Observations of Size-at-Age for Sockeye Salmon (*Oncorhynchus nerka*) Smolts from Sproat Lake, British Columbia (1977-2016)

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by

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ABSTRACT

Hyatt, K. D., Stiff, H. W. and Rankin, D. P. 2019. Observations of Size-at-Age for Sockeye Salmon (*Oncorhynchus nerka*) Smolts from Sproat Lake, British Columbia (1977-2016). Can. Manu. Rep. Fish. Aquat. Sci. 3186: v + 77 p.

Personnel from the Salmon in Regional Ecosystems Program (SIRE-P) and its predecessors have conducted annual sampling of juvenile salmon (*Oncorhynchus nerka*) migrating seaward from Sproat Lake in most years between 1977 and 2016. Observations of biological traits of smolts (e.g. size at sea entry) help inform ongoing research into the likely origins of large variations in production exhibited by Sockeye Salmon populations in freshwater and marine ecosystems in Canada's Pacific region. For Sproat Lake, smolts were collected from a fyke net set on one to several dates during the spring migration period (April to early June) at the outlet of the lake (Sproat River). Individual fish from sample collections were processed and measured for fork length and weight, and scales were taken. Fish weight (wet weight in grams) and length (fork length in mm) were obtained from either fresh, frozen or preserved samples but all observations here are expressed as fresh measure equivalents. Summary statistics of size-at-age of Sockeye Salmon smolts are tabulated in this report by survey date and age. A consistent annual index of Sproat Lake Sockeye smolt size was identified for the predominant age-1 class of migrants, based on a subset of the sample observations collected between April 14th (10th percentile) and May 22nd (90th percentile) of each year. The all-year averages for fork length and wet weights of age 1.0 Sockeye smolts exiting Sproat Lake were 7.4 cm and 3.7 grams respectively. The all-year averages for fork length and wet weights of age 2.0 Sockeye smolts were 8.7 cm and 5.8 grams respectively. Missing years of mean annual age 1 smolt size (2004, 2005, 2007, 2013-2016) were estimated based on a multi-variate relationship for average smolt length as a function of the average length of fry from trawl samples obtained in Sproat Lake during the previous fall/winter and the timing of the in-lake surveys.

RÉSUMÉ

Hyatt, K. D., Stiff, H. W. and Rankin, D. P. 2019. Observations of Size-at-Age for Sockeye Salmon (*Oncorhynchus nerka*) Smolts from Sproat Lake, British Columbia (1977-2016). Can. Manu. Rep. Fish. Aquat. Sci. 3186: v + 77 p.

Les employés du Programme du saumon dans les écosystèmes régionaux et leurs prédécesseurs ont effectué des échantillonnages annuels de saumons juvéniles (Oncorhynchus nerka) qui dévalaient du lac Sproat la plupart des années entre 1977 et 2016. L’observation des caractéristiques biologiques des saumoneaux (p. ex. la taille à l’entrée en mer) aide à orienter les recherches en cours sur les origines probables des grandes variations de la production des populations de saumon rouge dans les écosystèmes d’eau douce et marins de la région du Pacifique du Canada. Dans le cas du lac Sproat, les saumoneaux ont été capturés à l’aide d’un verveux à une ou plusieurs dates durant la migration printanière (d’avril à début juin) à la sortie du lac (rivière Sproat). Les poissons individuels ont été traités; on a mesuré leur longueur à la fourche et leur poids, et prélevé des écailles. Le poids (poids humide en grammes) et la longueur (longueur à la fourche en mm) du poisson ont été obtenus à partir d’échantillons frais, congelés ou conservés, mais toutes les observations sont exprimées ici en équivalents de mesures fraîches. Des statistiques sommaires sur la taille selon l’âge des saumoneaux rouges sont présentées dans le présent rapport par date de relevé et par âge. Un indice annuel uniforme de la taille des saumoneaux rouges du lac Sproat a été établi pour la classe d’âge 1 prédominante des migrateurs, d’après un sous-ensemble des observations des échantillons recueillies entre le 14 avril (10e centile) et le 22 mai (90e centile) de chaque année. Les moyennes sur toute l’année pour la longueur à la fourche et le poids humide des saumoneaux rouges d’âge 1 quittant le lac Sproat étaient de 7,4 cm et 3,7 grammes respectivement. Les moyennes sur toute l’année pour la longueur à la fourche et le poids humide des saumoneaux rouges d’âge 2 étaient de 8,7 cm et de 5,8 grammes respectivement. Pour les années où les données étaient manquantes (2004, 2005, 2007, 2013-2016), on a estimé la longueur moyenne annuelle des saumoneaux d’âge 1 à partir d’une relation à plusieurs variables exprimée sous la forme d’une fonction de la longueur moyenne des alevins des échantillons prélevés au chalut dans le lac Sproat l’automne et l’hiver précédents et du moment des relevés dans le lac.

INTRODUCTION

The Salmon in Regional Ecosystems Program (SIRE-P), and its predecessors, have been involved in a series of short- to medium-term studies spanning a roughly forty-year interval focused on more than thirty Sockeye Salmon conservation units (CUs) in Canada's Pacific region. Funding of short-term studies has been received from a variety of federal, provincial and industry sources with interests in salmon enhancement (Hyatt et al. 1984, 2004, 2005a; Hyatt and Stockner 1985), stock assessment (Hyatt and Steer 1987; Hyatt et al. 1994, 2000; McCreight 1994; Hyatt and Rankin 1999), habitat and stock restoration (Johannes et al. 1999, 2002; Hyatt et al. 2003; Hyatt and Stockwell 2019), climate change (Hyatt et al. 2005b, 2015b, 2016, 2018a; Stiff et al. 2018) and food-web research (McQueen et al. 2007; Hyatt et al. 2005b, 2011, 2018). Although most of these programs, focused on individual Sockeye CUs, have been completed and terminated within less than five years, a few of these Sockeye CUs, associated with each of several distinctive freshwater and marine adaptive zones (Holtby and Ciruna 2007), have been subjects of sufficient interest to permit assembly of longer term (>25 years) data sets on life-stage specific biological traits and abundance. Multidecadal patterns of annual production variations exhibited as total returns of adults (i.e. catch plus escapement) by these CUs have been documented by Hyatt et al. (2005b, 2016a, 2018a) in DFO's State of the Pacific Ocean reports, but assembly and documentation of associated abundance and biological trait observations by life-stage (Hyatt et al. 2015b; Stiff et al. 2018), to make these data more widely available to the scientific community, remains a work in progress.

In this report we summarize observational data collected to assess biological traits (size and age) of Sockeye Salmon smolts sampled during spring seaward migrations from Sproat Lake from 1977-2012. Smolt catch and effort data are analyzed to derive a consistent, representative estimate of mean annual Sproat Lake Sockeye smolt size by age class. Estimates of smolt size, based principally on statistical relations with pre-smolt (fry) size biosamples in the rearing lake, were used to infill missing years (2004, 2005, 2007) and extend the time-series for the years 2013-2016.

This report includes:

(1) a general map of sampling locations;

(2) smolt catch and effort summary tables and plots;

(3) plots of length/weight regressions and frequency distributions; and

(4) plots and tables of observed and "best" estimates of smolt size by year and age.

The results reported here are derived from projects designed to deliver on a variety of objectives but now comprise a sufficiently long time series of obervations to have utility as a basis for analysis of lake carrying capacity (Hyatt et al. 2011) and identification of the factors operating to control salmon production variations in either freshwater (Hyatt and Rankin 1999) or marine ecosystems (Hyatt et al 2015b).

STUDY AREA

Sproat Lake, located in central Vancouver Island (49°14'N x 126°06'W; elev. 29 m), is a moderately deep, oligotrophic waterbody (mean depth 59 m; max depth 195 m) with a surface area of approximately 4,000 hectares, draining a 35,000 hectare watershed (Hyatt et al. 2011, 2016; Rutherford et al. 1986; Stockner and Shortreed 1985). The lake drains from the northeast arm (Klehkoot Arm) via Sproat River, which combines with the Stamp River 13 km downstream to form the Somass River flowing into Alberni Inlet (Figure 1, Figure 2).

Smolt populations were sampled in Sproat River near the lake outlet (Hyatt et al. 1984; Rankin et al. 1994). Smolts captured during these surveys include: large numbers of Sockeye (*Oncorhynchus nerka*), smaller numbers of Coho (*O. kisutch*), Chinook (*O. tshawytsha*), and in some cases, Pink (*O. gorbuscha*) and Chum (*O. keta*) fry. The results presented here are limited to Sockeye smolts as samples of other species collected were not processed.

METHODS

Readers are encouraged to review Hyatt et al. (1984) and Rankin et al. (1994) for details regarding smolt sample acquisition and processing methods. However, the general methodology for the Sproat Lake system is outlined briefly here.

Smolt surveys were conducted during April through June. Survey timing was designed to encompass the period of peak smolt migrations (Rankin et al. 1994). Migrating smolts were captured via a variable mesh fyke net (2 x 2 x 7 m length; Gjernes 1979) set at the lake outlet, in Sproat River above Sproat Falls, where the river narrows and flows are restricted. On any given sampling date, the net was set one hour before sunset for a duration of 3 to 4 hours and checked at half-hour intervals as per the guidelines outlined in Hyatt et al. (1984). This period includes the time of peak diel smolt migration activity (Wood et al. 1993).

A sample size of 100-200 Sockeye smolts per sample night was recommended for each date sampled. If fewer than 100 smolts were caught during the first 4 hours of sampling, the net was left for the remainder of the night (about 6 hours) and retrieved in the morning. All fish captured were classified by species and preserved with labels identifying system, date, start and stop time, set number, species counts, initials of collection crew and total number of collections obtained during each survey date.

Sampled fish were generally preserved in buffered 3.7% formaldehyde for at least five weeks prior to laboratory processing for species, length, weight and scales. Alternatively, fish were preserved in 70% ethyl alcohol, and, in some cases, frozen prior to chemical preservation. Subsequently, in the laboratory at the Pacific Biological Station (PBS), fish were identified to species, and Sockeye smolts were weighed to 0.01 g and measured to 1 mm.

Between 1981 and 2012 smolt samples were processed in the PBS laboratory using a metric measuring board and electronic balance to determine fork lengths and preserved weights. Preserved smolt weights were converted to standardized fresh weights (Rankin et al. 1994) and are reported as such here. Age of fish was determined from scale analysis in the PBS Aging Lab. Scales were obtained for complete samples in some years (1977-1986), or for a subsample of fish >75 mm after 1986.

Too few scales were examined (N < 25) in some years to assign scale-based ages to mixed-age samples of smolts. In the absence of scale age data for a given year, monthly length-frequency distributions were reviewed for evidence of bi-modality to identify likely forklength threshold values to distinguish age classes. These were used in conjunction with multi-year age proportions by 5 mm forklength size class to assign a corresponding proportion of unaged fish in that size class to age.

Processed smolt data were compiled and analyzed using SAS® statistical software to tabulate summary statistics for fork length, preserved and standardized fresh weights, and smolt condition factor[1] by year, sample date and age class. Sample dates were converted to Julian day-of-year[2] for inter-annual comparisons. Univariate statistical procedures were used to detect and correct or exclude erroneous data from summary analyses.

Summary plots include:

(1) Weekly sample size, as an indicator of outmigration run-timing (ages pooled);

(2) Length and weight frequency distributions and regressions (by age class); and

(3) Trends in mean length (cm) and standardized fresh weight (g) over time (by age).[3]

Years for which Sockeye smolt size data were insufficient or unavailable (2004, 2005, 2007, 2013-2016) were infilled with estimates based on multi-year linear regression analysis of smolt length as a function of standardized estimates ($\mu \sim 0, \sigma^2$) of winter fry size (forklength) and abundance from representative acoustic trawl surveys (ATS) during the previous winter or fall[4], where available. Within- and between-year temporal effects were assessed by including terms for ocean entry year and week of fall/winter ATS sample date (shifted to increment from the previous July). Ocean entry year was forced into the regression model to address annual autocorrelation in the time-series.

The above analyses were used to identify a defensible and reproducible annual indicator of Sproat Lake Sockeye smolt size for covariation analyses (e.g. Hyatt et al. 2011).

Non-parametric test statistics were calculated over the resulting annual 40-year time-series for detection of trends (Mann-Kendall (MK)) and step changes in the mean (rank sum) (Kundzewicz and Robson 2000). Regime shift detection using sequential t-test analysis was applied after prewhitening using a target $P = 0.05$, cutoff length = 10 years, tuning constant = 2 and a subsample size = 6 years (STARS 6.2 software: Rodionov 2004).

RESULTS

The total annual number of Sockeye smolts sampled, with associated statistics for size are summarized in Table 1 by year and age, and tabulated by sample date and sample location in Appendix I. The annual frequency of fyke-net sampling dates in Sproat River is listed in Table 2. Sample meta-data, including total catch (where available) and total fish sampled by date, sample site, gear type, sampling agency and fish preservative type, are listed in Appendix IX[5,6]. Smolt

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[1] Fulton fish condition factor (K) is an index of fish 'health' that relates fish weight to length, and is influenced by age of fish, sex, season, maturation stage, fullness of gut, type of food consumed, amount of fat reserve, and degree of muscular development (Fulton 1902; *in* Barnham and Baxter 1998). $K = 10^5 \times W / L^3$, where W = Standard weight (g) and L = forklength (cm). K generally ranges from 0.5 ("poor condition") to 2.0 ("good condition"), with $K \leq 1$ for long, thin fish such as salmonid fry and smolts.

[2] For leap years, day-of-year was advanced by one day beginning in March to account for February 29th.

[3] For some figures, the Fulton fish condition factor (K) is multiplied by 10 for plotting purposes.

[4] Winter pre-smolt (fry) size and abundance estimates from Hyatt et al. (2016) and K. Hyatt, DFO Pacific Biological Station (unpub. data).

[5] Data issues are listed in Appendix X.

[6] Smolt data are available upon request. Contact Kim.Hyatt@dfo-mpo.gc.ca.

biosample observations were not available for 2004, 2005, or 2007, and were limited to <50 fish in 2003, 2008, 2010, 2012 and 2013 (Table 2).

In some years, few (0 - 30) scale-based age observations were available (1988, 2002, 2003, 2006, 2009, 2010, 2012, 2013) to rigorously characterize age composition. To obtain sufficient aged fish for mean size estimation, unaged fish were assigned to age as described above. Most (99%) of age assignments were to age 1; data changes are listed in Appendix X. Within-year summary statistics of fork length and standardized weight by sample date and age are tabulated in Appendix I.

As an indicator of seasonal smolt catch and relative abundance, sample size (count of Sockeye smolts retained by age) and percent of total annual retained catch are charted by year and sample date in Appendix II. Within-year seasonal trends in mean length and weight at age are presented in Appendix III.

Figure 3 summarizes the annual range of dates sampled (see Table 1 for actual sample sizes), with overlays of mean fork length and standard weight, by age class.

Annual size-at-age frequency distributions for fork length, standard weight, and fish condition (K) are organized in Appendix IV. These indicators are graphically summarized across all years in Figure 4. The annual absolute deviations from the multi-year averages displays significant differences in mean size and fish condition between years (Figure 5).

Statistical relations and corresponding regression and correlation coefficients for Sockeye length-weight relationships (by year and age) can be found in Appendix V. The multi-year length-weight at age relationships are presented in Figure 6.

The trend in within-season smolt size at age is plotted for length and weight observations by Julian day-of-year in Figure 7 (all years combined).

The multi-year seasonal distribution of smolt sample catch retained is plotted in Figure 8. Statistical quantiles of migration timing – based on Julian day-of-year – are compared in Table 3 for all available years versus "well-sampled" years where the number of sample dates exceed 3 and 5 days. Note that these observations represent only a coarse-grained indicator of timing because of the practice of retaining a maximum sample size of around two hundred individual fish for a given date. The actual catch on any date-specific sampling trip was often far higher than two hundred fish even though only two hundred were retained. Consequently, the observations here will generally conceal the timing of peak migration which tends to occur over a much shorter period than suggested by the annual plots in Appendix II.

The 10^{th} and 90^{th} day-of-year percentiles (April 14^{th} to May 22^{nd}), representing 80% of the smolt sample observations, were used as cutoff dates to subset the sample data to obtain statistical measures associated with a consistent inter-annual indicator for Age 1 smolt size (Table 4).

Estimates of age 1 mean smolt size for missing years (2004, 2005, 2007, 2013-2016) were obtained from a linear regression analysis based on *pre-smolt length*, as well as *ocean entry year*, an annual estimate of *juvenile abundance*, and the time-of-year of pre-smolt sample date (*week* number) plus interactions (Appendix VI). Step-wise selection retained only *pre-smolt length* as significant at the $\alpha = 0.05$ level ($r = 0.78$, $N = 29$, $P < 0.001$; Figure 9). However, an interaction term for pre-smolt forklength and week of ATS sample date was weakly significant ($P = 0.07$). Forcing *year* into the regression to account for annual temporal dependencies (autocorrelation) did not substantially change the explained variance ($r^2 \sim 0.6$) or regression coefficient ($b \sim 0.6$).

The model incorporating *year*, *pre-smolt fork length* and the interaction term between pre-smolt size and week of year yielded the highest coefficient of variation ($r^2 = 0.66$; Appendix VI), and was used to infill missing mean annual forklength. Estimated smolt lengths were converted to estimated standard weight based on the multi-year length/weight relation for age 1 smolts (Figure 6).

Final age 2 smolt size was not correlated with pre-smolt factors for the current or previous year. Best estimates for missing years (1980, 1985, 2003-2005, 2007, 2010, 2012, 2014-2016)[7] were based on the all-year linear relationship for mean age 2 fork length as a function of mean age 1 fork length ($r = 0.75$, $P < 0.001$, $N = 28$; Appendix VII, Appendix VIII).

Best estimates of mean annual Sockeye smolt size, including predictive values for missing years, were plotted in Figure 10, by age class (Table 4, Table 5). No linear parametric or non-parametric trends, autocorrelation, or regime step changes were detected in mean annual fork length or standard weight estimates.

DISCUSSION

Sampling Effort

Over the 30-plus years of available data for ocean entry (1977-2013), Sproat Lake Sockeye smolts were sampled on average 4.9 ± 3.0 dates across the months of April, May and June. The mode and median number of sample dates was 5. Sampling frequency was highest during the 1990s, when the frequency ranged from 7-12 dates per year. As of 2003, most years were sampled two times or less (Table 2). For years of low sampling frequency, survey dates may not have always occurred at representative periods of smolt outmigration (e.g. 2013, for which the sole biosample survey occurred on April 2nd).

Smolt Migration

Tallying the frequency of sample dates (Julian day-of-year) across all ocean entry years, weighted by sample size, yields a coarse indicator of smolt migration abundance (assuming catch is proportional to abundance, and effort is roughly equivalent across dates). This indicator can be restricted to years where the number of sample dates exceeds a certain annual minimum (e.g. 3-5 dates; see Table 2). The resultant "smolt migration timing" statistics indicate that, over the range of well-sampled years (1977-2002), Sproat smolt migration peaks in late April to early May (median date: May 1st), with 90% of migrants tallied between April 10th and May 25th (Figure 8). Mean, median and variance statistics did not vary significantly when included years were restricted to those with a minimum of 3, 4 or 5 sample dates (Table 3).

Migration timing varied between years, exhibiting – where sampling occurred weekly – potentially bimodal abundance patterns in some years (e.g. 1990-1992, 1995, 1998, 2002), characterized by a pulse of smolts migrating in early-to-mid-April, followed by another pulse in late April and May (Appendix I and Appendix II). Overall, age 1 fish represented approximately 96% of migrants, and age 2 fish comprised 4% (Table 1). However, age 2's often contributed a higher proportion (5-10 %) of the early April pulse of migrants, while the migrants in May were predominantly composed of age 1 fish (>98 %).

[7] Note that in 1980, 1985, 2003, 2010, and 2012, no age 2 smolts were found in sampled fish, therefore the predicted age 2 fork length is hypothetical for those years.

Smolt Size and Condition

The mean length and standard weight of age 1 fish for all available years (1977-2012[8]) were 7.4 ± 0.8 cm and 3.7 ± 1.1 g, respectively (N = 17,027; Table 1). Ninety-five percent of age 1 fish were less than 8.6 cm in fork length.

Age 2 fish averaged slightly larger, at 8.7 ± 0.9 cm and 5.8 ± 1.8 g (N = 565). However, maximum length/weight of age 1's ranged from 9 – 11 cm / 4 – 9 g, resulting in a wide overlap in the age-specific size distributions which precludes a simple size-based assignment of unaged fish to age class. Laboratory personnel attempted to take this overlap into account by focusing scale collection on the upper end of age 1 fish sizes (>75 mm).

This may have been complicated by significant variation in mean smolt size between years. Ignoring years of limited sampling effort and/or small sample size (2003, 2008, 2010, 2012, 2013), age 1 fish averaged < 3 g in weight in 1977, 1979, 1985, 1998, 2001 and 2002 (Figure 3 (top); Table 1), which was >1 standard deviation below the all-year average (3.7 g). Large age 1 smolts, averaging > 4.5 g occurred in 1978, 1981, 1986, 1992, and 1994 (Figure 5, Appendix IV).

The largest smolts were evident in 2008-2009, when age 1 smolt weights averaged > 5 g. Though sampling effort was low (1-2 sample dates per year) and exhibited limited sample size (<100 fish), samples were generally drawn from late-April to mid-May, and are therefore considered to be representative of the typical second pulse of principally age 1 migrants (Appendix II). Therefore, it appears that Sproat Sockeye smolt size improved +1-2 g some time between 2003 and 2006, and persisted at a significantly larger average size for several years (2008-2011) before falling below the long-term average in 2012. The subsequent increase in mean length evident in 2013 (weights were not available) may not be representative due to small sample size (N = 17; Table 1) and early sample timing (Appendix II, Appendix III).

Summary data in Table 4 reasonably replicate previous analyses for ocean entry years 2008-2012 (Hyatt et al. 2016b). The 2013 sample observations (17 smolts sampled on April 2, 2013; 10 age 1s, 7 age 2s) were included in Table 1 and Appendix I, but excluded from Best Estimates (Table 4) as outside of the mid-80th percentile for the migratory date range and characterized by poor smolt preservation condition.

Fulton's fish condition factor (K) – which expresses the relationship between fish length and weight – may provide more insight into fish health and survival than either size factor alone. Mean fish condition for age 1 and age 2 fish was K=0.9 (Figure 4), which is likely typical for freshwater stages of juvenile salmonids. Maximum age 1 fish condition occurred in 1998 and 2011 (Figure 5, Table 1). Fulton's K largely reflected inter-annual length and weight variation, with several exceptions (e.g. 1978, 1981, 1984, 1986, 1992, 2008), where larger weights were not characterized by a high K-factor due to associated large fork lengths; and 1998, where low weights were associated with a high K-factor because mean fork lengths were low as well (Figure 5, Table 1). The K-factor suggests significantly lower mean fish condition for most years between 1977-1986 and 1992-2002, despite significantly positive differences in length and/or weight from the multi-year mean during those years (Figure 5).

It should be noted that Sproat Lake fertilization efforts occurred in 1985 (Hyatt et al. 2016). This appeared to have no beneficial size effect on Sockeye smolts entering the ocean in the year of

[8] Weight data were not available for fish sampled in 2013 due to poor quality of fish preservation.

treatment (i.e. the Sockeye smolts actually exhibited below-average mean length and weight at 6.4 cm / 2.2 g respectively; N = 313). However, in 1986, age 1s (8.3 cm / 4.7 g; N = 211) and age 2s (10.8 cm / 10.5 g; N = 5) that had experienced the effects of the 1985 lake treatment were both larger than average (Figure 3, Figure 5, Appendix IV).

The length/weight curves for both age classes of Sproat Lake Sockeye are nearly identical despite the mean size differences: fresh standard weight (g) is approximately equivalent to 0.01 times the fork length (cm) cubed (Figure 6).

Mean annual length and weight statistics were correlated between age classes ($r = 0.75$, $P < 0.001$, N = 29; Appendix VII, VIII).

Seasonal Trends in Smolt Size

Smolt size in biosamples appeared to decrease in both age 1 and age 2 classes as the season progressed ($P < 0.01$; Figure 7), as evidenced when sampling effort involved > 3 dates (e.g. 1979-2002). This multi-year trend is driven, however, by a subset of years of strong within-season decline in the 1990s (e.g. 1989, 1993, 1995, 1996, 2000: $P < 0.001$; Appendix III), which may potentially mark an apparent shift from neutral or weakly positive changes in size in-season (perhaps related to spring growth) prior to 1989, to mainly negative trends in within-season fish size through to 2000. Diminishing size at age over the season potentially signifies a tendency towards earlier seaward migration of larger smolts (Wood et al. 2003). Due to lower sampling effort in recent decades, it is not clear if this trend has continued.

Best Estimates of Annual Smolt Size

Thirty years of data indicate that biosamples collected between mid-April and late May (weeks 14 - 20) are most representative of the size of fish of the dominant age 1 class. Sproat smolt migration peaks between late April and early May (median date: May 1st), with 90% of migrants tallied between April 5th and May 25th (Figure 8). As mean, median and variance statistics did not vary significantly when years were restricted to those with a minimum of 3, 4 or 5 sample dates (Table 3), and within-year seasonal trends in size were generally weak for age 1 Sockeye (Appendix III), it may be surmised that one or more sample dates between mid-April and late May are likely sufficient to characterize Sockeye smolt size, at least for the predominant age 1 class, provided it is based on a reasonable aggregate sample size (e.g. 50-100 fish).

As noted above, age 2 smolts make up a larger proportion of early April migrants (Table 1, Appendix III). To reduce the influence of unaged age 2's on the annual smolt size indicator, a later, narrower date-range based on the 10th and 90th percentiles (i.e. April 14th to May 22nd – encompassing 80% of migration observations) was used to subset the data. These thresholds yield a consistent, representative estimate of annual Sproat Lake Sockeye smolt size (age 1), given sufficient sample size (Figure 10, top; Table 4).

