Fishery Data Series No. 12-86

Chinook salmon fecundity in the Unalakleet River, 2008–2010

by

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and

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December 2012

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, 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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CHINOOK SALMON FECUNDITY IN THE UNALAKLEET RIVER, 2008–2010

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ABSTRACT

Unalakleet River Chinook salmon are one of the northernmost Chinook salmon stocks and to understand the production of the stock, reproductive potential should be examined. Over a three-year period, 2008–2010, Unalakleet River Chinook salmon were harvested from the gillnet test and subsistence fisheries to evaluate relationships between age, length, and fecundity.

A total of 110 Chinook salmon were harvested and 84 salmon were aged. Average fecundity for all Chinook salmon was 9,223 eggs per fish while aged salmon had an average fecundity of 9,289 eggs per fish. There were two dominant age classes: age-1.3 and age-1.4. Fecundity was positively correlated with length and there were distinct length-fecundity relationships for age-1.3 and age-1.4 Chinook salmon. Fecundity-at-length was generally larger for age-1.3 salmon than age-1.4 fish; however there was no difference in egg size.

While most results are similar to other studies, the relationship between length and fecundity by age is unclear; it may vary by region and system. Future work should explore other aspects of the reproductive potential of Unalakleet River Chinook salmon such as competitive interactions, egg deposition, and survival on the spawning grounds.

Key words: Chinook salmon, *Oncorhynchus tshawytscha*, Unalakleet River, fecundity, reproductive potential, age classes

INTRODUCTION

Chinook salmon *Oncorhynchus tshawytscha* have an adaptable life history that has allowed the species to inhabit rivers from northern Alaska to central California in North America and Siberia to Japan in Asia. Chinook salmon research has shown the number of eggs per female, fecundity, is positively correlated with length (Healy and Heard 1984; Quinn and Bloomberg 1992; Beacham and Murray 1993); larger fish have more eggs. If there is a reduction in the number of large females in the spawning population, then the reproductive potential of the population may be diminished thereby leading to smaller returns (Hankin and McKelvey 1985). Management practices may not take this reduction of spawning potential into account (Forbes and Peterman 1994).

Current escapement goal management in Alaska is typically based on a total number of salmon with no discrimination by size. This could ultimately lead to a decline in population size if selective harvest practices remove the largest individuals (Bromaghin et al. 2011). Attempting to understand the relationship between fecundity, length, and age may provide information to help develop a more holistic management approach where numbers of fish and eggs are considered collectively.

Unalakleet River is located in eastern Norton Sound and has a drainage area of approximately 2,815 km^2 (Figure 1). Radiotelemetry investigations have demonstrated Chinook salmon utilize several tributaries as well as the mainstem to spawn (Wuttig 1999). The Unalakleet River Chinook salmon stock is one of the northernmost Chinook salmon populations and has supported subsistence, commercial, and sport fisheries for several decades. However, Chinook salmon runs have declined since 2000 (Kent 2010), were designated a stock of yield concern in 2004 by the Alaska Board of Fisheries, and continue to hold this designation (Kent and Bergstrom 2009).

To be able to say something about the productivity of a stock and its ability to persist, salmon enumeration needs to be supplemented with information about the reproductive potential of a population. In this project we gathered baseline fecundity data from the Unalakleet River Chinook salmon population to establish a stock-specific relationship between fecundity, length, and age.

OBJECTIVES

1. Obtain fecundity estimates from Chinook salmon harvested in the inriver subsistence and gillnet test fisheries.
2. Describe the relationship between fecundity, length, and age of Unalakleet River Chinook salmon.

METHODS

Chinook salmon females were sampled opportunistically from the inriver subsistence (8-inch mesh gillnet) harvest and from the entire test fishery (5 7/8-inch mesh gillnet) catch in 2008–2010.

FECUNDITY SAMPLING

Sample collection and preservation

Date of collection, length (mideye to tail fork [METF], to nearest 5 mm), location or origin (subsistence or test fishery) of catch, and catch donor (if appropriate) were recorded for each salmon. Each ovarian skein was removed, placed in a labeled Ziploc[1] bag, and immersed in 70% ethanol then placed in a second Ziploc bag. All skeins were stored and ethanol levels maintained until samples were processed.

Sample processing

Skeins were removed from ethanol, rinsed and placed in a steamer bag filled with 2 ounces of water to prevent the eggs from fragmenting and becoming mealy. With the bag sealed, the bag was immersed in boiling water for 10 min, the skein removed, and all contents towel dried. The skein was weighed (to the nearest 0.1 g) and divided into 10 equal portions. Three randomly selected portions were weighed (to the nearest 0.1 g) and the number of eggs recorded. The fecundity of each fish was calculated by combining the subsamples. The sum of the six subsample (three per skein x two per fish) egg counts was divided by the combined six weights of the subsamples to estimate eggs per gram. This value was multiplied by the combined skein weights (two per fish) to estimate the total number of eggs. A full skein egg count was completed on several skeins to verify appropriateness of using subsamples to estimate total skein egg count. Egg size (grams per egg) was estimated by dividing the combined skein weights by estimated fecundity

SCALE AND AGE SAMPLING

Scales were collected from the left side of each Chinook salmon approximately two rows above the lateral line in the area crossed by a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (INPFC 1963). To compensate for regenerated and unreadable scales, three scales were taken from each Chinook salmon. Cleaned scales were mounted on gummed cards and impressions were made in cellulose acetate with a hydraulic scale press (Clutter and Whitesel 1956). Impressions were read with a microfiche reader and ages were determined by reading annuli as described in Mosher (1969). European notation was used to report ages in which the first digit refers to the freshwater age not including the year spent in the gravel and the second digit refers to the ocean age (Koo 1962).

