Fishery Data Series No. 06-70

Length-Girth, Length-Weight, and Fecundity of Yukon River Chinook Salmon *Oncorhynchus tshawytscha*

by

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and

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

Symbols and Abbreviations

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

Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

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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The Division of Sport Fish Fishery Data Series was established in 1987 for the publication of technically oriented results for a single project or group of closely related projects. Since 2004, the Division of Commercial Fisheries has also used the Fishery Data Series. Fishery Data Series reports are intended for fishery and other technical professionals. Fishery Data Series reports are available through the Alaska State Library and on the Internet: http://www.sf.adfg.state.ak.us/statewide/divreports/html/intersearch.cfm This publication has undergone editorial and peer review.

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ABSTRACT

Morphometric data including length, girth, and weight measurements were obtained along with age and sex data from Yukon River Chinook salmon *Onchorhynchus tshawytscha* caught in the test fisheries of the ADF&G sonar projects located near the villages of Pilot Station and Eagle in 2005. A total of 872 samples were taken, 693 from Pilot Station and 179 from Eagle. Linear regression was used to develop length-girth and length-weight models for males and females from each location. Comparisons were made between Pilot Station males and Pilot Station females, Eagle males and Eagle females, Pilot Station males and Eagle males, and Pilot Station females and Eagle females. There was a significant positive linear relationship between girth and length for all 4 data sets. For both Pilot Station and Eagle, the length-girth relationships for males and females were different. The length-girth relationship for males at Pilot Station differed from that of males at Eagle, whereas the length-girth relationships for females were the same at both locations. There was also a significant allometric relationship between weight and length for all 4 data sets. For both Pilot Station and Eagle, the length-weight relationships for males and females were the same, but the length-weight relationships for males and females combined at Pilot Station differed from those at Eagle. Results are consistent with the documented occurrence of weight loss and ovary development during upstream migration, but may also indicate differences in morphological characteristics between stocks. Fecundity samples were taken from the commercial harvest of Districts 5 and 6 of the Yukon River along with ASL data. Length and fecundity data were also obtained from a 1989 study of fecundity in District 6. Analysis of covariance was used to make comparisons between the fecundity of Districts 5 and 6 in 2005, and District 6 in 1989 and 2005. The fecundity of District 5 was significantly less than District 6 in 2005, and the fecundity of District 6 in 2005 was significantly less than District 6 in 1989. The results demonstrate some of the different sources of variation in fecundity.

Key words: Girth, weight, length, selectivity, length-girth, length-weight, allometric, Chinook salmon, Yukon River, fecundity, reproductive potential.

INTRODUCTION

MORPHOMETRICS

Age, sex, and length (ASL) data has been collected from Chinook salmon *Oncorhynchus tshawytscha* fisheries on the Yukon River as early as 1919 (Gilbert 1922) and regularly from commercial and subsistence fisheries since 1960. ASL data has also been collected from escapement projects for varying lengths of time, but represent a shorter time series and generally smaller sample sizes. A recent topic of discussion has been how or if the size of Chinook salmon spawning in the Yukon River has changed through time. Available ASL information from escapement projects is too short in duration to detect any but the most recent changes, which are confounded by short term environmental factors and are not necessarily representative of longer trends within the population. It has been suggested that fishing with large-mesh gillnets has affected the size and genetic variability of Yukon River Chinook stocks by selectively removing the larger females from the population. The affects of gillnets have not been substantiated, however, it is unlikely that exploitation has had no impact on these stocks which have been harvested in subsistence fisheries for thousands of years and in commercial fisheries for nearly a century, since humans invariably influence the characteristics of any resource that they utilize. However, comparison of the characteristics of current stocks to unexploited stocks is made problematic by lack of baseline data as to what the unexploited condition was. Continuing to expand ASL collections to include weight and girth measurements will allow for the estimation of weight and girth from length measurements, which may allow for the mining of the substantial ASL data set from Yukon commercial fisheries, providing additional information for analysis regarding size-related trends in Yukon River Chinook stocks.

Girth

Girth influences the retention of fish by different sized gillnets since a retained fish has to have a girth equal to or slightly greater than the mesh perimeter at the point of capture (Santos et al. 2006). Therefore, girth measurements of gillnet caught fish can offer insight into the selectivity of various mesh sizes used in gillnets. However, nets are usually thought of as length selective rather than girth selective, even though girth is more strongly related to the mechanical cause of capture. Length-girth relationships are important because they allow the estimation of girth from length measurements, which are easier to obtain and are more readily available. For most species, the relationship between girth and length is of the linear form $G = a + bL$ (Santos et al. 2006), where G is the observed girth, L is the observed length, and a and b are coefficients determined by regression. These relationships, in conjunction with existing length data, can be important tools in the management of gillnet fisheries.

Weight

With rising concerns about a decrease in size of Chinook salmon on the Yukon River, biologists and managers rely, in part, on the anecdotal evidence supplied by commercial, subsistence, and sport fishermen on the occurrence of large fish in the past and present. These fishermen often refer to the size of fish in terms of weight (J. Hilsinger, Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication). However, this information is incongruous with the size data collected by Alaska Department of Fish and Game (ADF&G), which is usually in terms of length. Length-weight relationships are of value because they allow the estimation of weight from length measurements, and vice-versa. The most common form of length-weight relationship is the allometric growth equation $W = aL^b$, where W is the observed weight, L is the observed length, and a and b are parameters estimated by linear regression with $\log(W) = \log(a) + b\log(L)$ (Quinn and Deriso 1999). With these relationships, biologists and managers can relate the anecdotal weight information given by fishermen to length data collected by ADF&G staff.

FECUNDITY

Studies to estimate the fecundity of Yukon River Chinook salmon have occurred periodically, but infrequently, since statehood. The number of eggs deposited in gravel represents the upper bounds of possible production in any given year. Changes in fecundity through time can provide insight into changes in productivity. Gathering data on fecundity could potentially be of use in the evaluation of alternative escapement goal models, using numbers of eggs instead of numbers of spawners or numbers of females.

