Fishery Data Series No. 18-09

# Evaluation of Methods used to Apportion Sonar Counts to Species at the RM19 Kenai River Sonar Site, 2016

by

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and

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May 2018

Alaska Department of Fish and Game

Divisions of Sport Fish and Commercial Fisheries

## Symbols and Abbreviations

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

*FISHERY DATA SERIES NO. 18-09*

# EVALUATION OF METHODS USED TO APPORTION SONAR COUNTS TO SPECIES AT THE RM19 KENAI RIVER SONAR SITE, 2016

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# ABSTRACT

DIDSON (dual-frequency identification sonar) is used to estimate the number of sockeye salmon *Oncorhynchus nerka* passing river mile (RM) 19 on the Kenai River of Upper Cook Inlet Alaska. DIDSON data are used to estimate the total number of salmon passing the sonar site, and north bank fish wheel catches are typically used to estimate the proportion of the total sonar count comprised of sockeye salmon when pink salmon *O. gorbuscha* are abundant in August. This project evaluated the efficacy of using other fishing methods (i.e., anchored gillnets, drift gillnets, and beach seines) to apportion sonar counts to species when large numbers of pink salmon were passing the RM19 sonar site in August 2016. Due to landownership issues and the presence of sport fishermen, only drift gillnets were fished on the south bank. Logistic regression was used to model the proportion of sockeye salmon along the south bank using the proportion of sockeye salmon in north bank fish wheel catches as the independent variable. Six species apportionment methods were evaluated. Sockeye salmon passage estimated using the standard fish wheel apportionment method was not significantly different from passage estimated using combined anchored gillnet and seine data to apportion sonar counts. Sockeye salmon passage estimated using the standard method was significantly higher than passage estimated using the other 4 alternative apportionment methods, but passage estimates using these alternative methods were 1.2% to 4.7% lower than estimates obtained using the standard method. Due to various problems encountered when fishing with gillnets and seines at the Kenai RM19 sonar site, we recommend that fish wheels continue to be used for species apportionment and that modeled species proportions based on north bank fish wheel catches be used to apportion south bank DIDSON counts.

Key words: sockeye salmon, *Oncorhynchus nerka*, pink salmon, *Oncorhynchus gorbuscha*, dual-frequency identification sonar DIDSON, escapement, acoustic assessment, riverine sonar, fisheries sonar, fish wheel, Upper Cook Inlet, Kenai River

# INTRODUCTION

The Kenai River is a glacially occluded river that drains approximately 5,200 km$^2$ of the western Kenai Peninsula, and it is the major sockeye salmon (*Oncorhynchus nerka*) producing watershed in Cook Inlet (Figure 1). The Kenai River also produces runs of coho salmon (*O. kisutch*), pink salmon (*O. gorbuscha*), and Chinook salmon (*O. tshawytscha*). Since 1968, sonars have been operated annually at a site 32 km (RM 19) upstream from the river mouth to estimate the number of sockeye salmon passing this site (Namvedt et al. 1977; Davis 1971). Various configurations of Bendix Corporation sonars have been used to estimate salmon passage at this site.[1] Dual-frequency identification sonars (DIDSON) replaced Bendix sonars at this site beginning in 2007 (Belcher et al. 2001, 2002; Maxwell et al. 2011). Historically, salmon catches in fish wheels (Figure 2) have been used to apportion total sonar counts to species if the proportion of non-sockeye salmon species was greater than 5% for 3 consecutive days and this was judged to be an increasing trend (Glick and Willette 2016). Fish wheels were once operated on both banks of the Kenai River, but beginning in the mid-1980s only the north bank fish wheel was operated because species composition was similar between the 2 banks (Glick and Willette 2016).

In past years, species apportionment was not considered a significant source of error in Kenai River sockeye salmon passage estimates because sonar counts were typically only apportioned by species during even-numbered years when pink salmon were abundant in August. However, in recent years, sockeye salmon have been entering the river later (e.g., 11 days late in 2006; 5 days late in 2007; 8 days late in 2014; and 8 days late in 2015) leading to greater overlap between sockeye and pink salmon inriver run timing.

In 2014, the standard method of using only fish wheel catches to apportion sonar counts to species was not applied due to concerns that sockeye salmon passage estimates were biased high

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

due to the presence of large numbers of pink salmon in the river during August (Glick and Willette 2016). The DIDSON sonar provides counts of passing salmon in 2 range sectors: 0–10 m and 11–30 m. In 2014, fish wheel catches were used to apportion sonar counts to species in the 0–10 m sector, and drift gillnet catches were used to apportion sonar counts to species in the 11–30 m sector. This method was used because the fish wheel catches fish within the 0–10 m sector and gillnets were fished primarily in the offshore 11–30 m sector. The proportion of sockeye salmon in fish wheel catches was about four times higher than the offshore gillnet catches, but the proportions were highly variable from day to day (Table 1). Comparisons between catches in the fish wheel and catches in gillnets fished only in the nearshore sector indicated higher sockeye salmon proportions in the gillnets, supporting the conclusion that differences between the fish wheel catches and offshore gillnet catches were due to differences in the distributions of sockeye and pink salmon (Table 2). Apportioning offshore sector sonar counts to species using gillnet catches reduced the 2014 total sockeye salmon passage estimate by 2.2%, because a small fraction (4.8% south bank, 6.7% north bank) of all sonar targets were counted in the offshore sector in August.

# OBJECTIVES

Due to the low fraction of all sonar targets in the offshore sector in 2014, this project focused on evaluating methods for apportioning sonar counts to species only in the nearshore sector (0–10 m from shore). The objectives of this project were as follows:

1. Conduct nearshore gillnetting along both banks of the Kenai River daily after species apportionment began;
2. Evaluate whether seining is a practical method for capturing salmon in the nearshore sector;
3. Test whether the proportion of sockeye salmon captured differed between 12.1 cm, 13.0 cm, and 15.2 cm mesh gillnets ($\alpha = 0.05$);
4. Test whether the proportion of sockeye salmon captured in gillnets (all mesh sizes combined) differed between banks ($\alpha = 0.05$);
5. Test whether the proportion of sockeye salmon captured differed between gillnets and fish wheels ($\alpha = 0.05$); and
6. Test whether sockeye salmon passage estimates differed when using the standard fish wheel apportionment method versus 5 other apportionment methods ($\alpha = 0.05$).

# METHODS

## FIELD OPERATIONS

Three gillnets of different mesh sizes, 12.1 cm (4.75 in), 13.0 cm (5.12 in), and 15.2 cm (6.0 in), were fished along each bank during each of two 3-hour sampling periods (1500–1800 and 1800–2100 hours) each day after species apportionment began on August 8. Each gillnet was 10 m in length, approximately 3 m deep, and constructed of #12 mono twist filament webbing, EF-6 floats, and 85/100 lead line. As much as possible, test fishing was conducted within 10 m of shore and at least 30 m downstream of the transducers and/or fish wheels along both banks to avoid catching fish that aggregate below the weirs. Each net deployment was called a set which began as soon as the crew deployed the net and ended when the net stopped fishing. Anchored gillnet sets were conducted by anchoring one end of the net onshore and then feeding the net out from a skiff (6 m length) moving offshore. When the entire net was deployed, the crew tossed the net buoy in the water and allowed the net to be carried by the current until it was parallel to the bank. Drift gillnet sets were conducted by feeding the net out from the skiff moving offshore from the bank. If the net was pulled by the current more than 10 m from shore, then the skiff was run back into the bank to pull the net back into the nearshore zone. Captured salmon were quickly removed from the net, enumerated by species, and released. Catches were recorded by species for each net set. At least 2 net sets were conducted during each 3-hour sampling period on each bank using each mesh size. The sample size goal was 20 salmon (all mesh sizes combined) on each bank during each 3-hour sampling period. If less than 20 salmon were captured on each bank during each sampling period, then up to 2 additional net sets were conducted (total of 4 sets), and equal fishing effort was maintained between mesh sizes as much as possible. If members of the public were fishing along the bank during the scheduled sampling period, sampling was rescheduled, if possible, to avoid interfering with them.

