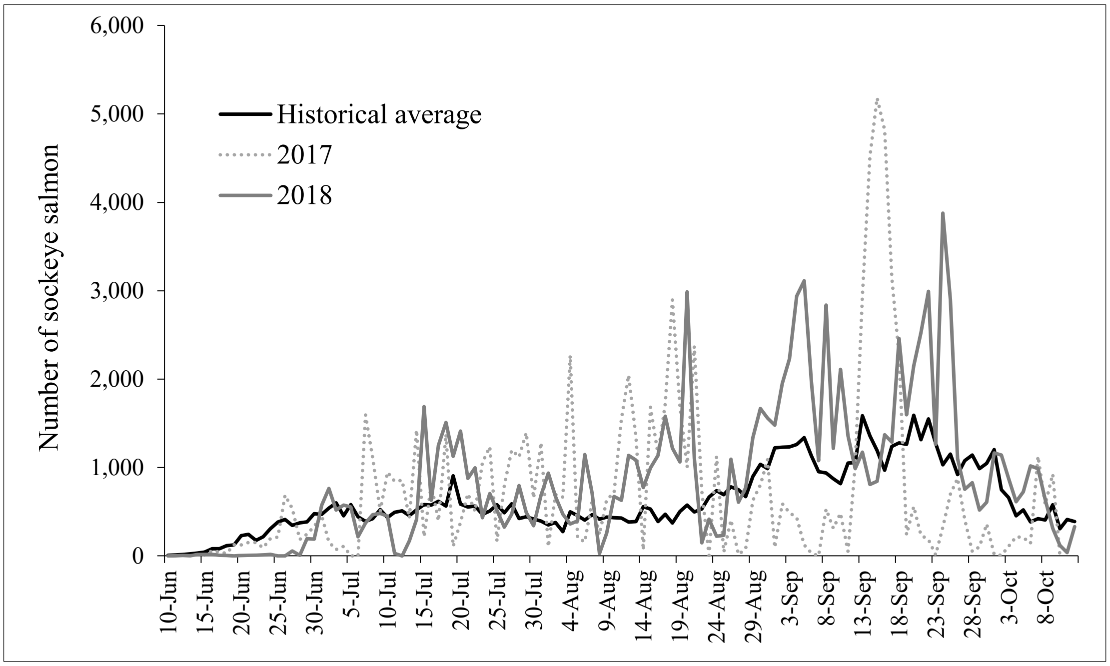

Figure 3.–Daily sockeye salmon counts (raw counts) at the Chilkat Lake weir in 2017 and 2018 compared to the historical average (1967–2016).

Table 1.–Weekly escapement of sockeye salmon at the Chilkat Lake weir compared to weekly management targets and biological escapement goal range of 70,000 to 150,000 fish, 2017.

	Escapement		Escapement goal	
Statistical week	Weekly	Cumulative	Cumulative lower bound	Cumulative upper bound
24	106	106	169	362
25	865	971	1,947	4,171
26	2,654	3,625	4,919	10,541
27	3,035	6,660	8,540	18,300
28	5,210	11,870	11,844	25,379
29	4,269	16,139	16,161	34,631
30	6,960	23,099	19,298	41,353
31	5,871	28,970	22,546	48,314
32	5,960	34,930	26,138	56,010
33	10,555	45,485	29,038	62,224
34	5,679	51,164	33,083	70,892
35	3,298	54,462	39,106	83,799
36	1,916	56,378	45,408	97,303
37	19,022	75,400	49,274	105,588
38	6,647	82,047	53,568	114,789
39	2,819	84,866	62,086	133,041
40	1,824	86,690	66,642	142,804
41	1,507	88,197	70,000	150,000

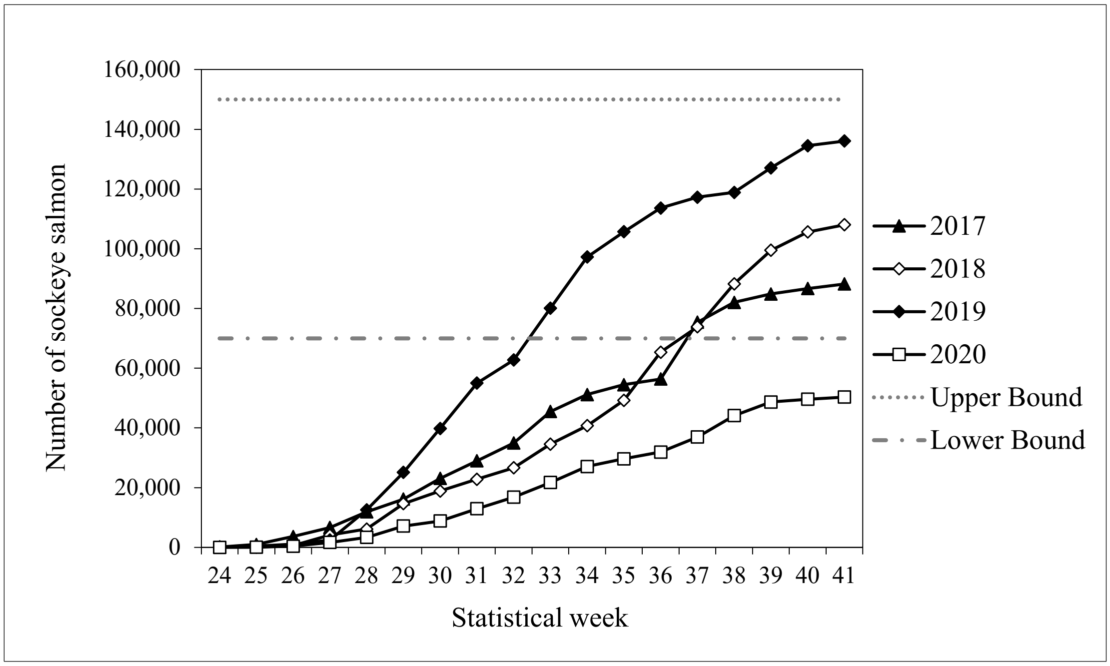

Figure 4.–Weekly cumulative escapement of sockeye salmon through the Chilkat Lake weir, 2017–2020, and upper and lower bounds of the annual escapement goal range of 70,000–150,000 fish.

Table 2.–Weekly escapement of sockeye salmon at the Chilkat Lake weir compared to weekly management targets and biological escapement goal range of 70,000 to 150,000 fish, 2018.

	Escapement		Escapement goal	
Statistical week	Weekly	Cumulative	Cumulative lower bound	Cumulative upper bound
24	58	58	89	190
25	39	97	1,301	2,788
26	462	559	4,231	9,066
27	3,566	4,125	8,101	17,359
28	2,006	6,131	11,381	24,388
29	8,490	14,621	15,552	33,326
30	4,237	18,858	18,802	40,290
31	3,952	22,810	21,804	46,723
32	3,835	26,645	25,840	55,371
33	7,927	34,572	28,673	61,442
34	6,174	40,746	32,560	69,772
35	8,513	49,259	37,684	80,752
36	16,117	65,376	44,845	96,096
37	8,494	73,870	48,775	104,517
38	14,374	88,244	52,655	112,832
39	11,238	99,482	59,823	128,193
40	6,143	105,625	65,952	141,325
41	2,422	108,047	70,000	150,000

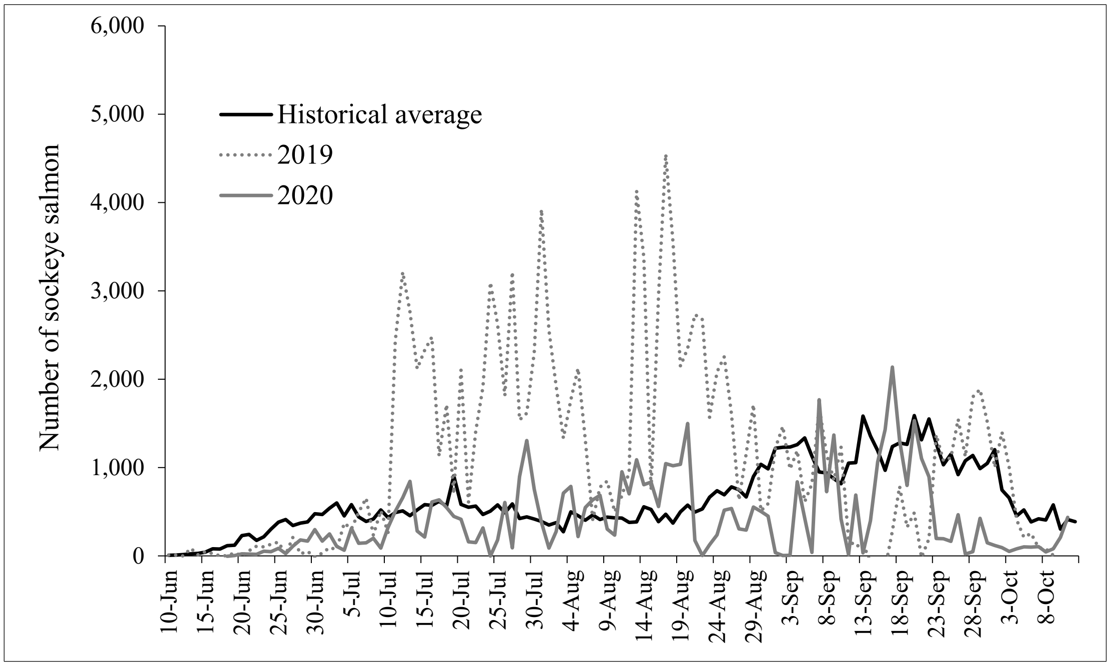

Figure 5.–Daily sockeye salmon counts (raw counts) at the Chilkat Lake weir in 2019 and 2020 compared to the historical average (1967–2016).

Table 3.–Weekly escapement of sockeye salmon at the Chilkat Lake weir compared to weekly management targets and biological escapement goal range of 70,000 to 150,000 fish, 2019.

	Escapement		Escapement goal	
Statistical week	Weekly	Cumulative	Cumulative lower bound	Cumulative upper bound
24	167	167	41	87
25	239	406	1,135	2,432
26	696	1,102	3,818	8,182
27	1,358	2,460	7,791	16,696
28	10,081	12,541	10,866	23,284
29	12,579	25,120	15,069	32,290
30	14,676	39,796	18,297	39,209
31	15,196	54,992	21,368	45,789
32	7,742	62,734	25,430	54,493
33	17,376	80,110	28,212	60,454
34	17,110	97,220	31,966	68,498
35	8,458	105,678	36,545	78,310
36	7,973	113,651	44,095	94,490
37	3,597	117,248	48,120	103,114
38	1,614	118,862	51,961	111,346
39	8,230	127,092	58,577	125,522
40	7,429	134,521	65,505	140,367
41[a]	1,570	136,091	70,000	150,000

[a] In 2019, the weir was removed early (after 9 October), so expansions were done to account for this early removal in statistical week 41. Based on the expansion, 1,133 fish were added to the weir count on 10 October.

Table 4.–Weekly escapement of sockeye salmon at the Chilkat Lake weir compared to weekly management targets and biological escapement goal range of 70,000 to 150,000 fish, 2020.

	Escapement		Escapement goal	
Statistical week	Weekly	Cumulative	Cumulative lower bound	Cumulative upper bound
24	0	0	25	53
25	27	27	976	2,091
26	365	392	3,507	7,516
27	1,241	1,633	7,153	15,327
28	1,721	3,354	10,415	22,319
29	3,793	7,147	14,401	30,858
30	1,673	8,820	17,973	38,514
31	4,126	12,946	21,039	45,084
32	3,866	16,812	24,813	53,172
33	4,925	21,737	27,798	59,568
34	5,342	27,079	31,373	67,227
35	2,571	29,650	35,494	76,059
36	2,276	31,926	43,222	92,618
37	5,029	36,955	47,528	101,845
38	7,168	44,123	51,466	110,284
39	4,551	48,674	57,316	122,820
40	908	49,582	65,281	139,888
41	726	50,308	67,774	145,230
42	438	50,746	70,000	150,000

ESCAPEMENT AGE, SEX, AND LENGTH COMPOSITION

2017

In 2017, the Chilkat Lake sockeye salmon escapement was composed primarily of age-1.3 (51.3%), age-2.2 (16.2%), and age-2.3 (29.3%) fish (Table 5; Appendices R and S). The remainder of the escapement (3.2%) was composed of age-0.3, age-1.1, age-1.2, age-1.4, and age-2.1 fish. The mean length of age-1.3 fish was 591 mm for males and 570 mm for females, mean length of age-2.2 fish was 541 for males and 527 for females, and mean length of age-2.3 fish was 586 mm for males and 572 mm for females (Table 6; Appendices T and U).

Table 5.–Age composition of the Chilkat Lake sockeye escapement weighted by statistical week, 2017.

Age class	Brood year	Estimated escapement	SE escapement	Percent of escapement	SE percent	Sample size
0.3	2013	314	179	0.4%	0.2%	3
1.1	2014	137	137	0.2%	0.2%	1
1.2	2013	1,766	443	2.0%	0.5%	16
1.3	2012	45,260	2,176	51.3%	2.5%	371
1.4	2011	460	232	0.5%	0.3%	4
2.1	2013	137	137	0.2%	0.2%	1
2.2	2012	14,315	2,829	16.2%	3.2%	49
2.3	2011	25,808	3,076	29.3%	3.5%	94
Total		88,197				539

Table 6.–Average length (mid eye to tail fork) of Chilkat Lake sockeye salmon by age class and sex, 2017.

		Male			Female			Total		
Age class	Brood year	Sample size	Mean length	SE	Sample size	Mean length	SE	Sample size	Mean length	SE
0.3	2013	1	460	0.0	2	538	12.5	3	512	26.8
1.1	2014	–	–	–	1	360	0.0	1	360	0.0
1.2	2013	9	529	9.0	7	520	12.0	16	525	7.1
1.3	2012	210	591	1.7	158	570	1.6	368	582	1.3
1.4	2011	2	575	35.0	2	570	0.0	4	573	14.4
2.1	2013	–	–	–	1	330	0.0	1	330	0.0
2.2	2012	17	541	6.3	32	527	4.4	49	532	3.7
2.3	2011	40	586	4.6	54	572	3.6	94	578	2.9

2018

In 2018, the Chilkat Lake sockeye salmon escapement was composed primarily of age-2.2 (42.2%), age-1.3 (28.7%), and age-2.3 (22.0%) fish (Table 7; Appendices R and S). The remainder of the escapement (7.1%) was composed of age-0.3, age-1.1, age-1.2, age-1.4, age-2.1, age-2.4, and age-3.3 fish. The mean length of age-1.3 fish was 581 mm for males and 572 mm for females, mean length of age-2.2 fish was 536 mm for males and 521 mm for females, and mean length of age-2.3 fish was 592 mm for males and 576 mm for females (Table 8; Appendices T and U).

Table 7.–Age composition of the Chilkat Lake sockeye escapement weighted by statistical week, 2018.

Age class	Brood year	Estimated escapement	SE escapement	Percent of escapement	SE percent	Sample size
0.3	2014	222	146	0.2%	0.1%	3
1.1	2015	312	180	0.3%	0.2%	3
1.2	2014	3,787	858	3.5%	0.8%	32
1.3	2013	31,015	2,156	28.7%	2.0%	236
1.4	2012	304	183	0.3%	0.2%	3
2.1	2014	2,197	1,014	2.0%	0.9%	9
2.2	2013	45,621	2,919	42.2%	2.7%	136
2.3	2012	23,736	2,646	22.0%	2.4%	119
2.4	2011	625	624	0.6%	0.6%	1
3.3	2011	229	228	0.2%	0.2%	1
Total		108,047				543

Table 8.–Average length (mid eye to tail fork) of Chilkat Lake sockeye salmon by age class and sex, 2018.

		Male			Female			Total		
Age class	Brood year	Sample size	Mean length	SE	Sample size	Mean length	SE	Sample size	Mean length	SE
0.3	2014	2	573	17.5	1	510	0.0	3	512	23.2
1.1	2015	3	358	6.7	–	–	–	3	358	6.7
1.2	2014	26	484	6.4	6	514	9.5	32	490	5.8
1.3	2013	110	581	2.8	125	572	2.0	235	576	1.7
1.4	2012	2	618	7.5	1	560	0.0	3	598	19.6
2.1	2014	8	383	5.1	1	405	0.0	9	386	5.1
2.2	2013	56	536	4.8	82	521	2.4	138	527	2.4
2.3	2012	72	592	3.4	49	576	3.4	121	585	2.5
2.4	2011	1	580	0.0	–	–	–	1	580	0.0
3.3	2011	–	–	–	1	560	0.0	1	560	0.0

2019

In 2019, the Chilkat Lake sockeye salmon escapement was composed primarily of age-1.3 (65.5%), age-2.2 (14.6%), and age-2.3 (18.6%) fish (Table 9; Appendices R and S). The remainder of the escapement (1.2%) was composed of age-0.2, age-0.3, age-1.2, and age-2.1 fish. The mean length of age-1.3 fish was 571 mm for males and 551 mm for females, mean length of age-2.2 fish was 504 for males and 508 for females, and mean length of age-2.3 fish was 566 mm for males and 547 mm for females (Table 10; Appendices T and U).

Table 9.–Age composition of the Chilkat Lake sockeye escapement weighted by statistical week, 2019.

Age class	Brood year	Estimated escapement	SE escapement	Percent of escapement	SE percent	Sample size
0.2	2016	33	32	0.0%	0.0%	1
0.3	2015	98	55	0.1%	0.0%	3
1.2	2015	1,171	485	0.9%	0.4%	10
1.3	2014	89,199	1,869	65.5%	1.4%	482
2.1	2015	327	171	0.2%	0.1%	4
2.2	2014	19,918	1,588	14.6%	1.2%	142
2.3	2013	25,345	1,642	18.6%	1.2%	175
Total		136,091				817

Table 10.–Average length (mid eye to tail fork) of Chilkat Lake sockeye salmon by age class and sex, 2019.

		Male			Female			Total		
Age class	Brood year	Sample size	Mean length	SE	Sample size	Mean length	SE	Sample size	Mean length	SE
0.2	2016	1	480	0.0	–	–	–	1	480	0.0
0.3	2015	3	572	12.0	–	–	–	3	572	12.0
1.2	2015	4	503	28.2	6	483	14.1	10	491	13.5
1.3	2014	218	571	1.9	256	551	1.5	474	560	1.3
2.1	2015	4	368	10.5	–	–	–	4	368	10.5
2.2	2014	54	504	5.6	87	508	3.0	141	507	2.8
2.3	2013	91	566	3.0	84	547	2.6	175	557	2.1

2020

In 2020, the Chilkat Lake sockeye salmon escapement was composed primarily of age-2.2 (34.7%), age-1.3 (27.0%), and age-2.3 (28.3%) fish (Table 11; Appendices R and S). The remainder of the escapement (9.9%) was composed of age-0.3, age-0.4, age-1.1, age-1.2, age-1.4, and age-2.1 fish. The mean length of age-1.3 fish was 559 mm for males and 545 mm for females, mean length of age-2.2 fish was 496 mm for males and 497 mm for females, and mean length of age-2.3 fish was 568 mm for males and 550 mm for females (Table 12; Appendices T and U).

Table 11.–Age composition of the Chilkat Lake sockeye escapement weighted by statistical week, 2020.

Age class	Brood year	Estimated escapement	SE escapement	Percent of escapement	SE percent	Sample size
0.3	2016	633	186	1.2%	0.4%	11
0.4	2015	63	62	0.1%	0.1%	1
1.1	2017	809	381	1.6%	0.7%	9
1.2	2016	2,224	524	4.4%	1.0%	26
1.3	2015	13,722	1,327	27.0%	2.6%	169
1.4	2014	484	188	1.0%	0.4%	7
2.1	2016	832	321	1.6%	0.6%	7
2.2	2015	17,634	1,226	34.7%	2.4%	222
2.3	2014	14,345	1,359	28.3%	2.7%	167
Total		50,746				619

Table 12.–Average length (mid eye to tail fork) of Chilkat Lake sockeye salmon by age class and sex, 2020.

		Male			Female			Total		
Age class	Brood year	Sample size	Mean length	SE	Sample size	Mean length	SE	Sample size	Mean length	SE
0.3	2016	10	546	8.5	1	530	0.0	11	545	7.8
0.4	2015	–	–	–	1	525	0.0	1	525	0.0
1.1	2017	8	336	6.3	1	360	0.0	9	338	6.2
1.2	2016	13	485	8.7	13	494	5.2	26	489	5.0
1.3	2015	73	559	4.2	95	545	2.3	168	551	2.3
1.4	2014	3	547	18.6	4	560	19.5	7	554	12.8
2.1	2016	6	360	6.7	1	355	0.0	7	359	5.7
2.2	2015	76	496	4.0	145	497	1.9	221	497	1.8
2.3	2014	73	568	3.5	94	550	2.6	167	558	2.2

FISH WHEEL COUNTS

After adjusting for effort, 4,866 sockeye salmon were caught at the fish wheels in 2017, 3,047 in 2018, 8,433 in 2019, and 2,626 in 2020. Effort adjustments compensated for 224 hours of inactivity in 2017, 898 hours of inactivity in 2018, 520 hours of inactivity in 2019, and 773 hours of inactivity in 2020. Accounting for effort therefore expanded the raw sockeye salmon counts by 7.7% in 2017, 10.8% in 2018, 10.8% in 2019, and 14.9% in 2020 (Appendix F). The fish wheels provided adequate inseason indication of the magnitude of the Chilkat Lake sockeye salmon escapement in 2017, 2019, and 2020. However, in 2018, the fish wheel catch did not provide an accurate indication of the large Chilkat Lake sockeye salmon escapement of 108,047 fish (Figure 6), because catch at the fish wheels was misleadingly low; this result was due at least in part to extremely low water and nearby highway construction that prevented the fish wheels from operating properly.

In 2019, sockeye salmon entered freshwater in large numbers early and late in the season, and the fish wheel catch stayed consistently above the historical weekly average during most statistical weeks (Figure 7). Fish wheel catch was below the weekly historical averages (1999–2016) for most of 2017, 2018, and 2020, with only a handful of statistical weeks of above-average numbers in the latter half of 2017 and 2018. In 2020, fish wheel catch remained below the weekly average for the entire year, which matched reasonably well with the poor escapement observed later at the Chilkat Lake weir (Figure 7; Appendix F).

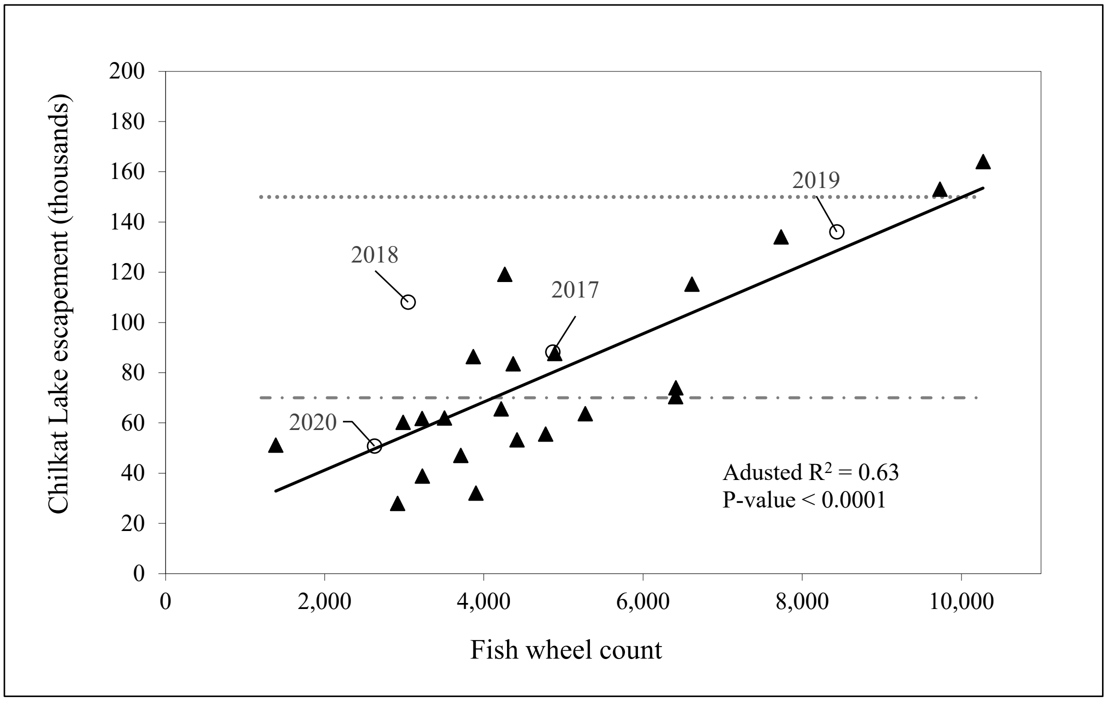

Figure 6.–Inseason fish wheel counts compared to expanded Chilkat Lake weir sockeye salmon escapement estimates (1990–2020). Historical years (1990–2016) are shown as triangles. The years 2017–2020 are shown as hollow circles. Upper and lower Chilkat Lake weir escapement goal bounds are shown as horizontal dotted and dot-dash lines, respectively. Years when the fish wheels (1992–1993) or weir (1996–1998) were not in operation were not included.