For years in which age 1 Sockeye smolt size observations were insufficient or unavailable (2004, 2005, 2007, 2013-2016), mean annual age 1 smolt size estimates were infilled based on the all-year multivariate linear relationship based on winter pre-smolt length, time-of-year (week) and ocean entry year ($r^2 = 0.66$; N = 24). Observed means and predictive estimates (represented by hollow squares) in the length and weight time-series in Figure 10 (top).

Mean annual age 2 smolt sizes are based on all available samples (Figure 10, bottom; Table 5). Age 2 size estimates should be considered highly uncertain, due to low frequency of occurrence in biosamples, especially since 2000. However, mean annual age 2 fork lengths and weights appear to co-vary reasonably well with age 1 size data, enabling missing annual age 2 fork lengths to be estimated based on the age 1 to age 2 regression relation (Appendix VII). It should be noted that, in some well-sampled years (e.g. 1980, 1985), no age 2 fish were represented in the samples, thus age 2 size estimates are completely hypothetical in those years. In other years, the age 2 size estimate may be based on fewer than 10 fish (Table 1; Appendix VIII). Thus, the age 2 time series should be used with caution.

Given the above qualifications, the resulting time-series represent the best estimates of Sproat Lake Sockeye smolt size, and may provide a basis for further analysis and identification of the factors operating to control salmon production variations in freshwater (e.g. Hyatt and Rankin 1999; Hyatt et al. 2011) or marine ecosystems (e.g. Hyatt et al. 2015b).

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MAPS

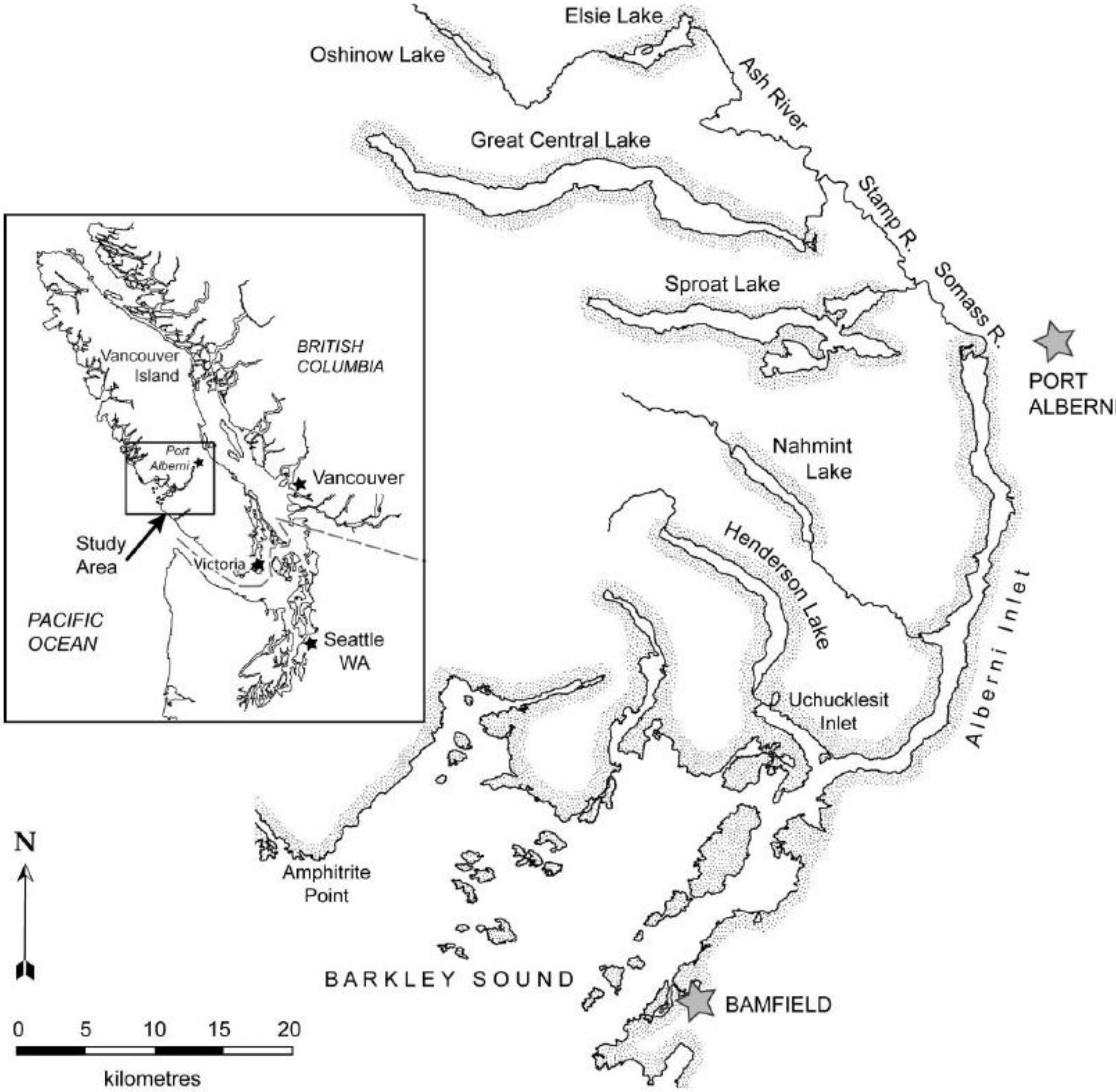


Figure 1. Location of Barkley Sound study lakes (including Sproat Lake) on the west coast of Vancouver Island, B.C.

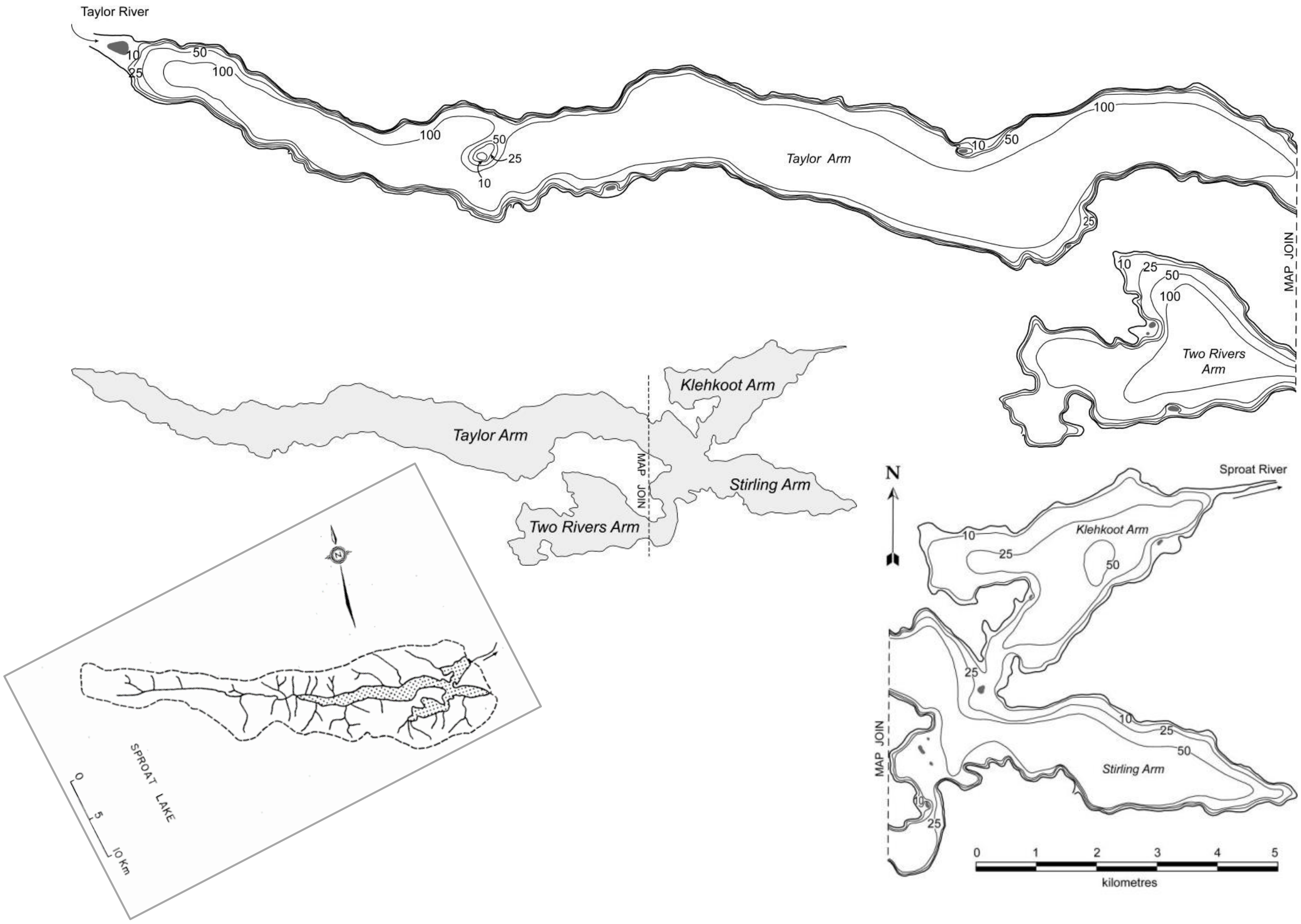


Figure 2. Sproat Lake bathymetric contours (in metres). Adapted from Hyatt et al. (2016b). Vector file from http://www.bcfisheries.gov.bc.ca/fishinv/basemaps-maps.html (Source: Province of B. C., Fisheries Branch, Inventory Operations, April 1985).

FIGURES

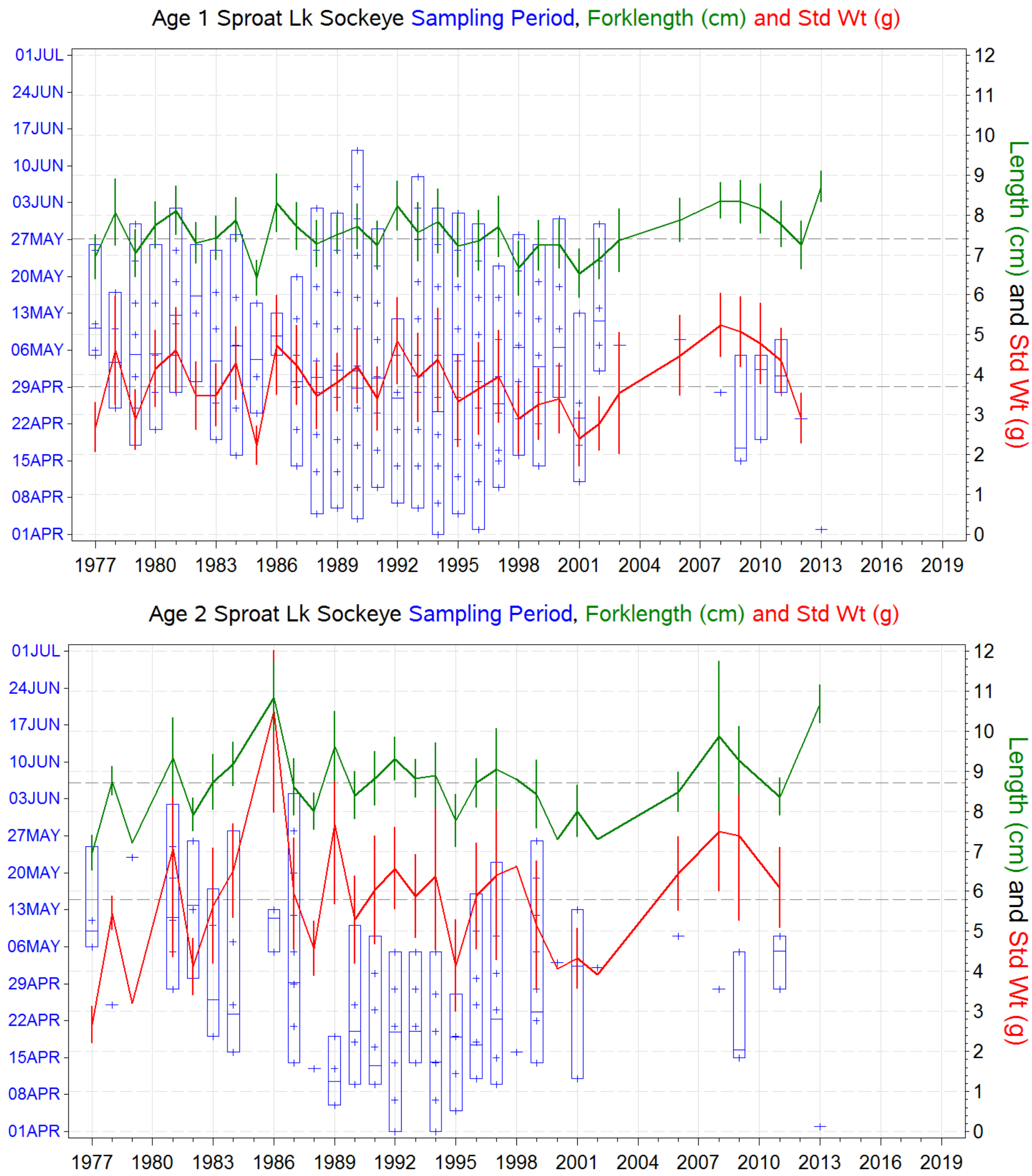
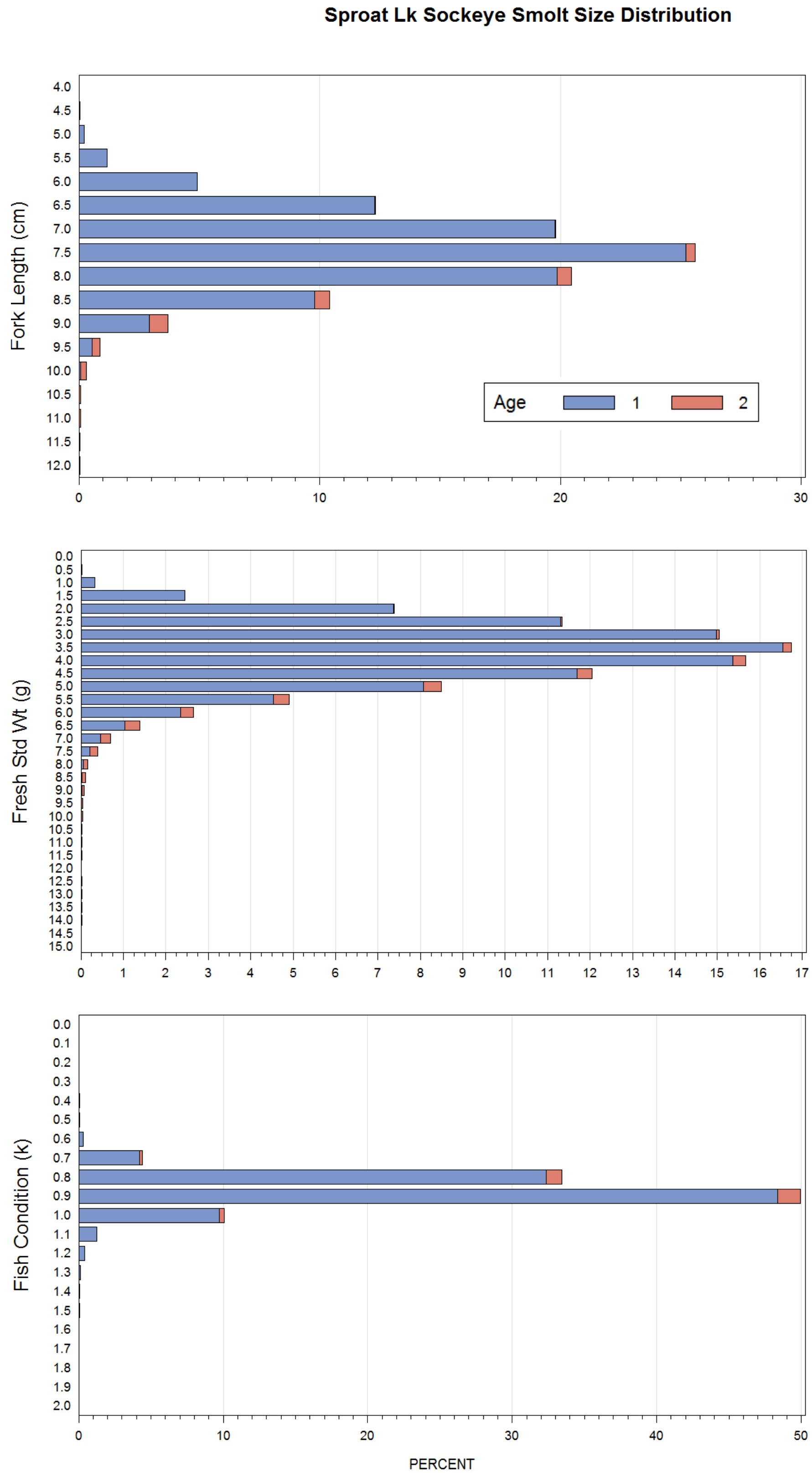


Figure 3. Sproat Lake Sockeye annual smolt sampling range (blue boxes; sample dates indicated by +-symbol), mean fork length ±1 standard deviation (cm; green), mean standard fresh weight ±1 standard deviation (grams; red), Top: Age 1; bottom: Age 2.



Fork Length (cm)	FREQ.	CUM. FREQ.	PCT.	CUM. PCT.
4.0	0	0	0.00	0.00
4.5	7	7	0.04	0.04
5.0	40	47	0.23	0.27
5.5	206	253	1.17	1.44
6.0	864	1117	4.91	6.35
6.5	2165	3282	12.31	18.66
7.0	3485	6767	19.81	38.47
7.5	4504	11271	25.60	64.07
8.0	3599	14870	20.46	84.53
8.5	1834	16704	10.43	94.96
9.0	648	17352	3.68	98.64
9.5	156	17508	0.89	99.53
10.0	53	17561	0.30	99.83
10.5	13	17574	0.07	99.90
11.0	11	17585	0.06	99.97
11.5	3	17588	0.02	99.98
12.0	3	17591	0.02	100.00

Fresh Std Wt (g)	FREQ.	CUM. FREQ.	PCT.	CUM. PCT.
0.0	0	0	0.00	0.00
0.5	1	1	0.01	0.01
1.0	58	59	0.33	0.34
1.5	429	488	2.44	2.78
2.0	1296	1784	7.38	10.15
2.5	1992	3776	11.34	21.49
3.0	2643	6419	15.04	36.53
3.5	2942	9361	16.74	53.27
4.0	2752	12113	15.66	68.93
4.5	2117	14230	12.05	80.98
5.0	1492	15722	8.49	89.47
5.5	862	16584	4.91	94.38
6.0	466	17050	2.65	97.03
6.5	245	17295	1.39	98.42
7.0	122	17417	0.69	99.12
7.5	70	17487	0.40	99.52
8.0	28	17515	0.16	99.68
8.5	18	17533	0.10	99.78
9.0	13	17546	0.07	99.85
9.5	6	17552	0.03	99.89
10.0	8	17560	0.05	99.93
10.5	2	17562	0.01	99.94
11.0	3	17565	0.02	99.96
11.5	1	17566	0.01	99.97
12.0	0	17566	0.00	99.97
12.5	2	17568	0.01	99.98
13.0	1	17569	0.01	99.98
13.5	1	17570	0.01	99.99
14.0	2	17572	0.01	100.00
14.5	0	17572	0.00	100.00
15.0	0	17572	0.00	100.00

Fish Condition (k)	FREQ.	CUM. FREQ.	PCT.	CUM. PCT.
0.0	0	0	0.00	0.00
0.1	0	0	0.00	0.00
0.2	0	0	0.00	0.00
0.3	0	0	0.00	0.00
0.4	1	1	0.01	0.01
0.5	9	10	0.05	0.06
0.6	54	64	0.31	0.36
0.7	770	834	4.38	4.75
0.8	5873	6707	33.42	38.17
0.9	8778	15485	49.95	88.12
1.0	1769	17254	10.07	98.19
1.1	224	17478	1.27	99.47
1.2	72	17550	0.41	99.87
1.3	17	17567	0.10	99.97
1.4	4	17571	0.02	99.99
1.5	1	17572	0.01	100.00
1.6	0	17572	0.00	100.00
1.7	0	17572	0.00	100.00
1.8	0	17572	0.00	100.00
1.9	0	17572	0.00	100.00
2.0	0	17572	0.00	100.00

Figure 4. Sproat Lake Sockeye smolt size distribution, all years. Standard fork length (cm, top), standard fresh weight (g, middle), Fulford fish condition factor (K, bottom).

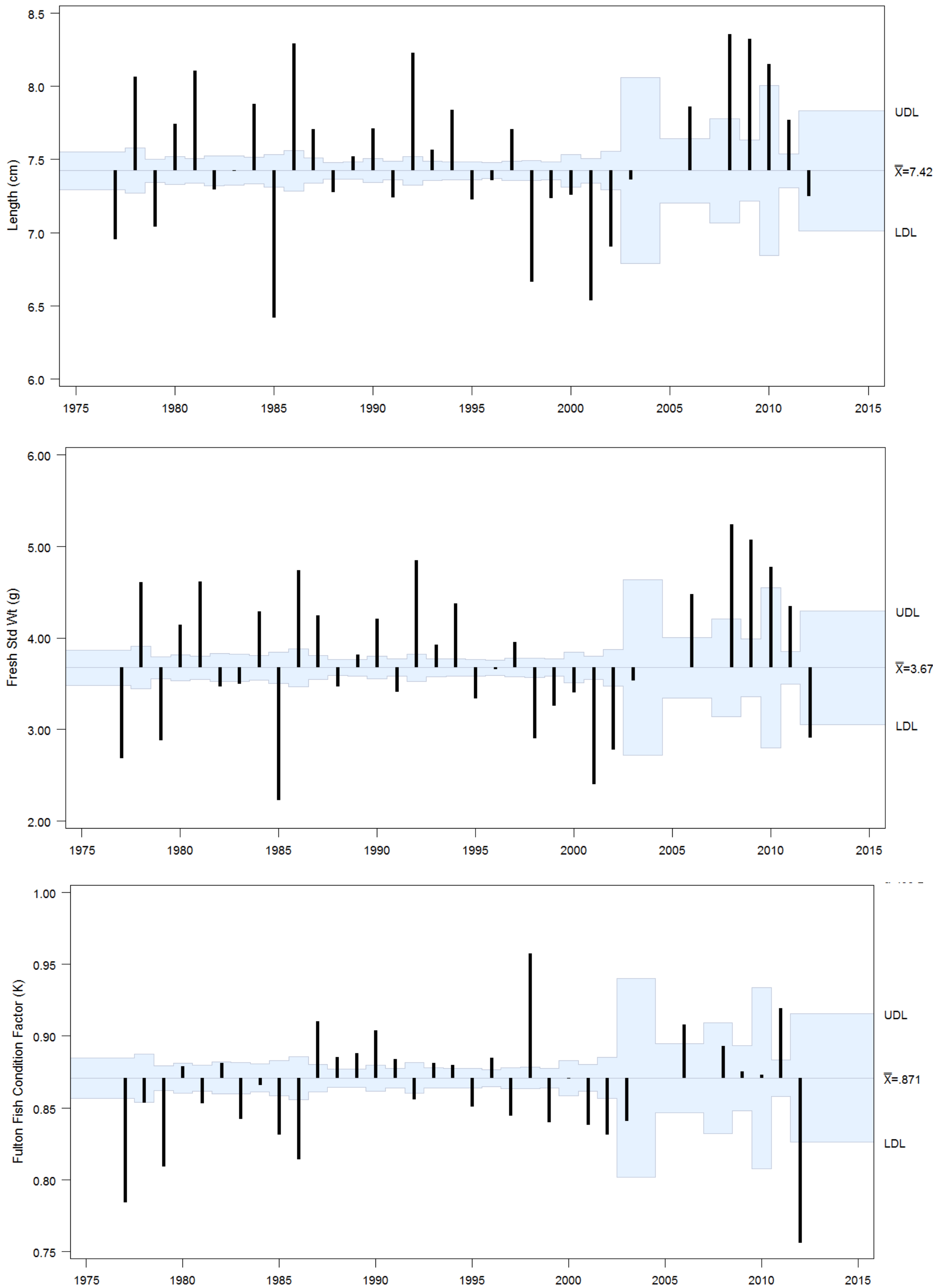


Figure 5. Absolute deviation of annual mean length (top), standard weight (middle), and fish condition factor (bottom) from the overall multi-year averages for Age 1 Sproat Lake Sockeye smolts.