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

DATA ANALYSIS

To develop the relationship between length and fecundity, full, intermediate, and reduced linear regression models were tested to determine the feasibility of pooling age classes. The full model allowed the slope and intercept to differ for each age class (Equation 1) while the reduced model assumed the slope and intercept were consistent between age classes (Equation 2). An intermediate model allowed for a constant slope but variable intercepts between age classes (Equation 3).

$$Fecundity = \beta_0 + \beta_1 * Length + \beta_2 * I(1.4) + \beta_3 * I(1.4) * Length + \varepsilon \quad (1)$$

$$Fecundity = \beta_0 + \beta_1 * Length + \varepsilon \quad (2)$$

$$Fecundity = \beta_0 + \beta_1 * Length + \beta_2 + I(1.4) + \varepsilon \quad (3)$$

where:

$I(1.4)$ = 1 if age-1.4 fish

= 0 if age-1.3 fish, and

$\varepsilon \sim N(0, \sigma^2)$.

Model fit was evaluated using an *F*-test (Neter et al. 1990). Relative fecundity, eggs per mm of body length, was calculated by dividing fecundity by fish length. A two sample t-test was used to examine differences in relative fecundity and egg size between age classes. Chi square and two sample t-tests were used to evaluate the effects of net size on fish length and age.

RESULTS

Unalakleet Chinook salmon run sizes were low during the study period, thus few fecundity samples were acquired each year. Over the three years of this study, a total of 110 Chinook salmon were sampled for fecundity and 84 salmon were aged (Table 1; Appendix A).

Based on the paired full skein counts and subsample estimated counts from 16 females, the subsample estimating method tended to overestimate fecundity by approximately 3% (Figure 2). Based on this relationship, all fecundity analyses were conducted using the subsample estimates. The average length of all Chinook salmon was 830 mm (SD = 59) and this was similar to the length of the subset that were aged (Table 2). Average fecundity for all sampled Chinook salmon was 9,223 eggs per female (SD = 1,818) and salmon that were aged had an average fecundity of 9,289 eggs per female (SD = 1,683) (Table 2). The dominant age classes in the study were age 1.3 and age 1.4. Age 1.3 Chinook salmon were shorter (average = 760 mm; SD = 47) than age 1.4 fish (average = 855 mm; SD = 45.5; Table 2). The average fecundity for age-1.3 Chinook salmon was 8,788 eggs (SD = 1,968) and ranged from 4,605 to 11,941 eggs per female. The average fecundity for age-1.4 Chinook salmon was 9,355 eggs (SD = 1,577) with a range of 6,181 to 12,866 eggs per female (Table 2). Age and length were dependent on net size (p = 0.033 and p = 0.061 respectively).

For regression analysis all sampling years were combined and only the dominant age classes were used. There was a significant difference between the full and reduced models ($p < 0.001$, Table 3). The intermediate model was not significantly different from the full model (p = 0.577; Table 4; Figure 3) but was significantly different from the reduced model (p = 0.000174;

Table 5; Figure 4). Based on the statistical differences between the models and selecting the most parsimonious model, the intermediate model was the most appropriate model to describe this data set (Table 3; Figure 5).

The average relative fecundity for all Chinook salmon was 11.09 (SD = 2.00); age-1.4 salmon had an average relative fecundity of 10.88 (SE = 0.22), similar to the average relative fecundity of age-1.3 salmon of 11.77 (SE = 0.46) (t-test, $t = 1.96$, $df = 78$, $p = 0.054$).

The average egg weight for all Chinook salmon was 0.113 g per egg (SD = 0.03). Age-1.3 Chinook salmon had an average egg weight of 0.106 g per egg (SE = 0.005) and age-1.4 Chinook salmon had an average egg weight of 0.116 g per egg (SE = 0.004); there was no significant difference in egg weight between age classes (t-test, $t = -1.264$, $df = 78$, $p = 0.210$).

DISCUSSION

Variation in the relationship between fecundity and length exists for different stocks (Healey and Heard 1984) highlighting the need to develop stock-specific fecundity estimates. Gathering baseline fecundity for Chinook salmon in Unalakleet River is the first step in developing fecundity estimates for Norton Sound Chinook salmon. The results of this project suggest there is a positive relationship between length and fecundity of Unalakleet River Chinook salmon however, that relationship is different for different age classes. A positive fecundity-length relationship has been reported in salmon fecundity studies (e.g., Healey and Heard 1984; Quinn and Bloomberg 1992; Beacham and Murray 1993) but the relationship between fecundity and age is not as clear and may vary by system. In the Tanana River, age-3 and age-4 Chinook salmon did not demonstrate different relationships to fecundity (Skaugstad and McCracken 1991), and this was similar to the Columbia River (Galbreath and Ridenhour 1964). However, Chinook salmon from the Nushagak District of Bristol Bay had a positive relationship between fecundity and age (Nelson and Biwer 1969).

