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Kenai River Drift Gillnet Pilot Study at River Mile 19, 2021

by

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July 2022

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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ABSTRACT

In August 2021, we investigated the feasibility of using drift gillnets at river mile (RM) 19 to examine the species composition and spatial distribution of salmon migrating past the Division of Commercial Fisheries sonar site. Currently, the site uses dual-frequency identification sonar (DIDSON) to estimate sockeye salmon (*Oncorhynchus nerka*) passage, and fish wheels are used to sample salmon for species composition and biological characteristics. Drift gillnetting was conducted for 6 days during August 5–24, 2021, using 9.1 m length gillnets consisting of 1 of 3 mesh sizes: 4 in, 4¾ in, or 5 in (10.2, 12.1, and 12.7 cm, respectively). Gillnetting occurred in 6 areas (0–10 m, 10–20 m, and 20–30 m) off each river bank, representing the area of the river where sonar data are collected to estimate passage of migrating sockeye salmon (sonar zones), and in 2 areas 0–10 m downstream of the fish wheel located on each river bank (fish wheel zones). Sockeye salmon composed the majority of the catch in both fish wheel and nearshore sonar zones. Sockeye salmon proportions declined offshore (>10 m) and during later sampling dates. Our results show that drift gillnets of various mesh sizes can be employed to capture migrating salmon at the Kenai River RM 19 sonar site. We present recommendations for future study designs.

Keywords: Sockeye salmon, *Oncorhynchus nerka,* Upper Cook Inlet, UCI, Kenai River, drift gillnets, sonar, fish wheels

INTRODUCTION

The Alaska Department of Fish and Game (ADF&G), Division of Commercial Fisheries, uses a DIDSON (dual-frequency identification sonar) to estimate the number of sockeye salmon (*Oncorhynchus nerka*) passing river mile (RM) 19 on the Kenai River in Upper Cook Inlet, Alaska (Figure 1). The total number of salmon passing the sonar site, along with fish wheel catches for species apportionment, are currently used to estimate the number of sockeye salmon in the total sonar passage estimate at RM 19 (Glick and Faulkner 2019). The Division of Sport Fish also uses these estimates to manage the inriver sport fishery to achieve the late-run sockeye salmon escapement goal. The purpose of this study is to determine if drift gillnets are a feasible and safe method for characterizing species apportionment at RM 19 during late-run sockeye salmon passage.

The Kenai River drainage in western Kenai Peninsula is approximately 5,200 km^2 and is the major sockeye salmon producing watershed in Cook Inlet (Marston and Frothingham 2021). The Kenai River also supports inriver sport fisheries for coho salmon (*O. kisutch*), pink salmon (*O. gorbuscha*), and Chinook salmon (*O. tshawytscha*). The Division of Commercial Fisheries' long-standing comprehensive sockeye salmon stock assessment program drives the implementation of the *Kenai River Late-Run Sockeye Salmon Management Plan 5AAC 21.360* and relies on the RM 19 DIDSON to formulate sockeye salmon abundance estimates for the inriver run and serves as the basis for the spawning escapement estimates. The Kenai River sockeye salmon assessment program began using sonar systems deployed on both banks of the Kenai River at RM 19 in 1968 to enumerate passage and estimate the annual migration of sockeye salmon into the Kenai River watershed (Davis 1971; Namvedt et al. 1977). Over several decades, the sockeye salmon stock assessment program has undergone numerous improvements to more accurately estimate inriver abundance, including a move from single beam (Bendix Corp.) sonar to the more advanced multibeam DIDSON technology in 2007 (Belcher et al. 2001, 2002; Maxwell et al. 2011).

Inriver assessment of sockeye salmon requires an estimate of the proportion of sockeye salmon in the total sonar salmon passage estimate. Initially, during the development of the RM 19 sonar program, gillnets and fish wheels were fished to obtain age, sex, and length (ASL) samples for brood stock information, but only fish wheels were used to apportion (by species) the total sonar salmon passage estimates, especially during even years in August, when the sockeye salmon run was ending and large numbers of pink salmon entered the river (Davis 1971; Namvedt et al. 1977). Fish wheels were operated on both banks of the Kenai River at RM 19 until the mid-1980s. However, during subsequent years, ADF&G has primarily operated only a north bank fish wheel due to budget cuts, issues pertaining to private land ownership on the south bank, and the prevailing view that species composition was similar between fish wheels on either bank (Ken Tarbox, retired Commercial Fisheries Biologist, ADF&G, Soldotna, AK, personal communication). As such, from the mid-1980s through 2020, ASL and species apportionment has been conducted primarily from the north bank fish wheel.