Fecundity is the number of eggs carried by a female fish. Along with egg size, egg number is closely related to the reproductive potential of a spawning population (Rounesfell 1957). For Chinook salmon, fecundity is linearly related to length (Bigler 1982; Skaugstad and McCracken 1991); hence, spawning populations with different length compositions will have different reproductive potentials. A reduction in the average size of Chinook salmon implies a decrease in reproductive potential, even if comparable escapements are achieved. Other sources of variation in reproductive potential of a population are differences in fecundity between years (Healy and Heard 1984) and localities (Crossin et al. 2004).

OBJECTIVES

1. Develop length-girth and length-weight models for Chinook salmon caught in the ADF&G test fisheries of Pilot Station and Eagle in 2005.
2. Compare the length-girth and length-weight relationships of males to females and of up-river fish to down-river fish.
3. Estimate fecundity of Chinook salmon caught in the commercial fisheries of District 5 and District 6 in 2005.
4. Compare fecundity of District 5 fish to District 6 fish in 2005.
5. Compare fecundity of District 6 fish in 1989 to District 6 fish in 2005.

METHODS

MORPHOMETRICS

Sample Collection

Age, sex, length, weight, and girth data for Chinook salmon were collected along with genetic samples from the ADF&G test fisheries in Pilot Station at river mile (RM) 123 and in Eagle (RM 1,213) (Figure 1). The test fisheries are associated with the Pilot Station and Eagle sonar projects; these projects fish 50 fathom (91.4 m) drift gillnets with mesh sizes of 2.75, 4.0, 5.25, 6.5, 7.5, and 8.5 inches daily. At Pilot Station, fishing occurred during June and July, and at Eagle, fishing occurred during July and August. Collections at Pilot Station represent mixed Yukon River stocks whereas Eagle represents a smaller aggregate of stocks bound for Canada. ASL data is collected annually at these projects as a standard operating procedure. Three scales were collected from the preferred area of each fish and preserved on a gum card and aged by ADF&G staff in Anchorage (INPFC 1963). Sex was determined by cutting the fish open and visually examining the gonads. Length was measured from mideye to tail fork (METF) and recorded to the nearest millimeter. Weight was measured to the nearest ounce with a hanging warehouse scale. Maximum girth was measured to the nearest millimeter with a cloth tape measure wrapped perpendicular to the longitudinal axis of the fish and recorded to the nearest millimeter.

Data Analysis

For girth, a full linear model was developed that included girth as the dependent variable, length as a continuous independent variable, sex and location as nominal independent variables, and all possible interaction terms. A similar model was developed for weight, except the logarithm of weight was the dependant variable and the logarithm of length was the continuous independent variable. Tests of significance of parameters were done using SAS General Linear Model procedure (SAS Institute Inc. 1988) at a significance level of $\alpha = 0.05$. Terms with non-significant parameters were dropped from the models and the parameters of the reduced models were then re-estimated and tested for significance. The final models yielded separate equations for the 4 categories: Pilot Station males (PM), Pilot Station females (PF), Eagle males (EM), and Eagle females (EF). Comparisons were then made between the equations of 4 category pairs: PM versus PF, EM versus EF, PM versus EM, and PF versus EF.

FECUNDITY

Sample Collection

The commercial harvest from Yukon River Subdistricts 5-B, 5-C, and 6-B was sampled in Fairbanks at a local fish processing facility in July of 2005 (Figure 1). The sampling dates coincided with the commercial openings in each district, however, the gear type (either fish wheel or set gillnet) used to catch the fish was not known. Fish were sampled from ice totes until the sampling goal of 100 females per subdistrict was reached. In addition to collecting roe skeins, standard ASL data were collected. While both male and female fish were sampled, gonads were only collected from the females. Roe skeins were immediately weighed to the nearest ounce, placed in plastic bags, and frozen for future analysis in Anchorage.

Eggs were thawed in coolers at room temperature in October of 2005. To establish fecundity for a particular female, both roe skeins were weighed to the nearest 0.01g, and subsamples of at least 100 eggs were taken from 1 skein in the following manner: the skein was divided into thirds and a minimum of 35 eggs was separated from each section. These eggs were then counted and weighed to the nearest 0.001g. Total egg counts were achieved for 16 fish (8 from each district). The individual fish fecundity was calculated for each fish in which a total count was not made.

$$F_j = \left(\frac{\sum egg_{ij}}{\sum g_{ij}} \right) G_j \tag{1}$$

where:

egg_{ij} = number of eggs in sub-sample i from fish j,

g_{ij} = weight of sub-sample i from fish j, and

G_j = weight of both skeins from fish j.

Length and fecundity data for District 6 in 1989 were obtained from Skaugstad and McCracken (1991).

Data Analysis

Adjusted average fecundities were calculated for each of the 3 groups: District 5 in 2005 (Y5-2005), District 6 in 2005 (Y6-2005), and District 6 in 1989 (Y6-1989). Comparisons of average fecundity were made between Y5-2005 and Y6-2005, and between Y6-1989 and Y6-2005.

Because Chinook salmon fecundity is linearly related to length, and because the length distributions were different among the 3 groups, analysis of covariance (ANACOVA) was used to adjust the average fecundities for the covariate *length.* ANACOVA was performed only after the necessary assumption of parallelism was justified by a test. Tests of parallelism and ANACOVA were done using SAS General Linear Model procedure (SAS Institute Inc. 1988) at a significance level of $\alpha = 0.05$.

RESULTS

MORPHOMETRICS

A total of 693 fish were sampled at Pilot Station for age, sex, length, weight, and girth; 224 were female and 469 were male. At Eagle, a total of 179 fish were sampled; 58 were female and 121 were male.