Despite the results of this study, there is limited ability to manage the harvest of Chinook salmon by age. A more practical approach may be to utilize the reduced model (i.e., no age differentiation) for management decisions. Mesh size can be used to preferentially harvest fish with respect to size (Howard and Evenson 2010). Fishery managers could use mesh size regulations in fisheries to control the size of the salmon harvested and potentially maximize the number of eggs on the spawning grounds. However, fecundity is only one factor in determining the reproductive potential of a stock. For example, egg size has also been linked to body size; larger eggs come from larger females and larger eggs produce larger alevin and fry (Fleming and Gross 1990). In this study there was no difference in egg size between age classes; that is bigger eggs did not necessarily come from larger fish. However, this study examined unfertilized eggs and the relationship of egg size between fertilized and unfertilized eggs has not been examined so it is difficult to draw conclusions about egg size and its impact on reproductive potential. Other aspects that should be addressed when evaluating stock specific reproductive potential are competitive interactions, success of egg deposition, and survival of alevin. For example, large females may have a physical and competitive advantage over smaller females for acceptable spawning habitat such that eggs deposited by large females would have a better chance at survival (Fleming and Gross 1989). Conversely, small salmon, in the absence of large, competitively dominant salmon, may become more prevalent and contribute more to the population over time. Additionally, small eggs may do better in sub-optimal redd conditions (van den Berghe and Gross 1989) and may have an advantage over large eggs.

In this study fecundity is generally overestimated by 3% using the subsample estimated counts. However, replicate counts were not conducted for each true count; therefore there is an unknown error associated with the true counts. Given this tradeoff, we felt it was acceptable to complete the fecundity analysis using the subsample estimates. The sample size for this study was small yet a difference between age and fecundity was detected, suggesting sample size was adequate. However, samples were not evenly distributed over the course of the study. The majority of the samples were taken in 2009 (50 out of 110 salmon) thus pooling all samples across years eliminated the ability to detect biases between years. Further, the majority of the age 1.3 Chinook salmon sampled were from 2008 (14 out of 26; Table 1) and the majority of age 1.4 salmon were from 2009 (32 out of 39; Table 1), suggesting only one cohort was examined Therefore, the relationship between fecundity and length by age class may be driven by an anomalous brood year rather than a stock specific pattern.

Developing a more complete assessment of the reproductive potential of the Unalakleet River Chinook salmon may inform the stock recruitment process by helping to explain variation in and importance of specific spawners to the model (Forbes and Peterman 1994). Fecundity is one aspect in evaluating the reproductive potential of a system thus it would be imprudent to implement management decisions based on fecundity alone. Future efforts should focus on collecting information about egg fitness, egg deposition, redd placement and success, and egg to alevin survival. These efforts will form a more complete view of the reproductive potential of the Unalakleet River Chinook salmon stock.

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TABLES AND FIGURES

Table 1.–Age composition of female Unalakleet River Chinook salmon sampled for fecundity, 2008–2010.

Year	Fecundity sample size	Aged sample size				
		1.3	1.4	2.3	1.5	Total
2008	34	14	12			26
2009	50	2	36	1	3	42
2010	26	3	13			16
Total	110	19	61	1	3	84

Table 2.–Average length (mm) and fecundity of Chinook salmon from the Unalakleet River, 2008–2010.

Age	Number Sampled	Average Length	SD	Average Fecundity	SD
1.3	19	760	47	8,788	1,968
1.4	61	855	45	9,355	1,577
2.3	1	750	-	10,759	-
1.5	3	880	35	10,153	1,854
Total	84	830	60	9,289	1,683
All Fish	110	830	59	9,223	1,818

Table 3.–Results of Analysis of Variance for the reduced model.

Regression Statistics	
Multiple R	0.593
R Square	0.351
Adjusted R Square	0.343
Standard Error	1363.447
Observations	80

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	7.85E+07	7.85E+07	42.233	6.97E-09
Residual	78	1.45E+08	1.86E+06		
Total	79	2.24E+08			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
β_0	-4.67E+03	2.14E+03	-2.180	0.032	-8938.445	-405.199	-8938.445	-405.199
$\beta_1 : Length$	1.67E+01	2.57E+00	6.499	6.965E-09	11.600	21.845	11.600	21.845

Table 4.–Results of Analysis of Variance for the full model

Regression Statistics	
Multiple R	0.680
R Square	0.463
Adjusted R Square	0.441
Standard Error	1257.124
Observations	80

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	1.03E+08	3.45E+07	21.8103	2.73E-10
Residual	76	1.20E+08	1.58E+06		
Total	79	2.24E+08			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
β_0	-12526.947	4.83E+03	-2.593	0.011	-22150.116	-2903.778	-22150.116	-2903.778
$\beta_1 : Length$	28.027	6.34E+00	4.419	3.24E-05	15.396	40.657	15.396	40.657
$\beta_2 : I(1.4)$	1482.121	5.75E+03	0.258	0.797	-9969.524	12933.767	-9969.524	12933.767
$\beta_3 : I(1.4) * Length$	-4.101	7.32E+00	-0.560	0.577	-18.675	10.473	-18.675	10.473

Table 5.–Results of Analysis of Variance for the intermediate model.