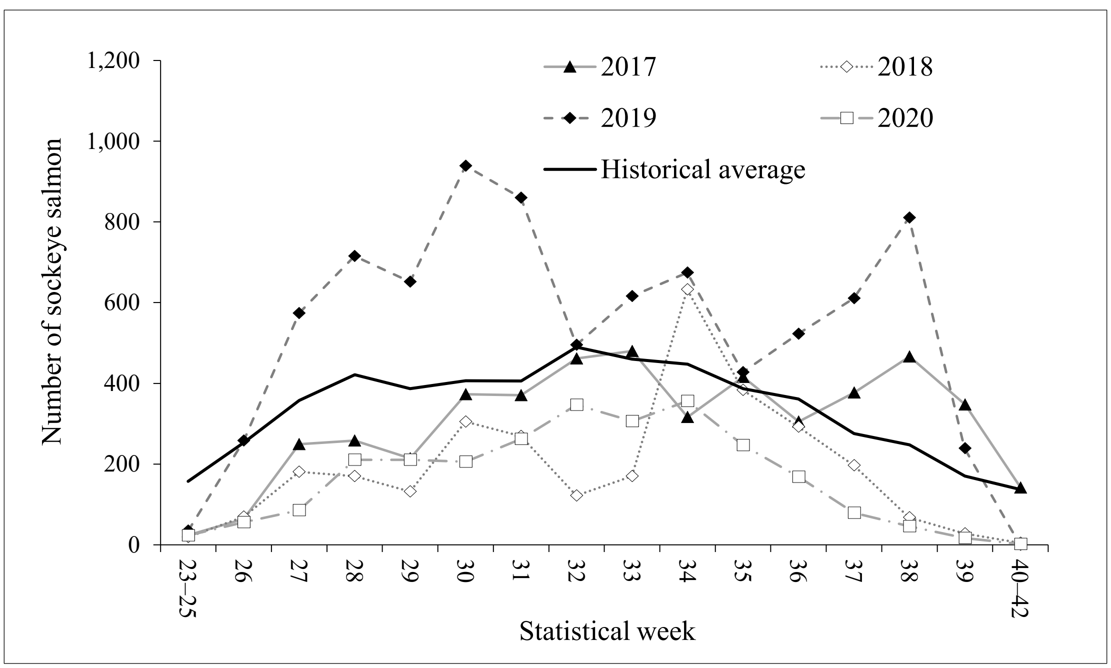

Figure 7.–Weekly fish wheel catch (2017–2020) compared to the historical average (1999–2016).

COMMERCIAL HARVEST ESTIMATE

2017

In 2017, 39,716 sockeye salmon were harvested in the District 15 commercial drift gillnet fishery. A total of 2,915 sockeye salmon were sampled, of which 1,840 fish (about 5% of the commercial harvest) were genotyped for use in genetic stock identification analysis (Appendix N). Chilkat Lake sockeye salmon accounted for an estimated 14.3% (90% CI = 12.7–16.0%) of the commercial harvest, all weeks combined, or approximately 5,698 fish (90% CI = 5,063–6,357 fish; Table 13; Appendices M and N). The Chilkat Lake sockeye salmon harvest was composed primarily of age-1.3 fish (62%), followed by age-2.3 fish (21%), age-2.2 fish (12%), and age-1.2 fish (2.0%). The total Chilkat Lake sockeye salmon run was estimated to be 93,895 fish, and the commercial harvest rate was estimated to be 6.1% (Appendix A). Additional sockeye salmon harvests of 254 fish in the sport fishery and 3,761 fish in the subsistence fishery consisted of unknown proportions of Chilkat Lake and Chilkat River mainstem fish; thus, the total harvest rate on Chilkat Lake fish only considers commercial harvest and represents a minimum estimate. Chilkat River mainstem sockeye salmon stocks contributed an estimated 515 fish (90% CI = 320–746 fish) to the commercial harvest.

2018

In 2018, 81,688 sockeye salmon were harvested in the District 15 commercial drift gillnet fishery. A total of 3,407 sockeye salmon were sampled, of which 1,794 fish (about 2% of the commercial harvest) were genotyped for use in genetic stock identification analysis (Appendix O). Chilkat Lake sockeye salmon accounted for an estimated 23.5% (90% CI = 21.6–25.5%) of the commercial harvest, all weeks combined, or approximately 19,235 fish (90% CI = 17,644–20,871 fish; Table 13; Appendices M and O). The Chilkat Lake sockeye salmon harvest was composed primarily of age-2.2 fish (41%), followed by age-1.3 fish (30%), age-2.3 fish (24%), and age-1.2 fish (3.0%). The total Chilkat Lake sockeye salmon run was estimated to be 127,282 fish, and the commercial harvest rate was estimated to be 15.1% (Appendix A). Additional sockeye salmon harvests of 1,149 fish in the sport fishery and 4,257 fish in the subsistence fishery consisted of unknown proportions of Chilkat Lake and Chilkat River mainstem fish; thus, the total harvest rate on Chilkat Lake fish represents a minimum estimate. Chilkat River mainstem sockeye salmon stocks contributed an estimated 707 fish (90% CI = 376–1,170 fish) to the commercial harvest.

2019

In 2019, 241,533 sockeye salmon were harvested in the District 15 commercial drift gillnet fishery. A total of 3,803 sockeye salmon were sampled, of which 1,880 fish (about 1% of the commercial harvest) were genotyped for use in genetic stock identification analysis (Appendix P). Chilkat Lake sockeye salmon accounted for an estimated 16.9% (90% CI = 15.2–18.9%) of the commercial harvest, all weeks combined, or approximately 40,935 fish (90% CI = 36,601–45,672 fish; Table 14; Appendices M and P). The Chilkat Lake sockeye salmon harvest was composed primarily of age-1.3 fish (70%), followed by age-2.3 fish (18%), age-2.2 fish (7%), and age-1.2 fish (1.0%). The total Chilkat Lake sockeye salmon run was estimated to be 177,026 fish, and the commercial harvest rate was estimated to be 23.1% (Appendix A). Additional sockeye salmon harvests of 436 fish in the sport fishery and 3,801 fish in the subsistence fishery consisted of unknown proportions of Chilkat Lake and Chilkat River mainstem fish; thus, the total harvest rate on Chilkat Lake fish represents a minimum estimate. Chilkat River mainstem sockeye salmon stocks contributed an estimated 11,637 fish (90% CI = 9,059–14,371 fish) to the commercial harvest.

2020

In 2020, 50,220 sockeye salmon were harvested in the District 15 commercial drift gillnet fishery. A total of 3,914 sockeye salmon were sampled, of which 1,666 fish (about 3% of the commercial harvest) were genotyped for use in genetic stock identification analysis (Appendix Q). Chilkat Lake sockeye salmon accounted for an estimated 17.5% (90% CI = 15.9–19.1%) of the commercial harvest, all weeks combined, or approximately 8,776 fish (90% CI = 7,992–9,571 fish; Table 14; Appendices M and Q). The Chilkat Lake sockeye salmon harvest was composed primarily of age-2.3 fish (38%) and age-2.2 fish (32%), followed by age-1.3 fish (25%) and age-1.2 fish (2.0%). The total Chilkat Lake sockeye salmon run was estimated to be 59,522 fish, and the commercial harvest rate was estimated to be 14.7% (Appendix A). Additional sockeye salmon harvests in the sport fishery (estimate not yet available) and 1,573 fish in the subsistence fishery (preliminary) consisted of unknown proportions of Chilkat Lake and Chilkat River mainstem fish; thus, the total harvest rate on Chilkat Lake fish represents a minimum estimate. Chilkat River mainstem sockeye salmon stocks contributed an estimated 1,368 fish (90% CI = 1,019–1,771 fish) to the commercial harvest.

Table 13.–Estimated commercial harvest of Chilkat Lake, Chilkoot Lake, and other sockeye salmon stocks in the District 15 commercial drift gillnet fishery based on MAGMA genetic stock identification analysis, 2017 and 2018. (Other stock groups include Chilkat River mainstem, Juneau mainland, Snettisham, Taku River/Stikine mainstem, and Other.)

	Statistical	Commercial	Estimated stock composition			Estimated Chilkat Lake harvest and 90% CI		
Year	week	harvest	Chilkoot Lake	Chilkat Lake	Other	Harvest	Lower 90%	Upper 90%
2017	25	1,358	5%	13%	82%	177	124	237
2017	26	2,623	6%	11%	82%	299	199	413
2017	27	1,743	6%	21%	73%	364	276	457
2017	28	759	11%	16%	72%	124	78	177
2017	29	6,077	2%	6%	92%	348	190	541
2017	30	5,834	3%	6%	91%	352	188	544
2017	31	5,590	6%	9%	86%	493	295	722
2017	32	5,772	5%	36%	59%	2,105	1,746	2,474
2017	33	2,171	8%	17%	74%	379	271	496
2017	34–40[a]	7,789	5%	14%	82%	1,056	736	1,407
2017	Total	39,716	5%	14%	81%	5,698	5,063	6,357
2018	25	263	18%	27%	55%	72	54	91
2018	26	904	8%	26%	66%	238	188	292
2018	27	3,630	16%	24%	60%	872	689	1,063
2018	28	6,450	27%	16%	57%	1,022	747	1,332
2018	29	4,303	28%	17%	55%	724	527	935
2018	30	10,149	39%	21%	40%	2,110	1,620	2,632
2018	31	19,931	50%	21%	29%	4,220	3,295	5,215
2018	32	8,880	42%	28%	31%	2,468	2,039	2,914
2018	33	8,357	24%	26%	50%	2,187	1,794	2,598
2018	34–40[a]	18,821	56%	28%	15%	5,323	4,413	6,275
2018	Total	81,688	42%	24%	35%	19,235	17,644	20,871

[a] In 2017 and 2018, harvest proportions for statistical weeks 35–40 were estimated using the proportions from the last statistical week with genetic samples, in this case statistical week 34.

Table 14.–Estimated commercial harvest of Chilkat Lake, Chilkoot Lake, and other sockeye salmon stocks in the District 15 commercial drift gillnet fishery based on MAGMA genetic stock identification analysis, 2019 and 2020. (Other stock groups include Chilkat River mainstem, Juneau mainland, Snettisham, Taku River/Stikine mainstem, and Other.)

			Estimated stock composition			Estimated Chilkat Lake harvest and 90% CI		
Year	Statistical week	Commercial harvest	Chilkoot Lake	Chilkat Lake	Other	Harvest	Lower 90%	Upper 90%
2019	25–26	2,215	17%	27%	57%	588	415	792
2019	27	6,573	20%	16%	64%	1,063	761	1,400
2019	28	10,573	28%	21%	52%	2,194	1,685	2,735
2019	29	18,540	49%	22%	29%	4,017	3,116	4,966
2019	30	42,029	60%	15%	25%	6,471	4,685	8,479
2019	31	69,841	77%	13%	10%	9,417	6,569	12,625
2019	32	36,104	79%	11%	10%	3,992	2,717	5,441
2019	33	33,072	54%	23%	23%	7,716	6,083	9,481
2019	34	15,126	53%	20%	27%	3,033	2,420	3,695
2019	35–40[a]	7,460	37%	33%	30%	2,443	2,054	2,838
2019	Total	241,533	62%	17%	21%	40,935	36,601	45,672
2020	26–27	1,700	13%	7%	80%	122	76	176
2020	28	3,163	31%	13%	57%	408	285	549
2020	29	4,090	41%	12%	47%	503	360	661
2020	30	5,162	26%	13%	61%	651	464	855
2020	31	5,410	44%	17%	39%	919	675	1,181
2020	32	11,066	76%	11%	13%	1,222	870	1,613
2020	33	6,821	48%	21%	31%	1,458	1,171	1,755
2020	34	8,993	49%	21%	29%	1,922	1,495	2,369
2020	35–39[b]	3,815	57%	41%	1%	1,570	1,375	1,770
2020	Total	50,220	50%	17%	33%	8,776	7,992	9,571

Note: The gray shaded row indicates genetic stock identification estimates did not meet acceptable levels of precision and accuracy to estimate the proportion of mixtures within 10% of the true mixture 90% of the time, due to low sample size.

[a] In 2019, harvest proportions for statistical weeks 36–40 were estimated using the proportions from the last statistical week with genetic samples, in this case statistical week 35.

[b] In 2020, harvest proportions for statistical weeks 37–39 were estimated using the proportions from the last statistical week with genetic samples, in this case statistical weeks 35–36.

LIMNOLOGICAL ASSESSMENT

Light and Temperature

Euphotic zone depth was examined as an average of the measurements from both stations on a given day. From 2017 to 2020, the seasonal mean (June–October) euphotic zone depth in Chilkat Lake averaged 21.2 m (range: 19.7–22.7 m; Appendix V). Interannual variability was high, and the euphotic zone depth was deepest in a different month each year. The shallowest euphotic zone depth was typically observed in the early months of the season (June–July), but the deepest euphotic zone depth for 2018 and 2020 also occurred during those two months (Table 15). During this period, the seasonal mean (June–October) water temperature at a depth of 1 m averaged 14.5 ºC (range: 13.5–15.7 ºC); it was coldest in October (average = 12.1 ºC) and warmest in August (average = 17.1 ºC). In all years (2017–2020), thermoclines (the depths at which temperature change was >1 ºC per m) were detected in 2 to 4 months between July and October (Figure 8). Thermocline depths varied from 5 m in July of 2019 to 18 m in October of 2020. The maximum lake surface temperature recorded per season was 19.9 ºC on 5 August 2017, 16.9 ºC on 11 August 2018, 20.7 ºC on 4 July 2019, and 16.7 ºC on 1 August 2020.

Table 15.–Euphotic zone depths (m) in Chilkat Lake, 2017–2020.

Year	Date	Station 1A	Station 2A	Average
2017	6-Jun	19.1	17.0	18.0
	5-Jul	22.5	21.2	21.9
	5-Aug[a]	76.7	19.3	19.3
	5-Sep	23.2	15.3	19.2
	4-Oct	40.3	28.0	34.2
	Average (June–October)	26.3	20.2	22.5
2018	6-Jun	15.7	16.7	16.2
	17-Jul	26.6	24.4	25.5
	11-Aug	15.8	18.7	17.2
	5-Sep	21.5	18.2	19.9
	October	ND	ND	ND
	Average (June–October)	19.9	19.5	19.7
2019	June	ND	ND	ND
	4-Jul	16.2	17.0	16.6
	2-Aug	17.9	17.0	17.4
	3-Sep	51.8	26.2	39.0
	3-Oct	17.7	17.6	17.6
	Average (June–October)	25.9	19.5	22.7
2020	4-Jun	34.1	14.8	24.5
	1-Jul	17.8	17.9	17.9
	1-Aug	14.5	20.0	17.2
	3-Sep	20.5	19.3	19.9
	1-Oct	24.0	14.9	19.4
	Average (June–October)	22.2	17.4	19.8

Note: ND = no data collected.

[a] The euphotic zone depth at Station 1A on 5 August 2017 was considered an outlier and not included in any average calculations.

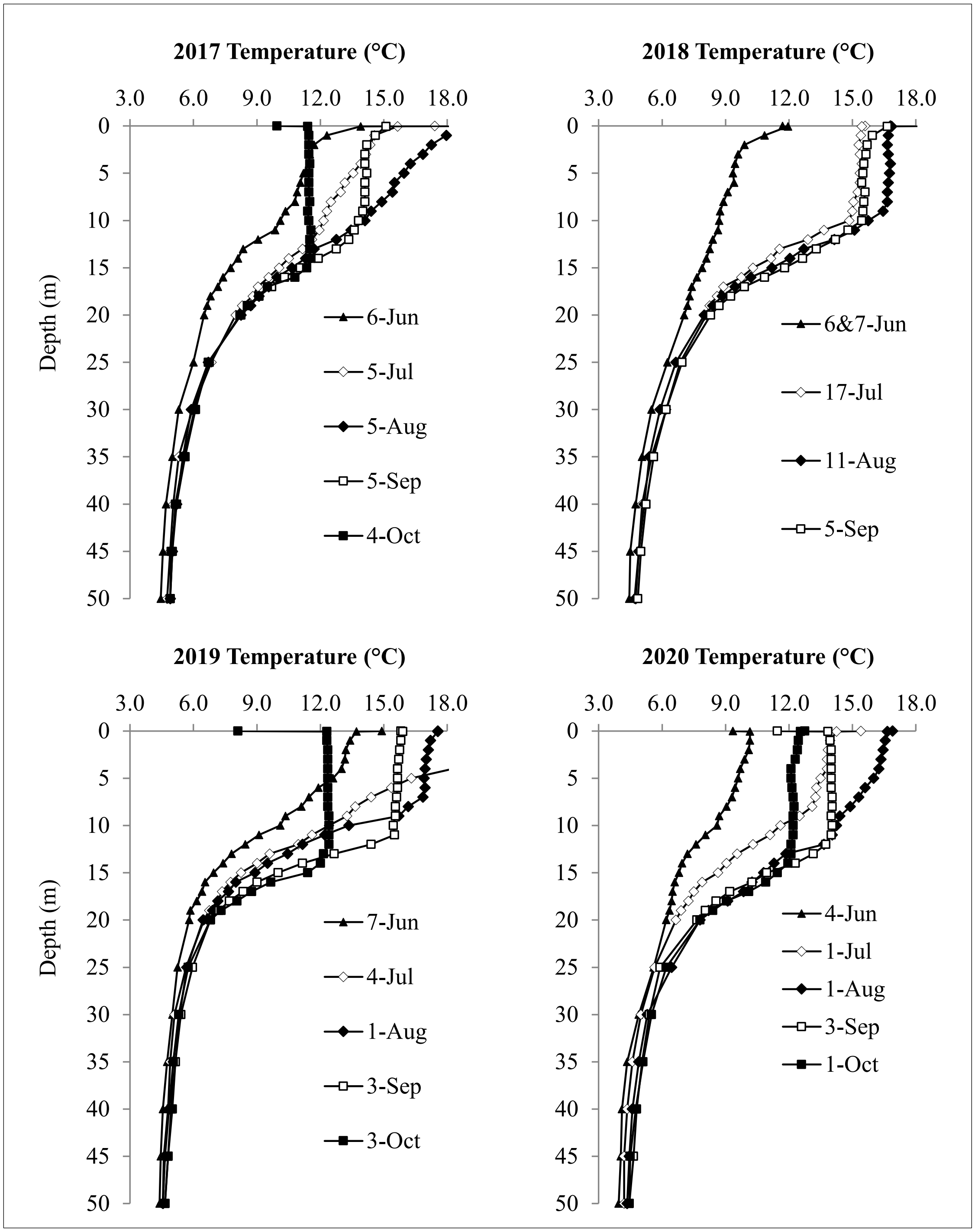

Figure 8.–Water temperature profiles by date (averaged between stations 1A and 2A) at Chilkat Lake, 2019–2020. The temperature profiles for June 2018 were averaged over two days.

Zooplankton Composition

Density and biomass of zooplankton in Chilkat Lake were dominated in all years by copepods (*Cyclops* sp.), followed by cladocerans (primarily *Bosmina* and several species of *Daphnia*)

(Tables 16–19; Appendix W). Total seasonal mean zooplankton density increased year over year from 2017 to 2020, although the maximum abundance of cladocerans occurred in 2019 and maximum abundance of copepods occurred in 2020 (Figure 9). Weighted seasonal zooplankton biomass was greatest in 2018 (2,204 mg/m^2) and trended slightly lower in 2019 and 2020. Estimated biomass was biased low to some degree in 2019 and 2020, however, because *Daphnia* were primarily identified by body parts in some monthly samples, which precluded length measurements required to estimate biomass.

Table 16.–Mean density of zooplankton per m^2 of lake surface area by sampling date and taxon in Chilkat Lake, 2017–2018. Density estimates were the average of two sampling stations, and ovigerous individuals were separated from non-egg-bearing individuals.

		Macrozooplankton density (number/m^2) by sampling date					Seasonal mean	
Year	Taxon/Date	6-Jun	7-Jul	5-Aug	5-Sep	5-Oct	Density	% Density
2017	*Cyclops* sp.	358,295	196,808	191,713	119,630	37,740	180,837	37%
	Ovig. *Cyclops*	113,771	47,207	29,207	26,745	7,981	44,982	9%
	Copepod nauplii	23,773	59,603	132,960	180,846	330,065	145,449	29%
	Bosmina	8,490	19,188	23,264	92,206	17,151	32,060	6%
	Ovig. *Bosmina*	0	0	0	0	467	93	<1%
	Daphnia spp.	15,283	94,244	39,565	98,913	39,183	57,438	12%
	Ovig. *Daphnia* spp.	0	0	4,755	2,292	2,292	1,868	<1%
	Daphnia galeata	0	0	3,057	18,679	0	4,347	1%
	Ovig. *D. galeata*	0	0	0	1,698	0	340	<1%
	Daphnia longiremus	8,490	1,528	0	1,698	0	2,343	<1%
	Ovig. *D. longiremus*	0	0	0	0	0	0	0%
	Daphnia rosea	2,547	33,113	12,056	12,566	3,099	12,676	3%
	Ovig. *D. rosea*	1,698	0	0	0	467	433	<1%
	Imm. Cladocera	21,226	17,490	3,906	15,113	934	11,734	2%
	Chydorinae	0	0	0	0	0	0	0%
	Total	553,574	469,180	440,482	570,385	439,379	494,600	100%
2018	Taxon/Date	June[a]	17-Jul	11-Aug	5-Sep	ND	Density	% Density
	Cyclops sp.	1,004,415	318,390	208,015	133,299	ND	416,030	55%
	Ovig. *Cyclops*	42,452	17,830	849	5,094	ND	16,556	2%
	Copepod nauplii	56,886	9,339	193,581	418,577	ND	169,596	22%
	Bosmina	0	9,339	20,377	38,207	ND	16,981	2%
	Ovig. *Bosmina*	0	0	0	0	ND	0	0%
	Daphnia spp.	16,132	332,824	25,471	39,905	ND	103,583	14%
	Ovig. *Daphnia* spp.	849	2,547	849	0	ND	1,061	<1%
	Daphnia galeata	0	0	0	0	ND	0	0%
	Ovig. *D. galeata*	0	0	0	0	ND	0	0%
	Daphnia longiremus	3,396	0	25,471	0	ND	7,217	1%
	Ovig. *D. longiremus*	849	0	0	0	ND	212	<1%
	Daphnia rosea	849	17,830	31,415	3,396	ND	13,372	2%
	Ovig. *D. rosea*	0	2,547	849	2,547	ND	1,486	<1%
	Chydorinae	0	0	0	0	ND	0	0%
	Imm. Cladocera	32,264	11,038	11,038	6,792	ND	15,283	2%
	Total	1,158,091	721,684	517,915	647,818	ND	761,377	100%

Notes: ND = no data collected.

[a] In 2018, samples collected at station 2A (June 6) and station 1A (June 16) were combined into a single "June" sample.

Table 17.–Estimated density of zooplankton per m^2 of lake surface area by sampling date and taxon in Chilkat Lake, 2019–2020. Density estimates were the average of the two sampling stations, and ovigerous individuals were separated from non-egg-bearing individuals.

		Macrozooplankton density (number/m^2) by sampling date					Seasonal mean	
Year	Taxon/Date [a]	7-Jun	4-Jul	2-Aug	3-Sep	3-Oct	Density	% Density
2019	*Cyclops* sp.	477,161	278,485	253,014	247,071	346,833	320,513	44%
	Ovig. *Cyclops*	0	0	8,490	0	5,943	2,887	<1%
	Copepod nauplii	13,585	13,585	43,301	136,696	321,362	105,706	14%
	Bosmina	13,585	221,600	71,319	61,131	56,886	84,904	12%
	Ovig. *Bosmina*	1,698	0	0	0	0	340	<1%
	Daphnia spp.	0	0	0	0	0	0	0%
	Ovig. *Daphnia* spp.	0	0	0	0	0	0	0%
	Daphnia galeata	0	0	0	0	0	0	0%
	Ovig. *D. galeata*	0	0	0	0	0	0	0%
	Daphnia longiremus	0	0	3,396	0	0	679	<1%
	Ovig. D. longiremus	0	0	0	0	0	0	0%
	Daphnia rosea	109,526	359,144	213,958	268,297	79,385	206,062	28%
	Ovig. *D. rosea*	1,698	2,547	9,339	0	5,519	3,821	1%
	Chydorinae	0	0	0	0	0	0	0%
	Imm. Cladocera	2,547	849	17,830	3,396	7,641	6,453	1%
	Total	619,800	876,210	620,649	716,590	823,569	731,364	100%
2020	Taxon/Date	4-Jun	1-Jul	1-Aug	3-Sep	1-Oct	Density	% Density
	Cyclops sp.	1,153,846	546,358	680,931	343,861	168,280	578,655	70%
	Ovig. *Cyclops*	0	0	0	0	594	119	<1%
	Copepod nauplii	71,744	6,792	5,943	57,056	290,457	86,398	11%
	Bosmina	0	7,641	23,773	182,204	137,629	70,250	9%
	Ovig. *Bosmina*	849	0	0	2,547	2,547	1,189	<1%
	Daphnia spp.	23,773	76,414	86,602	5,943	9,509	40,448	5%
	Ovig. *Daphnia* spp.	0	0	0	0	0	0	0%
	Daphnia galeata	0	0	0	0	0	0	0%
	Ovig. *D. galeata*	0	0	0	0	0	0	0%
	Daphnia longiremus	1,698	1,698	1,698	0	0	1,019	<1%
	Ovig. D. longiremus	1,274	0	0	0	0	255	<1%
	Daphnia rosea	19,103	37,782	46,697	62,489	24,537	38,122	5%
	Ovig. *D. rosea*	1,698	1,698	0	2,038	0	1,087	<1%
	Chydorinae	0	0	849	0	0	170	<1%
	Imm. Cladocera	425	5,943	0	5,773	4,245	3,277	<1%
	Total	1,274,410	684,327	846,493	661,912	637,799	820,988	100%

Table 18.–Estimated mean length and biomass of zooplankton by sampling date and taxon in Chilkat Lake, 2017–2018. Biomass estimates were the average of the two sampling stations, and ovigerous individuals were separated from non-egg-bearing individuals.