Length-Girth Relationships

There was a significant positive linear relationship between girth and length for all 4 data sets (Figure 2). The determination coefficients for the 4 categories were: for PM, $r^2 = 0.739$ ($p < 0.0001$); for PF, $r^2 = 0.723$ ($p < 0.0001$); for EM, $r^2 = 0.904$ ($p < 0.0001$); and for EF, $r^2 = 0.932$ ($p < 0.0001$). For both Pilot Station and Eagle, there was a difference between males and females in intercept and slope (Figure 2). The linear equation for males at Pilot Station differed from that of males at Eagle, whereas the lines for females at both locations coincided (Figure 3).

Length-Weight Relationships

There was a significant allometric relationship between weight and length for all 4 data sets (Figure 4). The determination coefficients for the 4 categories were: for PM, $r^2 = 0.907$ ($p < 0.0001$); for PF, $r^2 = 0.854$ ($p < 0.0001$); for EM, $r^2 = 0.936$ ($p < 0.0001$); and for EF, $r^2 = 0.844$ ($p < 0.0001$). For both Pilot Station and Eagle, there was no difference between males and females (Figure 4). However, the equations for males and females combined at Pilot Station differed from those at Eagle (Figure 4).

FECUNDITY

Although 100 samples were collected from each district in 2005, the freeze/thaw process caused the eggs of some fish to lyse and lose integrity, making the subsamples too “mushy” to obtain accurate egg counts. These fish were eliminated from the analysis resulting in a total sample size of 90 for Y5-2005 and 98 for Y6-2005 (Appendix A1 and A2). A total of 49 published data points were obtained for Y6-1989.

The adjusted average fecundities for Y5-2005, Y6-2005, and Y6-1989 were 5,511, 6,999, and 9,150, respectively (Figure 5). The adjusted average fecundity for Y5-2005 was significantly less than that for Y6-2005 ($p < 0.0001$). Likewise, the adjusted average fecundity for Y6-2005 was significantly less than that for Y6-1989 ($p < 0.0001$).

DISCUSSION

MORPHOMETRICS

Length-Girth Relationships

Statistical analysis detected a significant difference between the length-girth relationships for males and females at Pilot Station (Figure 2). The actual differences in girth are relatively small over the observable lengths. More than 90% of the fish fall between the lengths 600mm and 900mm. Within this range, the average difference in girth is 12mm (2.6%). Therefore, while differences in the length-girth relationships at Pilot Station may be statistically significant, they are probably not important from a biological or fisheries management standpoint. However, at Eagle, the average girth of the females is 63mm (14.0%) more than that of the males over the observable lengths (Figure 2). This greater difference may be because Eagle is much farther upstream than Pilot Station, and, as salmon migrate upstream, their ovaries grow and develop (Groot et al. 1995). On the other hand, this difference may be due to variations in the morphological characteristics between stocks. The fish sampled at Pilot Station represent mixed stocks destined for tributaries throughout the Yukon River drainage, whereas the fish sampled at Eagle are mostly representative of upper-river stocks bound for Canada.

When comparing the length-girth relationships of the males at each location, the data show that Pilot Station males have greater girth than Eagle males over all observable lengths (Figure 3). This result is not surprising since salmon tend to lose weight during upstream migration (Groot et al. 1995), but it may also be an indication that upper-river fish are more streamlined in an effort to facilitate somatic energy conservation. Crossin et al. (2004) found that Fraser River sockeye populations making difficult upriver migrations had morphologies that were smaller and more fusiform than populations making less difficult migrations. However, the linear equations for females at both locations are nearly identical (Figure 3b) indicating that weight loss may be compensated for by increased girth due to egg maturation during migration.

Differences in the length-girth relationships between males and females and between upriver and downriver fish have management implications since they can correlate to differences in gear selectivity. Gillnets are girth-selective, even though they are typically thought of as length-selective. If large-mesh gear is selecting for fish of large girth, then under conditions where the females have greater girth than males, this gear would tend to select disproportionately fewer males. However, this problem may be counteracted if the girth of females commonly exceeds the maximum girth retained by the gear.

Length-Weight Relationships

The length-weight relationships are practically identical for males and females within each sampling location, but differ between sampling locations when male and females are combined (Figure 4). At a given length, Pilot Station fish weigh more than Eagle fish over all observable lengths. This result is expected, since, as discussed earlier, salmon lose weight during upstream migration. In addition to weight loss, this difference may also be attributable to variation in growth characteristics between stocks. Evidence of this variation can be seen in the disparity between the exponents of the allometric growth equations for each location (Figure 4). The exponent for Eagle (3.29) is significantly greater than that for Pilot Station (3.12). The larger the exponent, the more rotund fish become with increasing length (Jones et al. 1999). This idea is corroborated by comparing the slope of the length-girth relationship for Eagle males (0.620) with that of Pilot Station males (0.543) (Figure 3). Even though Eagle males have smaller girth, the rate with which Eagle males lose girth as a function of length is less than that for Pilot Station males.

The difference in weight between locations should to be taken into account when considering anecdotal evidence from fishermen. When Canadian fishermen refer to the occurrence of large fish in the upper river, these fish correspond to even larger fish in the lower river. The length-weight relationships for Pilot Station and Eagle give some insight into the size correspondence between upriver and downriver fish. However, applying these relationships to historical data should be done with caution as they are based on data from only 1 year.

FECUNDITY

In 2005, the adjusted average fecundity for District Y5 was significantly less than that for District 6 (Figure 5). Studies by Crossin et al. (2003) suggest that the bioenergetic cost of migration in salmon comes at a cost to ovarian investment in the form of fewer eggs and smaller egg size. The difference between the adjusted average fecundities of Y5 and Y6 in 2005 may be attributable to a reduction in ovarian investment since many of the fish in District Y5 are bound for Canadian tributaries that are much farther upstream than District 6; genetic stock identification analyses can be used to determine the relative distances these fish are traveling. It is also possible that fish traveling shorter distances may not put on as much fat reserves to begin with. Salmon migrating long distances contribute less of their energy reserves to gonads and more to upstream travel than salmon migrating shorter distances (Kinnison et al. 2001). Managers should consider these differences when establishing escapement goals for Canada since the reproductive potential of Canadian spawners could be less than a comparable number of Alaskan spawners.