Sproat Lk Smolt Length to Weight Power Relationship Statistics

	Age							
	1				2			
	a	b	Rsq	N	a	b	Rsq	N
Stock								
Sproat Lk	0.0107	2.957	0.90	514	0.6872	2.201	0.87	18

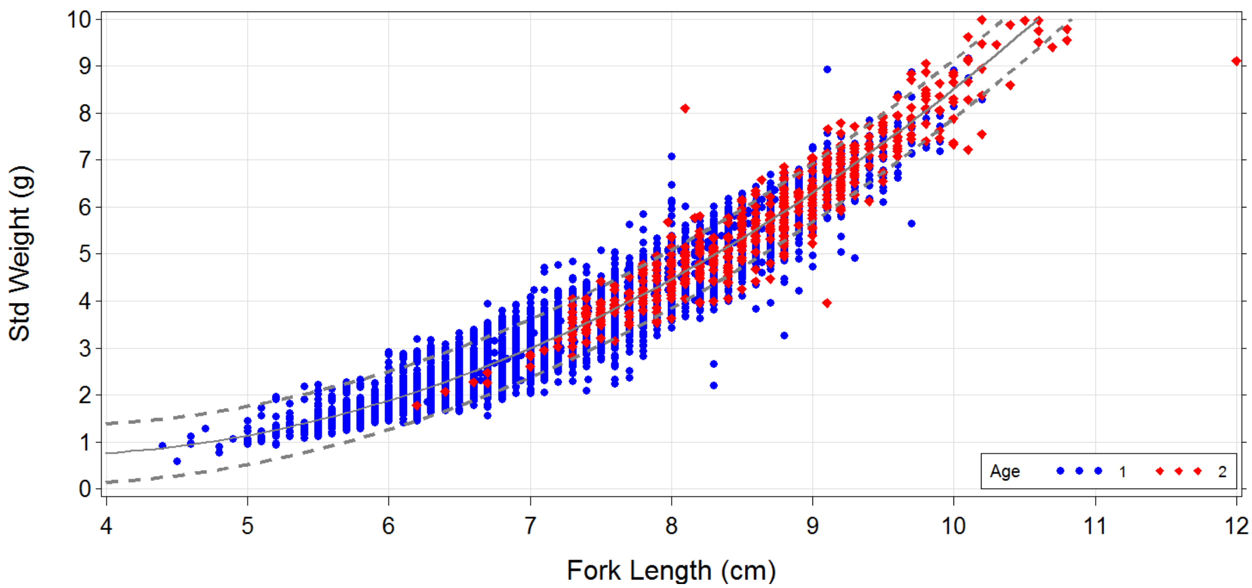


Figure 6. Sproat Lake Sockeye smolt length/weight relationship, all years.
Model: Std Weight = a • Fork Length ^{b}

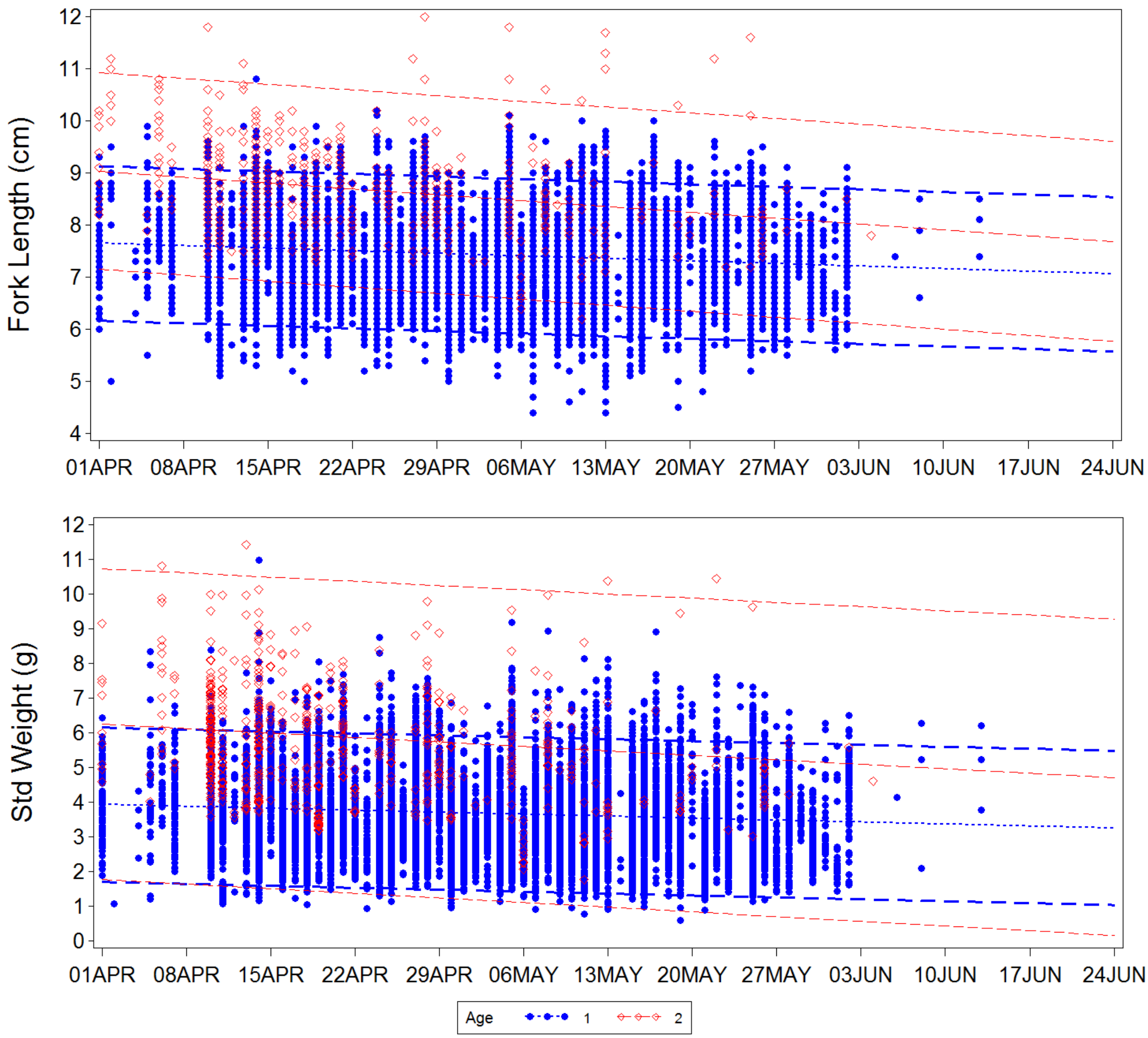
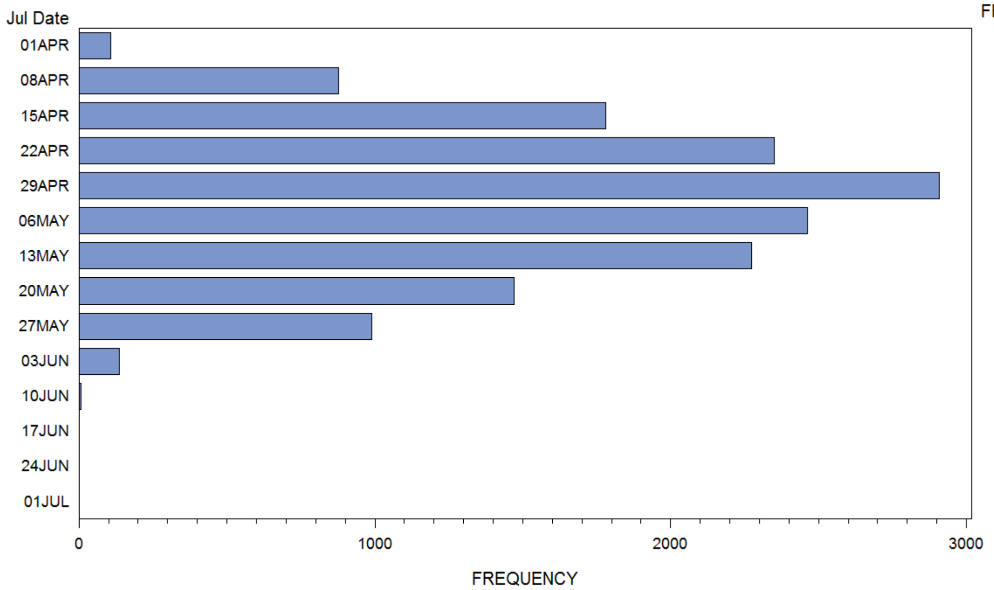


Figure 7. Decreasing trends in within-season smolt length (top) and weight (bottom), by age class, all years ($r < 0$; Adj. $r^2 < 0.03$; $N > 500$).



Jul Date	FREQ.	CUM. FREQ.	PCT.	CUM. PCT.
01APR	107	107	0.70	0.70
08APR	876	983	5.70	6.40
15APR	1780	2763	11.59	17.99
22APR	2351	5114	15.31	33.29
29APR	2908	8022	18.93	52.23
06MAY	2462	10484	16.03	68.26
13MAY	2275	12759	14.81	83.07
20MAY	1470	14229	9.57	92.64
27MAY	989	15218	6.44	99.08
03JUN	136	15354	0.89	99.96
10JUN	6	15360	0.04	100.00
17JUN	0	15360	0.00	100.00
24JUN	0	15360	0.00	100.00
01JUL	0	15360	0.00	100.00

Figure 8. Sproat Lake Sockeye smolt “abundance distribution” (frequency of sample dates (Julian day of year), weighted by sample size), across all years where the minimum number of sample dates >= 5 (see Table 2, Table 3).

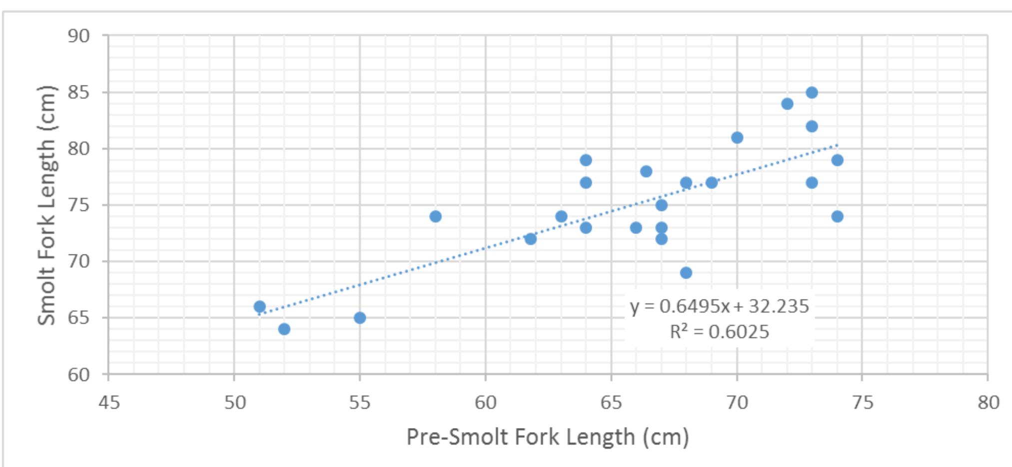


Figure 9. Simple linear relationship for age 1 fork length as a function of winter pre-smolt fork length, 1980-2011 (r = 0.78; N = 29).

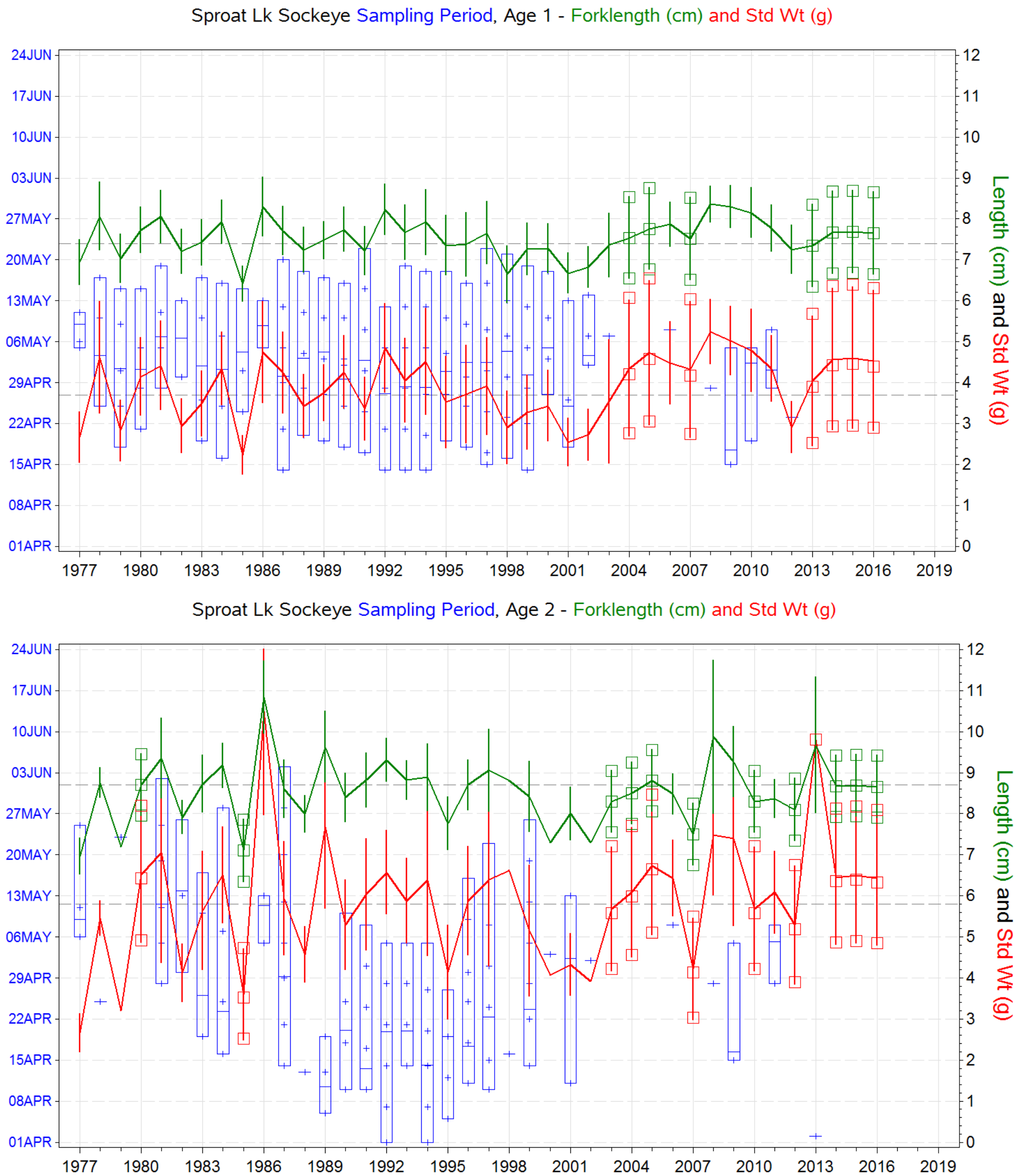


Figure 10. Best estimates of Sproat Lake Sockeye annual mean smolt size (solid lines) based on sampling effort (blue boxes) between April 14th and May 22nd each year for age 1 smolts (top), with predictive estimates for ocean entry years 2004, 2005, 2007, 2013-2016[9] (empty squares). Age 2 (bottom) based on all available samples; age 2 smolt size for missing years estimated based on age 1 to age 2 mean annual fork length.

[9] Smolt size data are insufficient or N/A.

TABLES

Sproat Lk

	Age																			
	1										2									
		Length (cm)				Fresh Std Wt (g)						Length (cm)				Fresh Std Wt (g)				
	N	AVG	P10	P95	MAX	AVG	P95	SD	K	Pct %	N	AVG	P10	P95	MAX	AVG	P95	SD	K	Pct %
Year																				
1977	243	7.0	6.3	7.8	8.6	2.7	3.7	0.6	0.78	95	13	7.0	6.4	7.7	7.7	2.7	3.5	0.5	0.78	5
1978	168	8.1	6.9	9.4	10.0	4.6	6.9	1.4	0.85	99	2	8.8	8.5	9.0	9.0	5.5	5.8	0.4	0.81	1
1979	638	7.0	6.3	8.0	8.9	2.9	4.2	0.7	0.81	100	1	7.2	7.2	7.2	7.2	3.2	3.2		0.86	0
1980	439	7.7	7.1	8.7	10.1	4.1	5.9	0.9	0.88	100										
1981	549	8.1	7.3	9.1	10.0	4.6	6.5	1.1	0.85	98	14	9.3	8.3	11.6	11.6	7.1	14.1	2.7	0.83	2
1982	382	7.3	6.7	8.0	8.6	3.5	4.9	0.8	0.88	96	16	7.9	7.5	8.6	8.6	4.1	5.2	0.7	0.83	4
1983	394	7.4	6.8	8.3	9.0	3.5	5.0	0.8	0.84	98	7	8.7	7.5	9.4	9.4	5.6	7.1	1.4	0.83	2
1984	483	7.9	7.2	8.7	9.7	4.3	5.8	0.9	0.87	97	14	9.2	8.6	10.1	10.1	6.5	8.3	1.2	0.84	3
1985	313	6.4	5.9	7.1	8.0	2.2	3.0	0.5	0.83	100										
1986	211	8.3	7.3	9.6	9.8	4.7	7.3	1.2	0.81	98	5	10.8	9.4	11.7	11.7	10.5	13.4	2.5	0.81	2
1987	518	7.7	6.9	8.6	9.5	4.2	6.0	1.0	0.91	92	48	8.6	7.8	9.9	10.2	5.9	8.9	1.4	0.92	8
1988	1,135	7.3	6.5	8.1	9.9	3.5	4.8	0.8	0.89	99	15	8.0	7.5	8.9	8.9	4.6	6.0	0.7	0.89	1
1989	1,099	7.5	6.9	8.3	9.1	3.8	5.1	0.7	0.89	98	27	9.6	8.6	10.8	11.1	7.7	10.8	2.0	0.84	2
1990	581	7.7	7.0	8.6	9.2	4.2	5.7	0.9	0.90	95	28	8.4	7.6	9.3	9.8	5.3	6.9	1.1	0.89	5
1991	969	7.2	6.5	8.1	9.0	3.4	4.7	0.8	0.88	90	106	8.8	8.0	9.9	10.6	6.0	8.4	1.3	0.87	10
1992	412	8.2	7.4	9.2	9.9	4.8	6.8	1.1	0.86	95	21	9.3	8.7	10.1	10.2	6.6	7.6	1.0	0.81	5
1993	909	7.6	6.5	8.6	9.8	3.9	5.6	1.1	0.88	98	14	8.8	8.0	9.3	9.3	5.9	7.2	1.0	0.85	2
1994	989	7.8	6.6	9.0	10.8	4.4	6.3	1.3	0.88	97	34	8.9	8.0	10.1	11.2	6.4	9.2	1.8	0.89	3
1995	1,005	7.2	6.2	8.5	9.9	3.3	5.3	1.1	0.85	97	30	7.8	7.3	9.3	9.8	4.1	6.5	1.1	0.87	3
1996	1,293	7.4	6.3	8.5	9.3	3.7	5.5	1.1	0.88	96	52	8.7	8.0	9.6	10.5	5.9	7.8	1.3	0.88	4
1997	850	7.7	6.7	8.9	10.2	4.0	5.9	1.1	0.84	98	21	9.1	8.2	11.2	11.8	6.4	10.5	2.1	0.84	2
1998	814	6.7	5.8	7.7	8.7	2.9	4.4	0.9	0.96	100	1	8.8	8.8	8.8	8.8	6.6	6.6		0.97	0
1999	988	7.2	6.5	8.3	9.5	3.3	4.8	0.9	0.84	95	54	8.4	7.4	10.0	10.8	5.1	8.7	1.6	0.84	5
2000	320	7.3	6.5	8.2	9.0	3.4	4.9	0.9	0.87	100	1	7.3	7.3	7.3	7.3	4.1	4.1		1.04	0
2001	537	6.5	5.7	7.5	8.3	2.4	3.6	0.7	0.84	99	6	8.0	7.4	8.8	8.8	4.3	5.4	0.7	0.84	1
2002	230	6.9	6.2	7.7	8.3	2.8	3.9	0.7	0.83	100	1	7.3	7.3	7.3	7.3	3.9	3.9		1.01	0
2003	10	7.4	6.5	8.7	8.7	3.5	6.4	1.5	0.84	100										
2006	83	7.9	7.2	8.6	9.1	4.5	6.0	1.0	0.91	95	4	8.5	8.0	9.1	9.1	6.4	7.7	0.9	1.05	5
2008	32	8.4	7.9	9.0	9.3	5.2	6.8	0.8	0.89	91	3	9.9	8.6	12.0	12.0	7.5	9.1	1.5	0.83	9
2009	90	8.3	7.7	9.0	9.4	5.0	6.3	0.8	0.88	87	14	9.3	8.6	11.8	11.8	7.4	14.1	2.1	0.92	13
2010	12	8.1	7.5	9.4	9.4	4.8	6.8	1.0	0.87	100										
2011	295	7.8	7.0	8.7	9.0	4.3	5.7	0.8	0.92	98	7	8.4	8.0	9.3	9.3	6.1	8.1	1.0	1.05	2
2012	24	7.2	6.5	8.2	8.2	2.9	3.8	0.6	0.76	100										
2013	10	8.7	8.3	9.5	9.5					59	7	10.7	10.0	11.2	11.2					41
All	17025	7.4	6.4	8.6	10.8	3.7	5.6	1.1	0.87	3E3	566	8.7	7.5	10.3	12.0	5.8	9.1	1.8	0.87	143

Table 1. Sproat Lake Sockeye annual smolt size statistics (standard fork length (cm), standard fresh weight (g)), by age.

Sproat Lk Sample Size by Week

The FREQ Procedure

Year

Year	Frequency	Cumulative Frequency
1977	5	5
1978	3	8
1979	7	15
1980	5	20
1981	6	26
1982	3	29
1983	5	34
1984	5	39
1985	3	42
1986	2	44
1987	8	52
1988	9	61
1989	9	70
1990	12	82
1991	8	90
1992	7	97
1993	10	107
1994	10	117
1995	9	126
1996	9	135
1997	8	143
1998	7	150
1999	7	157
2000	5	162
2001	4	166
2002	5	171
2003	1	172
2006	1	173
2008	1	174
2009	2	176
2010	2	178
2011	2	180
2012	1	181
2013	1	182

Table 2. Sproat Lake Sockeye annual smolt sampling frequency (dates per year).

Sproat Lk Smolt Abundance Density (Years 1977-2013)

Sample Dates (Day of Year, Weighted by #Fish)									
Min	Mean	Max	Std	P05	P10	Med	P90	P95	#Fish
90	122	164	14	101	104	121	142	146	17,371

Sproat Lk Smolt Abundance Density (Years 1977-2002)

Sample Dates (Day of Year, Weighted by #Fish)									
Min	Mean	Max	Std	P05	P10	Med	P90	P95	#Fish
90	122	164	14	101	104	121	142	146	16,779

Sproat Lk Smolt Abundance Density (Years Where #Dates >= 5)

Sample Dates (Day of Year, Weighted by #Fish)									
Min	Mean	Max	Std	P05	P10	Med	P90	P95	#Fish
90	122	164	14	100	104	121	142	145	14,432

Table 3. Sproat Lake Sockeye smolt "migration timing" statistics, including minimum, mean, maximum (Julian) day of year, standard deviation (days), and 5th, 10th, 50th (median), 90th and 95th percentiles, weighted by sample size. Top: all available years; all years where number of sample dates >= 3; bottom: all years where number of sample dates >= 5 dates. (Note: Mar 31st = 90; May 1st = 121; May 26th = 146; Jun 13th = 164)

Sproat Lk

	Age									
	1									
	N	Length (cm) AVG	Length (cm) P10	Length (cm) P95	Length (cm) MAX	Fresh Std Wt (g) AVG	Fresh Std Wt (g) P95	Fresh Std Wt (g) SD	K	Pct %
Year										
1977	226	6.9	6.3	7.8	8.6	2.7	3.7	0.6	0.78	88
1978	168	8.1	6.9	9.4	10.0	4.6	6.9	1.4	0.85	99
1979	526	7.0	6.3	8.0	8.9	2.8	4.1	0.7	0.80	82
1980	368	7.7	7.1	8.6	10.1	4.1	5.8	0.9	0.88	84
1981	397	8.1	7.2	9.2	10.0	4.4	6.4	1.1	0.83	71
1982	191	7.2	6.5	8.0	8.5	2.9	4.0	0.6	0.77	48
1983	359	7.4	6.8	8.3	9.0	3.5	5.0	0.8	0.84	90
1984	384	7.9	7.2	8.7	9.7	4.3	5.8	0.9	0.86	77
1985	313	6.4	5.9	7.1	8.0	2.2	3.0	0.5	0.83	100
1986	211	8.3	7.3	9.6	9.8	4.7	7.3	1.2	0.81	98
1987	518	7.7	6.9	8.6	9.5	4.2	6.0	1.0	0.91	92
1988	891	7.2	6.5	8.1	9.5	3.4	4.7	0.8	0.89	77
1989	958	7.5	6.9	8.2	9.1	3.7	4.9	0.7	0.89	85
1990	493	7.7	7.0	8.6	9.2	4.3	5.7	0.9	0.91	81
1991	823	7.2	6.5	8.1	9.0	3.4	4.6	0.8	0.88	77
1992	409	8.2	7.4	9.2	9.9	4.8	6.7	1.1	0.86	94
1993	821	7.7	6.7	8.6	9.8	4.0	5.6	1.0	0.88	89
1994	792	7.9	6.7	9.0	10.8	4.5	6.4	1.3	0.88	77
1995	737	7.3	6.4	8.5	9.9	3.5	5.4	1.1	0.86	71
1996	899	7.4	6.2	8.5	9.3	3.7	5.6	1.2	0.89	67
1997	596	7.7	6.7	8.9	10.2	3.9	5.9	1.2	0.85	68
1998	738	6.6	5.8	7.8	8.7	2.9	4.4	0.9	0.96	91
1999	888	7.3	6.5	8.4	9.5	3.3	4.9	0.9	0.83	85

(Continued)

Table 4. Statistics associated with best estimates of Sproat Lake Sockeye annual (ocean entry year) Age 1 mean smolt size (standard fork length (cm), standard fresh weight (g)), based on sampling effort between April 14th and May 22nd each year. Note: Values for 2004, 2005, 2007, 2013-2016 are estimated (Appendix VI).

	Age									
	1									
	N	Length (cm)				Fresh Std Wt (g)			K	Pct %
		AVG	P10	P95	MAX	AVG	P95	SD		
Year										
2000	300	7.3	6.5	8.2	9.0	3.4	4.9	0.9	0.87	93
2001	465	6.7	6.1	7.5	8.1	2.5	3.6	0.6	0.84	86
2002	155	6.8	6.2	7.6	7.9	2.7	3.8	0.6	0.85	67
2003	10	7.4	6.5	8.7	8.7	3.5	6.4	1.5	0.84	100
2004	1	7.5	7.5	7.5	7.5	4.2	4.2			
2005	1	7.8	7.8	7.8	7.8	4.6	4.6			
2006	83	7.9	7.2	8.6	9.1	4.5	6.0	1.0	0.91	95
2007	1	7.5	7.5	7.5	7.5	4.2	4.2			
2008	32	8.4	7.9	9.0	9.3	5.2	6.8	0.8	0.89	91
2009	90	8.3	7.7	9.0	9.4	5.0	6.3	0.8	0.88	87
2010	12	8.1	7.5	9.4	9.4	4.8	6.8	1.0	0.87	100
2011	295	7.8	7.0	8.7	9.0	4.3	5.7	0.8	0.92	98
2012	24	7.2	6.5	8.2	8.2	2.9	3.8	0.6	0.76	100
2013	1	7.4				3.9				
2014	1	7.7				4.4				
2015	1	7.7				4.5				
2016	1	7.7				4.4				
All	14179	7.4	6.4	8.7	10.8	3.7	5.7	1.1	0.87	3E3

Table 4, continued. Statistics associated with best estimates of Sproat Lake Sockeye annual (ocean entry year) Age 1 mean smolt size (standard fork length (cm), standard fresh weight (g)), based on sampling effort between April 14th and May 22nd each year. Note: Values for 2004, 2005, 2007, 2013-2016 are estimated (Appendix VI).