We also evaluated whether a beach seine (15 m in length, 2.7 m in depth, and 7 cm mesh) could be safely and effectively used to capture salmon in the Kenai River for species apportionment. Because the water level in the Kenai River in August 2016 was very high, there were no beaches available near the sonar site for net deployment, the water was too deep, and the current too swift for crews to work in the river. Therefore, the net was deployed from the shore as described for the anchored gillnets. When the net reached the bank, the crew drew up the leadline and people in the skiff drew up the corkline until the fish were accessible in the bag between the skiff and river bank. Captured salmon were quickly removed from the net, enumerated by species, and released. Typically, 4 beach seine sets were conducted during each 3-hour sampling period. Anchored gillnet and beach seine sets were only conducted on the north bank of the river because there were no suitable sites available along the south bank near the sonar site.

## DATA ANALYSIS

The chi-square statistic was used to test whether weekly fractions of sockeye salmon captured differed among 12.1 cm, 13.0 cm and 15.2 cm mesh gillnets with data from both banks pooled. Two separate analyses were conducted using drift and anchored gillnet data. In each analysis, a contingency table was constructed with weekly (columns) sockeye salmon catches and weekly catches of other salmon in each row with a row for each mesh size. The data were aggregated by week (August 8–August13 and August14–August19) to achieve expected values greater than 5 in each cell (Zar 1984).

The chi-square statistic was used to test whether weekly fractions of sockeye salmon captured in drift gillnets (all mesh sizes combined) differed between river banks. A contingency table was constructed with weekly (columns) sockeye salmon catches and weekly catches of other salmon in each row with a row for each river bank. The data were aggregated by week to achieve expected values greater than 5 in each cell (Zar 1984). Only drift gillnet data were used in this analysis because this was the only fishing method applied on both river banks.

The chi-square statistic was also used to test whether weekly fractions of sockeye salmon differed among the 4 fishing methods (anchored gillnet, drift gillnet, seine and fish wheel) applied on the north bank. In each analysis, a contingency table was constructed with weekly (columns) sockeye salmon catches and weekly catches of other salmon in each row with a row for each gear type. The data were aggregated by week to achieve expected values greater than 5 in each cell (Zar 1984).

The 6 species apportionment methods were evaluated as follows:

1. Fish wheel data were applied to apportion sonar counts on both banks (standard method);
2. Anchored gillnet and seine data combined were applied to apportion sonar counts on both banks;
3. Drift gillnet data from each bank were applied to apportion sonar counts on each bank separately;
4. Data from all fishing methods combined were applied to apportion sonar counts on both banks;
5. Data from all fishing methods combined were applied to apportion sonar counts on the north bank, and data from drift gillnets fished on the south bank were applied to apportion sonar counts on the south bank; and
6. Fish wheel data were applied to apportion sonar counts on the north bank, and modeled south bank species composition estimates were applied to apportion sonar counts on the south bank.

Method 6 involved using a model with north bank fish wheel data as the independent variable to estimate the fraction of sockeye salmon in the salmon population migrating along the south bank. Fish wheel catch data were compiled from 8 previous years (1978, 1980, 1984, 1994, 1998, and 2006–2008) when fish wheels were operated on both banks. The data were grouped into roughly week long periods after species apportionment began in August, and the proportion of fish wheel catches comprised of sockeye salmon was calculated for both banks. A logistic regression analysis was conducted with number of sockeye salmon (events) and number of all salmon (trials) captured in the south bank fish wheel during each week as the dependent variable and the proportion of north bank fish wheel catches comprised of sockeye salmon during each week as the independent variable. The data were grouped by week to satisfy the model assumption of independence of observations, to avoid expected cell frequencies less than 5, and to reduce noise in estimated probabilities (Harrell 2001). The ability of model predictions to discriminate between cases with and without a sockeye salmon capture event was assessed using the *c*-statistic (Steyerberg et al. 2010). The *c*-statistic can be interpreted as the rank correlation between the predicted probabilities of sockeye salmon capture events and the observed outcome. The logistic regression model was then used to predict the daily fraction of sockeye salmon in the salmon population migrating along the south bank using daily north bank fish wheel catches in 2016. A simulation model (10,000 iterations) was used to estimate the variance of predicted daily sockeye salmon proportions using the logistic regression model and incorporating uncertainty using the standard error of regression coefficients.

The *Z*-test statistic (Sprinthall 2003) was used to test whether sockeye salmon passage estimates differed when using the standard fish wheel apportionment method versus the other 5 methods. The same methods used to estimate annual sockeye salmon passage and its variance (Glick and Willette 2016) were applied using the other 5 apportionment methods. The daily passage of sockeye salmon ($N_{sd}$) was estimated by multiplying the total daily fish passage estimate ($N_d$) by the fraction of sockeye salmon in the migrating salmon population ($p_s$) estimated using the 6 apportionment methods, i.e.,

$$N_{sd} = N_d \cdot p_s \,. \tag{1}$$

Daily sockeye salmon passage estimates were summed to estimate annual total sockeye salmon passage using each apportionment method.

The variance of sockeye salmon passage estimates on bank (*b*) and on day (*d*), due to systematic sampling in time and adjustments for missing data, were approximated using Wolter's (1985) successive difference method, i.e.

$$\hat{V}\left[\hat{N}_{bd}\right] \cong (1-\frac{1}{j})\cdot\left(\frac{1}{m}\right)\cdot\left(\frac{1}{3.5(m-4)}\right)\cdot\sum_{h=5}^{m}(\frac{N_{bh}}{2}-N_{bh-1}+N_{bh-2}-N_{bh-3}+\frac{N_{bh-4}}{2})^2, \qquad (2)$$

where *m* was the number of hourly counts in a day (usually 24), *j* was the hourly sampling expansion factor (usually 60 minutes/10 minutes = 6). If sonar count data were missing in a day, the sample size (*m*) was adjusted accordingly. The total variance on day (*d*) was estimated by summing the variances from the 2 banks.

When daily total fish passage estimates was apportioned to species, the daily variance was estimated as:

$$\hat{V}[\hat{N}_{sd}]=N_d^2\cdot V(p_s)+p_s^2\cdot V(N_d)\text{-}V(p_s)\cdot V(N_d), \qquad (3)$$

(Goodman 1960). The variance of the sockeye salmon passage estimate for the season was estimated by summing the daily variances. The 95% confidence intervals for the total sockeye salmon passage estimate were estimated as described by Zar (1984).

# RESULTS

A total of 109 salmon were captured in 130 anchored gillnet sets on the north bank, 268 salmon were captured in 139 drift gillnet sets on the north bank, 293 salmon were captured in 160 drift gillnet sets on the south bank, 107 salmon were captured in 76 seine sets on the north bank, and 733 salmon were captured in 216 hours of fish wheel operation on the north bank (Appendix A1). In general, the proportion of sockeye salmon decreased and the proportion of pink salmon increased in all gear types during the 2 weeks of the project. The proportion of sockeye salmon was generally higher (lower) and the proportion of pink salmon lower (higher) in the anchored gillnet and seine catches versus the drift gillnet catches.

Proportions of sockeye salmon captured in 3 drift gillnet mesh sizes differed significantly during the first week but not the second week (Table 3; Appendix A2). During the first week, higher proportions of sockeye salmon were captured in the smaller mesh gillnets. Proportions of sockeye salmon captured in 3 anchored gillnet mesh sizes did not differ significantly during either week (Table 4). Proportions of sockeye salmon captured in drift gillnets (all mesh sizes combined) were significantly lower on the south versus the north bank during the second week (Table 5). The lower proportions of sockeye salmon captured in drift gillnets on the south bank were due to higher catches of pink salmon on this bank (Appendix A1).

