Regional Operational Plan CF.1J.2013.08

Operational Plan: Kanalku Lake Sockeye Salmon Stock Assessment

by

Raymond F. Vinzant

August 2013

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

Symbols and Abbreviations

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

Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

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

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Division of Commercial Fisheries

August 2013

Raymond F. Vinzant,
Alaska Department of Fish and Game, Division of Commercial Fisheries,
802 Third Street, Douglas, Alaska 99824, USA

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SIGNATURE PAGE

Project Title:	*Operational Plan: Kanalku Lake Sockeye Salmon Stock Assessment*
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Division, Region, and Area	*Commercial Fisheries, Region 1, Douglas*
Project Nomenclature:	*SP-114 USFS Kanalku Lake Subsistence; AKSSF grant 44722 Kanalku Creek Subsistence Sockeye.*
Period Covered	*2013*
Field Dates:	*June–August*
Plan Type:	*Category II*

Approval

Title	Name	Signature	Date
Project Leader	Raymond F. Vinzant	[signature]	8/29/13
Biometrician	Haixue Shen	Haixue Shen	08/15/2013
Research Coordinator	Steven C. Heinl	Steven C. Heinl	08/15/2013

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PURPOSE

The primary purpose of the sockeye salmon assessment project is to provide precise estimates of sockeye salmon total escapement into the Kanalku system, precise estimates of sockeye salmon spawning escapement at Kanalku Lake, and the mortality rate at the Kanalku Falls. In 2013, we will conduct the 7th year of weir operations at the outlet stream of Kanalku Lake to count fish entering the lake, observe run-timing, collect biological data, and estimate the spawning escapement of sockeye salmon. To further investigate sockeye salmon mortality associated with passage over Kanalku Falls, we will continue to incorporate two independent camera weirs in lower Kanalku Creek to estimate the total sockeye salmon escapement into the Kanalku system. This sockeye salmon stock assessment will provide escapement information for improved management of the primary traditional subsistence sockeye salmon stock for the people of Angoon.

OBJECTIVES

1. Count all salmon species entering lower Kanalku Creek, below Kanalku Falls, through a series of two double-camera weirs for the duration of the sockeye salmon run to estimate *total* escapement.
2. Count all salmon species passed through a picket weir into Kanalku Lake for the duration of the sockeye salmon run to estimate *spawning* escapement.
3. Validate the picket weir escapement count with a mark-recapture estimate of the sockeye salmon spawning population with an estimated coefficient of variation no greater than 15% of the point estimate.
4. Estimate the sockeye salmon mortality rate at Kanalku Falls.
5. Estimate the age, length, and sex composition of the Kanalku Lake sockeye salmon *spawning* escapement so that the estimated proportion of each age class is within 5% of the true value with at least 95% probability.

BACKGROUND

The coastal village of Angoon, Alaska, located on the western side of Admiralty Island, has a long history of utilizing sockeye salmon (*Oncorhynchus nerka*) from the Kanalku Lake drainage. The use of Kanalku Bay as a traditional subsistence fishery has been documented in several historical and archaeological records, and artifacts from a traditional salmon weir at the head of Kanalku Bay provide physical evidence of the exploitation of salmon resources for at least the last 1,000 years (de Laguna 1960; Moss 1989; Thornton et al. 1990; Goldschmidt and Haas 1998). Although other sockeye salmon runs in the vicinity are available for Angoon subsistence fishermen, including Sitkoh and Basket bays (Geiger et al. 2007), Kanalku Bay remains the preferred harvest area due to its close proximity to the village and ease of access through sheltered waterways.

The introduction of the commercial fishing industry in Southeast Alaska greatly influenced the lives of Native families since the early 20th century. New federal fishing laws and Native participation in the commercial fishing industry led to changes in traditional fishing practices among the Natives of Angoon and other Southeast villages (Thornton et al. 1990; Betts and Wolfe 1992; Turek et al. 2006). After the adoption of Alaska statehood, a non-commercial subsistence fishery was defined and put under a permit system (Turek et al. 2006). Residents of Angoon can obtain subsistence fishing permits for Kanalku, Sitkoh, and Basket bays, along with other nearby areas, but most people prefer to fish in Kanalku Bay (Conitz and Burril 2008). Participation in commercial fisheries by Angoon residents has declined since the 1980s. In 1980, 90 Angoon residents fished 134 commercial fisheries permits, by 1990, 76 Angoon residents fished 119 permits, by 2000, 37 Angoon residents fished 46 commercial permits and by 2010, only six Angoon residents fished six commercial permits (data from the Commercial Fisheries Entry Commission http://www.cfec.state.ak.us/fishery_statistics/earnings.htm). This decline in participation in commercial fisheries has led to a loss in mobility, which has concentrated the Angoon community's subsistence activities closer to home (Bednarski et. al. 2013).