	Age									
	2									
		Length (cm)				Fresh Std Wt (g)				
	N	AVG	P10	P95	MAX	AVG	P95	SD	K	Pct %
Year										
1977	13	7.0	6.4	7.7	7.7	2.7	3.5	0.5	0.78	5
1978	2	8.8	8.5	9.0	9.0	5.5	5.8	0.4	0.81	1
1979	1	7.2	7.2	7.2	7.2	3.2	3.2		0.86	0
1980		8.7				6.4				
1981	14	9.3	8.3	11.6	11.6	7.1	14.1	2.7	0.83	2
1982	16	7.9	7.5	8.6	8.6	4.1	5.2	0.7	0.83	4
1983	7	8.7	7.5	9.4	9.4	5.6	7.1	1.4	0.83	2
1984	14	9.2	8.6	10.1	10.1	6.5	8.3	1.2	0.84	3
1985		7.1				3.5				
1986	5	10.8	9.4	11.7	11.7	10.5	13.4	2.5	0.81	2
1987	48	8.6	7.8	9.9	10.2	5.9	8.9	1.4	0.92	8
1988	15	8.0	7.5	8.9	8.9	4.6	6.0	0.7	0.89	1
1989	27	9.6	8.6	10.8	11.1	7.7	10.8	2.0	0.84	2
1990	28	8.4	7.6	9.3	9.8	5.3	6.9	1.1	0.89	5
1991	106	8.8	8.0	9.9	10.6	6.0	8.4	1.3	0.87	10
1992	21	9.3	8.7	10.1	10.2	6.6	7.6	1.0	0.81	5
1993	14	8.8	8.0	9.3	9.3	5.9	7.2	1.0	0.85	2
1994	34	8.9	8.0	10.1	11.2	6.4	9.2	1.8	0.89	3
1995	30	7.8	7.3	9.3	9.8	4.1	6.5	1.1	0.87	3
1996	52	8.7	8.0	9.6	10.5	5.9	7.8	1.3	0.88	4
1997	21	9.1	8.2	11.2	11.8	6.4	10.5	2.1	0.84	2
1998	1	8.8	8.8	8.8	8.8	6.6	6.6		0.97	0
1999	54	8.4	7.4	10.0	10.8	5.1	8.7	1.6	0.84	5
2000	1	7.3	7.3	7.3	7.3	4.1	4.1		1.04	0
2001	6	8.0	7.4	8.8	8.8	4.3	5.4	0.7	0.84	1
2002	1	7.3	7.3	7.3	7.3	3.9	3.9		1.01	0
2003		8.3				5.6				
2004		8.5				6.0				
2005		8.8				6.6				
2006	4	8.5	8.0	9.1	9.1	6.4	7.7	0.9	1.05	5
2007		7.5				4.1				
2008	3	9.9	8.6	12.0	12.0	7.5	9.1	1.5	0.83	9
2009	14	9.3	8.6	11.8	11.8	7.4	14.1	2.1	0.92	13
2010		8.3				5.6				
2011	7	8.4	8.0	9.3	9.3	6.1	8.1	1.0	1.05	2

(Continued)

Table 5. Statistics associated with best estimates of Sproat Lake Sockeye annual (ocean entry year) Age 2 mean smolt size (standard fork length (cm), standard fresh weight (g)), based on sampling effort between April 14th and May 22nd each year. Note: Values for 1980, 1985, 2003-2005, 2007, 2010, 2013-2016 are estimated (Appendix VI).

	Age									
	2									
	N	Length (cm)				Fresh Std Wt (g)			K	Pct %
		AVG	P10	P95	MAX	AVG	P95	SD		
Year										
2012		8.1				5.2				
2013	8	10.3	8.1	11.2	11.2	9.8	9.8			41
2014		8.7				6.4				
2015		8.7				6.4				
2016		8.7				6.3				
All	578	8.7	7.5	10.3	12.0	5.8	9.1	1.8	0.87	143

APPENDIX I – Size Statistics by Sample Date

Appendix I. Annual Sockeye smolt size statistics by stock (lake), age class, and sample date.

		Age																	
		1									2								
			Length (cm)			Fresh Std Wt (g)						Length (cm)			Fresh Std Wt (g)				
		N	AVG	MAX	SE	AVG	MAX	SE	K	%	N	AVG	MAX	SE	AVG	MAX	SE	K	%
Year	Date																		
1977	05MAY77	10	6.7	7.8	0.16	2.5	3.9	0.21	0.80	4									
	06MAY77	79	6.9	8.2	0.07	2.6	4.4	0.08	0.78	31	8	6.9	7.7	0.15	2.6	3.5	0.17	0.79	3
	11MAY77	137	7.0	8.6	0.04	2.7	5.1	0.05	0.78	54	4	7.0	7.3	0.26	2.6	3.0	0.28	0.77	2
	25MAY77	7	7.2	7.6	0.26	2.9	3.7	0.28	0.78	3	1	7.2	7.2		3.0	3.0		0.81	0
	26MAY77	10	7.1	7.7	0.14	2.9	3.9	0.20	0.80	4									
	ALL	243	7.0	8.6	0.03	2.7	5.1	0.04	0.78	95	13	7.0	7.7	0.12	2.7	3.5	0.13	0.78	5
1978	Date																		
	25APR78	97	7.9	9.6	0.08	4.3	7.7	0.13	0.87	57	2	8.8	9.0	0.25	5.5	5.8	0.30	0.81	1
	10MAY78	16	7.8	9.1	0.22	4.0	6.2	0.34	0.80	9									
	17MAY78	55	8.5	10.0	0.10	5.3	8.9	0.18	0.84	32									
	ALL	168	8.1	10.0	0.06	4.6	8.9	0.11	0.85	99	2	8.8	9.0	0.25	5.5	5.8	0.30	0.81	1
1979	18APR79	107	7.0	8.2	0.05	2.6	4.1	0.06	0.74	17									
	25APR79	115	7.1	8.7	0.06	2.8	4.9	0.07	0.76	18									
	01MAY79	100	7.0	8.6	0.06	2.8	5.4	0.08	0.79	16									
	09MAY79	100	7.1	8.9	0.06	3.2	5.6	0.08	0.87	16									
	15MAY79	104	6.9	8.1	0.04	2.8	4.3	0.06	0.85	16									
	23MAY79	105	7.1	8.4	0.05	3.2	5.0	0.07	0.86	16	1	7.2	7.2		3.2	3.2		0.86	0
	30MAY79	7	6.7	7.5	0.17	2.7	3.8	0.23	0.86	1									
	ALL	638	7.0	8.9	0.02	2.9	5.6	0.03	0.81	100	1	7.2	7.2		3.2	3.2		0.86	0
1980	Date																		
	21APR80	108	7.6	8.9	0.05	3.8	6.3	0.08	0.85	25									
	28APR80	85	7.9	9.2	0.06	4.5	7.6	0.10	0.89	19									
1980	05MAY80	100	7.7	10.1	0.06	4.2	9.2	0.10	0.89	23									
	15MAY80	75	7.7	9.0	0.07	4.3	6.6	0.11	0.92	17									
	26MAY80	71	7.8	9.5	0.07	4.2	7.1	0.12	0.85	16									
	ALL	439	7.7	10.1	0.03	4.1	9.2	0.05	0.88	100									
1981	Date																		
	28APR81	138	8.1	9.5	0.06	4.5	7.2	0.09	0.84	25	2	8.9	9.6	0.70	6.3	7.9	1.67	0.87	0
	05MAY81	54	7.9	9.5	0.08	4.2	7.6	0.14	0.86	10	4	9.0	9.2	0.19	6.0	6.6	0.34	0.84	1
	11MAY81	144	8.1	10.0	0.05	4.1	8.1	0.09	0.78	26	4	9.2	10.4	0.44	5.8	8.6	0.98	0.74	1
	19MAY81	61	8.2	9.2	0.07	5.0	7.3	0.12	0.91	11	1	10.3	10.3		9.5	9.5		0.87	0
	25MAY81	98	8.3	9.4	0.05	5.3	7.3	0.09	0.92	17	2	10.9	11.6	0.75	11.9	14.1	2.25	0.92	0
	02JUN81	54	8.1	9.1	0.06	4.8	6.5	0.09	0.89	10	1	8.5	8.5		5.6	5.6		0.91	0

(Continued)

		Age																	
		1									2								
			Length (cm)			Fresh Std Wt (g)						Length (cm)			Fresh Std Wt (g)				
		N	AVG	MAX	SE	AVG	MAX	SE	K	%	N	AVG	MAX	SE	AVG	MAX	SE	K	%
Year	ALL																		
1981		549	8.1	10.0	0.03	4.6	8.1	0.05	0.85	98	14	9.3	11.6	0.26	7.1	14.1	0.72	0.83	2
1982	Date																		
	30APR82	94	7.3	8.5	0.05	3.1	4.8	0.06	0.79	24	6	8.0	8.6	0.20	3.9	4.7	0.21	0.76	2
	13MAY82	97	7.1	8.5	0.06	2.8	4.7	0.07	0.76	24	3	7.6	8.0	0.26	3.3	3.6	0.20	0.75	1
	26MAY82	191	7.4	8.6	0.03	4.0	6.4	0.05	0.99	48	7	8.0	8.3	0.10	4.7	5.2	0.16	0.92	2
	ALL	382	7.3	8.6	0.03	3.5	6.4	0.04	0.88	96	16	7.9	8.6	0.10	4.1	5.2	0.17	0.83	4
1983	Date																		
	19APR83	95	7.5	8.8	0.06	3.6	5.5	0.09	0.83	24	5	8.5	9.4	0.33	5.2	7.1	0.69	0.82	1
	26APR83	99	7.3	8.5	0.05	3.2	5.1	0.06	0.81	25									
	10MAY83	99	7.5	9.0	0.06	3.7	5.6	0.09	0.87	25	1	9.2	9.2		6.6	6.6		0.85	0
	17MAY83	66	7.3	8.4	0.05	3.4	4.9	0.07	0.85	16	1	9.2	9.2		6.6	6.6		0.85	0
1983	25MAY83	35	7.4	8.3	0.07	3.6	5.1	0.09	0.87	9									
	ALL	394	7.4	9.0	0.03	3.5	5.6	0.04	0.84	98	7	8.7	9.4	0.26	5.6	7.1	0.54	0.83	2
1984	Date																		
	16APR84	91	8.0	9.0	0.05	4.3	6.3	0.09	0.84	18	9	9.3	10.1	0.20	6.6	8.3	0.44	0.81	2
	25APR84	98	7.9	9.1	0.05	4.3	6.8	0.09	0.84	20	2	8.7	8.8	0.10	5.8	6.0	0.18	0.89	0
	07MAY84	97	7.9	9.7	0.05	4.3	7.2	0.09	0.87	20	2	9.4	9.5	0.15	7.1	7.8	0.65	0.87	0
	16MAY84	98	8.0	9.2	0.06	4.5	6.9	0.10	0.88	20									
	28MAY84	99	7.7	9.1	0.06	4.1	6.6	0.09	0.89	20	1	8.7	8.7		5.7	5.7		0.87	0
	ALL	483	7.9	9.7	0.02	4.3	7.2	0.04	0.87	97	14	9.2	10.1	0.14	6.5	8.3	0.31	0.84	3
1985	Date																		
	24APR85	152	6.5	8.0	0.04	2.3	5.0	0.04	0.83	49									
1985	01MAY85	13	6.3	7.2	0.11	2.2	3.2	0.12	0.85	4									
	15MAY85	148	6.3	7.3	0.03	2.1	3.2	0.03	0.83	47									
	ALL	313	6.4	8.0	0.02	2.2	5.0	0.03	0.83	100									
1986	Date																		
	05MAY86	112	8.1	9.8	0.07	4.4	7.8	0.12	0.80	52	1	10.8	10.8		9.6	9.6		0.76	0
	13MAY86	99	8.5	9.8	0.06	5.1	8.1	0.11	0.83	46	4	10.9	11.7	0.50	10.7	13.4	1.42	0.82	2
	ALL	211	8.3	9.8	0.05	4.7	8.1	0.09	0.81	98	5	10.8	11.7	0.39	10.5	13.4	1.13	0.81	2
1987	Date																		
	14APR87	23	7.9	8.9	0.12	4.6	6.5	0.21	0.92	4	6	9.4	10.2	0.34	7.7	9.5	0.67	0.93	1
	21APR87	180	7.5	8.9	0.04	3.9	6.3	0.07	0.90	32	11	8.8	9.7	0.19	6.1	7.9	0.32	0.89	2
	29APR87	101	7.7	9.0	0.06	4.3	6.6	0.11	0.92	18	18	8.5	9.8	0.12	5.7	8.9	0.27	0.93	3

(Continued)

		Age																	
		1									2								
			Length (cm)			Fresh Std Wt (g)						Length (cm)			Fresh Std Wt (g)				
		N	AVG	MAX	SE	AVG	MAX	SE	K	%	N	AVG	MAX	SE	AVG	MAX	SE	K	%
Year	Date																		
1987	05MAY87	94	7.8	9.2	0.05	4.4	7.3	0.09	0.91	17	6	8.5	9.9	0.31	5.7	8.4	0.59	0.91	1
	12MAY87	96	7.9	9.5	0.05	4.4	7.5	0.09	0.90	17	2	8.4	8.8	0.45	5.3	6.1	0.77	0.91	0
	20MAY87	24	8.0	9.1	0.14	4.9	6.8	0.24	0.94	4	3	7.9	8.1	0.10	4.8	5.0	0.11	0.98	1
	28MAY87										1	7.9	7.9		4.2	4.2		0.86	0
	04JUN87										1	7.8	7.8		4.6	4.6		0.97	0
	ALL	518	7.7	9.5	0.03	4.2	7.5	0.04	0.91	92	48	8.6	10.2	0.10	5.9	9.5	0.20	0.92	8
1988	Date																		
	05APR88	4	8.9	9.9	0.52	6.5	8.3	0.95	0.91	0									
	13APR88	185	7.4	9.9	0.05	3.5	7.7	0.07	0.85	16	15	8.0	8.9	0.11	4.6	6.0	0.17	0.89	1
	20APR88	200	7.0	9.5	0.04	3.1	7.5	0.05	0.88	17									
	28APR88	200	7.5	8.9	0.03	3.6	5.8	0.05	0.86	17									
1988	04MAY88	200	7.1	8.5	0.04	3.3	5.5	0.05	0.88	17									
	11MAY88	123	6.9	8.0	0.04	3.0	4.8	0.06	0.89	11									
	18MAY88	168	7.5	8.5	0.03	4.1	5.5	0.05	0.94	15									
	25MAY88	47	7.3	8.2	0.08	3.7	5.0	0.11	0.94	4									
	02JUN88	8	7.5	8.2	0.15	4.2	5.4	0.26	1.01	1									
	ALL	1,135	7.3	9.9	0.02	3.5	8.3	0.02	0.89	99	15	8.0	8.9	0.11	4.6	6.0	0.17	0.89	1
1989	Date																		
	06APR89	20	8.0	8.6	0.10	4.5	5.6	0.16	0.87	2	14	9.8	10.8	0.19	8.1	10.8	0.49	0.85	1
	13APR89	102	7.9	8.8	0.05	4.3	6.1	0.08	0.87	9	8	10.0	11.1	0.26	8.3	11.4	0.66	0.83	1
	19APR89	69	7.8	9.0	0.06	4.2	6.6	0.10	0.90	6	5	8.6	9.3	0.34	5.6	7.1	0.60	0.86	0
	27APR89	288	7.4	8.6	0.03	3.6	5.5	0.04	0.90	26									
1989	03MAY89	223	7.7	9.0	0.03	4.0	5.9	0.05	0.88	20									
	10MAY89	199	7.4	9.1	0.02	3.6	6.1	0.03	0.88	18									
	17MAY89	179	7.3	8.4	0.03	3.5	5.3	0.04	0.90	16									
	25MAY89	13	7.1	8.1	0.12	3.4	4.7	0.17	0.92	1									
	01JUN89	6	7.7	8.3	0.24	4.4	5.6	0.40	0.97	1									
	ALL	1,099	7.5	9.1	0.01	3.8	6.6	0.02	0.89	98	27	9.6	11.1	0.17	7.7	11.4	0.38	0.84	2
1990	Date																		
	04APR90	4	7.0	7.5	0.26	3.5	4.3	0.41	0.98	1									
	10APR90	58	7.5	9.0	0.07	3.6	6.7	0.12	0.84	10	11	8.7	9.3	0.15	5.6	6.9	0.23	0.85	2
	18APR90	129	7.6	9.0	0.05	3.9	6.7	0.07	0.89	21	7	8.3	9.8	0.32	5.3	9.1	0.71	0.89	1
	25APR90	159	7.8	8.9	0.04	4.3	6.2	0.06	0.89	26	5	8.2	8.5	0.16	4.9	5.4	0.28	0.89	1

(Continued)

		Age																	
		1									2								
			Length (cm)			Fresh Std Wt (g)						Length (cm)			Fresh Std Wt (g)				
		N	AVG	MAX	SE	AVG	MAX	SE	K	%	N	AVG	MAX	SE	AVG	MAX	SE	K	%
Year	Date																		
1990	02MAY90	15	7.5	8.6	0.14	4.0	5.8	0.21	0.95	2									
	03MAY90	5	7.4	7.9	0.18	3.9	4.5	0.23	0.95	1									
	10MAY90	140	7.8	9.2	0.05	4.4	6.8	0.08	0.93	23	5	8.1	8.5	0.12	5.1	6.2	0.27	0.96	1
	16MAY90	45	7.9	9.0	0.08	4.6	6.9	0.13	0.93	7									
	24MAY90	13	7.8	9.1	0.18	4.8	7.4	0.34	1.00	2									
	31MAY90	9	7.8	8.6	0.17	4.8	6.3	0.32	0.99	1									
	06JUN90	1	7.4	7.4		4.1	4.1		1.02	0									
	13JUN90	3	8.0	8.5	0.32	5.1	6.2	0.70	0.98	0									
	ALL	581	7.7	9.2	0.02	4.2	7.4	0.04	0.90	95	28	8.4	9.8	0.11	5.3	9.1	0.20	0.89	5
1991	Date																		
	10APR91	120	7.3	8.8	0.05	3.7	6.5	0.08	0.92	11	80	8.8	10.6	0.07	6.1	10.0	0.14	0.88	7
1991	17APR91	94	7.0	8.5	0.06	3.2	5.3	0.08	0.93	9	12	8.7	10.2	0.23	5.7	9.0	0.48	0.83	1
	24APR91	159	7.1	8.4	0.05	3.1	5.2	0.06	0.85	15	7	9.1	10.2	0.24	6.0	8.4	0.57	0.77	1
	01MAY91	199	6.8	8.1	0.04	3.0	5.0	0.05	0.92	19	1	9.3	9.3		6.7	6.7		0.83	0
	08MAY91	194	7.5	8.5	0.03	3.7	5.5	0.04	0.88	18	6	8.8	10.6	0.39	6.0	10.0	0.87	0.85	1
	15MAY91	170	7.6	9.0	0.04	3.7	6.2	0.06	0.84	16									
	22MAY91	7	7.3	7.7	0.10	3.4	3.9	0.14	0.87	1									
	29MAY91	26	7.5	8.4	0.07	3.6	5.0	0.10	0.85	2									
	ALL	969	7.2	9.0	0.02	3.4	6.5	0.03	0.88	90	106	8.8	10.6	0.06	6.0	10.0	0.13	0.87	10
1992	Date																		
	01APR92										3	9.8	10.2	0.23	7.4	7.6	0.14	0.78	1
	07APR92	3	8.4	9.0	0.33	5.2	6.8	0.81	0.87	1	1	9.2	9.2		7.1	7.1		0.92	0
1992	14APR92	5	8.2	8.9	0.29	4.9	6.2	0.52	0.88	1	2	9.1	9.6	0.50	6.6	7.4	0.85	0.87	0
	21APR92	144	8.2	9.5	0.05	4.8	7.7	0.09	0.85	33	8	9.2	9.9	0.15	6.6	8.1	0.32	0.84	2
	28APR92	169	8.2	9.7	0.04	4.9	7.4	0.08	0.87	39	5	9.2	10.0	0.26	6.0	7.3	0.62	0.78	1
	05MAY92	84	8.3	9.9	0.07	4.8	7.4	0.12	0.83	19	2	9.4	10.1	0.70	6.4	7.2	0.86	0.77	0
	12MAY92	7	7.7	8.6	0.30	4.1	5.8	0.48	0.85	2									
	ALL	412	8.2	9.9	0.03	4.8	7.7	0.05	0.86	95	21	9.3	10.2	0.11	6.6	8.1	0.22	0.81	5
1993	Date																		
	06APR93	2	7.9	8.0	0.15	4.3	4.5	0.22	0.89	0									
	14APR93	135	7.7	9.8	0.04	4.3	8.1	0.07	0.91	15	6	8.8	9.3	0.20	5.8	7.0	0.52	0.84	1
	21APR93	195	8.0	9.1	0.03	4.3	7.2	0.06	0.85	21	5	9.1	9.3	0.09	6.2	7.2	0.32	0.81	1
	28APR93	198	7.9	9.1	0.04	4.5	6.6	0.06	0.89	21	2	8.6	9.0	0.40	5.9	7.0	1.13	0.92	0

(Continued)

		Age																	
		1									2								
			Length (cm)			Fresh Std Wt (g)						Length (cm)			Fresh Std Wt (g)				
		N	AVG	MAX	SE	AVG	MAX	SE	K	%	N	AVG	MAX	SE	AVG	MAX	SE	K	%
Year	Date																		
1993	05MAY93	106	7.6	8.7	0.06	4.0	5.7	0.09	0.89	11	1	8.0	8.0		5.0	5.0		0.98	0
	12MAY93	162	7.1	8.6	0.06	3.2	6.1	0.08	0.87	18									
	19MAY93	25	6.9	8.1	0.13	2.9	4.9	0.18	0.88	3									
	27MAY93	72	6.5	8.4	0.07	2.5	6.2	0.11	0.89	8									
	02JUN93	11	7.2	7.9	0.17	3.6	5.1	0.31	0.96	1									
	08JUN93	3	7.7	8.5	0.56	4.5	6.3	1.26	0.94	0									
	ALL	909	7.6	9.8	0.02	3.9	8.1	0.04	0.88	98	14	8.8	9.3	0.13	5.9	7.2	0.28	0.85	2
1994	Date																		
	01APR94	93	7.6	9.3	0.07	3.9	6.4	0.11	0.86	9	6	8.8	10.1	0.29	5.9	9.2	0.68	0.84	1
	07APR94	85	7.6	9.0	0.08	3.9	6.6	0.12	0.87	8	4	8.9	9.5	0.28	6.3	7.7	0.74	0.89	0
	14APR94	186	7.9	10.8	0.06	4.5	11.0	0.10	0.88	18	14	8.6	10.0	0.21	5.9	8.9	0.44	0.89	1
1994	20APR94	67	7.4	9.1	0.10	3.9	7.2	0.16	0.91	7	5	9.1	9.6	0.27	7.0	7.9	0.50	0.91	0
	27APR94	197	8.3	9.6	0.04	4.9	7.3	0.07	0.86	19	3	10.0	11.2	0.69	9.1	12.3	1.82	0.88	0
	05MAY94	198	8.0	9.4	0.05	4.7	7.9	0.08	0.91	19	2	8.5	8.8	0.30	5.8	6.4	0.58	0.95	0
	12MAY94	132	7.7	9.4	0.07	4.1	7.5	0.12	0.87	13									
	18MAY94	12	6.8	8.4	0.22	2.9	5.5	0.33	0.87	1									
	26MAY94	14	7.3	9.0	0.25	3.5	6.4	0.37	0.88	1									
	02JUN94	5	6.0	6.3	0.10	1.8	2.3	0.12	0.83	0									
	ALL	989	7.8	10.8	0.03	4.4	11.0	0.04	0.88	97	34	8.9	11.2	0.14	6.4	12.3	0.31	0.89	3
1995	Date																		
	05APR95	31	7.7	9.2	0.16	4.0	7.0	0.23	0.82	3	2	8.1	8.2	0.15	4.4	4.8	0.39	0.84	0
	12APR95	17	7.8	8.6	0.16	4.2	5.7	0.23	0.86	2	3	8.3	9.8	0.77	5.1	8.1	1.49	0.86	0
1995	19APR95	181	8.0	9.9	0.04	4.5	8.0	0.07	0.87	17	19	7.6	9.3	0.13	3.9	6.5	0.21	0.87	2
	27APR95	194	7.2	8.8	0.04	3.2	6.1	0.06	0.85	19	6	7.8	8.8	0.23	4.2	6.2	0.40	0.89	1
	04MAY95	214	7.0	8.8	0.05	3.0	6.3	0.07	0.83	21									
	10MAY95	33	6.8	8.1	0.12	2.7	5.0	0.18	0.82	3									
	18MAY95	115	7.4	8.5	0.05	3.7	6.1	0.08	0.91	11									
	25MAY95	200	6.7	8.5	0.04	2.6	5.4	0.06	0.84	19									
	01JUN95	20	6.2	6.7	0.07	2.0	2.6	0.07	0.83	2									
	ALL	1,005	7.2	9.9	0.02	3.3	8.0	0.04	0.85	97	30	7.8	9.8	0.12	4.1	8.1	0.21	0.87	3
1996	Date																		
	02APR96	1	5.0	5.0		1.1	1.1		0.85	0									
	11APR96	152	7.5	9.1	0.05	3.9	6.3	0.08	0.89	11	29	8.7	10.5	0.13	5.9	10.0	0.27	0.89	2