Proportions of sockeye salmon captured in anchored gillnets were significantly higher than in drift gillnets fished on the north bank during both weeks (Table 6). Proportions of sockeye salmon captured in anchored gillnets versus seines were not significantly different during either week (Table 6). Proportions of sockeye salmon captured in anchored gillnets were significantly higher than in fish wheels only during the second week (Table 6). Proportions of sockeye salmon captured in drift gillnets were significantly lower than in seines during both weeks (Table 6). Proportions of sockeye salmon captured in drift gillnets were significantly lower than in the fish wheel only during the first week (Table 6). Proportions of sockeye salmon captured in seines were significantly higher than in the fish wheel only during the second week (Table 6).

Fish wheel data was compiled from both river banks for 15 approximately week long time periods in August 1978, 1980, 1984, 1994, 1998, and 2006–2008 (Table 7). The proportion of sockeye salmon in south bank fish wheel catches were significantly lower than in north bank catches in 10 cases, higher in the south bank catches in 2 cases, and not different between banks in 3 cases (Table 7). The proportion of sockeye salmon in fish wheel catches on both banks tended to decline during August. Logistic regression analysis indicated that the proportion of sockeye salmon in south bank fish wheel catches was significantly correlated ($P < 0.001$) with the sockeye salmon proportion in north bank catches. The *c*-statistic was 0.875 indicating that in 87.5% of all cases the model correctly predicted a higher probability for observations with the "event" outcome than the "non-event" observations. The logistic regression model predicted a lower proportion of sockeye salmon in south bank fish wheel catches except when sockeye salmon proportions were near zero (Figure 3a). Linear regression indicated that logistic model predicted proportions accounted for 79.2% of the variation in actual sockeye salmon proportions in south bank fish wheel catches (Figure 3b).

Sockeye salmon passage estimated using the standard fish wheel apportionment method was not significantly different from passage estimated using combined anchored gillnet and seine data to apportion sonar counts (Table 8). Sockeye salmon passage estimated using the standard fish wheel apportionment method was significantly higher than passage estimated using the other 4 alternative apportionment methods (Table 8), but passage estimates using these 4 alternative apportionment methods were only 1.2% to 4.7% lower than estimates obtained using the standard apportionment method.

# DISCUSSION

The proportion of sockeye salmon captured in small-mesh drift gillnets was higher whereas pink salmon were captured more in the larger mesh sizes (Table 3; Appendix A2). In the Yentna River, pink salmon were captured more often in smaller mesh gillnets (Glick and Willette 2016). Anecdotal information indicated pink salmon in the Kenai River were unusually large in 2016, therefore gillnetting results may not be consistent in future years when the relative sizes of sockeye and pink salmon may be different. It is not possible to determine whether the mix of gillnet mesh sizes used in this study provided a representative estimate of the species composition of salmon passing through the ensonified zone of the DIDSON.

Drift gillnets captured a lower proportion of sockeye salmon on the south bank during the second week of the project when pink salmon were more abundant (Table 5). A comparison of south and north bank fish wheel catches in previous years indicated a similar pattern in 10 of 15 cases suggesting that this pattern is not an artifact of the 2016 sampling methods (Table 7).

It appears that the proportion of pink salmon captured in fish wheels and drift gillnets is in part determined by the location where the gear is fished. Pink salmon mill and spawn at the RM19 sonar site, therefore if gear is fished in a milling area, pink salmon catches will be higher. Milling fish are not counted in the DIDSON images, so it is important that apportionment methods sample only migrating fish. Fish wheels primarily capture fish that are migrating upstream near the river bank; whereas, drift gillnets may capture more fish that are milling further offshore depending on how and where the gear is fished. Lacking an independent estimate of sockeye salmon passage, it is not possible to determine which apportionment method provided the most accurate sockeye salmon passage estimate. However, a mark–recapture study conducted in 2006–2008 at the Kenai RM19 sonar site concluded that DIDSON sonar estimates apportioned using north bank fish wheel catches were not biased (Willette et al. 2012).

We recommend that north bank fish wheel catches continue to be used to apportion DIDSON sonar counts to species at the Kenai RM19 sonar site. The comparison of sockeye salmon passage estimates using 6 apportionment methods indicated that differences between estimates were a relatively small proportion (1.2–4.7%) of the total passage estimate (Table 8), and it was not possible to unequivocally determine which apportionment method provided the most accurate sockeye salmon passage estimate. Drift gillnets probably capture some salmon that are milling and spawning in the area depending on how the gear is fished. Because milling fish are not counted in DIDSON images, fish wheel, anchored gillnet and seine catches probably provide more accurate apportionment data for fish migrating near the river bank. However, anchored gillnets and seines are not practical methods for apportioning sonar counts at the RM19 site, because catches were low and these gear types cannot be fished near the sonar site on the south bank due to private ownership of much of the riverbank and the presence of sport fishermen. A review of historic fish wheel catches on both banks indicated that the sockeye salmon proportion along the south bank in August could be estimated using north bank catch data (Figure 3a). We recommend that our logistic regression model predictions based on north bank fish wheel catches be used in the future to apportion south bank DIDSON counts.

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# TABLES

Table 1.–Chi-square tests for differences in the proportion of sockeye salmon caught in fish wheels versus drift gillnets fished primarily in the offshore sector (11–30 m from shore) at the Kenai RM19 sonar site in 2014.

| | | Number of salmon caught | | Proportion | Chi-square |
|---|---|---|---|---|---|
| Date | Gear | Sockeye | Total | sockeye | *P*-value |
| 8/4 | Gillnet | 3 | 17 | 0.176 | 0.015 |
| | Fish wheel | 43 | 54 | 0.796 | |
| 8/5 | Gillnet | 24 | 51 | 0.471 | 0.156 |
| | Fish wheel | 55 | 76 | 0.724 | |
| 8/6 | Gillnet | 14 | 65 | 0.215 | 0.044 |
| | Fish wheel | 85 | 208 | 0.409 | |
| 8/8 | Gillnet | 5 | 52 | 0.096 | <0.001 |
| | Fish wheel | 443 | 668 | 0.663 | |
| 8/9 | Gillnet | 11 | 69 | 0.159 | <0.001 |
| | Fish wheel | 140 | 213 | 0.657 | |
| 8/11 | Gillnet | 1 | 79 | 0.013 | <0.001 |
| | Fish wheel | 96 | 215 | 0.447 | |
| 8/12 | Gillnet | 2 | 58 | 0.034 | 0.001 |
| | Fish wheel | 23 | 74 | 0.311 | |
| 8/13 | Gillnet | 0 | 43 | 0.000 | 0.040 |
| | Fish wheel | 10 | 99 | 0.101 | |
| 8/14 | Gillnet | 0 | 15 | 0.000 | 0.198 |
| | Fish wheel | 8 | 71 | 0.113 | |
| All dates | Gillnet | 60 | 449 | 0.134 | <0.001 |
| | Fish wheel | 903 | 1,678 | 0.538 | |

Table 2.–Chi-square tests for differences in the proportion of sockeye salmon caught in fish wheels versus gillnets fished primarily in the nearshore sector (1–10 m from shore) along the north bank at the Kenai RM19 sonar site in 2014.

| | | Number of salmon caught | | Proportion | Chi-square |
|---|---|---|---|---|---|
| Date | Gear | Sockeye | Total | sockeye | *P*-value |
| 8/12 | Gillnet | 3 | 6 | 0.500 | 0.521 |
| | Fish wheel | 23 | 74 | 0.311 | |
| 8/13 | Gillnet | 5 | 33 | 0.152 | <0.001 |
| | Fish wheel | 10 | 99 | 0.101 | |
| 8/14 | Gillnet | 4 | 16 | 0.250 | 0.003 |
| | Fish wheel | 8 | 71 | 0.113 | |
| All dates | Gillnet | 12 | 55 | 0.218 | <0.001 |
| | Fish wheel | 41 | 244 | 0.168 | |

Table 3.–Chi-square tests for differences in the proportion of sockeye salmon caught in 3 mesh sizes of drift gillnets fished along both banks at the Kenai RM19 sonar site during 2 date periods in 2016.