In the late 1990s, annual reported subsistence harvests at Kanalku Bay increased substantially at the same time abundance of Kanalku Lake sockeye salmon appeared to decline. Although reported subsistence harvest tends to under-represent the true harvest (Conitz and Cartwright 2003, Lewis and Cartwright 2004, Lorrigan et al. 2004, Walker 2009), the reported harvests are useful for looking at trends in subsistence catch (Geiger et al. 2007). The reported subsistence harvest at Kanalku Bay increased from an average of 580 sockeye salmon in the late 1980s to an average of 1,550 in the late 1990s (Figure 1). Some Angoon residents reported a decline in the overall abundance of Kanalku sockeye salmon in the 1990s and suggested that community members "slow down" in harvesting that stock (Conitz and Cartwright 2005, Conitz and Burril 2008).

The Alaska Department of Fish and Game (ADF&G) initiated a stock assessment program in 2001 in response to the concern about declining run size and the lack of information about spawning escapements (Conitz and Cartwright 2005). From 2001 to 2006, mark-recapture estimates were conducted on the spawning grounds of Kanalku Lake to estimate the spawning population of sockeye salmon. In 2001, the reported subsistence harvest of sockeye salmon at Kanalku Bay far exceeded an alarmingly low mark-recapture estimate of less than 300 sockeye salmon spawners at Kanalku Lake (Conitz and Cartwright 2005). The Angoon community and ADF&G fisheries managers agreed by consensus that the community would voluntarily curtail fishing in Kanalku Bay during at least the first half of the run (defined as through 14 July) for the 2002 season (Conitz and Burril 2008). In addition, harvest limits at other nearby subsistence sockeye salmon fisheries were increased to encourage fishing effort elsewhere and allow the Kanalku stock to rebuild. During the voluntary closure from 2002 to 2006, the reported harvest of sockeye salmon in Kanalku Bay was minimal. Escapements in 2001 and 2003 were estimated to be less than 300 sockeye salmon but escapement estimates in 2002 and from 2004 to 2006 averaged about 1,300 fish (Conitz and Cartwright 2005).

The voluntary closure at Kanalku Bay was respected, for the most part, and the regular permitted subsistence fishery was resumed in 2006 with a later fishing season and smaller harvest limit of 15 sockeye salmon per household (Conitz and Burril 2008). The later season timing in 2006 made subsistence harvest difficult and it was subsequently shifted back to an earlier season in 2007 to provide more opportunity for subsistence fishermen. The harvest limit per household remained unchanged. Since 2007, the reported subsistence fishing effort and harvest has ranged from 400–700 sockeye salmon (2007–2011; Figure 1).

Beginning in 2007, ADF&G, in cooperation with the Angoon Community Association (ACA), improved the stock assessment project by installing a sockeye salmon weir directly below the outlet of Kanalku Lake to observe run timing, count the sockeye salmon *spawning* escapement, and conduct a weir-to-spawning grounds mark-recapture estimate of escapement. Escapements were less than 1,000 fish in both 2007 and 2008, but improved to more than 2,500 sockeye salmon in both 2009 and 2010 (Vinzant et al. 2009; Vinzant et al. 2010; Vinzant and Bednarski 2010; Vinzant et. al 2011). The escapement estimate in 2011 was about 700 sockeye salmon, likely a result of the very small parent-year escapement observed in 2007 (Vinzant et. al 2012) and the escapement estimate in 2012 was 1,123 (Vinzant et. al 2013) .