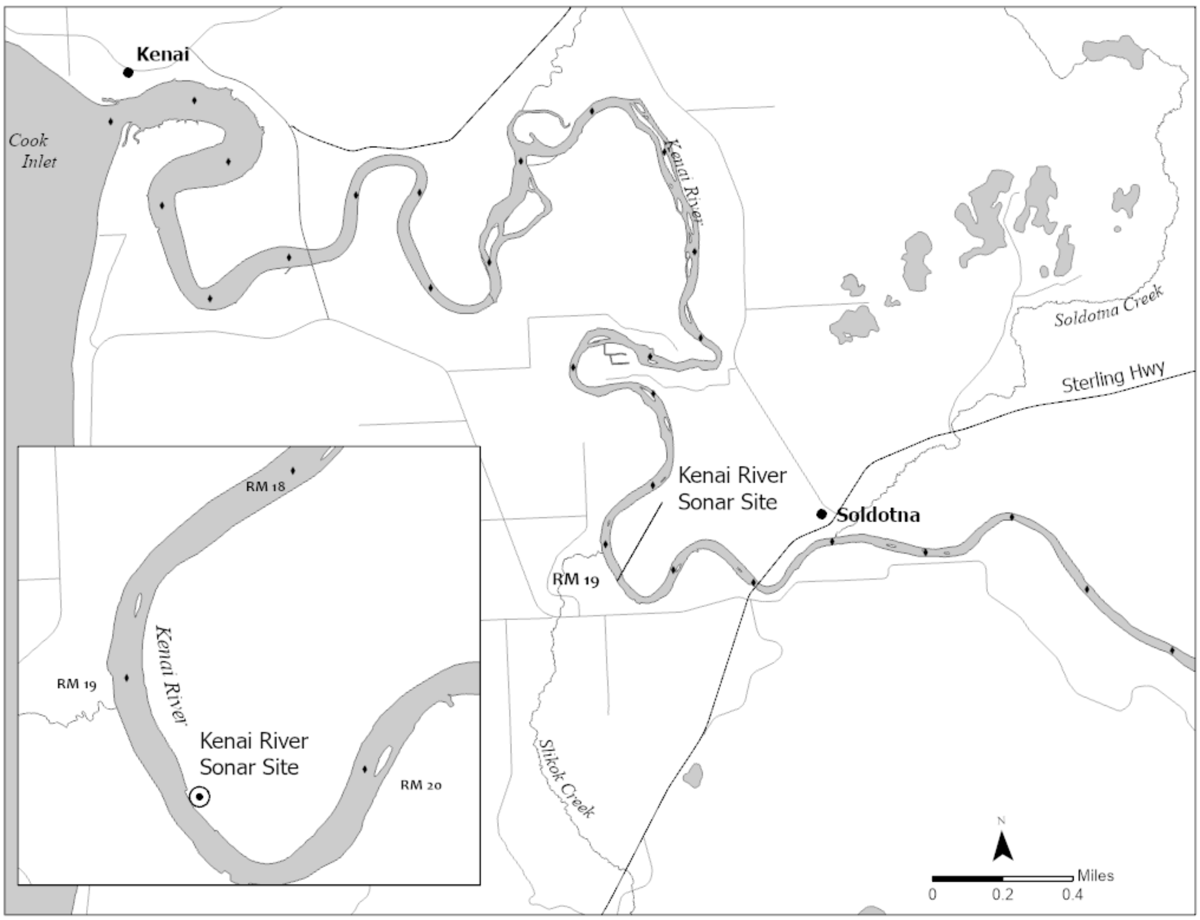

Figure 1.–Map showing location of the Division of Commercial Fisheries Kenai River sonar site used to enumerate sockeye salmon passage at river mile 19.

Historically, species apportionment was not considered a significant source of error in Kenai River sockeye salmon passage estimates, and sonar counts were generally only apportioned to species by the fish wheels in years when other species of salmon reached 5%. Mark–recapture studies were conducted in 2006–2008, which indicated that apportioned DIDSON passage estimates calculated from the north bank fish wheel were relatively unbiased and precise (Willette et al. 2012). During several recent years, sockeye salmon passage at RM 19 has been later than previously recorded. For example, the 2014–2015 and 2017–2018 sockeye salmon run midpoints ranged from 6 to 11 days late compared to the historical average (1979–2021) midpoint of the run. In 2020, the run passage midpoint at the sonar site was approximately 14 days later than the historical average (Glick and Wilburn *Draft*[1]), which is due in part to the cessation of the commercial Eastside set gillnet fishery on July 22, 2020 (thereby increasing sockeye salmon passage at RM 19). The later timing of the sockeye salmon migration into the Kenai River along with reduced commercial fishing in August has resulted in a greater overlap of both sockeye salmon and pink salmon at the RM 19 sonar site during August. Overlap of the 2 species is more likely to occur during even years because Kenai River pink salmon are "even year" fish, with more abundant runs during even years.