| | Gillnet mesh | Number of | Number of salmon caught | | | Proportion | Chi-square |
|---|---|---|---|---|---|---|---|
| Week | size (cm) | net sets | Sockeye | Other | Total | sockeye | *P*-value |
| 8/8-8/13 | 12.1 | 48 | 88 | 24 | 112 | 0.786 | 0.008 |
| | 13.0 | 44 | 79 | 24 | 103 | 0.766 | |
| | 15.2 | 46 | 59 | 38 | 97 | 0.608 | |
| 8/14-8/19 | 12.1 | 52 | 39 | 47 | 86 | 0.454 | 0.078 |
| | 13.0 | 57 | 27 | 54 | 81 | 0.333 | |
| | 15.2 | 52 | 24 | 58 | 82 | 0.293 | |

Table 4.–Fish exact tests for differences in the proportion of sockeye salmon caught in 3 mesh sizes of anchored gillnets fished along the north bank at the Kenai RM19 sonar site during 2 date periods in 2016.

| | Gillnet mesh | Number of | Number of salmon caught | | | Proportion | Fisherman |
|---|---|---|---|---|---|---|---|
| Week | size (cm) | net sets | Sockeye | Other | Total | sockeye | *P*-value |
| 8/8-8/13 | 12.1 | 24 | 25 | 3 | 28 | 0.893 | 0.425 |
| | 13.0 | 22 | 14 | 1 | 15 | 0.933 | |
| | 15.2 | 20 | 13 | 4 | 17 | 0.765 | |
| 8/14-8/19 | 12.1 | 22 | 16 | 8 | 24 | 0.667 | 1.000 |
| | 13.0 | 20 | 8 | 3 | 11 | 0.727 | |
| | 15.2 | 22 | 9 | 5 | 14 | 0.643 | |

Table 5.–Chi-square tests for differences in the proportion of sockeye salmon caught in drift gillnets (all mesh sizes combined) fished along the north versus south banks at the Kenai RM19 sonar site during 2 date periods in 2016.

| Week | River bank | Number of net sets | Number of salmon caught Sockeye | Other | Total | Proportion sockeye | Chi-square *P*-value |
|---|---|---|---|---|---|---|---|
| 8/8-8/13 | North | 71 | 120 | 45 | 165 | 0.727 | 0.903 |
| | South | 67 | 106 | 41 | 147 | 0.721 | |
| 8/14-8/19 | North | 68 | 51 | 52 | 103 | 0.495 | 0.000 |
| | South | 93 | 39 | 107 | 146 | 0.267 | |

Table 6.–Paired comparison chi-square tests for differences in the proportion of sockeye salmon caught using 4 methods along the north bank at the Kenai RM19 sonar site during 2 date periods in 2016.

| Week | Method | Number of net sets | Number of salmon caught Sockeye | Other | Total | Proportion sockeye | Chi-square *P*-value |
|---|---|---|---|---|---|---|---|
| 8/8-8/13 | Anchored gillnet | 66 | 52 | 8 | 60 | 0.867 | 0.029 |
| | Drift gillnet | 71 | 120 | 45 | 165 | 0.727 | |
| 8/14-8/19 | Anchored gillnet | 64 | 33 | 16 | 49 | 0.674 | 0.039 |
| | Drift gillnet | 68 | 51 | 52 | 103 | 0.495 | |
| | | | | | | | |
| 8/8-8/13 | Anchored gillnet | 66 | 52 | 8 | 60 | 0.867 | 0.515 |
| | Seine | 31 | 65 | 7 | 72 | 0.903 | |
| 8/14-8/19 | Anchored gillnet | 64 | 33 | 16 | 49 | 0.674 | 0.690 |
| | Seine | 45 | 25 | 10 | 35 | 0.714 | |
| | | | | | | | |
| 8/8-8/13 | Anchored gillnet | 66 | 52 | 8 | 60 | 0.867 | 0.121 |
| | Fish wheel | NA | 245 | 19 | 264 | 0.928 | |
| 8/14-8/19 | Anchored gillnet | 64 | 33 | 16 | 49 | 0.674 | 0.041 |
| | Fish wheel | NA | 244 | 225 | 469 | 0.520 | |
| | | | | | | | |
| 8/8-8/13 | Drift gillnet | 71 | 120 | 45 | 165 | 0.727 | 0.003 |
| | Seine | 31 | 65 | 7 | 72 | 0.903 | |
| 8/14-8/19 | Drift gillnet | 68 | 51 | 52 | 103 | 0.495 | 0.024 |
| | Seine | 45 | 25 | 10 | 35 | 0.714 | |
| | | | | | | | |
| 8/8-8/13 | Drift gillnet | 71 | 120 | 45 | 165 | 0.727 | <0.001 |
| | Fish wheel | NA | 245 | 19 | 264 | 0.928 | |
| 8/14-8/19 | Drift gillnet | 68 | 51 | 52 | 103 | 0.495 | 0.644 |
| | Fish wheel | NA | 244 | 225 | 469 | 0.520 | |
| 8/8-8/13 | Seine | 31 | 65 | 7 | 72 | 0.903 | 0.477 |
| | Fish wheel | NA | 245 | 19 | 264 | 0.928 | |
| 8/14-8/19 | Seine | 45 | 25 | 10 | 35 | 0.714 | 0.026 |
| | Fish wheel | NA | 244 | 225 | 469 | 0.520 | |

Table 7.–Chi-square tests for differences in the proportion of sockeye salmon caught in fish wheels operated along the north versus south banks at the Kenai RM19 sonar site in 1978, 1980, 1984, 1994, 1998, and 2006–2008.

| Year | Week | River bank | Number of salmon caught Sockeye | Other | Total | Proportion sockeye | Difference | Chi-square *P*-value |
|---|---|---|---|---|---|---|---|---|
| 1978 | 8/1-8/7 | North | 50 | 20 | 70 | 0.714 | 0.157 | 0.025 |
| | | South | 88 | 70 | 158 | 0.557 | | |
| | 8/8-8/15 | North | 5 | 7 | 12 | 0.417 | 0.314 | 0.001 |
| | | South | 18 | 157 | 175 | 0.103 | | |
| | 8/16-8/24 | North | 0 | 157 | 157 | 0.000 | -0.002 | 0.563 |
| | | South | 1 | 470 | 471 | 0.002 | | |
| 1980 | 8/1-8/7 | North | 20 | 4 | 24 | 0.833 | 0.258 | 0.018 |
| | | South | 65 | 48 | 113 | 0.575 | | |
| | 8/8-8/15 | North | 48 | 79 | 127 | 0.378 | 0.080 | 0.122 |
| | | South | 71 | 167 | 238 | 0.298 | | |
| | 8/16-8/27 | North | 18 | 247 | 265 | 0.068 | 0.063 | 0.000 |
| | | South | 12 | 2,373 | 2,385 | 0.005 | | |
| 1984 | 8/1-8/8 | North | 365 | 63 | 428 | 0.853 | 0.395 | 0.000 |
| | | South | 234 | 277 | 511 | 0.458 | | |
| 1994 | 8/13-8/24 | North | 2,001 | 304 | 2,305 | 0.868 | 0.056 | 0.001 |
| | | South | 416 | 96 | 512 | 0.813 | | |
| 1998 | 8/7-8/13 | North | 1,666 | 166 | 1,832 | 0.909 | 0.093 | 0.000 |
| | | South | 266 | 60 | 326 | 0.816 | | |
| 2006 | 8/8-8/13 | North | 908 | 120 | 1,028 | 0.883 | 0.052 | 0.003 |
| | | South | 531 | 108 | 639 | 0.831 | | |
| 2006 | 8/14-8/20 | North | 2,626 | 337 | 2,963 | 0.886 | 0.059 | <0.001 |
| | | South | 2,066 | 431 | 2,497 | 0.827 | | |
| | 8/21-8/31 | North | 1,152 | 1,707 | 2,859 | 0.403 | -0.126 | <0.001 |
| | | South | 485 | 432 | 917 | 0.529 | | |
| 2007 | 8/16-8/23 | North | 270 | 20 | 290 | 0.931 | 0.029 | 0.125 |
| | | South | 1,275 | 138 | 1,413 | 0.902 | | |
| 2008 | 8/2-8/9 | North | 765 | 111 | 876 | 0.873 | 0.060 | 0.001 |
| | | South | 540 | 124 | 664 | 0.813 | | |
| | 8/10-8/17 | North | 89 | 418 | 507 | 0.176 | -0.171 | <0.001 |
| | | South | 290 | 548 | 838 | 0.346 | | |