(Continued)

		Age																	
		1									2								
			Length (cm)			Fresh Std Wt (g)						Length (cm)			Fresh Std Wt (g)				
		N	AVG	MAX	SE	AVG	MAX	SE	K	%	N	AVG	MAX	SE	AVG	MAX	SE	K	%
Year	Date																		
1996	18APR96	187	7.9	9.3	0.04	4.5	7.0	0.06	0.92	14	13	8.9	9.6	0.13	6.4	7.3	0.24	0.90	1
	25APR96	124	7.5	8.8	0.06	4.0	6.4	0.09	0.91	9	1	8.3	8.3		4.8	4.8		0.83	0
	30APR96	195	7.8	9.0	0.04	4.2	6.9	0.07	0.89	14	5	8.8	9.1	0.14	6.0	7.0	0.40	0.88	0
	09MAY96	179	7.0	9.0	0.05	3.2	7.3	0.07	0.92	13	1	8.4	8.4		4.9	4.9		0.83	0
	16MAY96	214	6.8	8.9	0.05	2.8	6.5	0.08	0.84	16	3	8.2	8.4	0.09	4.0	4.1	0.04	0.72	0
	23MAY96	200	7.3	9.0	0.05	3.4	5.8	0.07	0.85	15									
	30MAY96	41	6.9	8.1	0.08	2.9	4.9	0.12	0.86	3									
	ALL	1,293	7.4	9.3	0.02	3.7	7.3	0.03	0.88	96	52	8.7	10.5	0.08	5.9	10.0	0.18	0.88	4
1997	Date																		
	10APR97	254	7.8	9.6	0.04	4.1	8.4	0.06	0.84	29	6	9.6	11.8	0.50	7.4	13.1	1.20	0.80	1
	15APR97	53	7.9	8.8	0.07	4.2	6.2	0.12	0.85	6	7	8.7	9.8	0.24	5.8	8.4	0.55	0.85	1
1997	17APR97	10	7.8	9.5	0.30	4.3	7.2	0.52	0.88	1									
	24APR97	198	8.1	10.2	0.04	4.4	8.7	0.07	0.81	23	2	8.6	8.7	0.10	5.4	5.5	0.07	0.85	0
	01MAY97	136	7.2	9.0	0.06	3.3	6.3	0.08	0.86	16	2	8.5	9.0	0.50	5.4	6.0	0.65	0.88	0
	08MAY97	58	7.4	9.6	0.11	3.6	8.9	0.20	0.84	7	1	9.2	9.2		6.9	6.9		0.89	0
	16MAY97	18	7.1	8.4	0.20	3.5	5.7	0.28	0.92	2									
	22MAY97	123	7.6	9.6	0.06	3.9	7.6	0.11	0.88	14	3	9.3	11.2	0.94	7.0	10.5	1.73	0.84	0
	ALL	850	7.7	10.2	0.03	4.0	8.9	0.04	0.84	98	21	9.1	11.8	0.22	6.4	13.1	0.46	0.84	2
1998	Date																		
	16APR98	157	6.9	8.3	0.05	3.1	5.6	0.07	0.93	19	1	8.8	8.8		6.6	6.6		0.97	0
	23APR98	44	6.9	8.7	0.12	3.2	6.4	0.18	0.93	5									
	30APR98	182	6.8	8.3	0.05	2.7	5.0	0.07	0.84	22									
1998	07MAY98	74	6.3	7.4	0.07	3.0	4.7	0.09	1.14	9									
	13MAY98	85	6.4	7.6	0.07	3.0	5.0	0.09	1.12	10									
	21MAY98	196	6.5	8.1	0.04	2.7	4.9	0.06	0.99	24									
	28MAY98	76	6.9	8.1	0.06	2.9	5.0	0.09	0.89	9									
	ALL	814	6.7	8.7	0.02	2.9	6.4	0.03	0.96	100	1	8.8	8.8		6.6	6.6		0.97	0
1999	Date																		
	14APR99	168	7.5	9.5	0.05	3.5	7.6	0.08	0.83	16	28	8.8	10.2	0.15	5.8	10.1	0.30	0.84	3
	22APR99	132	7.3	8.8	0.05	3.4	5.9	0.07	0.84	13	8	8.0	8.8	0.16	4.2	5.0	0.15	0.82	1
	28APR99	194	7.3	9.0	0.04	3.2	5.8	0.06	0.82	19	6	8.6	10.8	0.47	5.4	9.8	0.93	0.80	1
	05MAY99	186	7.1	9.3	0.04	3.1	6.9	0.06	0.84	18	4	8.2	8.7	0.21	4.4	5.3	0.41	0.80	0
	12MAY99	69	7.4	9.0	0.09	3.6	6.8	0.13	0.86	7	1	7.4	7.4		3.7	3.7		0.92	0

(Continued)

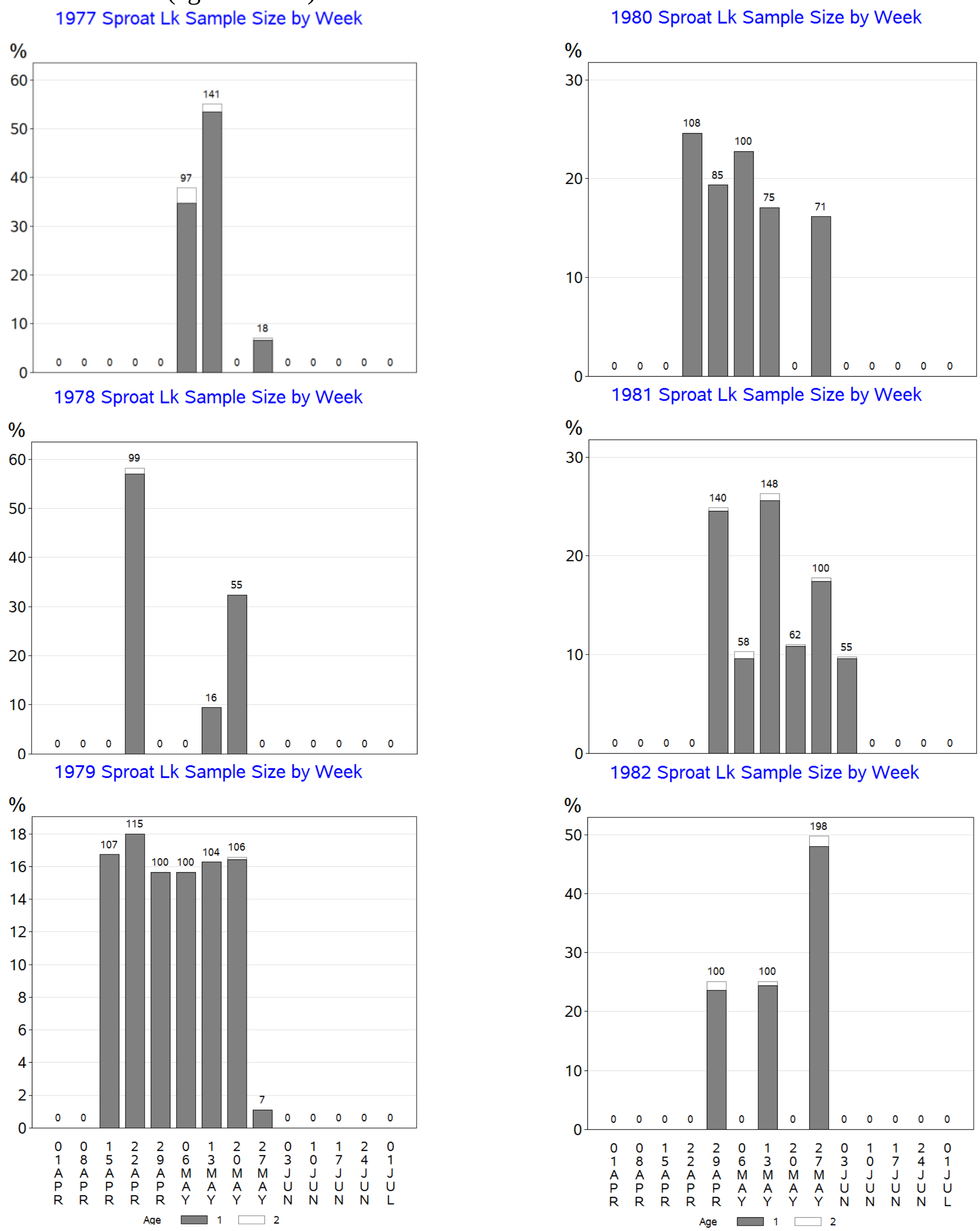
		Age																	
		1									2								
		N	Length (cm)			Fresh Std Wt (g)			K	%	N	Length (cm)			Fresh Std Wt (g)			K	%
			AVG	MAX	SE	AVG	MAX	SE				AVG	MAX	SE	AVG	MAX	SE		
Year	Date																		
1999	19MAY99	139	7.0	8.3	0.05	2.9	5.2	0.06	0.83	13	5	7.5	8.0	0.12	3.9	4.2	0.09	0.92	0
	26MAY99	100	7.1	8.3	0.05	3.2	5.0	0.08	0.88	10	2	7.4	7.5	0.05	3.9	3.9	0.04	0.94	0
	ALL	988	7.2	9.5	0.02	3.3	7.6	0.03	0.84	95	54	8.4	10.8	0.12	5.1	10.1	0.22	0.84	5
2000	Date																		
	27APR00	55	7.6	8.7	0.06	3.8	5.7	0.11	0.85	17									
	03MAY00	131	7.4	9.0	0.05	3.6	6.8	0.07	0.89	41	1	7.3	7.3		4.1	4.1		1.04	0
	10MAY00	100	7.0	8.3	0.06	3.0	5.0	0.08	0.86	31									
	18MAY00	14	7.0	7.9	0.13	3.1	4.8	0.20	0.90	4									
	31MAY00	20	6.9	7.9	0.10	2.9	4.7	0.14	0.87	6									
	ALL	320	7.3	9.0	0.03	3.4	6.8	0.05	0.87	100	1	7.3	7.3		4.1	4.1		1.04	0
2001	11APR01	72	5.6	8.3	0.06	1.5	5.1	0.07	0.81	13	2	8.8	8.8	0.00	5.3	5.4	0.11	0.77	0
	18APR01	200	6.2	7.2	0.02	2.0	2.3	0.01	0.83	37									
	26APR01	200	6.8	7.4	0.02	2.7	3.1	0.02	0.84	37									
	13MAY01	65	7.5	8.1	0.03	3.6	4.5	0.04	0.86	12	4	7.6	7.8	0.08	3.9	4.0	0.06	0.88	1
	ALL	537	6.5	8.3	0.03	2.4	5.1	0.03	0.84	99	6	8.0	8.8	0.26	4.3	5.4	0.30	0.84	1
2002	Date																		
	02MAY02	112	6.9	7.7	0.04	2.8	4.1	0.05	0.87	48	1	7.3	7.3		3.9	3.9		1.01	0
	07MAY02	38	6.6	7.9	0.09	2.4	4.2	0.10	0.80	16									
	14MAY02	5	6.8	7.8	0.27	2.5	4.3	0.45	0.76	2									
	23MAY02	22	7.2	8.3	0.11	3.1	5.2	0.18	0.81	10									
	30MAY02	53	7.0	8.2	0.07	2.8	4.3	0.09	0.79	23									
2002		230	6.9	8.3	0.03	2.8	5.2	0.04	0.83	100	1	7.3	7.3		3.9	3.9		1.01	0
2003	Date																		
	07MAY03	10	7.4	8.7	0.24	3.5	6.4	0.48	0.84	100									
	ALL	10	7.4	8.7	0.24	3.5	6.4	0.48	0.84	100									
2006	Date																		
	08MAY06	83	7.9	9.1	0.06	4.5	7.0	0.11	0.91	95	4	8.5	9.1	0.25	6.4	7.7	0.46	1.06	5
	ALL	83	7.9	9.1	0.06	4.5	7.0	0.11	0.91	95	4	8.5	9.1	0.25	6.4	7.7	0.46	1.06	5
2008	Date																		
	28APR08	32	8.4	9.3	0.08	5.2	7.0	0.14	0.89	91	3	9.9	12.0	1.07	7.5	9.1	0.85	0.83	9
	ALL	32	8.4	9.3	0.08	5.2	7.0	0.14	0.89	91	3	9.9	12.0	1.07	7.5	9.1	0.85	0.83	9

(Continued)

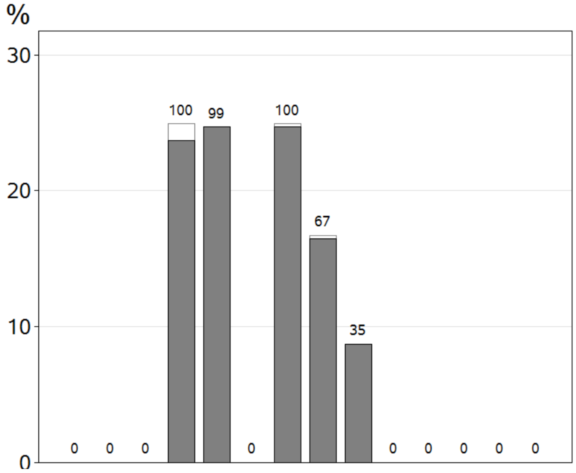
		Age																	
		1									2								
			Length (cm)			Fresh Std Wt (g)						Length (cm)			Fresh Std Wt (g)				
		N	AVG	MAX	SE	AVG	MAX	SE	K	%	N	AVG	MAX	SE	AVG	MAX	SE	K	%
Year	Date																		
2009	15APR09	79	8.3	9.4	0.05	5.1	6.7	0.08	0.88	76	13	9.1	9.7	0.12	6.9	8.8	0.25	0.92	13
	05MAY09	11	8.0	8.8	0.25	4.3	6.1	0.31	0.85	11	1	11.8	11.8		14.1	14.1		0.86	1
	ALL	90	8.3	9.4	0.05	5.0	6.7	0.09	0.88	87	14	9.3	11.8	0.23	7.4	14.1	0.56	0.92	13
2010	Date																		
	19APR10	2	7.9	8.3	0.40	4.7	5.2	0.52	0.94	17									
	05MAY10	10	8.2	9.4	0.20	4.8	6.8	0.34	0.86	83									
	ALL	12	8.1	9.4	0.17	4.8	6.8	0.29	0.87	100									
2011	Date																		
	28APR11	202	7.9	9.0	0.04	4.4	6.8	0.05	0.89	67	2	8.7	9.3	0.60	7.3	8.1	0.78	1.17	1
	08MAY11	93	7.5	9.0	0.06	4.1	6.2	0.09	0.98	31	5	8.2	8.5	0.10	5.6	6.1	0.15	1.01	2
	ALL	295	7.8	9.0	0.03	4.3	6.8	0.05	0.92	98	7	8.4	9.3	0.17	6.1	8.1	0.38	1.05	2
2012	23APR12	24	7.2	8.2	0.12	2.9	4.0	0.13	0.76	100									
	ALL	24	7.2	8.2	0.12	2.9	4.0	0.13	0.76	100									
2013	Date																		
	02APR13	10	8.7	9.5	0.12					59	7	10.7	11.2	0.18					41
	ALL	10	8.7	9.5	0.12					59	7	10.7	11.2	0.18					41

APPENDIX II – Seasonal Sample Size

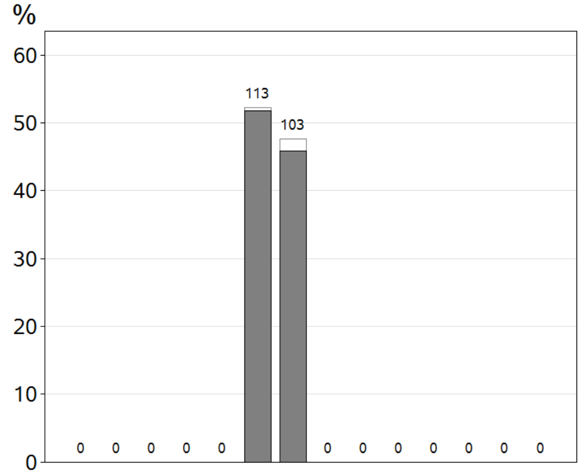
Appendix II. Smolt sample size (number of fish) and percent of total retained catch, by sample date (ages 1 and 2).