While Healy and Heard (1984) reported relatively small variation in fecundity between years within most populations of Chinook salmon, they did report a significant variation (increase) in the Yukon River from 1965 to 1981. A similar variation (decrease) was observed between 1989 and 2005 for District 6 (Figure 5). This variation may be due to differences in the average food availability between years (Healy and Heard 1984).

When evaluating the use of egg numbers in escapement goal analyses, another important consideration is the average egg size on the spawning grounds. Egg size is determined by the size of fish and by the amount of available energy that is not depleted during upstream migration (Quinn et al. 2004). Large eggs produce large fry with higher survival rates than small fry (Quinn 2005). Therefore, variation in the reproductive potential of a spawning stock is a function of variation in egg size and variation in fecundity, among other things. Investigators should be aware of these variations and incorporate them into the escapement goal models. A thorough understanding of the dynamic nature of reproductive potential would likely require multiple years of fecundity studies over a range of localities that would include both the size and number of eggs.

RECOMMENDATIONS

MORPHOMETRICS

The sample sizes achieved from the Pilot Station and Eagle test fisheries were adequate to produce significant length-girth and length-weight relationships for the 4 categories. In the case of Pilot Station, more than enough weight and girth observations were obtained. For future morphometric studies, it is recommended that a power analysis be conducted with the 2005 data to estimate the sample sizes of girth and weight measurements needed to produce significant relationships. Reducing the sample size could greatly enhance the efficiency of the sampling process.

FECUNDITY

While some roe samples were excluded from the study because the freeze/thaw process caused the eggs to disintegrate, the resulting sample sizes for Y5 and Y6 in 2005 were adequate to demonstrate significant differences. For future fecundity studies, it is recommended that a power analysis be conducted to estimate the sample sizes required to detect significant differences. Decreasing sample size could greatly improve the feasibility of conducting fecundity studies. For taking fecundity samples, it is also recommended that, rather than preserving entire egg skeins, the following steps be taken at the sampling location:

a) Remove eggs from fish.

b) Weigh both skeins.

c) Take subsamples from 1 skein as described in the “Methods” section.

d) Individually weigh each sub-sample.

At this point, there are 2 recommended methods of calculating the total number of eggs. One method involves preserving each sub-sample in 70% ethyl alcohol solution, which could then be shipped back to the lab for counting while the remainder of the egg skeins can be disposed of at the sampling location. The ethyl alcohol makes the eggs in the subsamples more firm and easier to count than eggs that have been through the freeze/thaw process. The other method involves counting out the sub-sample in the field and volumetrically calculating the number of eggs and does not require the use of ethyl alcohol which is classified as a hazardous material. Both these methods would reduce the logistical challenges involved with preserving and shipping large quantities of eggs.

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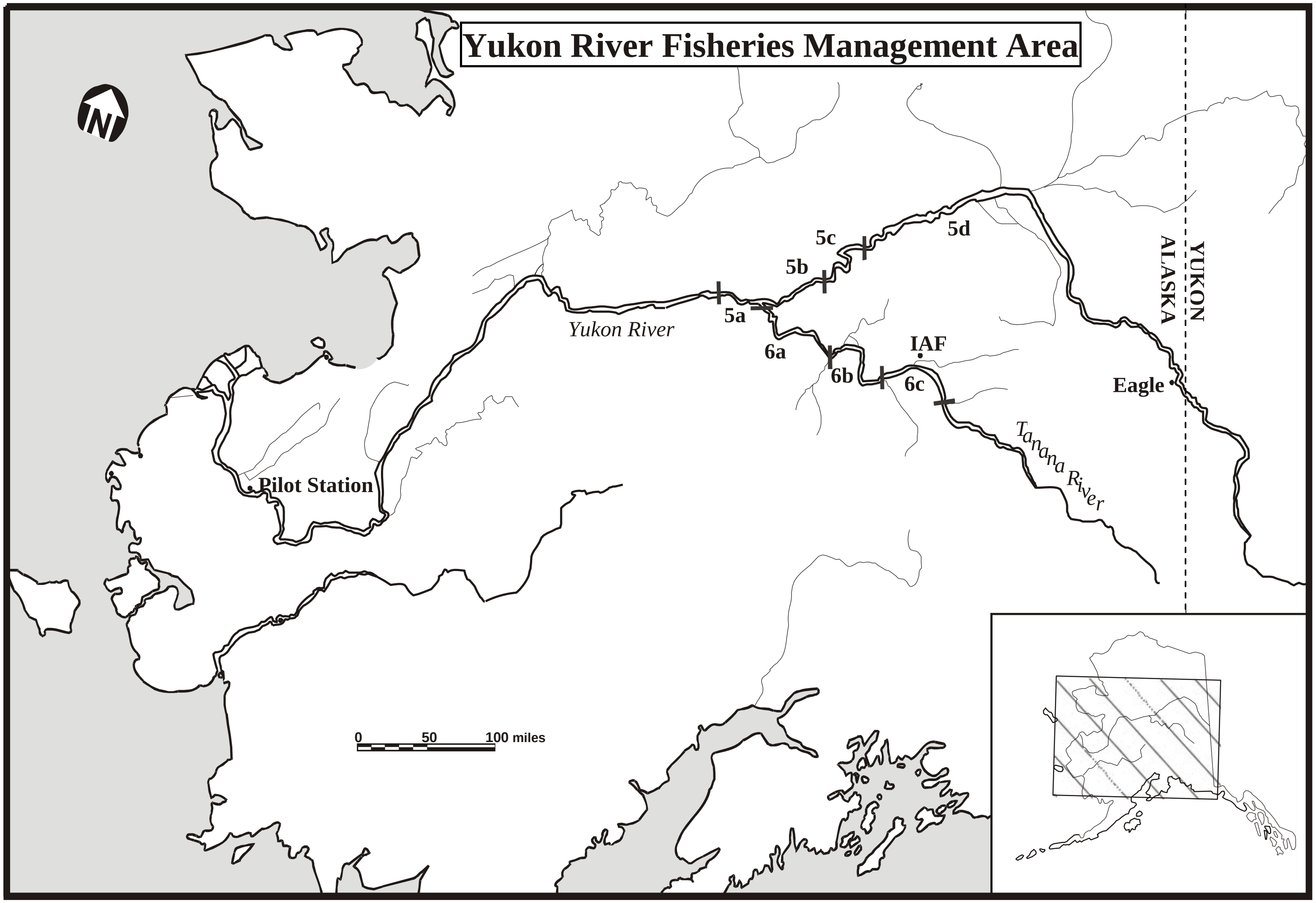
FIGURES



Note: Subdistricts indicated by letters.