Table 8.–Paired comparison *Z*-tests for differences in sockeye salmon passage estimated using 6 species apportionment methods in 2016.

| Apportionment method | Sockeye passage *N* | Sockeye passage V(N) | 95% Confidence interval Lower | 95% Confidence interval Upper | CV | Difference | Percent deviation | *Z*-test *P*-value |
|---|---|---|---|---|---|---|---|---|
| Standard fish wheel | 1,383,692 | 1.96E+07 | 1,374,795 | 1,392,154 | 0.003 | 14,984 | 1.1% | 0.158 |
| Gillnet & seine | 1,398,676 | 9.50E+07 | 1,379,577 | 1,417,775 | 0.007 | | | |
| | | | | | | | | |
| Standard fish wheel | 1,383,692 | 1.96E+07 | 1,374,795 | 1,392,154 | 0.003 | 64,889 | 4.7% | 0.000 |
| Drift gillnet | 1,318,803 | 5.31E+07 | 1,304,522 | 1,333,084 | 0.006 | | | |
| | | | | | | | | |
| Standard fish wheel | 1,383,692 | 1.96E+07 | 1,374,795 | 1,392,154 | 0.003 | 21,453 | 1.6% | 0.000 |
| All methods [a] | 1,362,239 | 1.39E+07 | 1,354,925 | 1,369,553 | 0.003 | | | |
| | | | | | | | | |
| Standard fish wheel | 1,383,692 | 1.96E+07 | 1,374,795 | 1,392,154 | 0.003 | 52,608 | 3.8% | 0.000 |
| All methods [b] | 1,331,084 | 4.28E+07 | 1,318,256 | 1,343,911 | 0.005 | | | |
| | | | | | | | | |
| Standard fish wheel | 1,383,692 | 1.96E+07 | 1,374,795 | 1,392,154 | 0.003 | 15,954 | 1.2% | 0.001 |
| Fish wheel [c] | 1,367,738 | 3.27E+06 | 1,364,196 | 1,371,280 | 0.001 | | | |

[a] Data from all fishing methods combined were applied to apportion sonar counts on both banks.

[b] Data from all fishing methods combined were applied to apportion sonar counts on the north bank and only drift gillnet data were applied to apportion sonar counts on the south bank.

[c] Data from the fish wheel were applied to apportion sonar counts on the north bank and modelled (logistic regression) species compositions were applied to apportion sonar counts on the south bank.

# FIGURES

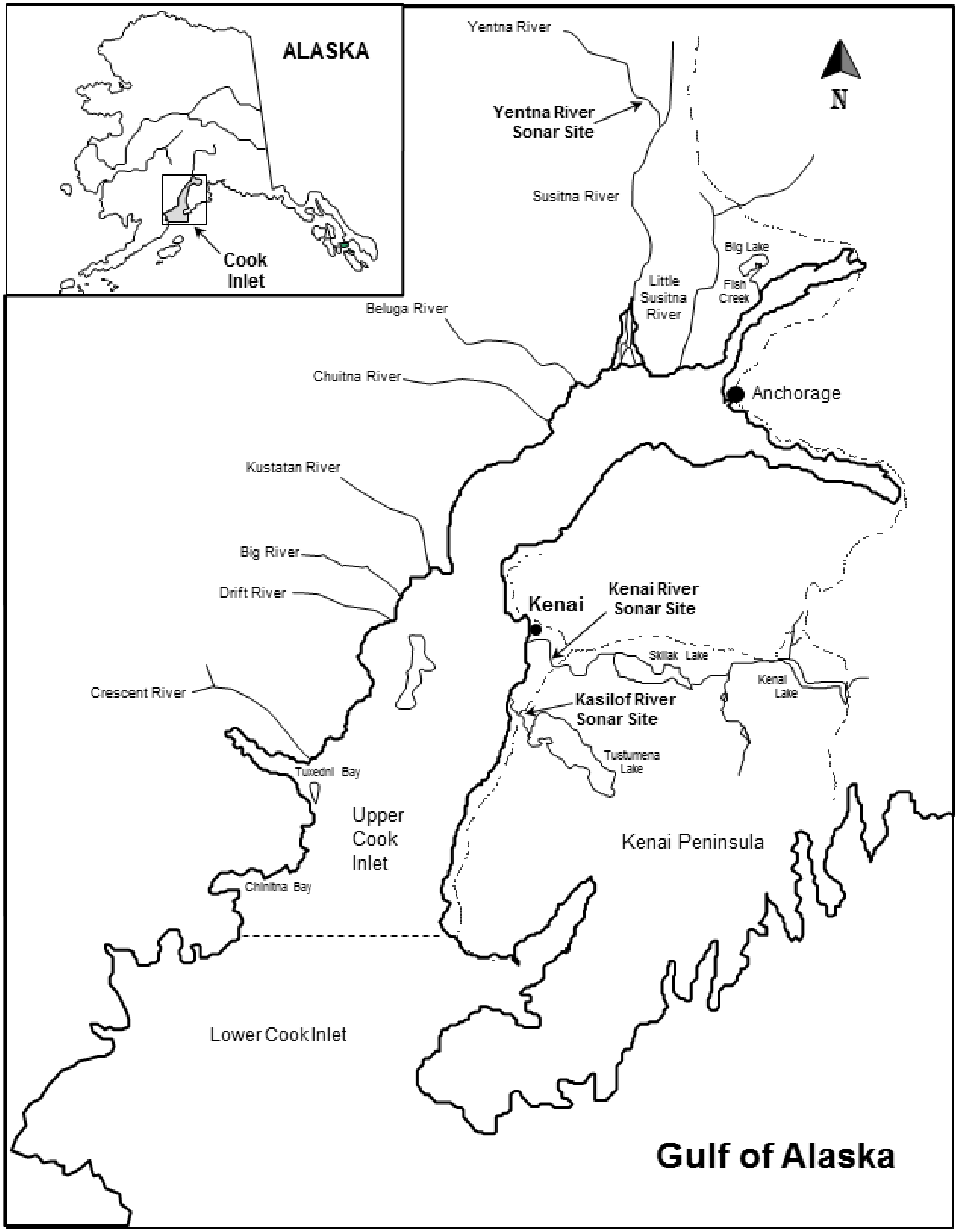


Figure 1.–Map showing location of the Kenai River sonar site used to enumerate sockeye salmon passage at river mile 19.

Figure 2.–Typical fish wheel installation on the north bank of the Kenai River.