Regression Statistics	
Multiple R	0.679
R Square	0.460
Adjusted R Square	0.446
Standard Error	1251.512
Observations	80

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	1.03E+08	5.15E+07	32.851	4.83E-11
Residual	77	1.21E+08	1.57E+06		
Total	79	2.24E+08			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
β_0	-1.02E+04	2.41E+03	-4.221	6.58E-05	-14988.659	-5380.362	-14988.659	-5380.362
$\beta_1 : Length$	2.49E+01	3.15E+00	7.920	1.45E-11	18.675	31.219	18.675	31.219
$\beta_2 : I(1.4)$	-1.73E+03	4.38E+02	-3.947	0.000174	-2603.658	-857.427	-2603.658	-857.427

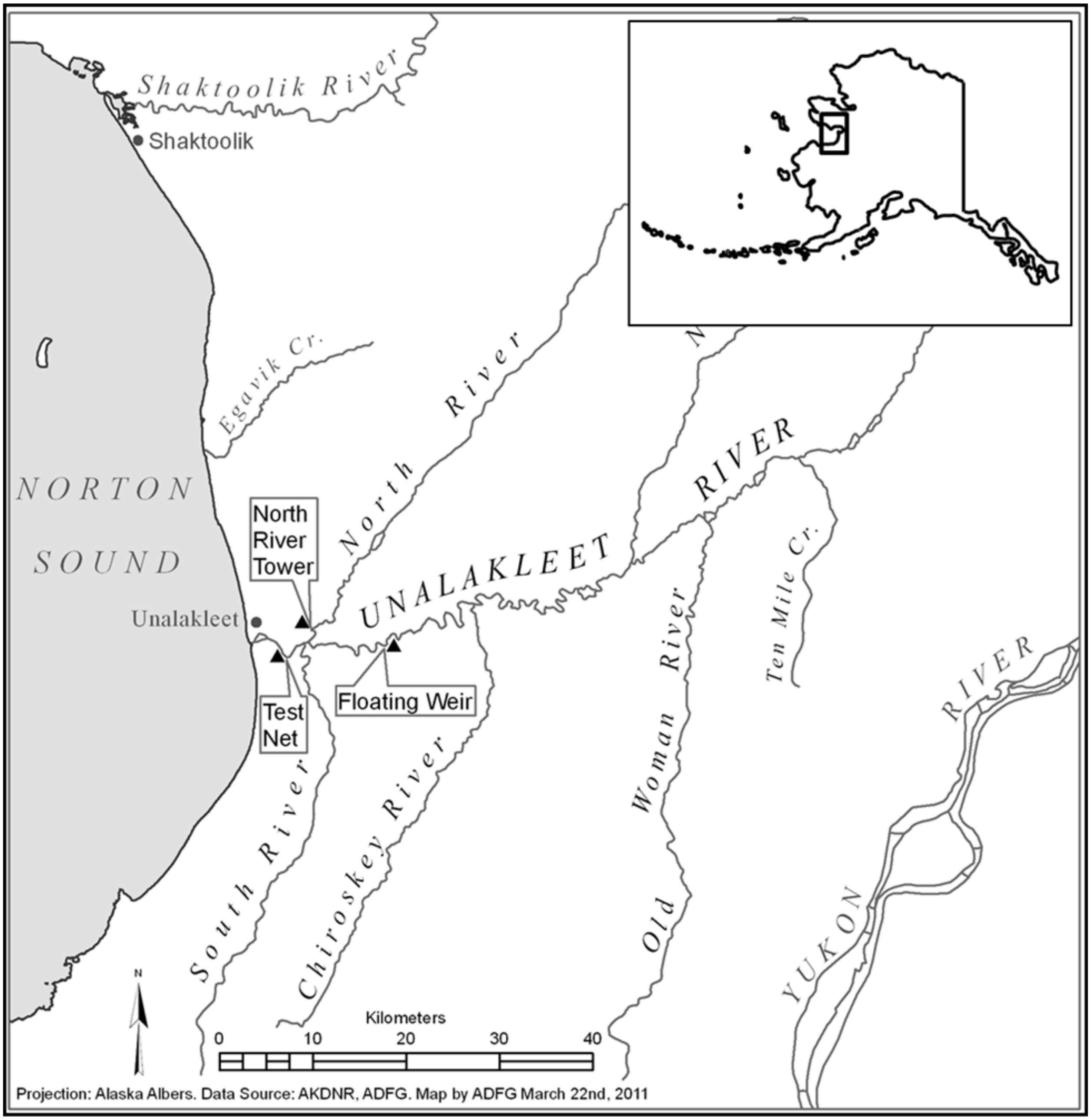

Figure 1.–Unalakleet River drainage, eastern Norton Sound.