Figure 1.–The Yukon Area showing Pilot Station, Eagle, Fairbanks, and Districts 5 and 6.

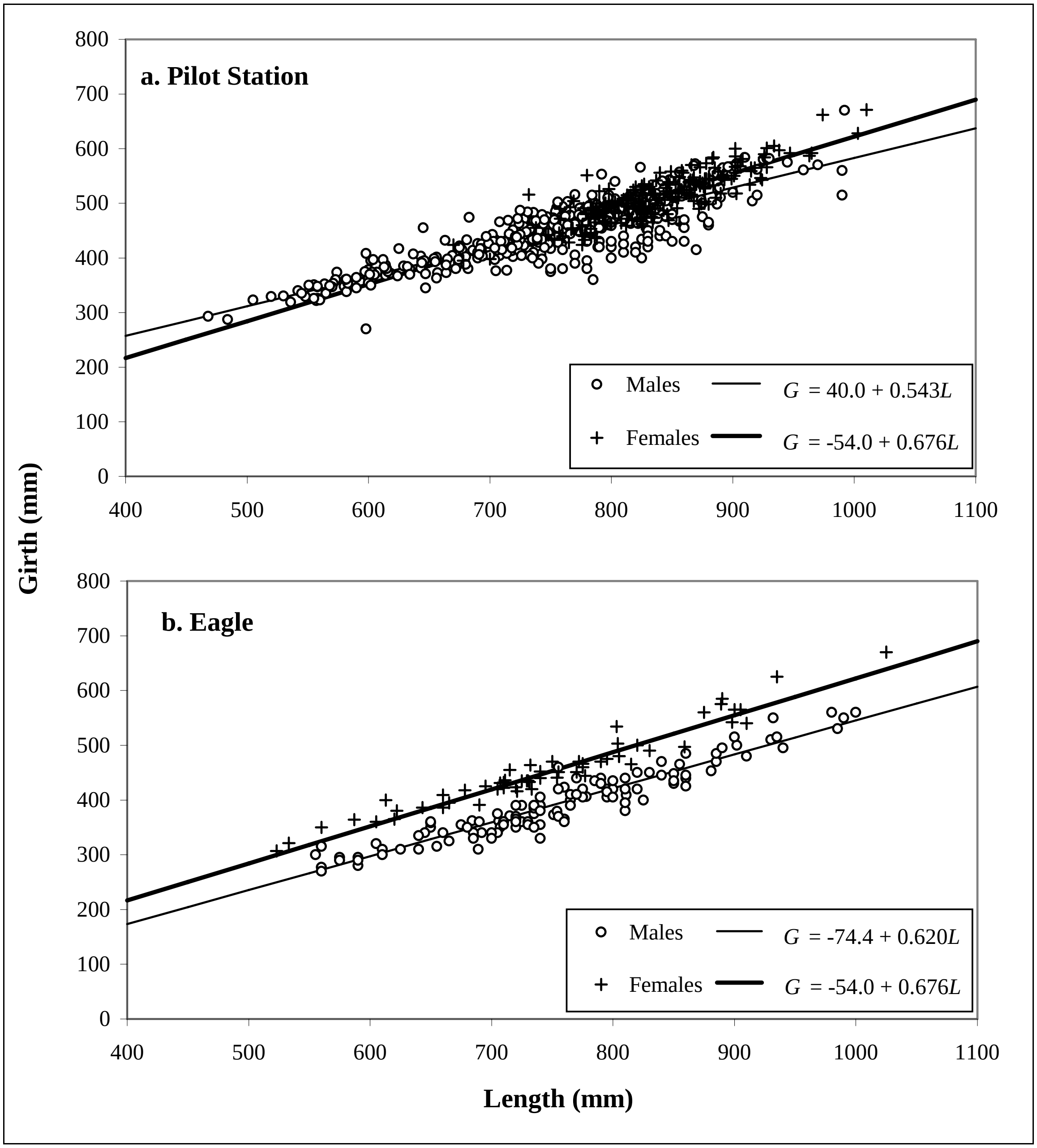


Figure 2.–Girth versus length of male and female Chinook salmon at Pilot Station (a) and Eagle (b).