Even though ADF&G has validated the north bank fish wheel as a valuable apportionment tool (Glick and Willette 2016), there is interest to investigate gillnetting as a potential method to apportion salmon estimates at RM 19 in areas not covered by the fish wheel. Changes to the existing fish wheel–based apportionment method may become important if the sockeye salmon runs continue to have later run timing and overlap with pink salmon runs to a greater extent than was observed historically.

OBJECTIVES

This pilot study was initiated to explore the feasibility of using drift gillnets to capture migrating salmon at the Kenai River RM 19 sonar site. Information from this project may be used to develop methods for examining spatial and temporal salmon migration characteristics by species to determine if future projects using drift gillnets can adequately apportion daily sonar passage estimates to species if necessary. The 2021 objectives were as follows:

PRIMARY OBJECTIVES

1) Estimate the daily proportion of sockeye salmon captured in gillnets from the nearshore south and north bank fish wheel zones at RM 19 such that the proportion estimate is within 15 percentage points of the true value 95% of the time.
2) Estimate the daily proportion of sockeye salmon captured in gillnets from the offshore south and north bank ensonified zones at RM 19 such that the proportion estimate is within 15 percentage points of the true value 95% of the time.

SECONDARY OBJECTIVES

1) Determine the feasibility of using gillnets to capture salmon migrating past the RM 19 sonar project site.
2) Determine the feasibility of collecting, holding, sampling, and marking (visible external fin clip or tag) salmon captured during gillnetting operations at RM 19.
3) Determine the feasibility of designing future studies to examine differences in the species composition among gillnets of various mesh sizes.

[1] Glick, W. J., and D. Wilburn. *Draft*. Kenai and Kasilof Rivers sockeye salmon inriver passage and escapement studies, 2021. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

METHODS

STUDY DESIGN

For 6 days during August 5–24, 2021, 3 separate drift gillnets (9.1 m in length and 3.1 m deep) were fished at the RM 19 sonar site (Table 1 and Figure 2). The gillnets were 1 of 3 mesh sizes: 4 in (10.2 cm), 4¾ in (12.1 cm), or 5 in (12.7 cm). Sampling periods were conducted over midday hours that varied by start and stop time, length of fishing period (hours), and mesh size fished on the days sampled. Gillnets were fished systematically when possible, drifting downstream through the river along the south and north banks at the sonar site. The systematic sampling consisted of 1 "fishwheel zone" and 3 different areas of the river off of each bank ensonified by the sonar, hereafter referred to as "sonar zones." Each fish wheel zone was defined as the nearshore area immediately downstream of each fishwheel from the riverbank out approximately 10 m toward the thalweg. The 3 sonar zones on each bank consisted of nearshore and offshore areas that collectively spanned from the bank in 10 m increments to a total distance of 30 m toward the thalweg. The 3 sonar zones coincided with the 30 m area of the river covered by the sonar (Figure 2). Set placement and retrieval was guided by fixed landmarks for nearshore sets, and a range finder as well as fixed landmarks were used for offshore sets to ensure the nets fished each of the 10 m wide sonar zones similarly through each sampling day. In the fish wheel zones, the 10 m wide drift zones were approximately 25 m in length, whereas the sonar zones were approximately 50 m. The drift time depended on the speed of the current and was less for all south bank zones due to a faster current than north bank zones with a slower current. For each drift, the net was deployed upstream of the designated zone and made taut by field staff to drift perpendicularly to the current through the designated zone. Drifts were terminated if the net was fishing outside of the designated area, the fixed landmark was reached indicating the end of the drift area was reached, or the net became snagged on the shoreline or was not fishing properly.

To attain the desired precision for estimating proportions of sockeye salmon, the sample size goal was to capture at least 43 fish from each zone or 172 fish from each bank for a total of 344 fish each day, if the 43-fish sample size was equally distributed among all 8 zones (Thompson 1987).