Sockeye salmon escapement at Kanalku Lake may also be affected by interception in nearby commercial fisheries conducted in Chatham Strait where sockeye salmon are harvested incidentally in purse seine fisheries targeting pink salmon (*O. gorbuscha*). Although we have no estimates of the harvest of Kanalku sockeye salmon, management of the Chatham Strait fisheries is based on the assumption that this interception is insignificant because of the early run timing of Kanalku sockeye salmon compared to the timing of fishery openings, the distance of Kanalku Bay from these fisheries, and the nature of the mixed stock area where fishing occurs (Geiger et al. 2007). Based on subsistence harvest data collected since 1985, 87% of the total season's subsistence harvest is completed by the time the first purse seine fishery opens in Upper Chatham, and 97% by the end of July (Geiger et al. 2007). In addition, the Chatham Strait shoreline along an area of approximately nine nautical miles from Parker Point to Point Samuel, west and north of Kootznahoo Inlet and the community of Angoon and Kanalku Inlet, has been closed to the purse seine fishery.

Kanalku Falls, a partial barrier to sockeye salmon migration in Kanalku Creek, is known to have a major influence on the size of the sockeye salmon escapement at Kanalku Lake. In most years, substantial numbers of sockeye salmon sit in the pools below the falls where they are susceptible to predation and repeatedly batter themselves on the rocks as they attempt to jump the falls and migrate upstream. In 1970, the U.S. Forest Service blasted resting pools and a small channel in the falls bedrock to assist migrating salmon (Geiger et al. 2007) but many fish still do not successfully ascend the falls. Incomplete studies conducted in 2008 and 2009 suggested that a large portion of the sockeye salmon escapement did not migrate past the falls in those years, but these studies did not provide precise estimates of the total sockeye salmon escapement into the Kanalku system (Vinzant and Bednarski 2010).

In 2012, ADF&G conducted a pilot study to estimate the total escapement of sockeye salmon into the Kanalku system and estimate the mortality rate at the Kanalku falls. A total of 2,289 sockeye salmon were counted at a weir operated below the falls and only 1,123 sockeye salmon were counted through a weir above the falls at the lake outlet (Vinzant et. al 2013). Thus, the potential sockeye salmon escapement into Kanalku Lake was reduced by more than 1,100 fish; an inriver mortality rate of 49%.

The primary purpose of the sockeye salmon assessment project is to provide precise estimates of sockeye salmon *total* escapement into the Kanalku system, precise estimates of sockeye salmon *spawning* escapement at Kanalku Lake, and the mortality rate at the Kanalku Falls. In 2013, we will conduct the 7th year of weir operations at the outlet stream of Kanalku Lake to count fish entering the lake, observe run-timing, collect biological data, and estimate the *spawning* escapement of sockeye salmon. To further investigate sockeye salmon mortality associated with passage over Kanalku Falls, we will continue to incorporate two independent camera weirs in lower Kanalku Creek to estimate the *total* sockeye salmon escapement into the Kanalku system.