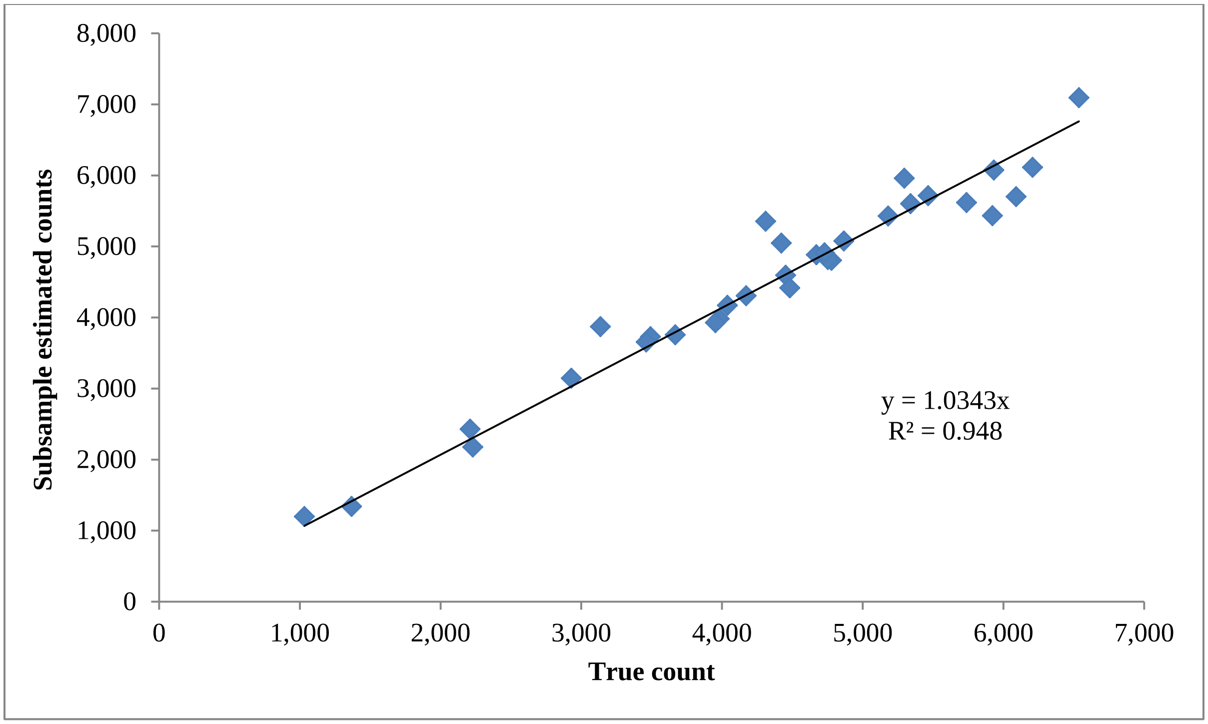

Figure 2.–Relationship between the true counts and the subsample estimated counts for Unalakleet River Chinook salmon, 2008–2010.

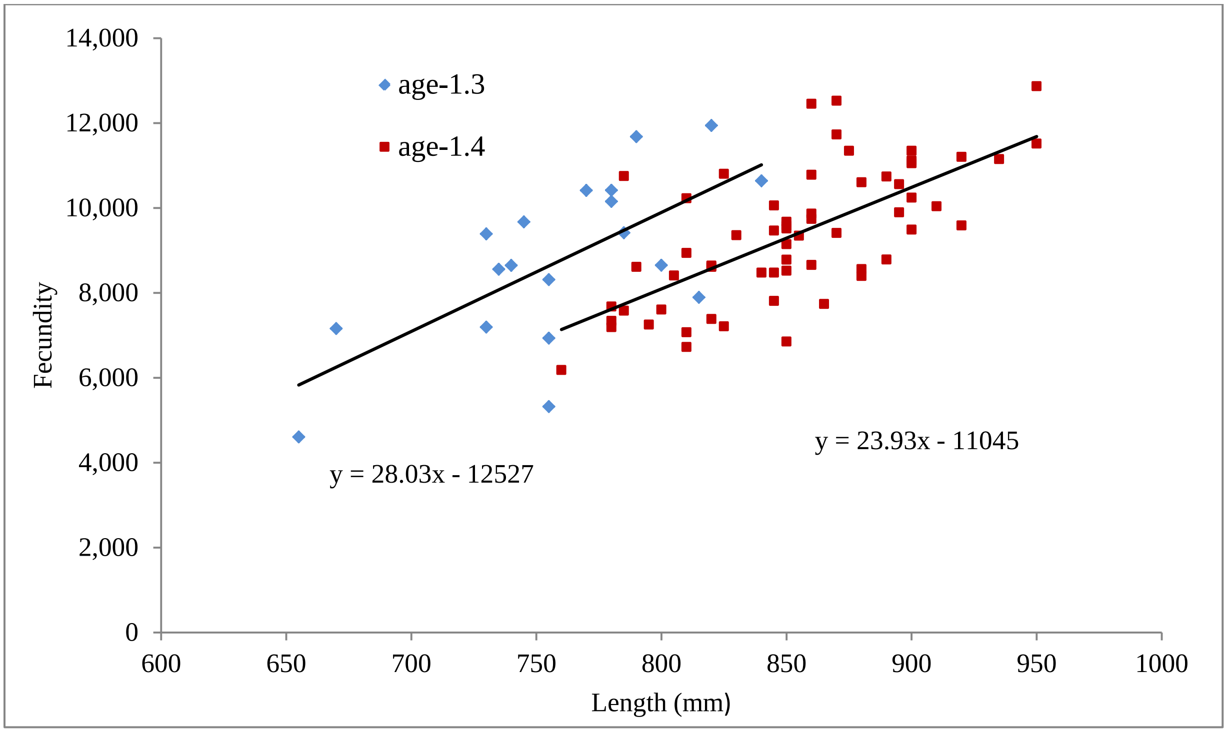

Figure 3.–Full model with distinct relationships between fecundity and length by age for Unalakleet River Chinook salmon, 2008–2010.