		Macrozooplankton length (mm) by sampling date					Weighted seasonal mean		
Year	Taxon/Date	6-Jun	7-Jul	5-Aug	5-Sep	5-Oct	Length (mm)	Biomass (mg/m^2)	% biomass
2017	*Cyclops* sp.	0.91	0.98	1.02	1.03	0.94	0.96	595	52%
	Ovig. *Cyclops*	1.05	1.06	1.09	1.16	1.19	1.07	186	16%
	Bosmina	0.32	0.39	0.41	0.39	0.39	0.39	44	4%
	Ovig. *Bosmina*	–	–	–	–	0.38	0.38	<1	<1%
	Daphnia spp.	0.77	0.90	0.97	0.89	1.01	0.92	221	19%
	Ovig. *Daphnia* spp.	–	–	1.62	1.26	1.43	1.39	20	2%
	Daphnia galeata	–	–	–	1.16	–	1.00	11	1%
	Ovig. *D. galeata*	–	–	–	1.35	–	1.35	2	<1%
	Daphnia longiremus	0.63	0.93	0	0.98	–	0.72	5	<1%
	Ovig. D. longiremus	–	–	–	–	–	–	–	–
	Daphnia rosea	0.85	1.22	1.27	0.92	1.04	1.16	64	6%
	Ovig. *D. rosea*	1.27	–	–	–	1.21	1.24	3	<1%
	Chydorinae	–	–	–	–	–	–	–	–
	Total							1,150	100%
2018	Taxon/Date	June [a]	17-Jul	11-Aug	5-Sep	ND	Length (mm)	Biomass (mg/m^2)	% biomass
	Cyclops sp.	0.89	1.06	1.10	1.09	ND	0.97	1,395	63%
	Ovig. *Cyclops*	1.20	1.19	1.17	1.15	ND	1.19	86	4%
	Bosmina	–	0.39	0.37	0.36	ND	0.37	21	1%
	Ovig. *Bosmina*	–	–	–	–	–	–	–	–
	Daphnia spp.	0.75	1.14	0.78	0.95	ND	1.08	565	26%
	Ovig. *Daphnia* spp.	–	1.10	1.60	–	ND	1.14	6	<1%
	D. galeata	–	–	–	–	–	–	–	–
	Ovig. *D. galeata*	–	–	–	–	–	–	–	–
	Daphnia longiremus	0.69	–	0.88	–	ND	0.87	25	1%
	Ovig. D. longiremus	–	–	–	–	–	–	–	–
	Daphnia rosea	1.22	1.30	1.37	1.08	ND	1.33	94	4%
	Ovig. *D. rosea*	–	1.28	1.33	1.44	ND	1.37	11	1%
	Chydorinae	–	–	–	–	–	–	–	–
	Total							2,204	100%

Notes: ND = no data collected. A dash (–) indicates taxa or life stage not present or samples too damaged to measure.

[a] In 2018, samples collected at station 2A (June 6) and station 1A (June 16) were combined into a single "June" sample.

Table 19.–Estimated mean length and biomass of zooplankton by sampling date and taxon in Chilkat Lake, 2019–2020. Biomass estimates were the average of the two sampling stations, and ovigerous individuals were separated from non-egg-bearing individuals.

		Macrozooplankton length (mm) by sampling date					Weighted seasonal mean		
Year	Taxon/Date	7-Jun	4-Jul	2-Aug	3-Sep	3-Oct	Length (mm)	Biomass (mg/m^2)	% biomass
2019 [a]	*Cyclops* sp.	0.93	1.07	1.03	0.87	0.89	0.90	950	53%
	Ovig. *Cyclops*	–	–	1.22	–	1.26	1.25	17	1%
	Bosmina	0.36	0.38	0.38	0.38	0.37	0.38	113	6%
	Ovig. *Bosmina*	0.45	–	–	–	–	0.45	1	<1%
	Daphnia spp.	–	–	–	–	–	–	–	–
	Ovig. *Daphnia* spp.	–	–	–	–	–	–	–	–
	Daphnia galeata	–	–	–	–	–	–	–	–
	Ovig. *D. galeata*	–	–	–	–	–	–	–	–
	Daphnia longiremus	–	–	1.16	–	–	1.16	4	<1%
	Ovig. D. longiremus	–	–	–	–	–	–	–	–
	Daphnia rosea	1.10	1.18	1.12	1.02	1.00	0.92	668	37%
	Ovig. *D. rosea*	1.11	1.55	1.57	–	1.33	1.47	34	2%
	Chydorinae	–	–	–	–	–	–	–	–
	Total							1,787	100%
2020 [b]	Taxon/Date	4-Jun	1-Jul	1-Aug	3-Sep	1-Oct	Length (mm)	Biomass (mg/m^2)	% biomass
	Cyclops sp.	0.76	0.92	1.06	1.03	0.91	0.90	1,647	80%
	Ovig. *Cyclops*	–	–	–	–	1.19	1.19	1	<1%
	Bosmina	–	0.36	0.44	0.38	0.38	0.38	96	5%
	Ovig. *Bosmina*	0.52	–	–	0.43	0.43	0.45	2	<1%
	Daphnia spp.	–	1.08	1.01	0.73	1.02	1.01	151	7%
	Ovig. *Daphnia* spp.	–	–	–	–	–	–	–	–
	Daphnia galeata	–	–	–	–	–	–	–	–
	Ovig. *D. galeata*	–	–	–	–	–	–	–	–
	Daphnia longiremus	0.50	0.97	0.72	–	–	0.67	3	<1%
	Ovig. D. longiremus	1.05	–	–	–	–	1.05	1	<1%
	Daphnia rosea	0.71	0.97	1.39	1.10	0.88	1.03	148	7%
	Ovig. *D. rosea*	1.12	1.20	–	1.34	–	1.22	6	<1%
	Chydorinae	–	–	0.57	–	–	0.57	1	<1%
	Total							2,056	100%

Notes: A dash (–) indicates taxa or life stage not observed or samples too damaged to measure.

[a] In 2019, June samples from station 2A and July samples from station 1A were damaged, which precluded measurement of Cyclops, Daphnia, and most Bosmina; thus, biomass may be underestimated.

[b] In 2020, Daphnia sp. lengths were not available for June samples from station 1A and many samples from station 2A because they were primarily identified by body parts; thus, biomass may be underestimated.

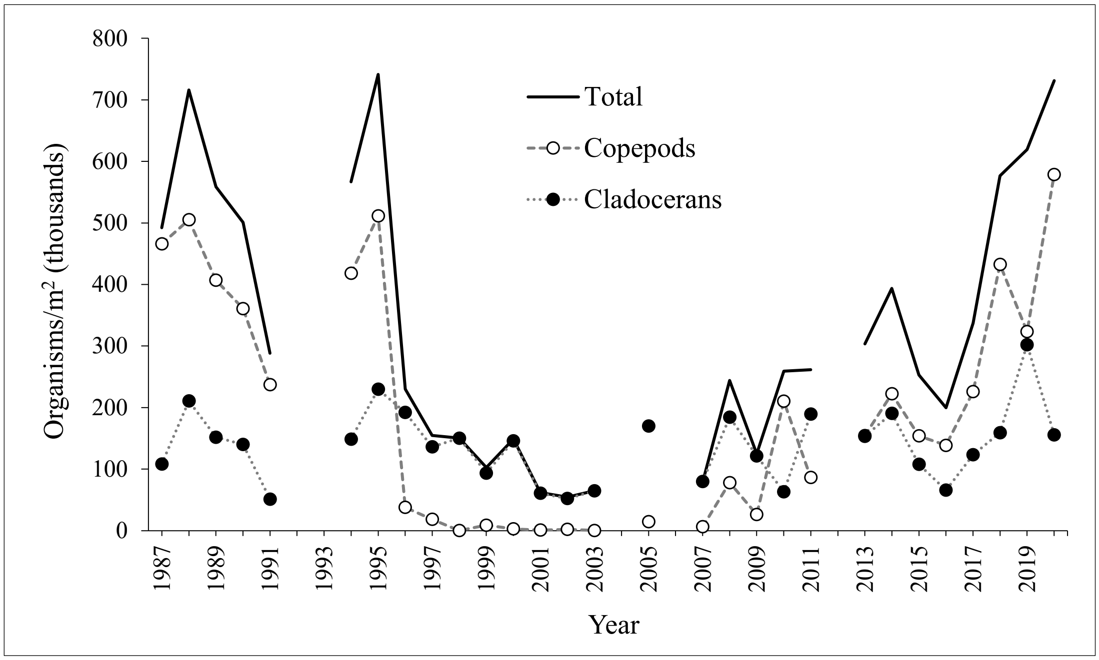

Figure 9.–Annual seasonal (June–October) mean zooplankton abundance in Chilkat Lake, 1987–2020. Copepod nauplii and immature cladocerans were not included because they were not enumerated in laboratory samples until 2002 and 2004. Sampling was not conducted in 1992 and 1993, and seasonal means were not calculated for years in which more than one month of sampling was missing (2004, 2006, and 2012).

DISCUSSION

Chilkat Lake sockeye salmon escapements were within the escapement goal range of 70,000 to 150,000 fish in 3 years, 2017–2019, but failed to reach the lower bound in 2020. Severe restrictions were placed on the commercial drift gillnet fishery in 2020 (Figure 1; Thynes et al. 2020; Ransbury et al. 2021), primarily to reduce harvest of Chilkat River Chinook salmon, designated as a stock of management concern in 2018 (Lum and Fair 2018), but also due to poor inseason run projections of Chilkat Lake sockeye salmon. Despite these restrictions, the Chilkat Lake escapement in 2020 (50,746 fish) was the 9th lowest in the 45 years since 1976 (the year total runs were first estimated; Appendix A) and the total run (59,522 fish) was the 4th lowest; thus, the escapement goal would not have been met had management restricted the commercial harvest to zero fish. Similarly, although sockeye salmon escapement in 2017 reached the lower bound of the escapement goal, the total run (93,895 fish) was the 7th lowest on record (Figure 10). Chilkat Lake sockeye salmon runs in 2018 and 2019 fared better, with total runs of 127,282 fish and 177,026 fish, respectively. Escapements in those years were also larger, with 108,047 fish in 2018 and 136,091 fish in 2019.

The introduction of the DIDSON in 2008 has led to much greater confidence in the escapement counts of Chilkat Lake sockeye salmon compared to the visual weir counts or mark–recapture estimates of previous years (Bednarski et al. 2017). Gradual improvements to the DIDSON operations continue to be implemented as identified in the project operational plan (Zeiser et al. 2020a). Species apportionment has improved since 2017, but sampling for species apportionment was poorly documented in prior years. A retrospective review of species apportionment in all years would improve the historical DIDSON expansion estimates and should be done prior to reviewing the Chilkat Lake sockeye salmon escapement goal. Likewise, inseason observer training should be formalized to ensure counting accuracy and consistency among observers throughout the season. In 2020, the old steel weir was replaced with an aluminum weir. The framework (bipods and stringers) of the old weir was traditionally left in place during the winter, and over the years the weir had suffered damage from logs and boats. The new weir was constructed to make it easier to maintain a fish-tight weir, improve public access through the boat gate, and allow for easier installation and removal (e.g., installation no longer requires divers to install the boat gate).

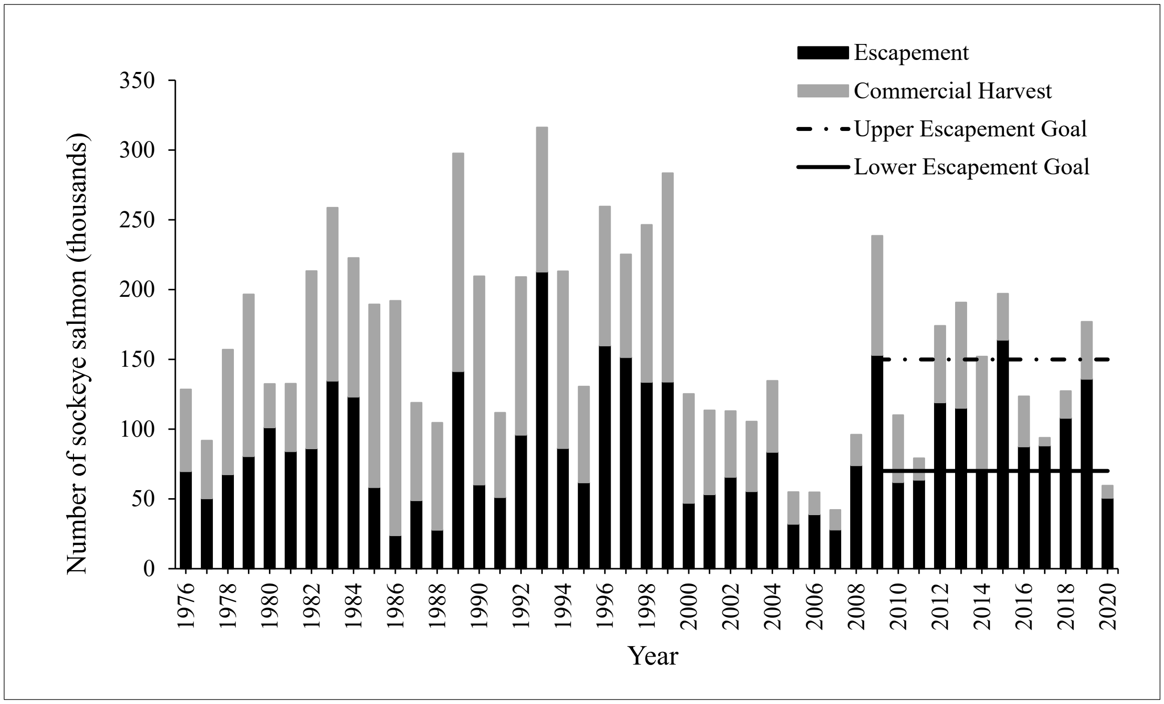

Figure 10.–Estimated total runs of Chilkat Lake sockeye salmon, 1976–2020, and the current biological escapement goal range of 70,000–150,000 sockeye salmon counted with the DIDSON system at the Chilkat Lake weir site. The biological escapement goal was established in 2009 (Eggers 2010). Escapements are represented by expanded weir counts from 1976 to 1995 and 1999 to 2007, expanded DIDSON counts from 2008–2020, and model output from 1996–1998 (posterior medians; Miller and Heinl 2018).

Estimated commercial harvest rates on the Chilkat Lake stock throughout the 4-year period ranged from only 6.1% (2017) to 23.1% (2019), well below the 1976–2016 average of 46.2%. The estimated harvest rates in 2017 and 2020 were the lowest in the entire time series. Estimated commercial harvests of Chilkat Lake sockeye salmon were also below average during the 2017–2020 period; none of the harvests in those years exceeded the 10-year average harvest of 46,664 fish, which was already below the historical average (1976–2016) of 77,771 fish. Small but unknown numbers of Chilkat Lake sockeye salmon are also harvested in the sport and subsistence fisheries; thus, the estimated total harvest rates are biased low. Estimated harvest rates would increase by an average 2.0% (range 0.1–5.1%; years 1985–2020) if sport and subsistence harvests were assumed to consist entirely of Chilkat Lake sockeye salmon. The estimated sport harvest of Chilkat Lake and mainstem spawning sockeye salmon in 2018 (1,149 fish) was an all-time high, but the reported subsistence harvest for all 4 years came in slightly below the historical average (1985–2016) of 4,324 fish (Appendix A). Over the 4 years 2017–2020, the estimated commercial harvest of Chilkat River mainstem fish as a proportion of the overall drainage harvest ranged from a low of 3.5% in 2018 to a high of 22.1% in 2019.

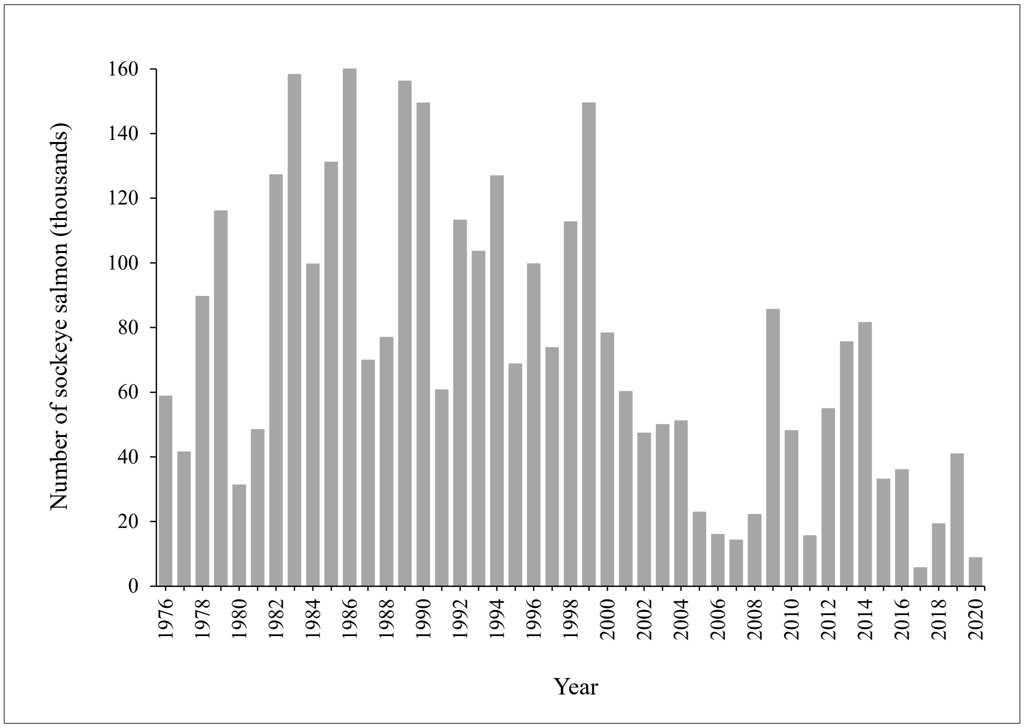

Figure 11.–Estimated commercial harvest of Chilkat Lake sockeye salmon, 1976–2020.

Commercial fishery harvest rates on sockeye salmon are regulated in part using inseason escapement projections generated by the fish wheel project on the Chilkat River. Effort-adjusted fish wheel catch was used to predict the total Chilkat Lake sockeye salmon escapement adequately enough in 2017, 2019, and 2020 to provide meaningful insight into inseason commercial fishery management, and predicted escapements were within 10% or less of actual escapements in those years (Figure 6). In 2018, however, the poor fish wheel catch suggested that the Chilkat Lake sockeye salmon escapement goal would not be met, whereas actual escapement at the weir (108,047 fish) was above average and well within the escapement goal range. The predicted escapement in 2018 (53,000 fish) was 51% below the actual escapement. The discrepancy appears to have been, at least in part, a result of extremely low water and nearby highway construction that prevented the fish wheels from operating correctly. A total of 898 hours required interpolation, significantly above the historical average of 477 hours. Our current means of adjusting for fish wheel effort, despite adding 10.8% more sockeye salmon in 2018, did not fully account for the significantly low catch, suggesting that other sources of error, such as poor fish wheel placement, may have been a factor. Historical fish wheel catch records dating back to 1990 are being digitized to allow for more robust analyses of effort, fish wheel placement, and other factors that may shed more light on anomalous years such as 2018.

Recent poor Chilkat Lake sockeye salmon runs (despite reduced fishery harvest and escapements within the escapement goal range) are the cause of significant speculation but may be due to a combination of changing climatic conditions, interspecies competition, and predation. In terms of warming conditions, large warm ocean phenomena such as the “Blob”, brought on by a strong El Niño phase (part of the El Niño-Southern Oscillation or ENSO), are changing ecosystem dynamics in the Gulf of Alaska (Fergusson et al. 2020). The “Blob” that occurred during 2014 and 2015 (Amaya et al. 2020) may have been responsible for the widespread, relatively poor runs of sockeye salmon throughout the region in 2017 and 2018 that were thought to be the result of poor smolt survival in the marine environment (Hyatt et al. 2018; Heinl et al. 2021; Ransbury et al. 2021). Even without oscillating events such as ENSO, the CO_2-induced heating of the entire planet warms Alaska at roughly 3 times the magnitude of mean global warming (Wendler et al. 2017), making warm water off the coast of Alaska more likely in the future. The identification of a second, smaller warm-water anomaly in 2019 suggests that future sockeye salmon runs may also be negatively affected (Amaya et al. 2020).

It is important to understand that while the “Blob” appears to fit 2017 fish well, the exact mechanisms that link warm-water anomalies in the Gulf of Alaska to poor sockeye salmon runs require still more investigation. The “Blob” does not easily explain the poor Chilkat Lake sockeye salmon run in 2020, one of the lowest runs ever, which consisted of fish that entered the ocean during cool La Niña years. Additionally, the strong run in 2019 suggests that there were no lingering harmful effects in the ocean from the warm years, and some positives have even been identified. *Daphnia* spp., common freshwater prey of sockeye salmon fry, have been shown to increase in density due to warming in Alaska lakes, leading to increased sockeye salmon growth during their first year of life (Schindler et al. 2005) and, subsequently, to earlier outmigration (Cline et al. 2019). Larger outmigrating smolts have better survival rates to a point (Koenings et al. 1993), and the earlier exodus may allow salmon to match their outmigration to the earlier increases in marine phytoplankton and zooplankton growth that occur during warmer years. However, over the course of the entire year there may be issues, because stronger early-season phytoplankton concentrations also correspond with weaker concentrations later in May and beyond (Pinchuk et al. 2008).

In addition to altered predator-prey dynamics between smolts and zooplankton, warmer conditions increase the metabolic rate of sockeye salmon nearly exponentially with increasing temperature (Brett 1983). During periods of warmer temperatures, sockeye salmon will naturally respond to diminishing food resources later in the season by switching food resources. For example, upon entering the marine environment, sockeye salmon consume a wide variety of euphausiid, amphipod, decapod, terrestrial insect, fish, egg, and cumacean prey. Although it is unclear how warming seas are affecting these populations (Dalpadado et al. 2016), there is evidence that Icy Strait sockeye salmon continue to meet their energetic demands (Fergusson et al. 2020). It is important to recognize that despite notable exceptions, the cumulative effects of warming in both the freshwater and marine environments are widely thought to negatively impact sockeye salmon at all life stages (Healey 2011; Prystay et al. 2017; Hyatt et al. 2018; Barnett et al. 2020; Elmer 2020) or at least cause significant behavioral change (Armstrong et al. 2016). With that in mind, more studies should be performed to elucidate under which conditions sockeye salmon perform better and worse in warming water.

Over the 5 years since the “Blob”, adult Chilkat Lake sockeye salmon declined in average length at all ages (Figure 12). This trend matches trends seen in the neighboring Chilkoot sockeye salmon stock (Ransbury et al. 2021), sockeye salmon elsewhere in Southeast Alaska (Brunette and Piston 2019; Iris Frank, ADF&G Commercial Fisheries salmon-aging laboratory supervisor, Douglas, personal communication), and sockeye salmon throughout broader Alaska (Oke et al. 2020). The most likely drivers of this decrease include reductions in salmon nutrient uptake or large salmon being selectively predated or harvested, but no mechanism has been clearly identified. Although warming marine conditions is a driver of prey scarcity, other indirect factors probably contribute. For example, competition at sea with hatchery chum salmon and pink salmon has been correlated with reduced productivity of sockeye salmon in the northeast Pacific (Irvine and Akenhead 2013). Similarly, juvenile sockeye salmon face competition from juvenile groundfish, with whom they share a significant dietary overlap (Daly et al. 2019). In terms of predation, there is no evidence that a natural predator is selectively pursuing large sockeye salmon, and it is unknown whether current commercial fishing practices have selectively reduced the size of the fish.