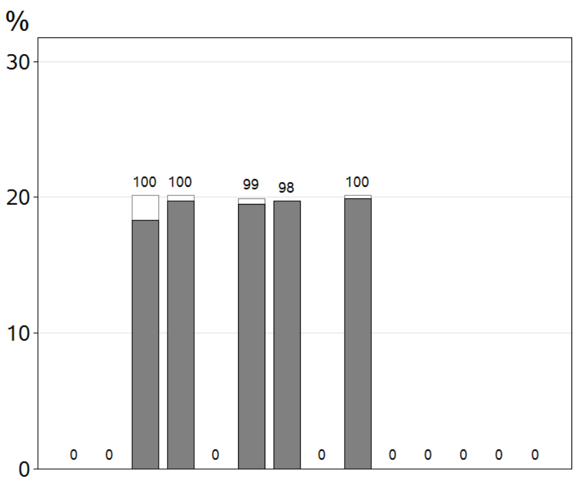
1983 Sproat Lk Sample Size by Week



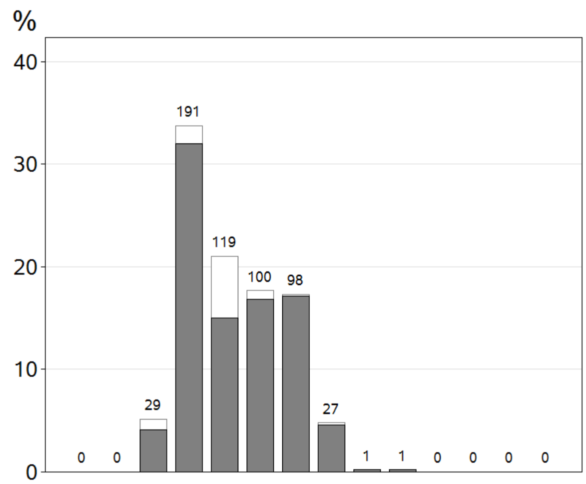
1986 Sproat Lk Sample Size by Week



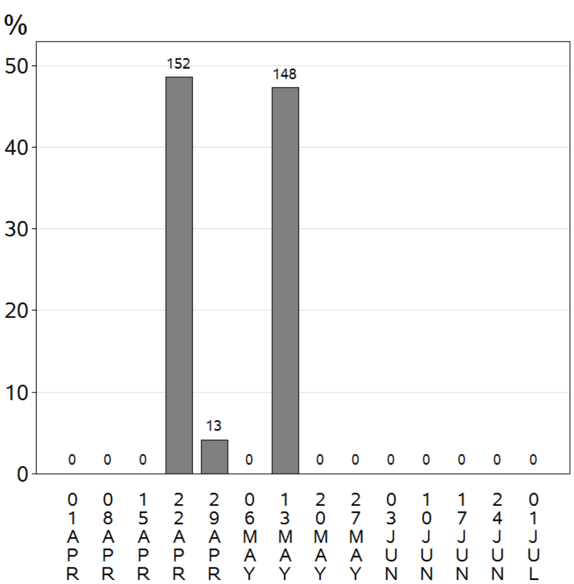
1984 Sproat Lk Sample Size by Week



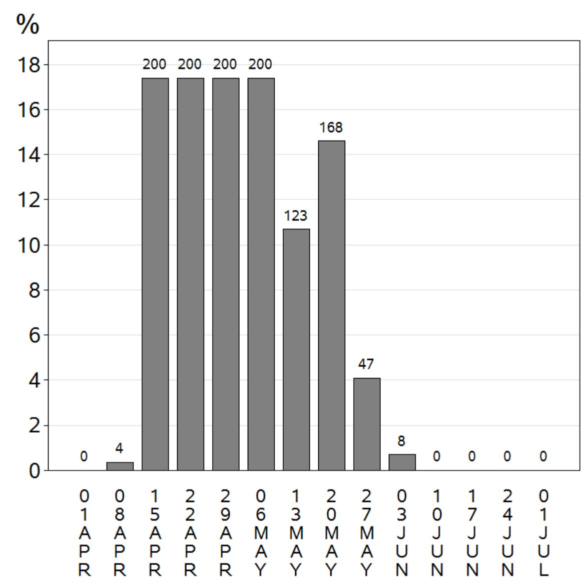
1987 Sproat Lk Sample Size by Week



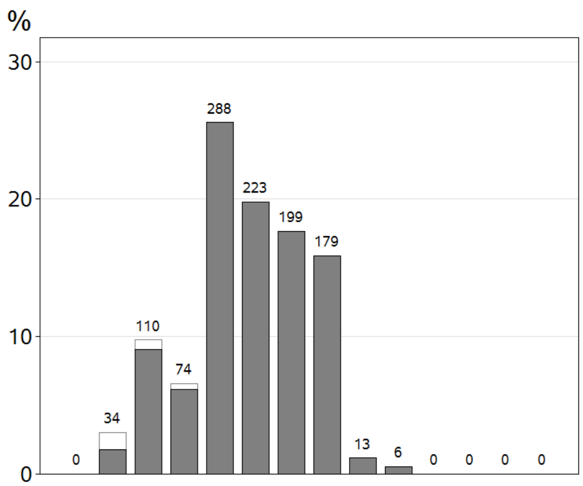
1985 Sproat Lk Sample Size by Week



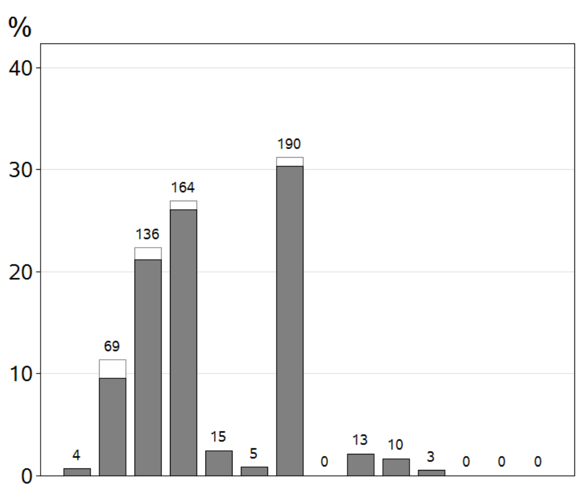
1988 Sproat Lk Sample Size by Week



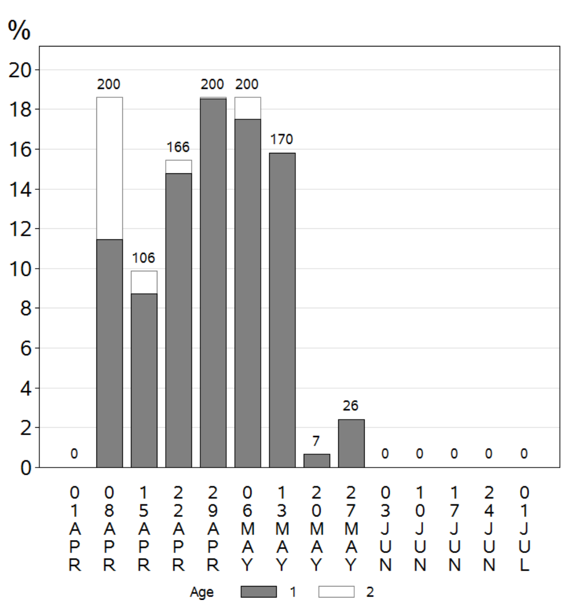
1989 Sproat Lk Sample Size by Week



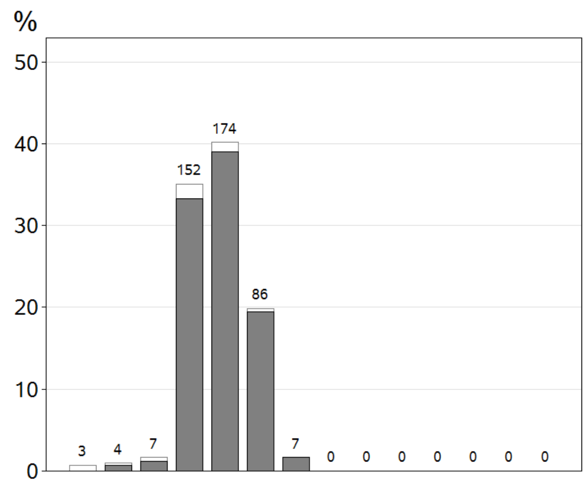
1990 Sproat Lk Sample Size by Week



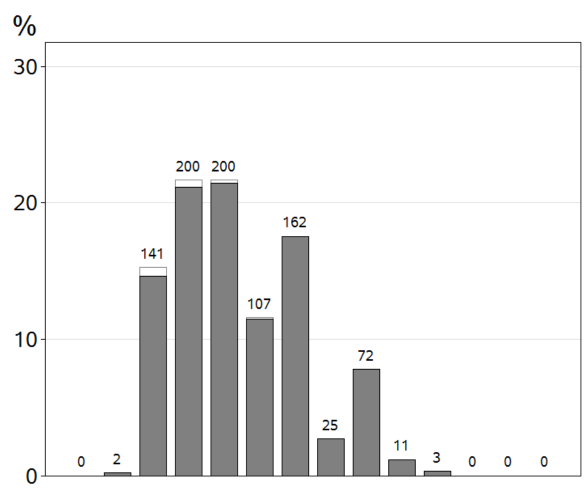
1991 Sproat Lk Sample Size by Week



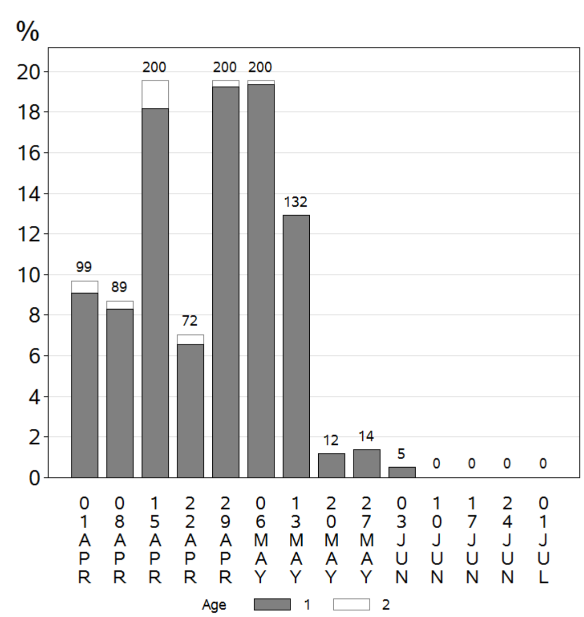
1992 Sproat Lk Sample Size by Week



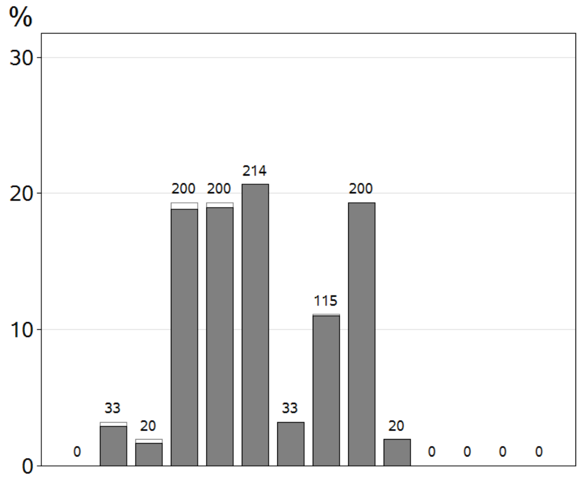
1993 Sproat Lk Sample Size by Week



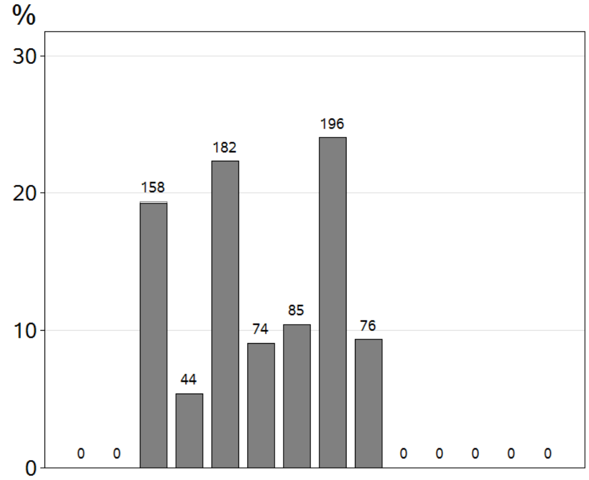
1994 Sproat Lk Sample Size by Week



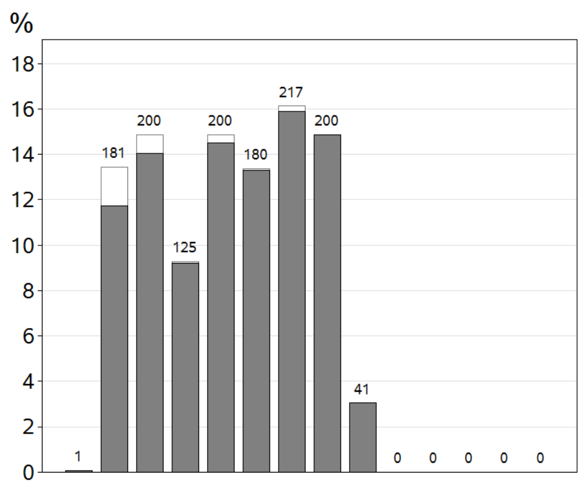
1995 Sproat Lk Sample Size by Week



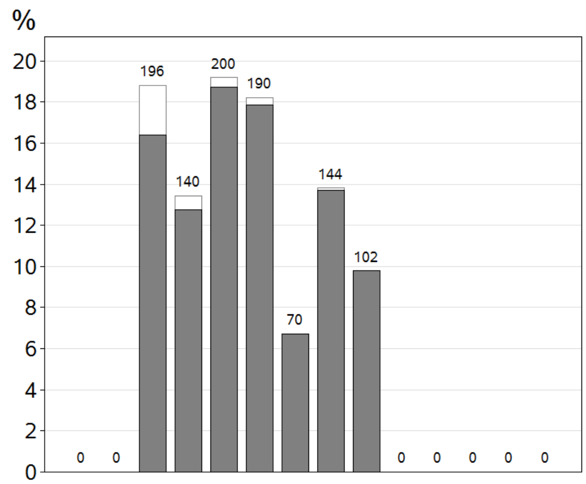
1998 Sproat Lk Sample Size by Week



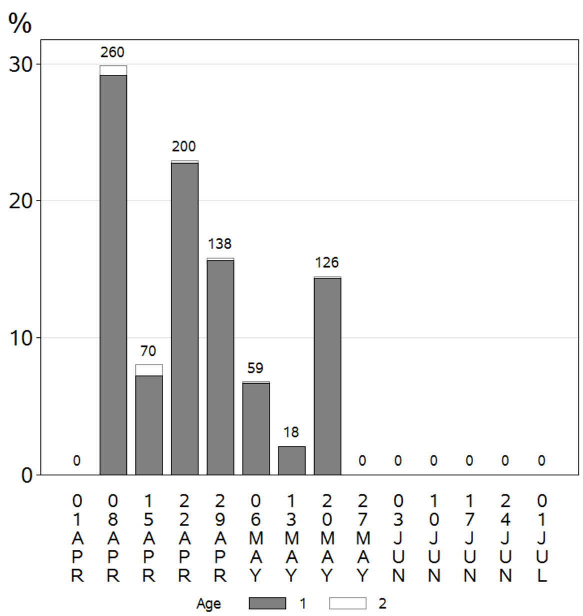
1996 Sproat Lk Sample Size by Week



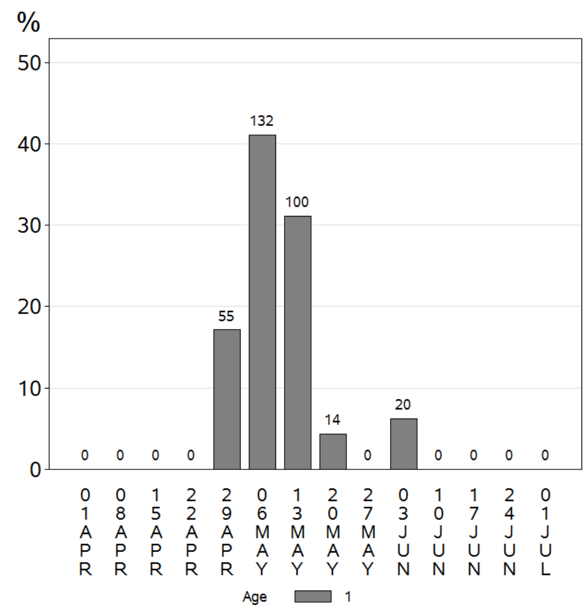
1999 Sproat Lk Sample Size by Week



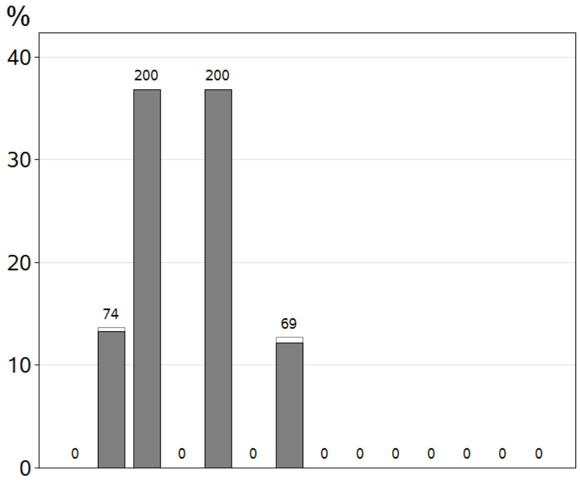
1997 Sproat Lk Sample Size by Week



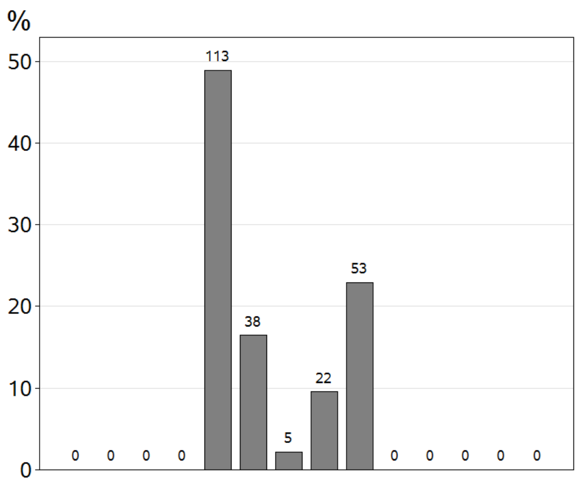
2000 Sproat Lk Sample Size by Week



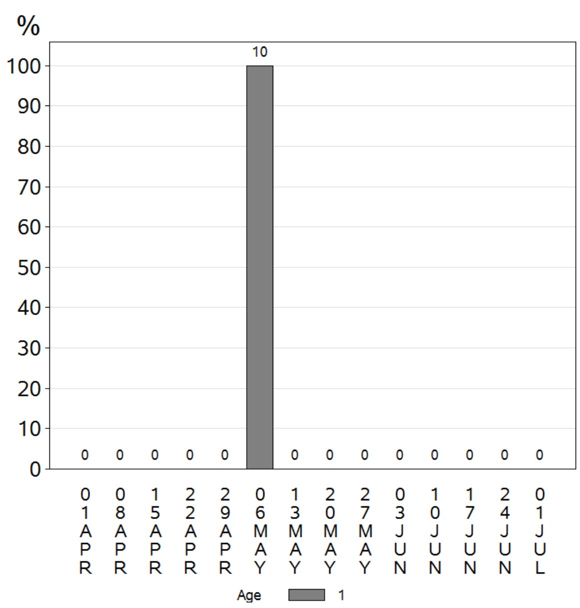
2001 Sproat Lk Sample Size by Week



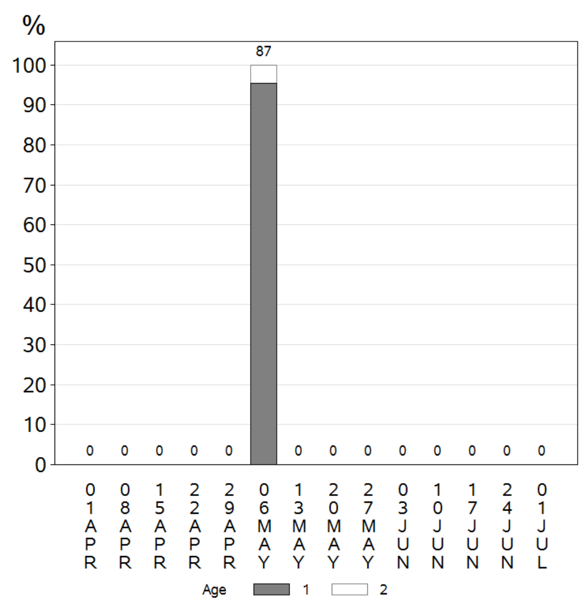
2002 Sproat Lk Sample Size by Week



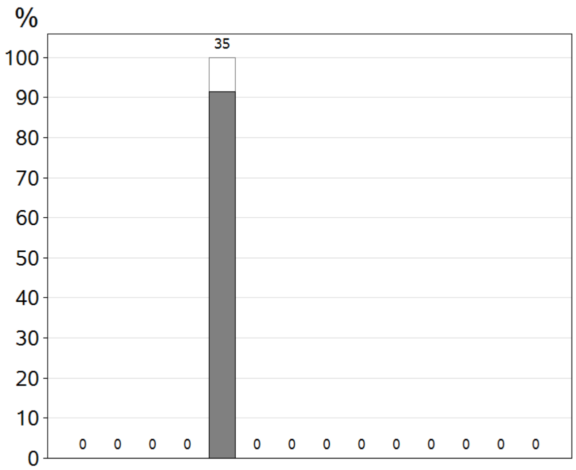
2003 Sproat Lk Sample Size by Week



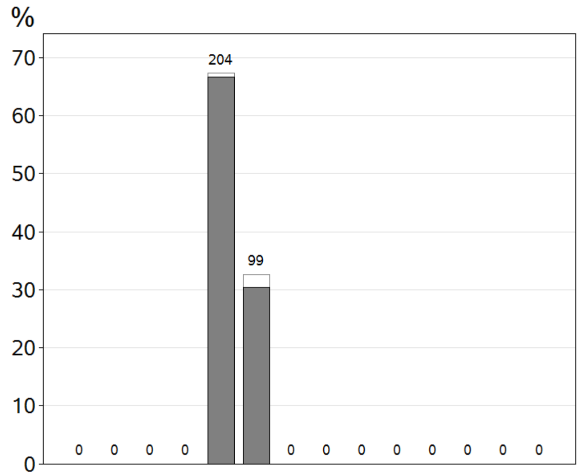
2006 Sproat Lk Sample Size by Week



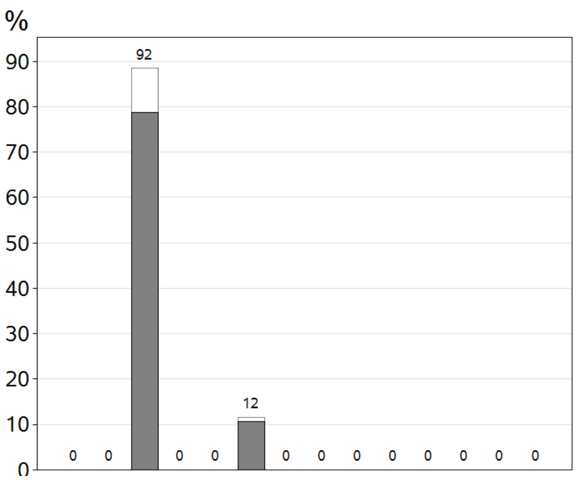
2008 Sproat Lk Sample Size by Week



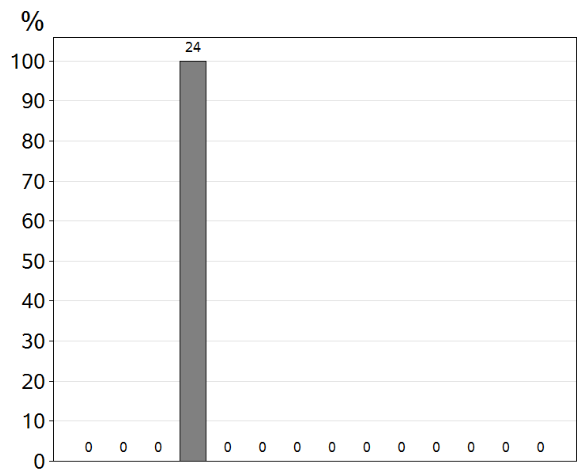
2011 Sproat Lk Sample Size by Week



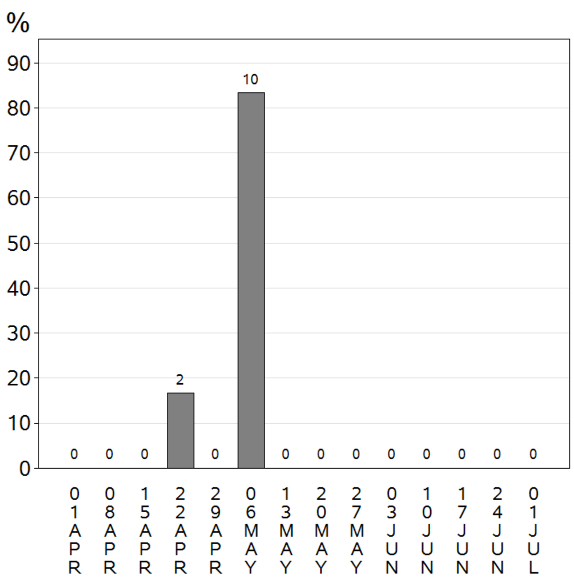
2009 Sproat Lk Sample Size by Week



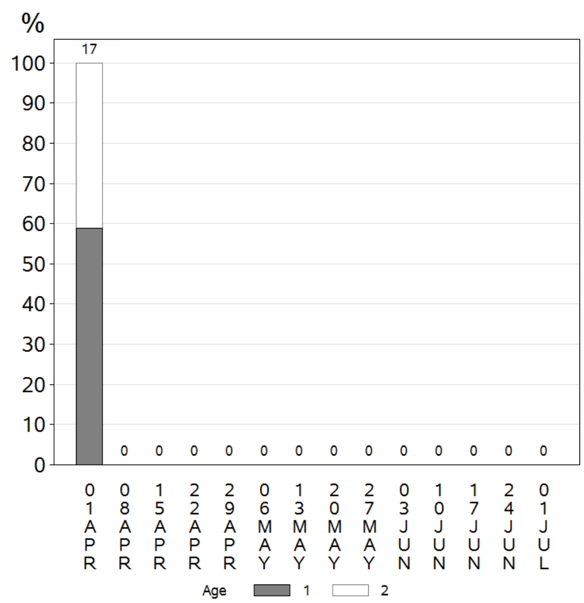
2012 Sproat Lk Sample Size by Week



2010 Sproat Lk Sample Size by Week

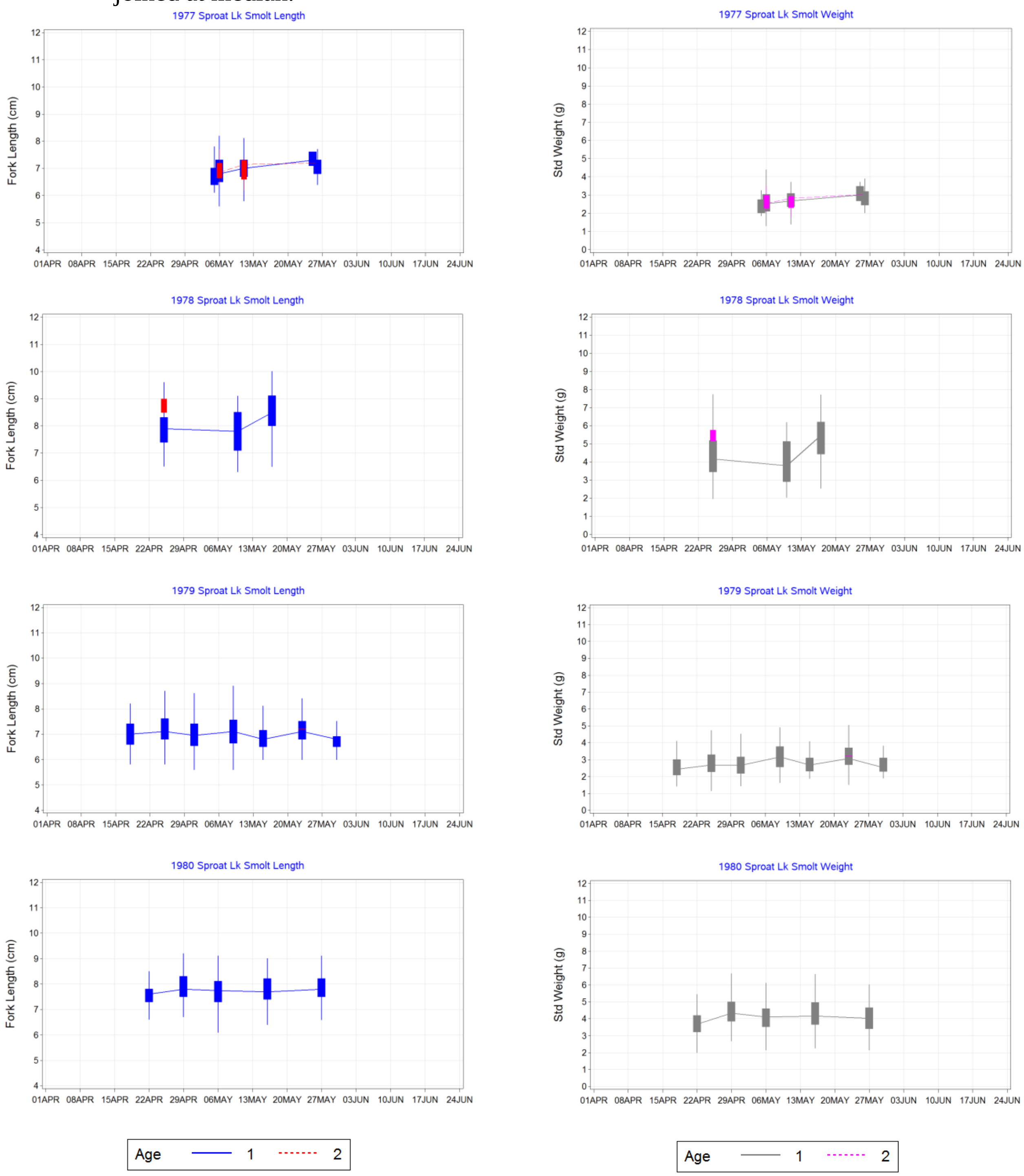


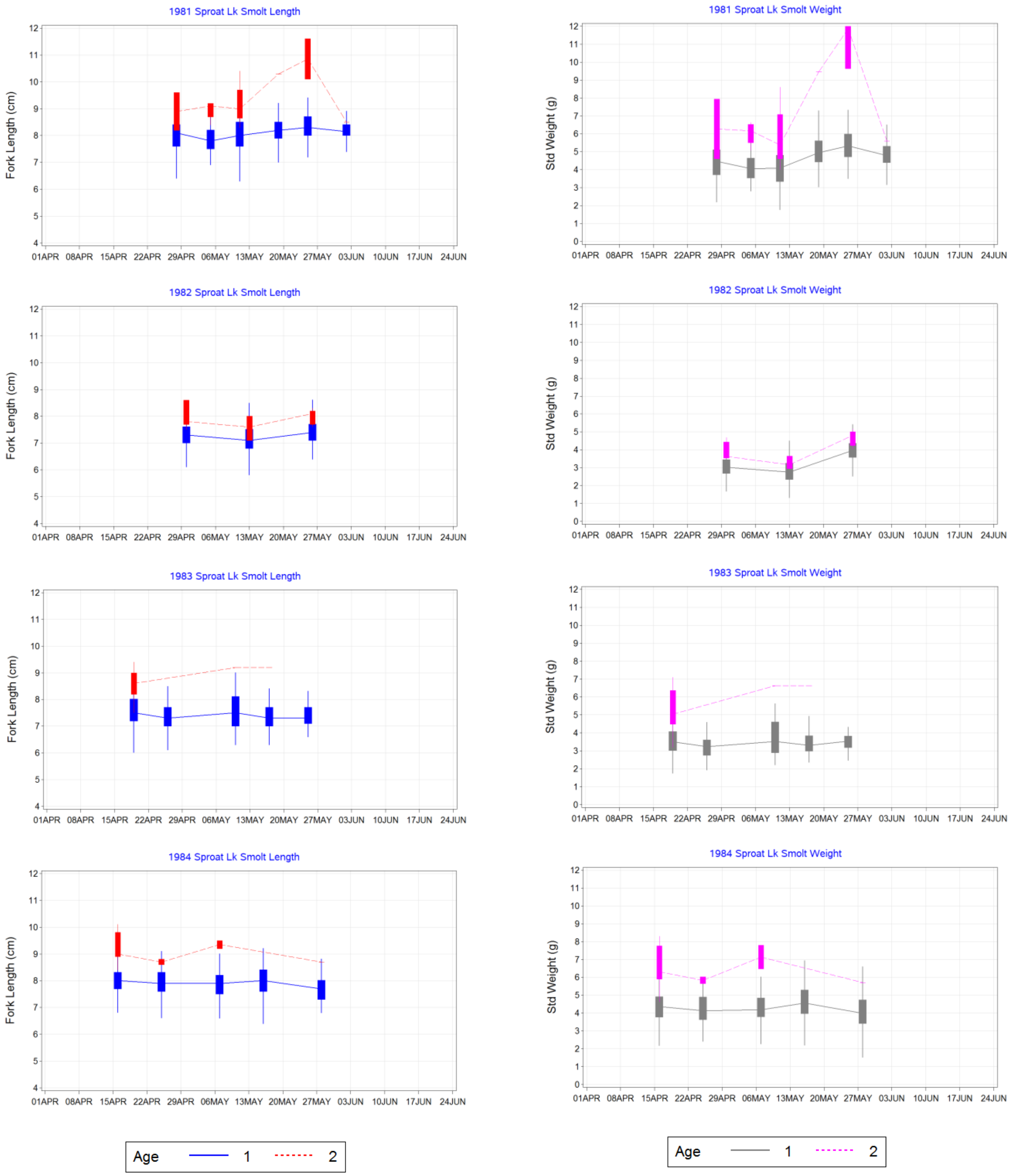
2013 Sproat Lk Sample Size by Week

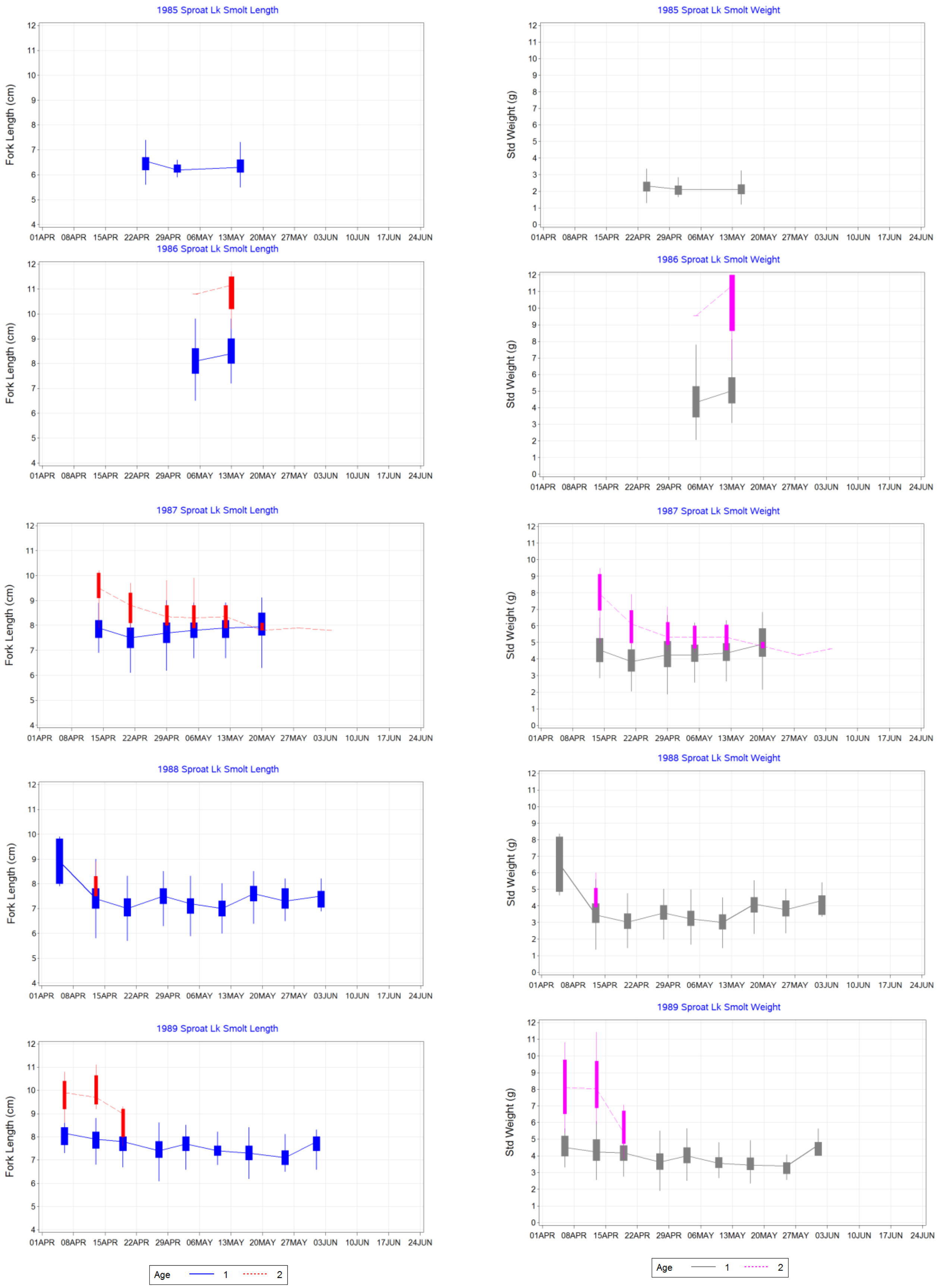


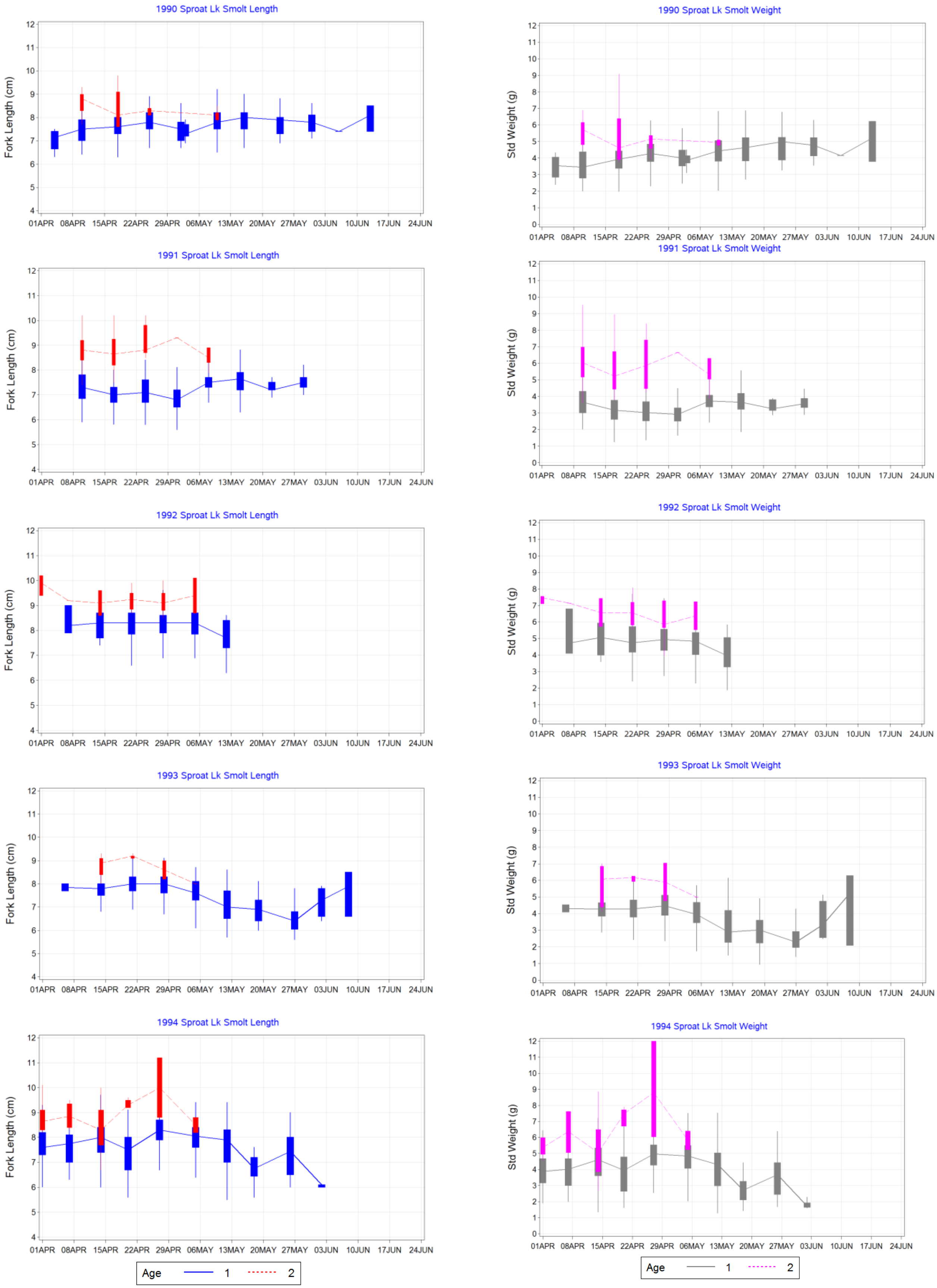
APPENDIX III – Seasonal Trends in Size

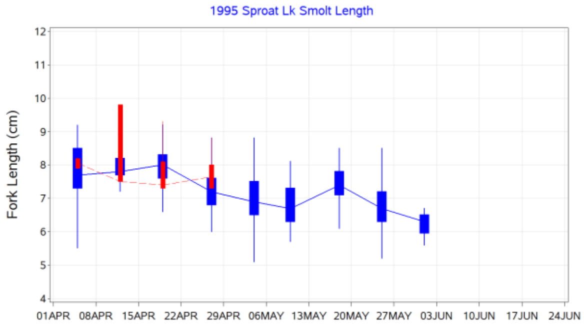
Appendix III. Seasonal time-trends in smolt size (Fork Length, left; Std Weight, right) by sample date and age class. Box and whiskers represent quartiles and extrema, joined at median.

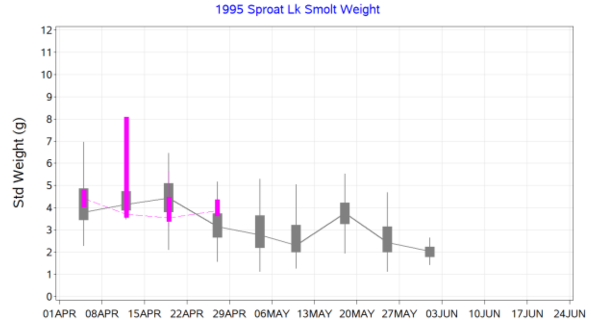


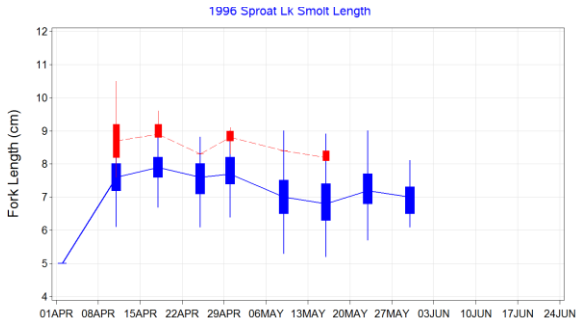

1981 Sproat Lk Smolt Length
1981 Sproat Lk Smolt Weight
1982 Sproat Lk Smolt Length
1982 Sproat Lk Smolt Weight
1983 Sproat Lk Smolt Length
1983 Sproat Lk Smolt Weight
1984 Sproat Lk Smolt Length
1984 Sproat Lk Smolt Weight
Fork Length (cm)
Std Weight (g)
01APR 08APR 15APR 22APR 29APR 06MAY 13MAY 20MAY 27MAY 03JUN 10JUN 17JUN 24JUN
Age 1 2
Age 1 2

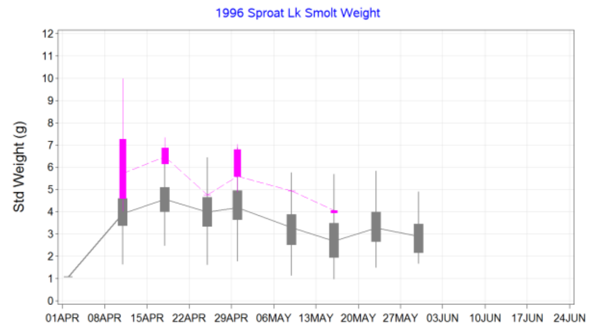

1985 Sproat Lk Smolt Length
1985 Sproat Lk Smolt Weight
1986 Sproat Lk Smolt Length
1986 Sproat Lk Smolt Weight
1987 Sproat Lk Smolt Length
1987 Sproat Lk Smolt Weight
1988 Sproat Lk Smolt Length
1988 Sproat Lk Smolt Weight