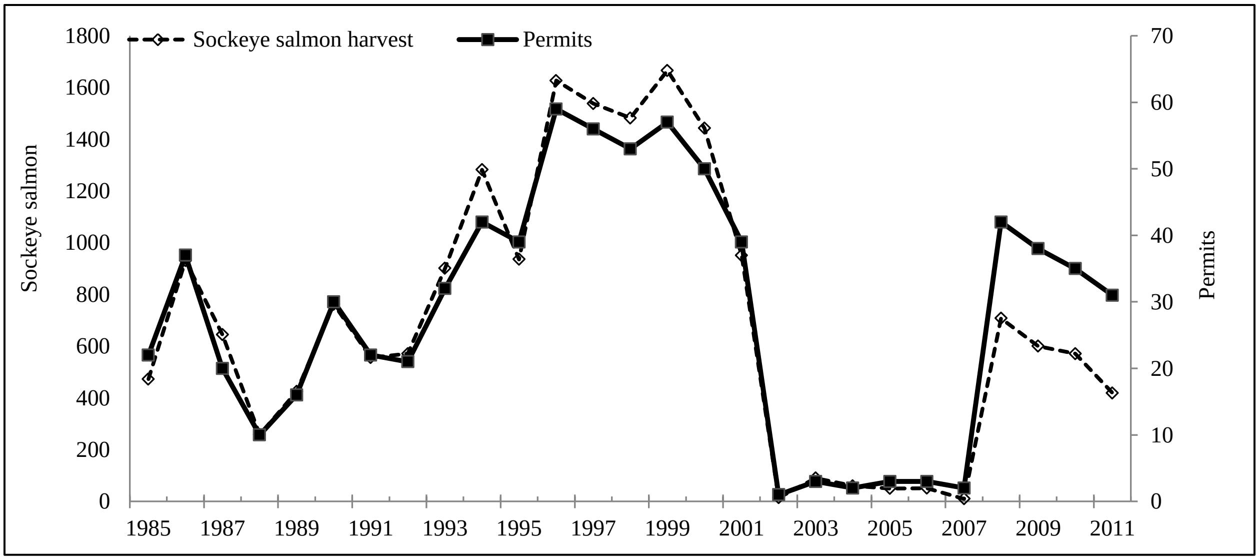

Figure 1.–Reported Subsistence sockeye salmon harvest and permits issued, 1985 to 2011.

METHODS

STUDY SITE

Kanalku Lake (lat. 57° 29.22'N, long. 134° 21.02'W) is located about 20 km southeast of Angoon (Figure 2) and lies in a steep mountainous valley within the Hood-Gambier Bay carbonates ecological subsection (Nowacki et al. 2001). The U-shaped valley and rounded mountainsides are characterized by underlying carbonate bedrock and built up soil layers supporting a highly productive spruce forest, especially over major colluvial and alluvial fans. The watershed area is approximately 32 km^2, with one major inlet stream (ADF&G stream no. 112-67-060) draining into the east end of the lake. The lake elevation is approximately 28 m. The lake surface area is approximately 113 hectares, with mean depth of 15 m, and maximum depth of 22 m (Figure 3). The outlet stream, Kanalku Creek (ADF&G stream no. 112-67-058), is 1.7 km long and drains into the east end of Kanalku Bay. In addition to sockeye salmon spawning in the lake, large numbers of pink salmon spawn in the lower part of the outlet creek and intertidal area. A few coho (*O. kisutch*) and chum (*O. keta*) salmon spawn in the Kanalku system, and resident populations of cutthroat trout (*O. clarkii*), Dolly Varden char (*Salvelinus malma*), and sculpin (*Cottus* sp.) are found in Kanalku Lake. Kanalku Falls, a waterfall approximately 8–10 m high and about 0.8 km upstream from the tidewater, forms a partial barrier to migrating sockeye salmon.