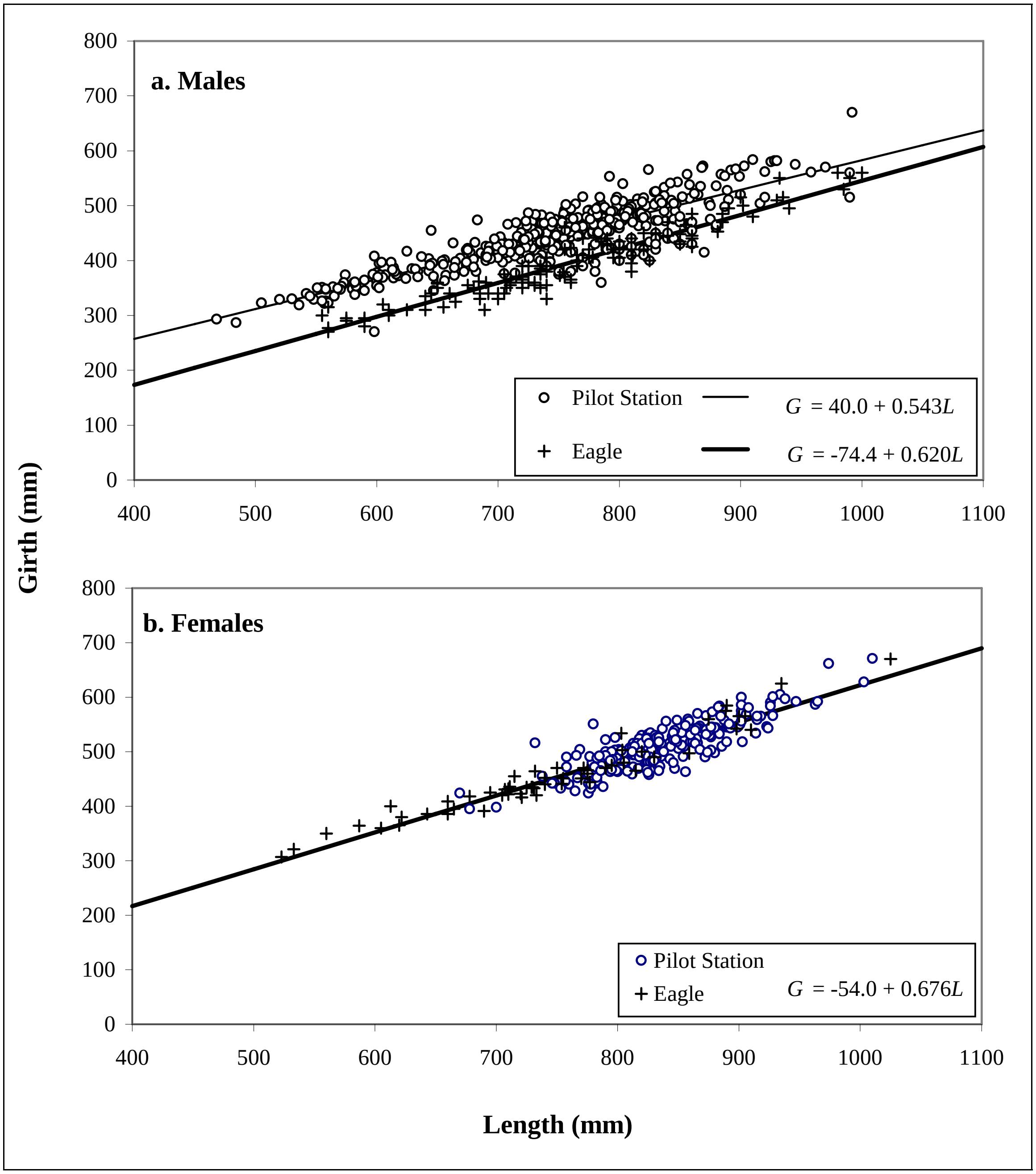


Figure 3.–Girth versus length at Pilot Station and Eagle for male (a) and female (b) Chinook salmon.