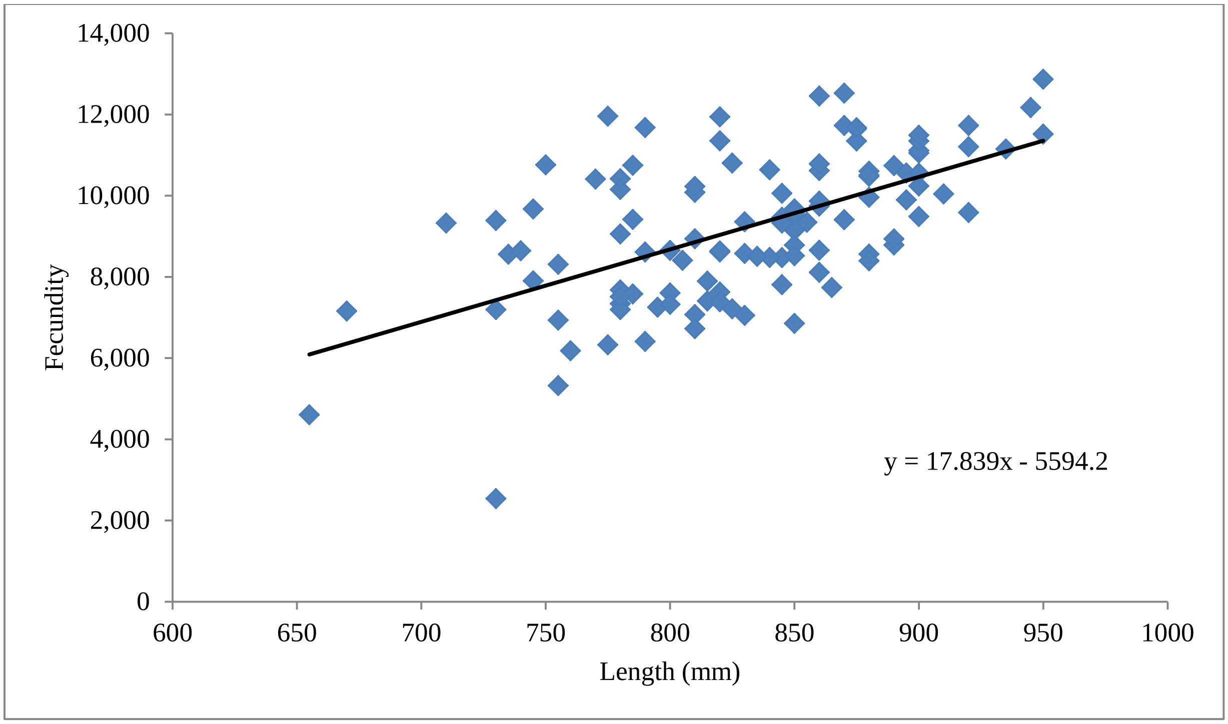

Figure 4.–Reduced model of the relationship between length and fecundity for Unalakleet River Chinook salmon, 2008–2010.