Secondary Objective 2 was to determine the feasibility of collecting, holding, sampling, and marking salmon captured during gillnetting operations at RM 19. However, no attempt was made to do this because it was apparent it would not be feasible due to difficulties in achieving sample size goals (see *Recommendations*), the small working area on boat for 3-staff, and the short handling time to process captured fish.

Table 1.–Dates and mesh sizes used during gillnetting at Kenai River RM 19, 2021.

Date	Mesh size (in)
5 Aug	4¾
10 Aug	4¾
12 Aug	4, 4¾
17 Aug	4, 4¾, 5
19 Aug	4, 4¾, 5
24 Aug	4, 4¾, 5

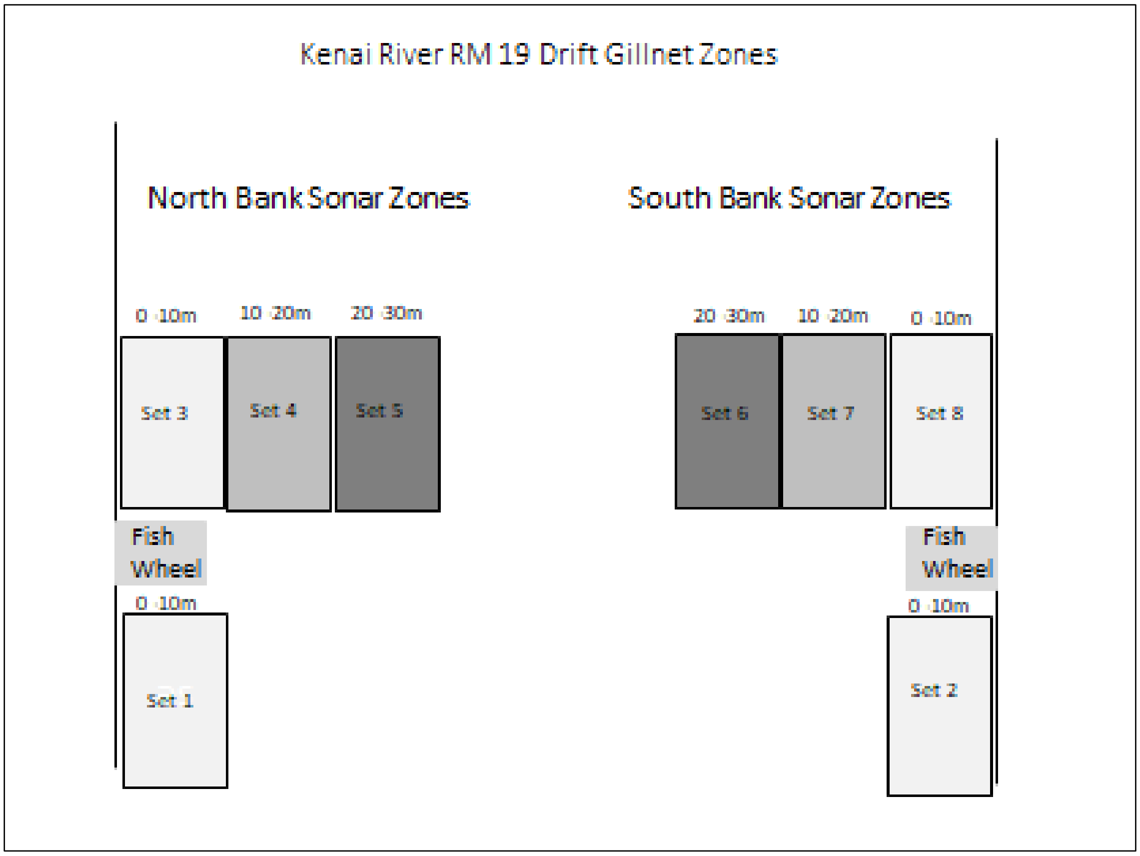

Figure 2.–Schematic diagram (not to scale) of the location of drift gillnetting zones at the RM 19 Kenai River sonar site, 2021.