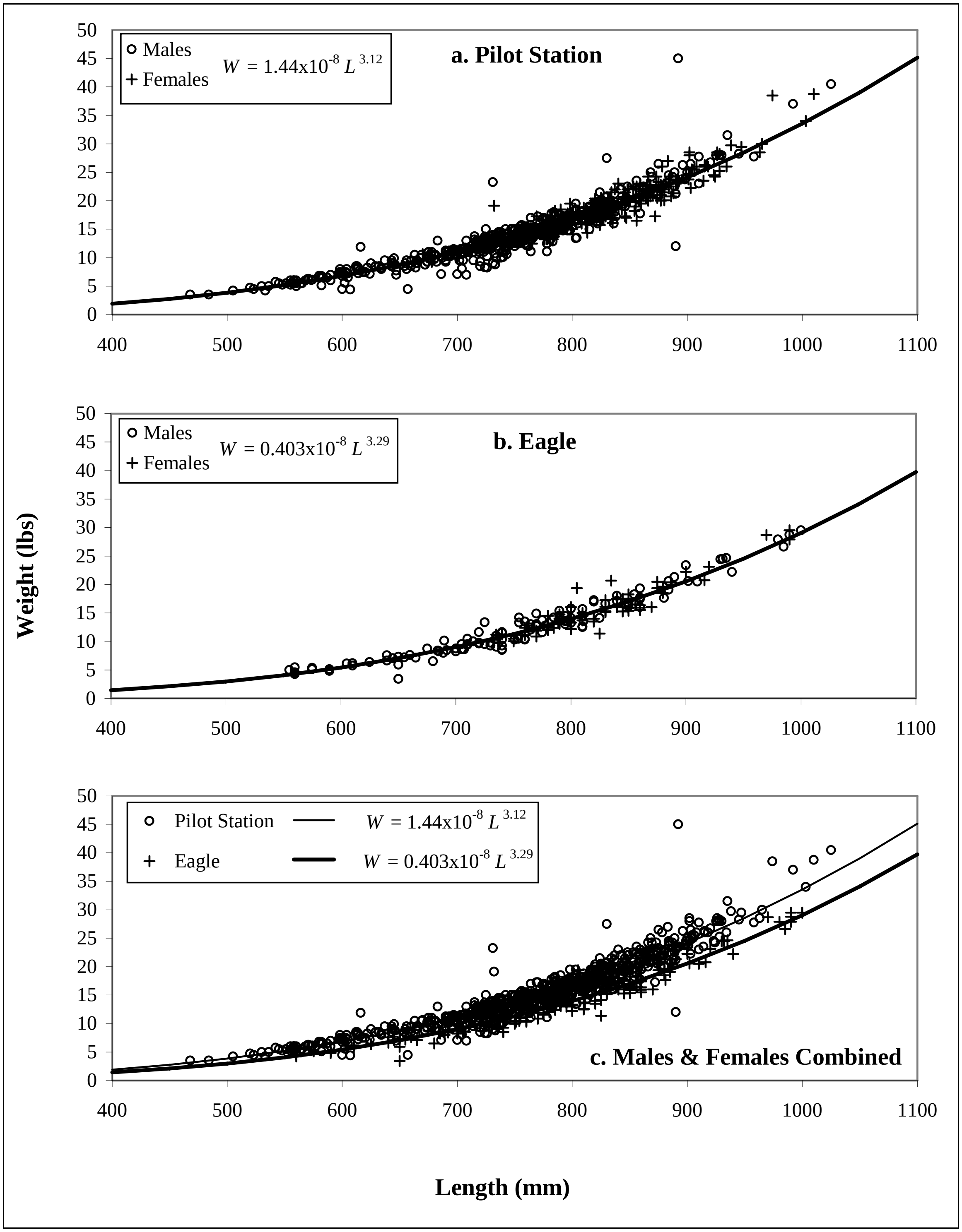


Figure 4.–Weight versus length for male and female Chinook salmon at Pilot Station (a) and Eagle (b), and weight versus length at Pilot Station and Eagle for males and females combined (c).

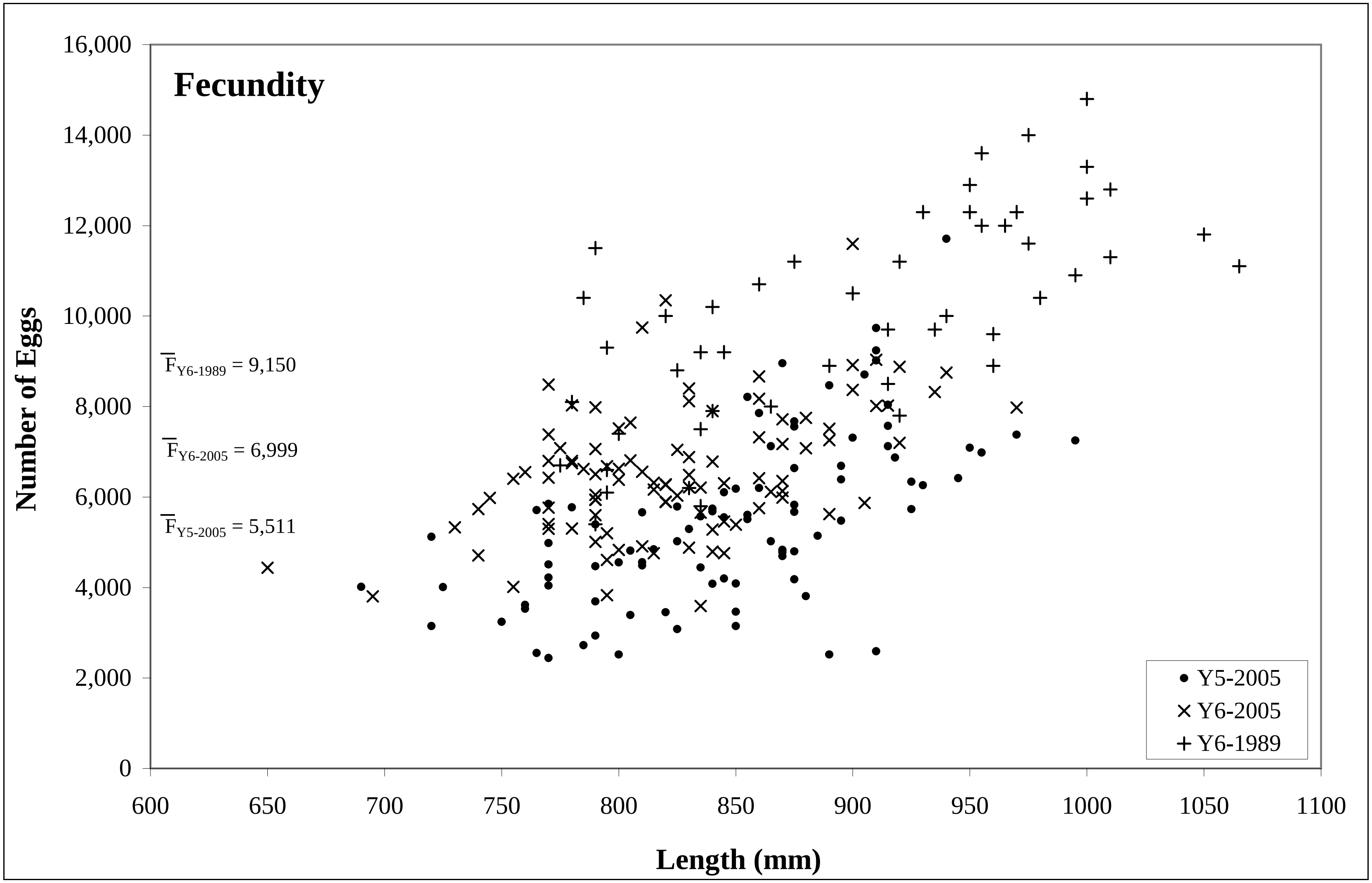


Figure 5.–Fecundity versus length (mideye to tail fork) of Yukon River Chinook salmon from Districts 5 and 6 in 2005, and District 6 in 1989, Yukon Area.

APPENDIX A. YUKON RIVER CHINOOK SALMON LENGTH, WEIGHT, GIRTH, AND ESTIMATED FECUNDITY DATA, 2005

Appendix A1.–Chinook salmon length, weight, girth, and estimated fecundity for Districts 5, Yukon River Drainage, 2005.