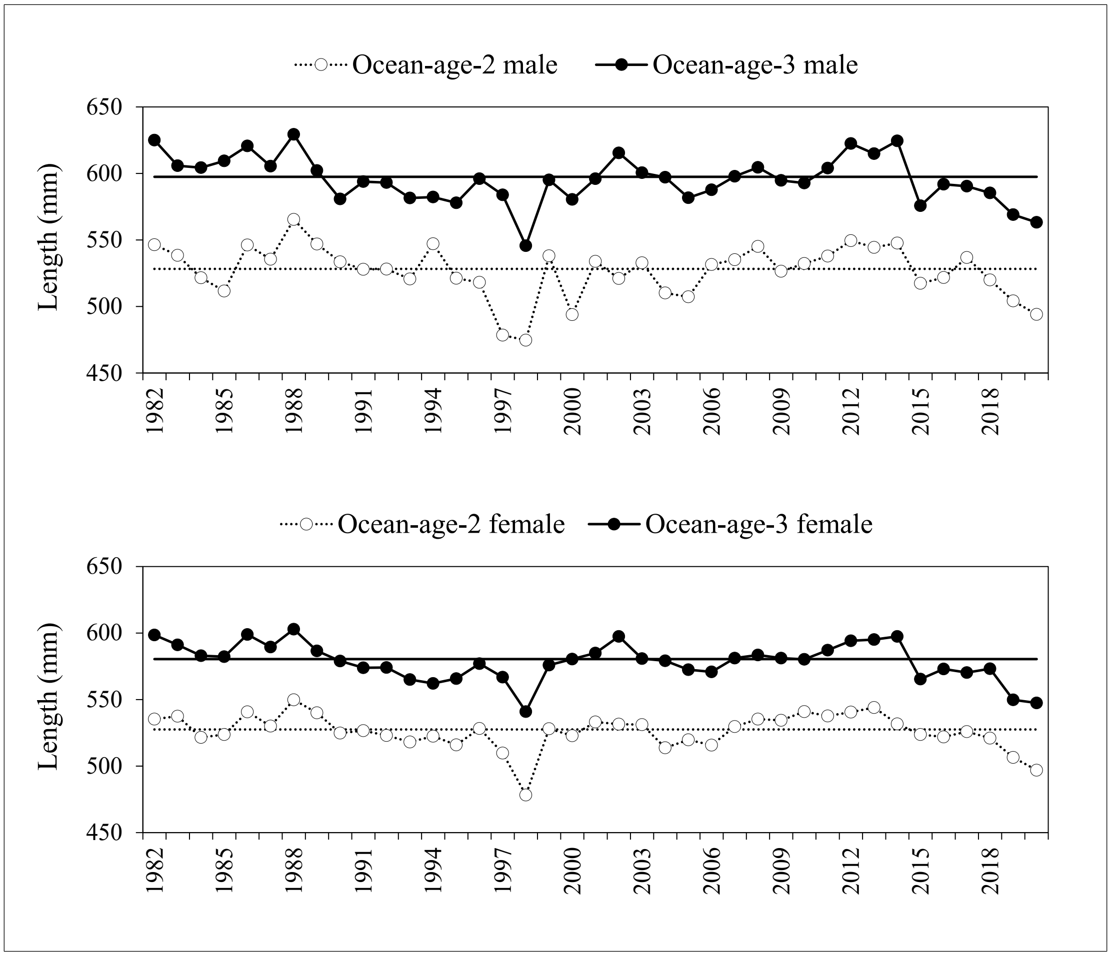

Figure 12.–Average annual sockeye salmon mid eye to fork length by sex and ocean age for the major age classes (ages 1.2, 1.3, 2.2, and 2.3) in the Chilkat Lake escapement compared to the 1982–2020 averages (horizontal lines).

Total zooplankton density, all species combined, declined substantially in the mid-1990s before trending upward again over the last 10 years (Figure 9; Appendix W). The decline was particularly dramatic in the copepod population, which exhibited a 98% reduction in average density from 515,000 per m^2 prior to 1996 to only 12,000 per m^2 over the next decade (Bednarski et al. 2017; Figure 9; Appendix V). Eggers et al. (2010) attributed this decline to increased predation resulting from 2 sockeye salmon fry stocking projects that occurred at Chilkat Lake. During 1994–1997 and in 2001, an average of 3.0 million fry were back-planted annually into Chilkat Lake, and from 1989–1998 and in 2003, incubation boxes introduced an estimated 0.3 million sockeye salmon fry annually. Once restructured by excessive predation, zooplankton communities can be slow to recover even after grazing pressure is reduced (Koenings and Kyle 1997). This is particularly true of copepods, which have a more protracted reproductive strategy compared to cladocerans (Pennak

1978) and are not as quick to respond to variation in lake productivity and abundance of predators (Kyle et al. 1990; Edmundson et al. 1992; Edmundson and Edmundson 2002). Zooplankton populations at Chilkat Lake have improved steadily since the late 2000s, and the total zooplankton density in 2020 was the second highest in the entire time series (Figure 9). Historical peaks in the abundance of copepods and cladocerans (particularly *Daphnia*), the preferred prey of juvenile sockeye salmon (Koenings 1983; Kyle et al. 1988; Koenings et al. 1989), were observed in 2020 and 2019, respectively.

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APPENDICES

Appendix A.–Estimated Chilkat Lake sockeye salmon escapement, commercial harvest, total run, and commercial harvest rates, 1976–2020. Chilkat mainstem fish are not included in the commercial harvest estimates; sport and subsistence harvest are not included in estimated total run or harvest rate.

Year	Escapement goal Lower	Escapement goal Upper	Escapement estimate	Commercial harvest	Total run	Harvest rate	Sport harvest	Subsistence harvest
1976	60,000	70,000	69,729	58,765	128,494	45.7%	ND	ND
1977	60,000	70,000	50,363	41,477	91,840	45.2%	ND	ND
1978	60,000	70,000	67,528	89,558	157,086	57.0%	ND	ND
1979	60,000	70,000	80,588	115,995	196,583	59.0%	ND	ND
1980	60,000	70,000	101,135	31,267	132,402	23.6%	ND	ND
1981	70,000	90,000	84,097	48,420	132,517	36.5%	ND	ND
1982	70,000	90,000	86,213	127,174	213,387	59.6%	ND	ND
1983	70,000	90,000	134,601	124,180	258,781	48.0%	ND	ND
1984	70,000	90,000	123,190	99,592	222,782	44.7%	ND	ND
1985	70,000	90,000	58,335	131,091	189,426	69.2%	ND	1,708
1986	70,000	90,000	23,947	168,006	191,953	87.5%	ND	1,695
1987	70,000	90,000	48,972	69,900	118,872	58.8%	ND	2,181
1988	70,000	90,000	27,722	76,883	104,605	73.5%	ND	2,647
1989	70,000	90,000	141,475	156,160	297,635	52.5%	314	3,165
1990	52,000	106,000	60,230	149,377	209,607	71.3%	357	3,994
1991	52,000	106,000	51,138	60,721	111,859	54.3%	249	4,023
1992	52,000	106,000	95,880	113,146	209,026	54.1%	81	3,932
1993	52,000	106,000	212,757	103,531	316,288	32.7%	161	3,902
1994	52,000	106,000	86,385	126,852	213,237	59.5%	141	4,023
1995	52,000	106,000	61,783	68,737	130,520	52.7%	174	5,137
1996[a]	52,000	106,000	159,968	99,677	259,645	38.4%	299	5,352
1997[a]	52,000	106,000	151,585	73,761	225,346	32.7%	225	4,068
1998[a]	52,000	106,000	133,791	112,630	246,421	45.7%	60	5,066
1999	52,000	106,000	134,048	149,410	283,458	52.7%	656	5,271
2000	52,000	106,000	47,077	78,265	125,342	62.4%	446	4,626
2001	52,000	106,000	53,239	60,183	113,422	53.1%	237	4,432
2002	52,000	106,000	65,611	47,332	112,943	41.9%	496	4,481
2003	52,000	106,000	55,516	49,955	105,471	47.4%	573	4,579
2004	52,000	106,000	83,534	51,110	134,644	38.0%	143	4,530
2005	52,000	106,000	32,098	22,852	54,950	41.6%	556	3,383
2006	80,000	200,000	38,850	15,979	54,829	29.1%	348	3,527
2007	80,000	200,000	27,915	14,208	42,123	33.7%	243	2,324
2008	80,000	200,000	73,979	22,156	96,135	23.0%	596	5,655
2009	70,000	150,000	153,033	85,551	238,584	35.9%	254	6,649
2010	70,000	150,000	61,906	48,079	109,985	43.7%	302	6,030
2011	70,000	150,000	63,628	15,599	79,227	19.7%	133	5,192
2012	70,000	150,000	119,142	54,884	174,026	31.5%	611	5,128
2013	70,000	150,000	115,237	75,588	190,825	39.6%	114	6,324
2014	70,000	150,000	70,470	81,502	151,972	53.6%	97	6,553
2015	70,000	150,000	164,014	33,085	197,099	16.8%	390	3,431
2016	70,000	150,000	87,622	35,991	123,613	29.1%	89	5,375
2017	70,000	150,000	88,197	5,698	93,895	6.1%	254	3,761

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Year	Escapement goal Lower	Escapement goal Upper	Escapement estimate	Commercial harvest	Total run	Harvest rate	Sport harvest	Subsistence harvest
2018	70,000	150,000	108,047	19,235	127,282	15.1%	1,149	4,257
2019	70,000	150,000	136,091	40,935	177,026	23.1%	436	3,801
2020[b]	70,000	150,000	50,746	8,776	59,522	14.7%	NA	1,573
1976–2016 Average			86,789	77,771	164,560	46.2%	298	4,324
1976–2016 Median			73,979	73,761	151,972	45.7%	252	4,457
1976–2016 Lower Quartile			55,516	48,079	112,943	35.9%	143	3,503
1976–2016 Upper Quartile			119,142	112,630	213,237	54.3%	404	5,212

Note: ND = no data.

[a] The weir was not operated from 1996 to 1998. Escapement values for those years are the posterior medians from model output by Miller and Heinl (2018).

[b] The 2020 estimates of sport harvest was not available for this report, and the 2020 subsistence harvest is preliminary.

Appendix B.–ADF&G statistical weeks, 2017–2020.

Statistical week	2017		2018		2019		2020	
	Beginning	Ending	Beginning	Ending	Beginning	Ending	Beginning	Ending
23	4-Jun	10-Jun	3-Jun	9-Jun	2-Jun	8-Jun	31-May	6-Jun
24	11-Jun	17-Jun	10-Jun	16-Jun	9-Jun	15-Jun	7-Jun	13-Jun
25	18-Jun	24-Jun	17-Jun	23-Jun	16-Jun	22-Jun	14-Jun	20-Jun
26	25-Jun	1-Jul	24-Jun	30-Jun	23-Jun	29-Jun	21-Jun	27-Jun
27	2-Jul	8-Jul	1-Jul	7-Jul	30-Jun	6-Jul	28-Jun	4-Jul
28	9-Jul	15-Jul	8-Jul	14-Jul	7-Jul	13-Jul	5-Jul	11-Jul
29	16-Jul	22-Jul	15-Jul	21-Jul	14-Jul	20-Jul	12-Jul	18-Jul
30	23-Jul	29-Jul	22-Jul	28-Jul	21-Jul	27-Jul	19-Jul	25-Jul
31	30-Jul	5-Aug	29-Jul	4-Aug	28-Jul	3-Aug	26-Jul	1-Aug
32	6-Aug	12-Aug	5-Aug	11-Aug	4-Aug	10-Aug	2-Aug	8-Aug
33	13-Aug	19-Aug	12-Aug	18-Aug	11-Aug	17-Aug	9-Aug	15-Aug
34	20-Aug	26-Aug	19-Aug	25-Aug	18-Aug	24-Aug	16-Aug	22-Aug
35	27-Aug	2-Sep	26-Aug	1-Sep	25-Aug	31-Aug	23-Aug	29-Aug
36	3-Sep	9-Sep	2-Sep	8-Sep	1-Sep	7-Sep	30-Aug	5-Sep
37	10-Sep	16-Sep	9-Sep	15-Sep	8-Sep	14-Sep	6-Sep	12-Sep
38	17-Sep	23-Sep	16-Sep	22-Sep	15-Sep	21-Sep	13-Sep	19-Sep
39	24-Sep	30-Sep	23-Sep	29-Sep	22-Sep	28-Sep	20-Sep	26-Sep
40	1-Oct	7-Oct	30-Sep	6-Oct	29-Sep	5-Oct	27-Sep	3-Oct
41	8-Oct	14-Oct	7-Oct	13-Oct	6-Oct	12-Oct	4-Oct	10-Oct
42	15-Oct	21-Oct	14-Oct	15-Oct	13-Oct	19-Oct	11-Oct	17-Oct

The weekly sockeye salmon age-sex distribution, the seasonal age-sex distribution weighted by week, and the mean length by age and sex weighted by week were calculated using equations from Cochran (1977).

Let

h	=	index of the stratum (week),
j	=	index of the age class,
p_{hj}	=	proportion of the sample taken during stratum h that is age j,
n_h	=	number of fish sampled in week h, and
n_{hj}	=	number observed in class j, week h.

Then the age distribution was estimated for each week of the escapement in the usual manner:

$$\hat{p}_{hj} = n_{hj}/n_h. \quad (1)$$

If N_h equals the number of fish in the escapement in week h, standard errors of the weekly age class proportions are calculated in the usual manner (Cochran 1977, page 52, equation 3.12):

$$SE(\hat{p}_{hj}) = \sqrt{\left[\frac{(\hat{p}_{hj})(1-\hat{p}_{hj})}{n_h-1}\right][1 - n_h/N_h]}. \quad (2)$$

The age distributions for the total escapement were estimated as a weighted sum (by stratum size) of the weekly proportions. That is,

$$\hat{p}_j = \sum_h p_{hj}\,(N_h/N), \quad (3)$$

such that N equals the total escapement. The standard error of a seasonal proportion is the square root of the weighted sum of the weekly variances (Cochran 1977, pages 107–108):

$$SE(\hat{p}_j) = \sqrt{\sum_j^h \left[SE(\hat{p}_{hj})\right]^2 (N_h/N)^2}. \quad (4)$$

The mean length, by sex and age class (weighted by week of escapement), and the variance of the weighted mean length, were calculated using the following equations from Cochran (1977, pages 142–144) for estimating means over subpopulations. That is, let i equal the index of the individual fish in the age-sex class j, and y_{hij} equal the length of the ith fish in class j, week h, so that,

$$\hat{\bar{Y}}_j = \frac{\sum_h (N_h/n_h) \sum_i y_{hij}}{\sum_h (N_h/n_h) n_{hj}}, \text{ and} \quad (5)$$

$$\hat{V}\left(\hat{\bar{Y}}_j\right) = \frac{1}{\hat{N}_j^2} \sum_h \frac{N_h^2(1-n_h/N_h)}{n_h(n_h-1)} \left[\sum_i \left(y_{hij} - \bar{y}_{hj}\right)^2 + n_{hj}\left(1 - \frac{n_{hj}}{n_h}\right)\left(\bar{y}_{hj} - \hat{\bar{Y}}_j\right)^2\right]. \quad (6)$$

Appendix D.–Chilkat Lake weir and DIDSON dates of operation, sockeye and coho salmon counts, and counts expanded to account for late installation and early removal of the project, 1971–2020. For the weir counts, visual counts that were expanded for late installation were expanded to 31 May (years 1982, 1983, 1985, 1987, 1988, 1999, 2001–2007). For the weir counts, visual counts that were expanded for early removal were expanded to 20 November (years 1972, 1974, 1977, 1980, 1982, 1984, 1994, 1995, 2001, 2003–2006).

			Sockeye salmon		Coho salmon	
Year	Start date	End date	Raw count	Expanded count	First day past weir	Raw count
1971	31-May	28-Oct	49,342	49,342	27-Sep	1,063
1972	3-Jun	**12-Oct**	51,860	53,082	3-Oct	518
1973	11-Jun	15-Oct	50,527	50,527	20-Sep	157
1974	31-May	**30-Sep**	84,456	94,900	23-Sep	161
1975	4-Jun	6-Nov	41,520	41,520	15-Sep	699
1976	3-Jun	20-Oct	69,729	69,729	12-Sep	196
1977	3-Jun	**27-Sep**	41,044	50,363	ND	ND
1978	5-Jun	5-Nov	67,528	67,528	21-Sep	370
1979	9-Jun	11-Nov	80,588	80,588	21-Sep	963
1980	15-Jun	**8-Oct**	95,347	101,135	ND	ND
1981	11-Jun	22-Oct	84,097	84,097	21-Sep	1,149
1982	**24-Jun**	**7-Oct**	80,221	86,213	21-Sep	163
1983	**22-Jun**	12-Nov	134,022	134,601	9-Sep	1,023
1984	9-Jun	**7-Oct**	115,269	123,190	21-Aug	691
1985	**23-Jun**	23-Oct	57,649	58,335	13-Sep	564
1986	16-Jun	14-Nov	23,947	23,947	11-Sep	635
1987	**19-Jun**	20-Nov	48,861	48,972	17-Sep	942
1988	**18-Jun**	14-Nov	27,662	27,722	4-Sep	1,307
1989	5-Jun	28-Oct	141,475	141,475	16-Sep	1,260
1990	6-Jun	13-Nov	60,230	60,230	2-Sep	630
1991	9-Jun	25-Oct	51,138	51,138	12-Sep	1,462
1992	8-Jun	15-Oct	95,880	95,880	12-Sep	1,099
1993	13-Jun	15-Oct	212,757	212,757	13-Sep	595
1994	31-May	**6-Oct**	80,859	86,385	6-Sep	800
1995	6-Jun	**9-Oct**	59,698	61,783	15-Aug	797
1996[a]	–	–	–	–	–	–
1997[a]	–	–	–	–	–	–
1998[a]	–	–	–	–	–	–
1999	**30-Jun**	27-Oct	129,533	134,048	11-Sep	2,788
2000	16-Jun	16-Oct	47,077	47,077	3-Sep	872
2001	**19-Jun**	**13-Oct**	51,979	53,239	23-Aug	978
2002	**22-Jun**	17-Oct	65,085	65,611	26-Aug	4,740
2003	**27-Jun**	**10-Oct**	52,417	55,516	29-Aug	1,678
2004	**6-Jul**	**13-Oct**	75,632	83,534	19-Aug	4,915
2005	**28-Jun**	**12-Oct**	30,145	32,098	10-Sep	327
2006	**27-Jun**	**10-Oct**	37,108	38,850	12-Aug	1,779
2007	**13-Jul**	17-Oct	21,236	27,915	4-Sep	4,651
2008[b]	**27-Jun**	19-Oct	71,735	73,979	31-Aug	11,464
2009	15-Jun	12-Oct	153,033	153,033	6-Sep	4,880
2010	18-Jun	20-Oct	61,906	61,906	11-Sep	5,813
2011	8-Jun	16-Oct	63,628	63,628	11-Sep	3,625
2012	18-Jun	**1-Oct**	107,723	119,142	21-Aug	2,753
2013	19-Jun	**6-Oct**	110,979	115,237	25-Sep	3,095
2014	17-Jun	16-Oct	70,470	70,470	15-Sep	3,680

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			Sockeye salmon		Coho salmon	
Year	Start date	End date	Raw count	Expanded count	First day past weir	Raw count
2015	**26-Jun**	**29-Sep**	135,110	164,014	4-Sep	1,832
2016	**24-Jun**	11-Oct	85,935	87,622	9-Sep	2,329
2017	15-Jun	10-Oct	88,197	88,197	10-Sep	1,819
2018	10-Jun	12-Oct	108,047	108,047	16-Aug	3,678
2019	10-Jun	**9-Oct**	134,958	136,091	24-Aug	6,020
2020	18-Jun	11-Oct	50,746	50,746	27-Aug	3,862
Average (1971–2016)	15-Jun	18-Oct	76,196	79,125	3-Sep	1,938

Note: ND = no data collected. Bold dates denote when the weir started operations late or ended operations early.

Note: There is much greater confidence in the DIDSON escapement counts of Chilkat Lake sockeye salmon than in the visual weir counts or mark–recapture estimates; however, DIDSON counts should still be considered minimum estimates of escapement due to operational rather than technological limitations (see the escapement estimates section of the Results and Discussions).

[a] The weir was not operated 1996–1998.

[b] DIDSON sonar was used at the weir from 2008 onward.

Chilkat Lake Visual Weir Count Expansions

The visual counts, which were used prior to DIDSON installation in 2008, were expanded to 31 May if the weir was not in operation on or prior to 16 June. Specifically, visual counts were expanded to 31 May in 1982, 1983, 1985, 1987, 1988, 1999, and 2001–2007 to account for late installations. A base year, used for a late installation expansion, was defined as a year in which the weir was installed on or prior to 16 June, regardless of the removal date (i.e., 1971–1981, 1984, 1986, 1989–1995, and 2000; Appendix D). For example, in 2007 the weir was installed on 13 July and the total weir count through 17 October was 21,236 (*X*) sockeye salmon. To determine the late installation expansion, cumulative escapement from 13 July on (*X*) (i.e., to the end of the weir operation in each base year) was regressed against total escapement in the late installation base years (*Y*). For these base years, total escapement was calculated through the duration of the weir operation which ranged from 27 September in 1977 to 14 November in 1986. Using the results of the linear regression,

$$\widehat{Y_i} = a + bX_i, \quad (1)$$

the expanded weir count in 2007 ($\hat{Y}$) was calculated as 27,915, where a = 5,770 and b = 1.04 (see table below). Therefore, it was assumed that 6,679 sockeye salmon would have been counted from 31 May to 12 July, if the weir had been in operation. The year 2007 was then added to the early removal base years.

Similarly, visual counts were expanded to 20 November in 1972, 1974, 1977, 1980, 1982, 1984, 1994, 1995, 2001, and 2003–2006 to account for weir removal prior to 15 October. A base year, used for an early removal expansion, was defined as a year in which the weir remained in operation on or after 15 October, regardless of the install date (i.e., 1971, 1973, 1975, 1976, 1978, 1979, 1981, 1983, 1985–1993, 1999, 2000, 2002, 2007; Appendix D). For example, in 2005 the weir was removed on 12 October and the total weir count was 31,628 (*X*) sockeye salmon for that year (after first expanding for late installation). To determine the early removal expansion, cumulative escapement to 12 October (*X*) was regressed against total escapement in the early removal base years (*Y*). For the base years, total escapement included the entire count during weir operation, not just the period from 16 June to 15 October. This ranged from as early as 15 October in the base year 1993 to as late as 20 November in the base year 1987. Using the results of this regression, the expanded weir count in 2005 ($\hat{Y}$) was then calculated as 32,098, where a = -706 and b = 1.04. Therefore, in 2005, when the weir was removed early on 12 October, it was estimated that 470 fish would have been counted from 13 October to 20 November if the weir had still been in operation during that time period.

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Intercept (*a*), slope (*b*), and *R*-squared values from the output of the linear regressions for late installation and early removal expansions of the Chilkat Lake weir were as follows (all regressions were significant at the $p < 0.001$ value):

	Date	*a*	*b*	R^2
Late installation	18 June	24	1.00	1.00
	19 June	52	1.00	1.00
	22 June	475	1.00	1.00
	23 June	613	1.00	1.00
	24 June	475	1.01	1.00
	27 June	618	1.02	1.00
	28 June	852	1.02	0.99
	30 June	1,295	1.02	0.99
	6 July	3,243	1.03	0.98
	13 July	5,770	1.04	0.97
Early removal	27 September	5,462	1.09	0.95
	30 September	1,553	1.11	0.97
	6 October	-1,457	1.09	1.00
	7 October	-1,723	1.08	1.00
	8 October	-2,123	1.08	1.00
	9 October	-2,824	1.08	1.00
	10 October	-2,208	1.07	1.00
	12 October	-706	1.04	1.00
	13 October	-406	1.03	1.00

Chilkat Lake DIDSON Count Expansions

After the DIDSON install in 2008, the base period of weir operation was changed to 20 June–10 October. By this metric, the DIDSON was installed late in years 2008, 2015, and 2016 and removed early in 2012, 2013, 2015, and 2019 (Appendix D). Linear regression, similar to the method used to expand the visual weir counts, was applied to the DIDSON counts.

When the DIDSON was installed late, escapement data were expanded by regressing cumulative escapement by date (24 June–27 June) against total escapement in the late installation base years 2009–2014, 2017–2020. Base years for the late installation of DIDSON counts were defined as years that the DIDSON was installed on or prior to 20 June, regardless of the removal date. For these base years, total escapement was calculated through the duration of the DIDSON installation. The 10 base years used in the regression for late installation expansions in this report were updated from the 6 base years used in Bednarski et al. 2017 (see table below). Updating the base years updated the regression used for the expansion and updated the final expanded escapement counts. After late installation expansion, the 2008 and 2016 escapements were then added to the early removal base years.