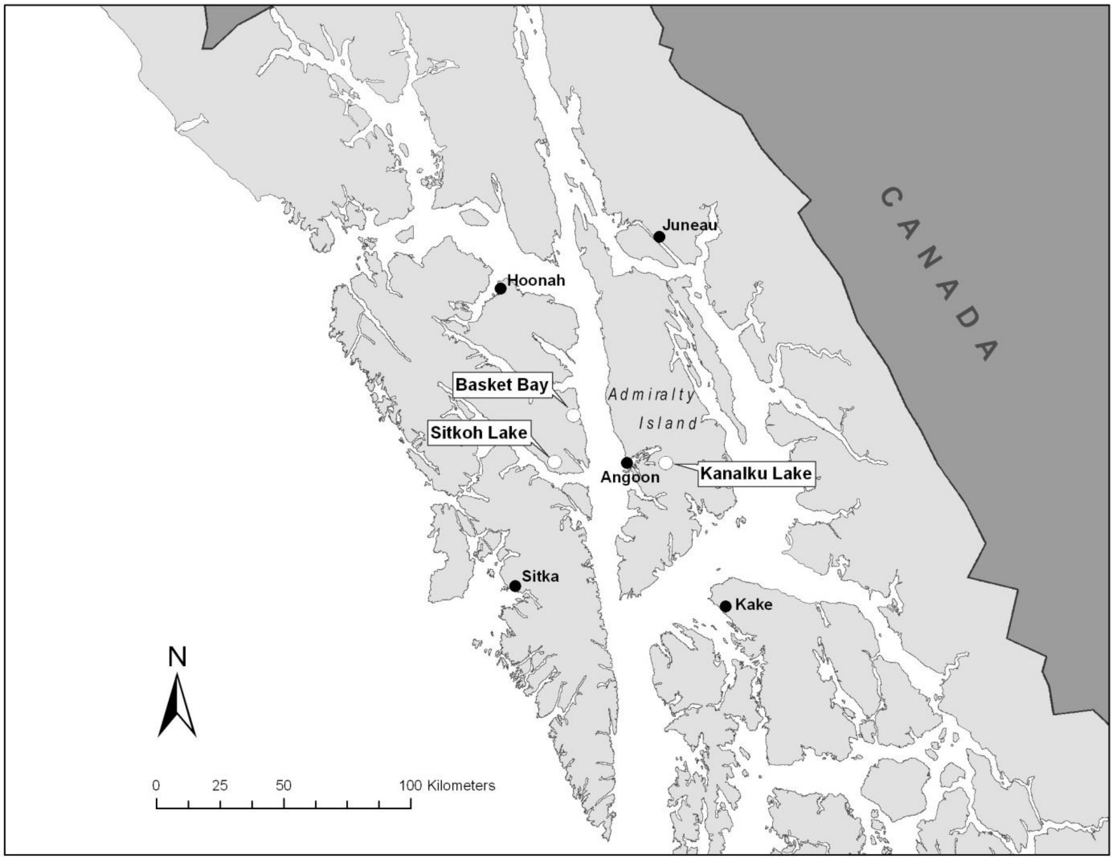

Figure 2.–Map of Southeast Alaska showing location of Kanalku Lake and the village of Angoon.

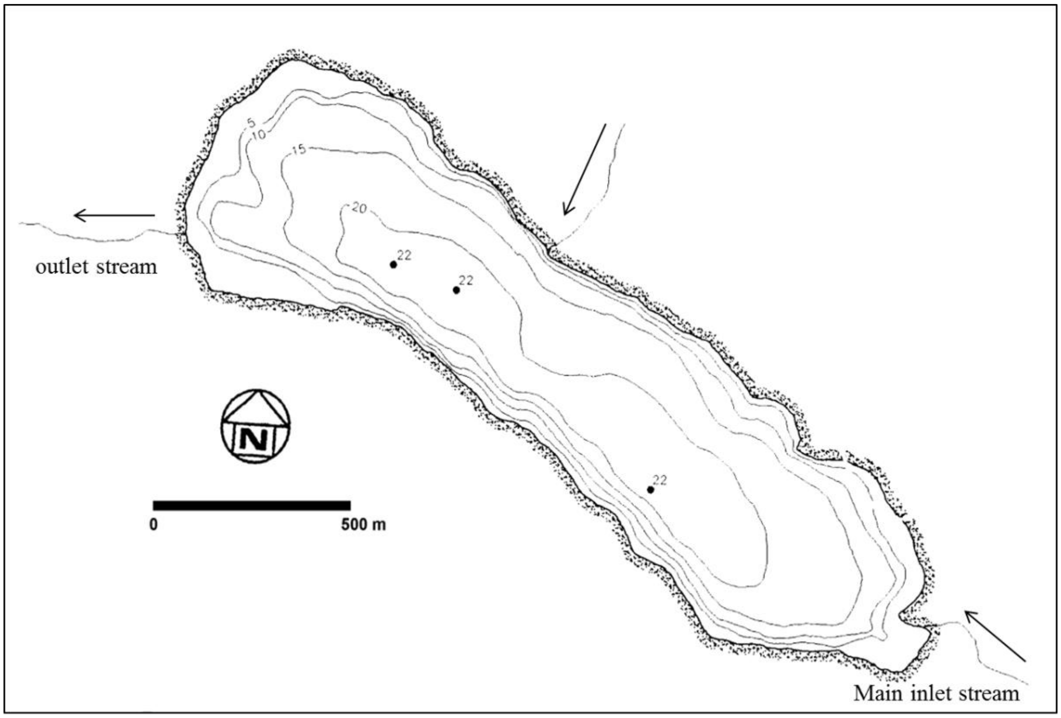

Figure 3.–Bathymetric map of Kanalku Lake, showing 5 m depth contours. Arrows indicate direction of stream flow.