Length (mm)	Weight (lbs)	Girth (mm)	Estimated Fecundity	Length (mm)	Weight (lbs)	Girth (mm)	Estimated Fecundity
690	18.6	470	4,015	850	18.6	490	3,144
720	10.9	395	5,122	855	18.7	495	5,510
720	9.6	350	3,149	855	20.7	530	8,212
725	10.6	377	4,009	855	17.0	473	5,602
750	12.0	400	3,240	860	17.9	465	7,855
760	13.8	435	3,616	860	19.8	489	6,200
760	11.4	383	3,527	865	19.5	486	7,121
765	13.6	425	2,553	865	17.0	465	5,021
765	12.6	435	5,712	870	19.4	503	8,957
770	14.9	440	4,039	870	19.4	491	4,783
770	13.7	425	5,846	870	14.8	425	4,690
770	15.7	445	4,983	870	18.1	488	4,832
770	13.1	405	4,219	875	21.0	525	5,672
770	10.6	371	2,443	875	21.0	490	7,553
770	13.4	421	4,507	875	15.2	475	4,180
780	13.9	438	5,768	875	17.0	475	5,828
785	13.1	427	2,727	875	21.5	520	4,795
790	14.1	415	4,471	875	21.8	523	7,670
790	10.1	366	3,690	875	20.1	520	6,640
790	14.4	440	2,938	880	18.8	456	3,810
790	13.2	413	5,390	885	20.6	504	5,143
800	12.9	435	4,551	890	21.7	524	8,468
800	12.8	401	2,519	890	20.1	481	2,517
805	15.0	455	4,814	895	19.8	480	5,478
805	14.2	410	3,393	895	23.8	531	6,385
810	16.6	470	5,658	895	20.5	535	6,688
810	14.2	447	4,485	900	23.5	527	7,310
810	15.4	454	4,559	905	20.9	496	8,704
815	14.1	435	4,843	910	24.4	541	9,020
820	14.3	410	3,450	910	23.8	541	2,591
825	14.1	421	5,790	910	20.1	523	9,733
825	14.1	422	3,078	910	21.1	512	9,238
825	15.2	443	5,018	915	25.4	545	8,041
830	17.4	459	5,292	915	20.6	524	7,571
835	17.5	460	5,573	915	21.1	497	7,122
835	17.2	461	4,442	918	23.3	531	6,874
840	18.0	505	5,681	925	24.7	539	6,338
840	15.0	450	4,083	925	24.6	523	5,733

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Length (mm)	Weight (lbs)	Girth (mm)	Estimated Fecundity	Length (mm)	Weight (lbs)	Girth (mm)	Estimated Fecundity
840	17.1	472	5,745	930	22.3	554	6,262
845	18.1	484	5,546	940	20.4	517	11,708
845	17.7	460	6,104	945	26.6	567	6,415
845	16.1	461	4,198	950	30.0	595	7,089
850	19.6	480	6,183	955	25.9	539	6,980
850	18.3	474	4,089	970	29.8	603	7,377
850	18.3	515	3,464	995	31.6	585	7,251
Avg. 797	14.6	435	4,412	897	21.4	513	6,536

Appendix A2.–Chinook salmon length, weight, girth and estimated fecundity for Districts 6, Yukon River Drainage, 2005.

Length (mm)	Weight (lbs)	Girth (mm)	Estimated Fecundity	Length (mm)	Weight (lbs)	Girth (mm)	Estimated Fecundity
650	8.0	365	4,437	810	15.7	465	9,743
695	8.1	366	3,804	815	12.9	440	6,166
730	8.7	370	5,334	815	15.7	466	6,314
740	10.8	397	4,709	815	14.9	439	4,758
740	12.6	430	5,734	820	13.8	470	6,268
745	10.6	395	5,981	820	16.6	477	6,280
755	10.9	398	4,012	820	15.7	460	5,889
755	14.7	420	6,405	820	15.2	453	5,901
760	13.5	453	6,548	820	15.4	468	10,348
770	10.4	400	5,406	825	15.0	459	6,029
770	13.3	460	6,797	825	17.1	498	7,045
770	10.9	400	6,425	830	16.3	470	6,885
770	13.3	442	5,766	830	16.1	466	4,884
770	14.7	460	8,482	830	16.8	486	6,215
770	11.4	405	7,384	830	16.0	460	8,399
770	10.5	395	5,299	830	16.4	482	8,117
775	13.8	445	7,084	830	16.4	440	6,486
780	13.1	434	6,800	835	16.5	450	3,592
780	10.9	400	5,306	835	17.9	505	5,655
780	14.0	454	8,027	835	18.5	502	6,211
780	13.2	438	6,750	840	15.4	445	5,281
785	13.3	417	6,621	840	14.6	446	4,794
790	12.1	430	5,011	840	18.1	471	6,780
790	11.1	420	5,945	840	19.2	500	7,897
790	10.0	390	6,502	845	18.56	534	6,303
790	12.9	450	5,938	845	17.3	472	4,758
790	12.4	430	7,981	845	16.7	460	5,460
790	14.1	444	6,047	850	19.2	509	5,387
790	14.8	443	5,599	860	19.0	485	7,320
790	14.2	432	7,058	860	18.4	508	8,172
795	13.2	450	6,685	860	17.7	488	5,753
795	13.6	436	4,607	860	17.9	480	6,415
795	14.3	429	5,196	860	20.3	513	8,667
795	13.0	431	3,832	865	18.3	476	6,113
800	12.8	450	4,831	870	17.7	505	6,352
800	15.3	460	6,629	870	15.7	480	6,130
800	13.4	430	6,382	870	18.8	497	5,985
800	15.9	468	7,515	870	18.1	498	7,170
805	14.6	465	6,808	870	19.5	496	7,719
805	15.3	464	7,647	880	22.2	535	7,750
810	13.5	420	4,909	880	19.1	488	7,079
810	14.9	465	6,562	890	18.4	500	7,511

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Length (mm)	Weight (lbs)	Girth (mm)	Estimated Fecundity	Length (mm)	Weight (lbs)	Girth (mm)	Estimated Fecundity
890	19.6	487	7,254	910	23.0	539	8,011
890	20.1	510	5,620	915	22.7	531	8,021
900	21.6	530	11,597	920	24.1	530	8,881
900	24.8	555	8,919	920	23.8	515	7,200
900	21.0	518	8,366	935	24.7	542	8,320
905	21.6	521	5,870	940	25.5	561	8,751
910	20.4	513	9,034	970	27.0	548	7,978
Avg. 793	13.9	441	6,356	855	18.2	488	6,799