(a)

(b)

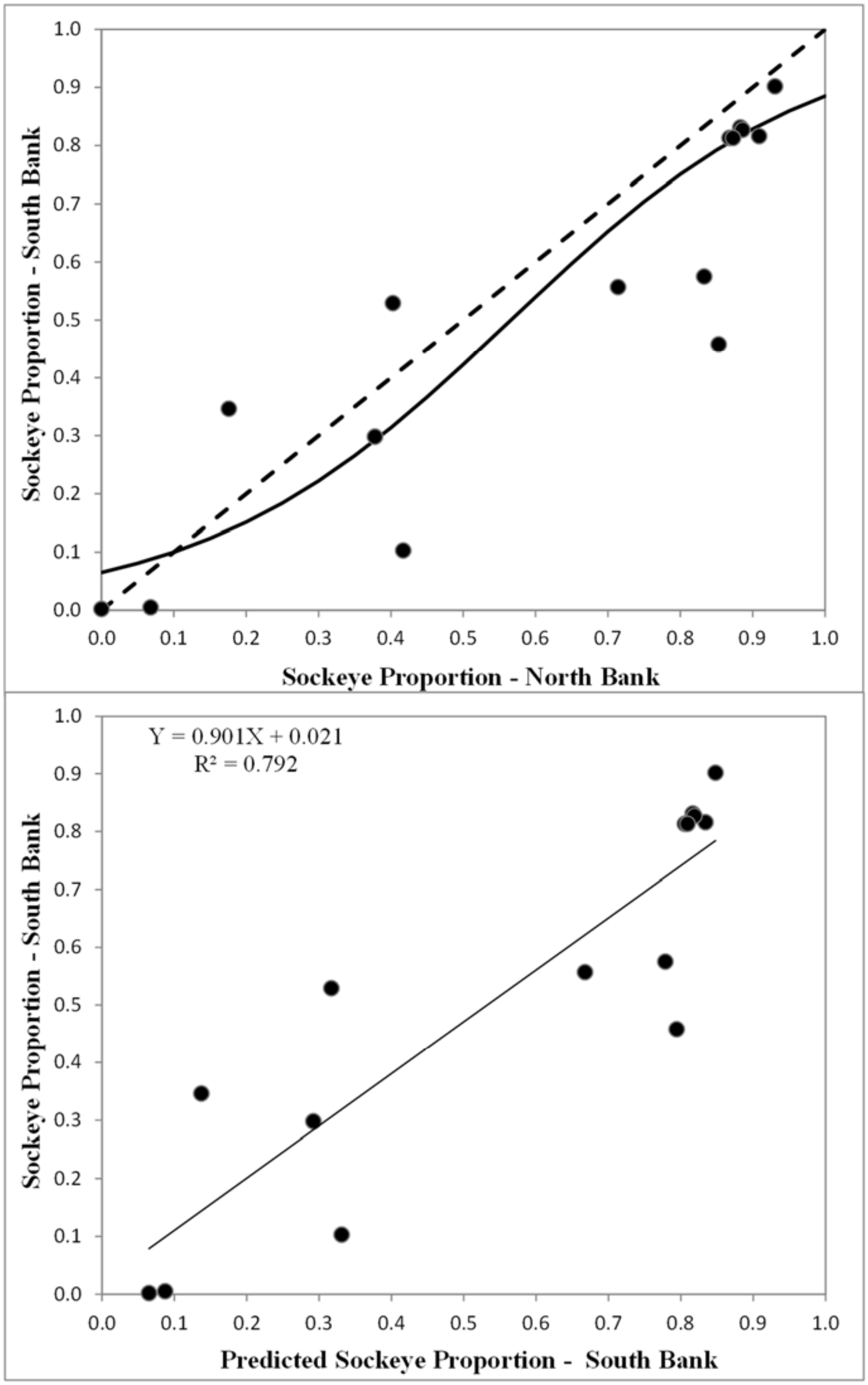


Figure 3.–(a) Proportions of sockeye salmon along the south bank at the Kenai RM19 sonar site predicted by a logistic regression model (solid line) with the proportions of sockeye salmon in fish wheel catches on the north bank as the independent variable. The 1:1 line (dashed) is shown for comparison. (b) Relationship between the proportions of sockeye salmon along the south bank and sockeye salmon proportions predicted by a logistic regression model.

# APPENDIX A: CATCH DATA SUMMARY

Appendix A1.–Summary of fish catch data by gear type (all gillnet mesh sizes combined), bank and date, August 8–19, 2016.

| | | | | Catch | | | | | | | Proportion | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gear | Bank | Date | Number of net sets | Sockeye | Pink | Coho | Chinook | RBT | DV | Total salmon | Sockeye | Pink |
| Anchored gillnet | North | 8/8 | 6 | 5 | 0 | 0 | 0 | 2 | 0 | 5 | 1.000 | 0.000 |
| Anchored gillnet | North | 8/9 | 12 | 7 | 1 | 1 | 0 | 0 | 0 | 9 | 0.778 | 0.111 |
| Anchored gillnet | North | 8/10 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | . | . |
| Anchored gillnet | North | 8/11 | 12 | 10 | 1 | 0 | 0 | 0 | 1 | 11 | 0.909 | 0.091 |
| Anchored gillnet | North | 8/12 | 12 | 16 | 2 | 0 | 0 | 0 | 0 | 18 | 0.889 | 0.111 |
| Anchored gillnet | North | 8/13 | 12 | 14 | 1 | 2 | 0 | 2 | 0 | 17 | 0.824 | 0.059 |
| Anchored gillnet | North | 8/14 | 12 | 6 | 3 | 0 | 1 | 0 | 0 | 10 | 0.600 | 0.300 |
| Anchored gillnet | North | 8/15 | 12 | 6 | 0 | 1 | 0 | 0 | 0 | 7 | 0.857 | 0.000 |
| Anchored gillnet | North | 8/16 | 12 | 11 | 2 | 0 | 0 | 0 | 0 | 13 | 0.846 | 0.154 |
| Anchored gillnet | North | 8/17 | 10 | 0 | 1 | 1 | 1 | 1 | 0 | 3 | 0.000 | 0.333 |
| Anchored gillnet | North | 8/18 | 12 | 3 | 4 | 1 | 0 | 0 | 0 | 8 | 0.375 | 0.500 |
| Anchored gillnet | North | 8/19 | 6 | 7 | 1 | 0 | 0 | 1 | 0 | 8 | 0.875 | 0.125 |
| Drift gillnet | North | 8/8 | 14 | 12 | 4 | 0 | 5 | 4 | 0 | 21 | 0.571 | 0.190 |
| Drift gillnet | North | 8/9 | 12 | 26 | 1 | 2 | 4 | 4 | 0 | 33 | 0.788 | 0.030 |
| Drift gillnet | North | 8/10 | 10 | 17 | 4 | 2 | 3 | 1 | 0 | 26 | 0.654 | 0.154 |
| Drift gillnet | North | 8/11 | 11 | 20 | 4 | 2 | 2 | 0 | 0 | 28 | 0.714 | 0.143 |
| Drift gillnet | North | 8/12 | 12 | 22 | 4 | 3 | 3 | 1 | 0 | 32 | 0.688 | 0.125 |
| Drift gillnet | North | 8/13 | 12 | 23 | 1 | 0 | 1 | 0 | 0 | 25 | 0.920 | 0.040 |
| Drift gillnet | North | 8/14 | 12 | 17 | 1 | 1 | 2 | 1 | 0 | 21 | 0.810 | 0.048 |
| Drift gillnet | North | 8/15 | 12 | 6 | 3 | 2 | 1 | 1 | 0 | 12 | 0.500 | 0.250 |
| Drift gillnet | North | 8/16 | 12 | 12 | 13 | 3 | 2 | 0 | 0 | 30 | 0.400 | 0.433 |
| Drift gillnet | North | 8/17 | 14 | 10 | 7 | 2 | 2 | 0 | 0 | 21 | 0.476 | 0.333 |
| Drift gillnet | North | 8/18 | 12 | 6 | 2 | 4 | 1 | 1 | 0 | 13 | 0.462 | 0.154 |
| Drift gillnet | North | 8/19 | 6 | 0 | 4 | 2 | 0 | 0 | 0 | 6 | 0.000 | 0.667 |
| Drift gillnet | South | 8/8 | 17 | 4 | 2 | 0 | 2 | 0 | 0 | 8 | 0.500 | 0.250 |