DATA COLLECTION

For each day sampled, multiple sets occurred on each side of the river, and therefore data were collected in sampling replicates. Each sampling replicate was a total of 8 sets, with 4 sets per bank: 1 set in the fishwheel zone on each bank plus 3 sets in the sonar zones off each bank (Figure 2). Replicates were undertaken in turn such that sets at the south bank were followed by sets at the north bank before returning to the south bank to begin the next replicate. The 3 sonar zone sets started near the bank and moved offshore in 10 m increments for the next 2 sets before returning to begin the next replicate in the fish wheel zone again. For days when gillnets of more than 1 mesh size were fished, a replicate was completed before the mesh size was changed. The bank, zone (fish wheel or sonar), start and stop time, and number of fish caught by species for each set was recorded electronically using data entry software on a Juniper Systems Inc. Allegro II field computer (Appendix A1). After each sampling day, the field computer data were downloaded to a desktop computer and converted into comma separated text (.csv) format for analysis. In addition, crews recorded information about fish handling, physical riverine characteristics of the zones, boat traffic, interactions with the public, and extent of downstream travel while fish and net handling.

Data Analysis

The daily proportion estimate ($\hat{p}_{sbz}$) of sockeye salmon from zone *z* (fish wheel nearshore, midshore, or offshore) of bank *b* (north bank or south bank) was calculated using the equation below:

$$\hat{p}_{sbz} = \frac{n_{sbz}}{n_{bz}} \tag{1}$$

where n_{bz} is the total number of fish sampled from zone *z* of bank *b*, and n_{sbz} is the number of sockeye salmon sampled from the same zone.

The variance of $\hat{p}_{sbz}$ was calculated as follows (Cochran 1977):

$$\text{var}(\hat{p}_{sbz}) = \frac{\hat{p}_{sbz}(1-\hat{p}_{sbz})}{(n_{bz}-1)} \tag{2}$$

RESULTS

Daily catches for all zones off both banks combined never reached the desired precision level for Primary Objectives 1 and 2 and ranged from 194 fish on August 5 to 64 fish on August 24, of which sockeye salmon composed a majority of the catch each day (Table 2). The catches from the fish wheel zones on each bank were dominated by sockeye salmon: the south bank fish wheel zone ranged from 0.97 (SE = 0.03) on August 5 to 0.64 (SE = 0.13) on August 24, and the north bank fish wheel zone ranged from 0.95 (SE = 0.03) to 0.75 (SE = 0.11) over the same period (Table 3). The proportions of sockeye salmon in the sonar zones were typically higher for the nearshore sonar zone (0–10 m) than for either offshore sonar zones (10–20 m and 20–30 m; Table 3). Overall, fewer Pacific salmon were caught in the offshore south bank sonar zones than the north bank offshore sonar zones (Table 4). In addition, for all but 1 sampling day (August 17), the proportion of sockeye salmon caught in south bank offshore sonar zones (10–30 m) was consistently lower than the proportion of sockeye salmon captured from north bank offshore sonar zones (Tables 4). It should be noted that because this study occurred in an odd year (2021) and Kenai River pink salmon are “even year” fish, few pink salmon entered the Kenai River. Drift time varied by river bank and was approximately 50% less on the south bank in comparison to the north bank, except on August 19, when total drift fishing effort was about 36 minutes on the south bank and 40 minutes on the north bank (Table 5).

Three mesh sizes were fished on 4 of the 6 sampling days: August 12, 17, 19, and 24 (Table 5). On days when multiple mesh sizes were used, the 4 in (10.2 cm) mesh captured larger total numbers of fish of all species; however, the proportion of sockeye salmon captured was greater for the 4¾ in (12.1 cm) mesh on August 12 (0.82, SD = 0.07) and the 5 in (12.7 cm) mesh on August 17 (0.86, SD = 0.08; Table 6). Species composition of catches included coho, Chinook, and pink salmon as well as rainbow trout (*O. mykiss*), Dolly Varden (*Salvelinus malma*), and round whitefish (*Prosopium cylindraceum*; Table 6).

Table 2.–Number and proportion of sockeye salmon captured in drift gillnets at Kenai River RM 19 by date and bank compared to all species captured, 2021.

		Number of fish captured			Proportion	
Date	Bank	Sockeye salmon	Other[a]	Total	sockeye	SE
5 Aug	South	47	2	49	0.96	0.03
	North	130	15	145	0.9	0.03
10 Aug	South	31	9	40	0.78	0.07
	North	103	13	116	0.89	0.03
12 Aug	South	22	12	34	0.65	0.08
	North	65	17	82	0.79	0.05
17 Aug	South	28	6	34	0.82	0.07
	North	79	25	104	0.76	0.04
19 Aug	South	25	11	36	0.69	0.08
	North	69	14	83	0.83	0.04
24 Aug	South	13	12	25	0.52	0.1
	North	30	9	39	0.77	0.07

[a] Other species include pink salmon (*O. gorbuscha*), Chinook salmon (*O. tshawytscha*), coho salmon (*O. kisutch*), rainbow trout (*Oncorhynchus mykiss*), Dolly Varden (*Salvelinus malma*), and round whitefish (*Prosopium cylindraceum*).