1989 Sproat Lk Smolt Length
1989 Sproat Lk Smolt Weight
Fork Length (cm)
Std Weight (g)
01APR 08APR 15APR 22APR 29APR 06MAY 13MAY 20MAY 27MAY 03JUN 10JUN 17JUN 24JUN
Age 1 2
Age 1 2

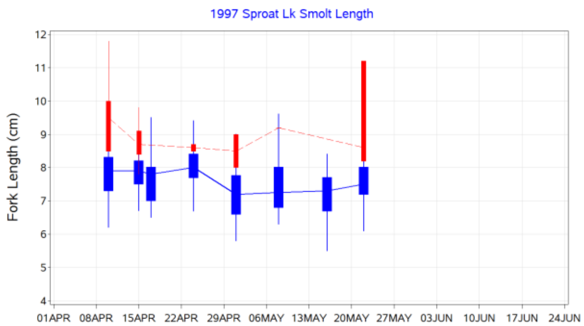

1990 Sproat Lk Smolt Length
1990 Sproat Lk Smolt Weight
1991 Sproat Lk Smolt Length
1991 Sproat Lk Smolt Weight
1992 Sproat Lk Smolt Length
1992 Sproat Lk Smolt Weight
1993 Sproat Lk Smolt Length
1993 Sproat Lk Smolt Weight
1994 Sproat Lk Smolt Length
1994 Sproat Lk Smolt Weight
Fork Length (cm)
Std Weight (g)
01APR 08APR 15APR 22APR 29APR 06MAY 13MAY 20MAY 27MAY 03JUN 10JUN 17JUN 24JUN
Age 1 2
Age 1 2

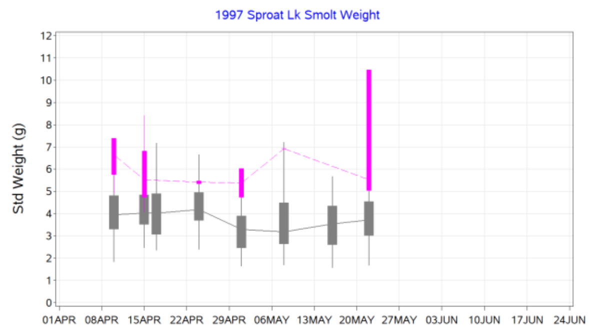

1995 Sproat Lk Smolt Length
Fork Length (cm)
01APR 08APR 15APR 22APR 29APR 06MAY 13MAY 20MAY 27MAY 03JUN 10JUN 17JUN 24JUN

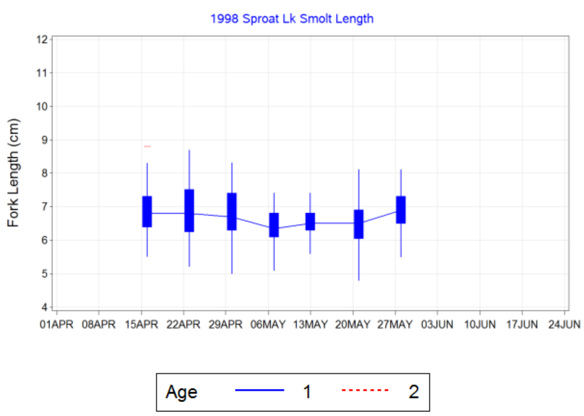

1995 Sproat Lk Smolt Weight
Std Weight (g)
01APR 08APR 15APR 22APR 29APR 06MAY 13MAY 20MAY 27MAY 03JUN 10JUN 17JUN 24JUN


1996 Sproat Lk Smolt Length
Fork Length (cm)
01APR 08APR 15APR 22APR 29APR 06MAY 13MAY 20MAY 27MAY 03JUN 10JUN 17JUN 24JUN

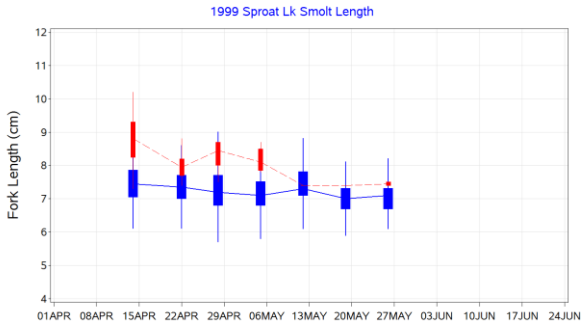

1996 Sproat Lk Smolt Weight
Std Weight (g)
01APR 08APR 15APR 22APR 29APR 06MAY 13MAY 20MAY 27MAY 03JUN 10JUN 17JUN 24JUN

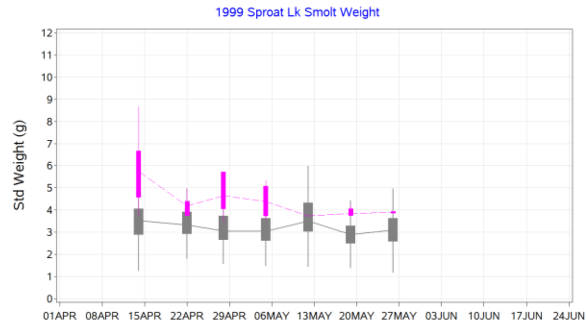

1997 Sproat Lk Smolt Length
Fork Length (cm)
01APR 08APR 15APR 22APR 29APR 06MAY 13MAY 20MAY 27MAY 03JUN 10JUN 17JUN 24JUN

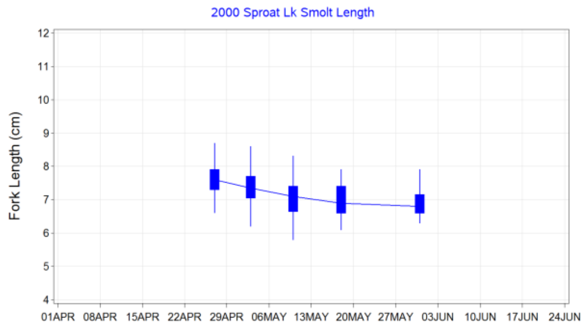

1997 Sproat Lk Smolt Weight
Std Weight (g)
01APR 08APR 15APR 22APR 29APR 06MAY 13MAY 20MAY 27MAY 03JUN 10JUN 17JUN 24JUN

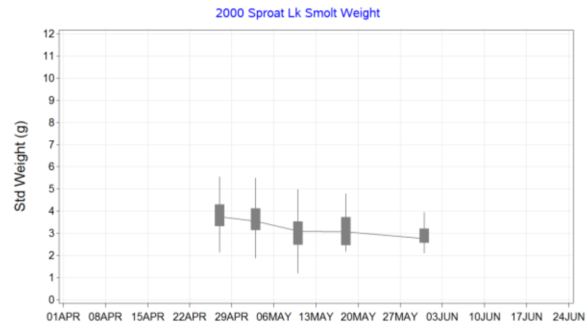

1998 Sproat Lk Smolt Length
Fork Length (cm)
01APR 08APR 15APR 22APR 29APR 06MAY 13MAY 20MAY 27MAY 03JUN 10JUN 17JUN 24JUN
Age 1 2

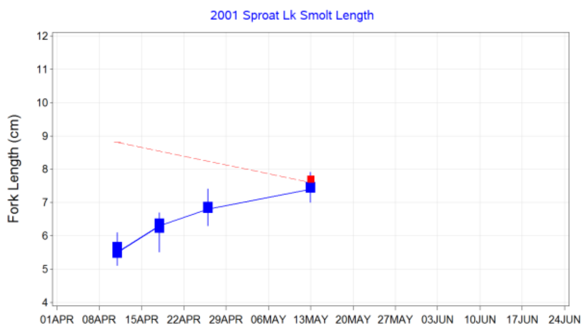

1998 Sproat Lk Smolt Weight
Std Weight (g)
01APR 08APR 15APR 22APR 29APR 06MAY 13MAY 20MAY 27MAY 03JUN 10JUN 17JUN 24JUN
Age 1 2

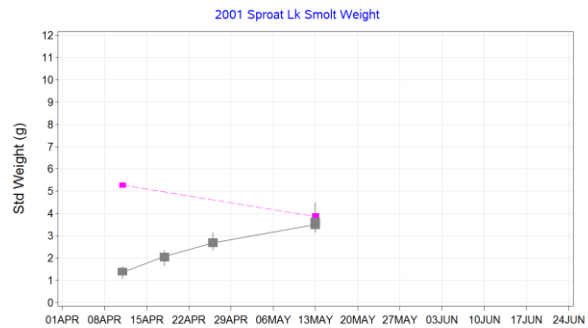

1999 Sproat Lk Smolt Length
Fork Length (cm)

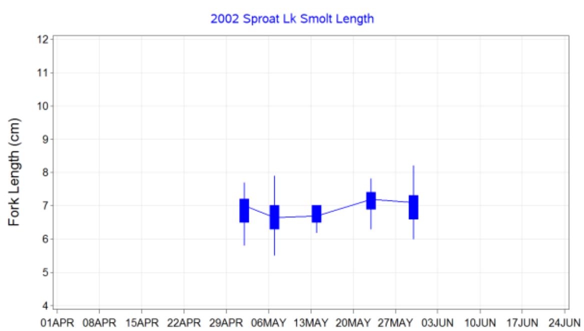

1999 Sproat Lk Smolt Weight
Std Weight (g)

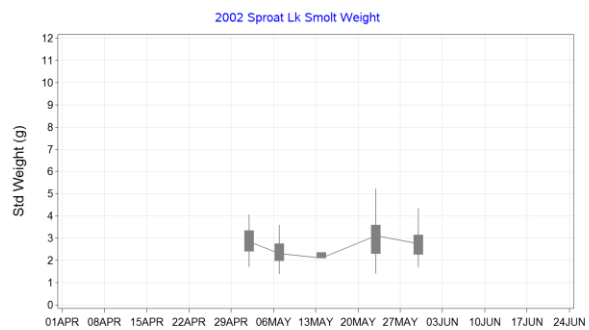

2000 Sproat Lk Smolt Length
Fork Length (cm)

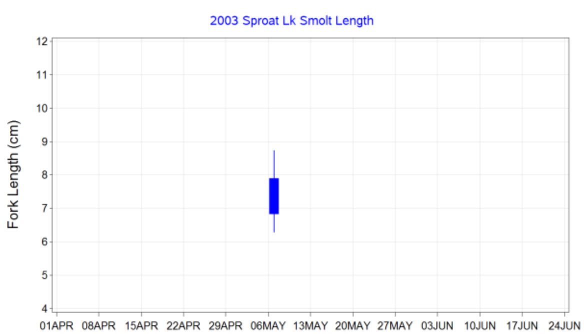

2000 Sproat Lk Smolt Weight
Std Weight (g)


2001 Sproat Lk Smolt Length
Fork Length (cm)

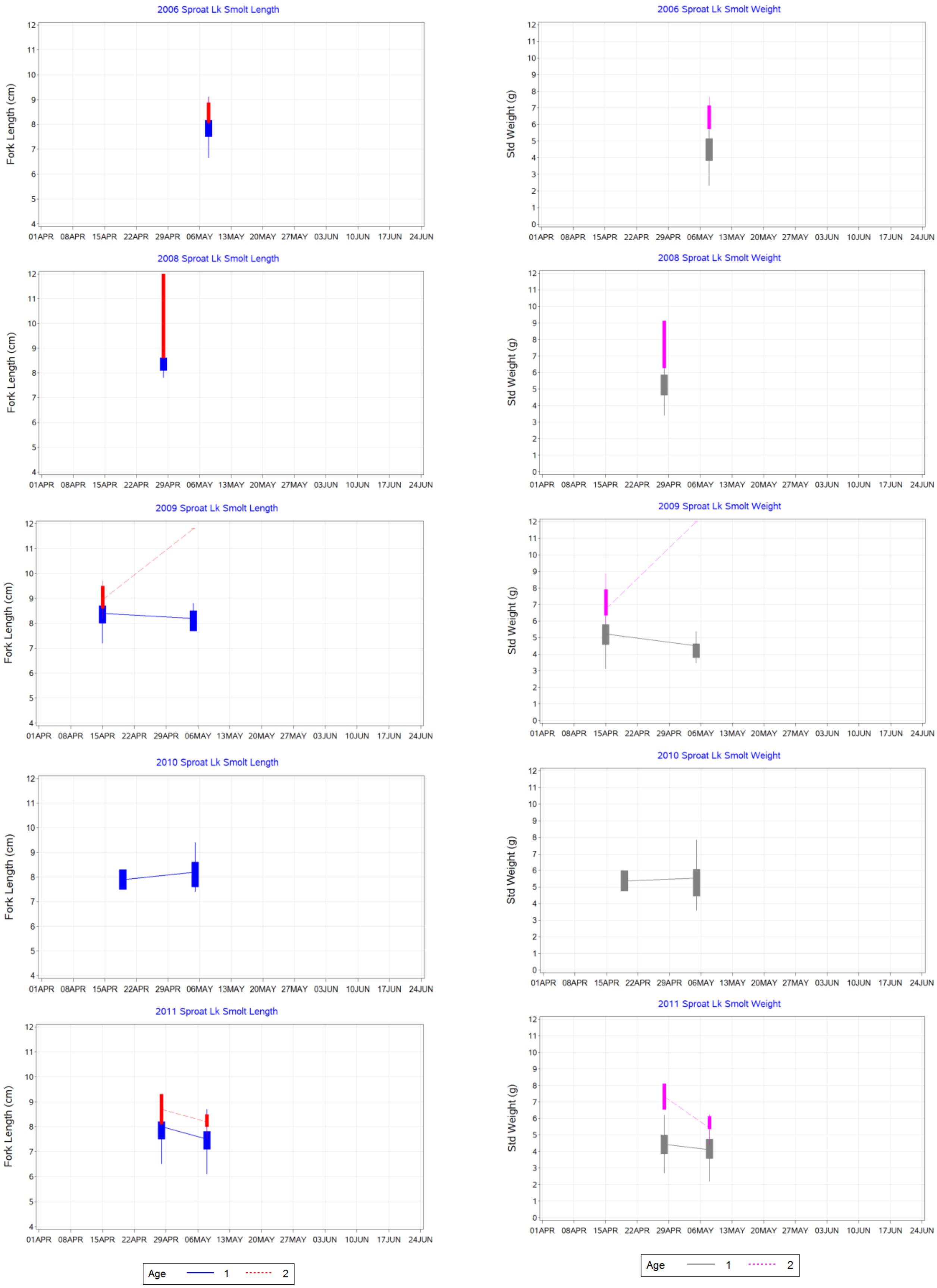

2001 Sproat Lk Smolt Weight
Std Weight (g)

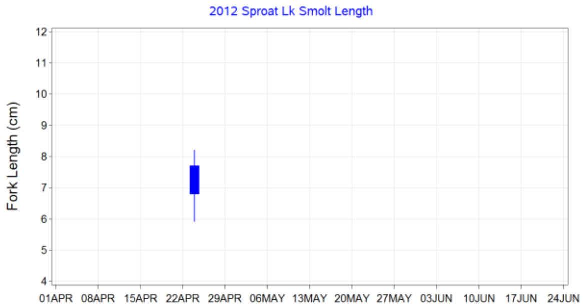

2002 Sproat Lk Smolt Length
Fork Length (cm)

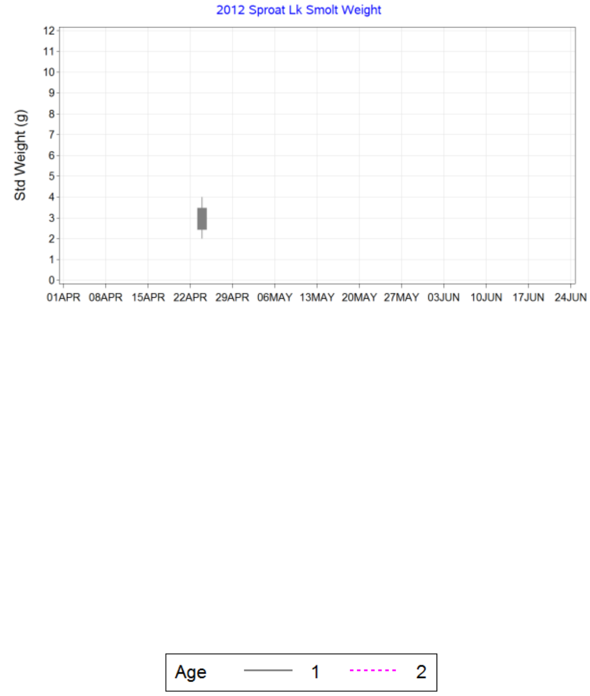

2002 Sproat Lk Smolt Weight
Std Weight (g)

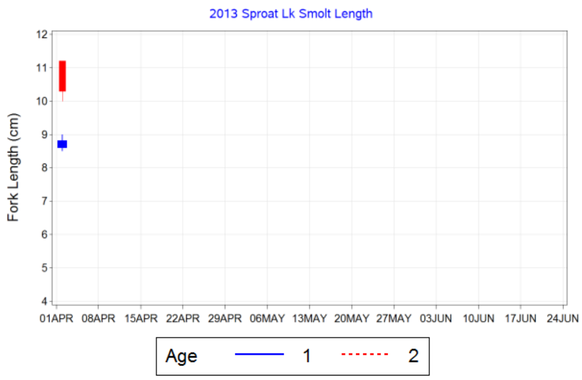

2003 Sproat Lk Smolt Length
Fork Length (cm)


2003 Sproat Lk Smolt Weight
Std Weight (g)


2006 Sproat Lk Smolt Length
Fork Length (cm)
2006 Sproat Lk Smolt Weight
Std Weight (g)
2008 Sproat Lk Smolt Length
Fork Length (cm)
2008 Sproat Lk Smolt Weight
Std Weight (g)
2009 Sproat Lk Smolt Length
Fork Length (cm)
2009 Sproat Lk Smolt Weight
Std Weight (g)
2010 Sproat Lk Smolt Length
Fork Length (cm)
2010 Sproat Lk Smolt Weight
Std Weight (g)
2011 Sproat Lk Smolt Length
Fork Length (cm)
2011 Sproat Lk Smolt Weight
Std Weight (g)
01APR 08APR 15APR 22APR 29APR 06MAY 13MAY 20MAY 27MAY 03JUN 10JUN 17JUN 24JUN
Age 1 2
Age 1 2