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DIDSON counts in years when the DIDSON was removed early were then expanded by regressing cumulative escapement by date (29 September–9 October) against total escapement in the early removal base years (2008–2011, 2014, 2016–2018, 2020). A base year, for the early removal expansion of DIDSON counts, was a year that the DIDSON was still in operation on or after 10 October, regardless of whether the DIDSON was installed late in the early part of the season. Again, for the base years, total escapement included the entire fish count from the DIDSON installation through the end of DIDSON operation, not just the period from 20 June to 10 October. These 9 early removal base years were updated in this report from the 6 base years for early removal used in the Bednarski et al. (2017) report. Updating the base years updated the regression used for the expansion and updated the final expanded escapement counts. In 2015, the weir was installed late and removed early so expansions were done to account for both late installation and early removal. Intercept (*a*), slope (*b*), and *R*-squared values from the output of the linear regressions for late installation and early removal expansions of the Chilkat Lake DIDSON were as follows (all regressions were significant at the $p < 0.001$ value):

	Date	*a*	*b*	R^2
Late installation	24 June	-2,981	1.05	0.99
	26 June	-1,945	1.05	0.99
	27 June	-2,044	1.06	0.99
Early removal	29 September	-4,184	1.20	0.95
	1 October	205	1.10	0.97
	6 October	5,860	0.99	0.98
	9 October	5,569	0.97	0.98

Limitations of the Expanded Counts

Expanded weir and DIDSON counts are considered more accurate estimates of the annual escapement, because expanded counts adjust the raw counts to account for missed days each year. However, this is an imperfect solution to a difficult problem and there are many limitations with the methods applied.

The first limitation is that by applying a target end date (e.g., 15 October for operation of the weir during pre-DIDSON years and 10 October for operation of the weir during DIDSON years), expansions are limited to the years that the DIDSON (or weir) was removed prior to the target date (or installed after a target date); these counts still underrepresent the true escapement because we know fish continue to enter the lake after the target date. For example, in 2017, the DIDSON was operated from 15 June to 10 October. Therefore, the counts in 2017 were not expanded because operations encompassed the target dates. In 2019, however, the DIDSON was operated from 10 June to 9 October, so the counts were expanded to account for the missed days of operation from 10 October to 20 October.

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The second limitation is that it is difficult to run the weir after 10 October due to low water and budget constraints; as a result, there are few years of data that extend through the end of October to add information about missed counts using the DIDSON. In most years, the numbers of fish counted after 10 October are low. For example, in the pre-DIDSON years 1978, 1979, 1983, 1986–1988, and 1990, weir operations extended through early or mid-November and counts after 15 October accounted for only 2% or less of the total sockeye salmon escapement. However, once the DIDSON was installed, the DIDSON counts that extended through mid-October were more variable and accounted for <1% (2011), 6% (2010), 7% (2014), and 17% (2008) of the escapement. If the weir and DIDSON could be operated through the end of October for a number of years, the additional counts would be very informative, but budget constraints (in particular) and low water continue to prevent this from occurring. Because the sockeye salmon proportion of the total escapement that enters Chilkat Lake through October and November is highly variable and inconsistent, it is recommended that the escapement goal analysis be revisited to include (i) a model using only raw, unexpanded weir and DIDSON counts, and a (ii) a model with escapement data from the current expansion methods described above. The third limitation is that, up until recent years, species apportionment, which determines the portion of the run attributed to sockeye salmon late in the season, has been inconsistent and poorly documented. As a result, it is difficult to assess the accuracy of the very large numbers of sockeye salmon counted after mid-October in 2008 that contributed such a large portion of the total escapement.

Future Recommendations

The weir/DIDSON operation should be conducted during a base period from 20 June to 10 October. Otherwise, DIDSON counts should be expanded to account for late installation or early removal using two methods: a) expand the counts the entire length of the season from 31 May to 20 October for years that do not encompass the base period, and b) expand the counts the entire length of the base period (20 June to 10 October) for years that do not encompass the base period. The base years used in the late installation/early removal regressions should be updated every 3 years, because updating the base years used in the regression also updates prior years that need to be expanded and also affects the weighted age composition of escapement.

Appendix F.–Raw and expanded sockeye salmon catch at the Chilkat River fish wheels, 1990–2020.

	Days operated				Effort adjustment		
Year[a]	Start	End	Total days	Raw count	Expanded count	Hours interpolated	Percent change
1990	13-Aug	29-Oct	78	2,984	ND	ND	ND
1991	8-May	20-Jul	74	1,385	ND	ND	ND
1994	18-Jun	12-Sep	87	3,865	ND	ND	ND
1995	16-Jun	16-Sep	93	3,224	ND	ND	ND
1996	22-Jun	16-Sep	87	3,115	ND	ND	ND
1997	11-Jun	10-Oct	122	5,016	ND	ND	ND
1998	9-Jun	13-Oct	127	5,747	ND	ND	ND
1999	8-Jun	8-Oct	123	7,735	ND	ND	ND
2000	9-Jun	7-Oct	121	3,709	ND	ND	ND
2001	6-Jun	7-Oct	124	4,414	ND	ND	ND
2002	7-Jun	19-Oct	135	4,217	ND	ND	ND
2003	6-Jun	21-Oct	138	4,551	4,774	393	4.9%
2004	7-Jun	19-Oct	135	4,366	ND	ND	ND
2005	6-Jun	11-Oct	128	3,692	3,900	415	5.6%
2006	7-Jun	14-Oct	130	3,169	3,227	205	1.8%
2007	11-Jun	9-Oct	121	2,751	2,914	387	5.9%
2008	10-Jun	10-Oct	123	6,412	ND	ND	ND
2009	11-Jun	9-Oct	121	9,045	9,730	611	7.6%
2010	7-Jun	11-Oct	127	3,504	ND	ND	ND
2011	7-Jun	8-Oct	124	4,940	5,274	512	6.8%
2012	12-Jun	7-Oct	118	4,101	4,260	387	4.0%
2013	6-Jun	3-Oct	120	5,961	6,614	729	11.0%
2014	5-Jun	8-Oct	126	6,165	6,409	288	4.0%
2015	8-Jun	6-Oct	121	9,971	10,272	448	3.0%
2016	9-Jun	5-Oct	119	4,651	4,891	875	5.2%
2017	7-Jun	4-Oct	120	4,517	4,866	224	7.7%
2018	8-Jun	3-Oct	118	2,750	3,047	898	10.8%
2019	9-Jun	27-Sep	111	7,608	8,433	520	10.8%
2020	8-Jun	29-Sep	114	2,285	2,626	773	14.9%
Average (1990–2016)	10-Jun	4-Oct	117	4,748	5,660	477	5.4%

Note: ND = no data.

[a] The fish wheels were not operated in 1992 or 1993.

Appendix G.–Chilkat River fish wheel counts of sockeye salmon by statistical week and year, 1999–2020.

Year	Statistical week																Total
	23–25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40–42	
1999	43	183	422	962	567	766	518	617	680	654	602	295	302	413	308	403	7,735
2000	83	330	371	359	441	317	306	292	255	246	148	199	110	135	60	47	3,709
2001	24	175	232	274	450	804	447	632	348	280	238	253	91	75	67	24	4,414
2002	179	273	339	340	303	337	433	441	384	283	259	338	176	67	33	32	4,217
2003	105	246	307	253	205	243	463	545	639	619	535	275	182	88	43	25	4,774
2004	30	110	264	395	396	305	352	588	481	448	337	352	81	74	53	100	4,366
2005	48	130	159	194	252	304	250	344	301	258	216	350	260	491	228	114	3,900
2006	7	46	112	125	99	155	385	417	278	477	311	216	225	153	43	180	3,227
2007	4	8	36	112	164	351	134	167	235	167	247	395	325	196	225	147	2,914
2008	57	249	248	436	620	454	343	394	454	576	710	708	424	326	232	181	6,412
2009	543	793	884	502	317	364	578	907	806	636	608	611	697	461	719	304	9,730
2010	85	64	303	281	399	233	285	277	385	474	279	90	162	100	45	42	3,504
2011	174	123	297	430	348	353	379	553	461	368	441	442	213	360	205	128	5,274
2012	104	285	446	513	343	291	250	170	320	365	397	343	174	131	75	53	4,260
2013	120	477	499	276	294	250	470	294	523	682	374	640	427	549	365	372	6,614
2014	1,131	693	574	354	324	357	259	502	321	490	352	290	288	199	175	99	6,409
2015	83	305	615	1,123	954	991	1,098	1,091	865	713	679	462	496	498	108	191	10,272
2016	13	71	335	660	491	441	363	584	548	322	235	253	327	150	83	14	4,891
2017	24	65	249	258	214	373	371	462	480	317	416	305	377	466	347	142	4,866
2018	19	70	181	170	132	305	270	122	171	633	384	293	197	68	28	5	3,047
2019	35	258	574	715	652	940	860	495	616	675	428	523	611	811	239	ND[a]	8,433
2020	23	56	86	211	211	206	263	347	306	357	247	169	80	46	17	2	2,626
Average (1999–2016)	157	253	358	422	387	406	406	490	460	448	387	362	276	248	170	137	5,368
Average (2017–2020)	25	112	273	339	302	456	441	357	393	495	369	322	316	348	158	50	4,743

Note: Gray cells denote years (1999–2002, 2004, 2008, and 2010) for which only raw counts are available; counts for all other years were expanded to account for fish wheel effort.

[a] In 2019, the fish wheels were not operated after statistical week 39.

Appendix H.–Water level (cm), water temperature (ºC), and water visibility (very poor, poor, fair, good, or excellent) at the Chilkat Lake weir, 2017–2020.

	2017			2018			2019			2020		
Date	Water level (cm)	Water temp (ºC)	Water visibility	Water level (cm)	Water temp (ºC)	Water visibility	Water level (cm)	Water temp (ºC)	Water visibility	Water level (cm)	Water temp (ºC)	Water visibility
10-Jun	ND	ND	ND	69	10	poor	118	14	fair	ND	ND	ND
11-Jun	ND	ND	ND	69	10	fair	116	13	good	ND	ND	ND
12-Jun	ND	ND	ND	69	9	fair	118	13	fair	ND	ND	ND
13-Jun	ND	ND	ND	69	12	fair	118	14	poor	ND	ND	ND
14-Jun	ND	ND	ND	70	12	good	118	14	fair	ND	ND	ND
15-Jun	129	14	fair	72	11	good	118	13.5	fair	ND	ND	ND
16-Jun	124	14	fair	73	11	poor	121	13	poor	ND	ND	ND
17-Jun	121	13	fair	73	12	fair	138	9	poor	ND	ND	ND
18-Jun	116	13	good	78	12	poor	142	11	poor	145	13.5	poor
19-Jun	109	13	good	81	13	fair	140	11	poor	152	15	good
20-Jun	108	13	fair	89	14	poor	138	14	poor	154	13	fair
21-Jun	105	13	fair	95	15	poor	138	15	poor	158	10	poor
22-Jun	101	13	fair	97	14	poor	130	15	fair	158	12	poor
23-Jun	99	13	fair	105	14	poor	120	15	fair	157	12	fair
24-Jun	99	13	fair	101	14	fair	121	15	excellent	154	12.5	fair
25-Jun	99	15	fair	100	13	fair	125	16	fair	152	12.5	fair
26-Jun	100	14	excellent	100	13	fair	138	7	very poor	148	12	fair
27-Jun	99	14	poor	101	13.5	fair	146	5	poor	145	12	fair
28-Jun	101	14	fair	100	13.5	fair	152	12	poor	145	15	good
29-Jun	103	13	fair	94	14	fair	170	5	poor	145	14	good
30-Jun	108	13	fair	92	14	fair	180	5	poor	144	14	fair
1-Jul	107	13	poor	91	14	fair	179	20	poor	144.5	14	fair
2-Jul	118	13	good	90	14.5	good	175	20	poor	148	13	poor
3-Jul	129	7	poor	88	15	good	172	19	fair	150	13.5	fair
4-Jul	131	15	fair	90	14	good	169	19	fair	157	15	good
5-Jul	135	15	fair	95	14	good	169	20	fair	158.5	16	fair
6-Jul	141	15	fair	100	14	fair	170	21	poor	156.5	15	fair
7-Jul	145	15	fair	99	15	good	166	20	fair	155	15	good
8-Jul	148	15	fair	100	15	poor	156	20	fair	158	14	good
9-Jul	144	15	fair	100	16	poor	154	20	fair	159	14	fair
10-Jul	145	15	good	ND	ND	ND	150	20	fair	161	14.5	fair
11-Jul	139	15	fair	ND	ND	ND	143	19	poor	161	14.5	good
12-Jul	135	15	fair	ND	ND	ND	131	18.5	fair	158	15	fair
13-Jul	131	15	fair	132	14.5	fair	127	18	fair	154.5	15	fair
14-Jul	136	15	good	130	16	good	121	17	fair	151	14	poor
15-Jul	137	15	good	131	15	good	116	18	fair	149	14	good
16-Jul	137	15	fair	130	14.5	fair	117	16	fair	145	15	good

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	2017			2018			2019			2020		
Date	Water level (cm)	Water temp (ºC)	Water visibility	Water level (cm)	Water temp (ºC)	Water visibility	Water level (cm)	Water temp (ºC)	Water visibility	Water level (cm)	Water temp (ºC)	Water visibility
17-Jul	132	16	good	134	15	fair	121	17	fair	144	15	poor
18-Jul	132	15	good	130	16	good	128	11	poor	143	15	fair
19-Jul	138	15	fair	128	15	good	125	11	poor	143	15	poor
20-Jul	141	15	fair	122	16	fair	126	16	poor	142	14	poor
21-Jul	139	15	good	120	16	fair	126	16	fair	148	15	poor
22-Jul	140	15	good	120	18	fair	124	18	fair	152	14	poor
23-Jul	140	15	good	119	17	fair	123	17	fair	154	14	poor
24-Jul	141	15	good	119	19	fair	120	17	fair	165	3	very poor
25-Jul	140	15	good	122	19	good	119	17	poor	169	10	very poor
26-Jul	134	16	good	127	7	poor	125	17	poor	169	14	poor
27-Jul	128	16	excellent	131	8	poor	129	16	poor	170	14	poor
28-Jul	128	16	good	136	16	poor	130	15	fair	179	4	very poor
29-Jul	126	16	good	133	18	poor	130	15	fair	167	15	poor
30-Jul	124	16	good	132	19	poor	124	16	fair	162	15	good
31-Jul	122	16	fair	138	5	poor	120	16	excellent	164	12	very poor
1-Aug	122	16	fair	140	5	poor	120	18	fair	171	18	fair
2-Aug	120	16	excellent	136	18	poor	119	17	poor	179	6	very poor
3-Aug	128	16	poor	127	18	poor	121	19	fair	174	16	good
4-Aug	131	17	good	122	16	fair	125	19	fair	169	16	good
5-Aug	138	20	good	118	20	fair	122	19	poor	164	15	fair
6-Aug	141	10	good	119	18	fair	121	19	poor	169	10	fair
7-Aug	148	8	poor	119	16	poor	129	12	poor	164	16	excellent
8-Aug	158	8	poor	136	5	poor	137	7	poor	157	10	good
9-Aug	154	20	fair	159	4	poor	138	6	poor	165	14	poor
10-Aug	148	20	fair	143	15	poor	130	18	fair	164	12	poor
11-Aug	144	20	fair	129	15	poor	135	18	fair	162	15	fair
12-Aug	138	20	fair	120	16	fair	136	20	fair	155	14	excellent
13-Aug	132	20	fair	119	16	poor	135	19	fair	150	14	excellent
14-Aug	132	18	poor	125	15	poor	130	19	fair	145	14	good
15-Aug	128	18	poor	118	16	poor	134	18	fair	141	14	good
16-Aug	120	18	fair	108	15	poor	137	9	poor	140	14	good
17-Aug	121	17	poor	100	15	fair	136	18	fair	137	14	excellent
18-Aug	122	17	good	96	15	fair	125	13	poor	135	14	good
19-Aug	119	15	good	90	15	good	120	14	fair	133	14	fair
20-Aug	120	15	good	90	16	good	114	14	excellent	129	14	good
21-Aug	122	15	good	82	17	good	109	14	excellent	127	14	good
22-Aug	118	15	poor	113	7	poor	105	15	excellent	133	15	good
23-Aug	122	14	fair	124	5	poor	103	14	fair	140	9	very poor

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	2017			2018			2019			2020		
Date	Water level (cm)	Water temp (ºC)	Water visibility	Water level (cm)	Water temp (ºC)	Water visibility	Water level (cm)	Water temp (ºC)	Water visibility	Water level (cm)	Water temp (ºC)	Water visibility
24-Aug	114	14	poor	130	6	poor	102	15	excellent	145	5	very poor
26-Aug	96	14	fair	130	15	fair	100	15	fair	140	14	fair
27-Aug	96	14	fair	128	16	poor	106	15	fair	139	14	poor
28-Aug	89	14	poor	130	16	poor	103	15	poor	135	13	good
29-Aug	88	14	good	128	16	good	101	15	poor	131	14	good
30-Aug	90	14	poor	124	16	good	100	15	poor	132	14	good
31-Aug	90	14	poor	120	16	fair	93	15	poor	134	12	very poor
1-Sep	89	13	good	117	15	poor	92	16	excellent	158	4	very poor
2-Sep	87	13	good	112	15	fair	92	15	fair	155	3	very poor
3-Sep	85	13	good	109	15	good	92	15	fair	158	4	very poor
4-Sep	83	13	fair	106	16	good	94	15	poor	157	12	poor
5-Sep	101	13	poor	104	15	good	92	15	fair	149	13	fair
6-Sep	106	6	poor	102	16	good	91	15	fair	144	13	good
7-Sep	130	6	poor	100	15	good	90	14	fair	140	14	good
8-Sep	133	10	poor	98	15	good	93	15	fair	138	13	poor
9-Sep	135	13	fair	96	14	good	97	15	fair	137	14	poor
10-Sep	121	13	fair	96	14	good	97	7	fair	139	14	poor
11-Sep	110	12	fair	95	14	fair	113	4	poor	142	5	poor
12-Sep	98	12	fair	95	14	fair	105	7	fair	144	4	fair
13-Sep	96	12	fair	93	14	fair	110	7	excellent	145	11	good
14-Sep	94	12	fair	92	13	fair	120	5	poor	144	12	good
15-Sep	92	12	fair	90	12	fair	118	5	poor	142	12	good
16-Sep	88	12	fair	88	11	good	120	6	poor	138	12	excellent
17-Sep	80	12	fair	86	11	good	121	7	excellent	136	13	excellent
18-Sep	75	12	fair	85	11	good	119	13	fair	134	13	excellent
19-Sep	72	13	good	ND	ND	ND	123	11	very poor	132	12	good
20-Sep	70	13	good	ND	ND	ND	124	13	poor	128	12	fair
21-Sep	69	13	good	ND	ND	ND	138	6	poor	126	12	good
22-Sep	64	13	good	81	11	good	141	5	poor	125	12	good
23-Sep	63	13	good	79	11	good	132	12	fair	125	12	fair
24-Sep	61	13	good	78	12	good	125	12	fair	125	12	good
25-Sep	60	13	poor	77	12	poor	118	13	excellent	126	12	good
26-Sep	59	13	good	79	12	fair	113	12	excellent	126	13	good
27-Sep	70	13	poor	78	10	fair	108	11	excellent	137	4	very poor
28-Sep	90	8	poor	77	11	good	104	11	excellent	154	4	very poor
29-Sep	91	9	poor	75	10	good	100	11	excellent	151	10	poor
30-Sep	90	10	fair	74	9	good	96	11	excellent	142	11	fair
1-Oct	89	10	fair	74	9	fair	100	11	poor	140	11	poor

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	2017			2018			2019			2020		
Date	Water level (cm)	Water temp (ºC)	Water visibility	Water level (cm)	Water temp (ºC)	Water visibility	Water level (cm)	Water temp (ºC)	Water visibility	Water level (cm)	Water temp (ºC)	Water visibility
2-Oct	85	10	fair	ND	ND	ND	95	11	poor	136	10	good
4-Oct	79	10	fair	ND	ND	ND	90	9	excellent	142	11	fair
5-Oct	81	10	poor	72	9	fair	89	10	fair	145	10	poor
6-Oct	79	10	fair	72	9	fair	89	10	poor	ND	ND	ND
7-Oct	76	10	fair	72	9	fair	88	8	fair	140	9	fair
8-Oct	74	10	fair	72	9	fair	87	7	fair	135	9	good
9-Oct	71	10	fair	71	8	fair	85	7	fair	131	8	poor
10-Oct	ND	ND	ND	70	7	fair	ND	ND	ND	127	9	excellent
11-Oct	ND	ND	ND	70	7	poor	ND	ND	ND	122	9	good
12-Oct	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Note: ND = no data collected.

Appendix I.–Daily Chilkat Lake weir counts of salmon, by species, 2017. Species apportionment of Chilkat Lake DIDSON counts started on the first day a coho salmon was observed at the weir or captured in morning beach seine sampling events in conjunction with sockeye salmon scale sampling (denoted by the horizontal dotted line). Species apportionment data collected in 2017 were minimal; therefore, the 10-year average proportion of coho salmon was used for species apportionment.

		Species apportionment	Daily escapement	
Date	Total DIDSON count	Proportion of coho salmon in sample	Sockeye salmon	Coho salmon
15-Jun	6		6	
16-Jun	59		59	
17-Jun	41		41	
18-Jun	28		28	
19-Jun	126		126	
20-Jun	125		125	
21-Jun	150		150	
22-Jun	151		151	
23-Jun	90		90	
24-Jun	195		195	
25-Jun	213		213	
26-Jun	686		686	
27-Jun	536		536	
28-Jun	186		186	
29-Jun	245		245	
30-Jun	333		333	
1-Jul	455		455	
2-Jul	155		155	
3-Jul	72		72	
4-Jul	107		107	
5-Jul	1		1	
6-Jul	-4		-4	
7-Jul	1,597		1,597	
8-Jul	1,107		1,107	
9-Jul	502		502	
10-Jul	946		946	
11-Jul	843		843	
12-Jul	854		854	
13-Jul	424		424	
14-Jul	1,426		1,426	
15-Jul	215		215	
16-Jul	806		806	
17-Jul	395		395	
18-Jul	1,376		1,376	
19-Jul	108		108	
20-Jul	378		378	
21-Jul	702		702	
22-Jul	504		504	
23-Jul	1,055		1,055	
24-Jul	1,233		1,233	
25-Jul	167		167	
26-Jul	796		796	
27-Jul	1,197		1,197	
28-Jul	1,119		1,119	
29-Jul	1,393		1,393	
30-Jul	654		654	
31-Jul	1,282		1,282	
1-Aug	104		104	
2-Aug	695		695	
3-Aug	665		665	
4-Aug	2,266		2,266	

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Date	Total DIDSON count	Species apportionment	Daily escapement	
		Proportion of coho salmon in sample	Sockeye salmon	Coho salmon
5-Aug	205		205	
6-Aug	158		158	
7-Aug	624		624	
8-Aug	241		241	
9-Aug	636		636	
10-Aug	711		711	
11-Aug	1,547		1,547	
12-Aug	2,043		2,043	
13-Aug	1,349		1,349	
14-Aug	66		66	
15-Aug	1,684		1,684	
16-Aug	1,148		1,148	
17-Aug	1,718		1,718	
18-Aug	2,897		2,897	
19-Aug	1,693		1,693	
20-Aug	1,004		1,004	
21-Aug	2,373		2,373	
22-Aug	728		728	
23-Aug	3		3	
24-Aug	1,123		1,123	
25-Aug	43		43	
26-Aug	405		405	
27-Aug	15		15	
28-Aug	79		79	
29-Aug	626		626	
30-Aug	803		803	
31-Aug	1,090		1,090	
1-Sep	95		95	
2-Sep	590		590	
3-Sep	488		488	
4-Sep	434		434	
5-Sep	125		125	
6-Sep	31		31	
7-Sep	-1		-1	
8-Sep	529		529	
9-Sep	310		310	
10-Sep	489	0.0142	482	7
11-Sep	51	0.0142	50	1
12-Sep	1,043	0.0142	1,028	15
13-Sep	2,986	0.0142	2,944	42
14-Sep	4,584	0.0142	4,519	65
15-Sep	5,256	0.0142	5,181	75
16-Sep	4,888	0.0142	4,818	70
17-Sep	3,296	0.0453	3,147	149
18-Sep	2,379	0.0453	2,271	108
19-Sep	251	0.0453	240	11
20-Sep	585	0.0453	559	26
21-Sep	245	0.0453	234	11
22-Sep	192	0.0453	183	9
23-Sep	14	0.0453	13	1
24-Sep	358	0.0936	324	34
25-Sep	768	0.0936	696	72
26-Sep	965	0.0936	875	90
27-Sep	454	0.0936	411	43
28-Sep	55	0.0936	50	5

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Date	Total DIDSON count	Species apportionment	Daily escapement	
		Proportion of coho salmon in sample	Sockeye salmon	Coho salmon
29-Sep	114	0.0936	103	11
30-Sep	397	0.0936	360	37
1-Oct	19	0.1721	16	3
2-Oct	9	0.1721	7	2
3-Oct	130	0.1721	108	22
4-Oct	261	0.1721	216	45
5-Oct	250	0.1721	207	43
6-Oct	174	0.1721	144	30
7-Oct	1,360	0.1721	1,126	234
8-Oct	796	0.2705	581	215
9-Oct	1,266	0.2705	924	342
10-Oct	3	0.2705	2	1

Appendix J.–Daily Chilkat Lake weir counts of salmon, by species, 2018. Species apportionment of Chilkat Lake DIDSON counts started on the first day a coho salmon was observed at the weir or captured in morning beach seine sampling events in conjunction with sockeye salmon scale sampling (denoted by the horizontal dotted line). The daily sampling ratio is the number of sockeye salmon to number of coho salmon.