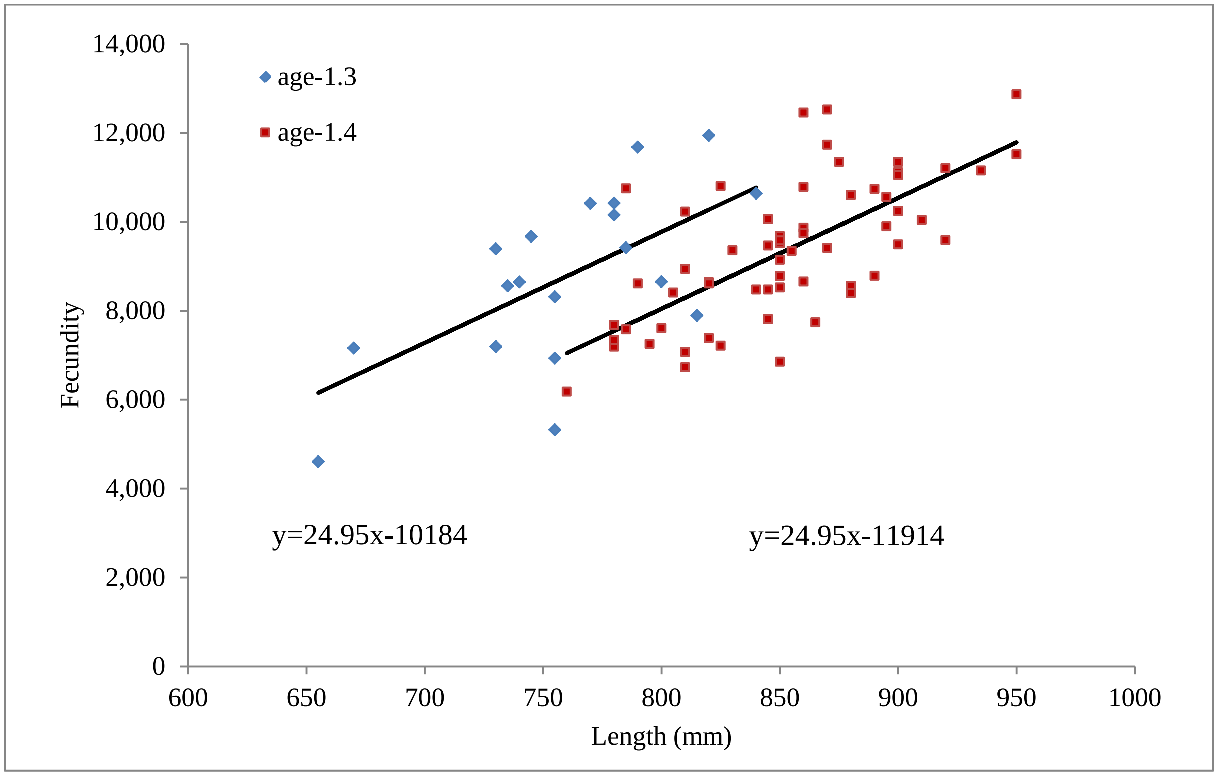

Figure 5.–Intermediate model with constant slope and different intercepts for the relationship between length and fecundity by age for Unalakleet River Chinook salmon, 2008–2010.

APPENDICES

Appendix A1.–2008 Unalakleet River Chinook salmon age, length (mm), and fecundity data.

Fishery	Age	Length	Sample weight	Sample egg count	eggs/gram	Full skein weight	Full skein estimated count	True total count
SF	1.4	790	60	926	15.43	609.4	9405.07	
SF	1.4	900	60	583	9.72	815	7919.08	
SF	1.3	785	60	716	11.93	581.9	6944.01	
SF	1.3	780	60	481	8.02	1068.3	8564.21	
SF	na	810	144	1088	7.56	1462.9	11053.02	
TF	1.3	730	255.4	2556	10.01	877.8	8784.87	8760
TF	1.3	755	283.9	2833	9.98	943.4	9414.06	
TF	1.4	820	105.8	1402	13.25	347.5	4604.87	4439
TF	1.4	890	273.1	3158	11.56	900.8	10416.43	
TF	1.3	655	277.4	3049	10.99	917.8	10087.86	
TF	1.3	740	238.2	2589	10.87	795.3	8644.13	
TF	1.4	870	483.9	3756	7.76	1613.8	12526.21	12459
TF	1.4	855	245.4	2841	11.58	807.3	9346.13	
TF	1.3	780	481.7	3058	6.35	1599.1	10151.65	
TF	na	710	208.2	2798	13.44	694	9326.67	
TF	na	875	500.7	3494	6.98	1669	11646.67	
TF	1.4	810	303.7	2116	6.97	1014.8	7070.52	6884
TF	1.4	760	323.3	1865	5.77	1071.5	6181.09	
TF	1.4	825	202.5	2146	10.60	680.5	7211.62	
TF	na	830	280.6	2112	7.53	937.6	7057.06	
TF	1.3	790	400.8	3505	8.75	1335.4	11678.09	11272
TF	1.3	770	393.3	3110	7.91	1316.5	10410.16	
TF	1.4	950	696.1	3857	5.54	2322.1	12866.46	
TF	na	780	285	2693	9.45	958.7	9058.87	
TF	1.3	735	310.5	2544	8.19	1044.4	8557.02	
TF	1.3	815	320.9	2375	7.40	1066.2	7891.01	
TF	1.3	670	186.5	2132	11.43	626.1	7157.35	
TF	na	775	299.5	1897	6.33	999	6327.56	
TF	1.3	730	283.9	2156	7.59	947.1	7192.49	
TF	1.4	780	347	2184	6.29	1165.7	7336.86	
TF	1.4	845	313.2	2521	8.05	1052.8	8474.17	
TF	1.3	745	249	2877	11.55	837	9670.88	
TF	na	775	332.3	3592	10.81	1106.3	11958.56	
TF	na	730	141.3	767	5.43	467.8	2539.30	2401

Note: na = no age; SF = subsistence fishery; TF = test fishery.

Appendix A2.–2009 Unalakleet River Chinook salmon age, length (mm), and fecundity data.