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| Gear | Bank | Date | Number of net sets | Catch: Sockeye | Pink | Coho | Chinook | RBT | DV | Total salmon | Proportion: Sockeye | Pink |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drift gillnet | South | 8/9 | 4 | 3 | 1 | 0 | 0 | 0 | 0 | 4 | 0.750 | 0.250 |
| Drift gillnet | South | 8/10 | 11 | 26 | 4 | 1 | 2 | 0 | 0 | 33 | 0.788 | 0.121 |
| Drift gillnet | South | 8/11 | 12 | 24 | 2 | 4 | 0 | 2 | 0 | 30 | 0.800 | 0.067 |
| Drift gillnet | South | 8/12 | 14 | 34 | 7 | 1 | 4 | 0 | 0 | 46 | 0.739 | 0.152 |
| Drift gillnet | South | 8/13 | 9 | 15 | 7 | 4 | 0 | 0 | 0 | 26 | 0.577 | 0.269 |
| Drift gillnet | South | 8/14 | 18 | 7 | 3 | 0 | 2 | 0 | 0 | 12 | 0.583 | 0.250 |
| Drift gillnet | South | 8/15 | 18 | 0 | 5 | 0 | 3 | 0 | 0 | 8 | 0.000 | 0.625 |
| Drift gillnet | South | 8/16 | 18 | 6 | 30 | 5 | 4 | 0 | 0 | 45 | 0.133 | 0.667 |
| Drift gillnet | South | 8/17 | 12 | 9 | 8 | 6 | 2 | 0 | 0 | 25 | 0.360 | 0.320 |
| Drift gillnet | South | 8/18 | 18 | 12 | 23 | 5 | 0 | 0 | 1 | 40 | 0.300 | 0.575 |
| Drift gillnet | South | 8/19 | 9 | 5 | 9 | 1 | 1 | 0 | 0 | 16 | 0.313 | 0.563 |
| Seine | North | 8/8 | 5 | 9 | 0 | 0 | 0 | 0 | 0 | 9 | 1.000 | 0.000 |
| Seine | North | 8/9 | 4 | 11 | 0 | 1 | 0 | 0 | 0 | 12 | 0.917 | 0.000 |
| Seine | North | 8/10 | 4 | 6 | 0 | 1 | 0 | 0 | 0 | 7 | 0.857 | 0.000 |
| Seine | North | 8/11 | 4 | 3 | 3 | 0 | 0 | 0 | 0 | 6 | 0.500 | 0.500 |
| Seine | North | 8/12 | 6 | 24 | 0 | 1 | 0 | 0 | 0 | 25 | 0.960 | 0.000 |
| Seine | North | 8/13 | 8 | 12 | 1 | 0 | 0 | 0 | 0 | 13 | 0.923 | 0.077 |
| Seine | North | 8/14 | 8 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 1.000 | 0.000 |
| Seine | North | 8/15 | 8 | 8 | 2 | 0 | 0 | 0 | 0 | 10 | 0.800 | 0.200 |
| Seine | North | 8/16 | 9 | 8 | 0 | 1 | 0 | 0 | 0 | 9 | 0.889 | 0.000 |
| Seine | North | 8/17 | 8 | 2 | 1 | 2 | 0 | 0 | 0 | 5 | 0.400 | 0.200 |
| Seine | North | 8/18 | 8 | 3 | 0 | 3 | 0 | 0 | 0 | 6 | 0.500 | 0.000 |
| Seine | North | 8/19 | 4 | 1 | 0 | 1 | 0 | 0 | 0 | 2 | 0.500 | 0.000 |
| Fish wheel | North | 8/8 | 23.4 | 37 | 0 | 0 | 0 | 0 | 0 | 37 | 1.000 | 0.000 |
| Fish wheel | North | 8/9 | 24.0 | 18 | 1 | 0 | 0 | 0 | 0 | 19 | 0.947 | 0.053 |
| Fish wheel | North | 8/10 | 21.5 | 22 | 0 | 0 | 1 | 0 | 0 | 23 | 0.957 | 0.000 |

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| Gear | Bank | Date | Number of net sets | Catch | | | | | | Total salmon | Proportion | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Sockeye | Pink | Coho | Chinook | RBT | DV | | Sockeye | Pink |
| Fish wheel | North | 8/11 | 23.7 | 5 | 0 | 0 | 0 | 0 | 0 | 5 | 1.000 | 0.000 |
| Fish wheel | North | 8/12 | 18.3 | 94 | 6 | 1 | 0 | 0 | 0 | 101 | 0.931 | 0.059 |
| Fish wheel | North | 8/13 | 17.0 | 69 | 9 | 1 | 0 | 0 | 0 | 79 | 0.873 | 0.114 |
| Fish wheel | North | 8/14 | 16.7 | 70 | 15 | 4 | 1 | 0 | 0 | 90 | 0.778 | 0.167 |
| Fish wheel | North | 8/15 | 15.5 | 74 | 45 | 7 | 6 | 0 | 0 | 132 | 0.561 | 0.341 |
| Fish wheel | North | 8/16 | 15.5 | 44 | 34 | 8 | 5 | 0 | 0 | 91 | 0.484 | 0.374 |
| Fish wheel | North | 8/17 | 14.2 | 30 | 41 | 13 | 2 | 0 | 0 | 86 | 0.349 | 0.477 |
| Fish wheel | North | 8/18 | 13.5 | 16 | 14 | 10 | 1 | 0 | 0 | 41 | 0.390 | 0.341 |
| Fish wheel | North | 8/19 | 12.5 | 10 | 14 | 5 | 0 | 0 | 0 | 29 | 0.345 | 0.483 |

*Note*: RBT is rainbow trout and DV is Dolly Varden.

Appendix A2.–Summary of gillnet catch data by mesh size, bank and date, August 8–19, 2016.

| Gillnet mesh size (cm) | Bank | Date | Number of net sets | Catch: Sockeye | Pink | Coho | Chinook | RBT | DV | Total salmon | Proportion: Sockeye | Pink |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12.1 | North | 8/8 | 8 | 10 | 1 | 0 | 2 | 5 | 0 | 13 | 0.769 | 0.077 |
| 12.1 | North | 8/9 | 8 | 12 | 1 | 0 | 1 | 3 | 0 | 14 | 0.857 | 0.071 |
| 12.1 | North | 8/10 | 8 | 4 | 2 | 2 | 1 | 1 | 0 | 9 | 0.444 | 0.222 |
| 12.1 | North | 8/11 | 7 | 10 | 1 | 0 | 0 | 0 | 1 | 11 | 0.909 | 0.091 |
| 12.1 | North | 8/12 | 9 | 11 | 0 | 1 | 1 | 1 | 0 | 13 | 0.846 | 0.000 |
| 12.1 | North | 8/13 | 8 | 14 | 1 | 0 | 0 | 2 | 0 | 15 | 0.933 | 0.067 |
| 12.1 | North | 8/14 | 8 | 8 | 0 | 1 | 1 | 0 | 0 | 10 | 0.800 | 0.000 |
| 12.1 | North | 8/15 | 8 | 6 | 2 | 1 | 0 | 0 | 0 | 9 | 0.667 | 0.222 |
| 12.1 | North | 8/16 | 8 | 11 | 3 | 1 | 1 | 0 | 0 | 16 | 0.688 | 0.188 |
| 12.1 | North | 8/17 | 8 | 4 | 2 | 0 | 1 | 0 | 0 | 7 | 0.571 | 0.286 |
| 12.1 | North | 8/18 | 8 | 6 | 4 | 2 | 0 | 1 | 0 | 12 | 0.500 | 0.333 |
| 12.1 | North | 8/19 | 4 | 0 | 4 | 2 | 0 | 1 | 0 | 6 | 0.000 | 0.667 |
| 12.1 | South | 8/8 | 6 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 1.000 | 0.000 |
| 12.1 | South | 8/9 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 3 | 0.667 | 0.333 |
| 12.1 | South | 8/10 | 4 | 12 | 2 | 0 | 1 | 0 | 0 | 15 | 0.800 | 0.133 |
| 12.1 | South | 8/11 | 4 | 9 | 0 | 0 | 0 | 1 | 0 | 9 | 1.000 | 0.000 |
| 12.1 | South | 8/12 | 5 | 20 | 1 | 1 | 3 | 0 | 0 | 25 | 0.800 | 0.040 |
| 12.1 | South | 8/13 | 3 | 7 | 2 | 2 | 0 | 0 | 0 | 11 | 0.636 | 0.182 |
| 12.1 | South | 8/14 | 6 | 2 | 0 | 0 | 1 | 0 | 0 | 3 | 0.667 | 0.000 |
| 12.1 | South | 8/15 | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0.000 | 1.000 |
| 12.1 | South | 8/16 | 6 | 4 | 3 | 1 | 1 | 0 | 0 | 9 | 0.444 | 0.333 |
| 12.1 | South | 8/17 | 3 | 5 | 4 | 2 | 1 | 0 | 0 | 12 | 0.417 | 0.333 |
| 12.1 | South | 8/18 | 6 | 4 | 10 | 2 | 0 | 0 | 1 | 16 | 0.250 | 0.625 |
| 12.1 | South | 8/19 | 3 | 5 | 3 | 1 | 0 | 0 | 0 | 9 | 0.556 | 0.333 |