		Samples (beach seine)			Daily escapement	
Date	Total DIDSON count	Daily sample ratio (sockeye:coho)	Total count from prior day's sampling (must be ≥68 fish)	Total number of coho in prior day's sampling	Sockeye salmon	Coho salmon
10-Jun	0				0	0
11-Jun	2				2	0
12-Jun	3				3	0
13-Jun	1				1	0
14-Jun	16				16	0
15-Jun	19				19	0
16-Jun	17				17	0
17-Jun	7				7	0
18-Jun	4				4	0
19-Jun	0				0	0
20-Jun	3				3	0
21-Jun	6				6	0
22-Jun	6				6	0
23-Jun	13				13	0
24-Jun	19				19	0
25-Jun	0				0	0
26-Jun	0				0	0
27-Jun	55				55	0
28-Jun	6	0:1			6	0
29-Jun	194	10:0			194	0
30-Jun	188	2:0			188	0
1-Jul	573	ND			573	0
2-Jul	763	ND			763	0
3-Jul	517	ND			517	0
4-Jul	574	ND			574	0
5-Jul	553	ND			553	0
6-Jul	216	ND			216	0
7-Jul	370	27:0			370	0
8-Jul	465	13:0			465	0
9-Jul	480	20:0			480	0
10-Jul	451	ND			451	0
11-Jul	29	ND			29	0
12-Jul	0	1:0			0	0
13-Jul	170	4:0			170	0
14-Jul	411	10:0			411	0
15-Jul	1,689	10:0			1689	0
16-Jul	629	10:0			629	0
17-Jul	1,251	75:0			1251	0
18-Jul	1,509	10:0			1509	0
19-Jul	1,125	10:0			1125	0
20-Jul	1,411	10:0			1411	0
21-Jul	876	10:0			876	0
22-Jul	995	10:0			995	0
23-Jul	431	2:0			431	0
24-Jul	706	12:0			706	0
25-Jul	514	20:0			514	0
26-Jul	325	1:0			325	0
27-Jul	472	2:0			472	0
28-Jul	794	ND			794	0
29-Jul	491	14:0			491	0

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		Samples (beach seine)			Daily escapement	
Date	Total DIDSON count	Daily sample ratio (sockeye:coho)	Total count from prior day's sampling (must be ≥68 fish)	Total number of coho in prior day's sampling	Sockeye salmon	Coho salmon
30-Jul	342	11:0			342	0
31-Jul	682	10:0			682	0
1-Aug	936	10:0			936	0
2-Aug	670	9:0			670	0
3-Aug	471	6:0			471	0
4-Aug	360	15:0			360	0
5-Aug	396	14:0			396	0
6-Aug	1,146	10:0			1,146	0
7-Aug	707	9:0			707	0
8-Aug	26	1:0			26	0
9-Aug	258	ND			258	0
10-Aug	673	1:0			673	0
11-Aug	629	4:0			629	0
12-Aug	1,138	10:0			1,138	0
13-Aug	1,083	10:0			1,083	0
14-Aug	774	10:0			774	0
15-Aug	997	10:0			997	0
16-Aug	1,152	10:1	79	1	1,137	15
17-Aug	1,601	ND	76	1	1,580	21
18-Aug	1,234	9:0	75	1	1,218	16
19-Aug	1,064	68:0	68	0	1,064	0
20-Aug	2,987	68:0	68	0	2,987	0
21-Aug	1,139	66:2	68	2	1,106	34
22-Aug	153	2:0	70	2	149	4
23-Aug	426	ND	70	2	414	12
24-Aug	228	ND	70	2	221	7
25-Aug	240	ND	70	2	233	7
26-Aug	1,120	15:0	85	2	1,094	26
27-Aug	619	21:0	106	2	607	12
28-Aug	770	68:0	68	0	770	0
29-Aug	1,337	68:0	68	0	1,337	0
30-Aug	1,667	68:0	68	0	1,667	0
31-Aug	1,558	153:0	153	0	1,558	0
1-Sep	1,480	24:0	177	0	1,480	0
2-Sep	1,951	188:0	188	0	1,951	0
3-Sep	2,291	71:2	73	2	2,228	63
4-Sep	3,021	ND	73	2	2,938	83
5-Sep	3,201	ND	73	2	3,113	88
6-Sep	2,027	ND	73	2	1,971	56
7-Sep	1,108	ND	73	2	1,078	30
8-Sep	2,925	227:7	234	7	2,838	88
9-Sep	1,228	98:1	99	1	1,216	12
10-Sep	2,126	35:0	134	1	2,110	16
11-Sep	1,426	78:4	82	4	1,356	70
12-Sep	1,030	93:4	97	4	988	42
13-Sep	1,228	229:11	240	11	1,172	56
14-Sep	865	130:9	139	9	809	56
15-Sep	911	112:9	121	9	843	68
16-Sep	1,490	59:6	186	15	1,370	120
17-Sep	1,318	79:2	81	2	1,285	33
18-Sep	2,592	74:4	78	4	2,459	133
19-Sep	1,681	ND	78	4	1,595	86
20-Sep	2,265	ND	78	4	2,149	116
21-Sep	2,661	ND	78	4	2,525	136
22-Sep	3,118	94:4	98	4	2,991	127

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Date	Total DIDSON count	Samples (beach seine) Daily sample ratio (sockeye:coho)	Total count from prior day's sampling (must be ≥68 fish)	Total number of coho in prior day's sampling	Daily escapement Sockeye salmon	Coho salmon
23-Sep	1,329	96:5	101	5	1,263	66
24-Sep	3,919	94:1	95	1	3,878	41
25-Sep	2,926	23:0	118	1	2,901	25
26-Sep	1,161	89:5	94	5	1,099	62
27-Sep	908	73:15	88	15	753	155
28-Sep	929	113:14	127	14	827	102
29-Sep	592	62:9	71	9	517	75
30-Sep	681	35:3	109	12	606	75
1-Oct	1,460	71:18	89	18	1,165	295
2-Oct	1,429	ND	89	18	1,140	289
3-Oct	1,099	ND	89	18	877	222
4-Oct	769	ND	89	18	613	156
5-Oct	865	57:11	68	11	725	140
6-Oct	1,090	126:9	135	9	1,017	73
7-Oct	1,130	153:22	175	22	988	142
8-Oct	683	210:15	225	15	637	46
9-Oct	334	56:4	285	19	312	22
10-Oct	130	24:5	89	9	117	13
11-Oct	42	0:1	90	10	37	5
12-Oct	372	ND	90	10	331	41

Note: ND = no data.

Appendix K.–Daily Chilkat Lake weir counts of salmon, by species, 2019. Species apportionment of Chilkat Lake DIDSON counts started on the first day a coho salmon was observed at the weir or captured in morning beach seine sampling events in conjunction with sockeye salmon scale sampling (denoted by the horizontal dotted line). The daily sampling ratio is the number of sockeye salmon to number of coho salmon.

		Samples (beach seine)			Daily escapement	
Date	Total DIDSON count	Daily sample ratio (sockeye:coho)	Total count from prior day's sampling (must be ≥68 fish)	Total number of coho in prior day's sampling	Sockeye salmon	Coho salmon
10-Jun	9				9	0
11-Jun	10				10	0
12-Jun	0				0	0
13-Jun	86				86	0
14-Jun	14				14	0
15-Jun	48				48	0
16-Jun	26				26	0
17-Jun	3				3	0
18-Jun	2				2	0
19-Jun	36				36	0
20-Jun	1				1	0
21-Jun	59				59	0
22-Jun	112				112	0
23-Jun	103				103	0
24-Jun	132				132	0
25-Jun	157				157	0
26-Jun	17				17	0
27-Jun	211				211	0
28-Jun	25				25	0
29-Jun	51				51	0
30-Jun	-12				-12	0
1-Jul	31				31	0
2-Jul	94				94	0
3-Jul	73				73	0
4-Jul	372				372	0
5-Jul	306				306	0
6-Jul	494				494	0
7-Jul	655				655	0
8-Jul	236				236	0
9-Jul	514				514	0
10-Jul	265				265	0
11-Jul	2,434				2,434	0
12-Jul	3,214				3,214	0
13-Jul	2,763				2,763	0
14-Jul	2,118				2,118	0
15-Jul	2,327				2,327	0
16-Jul	2,477				2,477	0
17-Jul	1,133				1,133	0
18-Jul	1,713				1,713	0
19-Jul	705				705	0
20-Jul	2,106				2,106	0
21-Jul	608				608	0
22-Jul	1,410				1,410	0
23-Jul	1,913				1,913	0
24-Jul	3,096				3,096	0
25-Jul	2,618				2,618	0
26-Jul	1,815				1,815	0
27-Jul	3,216				3,216	0
28-Jul	1,541				1,541	0
29-Jul	1,615				1,615	0

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Date	Total DIDSON count	Samples (beach seine): Daily sample ratio (sockeye:coho)	Samples (beach seine): Total count from prior day's sampling (must be ≥68 fish)	Samples (beach seine): Total number of coho in prior day's sampling	Daily escapement: Sockeye salmon	Daily escapement: Coho salmon
30-Jul	2,306				2,306	0
31-Jul	3,923				3,923	0
1-Aug	2,555				2,555	0
2-Aug	1,924				1,924	0
3-Aug	1,332				1,332	0
4-Aug	1,767				1,767	0
5-Aug	2,124				2,124	0
6-Aug	1,317				1,317	0
7-Aug	409				409	0
8-Aug	779				779	0
9-Aug	847				847	0
10-Aug	499				499	0
11-Aug	682				682	0
12-Aug	949				949	0
13-Aug	4,131				4,131	0
14-Aug	3,379				3,379	0
15-Aug	744				744	0
16-Aug	2,943				2,943	0
17-Aug	4,548				4,548	0
18-Aug	3,554	98:0			3,554	0
19-Aug	2,148	148:0			2,148	0
20-Aug	2,350	143:0			2,350	0
21-Aug	2,733	77:0			2,733	0
22-Aug	2,675	94:0			2,675	0
23-Aug	1,568	18:0			1,568	0
24-Aug	2,136	59:2	79	2	2,082	54
25-Aug	2,304	30:0	91	2	2,253	51
26-Aug	1,630	35:0	126	2	1,604	26
27-Aug	636	118:1	119	1	631	5
28-Aug	1,165	22:0	141	1	1,157	8
29-Aug	1,728	111:1	112	1	1,713	15
30-Aug	509	91:0	91	0	509	0
31-Aug	591	59:0	150	0	591	0
1-Sep	1,274	65:3	68	3	1,218	56
2-Sep	1,500	85:2	87	2	1,466	34
3-Sep	1,004	49:1	137	3	982	22
4-Sep	1,240	50:3	103	4	1,192	48
5-Sep	632	130:4	134	4	613	19
6-Sep	825	97:1	98	1	817	8
7-Sep	1,704	90:1	91	1	1,685	19
8-Sep	1,150	103:0	103	0	1,150	0
9-Sep	881	359:9	368	9	859	22
10-Sep	1,258	59:1	428	10	1,229	29
11-Sep	187	11:0	71	1	184	3
12-Sep	107	20:0	91	1	106	1
13-Sep	150	4:5	100	6	141	9
14-Sep	-77	1:0	101	6	-72	-5
15-Sep	-115	6:0	107	6	-109	-6
16-Sep	-151	13:0	120	6	-143	-8
17-Sep	298	ND	120	6	283	15
18-Sep	869	220:23	243	23	787	82
19-Sep	359	ND	243	23	325	34
20-Sep	540	21:2	266	25	489	51
21-Sep	-20	ND	266	25	-18	-2
22-Sep	215	3:1	270	26	194	21

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Date	Total DIDSON count	Samples (beach seine) Daily sample ratio (sockeye:coho)	Total count from prior day's sampling (must be ≥68 fish)	Total number of coho in prior day's sampling	Daily escapement Sockeye salmon	Coho salmon
23-Sep	1,528	88:10	98	10	1,372	156
24-Sep	1,245	129:20	149	20	1,078	167
25-Sep	1,361	152:34	186	34	1,112	249
26-Sep	1,823	79:14	93	14	1,549	274
27-Sep	1,618	73:32	105	32	1,125	493
28-Sep	2,589	89:39	128	39	1,800	789
29-Sep	2,502	318:104	422	104	1,885	617
30-Sep	1,888	86:21	107	21	1,517	371
1-Oct	1,251	7:2	116	23	1,003	248
2-Oct	1,773	16:6	138	29	1,400	373
3-Oct	1,299	9:6	153	35	1,002	297
4-Oct	872	15:33	85	45	410	462
5-Oct	549	3:4	70	43	212	337
6-Oct	591	13:4	72	41	254	337
7-Oct	215	1:0	73	41	94	121
8-Oct	189	5:8	86	49	81	108
9-Oct	18	1:2	89	51	8	10

Note: ND = no data.

Appendix L.–Daily Chilkat Lake weir counts of salmon, by species, 2020. Species apportionment of Chilkat Lake DIDSON counts started on the first day a coho salmon was observed at the weir or captured in morning beach seine sampling events in conjunction with sockeye salmon scale sampling (denoted by the horizontal dotted line). The daily sampling ratio is the number of sockeye salmon to number of coho salmon.

		Samples (beach seine)			Daily escapement	
Date	Total DIDSON count	Daily sample ratio (sockeye:coho)	Total count from prior day's sampling (must be ≥68 fish)	Total number of coho in prior day's sampling	Sockeye salmon	Coho salmon
18-Jun	-2				-2	0
19-Jun	5				5	0
20-Jun	24				24	0
21-Jun	21				21	0
22-Jun	19				19	0
23-Jun	54				54	0
24-Jun	49				49	0
25-Jun	86				86	0
26-Jun	26				26	0
27-Jun	110				110	0
28-Jun	182				182	0
29-Jun	167				167	0
30-Jun	299				299	0
1-Jul	169				169	0
2-Jul	250				250	0
3-Jul	109				109	0
4-Jul	65				65	0
5-Jul	311				311	0
6-Jul	143				143	0
7-Jul	150				150	0
8-Jul	200				200	0
9-Jul	90				90	0
10-Jul	322				322	0
11-Jul	505				505	0
12-Jul	660				660	0
13-Jul	843				843	0
14-Jul	281				281	0
15-Jul	215				215	0
16-Jul	611				611	0
17-Jul	634				634	0
18-Jul	549				549	0
19-Jul	448				448	0
20-Jul	415				415	0
21-Jul	159				159	0
22-Jul	152				152	0
23-Jul	317				317	0
24-Jul	0				0	0
25-Jul	182				182	0
26-Jul	604				604	0
27-Jul	93				93	0
28-Jul	899				899	0
29-Jul	1,307				1,307	0
30-Jul	755				755	0
31-Jul	379				379	0
1-Aug	89				89	0
2-Aug	277				277	0
3-Aug	711				711	0
4-Aug	788				788	0
5-Aug	220				220	0
6-Aug	549				549	0

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Date	Total DIDSON count	Samples (beach seine): Daily sample ratio (sockeye:coho)	Samples (beach seine): Total count from prior day's sampling (must be ≥68 fish)	Samples (beach seine): Total number of coho in prior day's sampling	Daily escapement: Sockeye salmon	Daily escapement: Coho salmon
7-Aug	635				635	0
8-Aug	686				686	0
9-Aug	303				303	0
10-Aug	237				237	0
11-Aug	953				953	0
12-Aug	702				702	0
13-Aug	1,088				1,088	0
14-Aug	806				806	0
15-Aug	836				836	0
16-Aug	560				560	0
17-Aug	1,044				1,044	0
18-Aug	1,021				1,021	0
19-Aug	1,038				1,038	0
20-Aug	1,499				1,499	0
21-Aug	176				176	0
22-Aug	4				4	0
23-Aug	128				128	0
24-Aug	238				238	0
25-Aug	517				517	0
26-Aug	536				536	0
27-Aug	312	56:1[a]	57	1	307	5
28-Aug	296	25:0	82	1	292	4
29-Aug	553	79:0	79	0	553	0
30-Aug	505	154:0	154	0	505	0
31-Aug	451	17:0	171	0	451	0
1-Sep	38	ND	171	0	38	0
2-Sep	6	ND	171	0	6	0
3-Sep	8	ND	171	0	8	0
4-Sep	845	14:1	186	1	840	5
5-Sep	430	14:0	200	1	428	2
6-Sep	41	2:1	203	2	41	0
7-Sep	1,883	186:12	198	12	1,769	114
8-Sep	794	77:7	84	7	728	66
9-Sep	1,469	68:5	73	5	1,368	101
10-Sep	422	122:1	123	1	419	3
11-Sep	15	7:0	130	1	15	0
12-Sep	694	1:0	131	1	689	5
13-Sep	35	2:0	133	1	35	0
14-Sep	417	16:6	155	7	398	19
15-Sep	1,149	3:5	163	12	1,064	85
16-Sep	1,537	160:12	172	12	1,430	107
17-Sep	2,290	141:10	151	10	2,138	152
18-Sep	1,372	197:10	207	10	1,306	66
19-Sep	906	213:29	242	29	797	109
20-Sep	1,676	127:12	139	12	1,531	145
21-Sep	1,204	203:19	222	19	1,101	103
22-Sep	1,054	124:22	146	22	895	159
23-Sep	266	51:18	69	18	197	69
24-Sep	253	26:5	100	23	195	58
25-Sep	203	87:20	107	20	165	38
26-Sep	569	5:0	112	20	467	102
27-Sep	24	ND	112	20	20	4
28-Sep	60	ND	112	20	49	11
29-Sep	519	1:0	113	20	427	92
30-Sep	181	ND	113	20	149	32

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Appendix L.–Page 3 of 3.

Date	Total DIDSON count	Samples (beach seine) Daily sample ratio (sockeye:coho)	Total count from prior day's sampling (must be ≥68 fish)	Total number of coho in prior day's sampling	Daily escapement Sockeye salmon	Coho salmon
1-Oct	333	35:64	99	64	118	215
2-Oct	266	ND	99	64	94	172
3-Oct	144	ND	99	64	51	93
4-Oct	167	38:12	149	76	82	85
5-Oct	212	2:3	154	79	103	109
6-Oct	205	0:1	155	80	99	106
7-Oct	166	9:12	77	28	106	60
8-Oct	136	14:32	68	45	46	90
9-Oct	239	5:12	84	56	80	159
10-Oct	573	24:38	79	50	210	363
11-Oct	1,192	0:0	79	50	438	754

Note: ND = no data.

[a] August 27th was the first time a coho salmon was seen at the Chilkat Lake weir in 2020. On this day, the ratio of sockeye to coho salmon in a seine sample of 57 fish was used to apportion the total daily count of 312 fish. The rest of the season, a minimum of 68 fish, based on 1 day or multiple days, was used to apportion the daily count into sockeye and coho salmon.

Appendix M.–Estimated commercial harvest of Chilkat Lake, Chilkoot Lake, and other sockeye salmon stocks in the District 15 commercial drift gillnet fishery based on scale pattern analysis (1976–2016) and genetic stock identification (2017–2020).

	Harvest			Percentile rank			Percent of harvest		
Year	Chilkoot Lake	Chilkat Lake	Other	Chilkoot Lake	Chilkat Lake	Other	Chilkoot Lake	Chilkat Lake	Other
1976	61,861	58,765	4,796	0.52	0.43	0.11	49%	47%	4%
1977	113,555	41,477	5,389	0.66	0.25	0.14	71%	26%	3%
1978	14,264	89,558	4,658	0.11	0.68	0.09	13%	83%	4%
1979	69,864	115,995	7,117	0.59	0.82	0.16	36%	60%	4%
1980	21,244	31,267	1,588	0.20	0.18	0.02	39%	58%	3%
1981	43,756	48,420	1,070	0.45	0.34	0.00	47%	52%	1%
1982	144,748	127,174	1,911	0.82	0.89	0.05	53%	46%	1%
1983	242,034	124,180	3,965	0.93	0.84	0.07	65%	34%	1%
1984	225,634	99,592	9,502	0.89	0.70	0.18	67%	30%	3%
1985	153,533	131,091	18,704	0.84	0.91	0.50	51%	43%	6%
1986	110,114	168,006	12,174	0.61	1.00	0.30	38%	58%	4%
1987	327,323	69,900	18,658	1.00	0.52	0.48	79%	17%	4%
1988	248,640	76,883	26,353	0.95	0.59	0.75	71%	22%	7%
1989	292,830	156,160	25,908	0.98	0.98	0.73	62%	33%	5%
1990	181,260	149,377	31,499	0.86	0.93	0.82	50%	41%	9%
1991	228,607	60,721	24,353	0.91	0.48	0.68	73%	19%	8%
1992	142,471	113,146	33,729	0.80	0.80	0.91	49%	39%	12%
1993	52,080	103,531	19,605	0.48	0.75	0.57	30%	59%	11%
1994	25,367	126,852	19,578	0.30	0.86	0.55	15%	74%	11%
1995	9,637	68,737	10,302	0.09	0.50	0.23	11%	78%	12%
1996	19,882	99,677	30,019	0.18	0.73	0.80	13%	67%	20%
1997	31,822	73,761	13,245	0.36	0.55	0.34	27%	62%	11%
1998	2,838	112,630	19,469	0.02	0.77	0.52	2%	83%	14%
1999	4,604	149,410	9,547	0.05	0.95	0.20	3%	91%	6%
2000	14,622	78,265	16,673	0.14	0.61	0.41	13%	71%	15%
2001	66,355	60,183	21,273	0.55	0.45	0.61	45%	41%	14%
2002	24,200	47,332	10,482	0.25	0.30	0.27	30%	58%	13%
2003	32,446	49,955	12,729	0.41	0.36	0.32	34%	53%	13%
2004	66,498	51,110	33,637	0.57	0.39	0.89	44%	34%	22%
2005	29,276	22,852	13,341	0.34	0.16	0.36	45%	35%	20%
2006	119,201	15,979	10,400	0.68	0.09	0.25	82%	11%	7%
2007	125,199	14,208	17,529	0.75	0.05	0.45	80%	9%	11%
2008	7,491	22,156	17,008	0.07	0.14	0.43	16%	47%	36%
2009	16,622	85,551	24,422	0.16	0.66	0.70	13%	68%	19%
2010	32,064	48,079	20,830	0.39	0.32	0.59	32%	48%	21%
2011	26,766	15,599	21,428	0.32	0.07	0.64	42%	24%	34%
2012	124,366	54,884	45,393	0.73	0.41	0.98	55%	24%	20%
2013	23,111	75,588	23,404	0.23	0.57	0.66	19%	62%	19%
2014	110,487	81,502	42,693	0.64	0.64	0.95	47%	35%	18%
2015	58,568	33,085	39,924	0.50	0.20	0.93	45%	25%	30%
2016	119,843	35,991	33,010	0.70	0.23	0.86	63%	19%	17%
2017	1,933	5,698	32,085	0.00	0.00	0.84	5%	14%	81%
2018	33,969	19,235	28,483	0.43	0.11	0.77	42%	24%	35%
2019	149,586	40,935	51,012	0.82	0.25	1.00	62%	17%	21%
2020	24,878	8,776	16,566	0.27	0.02	0.39	50%	17%	33%
Average[a]	91,831	77,771	18,471				42%	46%	12%
Median[a]	61,861	73,761	18,658				45%	46%	11%

[a] Average and median values use 1976–2016 data.

Appendix N.–District 15 commercial drift gillnet fishery genetic stock composition results by statistical week and reporting group, 2017.

Statistical week	Sample size	Genotyped	Aged only	Not genotyped or aged	Reporting group	Mean	SD	CI 5%	CI 95%
25	300	185	95	20	Chilkat Lake	0.131	0.026	0.091	0.175
					Chilkat Mainstem	0.005	0.010	0.000	0.027
					Chilkoot	0.045	0.016	0.023	0.074
					Other	0.819	0.030	0.767	0.866
26	305	187	95	23	Chilkat Lake	0.114	0.025	0.076	0.157
					Chilkat Mainstem	0.033	0.015	0.011	0.061
					Chilkoot	0.064	0.020	0.035	0.099
					Other	0.790	0.033	0.735	0.842
27	312	185	104	23	Chilkat Lake	0.209	0.032	0.159	0.262
					Chilkat Mainstem	0.062	0.019	0.033	0.096
					Chilkoot	0.065	0.021	0.034	0.101
					Other	0.664	0.038	0.601	0.725
28	190	188	2	0	Chilkat Lake	0.164	0.039	0.103	0.233
					Chilkat Mainstem	0.005	0.010	0.000	0.027
					Chilkoot	0.113	0.033	0.065	0.170
					Other	0.718	0.049	0.634	0.795
29	360	187	152	21	Chilkat Lake	0.057	0.018	0.031	0.089
					Chilkat Mainstem	0.006	0.007	0.000	0.020
					Chilkoot	0.024	0.013	0.007	0.049
					Other	0.912	0.022	0.872	0.946
30	305	183	113	9	Chilkat Lake	0.060	0.019	0.032	0.093
					Chilkat Mainstem	0.014	0.012	0.000	0.037
					Chilkoot	0.035	0.015	0.014	0.061
					Other	0.891	0.026	0.846	0.930
31	240	185	49	6	Chilkat Lake	0.088	0.023	0.053	0.129
					Chilkat Mainstem	0.001	0.003	0.000	0.007
					Chilkoot	0.056	0.020	0.026	0.092
					Other	0.855	0.029	0.804	0.900
32	303	170	111	22	Chilkat Lake	0.365	0.039	0.303	0.429
					Chilkat Mainstem	0.028	0.013	0.010	0.051
					Chilkoot	0.050	0.018	0.024	0.083
					Other	0.558	0.040	0.491	0.624
33	300	184	101	15	Chilkat Lake	0.175	0.031	0.125	0.228
					Chilkat Mainstem	0.005	0.007	0.000	0.020
					Chilkoot	0.085	0.022	0.051	0.124
					Other	0.736	0.037	0.673	0.796
34–40	300	186	98	16	Chilkat Lake	0.136	0.026	0.094	0.181
					Chilkat Mainstem	0.001	0.003	0.000	0.008
					Chilkoot	0.048	0.018	0.021	0.080
					Other	0.815	0.030	0.764	0.862
All	2,915	1,840	920	155	Chilkat Lake	0.143	0.010	0.127	0.160
					Chilkat Mainstem	0.013	0.003	0.008	0.019
					Chilkoot	0.049	0.007	0.038	0.060
					Other	0.795	0.011	0.776	0.813

Appendix O.–District 15 commercial drift gillnet fishery genetic stock composition results by statistical week and reporting group, 2018.