SOCKEYE SALMON TOTAL ESCAPEMENT ESTIMATE

The *total* sockeye salmon escapement in the Kanalku Creek system will be counted through a series of two video camera weirs located approximately 0.4 km downstream of the Kanalku falls (approximately 0.5 km upstream of the creek mouth). There are two advantages to this method over a standard picket weir: 1) fish will swim freely through the weir, primarily at night, which will greatly reduce the incidence of fish holding behind the weir and eliminate the need to handle fish; and 2) the two-weir system will validate weir counts and eliminate the need for back-up mark-recapture studies. The weirs will be installed in mid-June and will be removed once the sockeye salmon run is complete, at the end of August.

Lower Creek Camera-Weirs

Weirs will be constructed by anchoring an aluminum video chute to the stream bed. Two to four 2.4 m weir panels will be attached to each side of the video chutes and anchored into the stream bed in a “V” alignment (pointing upstream) to help guide fish quickly through the chutes. Weir panels will be fitted with 1.5 m-tall, 1.3 cm-diameter EMT conduit pickets with “pink salmon” spacing at 4.5 cm on center. Vinyl-coated welded wire fencing (2.5 cm^2 mesh) will be attached to the weir panel ends and extended to the stream banks as wings. The fencing material will be supported by a series of 2 m fence posts driven into the stream bottom spaced approximately 2.4 m apart. Three rows of 1.3 cm EMT conduit will be used as horizontal stringers and attached to the vertical posts with cable ties. The fencing material will be secured to the EMT stringers with cable ties. The fencing material will be folded to form an apron on the upstream side of the weir, approximately 45 cm wide, and secured to the stream bottom with a double row of sandbags. Sandbags will also be placed on the downstream side of the fencing to help reduce scouring of the streambed. The weirs will be cleaned and inspected daily for holes or scouring to ensure the structure is fish-tight. Stream height will be measured daily at a fixed location at the weir site so that measurements are comparable across all years of the project.

Camera Counts

At each camera-weir, two underwater 3.6 mm color video cameras containing Sony[1] 8.47 mm (1/3in) HAD CCD sensors will be installed on the left and right sides of the video chute to observe passing fish. Video cables will transfer the data from the cameras to mini-DVR's (Digital Video Recorders) that record motion-detected, 30-frames-per-second, and video files will be stored on memory cards (SD cards). Each camera/DVR pair will be wired independently so that if one set fails the count will not be compromised. The video chutes will be lighted at night by three bright white 25.4 cm, 14-bulb bright white LED light strips attached to each of the video camera chutes. Photoelectric sensors will be used to turn the lights on from dusk to dawn. The paired video system will be powered by two 140-W solar panels that trickle charge a 100 ah AGM (absorption glass matt) 12V DC battery through a metered 30A charge controller. The solar panels will be positioned to face the mid-day sun. The mini-DVR's and a 17.78 cm color TFT monitor will be housed in a Pelican case. Voltage converters will be used to regulate the 12V-5V power to the mini-DVR's.

At each station, a pair of SD cards (for left and right cameras) will be swapped back and forth daily. The crew will use a laptop computer to review video data contained on the SD cards at camp daily. Separate counts will be kept for all fish species captured by the cameras. Counts by hour for each camera and any other observations will be recorded on daily data sheets. At the end of the season, video files will be reviewed to corroborate inseason counts.

SOCKEYE SALMON SPAWNING ESCAPEMENT ESTIMATE

We will continue to use a standard picket weir to estimate the *spawning* escapement of sockeye salmon into Kanalku Lake. In 2013, we will test the application of a camera net-weir in the outlet of the lake. The camera-net weir will be used to count fish into the lake, validate the picket weir count, and serve as the recapture location for a back-up mark-recapture estimate. Successful application of a camera net-weir system at Kanalku Lake will result in a reduction in both the handling of live fish and the overall cost of the project from previous years by eliminating a month of mark-recapture work that was previously conducted on the spawning grounds in September.