Table 3.–Number and proportion of sockeye salmon compared to all species caught by date, bank, location, and distance from shore, 2021.

			Distance from	Number of fish captured			Proportion	
Date	Bank	Location	shore (m)	Sockeye salmon	Other[a]	Total	sockeye	SE
5 Aug	South	Fishwheel	0–10	29	1	30	0.97	0.03
		Sonar	0–10	16	0	16	1	0
		Sonar	10–20	2	1	3	0.67	0.33
		Sonar	20–30	0	0	0	0	0
	North	Fishwheel	0–10	38	2	40	0.95	0.03
		Sonar	0–10	37	3	40	0.93	0.04
		Sonar	10–20	40	2	42	0.95	0.03
		Sonar	20–30	15	8	23	0.65	0.1
10 Aug	South	Fishwheel	0–10	21	7	28	0.75	0.08
		Sonar	0–10	9	1	10	0.9	0.1
		Sonar	10–20	1	1	2	0.5	0.5
		Sonar	20–30	0	0	0	0	0
	North	Fishwheel	0–10	28	1	29	0.97	0.03
		Sonar	0–10	41	4	45	0.91	0.04
		Sonar	10–20	27	3	30	0.9	0.06
		Sonar	20–30	7	5	12	0.58	0.15
12 Aug	South	Fishwheel	0–10	18	2	20	0.9	0.07
		Sonar	0–10	4	5	9	0.44	0.18
		Sonar	10–20	0	3	3	0	0
		Sonar	20–30	0	2	2	0	0

-continued-

Table 3.–Page 2 of 2.

Date	Bank	Location	Distance from shore	Number of fish captured: Sockeye salmon	Other[a]	Total	Proportion sockeye	SE
12 Aug	North	Fishwheel	0–10	15	5	20	0.75	0.1
		Sonar	0–10	34	1	35	0.97	0.03
		Sonar	10–20	13	7	20	0.65	0.11
		Sonar	20–30	3	4	7	0.43	0.2
17 Aug	South	Fishwheel	0–10	11	1	12	0.92	0.08
		Sonar	0–10	15	0	15	1	0
		Sonar	10–20	0	4	4	0	0
		Sonar	20–30	2	1	3	0.67	0.33
	North	Fishwheel	0–10	29	3	32	0.91	0.05
		Sonar	0–10	45	5	50	0.9	0.04
		Sonar	10–20	3	9	12	0.25	0.13
		Sonar	20–30	2	8	10	0.2	0.13
19 Aug	South	Fishwheel	0–10	19	5	24	0.79	0.08
		Sonar	0–10	4	2	6	0.67	0.21
		Sonar	10–20	2	2	4	0.5	0.29
		Sonar	20–30	0	2	2	0	0
	North	Fishwheel	0–10	23	3	26	0.88	0.06
		Sonar	0–10	40	2	42	0.95	0.03
		Sonar	10–20	5	6	11	0.45	0.16
		Sonar	20–30	1	3	4	0.25	0.25
24 Aug	South	Fishwheel	0–10	9	5	14	0.64	0.13
		Sonar	0–10	4	2	6	0.67	0.21
		Sonar	10–20	0	1	1	0	0
		Sonar	20–30	0	4	4	0	0
	North	Fishwheel	0–10	12	4	16	0.75	0.11
		Sonar	0–10	7	0	7	1	0
		Sonar	10–20	5	5	10	0.5	0.17
		Sonar	20–30	6	0	6	1	0

[a] Other species include pink salmon (*O. gorbuscha*), Chinook salmon (*O. tshawytscha*), coho salmon (*O. kisutch*), rainbow trout (*Oncorhynchus mykiss*), Dolly Varden (*Salvelinus malma*), and round whitefish (*Prosopium cylindraceum*).

Table 4.–Number and proportion of sockeye salmon by bank and distance from shore compared to other species captured, August 2021.