Statistical week	Sample size	Genotyped	Aged only	Not genotyped or aged	Reporting group	Mean	SD	CI 5%	CI 95%
25	126	121	5	0	Chilkat Lake	0.273	0.043	0.204	0.346
					Chilkat Mainstem	0.061	0.026	0.022	0.109
					Chilkoot	0.178	0.035	0.124	0.237
					Other	0.488	0.048	0.410	0.567
26	326	186	100	40	Chilkat Lake	0.264	0.035	0.208	0.322
					Chilkat Mainstem	0.104	0.024	0.068	0.145
					Chilkoot	0.081	0.022	0.049	0.120
					Other	0.551	0.040	0.485	0.615
27	413	183	195	35	Chilkat Lake	0.240	0.031	0.190	0.293
					Chilkat Mainstem	0.060	0.023	0.025	0.100
					Chilkoot	0.160	0.027	0.118	0.205
					Other	0.540	0.040	0.475	0.606
28	503	186	261	56	Chilkat Lake	0.158	0.028	0.116	0.207
					Chilkat Mainstem	0.023	0.015	0.001	0.050
					Chilkoot	0.268	0.033	0.214	0.323
					Other	0.551	0.038	0.488	0.613
29	390	186	166	38	Chilkat Lake	0.168	0.029	0.122	0.217
					Chilkat Mainstem	0.001	0.003	0.000	0.006
					Chilkoot	0.283	0.035	0.227	0.341
					Other	0.548	0.040	0.483	0.613
30	310	188	89	33	Chilkat Lake	0.208	0.030	0.160	0.259
					Chilkat Mainstem	0.008	0.010	0.000	0.028
					Chilkoot	0.392	0.036	0.332	0.452
					Other	0.392	0.037	0.331	0.454
31	399	187	166	46	Chilkat Lake	0.212	0.029	0.165	0.262
					Chilkat Mainstem	0.003	0.006	0.000	0.015
					Chilkoot	0.503	0.037	0.442	0.562
					Other	0.282	0.035	0.225	0.341
32	300	182	88	30	Chilkat Lake	0.278	0.030	0.230	0.328
					Chilkat Mainstem	0.001	0.002	0.000	0.004
					Chilkoot	0.417	0.035	0.359	0.476
					Other	0.305	0.034	0.251	0.361
33	340	189	114	37	Chilkat Lake	0.262	0.029	0.215	0.311
					Chilkat Mainstem	0.001	0.002	0.000	0.005
					Chilkoot	0.239	0.031	0.189	0.291
					Other	0.499	0.036	0.440	0.558
34–40	300	186	80	34	Chilkat Lake	0.283	0.030	0.234	0.333
					Chilkat Mainstem	0.004	0.006	0.000	0.016
					Chilkoot	0.565	0.034	0.508	0.620
					Other	0.149	0.027	0.107	0.194
All	3,407	1,794	1,264	349	Chilkat Lake	0.235	0.012	0.216	0.255
					Chilkat Mainstem	0.009	0.003	0.005	0.014
					Chilkoot	0.416	0.014	0.393	0.439
					Other	0.340	0.014	0.318	0.363

Appendix P.–District 15 commercial drift gillnet fishery genetic stock composition results by statistical week and reporting group, 2019.

Statistical week	Sample size	Genotyped	Aged only	Not genotyped or aged	Reporting group	Mean	SD	CI 5%	CI 95%
25–26	539	187	297	55	Chilkat Lake	0.266	0.052	0.187	0.357
					Chilkat Mainstem	0.191	0.050	0.109	0.273
					Chilkoot	0.165	0.026	0.124	0.211
					Other	0.378	0.039	0.315	0.444
27	418	188	186	44	Chilkat Lake	0.162	0.030	0.116	0.213
					Chilkat Mainstem	0.149	0.032	0.099	0.203
					Chilkoot	0.202	0.028	0.156	0.249
					Other	0.488	0.040	0.422	0.555
28	448	190	212	46	Chilkat Lake	0.208	0.030	0.159	0.259
					Chilkat Mainstem	0.100	0.024	0.062	0.142
					Chilkoot	0.277	0.032	0.225	0.331
					Other	0.416	0.038	0.354	0.478
29	289	188	90	11	Chilkat Lake	0.217	0.030	0.168	0.268
					Chilkat Mainstem	0.125	0.027	0.083	0.171
					Chilkoot	0.493	0.035	0.436	0.550
					Other	0.165	0.030	0.118	0.216
30	350	188	151	11	Chilkat Lake	0.154	0.028	0.111	0.202
					Chilkat Mainstem	0.060	0.020	0.030	0.095
					Chilkoot	0.597	0.035	0.539	0.654
					Other	0.188	0.031	0.139	0.240
31	350	187	141	22	Chilkat Lake	0.135	0.027	0.094	0.181
					Chilkat Mainstem	0.047	0.015	0.025	0.073
					Chilkoot	0.770	0.030	0.719	0.818
					Other	0.049	0.019	0.020	0.083
32	470	186	256	28	Chilkat Lake	0.111	0.023	0.075	0.151
					Chilkat Mainstem	0.020	0.011	0.005	0.041
					Chilkoot	0.787	0.028	0.740	0.830
					Other	0.082	0.020	0.052	0.118
33	330	188	127	15	Chilkat Lake	0.233	0.031	0.184	0.287
					Chilkat Mainstem	0.008	0.010	0.000	0.029
					Chilkoot	0.536	0.034	0.479	0.593
					Other	0.222	0.033	0.170	0.277
34	310	188	101	21	Chilkat Lake	0.201	0.026	0.160	0.244
					Chilkat Mainstem	0.001	0.004	0.000	0.008
					Chilkoot	0.532	0.035	0.475	0.590
					Other	0.266	0.033	0.214	0.321
35–40	299	190	100	9	Chilkat Lake	0.327	0.032	0.275	0.380
					Chilkat Mainstem	0.004	0.007	0.000	0.019
					Chilkoot	0.370	0.034	0.315	0.428
					Other	0.298	0.034	0.242	0.355
All	3,803	1,880	1,661	262	Chilkat Lake	0.169	0.011	0.152	0.189
					Chilkat Mainstem	0.048	0.007	0.038	0.059
					Chilkoot	0.619	0.013	0.597	0.641
					Other	0.163	0.010	0.146	0.180

Note: Gray highlighted rows indicate the genetic stock identification estimates did not meet acceptable levels of precision and accuracy to estimate the proportion of mixtures within 10% of the true mixture 90% of the time.

Appendix Q.–District 15 commercial drift gillnet fishery genetic stock composition results by statistical week and reporting group, 2020.

Statistical week	Sample size	Genotyped	Aged only	Not genotyped or aged	Reporting group	Mean	SD	CI 5%	CI 95%
26–27	537	187	272	78	Chilkat Lake	0.072	0.018	0.045	0.103
					Chilkat Mainstem	0.088	0.022	0.054	0.126
					Chilkoot	0.130	0.024	0.093	0.171
					Other	0.711	0.034	0.654	0.765
28	498	187	232	79	Chilkat Lake	0.129	0.025	0.090	0.173
					Chilkat Mainstem	0.108	0.022	0.074	0.146
					Chilkoot	0.305	0.034	0.251	0.361
					Other	0.458	0.038	0.397	0.520
29	504	185	256	63	Chilkat Lake	0.123	0.022	0.088	0.162
					Chilkat Mainstem	0.057	0.016	0.032	0.085
					Chilkoot	0.408	0.035	0.352	0.466
					Other	0.412	0.036	0.354	0.470
30	554	184	276	94	Chilkat Lake	0.126	0.023	0.090	0.166
					Chilkat Mainstem	0.065	0.017	0.039	0.096
					Chilkoot	0.263	0.031	0.213	0.314
					Other	0.546	0.036	0.487	0.605
31	344	186	118	40	Chilkat Lake	0.170	0.028	0.125	0.218
					Chilkat Mainstem	0.031	0.018	0.000	0.062
					Chilkoot	0.438	0.035	0.379	0.495
					Other	0.361	0.039	0.300	0.425
32	397	186	159	52	Chilkat Lake	0.110	0.021	0.079	0.146
					Chilkat Mainstem	0.002	0.003	0.000	0.009
					Chilkoot	0.760	0.030	0.709	0.807
					Other	0.128	0.026	0.088	0.172
33	480	184	205	91	Chilkat Lake	0.214	0.026	0.172	0.257
					Chilkat Mainstem	0.001	0.003	0.000	0.007
					Chilkoot	0.479	0.033	0.425	0.534
					Other	0.306	0.033	0.252	0.362
34	260	184	64	12	Chilkat Lake	0.214	0.030	0.166	0.263
					Chilkat Mainstem	0.011	0.011	0.000	0.033
					Chilkoot	0.492	0.036	0.433	0.551
					Other	0.283	0.036	0.226	0.343
35–39	340	183	114	43	Chilkat Lake	0.411	0.032	0.360	0.464
					Chilkat Mainstem	0.003	0.004	0.000	0.012
					Chilkoot	0.574	0.032	0.521	0.626
					Other	0.012	0.009	0.002	0.029
all	3,914	1,666	1,696	552	Chilkat Lake	0.175	0.010	0.159	0.191
					Chilkat Mainstem	0.027	0.005	0.020	0.035
					Chilkoot	0.495	0.013	0.475	0.516
					Other	0.303	0.012	0.283	0.323

Appendix R.–Estimated age composition of sockeye salmon harvested in the District 15 commercial drift gillnet fishery by year and reporting group, 2017–2020.

Year	Age	Reporting group	Mean	SD	CI 5%	CI 95%	P0
2017	0.3	Chilkat Lake	0.002	0.001	0.000	0.004	0.015
2017	0.3	Chilkat Mainstem	0.008	0.002	0.005	0.012	0.000
2017	0.3	Chilkoot	0.002	0.001	0.000	0.004	0.000
2017	0.3	Other	0.032	0.004	0.026	0.039	0.000
2017	1.2	Chilkat Lake	0.003	0.002	0.001	0.006	0.000
2017	1.2	Chilkat Mainstem	0.000	0.001	0.000	0.001	0.159
2017	1.2	Chilkoot	0.009	0.003	0.004	0.014	0.000
2017	1.2	Other	0.196	0.009	0.182	0.210	0.000
2017	1.3	Chilkat Lake	0.089	0.008	0.076	0.103	0.000
2017	1.3	Chilkat Mainstem	0.003	0.002	0.000	0.006	0.006
2017	1.3	Chilkoot	0.030	0.005	0.021	0.039	0.000
2017	1.3	Other	0.504	0.013	0.482	0.525	0.000
2017	2.2	Chilkat Lake	0.017	0.003	0.012	0.023	0.000
2017	2.2	Chilkat Mainstem	0.000	0.000	0.000	0.000	0.788
2017	2.2	Chilkoot	0.000	0.000	0.000	0.000	0.766
2017	2.2	Other	0.021	0.004	0.016	0.028	0.000
2017	2.3	Chilkat Lake	0.030	0.005	0.023	0.038	0.000
2017	2.3	Chilkat Mainstem	0.000	0.000	0.000	0.000	0.782
2017	2.3	Chilkoot	0.007	0.003	0.003	0.012	0.000
2017	2.3	Other	0.032	0.004	0.025	0.038	0.000
2017	Other	Chilkat Lake	0.002	0.001	0.001	0.004	0.000
2017	Other	Chilkat Mainstem	0.002	0.001	0.001	0.004	0.000
2017	Other	Chilkoot	0.002	0.001	0.001	0.004	0.000
2017	Other	Other	0.010	0.002	0.007	0.014	0.000
2018	0.3	Chilkat Lake	0.001	0.001	0.000	0.003	0.006
2018	0.3	Chilkat Mainstem	0.004	0.001	0.002	0.007	0.000
2018	0.3	Chilkoot	0.001	0.001	0.000	0.004	0.004
2018	0.3	Other	0.017	0.003	0.013	0.022	0.000
2018	1.2	Chilkat Lake	0.007	0.003	0.003	0.012	0.000
2018	1.2	Chilkat Mainstem	0.000	0.000	0.000	0.001	0.179
2018	1.2	Chilkoot	0.089	0.009	0.075	0.103	0.000
2018	1.2	Other	0.167	0.009	0.152	0.183	0.000
2018	1.3	Chilkat Lake	0.071	0.008	0.059	0.084	0.000
2018	1.3	Chilkat Mainstem	0.002	0.002	0.000	0.006	0.019
2018	1.3	Chilkoot	0.303	0.013	0.282	0.324	0.000
2018	1.3	Other	0.133	0.010	0.117	0.149	0.000
2018	2.2	Chilkat Lake	0.096	0.007	0.084	0.108	0.000
2018	2.2	Chilkat Mainstem	0.000	0.000	0.000	0.000	0.773

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Year	Age	Reporting group	Mean	SD	CI 5%	CI 95%	P0
2018	2.2	Chilkoot	0.000	0.000	0.000	0.000	0.742
2018	2.2	Other	0.004	0.002	0.002	0.007	0.000
2018	2.3	Chilkat Lake	0.056	0.006	0.046	0.066	0.000
2018	2.3	Chilkat Mainstem	0.000	0.000	0.000	0.000	0.793
2018	2.3	Chilkoot	0.022	0.005	0.014	0.030	0.000
2018	2.3	Other	0.010	0.003	0.006	0.015	0.000
2018	Other	Chilkat Lake	0.005	0.002	0.002	0.008	0.000
2018	Other	Chilkat Mainstem	0.002	0.001	0.001	0.004	0.000
2018	Other	Chilkoot	0.001	0.001	0.000	0.003	0.001
2018	Other	Other	0.010	0.002	0.007	0.014	0.000
2019	0.3	Chilkat Lake	0.005	0.003	0.000	0.010	0.003
2019	0.3	Chilkat Mainstem	0.036	0.005	0.028	0.045	0.000
2019	0.3	Chilkoot	0.005	0.002	0.002	0.008	0.000
2019	0.3	Other	0.057	0.005	0.049	0.066	0.000
2019	1.2	Chilkat Lake	0.002	0.001	0.000	0.004	0.003
2019	1.2	Chilkat Mainstem	0.001	0.001	0.000	0.003	0.037
2019	1.2	Chilkoot	0.052	0.006	0.043	0.061	0.000
2019	1.2	Other	0.019	0.004	0.014	0.026	0.000
2019	1.3	Chilkat Lake	0.119	0.010	0.103	0.137	0.000
2019	1.3	Chilkat Mainstem	0.009	0.003	0.005	0.014	0.000
2019	1.3	Chilkoot	0.559	0.013	0.537	0.580	0.000
2019	1.3	Other	0.073	0.008	0.061	0.087	0.000
2019	2.2	Chilkat Lake	0.013	0.002	0.009	0.016	0.000
2019	2.2	Chilkat Mainstem	0.000	0.000	0.000	0.001	0.554
2019	2.2	Chilkoot	0.000	0.000	0.000	0.000	0.693
2019	2.2	Other	0.002	0.001	0.000	0.005	0.000
2019	2.3	Chilkat Lake	0.030	0.003	0.025	0.036	0.000
2019	2.3	Chilkat Mainstem	0.001	0.001	0.000	0.003	0.289
2019	2.3	Chilkoot	0.004	0.002	0.001	0.008	0.000
2019	2.3	Other	0.007	0.002	0.004	0.011	0.000
2019	Other	Chilkat Lake	0.001	0.001	0.000	0.002	0.000
2019	Other	Chilkat Mainstem	0.001	0.001	0.001	0.003	0.000
2019	Other	Chilkoot	0.000	0.000	0.000	0.001	0.001
2019	Other	Other	0.004	0.001	0.002	0.006	0.000
2020	0.3	Chilkat Lake	0.001	0.001	0.000	0.004	0.006
2020	0.3	Chilkat Mainstem	0.022	0.003	0.017	0.028	0.000
2020	0.3	Chilkoot	0.001	0.001	0.000	0.003	0.035
2020	0.3	Other	0.026	0.004	0.020	0.033	0.000
2020	1.2	Chilkat Lake	0.004	0.002	0.001	0.007	0.000

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Year	Age	Reporting group	Mean	SD	CI 5%	CI 95%	P0
2020	1.2	Chilkat Mainstem	0.000	0.001	0.000	0.003	0.584
2020	1.2	Chilkoot	0.052	0.007	0.042	0.063	0.000
2020	1.2	Other	0.114	0.007	0.102	0.126	0.000
2020	1.3	Chilkat Lake	0.044	0.006	0.035	0.055	0.000
2020	1.3	Chilkat Mainstem	0.001	0.002	0.000	0.006	0.467
2020	1.3	Chilkoot	0.418	0.012	0.398	0.437	0.000
2020	1.3	Other	0.139	0.009	0.124	0.155	0.000
2020	2.2	Chilkat Lake	0.056	0.006	0.047	0.065	0.000
2020	2.2	Chilkat Mainstem	0.000	0.000	0.000	0.000	0.837
2020	2.2	Chilkoot	0.001	0.002	0.000	0.005	0.359
2020	2.2	Other	0.008	0.003	0.004	0.013	0.000
2020	2.3	Chilkat Lake	0.067	0.006	0.058	0.077	0.000
2020	2.3	Chilkat Mainstem	0.000	0.000	0.000	0.000	0.839
2020	2.3	Chilkoot	0.015	0.004	0.009	0.022	0.000
2020	2.3	Other	0.005	0.003	0.002	0.010	0.000
2020	Other	Chilkat Lake	0.002	0.001	0.001	0.004	0.000
2020	Other	Chilkat Mainstem	0.003	0.001	0.001	0.005	0.000
2020	Other	Chilkoot	0.008	0.002	0.004	0.011	0.000
2020	Other	Other	0.011	0.002	0.007	0.015	0.000

Appendix S.–Historical age composition of the Chilkat Lake sockeye salmon escapement weighted by statistical week, 1982–2020.

		Age class											
Year[a]	Weighted by statistical week	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	3.3	Other
1982	Proportion by age class	0.62%	0.06%	2.19%	1.65%	12.05%	47.69%	0.00%	33.99%	1.58%	0.00%	0.08%	0.08%
	SE of %	0.36%	0.06%	0.43%	0.25%	0.64%	1.79%	0.00%	1.75%	0.56%	0.00%	0.06%	---
	n (sample size)	6	1	38	43	210	739	0	568	21	0	2	2
1983	Proportion by age class	0.63%	0.00%	2.94%	3.28%	32.26%	32.45%	0.02%	28.17%	0.18%	0.02%	0.04%	0.00%
	SE of %	0.15%	0.00%	0.32%	0.37%	0.65%	0.87%	0.02%	0.88%	0.09%	0.02%	0.04%	---
	n (sample size)	21	0	92	78	1,083	795	1	772	4	1	1	0
1984	Proportion by age class	0.12%	0.04%	1.61%	1.51%	22.57%	53.54%	0.03%	20.28%	0.22%	0.03%	0.05%	0.00%
	SE of %	0.09%	0.04%	0.27%	0.25%	0.71%	0.90%	0.03%	0.81%	0.10%	0.03%	0.05%	---
	n (sample size)	2	1	41	42	621	1,463	1	550	5	1	1	0
1985	Proportion by age class	0.88%	0.00%	0.66%	3.48%	10.00%	39.25%	0.41%	44.77%	0.37%	0.00%	0.00%	0.17%
	SE of %	0.32%	0.00%	0.24%	0.54%	0.77%	1.36%	0.23%	1.44%	0.16%	0.00%	0.00%	---
	n (sample size)	8	0	9	44	123	529	3	609	6	0	0	2
1986	Proportion by age class	0.00%	0.00%	3.77%	0.99%	2.58%	26.71%	0.00%	63.32%	2.32%	0.00%	0.30%	0.00%
	SE of %	0.00%	0.00%	0.75%	0.48%	0.79%	2.16%	0.00%	2.29%	0.73%	0.00%	0.27%	---
	n (sample size)	0	0	16	5	15	194	0	687	18	0	5	0
1987	Proportion by age class	1.26%	0.00%	1.78%	3.36%	24.20%	34.77%	0.00%	33.70%	0.78%	0.00%	0.14%	0.00%
	SE of %	0.38%	0.00%	0.42%	0.66%	1.14%	1.51%	0.00%	1.59%	0.31%	0.00%	0.08%	---
	n (sample size)	13	0	27	40	358	499	0	512	8	1	3	0
1988	Proportion by age class	0.00%	0.06%	0.55%	0.00%	25.04%	12.75%	0.08%	61.18%	0.07%	0.02%	0.24%	0.00%
	SE of %	0.00%	0.04%	0.24%	0.00%	0.84%	1.46%	0.04%	1.65%	0.05%	0.02%	0.24%	---
	n (sample size)	0	2	16	0	908	151	4	833	2	1	1	0
1989	Proportion by age class	0.00%	0.00%	0.73%	0.00%	36.44%	34.95%	0.10%	27.50%	0.14%	0.00%	0.10%	0.05%
	SE of %	0.00%	0.00%	0.19%	0.00%	0.78%	0.87%	0.06%	0.92%	0.14%	0.00%	0.07%	---
	n (sample size)	0	0	28	0	1,660	1,119	4	1,059	1	0	2	1
1990	Proportion by age class	0.00%	0.09%	2.04%	0.00%	14.62%	26.96%	0.38%	55.27%	0.63%	0.01%	0.01%	0.00%
	SE of %	0.00%	0.06%	0.40%	0.00%	0.81%	0.98%	0.11%	1.16%	0.19%	0.00%	0.01%	---
	n (sample size)	0	2	47	0	368	653	13	1,529	20	2	1	0
1991	Proportion by age class	0.00%	0.00%	2.49%	0.00%	34.09%	20.85%	0.04%	42.25%	0.00%	0.15%	0.14%	0.00%
	SE of %	0.00%	0.00%	0.47%	0.00%	1.82%	1.07%	0.04%	1.89%	0.00%	0.07%	0.08%	---
	n (sample size)	0	0	34	0	578	350	1	632	0	4	3	0