Picket Weir count

The Kanalku picket weir will be located in Kanalku Creek, across the outlet stream at the west side of the lake, and operated throughout the duration of the sockeye salmon run, from the last week in June through the end of August. The weir will consist of aluminum bipod supports anchored into the stream sediment. The supports are connected by rows of stringers that extend across the entire stream bed, with pickets inserted through regularly-spaced holes in the stringers and extended to the stream bottom. Picket spacing is 4.45 cm on center of the pickets. This spacing, called "pink salmon spacing," allows for 52 pickets per channel with a maximum space

[1] Product names used in this publication are included for completeness but do not constitute product endorsement.

of approximately 3.81 cm between pickets. Sandbags will be placed across the stream along both sides of the weir to help stabilize the substrate and secure the pickets. A weir trap, sampling station, and catwalk will be constructed and attached to the weir. We will inspect the weir daily for malfunction and breaches.

To minimize handling, fish will be counted through the weir by pulling one or two pickets at the upstream side of the weir trap whenever possible. We will place white sandbags on the bottom of the stream bed at this exit point to aid in fish identification. In addition to counting all fish by species, all sockeye salmon will be visually categorized as jacks (fish less than 400 mm in length) or full-size adults, and recorded separately. Daily observations of the water level (cm), air and water temperature (°C), precipitation (mm), and weather will be recorded at the weir. Water level will be measured daily at approximately the same location (within 1 m^2) as the 2007 to 2012 field seasons.

Camera-Net-Weir

Fish will be counted through a video camera-net-weir placed across the outlet of Kanalku Lake, just upstream of the picket weir, and operated throughout the duration of the sockeye salmon run (from the last week in June through the end of August). The net weir will consist of a 50 m × 4 m section of nylon seine netting, with 3.2 cm web, strung across the lake outlet in a "V" shape, and attached to an aluminum video chute. Two video cameras will be attached to each side of the video chute. A low-stretch nylon rope will be attached approximately 1 m from the bottom of the netting as a tension line. The tension line will be anchored tightly to the stream banks and the video chute to form the "V" shape. A heavy lead line will be attached to the bottom of the netting. The area between the tension line and lead line will act as an apron to keep fish contained by the weir. A cork line will be attached to the top of the netting and will be allowed to float back in the current. (See Camera Counts section above for more detail on video operation and camera counts.)

MARK-RECAPTURE POPULATION ESTIMATE

The *spawning* population of sockeye salmon will be estimated with a two-event mark-recapture study. Fish will be marked at the picket weir (Event 1) and examined for marks at the camera-net-weir (Event 2). The mark-recapture study will allow us to determine if sockeye salmon passed through the primary picket weir undetected, and will serve as a back-up estimate in the case that either the picket weir or camera-net-weir is breached or damaged. Event 1—Fish will be marked at the picket weir with an adipose fin clip. To minimize handling, we will mark fish that are also sampled for age, sex, and length (see below). Sockeye salmon that appear unhealthy will be enumerated and released without marks. Event 2—fish counted at the camera-net-weir will be examined for presence/absence of an adipose fin and mark status will be recorded. Fish that cannot confidently be examined for presence of an adipose fin will not be counted in the mark-recapture study.

ADULT POPULATION AGE AND SIZE COMPOSITION

The age composition of sockeye salmon at Kanalku Lake will be determined from a minimum of 425 scale samples collected from live fish at the picket weir. Based on the work by Thompson (1992), and assuming a run of around 1,000 sockeye salmon, a sample of 338 fish will be adequate to ensure the estimated proportions of each age class will be within 5% of the true value with at least 95% probability. We increased our sampling goal to 425 fish for the season to ensure we meet the sampling target even if 25% of the scale samples are unreadable. We will begin the season with a weekly sampling goal of 30% of the cumulative weekly escapement. Weekly sampling goals will be adjusted by the project leader depending on the strength of the run. If a fish appears overly stressed after marking, or if the handling time exceeds 30 seconds out of the water, the fish will be released without additional sampling. The length of each fish will be measured from mideye to tail fork, to the nearest millimeter. Sex will be determined by length and shape of the kype or jaw. Three scales will be taken from the preferred area of each fish (INPFC 1963), mounted on a gum-card, and prepared for analysis as described by Clutter and Whitesel (1956).

DATA ANALYSIS

MARK-RECAPTURE POPULATION ESTIMATE

We will estimate the sockeye salmon spawning escapement using Chapman's Modified Petersen estimator (Seber 1982):

$$\widehat{N} = \frac{(m+1)(c+1)}{(r+1)}, \tag{1}$$

where $\widehat{N}$ is the estimated population size, *m* is the estimated number of fish marked during Event 1, *c* is the number of fish captured and sampled for marks during Event 2, and *r* is the number of fish recaptured during Event 2 that were marked in Event 1.