		South bank					North bank				
		Number of fish captured					Number of fish captured				
Date	Distance from shore (m)	Sockeye salmon	Other[a]	Total	Proportion sockeye (p)	SE	Sockeye salmon	Other[a]	Total	Proportion sockeye (p)	SE
5 Aug	0–10	45	1	46	0.98	0.02	75	5	80	0.94	0.03
	10–30	2	1	3	0.67	0.33	55	10	65	0.85	0.05
	0–30	47	2	49	0.96	0.03	130	15	145	0.90	0.03
10 Aug	0–10	30	8	38	0.79	0.07	69	5	74	0.93	0.03
	10–30	1	1	2	0.50	0.5	34	8	42	0.81	0.06
	0–30	31	9	40	0.78	0.07	103	13	116	0.89	0.03
12 Aug	0–10	22	7	29	0.76	0.08	49	6	55	0.89	0.04
	10–30	0	5	5	0.00	0	16	11	27	0.59	0.1
	0–30	22	12	34	0.65	0.08	65	17	82	0.79	0.05
17 Aug	0–10	26	1	27	0.96	0.04	74	8	82	0.90	0.03
	10–30	2	5	7	0.29	0.18	5	17	22	0.23	0.09
	0–30	28	6	34	0.82	0.07	79	25	104	0.76	0.04
19 Aug	0–10	23	7	30	0.77	0.08	63	5	68	0.93	0.03
	10–30	2	4	6	0.33	0.21	6	9	15	0.40	0.13
	0–30	25	11	36	0.69	0.08	69	14	83	0.83	0.04
24 Aug	0–10	13	7	20	0.65	0.11	19	4	23	0.83	0.08
	10–30		5	5	0.00	0	11	5	16	0.69	0.12
	0–30	13	12	25	0.52	0.1	30	9	39	0.77	0.07
All days	0-10	159	31	190	0.84	0.09	349	33	382	0.91	0.04
	10–30	7	21	28	0.25	0.12	127	60	187	0.68	0.07

[a] Other species include pink salmon (*O. gorbuscha*), Chinook salmon (*O. tshawytscha*), coho salmon (*O. kisutch*), rainbow trout (*Oncorhynchus mykiss*), Dolly Varden (*Salvelinus malma*), and round whitefish (*Prosopium cylindraceum*).

Table 5.–Summary of drift gillnet fishing effort in minutes fished by gillnet mesh size, day, and river bank, 2021.

		Effort in minutes			
Date	Location	4-inch mesh	4¾-inch mesh	5-inch mesh	Daily total all sizes
5 Aug	South bank	–	15.24	–	–
	North bank	–	34.84	–	–
	Total	–	50.08	–	–
10 Aug	South bank	–	17.46	–	–
	North bank	–	35.21	–	–
	Total	–	52.67	–	–
12 Aug	South bank	9.95	2.53	11.33	23.81
	North bank	20.20	7.17	10.93	38.30
	Total	30.15	9.70	22.26	62.11
17 Aug	South bank	10.00	12.02	3.20	25.22
	North bank	39.11	14.10	3.33	56.54
	Total	49.11	26.12	6.53	81.76
19 Aug	South bank	15.72	8.19	12.50	36.41
	North bank	14.38	13.17	12.75	40.30
	Total	30.10	21.36	25.25	76.71
24 Aug	South bank	6.59	7.47	5.10	19.16
	North bank	14.38	10.03	8.12	32.53
	Total	20.97	17.50	13.22	51.69
All days	South bank	42.26	47.67	32.13	122.06
	North bank	88.07	79.68	35.13	202.88
	Total	130.33	127.35	67.26	324.94

Table 6.–Number and proportion of sockeye salmon captured relative to all fish species captured by date and mesh size, 2021.

Date	Mesh size (in)	Number of salmon captured: Sockeye	Coho	Chinook	Pink	Number of other fish captured: Rainbow trout	Dolly Varden	Round whitefish	Total other	Total fish	Sockeye proportion	SE
5 Aug	4¾	177	4	8	0	5	0	0	17	194	0.91	0.02
10 Aug	4¾	134	8	7	0	5	2	0	22	156	0.86	0.03
12 Aug	4	43	0	3	3	5	2	1	14	57	0.75	0.06
	4¾	23	3	1	0	1	0	0	5	28	0.82	0.07
	5	21	3	6	0	0	1	0	10	31	0.68	0.09
17 Aug	4	60	9	7	0	1	2	1	20	80	0.75	0.05
	4¾	29	2	3	0	3	0	0	8	37	0.78	0.07
	5	18	2	1	0	0	0	0	3	21	0.86	0.08
19 Aug	4	36	6	1	0	0	0	0	7	43	0.84	0.06
	4¾	28	3	3	0	3	0	0	9	37	0.76	0.07
	5	30	7	1	1	0	0	0	9	39	0.77	0.07
24 Aug	4	15	2	1	0	2	0	0	5	20	0.75	0.1
	4¾	15	4	0	0	4	1	0	9	24	0.63	0.1
	5	13	6	1	0	0	0	0	7	20	0.65	0.11
All days	4	154	17	12	3	8	4	2	46	200	0.77	0.03
	4¾	95	24	22	0	21	3	0	70	476	0.75	0.04
	5	82	18	9	1	0	1	0	29	111	0.74	0.04
	Total	642	59	43	4	29	8	2	145	787	–	–