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Year	Weighted by statistical week	Age class											
		1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	3.3	Other
1992	Proportion by age class	0.00%	0.05%	0.68%	0.00%	21.57%	20.92%	0.18%	56.38%	0.07%	0.05%	0.07%	0.04%
	SE of %	0.00%	0.03%	0.15%	0.00%	0.66%	1.06%	0.08%	1.14%	0.07%	0.05%	0.05%	---
	n (sample size)	0	3	27	0	1,021	424	5	1,019	1	1	2	2
1993	Proportion by age class	0.00%	0.04%	3.67%	0.00%	7.64%	32.98%	0.00%	51.06%	4.42%	0.00%	0.00%	0.19%
	SE of %	0.00%	0.03%	0.35%	0.00%	0.39%	1.21%	0.00%	1.26%	0.57%	0.00%	0.00%	---
	n (sample size)	0	2	151	0	356	856	0	915	85	0	0	2
1994	Proportion by age class	0.00%	0.00%	1.95%	0.00%	40.22%	19.32%	0.06%	37.01%	0.17%	0.00%	1.28%	0.00%
	SE of %	0.00%	0.00%	0.35%	0.00%	1.19%	1.15%	0.05%	1.36%	0.10%	0.00%	0.35%	---
	n (sample size)	0	0	57	0	1,281	249	2	581	3	0	14	0
1995	Proportion by age class	0.00%	0.01%	4.44%	0.00%	25.00%	21.40%	0.74%	48.17%	0.16%	0.08%	0.01%	0.00%
	SE of %	0.00%	0.01%	0.46%	0.00%	1.01%	0.99%	0.18%	1.20%	0.11%	0.08%	0.01%	---
	n (sample size)	0	1	148	0	730	476	23	1,308	3	1	1	0
1996	Proportion by age class	0.00%	0.00%	10.39%	0.00%	67.53%	8.77%	0.00%	13.31%	0.00%	0.00%	0.00%	0.00%
	SE of %	0.00%	0.00%	1.74%	0.00%	2.67%	1.61%	0.00%	1.94%	0.00%	0.00%	0.00%	---
	n (sample size)	0	0	32	0	208	27	0	41	0	0	0	0
1997	Proportion by age class	0.40%	0.00%	38.80%	1.33%	19.87%	14.00%	0.00%	25.60%	0.00%	0.00%	0.00%	0.00%
	SE of %	0.23%	0.00%	1.78%	0.42%	1.46%	1.27%	0.00%	1.59%	0.00%	0.00%	0.00%	---
	n (sample size)	3	0	291	10	149	105	0	192	0	0	0	0
1998	Proportion by age class	0.08%	0.00%	4.92%	0.33%	69.45%	19.03%	0.00%	6.01%	0.00%	0.17%	0.00%	0.00%
	SE of %	0.08%	0.00%	0.63%	0.17%	1.33%	1.13%	0.00%	0.69%	0.00%	0.12%	0.00%	---
	n (sample size)	1	0	59	4	832	228	0	72	0	2	0	0
1999	Proportion by age class	0.00%	0.00%	1.34%	0.00%	22.88%	16.99%	0.08%	58.48%	0.03%	0.19%	0.00%	0.00%
	SE of %	0.00%	0.00%	0.23%	0.00%	0.68%	0.97%	0.05%	1.10%	0.03%	0.10%	0.00%	---
	n (sample size)	0	0	43	0	806	365	3	1,325	1	5	0	0
2000	Proportion by age class	0.00%	0.07%	1.77%	0.00%	5.52%	8.89%	0.25%	80.00%	3.45%	0.03%	0.02%	0.00%
	SE of %	0.00%	0.07%	0.31%	0.00%	0.53%	0.74%	0.14%	1.00%	0.48%	0.02%	0.02%	---
	n (sample size)	0	1	56	0	119	180	6	1,886	65	2	1	0
2001	Proportion by age class	0.00%	0.00%	2.94%	0.00%	71.39%	7.61%	0.19%	15.37%	0.05%	0.26%	2.11%	0.08%
	SE of %	0.00%	0.00%	0.38%	0.00%	0.88%	0.52%	0.11%	0.72%	0.04%	0.13%	0.26%	---
	n (sample size)	0	0	71	0	1,335	289	3	631	2	4	101	5

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Year	Weighted by statistical week	Age class											
		1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	3.3	Other
2002	Proportion by age class	0.03%	0.00%	2.50%	0.20%	20.33%	25.01%	0.38%	51.42%	0.00%	0.01%	0.10%	0.03%
	SE of %	0.03%	0.00%	0.37%	0.14%	0.81%	1.08%	0.14%	1.22%	0.00%	0.00%	0.10%	---
	n (sample size)	1	0	62	3	663	503	10	1,259	0	1	1	1
2003	Proportion by age class	0.05%	0.02%	2.51%	0.25%	10.83%	19.18%	0.11%	66.59%	0.25%	0.20%	0.00%	0.00%
	SE of %	0.03%	0.01%	0.25%	0.09%	0.51%	1.35%	0.05%	1.40%	0.12%	0.08%	0.00%	---
	n (sample size)	4	3	110	8	456	322	4	1,248	7	7	0	0
2004	Proportion by age class	0.09%	0.08%	3.68%	0.26%	47.11%	18.11%	0.02%	29.90%	0.15%	0.23%	0.38%	0.00%
	SE of %	0.05%	0.06%	0.38%	0.11%	0.73%	0.75%	0.01%	0.82%	0.08%	0.11%	0.12%	---
	n (sample size)	4	2	106	6	1,494	517	1	853	4	5	12	0
2005	Proportion by age class	0.06%	0.08%	3.44%	0.33%	28.55%	10.21%	0.59%	56.54%	0.08%	0.04%	0.08%	0.00%
	SE of %	0.04%	0.04%	0.38%	0.15%	0.84%	0.70%	0.16%	0.99%	0.08%	0.04%	0.08%	---
	n (sample size)	2	3	89	6	759	215	15	1,172	1	1	1	0
2006	Proportion by age class	0.12%	0.05%	4.64%	0.57%	55.43%	6.49%	0.02%	32.32%	0.04%	0.00%	0.32%	0.00%
	SE of %	0.08%	0.03%	0.48%	0.17%	1.14%	0.54%	0.02%	1.09%	0.04%	0.00%	0.11%	---
	n (sample size)	2	4	98	13	1,069	145	1	721	1	0	9	0
2007	Proportion by age class	0.31%	0.02%	4.57%	2.05%	22.45%	25.35%	0.40%	44.10%	0.33%	0.38%	0.00%	0.04%
	SE of %	0.12%	0.02%	0.63%	0.37%	1.11%	1.42%	0.15%	1.57%	0.21%	0.15%	0.00%	---
	n (sample size)	10	1	99	35	470	318	9	613	5	8	0	2
2008	Proportion by age class	0.22%	1.42%	4.18%	0.39%	25.14%	56.35%	0.08%	12.11%	0.00%	0.05%	0.05%	0.02%
	SE of %	0.10%	0.23%	0.49%	0.19%	1.22%	1.85%	0.03%	1.65%	0.00%	0.04%	0.04%	---
	n (sample size)	7	45	114	4	434	405	5	148	0	1	1	1
2009	Proportion by age class	0.23%	0.36%	2.32%	0.30%	51.26%	20.21%	0.00%	25.30%	0.00%	0.00%	0.03%	0.00%
	SE of %	0.10%	0.12%	0.32%	0.11%	0.69%	0.87%	0.00%	0.88%	0.00%	0.00%	0.02%	---
	n (sample size)	6	10	56	8	1,280	468	0	486	0	0	1	0
2010	Proportion by age class	0.62%	0.00%	1.98%	1.25%	24.81%	12.32%	0.77%	58.01%	0.07%	0.08%	0.00%	0.08%
	SE of %	0.21%	0.00%	0.36%	0.36%	1.00%	1.11%	0.23%	1.36%	0.07%	0.08%	0.00%	---
	n (sample size)	10	0	32	13	355	142	13	597	1	1	0	1
2011	Proportion by Age Class	0.22%	0.18%	6.25%	2.80%	26.57%	34.79%	0.04%	28.50%	0.43%	0.07%	0.16%	0.00%
	SE of %	0.18%	0.09%	0.70%	0.51%	1.17%	1.21%	0.02%	1.34%	0.18%	0.07%	0.10%	---
	n (sample size)	2	4	107	39	444	523	2	391	6	1	3	0

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		Age class											
Year	Weighted by statistical week	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	3.3	Other
2012	Proportion by age class	0.27%	1.14%	2.62%	0.56%	27.23%	50.32%	0.10%	16.29%	1.15%	0.09%	0.04%	0.19%
	SE of %	0.11%	0.28%	0.41%	0.18%	0.90%	1.27%	0.06%	1.11%	0.36%	0.07%	0.04%	---
	n (sample size)	7	19	49	10	587	613	3	240	15	2	1	2
2013	Proportion by age class	0.19%	0.56%	7.07%	0.45%	16.36%	31.79%	0.44%	42.72%	0.27%	0.06%	0.08%	0.00%
	SE of %	0.08%	0.22%	1.41%	0.22%	0.85%	2.46%	0.16%	2.59%	0.13%	0.06%	0.08%	---
	n (sample size)	6	8	110	7	321	277	8	533	5	1	1	0
2014	Proportion by age class	0.24%	0.00%	0.62%	1.36%	41.63%	29.99%	0.00%	24.64%	0.37%	0.10%	0.75%	0.29%
	SE of %	0.11%	0.00%	0.21%	0.33%	0.91%	1.90%	0.00%	1.86%	0.20%	0.06%	0.45%	---
	n (sample size)	9	0	15	24	629	320	0	279	4	3	9	4
2015	Proportion by age class	0.15%	0.14%	3.70%	0.61%	11.69%	16.63%	0.44%	65.89%	0.72%	0.02%	0.00%	0.00%
	SE of %	0.06%	0.06%	0.34%	0.20%	0.92%	1.67%	0.35%	1.87%	0.38%	0.02%	0.00%	---
	n (sample size)	6	5	129	11	280	190	5	881	7	1	0	0
2016	Proportion by age class	0.15%	0.00%	2.85%	1.09%	33.45%	26.75%	0.00%	35.71%	0.00%	0.00%	0.00%	0.00%
	SE of %	0.08%	0.00%	0.50%	0.44%	1.38%	1.63%	0.00%	1.92%	0.00%	0.00%	0.00%	---
	n (sample size)	4	0	59	8	465	184	0	282	0	0	0	0
2017	Proportion by age class	0.16%	0.36%	2.00%	0.16%	51.32%	16.23%	0.52%	29.26%	0.00%	0.00%	0.00%	0.00%
	SE of %	0.15%	0.20%	0.50%	0.15%	2.47%	3.21%	0.26%	3.49%	0.00%	0.00%	0.00%	---
	n (sample size)	1	3	16	1	371	49	4	94	0	0	0	0
2018	Proportion by age class	0.29%	0.21%	3.50%	2.03%	28.71%	42.22%	0.28%	21.97%	0.00%	0.58%	0.21%	0.00%
	SE of %	0.17%	0.13%	0.79%	0.94%	2.00%	2.70%	0.17%	2.45%	0.00%	0.58%	0.21%	---
	n (sample size)	3	3	32	9	236	136	3	119	0	1	1	0
2019	Proportion by age class	0.00%	0.07%	0.86%	0.24%	65.54%	14.64%	0.00%	18.62%	0.00%	0.00%	0.00%	0.02%
	SE of %	0.00%	0.04%	0.36%	0.13%	1.37%	1.17%	0.00%	1.21%	0.00%	0.00%	0.00%	---
	n (sample size)	0	3	10	4	482	142	0	175	0	0	0	1
2020	Proportion by age class	1.59%	1.25%	4.38%	1.64%	27.04%	34.75%	0.95%	28.27%	0.00%	0.00%	0.00%	0.12%
	SE of %	0.75%	0.37%	1.03%	0.63%	2.61%	2.42%	0.37%	2.68%	0.00%	0.00%	0.00%	---
	n (sample size)	9	11	26	7	169	222	7	167	0	0	0	1

[a] Age composition estimates from 1996 to 1998 were not weighted by statistical week since the weir was not operated in those years.

Appendix T.–Average lengths (mid eye to tail fork in mm) of male sockeye salmon in the Chilkat Lake escapement by major age class, 1982–2020.

	Age 1.2			Age 1.3			Age 2.2			Age 2.3		
Year	Mean	SE	*n*	Mean	SE	*n*	Mean	SE	*n*	Mean	SE	*n*
1982	528	10.0	18	619	2.4	120	547	2.3	293	627	1.3	335
1983	491	5.7	54	604	1.6	528	545	1.9	405	609	1.9	392
1984	513	11.7	27	606	1.4	350	522	1.6	750	603	1.7	317
1985	502	7.7	6	607	2.5	76	512	2.6	252	610	1.4	315
1986	473	14.9	10	617	8.9	10	555	4.0	83	621	1.3	428
1987	507	11.5	20	604	2.1	198	538	2.5	246	606	2.1	314
1988	550	4.9	13	627	0.9	717	567	3.1	107	632	1.1	594
1989	537	9.4	22	605	1.2	1,050	547	1.2	574	596	1.8	526
1990	510	7.8	33	585	2.9	179	536	1.8	358	580	1.7	879
1991	520	6.8	25	596	1.7	297	529	1.7	227	592	2.0	318
1992	520	5.3	15	594	1.3	545	528	2.0	278	593	1.5	609
1993	505	3.9	103	582	2.2	186	524	1.6	516	582	1.6	535
1994	547	7.9	44	582	1.2	892	547	3.3	173	583	1.9	344
1995	514	3.8	127	579	1.6	433	524	2.2	290	577	1.5	793
1996	525	3.1	21	598	2.6	99	510	6.8	19	582	7.1	16
1997	470	2.6	193	587	3.3	64	516	5.1	45	582	4.1	73
1998	479	2.5	56	545	1.8	401	473	2.5	112	552	4.2	38
1999	553	8.6	32	602	1.5	483	536	2.5	226	591	1.3	701
2000	482	5.3	52	583	6.2	56	500	3.7	111	580	1.6	858
2001	525	7.3	51	596	1.5	617	536	2.9	174	597	1.6	359
2002	499	9.7	27	616	2.0	309	524	3.1	232	615	1.5	634
2003	515	5.1	68	591	2.3	207	541	3.2	158	604	1.1	617
2004	513	5.2	57	597	0.9	744	509	2.2	250	598	1.2	467
2005	489	5.5	66	576	1.8	309	519	3.4	103	585	1.3	542
2006	533	5.1	64	592	1.1	560	530	4.9	88	581	1.6	365
2007	522	5.3	59	598	1.9	240	540	3.3	168	598	1.5	296
2008	518	6.6	69	605	2.3	183	554	2.6	216	603	4.3	61
2009	483	6.6	41	595	1.5	536	536	3.2	181	595	2.2	196
2010	490	12.2	22	585	2.9	130	547	5.3	62	596	1.7	298
2011	496	5.0	78	602	2.5	177	554	2.5	202	606	2.2	146
2012	510	8.8	26	620	1.8	223	554	2.5	227	626	2.6	120
2013	518	5.4	65	618	2.6	134	559	3.5	115	613	2.5	202
2014	592	6.0	3	625	1.9	274	546	4.0	109	625	2.1	111
2015	502	3.4	59	581	2.9	106	534	3.8	56	574	1.9	345
2016	521	5.1	35	592	1.3	196	522	4.1	68	593	2.1	117
2017	529	9.0	9	591	1.7	210	541	6.3	17	586	4.6	40
2018	484	6.4	26	581	2.8	110	536	4.8	56	592	3.4	72
2019	503	28.2	4	571	1.9	218	504	5.6	54	566	3.0	91
2020	485	8.7	13	559	4.2	73	496	4.0	76	568	3.5	73
Average (1982–2016)	513			597			533			597		
Average (2017–2020)	500			575			519			578		

Appendix U.–Average lengths (mid eye to tail fork in mm) of female sockeye salmon in the Chilkat Lake escapement by major age class, 1982–2020.

	Age 1.2			Age 1.3			Age 2.2			Age 2.3		
Year	Mean	SE	*n*	Mean	SE	*n*	Mean	SE	*n*	Mean	SE	*n*
1982	509	5.7	20	594	2.8	90	536	1.4	444	600	1.7	233
1983	522	4.6	38	589	1.1	529	539	1.3	384	594	1.3	367
1984	516	11.7	14	583	1.4	270	522	1.1	710	583	1.9	231
1985	508	20.4	3	582	3.3	47	524	1.3	277	582	1.5	293
1986	521	15.6	6	575	10.8	5	542	2.5	110	599	1.7	259
1987	514	12.4	7	590	1.9	160	530	1.8	252	589	1.8	198
1988	500	40.4	3	598	1.6	189	553	4.6	44	607	1.7	237
1989	534	20.0	6	588	1.0	607	540	1.0	524	585	1.1	526
1990	520	7.7	14	578	1.8	189	525	1.5	294	579	1.1	648
1991	518	8.0	9	572	1.4	281	527	1.8	123	576	1.4	314
1992	512	8.0	11	573	1.1	475	524	2.0	146	575	1.3	410
1993	516	3.2	48	566	1.8	170	518	1.3	340	565	1.5	379
1994	538	8.7	13	561	1.3	386	520	3.4	76	564	1.9	236
1995	505	9.0	21	566	1.4	296	517	2.0	185	566	1.2	514
1996	530	4.0	11	578	2.2	109	526	4.3	8	574	4.0	25
1997	502	3.2	82	566	3.2	83	522	3.6	51	567	2.7	115
1998	465	7.6	3	542	1.2	430	478	1.8	116	532	4.4	34
1999	520	10.8	11	580	1.4	323	529	2.1	138	574	1.0	623
2000	500	33.3	3	578	3.8	62	524	3.5	68	580	0.9	1,012
2001	556	7.7	20	586	0.9	714	529	2.5	115	581	1.7	272
2002	525	5.7	34	598	1.4	345	532	1.8	270	597	1.1	598
2003	528	4.5	41	578	1.5	248	532	2.1	160	582	1.0	630
2004	519	2.8	49	579	0.8	750	513	1.3	267	578	1.2	386
2005	505	6.7	22	570	1.0	448	523	2.2	109	574	0.9	628
2006	517	3.1	34	573	0.9	509	515	3.7	57	568	1.2	355
2007	521	4.1	40	582	1.7	230	532	1.9	150	581	1.3	317
2008	533	4.6	45	582	1.5	251	536	1.9	189	587	2.2	86
2009	525	5.3	15	581	0.9	744	535	1.5	287	581	1.4	290
2010	561	8.1	10	579	1.6	225	538	2.5	80	581	1.4	297
2011	532	5.1	29	585	1.4	266	538	1.4	321	589	1.3	245
2012	529	4.2	23	594	1.4	363	541	1.4	386	596	2.4	120
2013	534	4.8	45	593	2.0	187	547	1.9	162	596	1.3	331
2014	533	6.8	12	597	1.5	352	532	2.1	211	598	2.1	168
2015	517	3.1	69	571	1.6	174	527	1.8	134	564	1.1	533
2016	523	3.9	24	572	1.3	269	522	2.2	115	575	1.6	165
2017	520	12.0	7	570	1.6	158	527	4.4	32	572	3.6	54
2018	514	9.5	6	572	2.0	125	521	2.4	82	576	3.4	49
2019	483	14.1	6	551	1.5	256	508	3.0	87	547	2.6	84
2020	494	5.2	13	545	2.3	95	497	1.9	145	550	2.6	94
Average (1982–2016)	520			579			528			580		
Average (2017–2020)	503			559			513			561		

Appendix V.–Monthly and seasonal mean euphotic zone depths (EZD) and water temperatures at Chilkat Lake. All entries are averages of data from stations 1A and 2A. Annual averages were not included for years missing more than 1 month of data.

	EZD (m)						Water temperature (ºC) at 1.0 m depth					
Year	June	July	Aug	Sept	Oct	Mean	June	July	Aug	Sept	Oct	Mean
1987	15.3	14.9	20.2	17.9	14.6	16.6	9.6	14.5	15.7	11.6	7.5	11.8
1988	11.7	16.6	16.8	22.6	22.5	18.0	13.3	14.3	14.2	12.5	10.9	13.0
1989	16.7	12.9	18.9	19.9	19.4	17.6	11.8	17.0	17.3	13.9	9.3	13.9
1990	13.6	16.5	19.1	14.4	8.0	14.3	13.0	14.9	15.5	14.8	10.8	13.8
1991	13.0	14.4	16.0	19.8	14.6	15.6	10.6	14.3	15.3	12.2	8.2	12.1

1995	11.5	16.8	14.3	19.4	21.3	16.7	13.3	16.0	16.0	13.7	9.9	13.8

1999	10.0	17.8	21.1	20.7	22.2	18.4	14.3	14.7	16.2	12.7	7.9	13.2
2000	15.7	19.9	23.2	20.3	20.8	20.0	12.1	14.3	14.8	12.0	7.9	12.2
2001	28.4	23.5	16.5	16.7	18.2	20.7	14.0	14.5	17.2	12.7	9.4	13.6
2002	ND	18.5	18.0	25.2	33.1	23.7	13.4	13.6	15.5	12.3	9.9	12.9
2003	19.5	20.5	23.7	22.1	33.9	23.9	12.8	17.3	16.4	13.4	10.3	14.0
2004	21.9	ND	19.7	13.9	ND	ND	ND	ND	ND	17.0	ND	17.0
2005	23.0	ND	23.6	ND	21.7	ND	14.3	16.2	17.3	ND	10.3	14.5

2007	28.3	16.2	25.0	22.3	22.7	22.9	12.7	16.2	15.6	13.1	8.3	13.2
2008	ND	21.5	18.1	16.1	ND	ND	ND	13.0	14.8	11.6	ND	13.1

2010	13.4	22.4	14.8	21.1	ND	17.9	12.4	15.0	15.2	14.6	ND	14.3
2011	18.0	35.8	28.8	19.9	26.2	25.7	13.1	14.8	13.9	11.6	9.8	12.6
2012	ND	28.1	25.5	31.9	ND	ND	ND	11.6	16.2	12.6	ND	13.5
2013	13.9	28.9	17.3	ND	26.5	21.7	16.8	19.9	15.8	ND	11.1	15.9
2014	19.9	17.0	21.6	18.9	17.1	18.9	8.2	14.0	15.3	ND	ND	12.5
2015	28.0	19.8	16.0	ND	14.1	19.5	16.1	16.1	15.1	ND	10.8	14.5
2016	15.6	17.5	16.5	16.9	ND	16.6	12.2	15.8	16.5	15.8	11.5	14.4
2017	18.0	21.9	19.3	19.2	34.2	22.5	12.3	14.6	18.0	14.6	11.5	14.2
2018	16.2	25.5	17.2	19.9	ND	19.7	10.9	15.4	16.7	16.0	ND	14.8
2019	ND	16.6	17.4	39.0	17.6	22.7	13.4	20.0	17.2	15.8	12.3	15.7
2020	24.5	17.9	17.2	19.9	19.4	19.8	10.2	14.0	16.6	14.0	12.5	13.5
Average (1987–2016)	17.8	20.0	19.8	20.0	21.7	19.4	12.6	15.3	15.9	13.2	9.6	13.6
Average (2017–2020)	19.6	20.5	17.8	24.5	23.7	21.2	11.7	16.0	17.1	15.1	12.1	14.5

Source: Data from 1987 to 1991 are from Barto (1996).

Note: ND = no data collected.

Appendix W.–Estimated monthly and seasonal mean zooplankton density and biomass at Chilkat Lake, 1987–2020. All stations were averaged and species combined.

			Monthly mean density (no./m²/1000)					Seasonal mean density (no./m²/1000)			Weighted mean biomass (mg/m²/1000)		
Year	Lab.	Stations sampled	June	July	Aug.	Sep.	Oct.	Cladoceran	Copepod	Total	Cladoceran	Copepod	Total
1987	Soldotna	2	1,227	705	621	201	119	108	466	492	0.21	1.12	1.34
1988	Soldotna	2	1,196	841	782	513	249	211	505	716	0.42	1.17	1.59
1989	Soldotna	2	733	985	687	161	229	152	407	559	0.28	0.95	1.23
1990	Soldotna	2	946	640	481	298	139	140	361	501	0.31	0.84	1.16
1991	Soldotna	2	805	106	396	49	86	51	237	288	0.12	0.65	0.77
1994	Soldotna	4	931	750	696	287	171	149	418	567	0.31	1.73	2.04
1995	Soldotna	4	1,248	1,157	841	423	39	230	512	741	0.46	1.52	1.98
1996	Soldotna	4	88	413	258	278	113	192	38	230	0.45	0.20	0.66
1997	Soldotna	4	55	233	186	229	70	136	18	155	0.43	0.08	0.51
1998	Soldotna	4	201	244	155	77	75	150	0	150	0.31	0.00	0.31
1999	Soldotna	4	18	66	147	123	160	94	9	103	0.21	0.04	0.25
2000	Soldotna	4	34	177	234	240	61	146	3	149	0.45	0.01	0.47
2001	Soldotna	4	25	150	92	18	24	61	1	62	0.07	0.00	0.07
2002	Soldotna	4	3	15	110	127	16	52	2	54	0.13	0.01	0.14
2003	Soldotna	4	8	33	98	98	89	65	ND	65	0.09	0.00	0.09
2004	Kodiak	4	ND	230	ND	588	ND	ND	ND	ND	ND	ND	ND
2005	Kodiak	4	99	364	204	ND	35	170	15	176	0.50	0.07	0.56
2006	Kodiak	4	ND	ND	208	ND	37	ND	ND	ND	ND	ND	ND
2007	Kodiak	4	29	80	131	121	37	80	6	80	0.20	0.02	0.23
2008	Kodiak	2	137	454	416	148	65	184	78	244	0.35	0.41	0.76
2009	Kodiak	2	66	215	109	ND	110	121	26	125	0.16	0.13	0.30
2010	Kodiak	2	94	206	620	253	124	63	210	259	0.14	0.45	0.59
2011	Kodiak	2	136	475	436	167	92	189	86	261	0.94	0.39	1.33
2012	Kodiak	2	292	486	ND	208	ND	ND	ND	ND	ND	ND	ND
2013	Kodiak	2	541	330	ND	248	95	153	155	303	0.34	0.82	1.16
2014	Kodiak	2	530	801	328	229	79	191	222	394	0.46	0.78	1.24
2015	Kodiak	2	448	335	121	106	ND	108	154	253	0.36	0.50	0.86
2016	Kodiak	2	291	363	173	99	72	66	139	200	0.36	0.51	0.73
2017	Kodiak	2	509	392	304	374	108	123	226	337	0.37	0.78	1.15
2018	Kodiak	2	1,069	701	313	222	ND	159	433	576	0.72	1.48	2.20
2019	Kodiak	2	604	862	560	576	495	302	323	619	0.82	0.97	1.79
2020	Kodiak	2	1,202	672	841	599	343	156	579	731	0.41	1.65	2.06

Notes: ND = no data. Copepod nauplii and immature cladocerans were not included, because they were not enumerated in laboratory samples until 2002 and 2004. Seasonal means were not calculated for 2004, 2006, and 2012 because more than one month of sampling was missing.