We will use a parametric bootstrap procedure to estimate the standard error and construct the 95% confidence intervals for the escapement estimate. We will assume that the number of marked fish recaptured (*r*) in Event 2 follows a hypergeometric probability distribution. Then we use the number of fish marked (*m*) in Event 1, the number of fish caught (*c*) in Event 2, and the Petersen estimate of escapement ($\widehat{N}$) to generate 5,000 simulated recapture numbers (*r*), based on the hypergeometric probability density function, $f(r|\ m, c, \widehat{N})$. From the bootstrap values of *r*, we will derive 5,000 Petersen escapement estimates, then calculate the standard error of these estimates and use the 0.025 and 0.975 quantiles to construct the 95% confidence intervals. We will deem the picket weir count of sockeye salmon to be "verified" if the count falls within the 95% confidence intervals of the mark-recapture estimate.

ESTIMATE OF MORTALITY RATE AT KANALKU FALLS

The mortality rate at the Kanalku Falls (i.e., the number of fish that did not successfully ascend the falls) will be estimated by subtracting the best estimate of *spawning* escapement from the estimated *total* sockeye salmon escapement into the Kanalku Creek system.

ADULT POPULATION AGE AND SIZE COMPOSITION

Scale samples will be analyzed at the ADF&G salmon aging laboratory in Douglas, Alaska, and age classes will be designated by the European aging system where freshwater and saltwater years are separated by a period (e.g., 1.3 denotes a five-year-old fish with one freshwater and three ocean years; Koo 1962). We will estimate multiple age-class proportions and means, together with estimates of their standard errors, as described by Thompson (1992) and Cochran (1977). The weekly age-sex distribution, the seasonal age-sex distribution weighted by week, and the mean length by age and sex weighted by week will be calculated using standard methods (Cochran 1977; Appendix 1).

SCHEDULE AND DELIVERABLES

The camera-weirs on lower Kanalku Creek will be operated from the week of 10 June to approximately 20 August. The crew will check camera and weir operation daily. The picket weir and camera-net-weir will be in place at the lake outlet and operational by 25 June. ADF&G staff will keep track of fish counts and other information from the weirs daily, and will routinely error-check and enter weir data into electronic files. Video data recorded by the camera systems will be reviewed daily by the crew and entered into an electronic database. Data analysis will begin as soon as each portion of the field data collection is completed, and will be finished and reviewed during preparation of the annual report. We will complete a draft annual report to be submitted for peer review in the ADF&G Fishery Data Series by 31 May 2014. Progress reports will be completed and submitted to granting authorities by December 2013. This report will be co-authored by Vinzant, Bednarski, and Heinl; other co-authors may be added.

RESPONSIBILITIES

ADF&G

Julie Bednarski, Fishery Biologist II, Project Leader. Oversight of all aspects of project, including planning, budgeting, sample design, permits, equipment, personnel, and training. Analyzes data and reports project results. Assists with fieldwork.

Raymond F. Vinzant, Fishery Biologist I, Field Biologist. Assists with all aspects of the project, including operational planning, equipment, oversight of fieldwork, data analysis, and technical report writing.

Vacant, Fish and Wildlife Technician III. Assists with all aspects of fieldwork, including equipment and supply procurement, technical support, and data collection.

Steven C. Heinl, Regional Research Coordinator. Assists with project operational planning, fieldwork, and review of project report.

Haixue Shen, Biometrician II. Assists with sampling design, project operational planning, and data analysis.

ACA

Raynelle Jack, Executive Secretary. Oversight of ACA personnel and coordination with ADF&G staff.

Vacant, Fisheries Technician. Acts as the Angoon Crew Leader, and assists in field work, camp construction and maintenance, data collection, and coordination with ADF&G staff.

Vacant, Fisheries Technician. Assists with all aspects of field work and data collection, camp construction and maintenance.

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APPENDIX

Appendix A.–The weekly 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:

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

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):

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

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

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

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):

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

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,

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

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