RECOMMENDATIONS

This 6-day pilot project assessed the feasibility of using drift gillnets as a sampling tool to quantify species composition and allowed us to develop data collection methods and scope staffing needs should future projects continue. Our results show that for the sampling effort and locations used in this study, drift gillnets were not able to capture enough Pacific salmon at RM 19 to meet the sample size goal of 43 fish from each of the 8 netting zones for all days sampled (Tables 2–4). Therefore, we recommend future projects be adjusted by increasing the sampling time for each day and (or) that the objectives be revised such that gillnetting effort is conducted in the fish wheel zones (0–10 m) where most of the Pacific salmon migration occurs because on some sampling days, there were no sockeye salmon and very few fish of any species captured in the offshore sonar zones (10–30 m; Tables 3 and 4). Increasing the netting effort would likely result in increased catches and augment the ability to detect any differences in species composition across the drift zones at RM 19.

A challenge in achieving adequate sample sizes as well as equal fishing effort (drift time) between river banks is that the south bank fish wheel zone is mostly near private property. When sport anglers fished from the south bank, per verbal communications with private landowners, sampling was not conducted in the south bank fish wheel zone, and to a lesser extent not conducted in the 10–20 m sonar zone, which contributed to small sample sizes and less fishing effort. Having less netting effort on the south bank, by default, increases sampling effort in all north bank zones. Adequate sample sizes were achieved in the north bank fish wheel zone on 5 of the 6 sampling days compared to just 1 of 6 sampling days in the south bank fish wheel zone (Tables 3–5). No sampling interference was experienced in the 6 other drift gillnet zones. The differences in current speed (discharge) between riverbanks was noticeable because the duration of drifts in all the south bank zones were about half of the time (30 seconds) compared to drifts in the north bank zones (1 minute).

Another important aspect of this pilot project was to determine the feasibility of collecting, holding, sampling, and marking (visible external fin clip or tag) salmon captured during gillnetting operations. During this project, fish caught from drift gillnets were removed from the zone of capture and displaced downstream; the distance of this displacement varied considerably due to several factors such as number of fish captured in each set, species captured, mesh size, discharge, boat traffic, and the amount of handling time to remove fish from the net. Lack of workspace on the boat as well as achieving sample size objectives were also considerations. Based on the issues discussed here, we suggest that a separate study would be necessary for tagging projects.

The relative capture efficiency of gillnets varies by mesh size and fish species (Hamley 1975). We used 3 different mesh sizes during sampling (Table 5). Total catch of all species and catch of sockeye salmon were greatest with the 4 in (10.2 cm) mesh, whereas the 5 in (12.7 cm) mesh caught the least; however, the 4¾ in (12.1 cm) and the 4.0 in mesh were both fished nearly double the amount of time the 5 in mesh was fished. Previous projects at RM 19 employed 5.0 in mesh (Glick and Willette 2016). We recommend a sampling protocol that distributes fishing effort equally among the various mesh sizes if future projects use multiple mesh sizes, and it is feasible to design future objectives to look at differences in the species composition among various sized mesh gillnets.

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APPENDIX A: SAMPLING FORM

Appendix A1.–RM 19 Kenai River drift gillnetting sampling form

KENAI RIVER RM19 NETTING FORM

Page_____of _____

Date:________________ Names:_____________________

					Start	Stop	Species captured						
Rep	Set	Bank	Loc	Mesh	Time	Time	Sockeye	Pink	Coho	Chinook	RB	DV	Comments

	Time	Secchi
Start		
End		

Rep: 8 sets, 1 set at each location off each bank **Set:** begin 1 each day **Bank:** Bouy thrown towards (N or S) **Loc:** Location, F&W= below fishwheel, NS=nearshore adjactent to sonar 0-10m offshore, M=mid 10-20m offshore and OFF=offshore 20-30m, **Mesh:** in inches (4.75, etc.) **Start time:** military to nearest sec. when bouy is thrown **Stop time:** military to nearest sec. when leads begin being pulled. **Comments:** any pertinent info. **Secch:** nearest 0.05 m