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| Gillnet mesh size (cm) | Bank | Date | Number of net sets | Catch: Sockeye | Catch: Pink | Catch: Coho | Catch: Chinook | Catch: RBT | Catch: DV | Total salmon | Proportion: Sockeye | Proportion: Pink |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13.0 | North | 8/8 | 6 | 3 | 0 | 0 | 0 | 1 | 0 | 3 | 1.000 | 0.000 |
| 13.0 | North | 8/9 | 8 | 10 | 0 | 1 | 0 | 1 | 0 | 11 | 0.909 | 0.000 |
| 13.0 | North | 8/10 | 8 | 7 | 0 | 0 | 1 | 0 | 0 | 8 | 0.875 | 0.000 |
| 13.0 | North | 8/11 | 8 | 12 | 1 | 1 | 2 | 0 | 0 | 16 | 0.750 | 0.063 |
| 13.0 | North | 8/12 | 7 | 8 | 2 | 0 | 2 | 0 | 0 | 12 | 0.667 | 0.167 |
| 13.0 | North | 8/13 | 8 | 14 | 1 | 1 | 0 | 0 | 0 | 16 | 0.875 | 0.063 |
| 13.0 | North | 8/14 | 8 | 9 | 1 | 0 | 1 | 1 | 0 | 11 | 0.818 | 0.091 |
| 13.0 | North | 8/15 | 8 | 3 | 1 | 0 | 0 | 0 | 0 | 4 | 0.750 | 0.250 |
| 13.0 | North | 8/16 | 8 | 3 | 6 | 0 | 1 | 0 | 0 | 10 | 0.300 | 0.600 |
| 13.0 | North | 8/17 | 8 | 3 | 4 | 2 | 1 | 1 | 0 | 10 | 0.300 | 0.400 |
| 13.0 | North | 8/18 | 8 | 2 | 2 | 3 | 1 | 0 | 0 | 8 | 0.250 | 0.250 |
| 13.0 | North | 8/19 | 4 | 5 | 1 | 0 | 0 | 0 | 0 | 6 | 0.833 | 0.167 |
| 13.0 | South | 8/8 | 5 | 2 | 1 | 0 | 1 | 0 | 0 | 4 | 0.500 | 0.250 |
| 13.0 | South | 8/10 | 4 | 10 | 0 | 1 | 0 | 0 | 0 | 11 | 0.909 | 0.000 |
| 13.0 | South | 8/11 | 4 | 11 | 0 | 2 | 0 | 1 | 0 | 13 | 0.846 | 0.000 |
| 13.0 | South | 8/12 | 5 | 10 | 2 | 0 | 1 | 0 | 0 | 13 | 0.769 | 0.154 |
| 13.0 | South | 8/13 | 3 | 6 | 3 | 2 | 0 | 0 | 0 | 11 | 0.545 | 0.273 |
| 13.0 | South | 8/14 | 6 | 2 | 1 | 0 | 1 | 0 | 0 | 4 | 0.500 | 0.250 |
| 13.0 | South | 8/15 | 6 | 0 | 1 | 0 | 2 | 0 | 0 | 3 | 0.000 | 0.333 |
| 13.0 | South | 8/16 | 6 | 2 | 9 | 3 | 1 | 0 | 0 | 15 | 0.133 | 0.600 |
| 13.0 | South | 8/17 | 6 | 1 | 2 | 2 | 1 | 0 | 0 | 6 | 0.167 | 0.333 |
| 13.0 | South | 8/18 | 6 | 5 | 5 | 1 | 0 | 0 | 0 | 11 | 0.455 | 0.455 |
| 13.0 | South | 8/19 | 3 | 0 | 3 | 0 | 1 | 0 | 0 | 4 | 0.000 | 0.750 |
| 15.2 | North | 8/8 | 6 | 4 | 3 | 0 | 3 | 0 | 0 | 10 | 0.400 | 0.300 |
| 15.2 | North | 8/9 | 8 | 11 | 1 | 2 | 3 | 0 | 0 | 17 | 0.647 | 0.059 |
| 15.2 | North | 8/10 | 6 | 6 | 2 | 0 | 1 | 0 | 0 | 9 | 0.667 | 0.222 |

-continued-

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| Gillnet mesh size (cm) | Bank | Date | Number of net sets | Catch: Sockeye | Pink | Coho | Chinook | RBT | DV | Total salmon | Proportion: Sockeye | Pink |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15.2 | North | 8/11 | 8 | 8 | 3 | 1 | 0 | 0 | 0 | 12 | 0.667 | 0.250 |
| 15.2 | North | 8/12 | 8 | 19 | 4 | 2 | 0 | 0 | 0 | 25 | 0.760 | 0.160 |
| 15.2 | North | 8/13 | 8 | 9 | 0 | 1 | 1 | 0 | 0 | 11 | 0.818 | 0.000 |
| 15.2 | North | 8/14 | 8 | 6 | 3 | 0 | 1 | 0 | 0 | 10 | 0.600 | 0.300 |
| 15.2 | North | 8/15 | 8 | 3 | 0 | 2 | 1 | 1 | 0 | 6 | 0.500 | 0.000 |
| 15.2 | North | 8/16 | 8 | 9 | 6 | 2 | 0 | 0 | 0 | 17 | 0.529 | 0.353 |
| 15.2 | North | 8/17 | 8 | 3 | 2 | 1 | 1 | 0 | 0 | 7 | 0.429 | 0.286 |
| 15.2 | North | 8/18 | 8 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1.000 | 0.000 |
| 15.2 | North | 8/19 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 1.000 | 0.000 |
| 15.2 | South | 8/8 | 6 | 0 | 1 | 0 | 1 | 0 | 0 | 2 | 0.000 | 0.500 |
| 15.2 | South | 8/9 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1.000 | 0.000 |
| 15.2 | South | 8/10 | 3 | 4 | 2 | 0 | 1 | 0 | 0 | 7 | 0.571 | 0.286 |
| 15.2 | South | 8/11 | 4 | 4 | 2 | 2 | 0 | 0 | 0 | 8 | 0.500 | 0.250 |
| 15.2 | South | 8/12 | 4 | 4 | 4 | 0 | 0 | 0 | 0 | 8 | 0.500 | 0.500 |
| 15.2 | South | 8/13 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 4 | 0.500 | 0.500 |
| 15.2 | South | 8/14 | 6 | 3 | 2 | 0 | 0 | 0 | 0 | 5 | 0.600 | 0.400 |
| 15.2 | South | 8/15 | 6 | 0 | 3 | 0 | 1 | 0 | 0 | 4 | 0.000 | 0.750 |
| 15.2 | South | 8/16 | 6 | 0 | 18 | 1 | 2 | 0 | 0 | 21 | 0.000 | 0.857 |
| 15.2 | South | 8/17 | 3 | 3 | 2 | 2 | 0 | 0 | 0 | 7 | 0.429 | 0.286 |
| 15.2 | South | 8/18 | 6 | 3 | 8 | 2 | 0 | 0 | 0 | 13 | 0.231 | 0.615 |
| 15.2 | South | 8/19 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 3 | 0.000 | 1.000 |

*Note*: RBT is rainbow trout and DV is Dolly Varden.