Fishery	Age	Length	Sample Weight	Sample egg count	eggs/gram	Full skein weight	Full skein estimated count	True total count
TF	1.4	785	195	3225	16.54	650	10750	10512
TF	1.4	950	519.6	3456	6.65	1731.5	11516.67	
TF	na	830	235.5	2574	10.93	784.6	8575.628	
TF	1.3	820	344.7	3581	10.39	1149.4	11940.82	
TF	1.4	860	315	2599	8.25	1049.2	8656.733	
SF	1.4	840	278.4	2543	9.13	928	8476.667	8211
SF	1.4	880	313.2	2571	8.21	1042.7	8559.329	
TF	1.4	850	323.1	2059	6.37	1075.5	6853.774	
TF	2.3	750	145.5	2893	19.88	534.8	10633.51	
TF	1.4	900	433.5	3336	7.70	1444	11112.3	
TF	na	820	233.1	2291	9.83	775.9	7625.855	6804
SF	1.4	810	220.5	2020	9.16	734.1	6725.088	
SF	1.4	890	485.1	3223	6.64	1616.3	10738.68	
SF	1.4	850	380.1	2854	7.51	1267.2	9514.835	
SF	1.4	845	295.5	2343	7.93	984.9	7809.207	
SF	1.4	800	273.3	2281	8.35	911.1	7604.168	
SF	na	880	262.8	2991	11.38	875.2	9960.895	9537
SF	na	880	341.7	3142	9.20	1139.2	10475.17	
SF	1.4	810	280.2	2683	9.58	933.6	8939.503	
SF	na	790	219.3	1923	8.77	730.9	6409.123	
SF	1.4	900	375.6	3405	9.07	1251.7	11347.28	
SF	1.5	920	427.8	3520	8.23	1425.7	11730.86	11946
SF	1.4	880	249	3197	12.84	825.7	10601.46	
SF	1.4	845	304.2	3020	9.93	1013.3	10059.72	
SF	na	835	251.4	2551	10.15	838.2	8505.363	
SF	1.4	920	409.5	2878	7.03	1364.1	9587.008	
SF	1.4	870	311.1	2823	9.07	1036.9	9409.093	9206
SF	1.4	845	327.9	2838	8.66	1093.7	9466.059	
SF	1.4	860	346.8	2922	8.43	1156.4	9743.37	
SF	1.4	850	291.9	2903	9.95	972.9	9675.672	
SF	1.3	755	189.9	1597	8.41	632.8	5321.651	
SF	1.4	830	371.1	2808	7.57	1236.4	9355.46	
TF	na	890	340.2	2680	7.88	1134.1	8934.121	
TF	1.4	850	289.5	2874	9.93	965	9580	
TF	1.4	780	194.7	2303	11.83	649.2	7679.032	
TF	1.4	785	224.1	2275	10.15	746.5	7578.257	
TF	1.4	865	304.5	2549	8.37	915	7659.557	
TF	1.4	910	462	3013	6.52	1539.6	10040.72	
TF	1.5	860	412.5	3186	7.72	1374.6	10616.91	
TF	1.4	870	307.2	3519	11.46	1024	11730	
TF	1.4	795	346.5	2176	6.28	1154.6	7250.821	
TF	1.4	825	382.8	3240	8.46	1276.3	10802.54	

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Fishery	Age	Length	Sample Weight	Sample egg count	eggs/gram	Full skein weight	Full skein estimated count	True total count
TF	1.5	860	310.8	2434	7.83	1035.7	8110.984	
	1.4	810	270.9	3066	11.32	903.7	10227.92	
	na	815	217.5	2222	10.22	724.9	7405.645	
	1.4	850	342.3	2742	8.01	1141.6	9144.806	
	1.4	895	492.3	3167	6.43	1641.5	10559.88	
	1.4	780	283.8	2158	7.60	945.8	7191.813	
	1.4	880	422.4	2520	5.97	1407.3	8395.824	
	1.4	820	419.7	2592	6.18	1399.2	8641.235	

Note: na = no age; SF = subsistence fishery; TF = test fishery.

Appendix A3.–2010 Unalakleet River Chinook salmon age, length (mm), and fecundity data.

Fishery	Age	Length	Sample Weight	Sample egg count	eggs/gram	Full skein weight	Full skein estimated count	True total count
SF	na	800	201.00	2171	10.80	678.00	7323	
SF	na	na	375.00	4076	10.87	1251.00	13598	
SF	1.4	900	276.00	2862	10.37	915.00	9488	
SF	na	945	600.00	3658	6.10	1996.00	12169	
SF	na	875	273.00	3526	12.92	904.00	11676	10761
SF	1.4	935	231.00	3354	14.52	768.00	11151	
SF	1.4	895	318.00	2964	9.32	1062.00	9899	
SF	na	780	258.00	2256	8.74	859.00	7511	
SF	na	880	429.00	3162	7.37	1425.00	10503	
SF	1.4	860	357.00	2965	8.31	1188.00	9867	
SF	1.4	850	216.00	2628	12.17	722.00	8784	
SF	1.4	860	345.00	3246	9.41	1146.00	10782	9492
SF	1.3	755	189.00	2513	13.30	625.00	8310	
SF	1.4	820	66.00	2267	34.35	215.00	7385	6954
SF	1.4	805	102.00	2478	24.29	346.00	8406	
TF	1.4	850	363.00	2548	7.02	1214.00	8521	
TF	1.3	840	201.00	3210	15.97	666.00	10636	
TF	1.4	900	492.00	3080	6.26	1636.00	10242	
TF	na	845	309.00	2803	9.07	1028.00	9325	9211
TF	1.4	875	336.00	3413	10.16	1117.00	11346	
TF	1.4	920	459.00	3359	7.32	1531.00	11204	
TF	1.4	860	390.00	3751	9.62	1295.00	12455	
TF	1.3	800	267.00	2578	9.66	896.00	8651	
TF	1.2	900	585.00	3170	5.42	1948.00	10556	
TF	na	745	234.00	2365	10.11	782.00	7904	
TF	na	900	294.00	3440	11.70	982.00	11490	

Note: na = no age; SF = Subsistence fishery; TF = Test fishery.