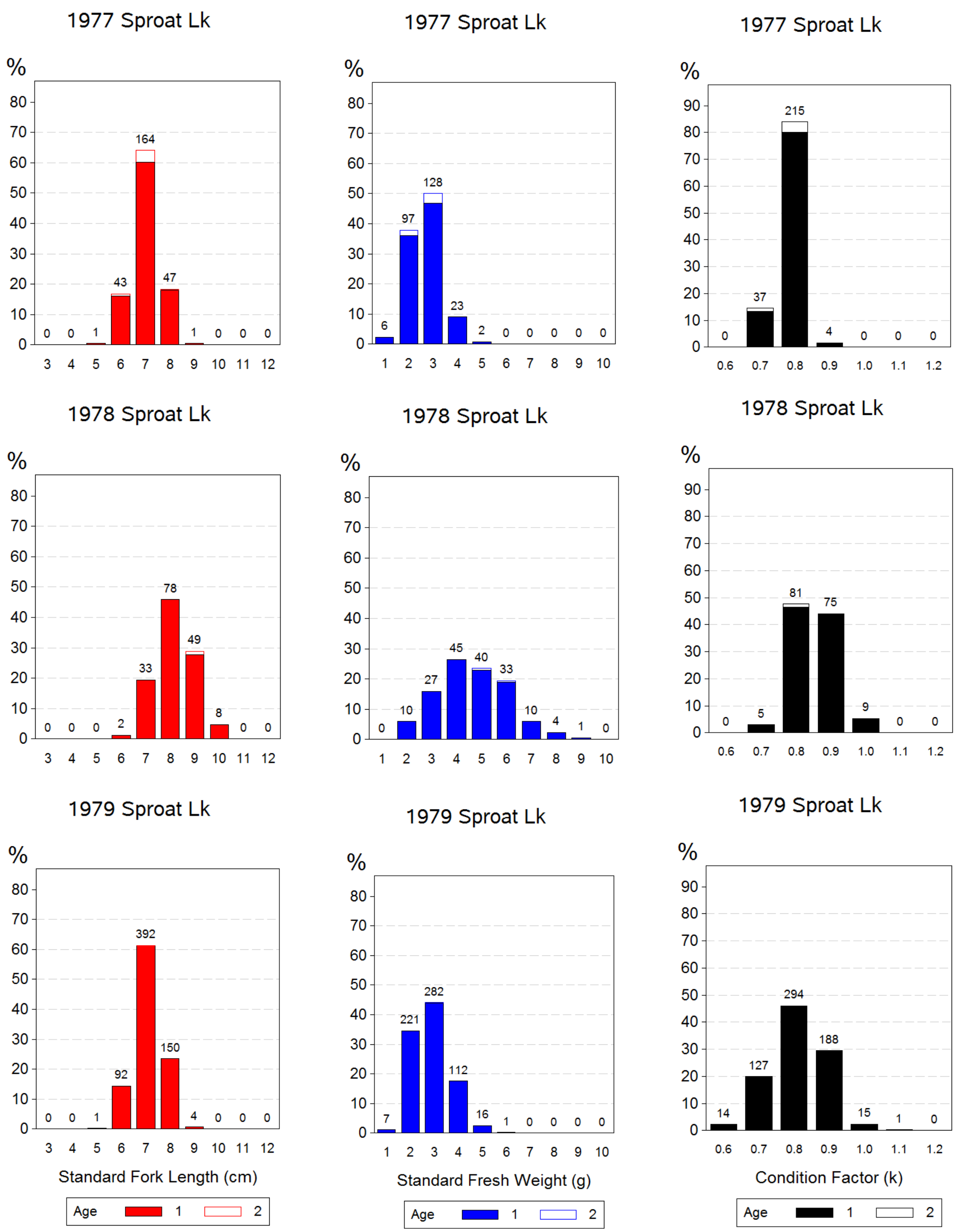

2012 Sproat Lk Smolt Length
Fork Length (cm)
12
11
10
9
8
7
6
5
4
01APR 08APR 15APR 22APR 29APR 06MAY 13MAY 20MAY 27MAY 03JUN 10JUN 17JUN 24JUN

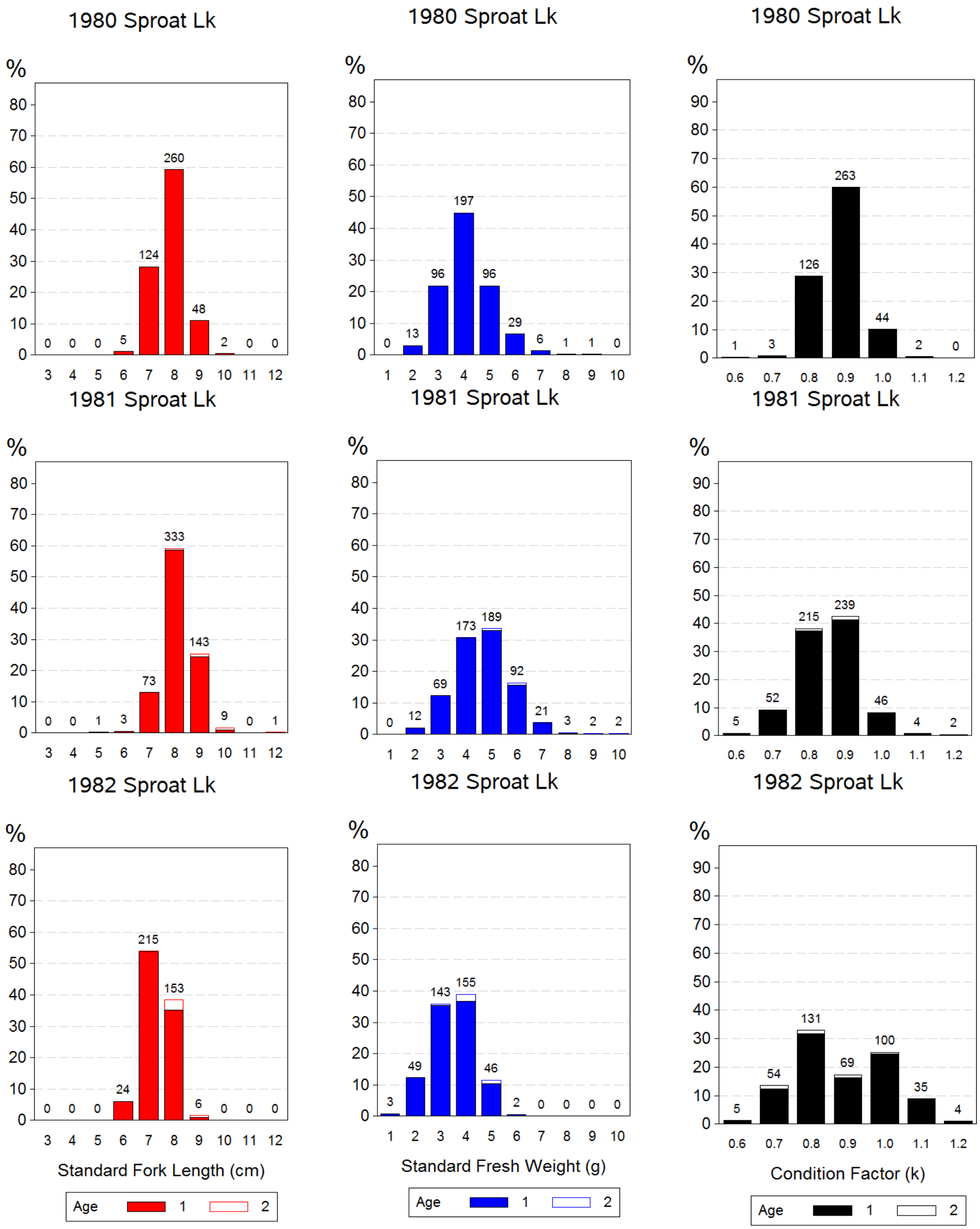

2012 Sproat Lk Smolt Weight
Std Weight (g)
12
11
10
9
8
7
6
5
4
3
2
1
0
01APR 08APR 15APR 22APR 29APR 06MAY 13MAY 20MAY 27MAY 03JUN 10JUN 17JUN 24JUN
Age 1 2

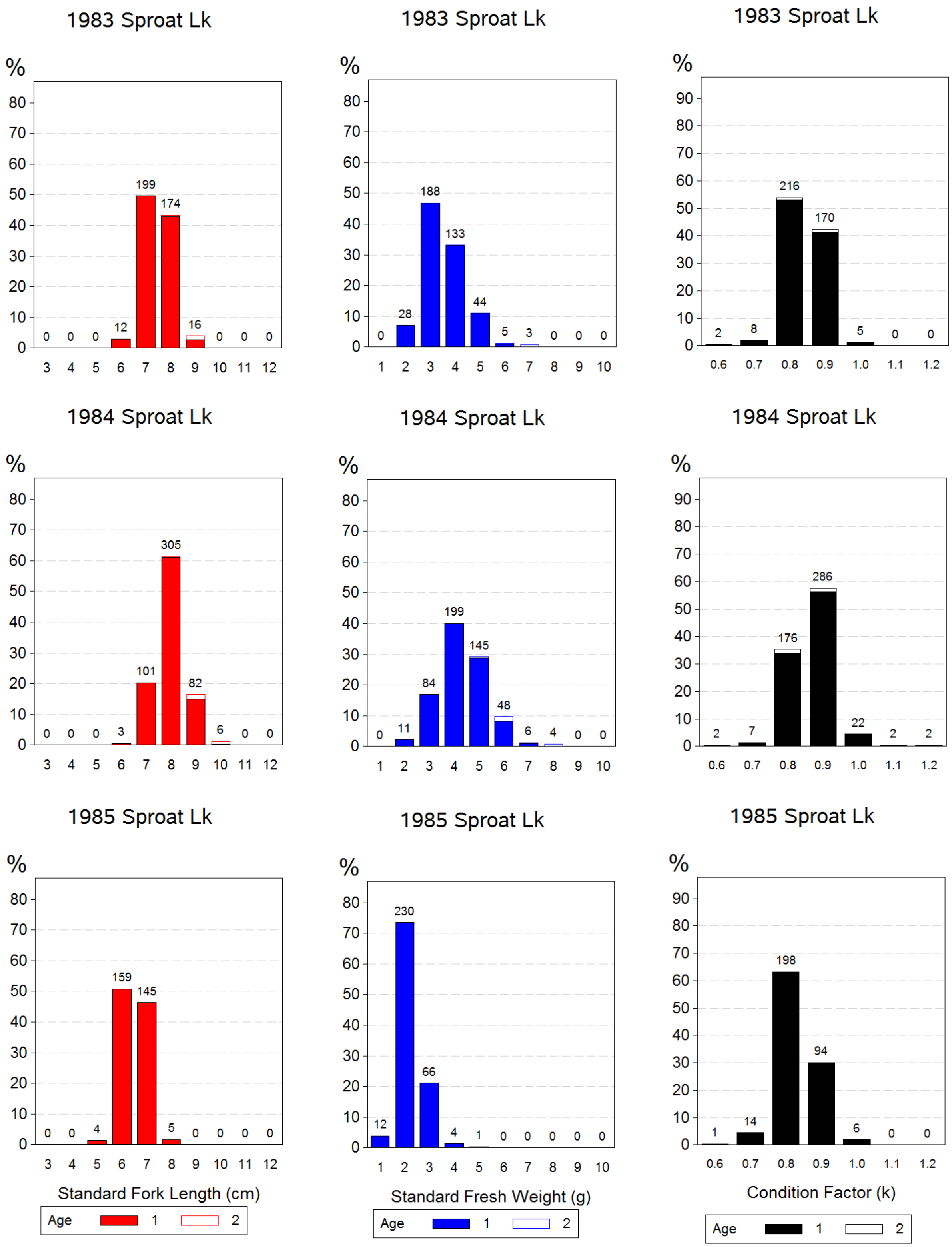

2013 Sproat Lk Smolt Length
Fork Length (cm)
12
11
10
9
8
7
6
5
4
01APR 08APR 15APR 22APR 29APR 06MAY 13MAY 20MAY 27MAY 03JUN 10JUN 17JUN 24JUN
Age 1 2

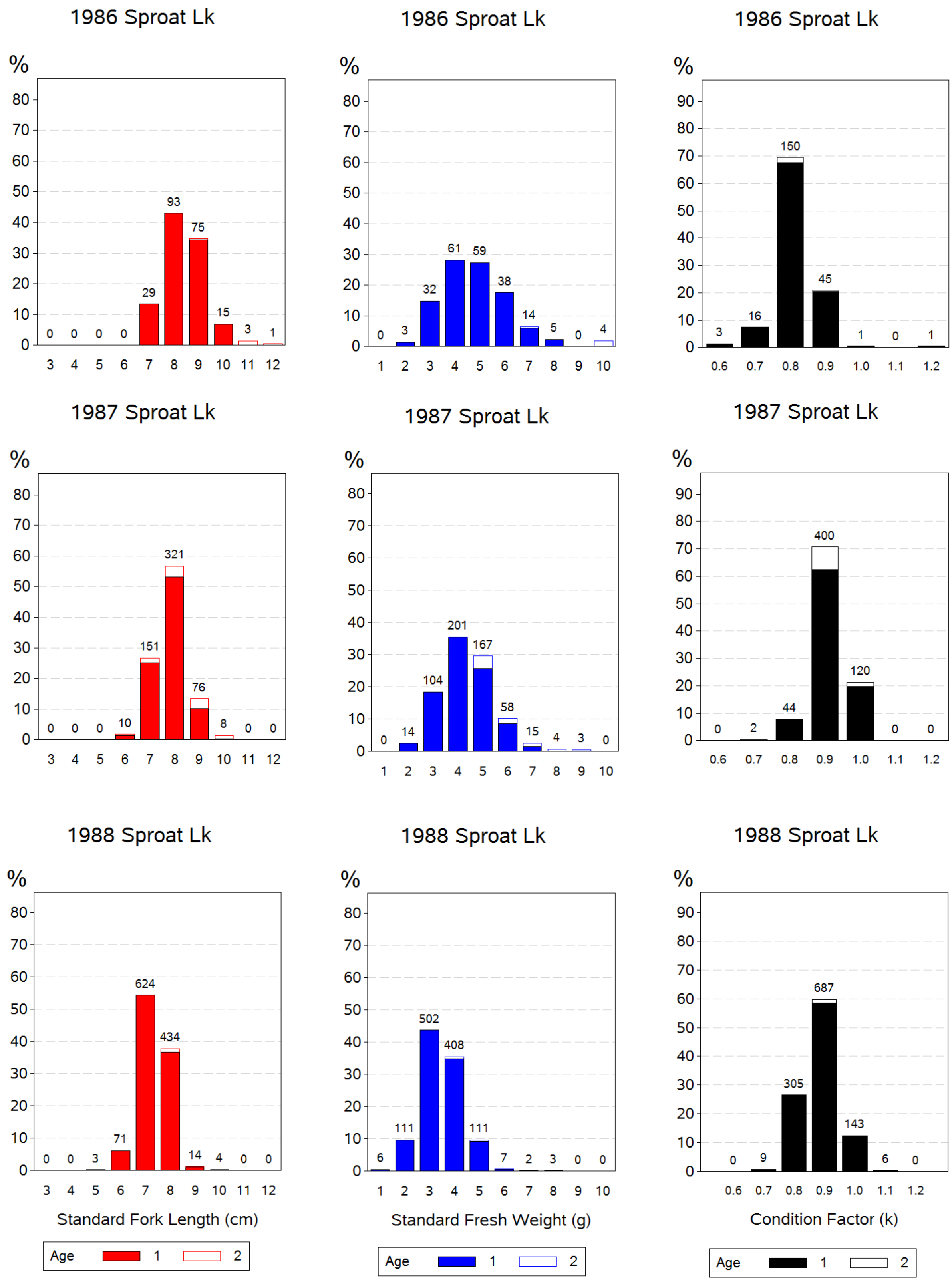
APPENDIX IV – Annual Size Frequency Distributions

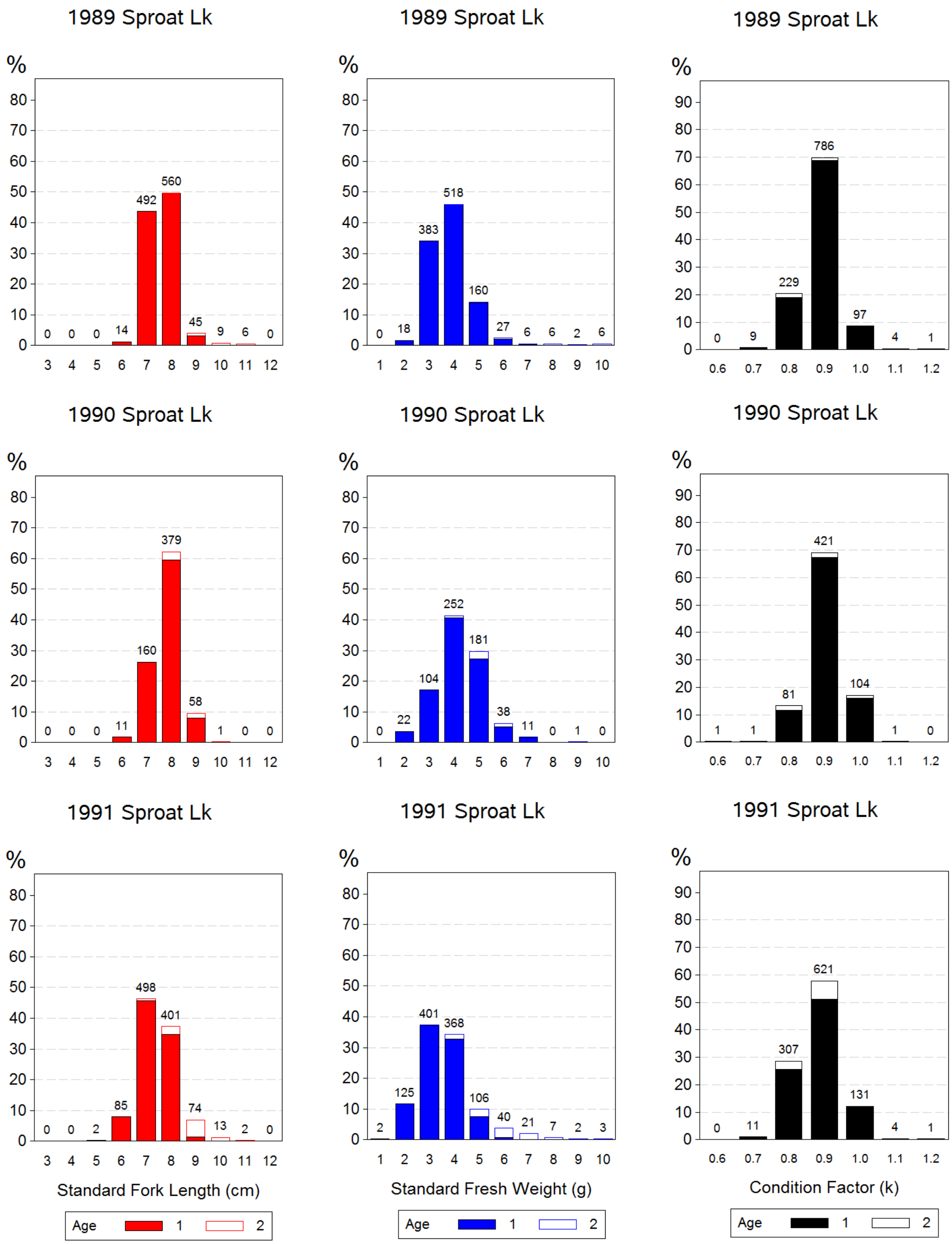
Appendix IV. Sproat Lake Sockeye smolt size frequency distributions (Fork Length (cm), left; Std Weight (g), middle; Condition Factor (k), right) by year and age class.

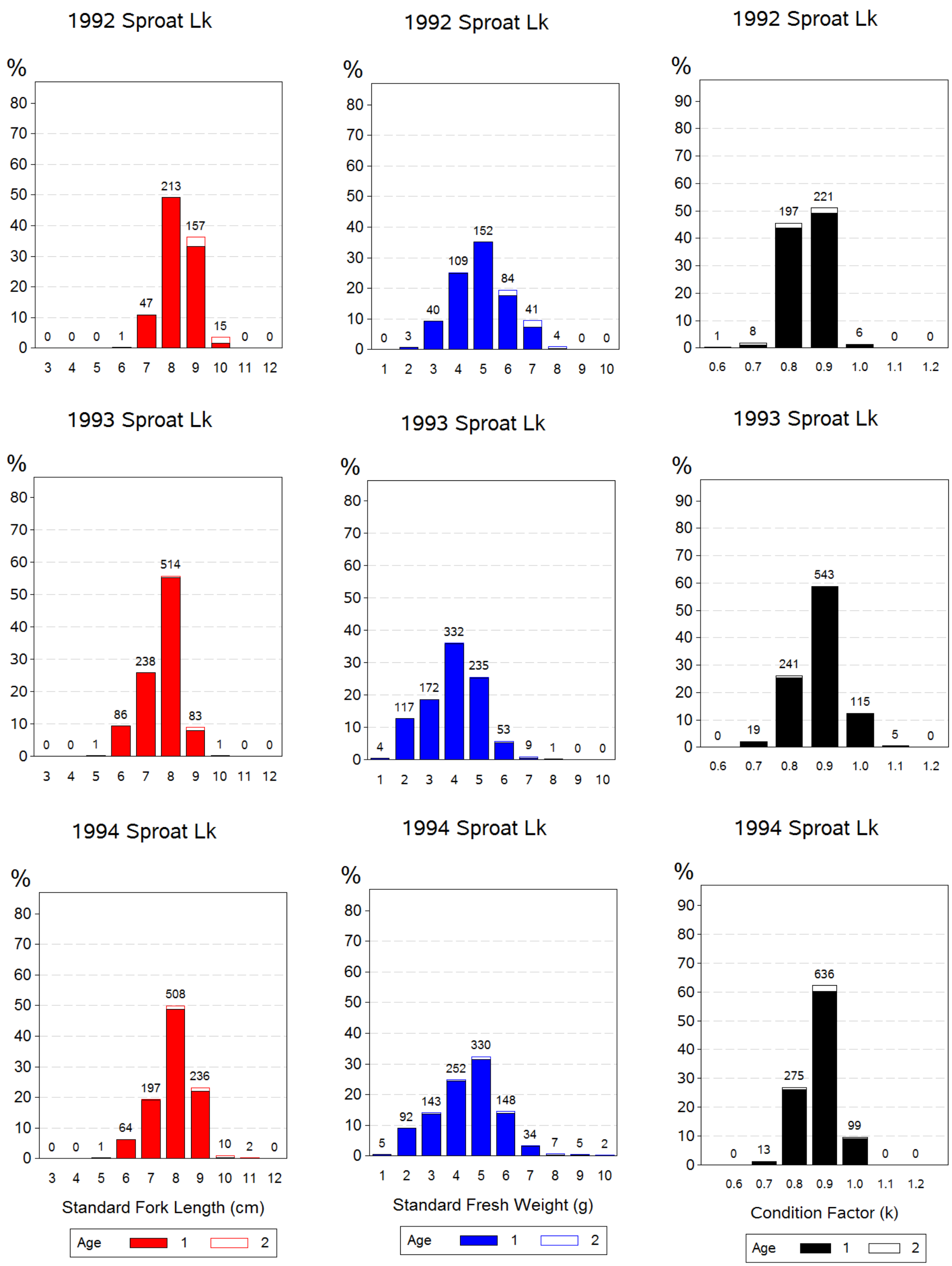


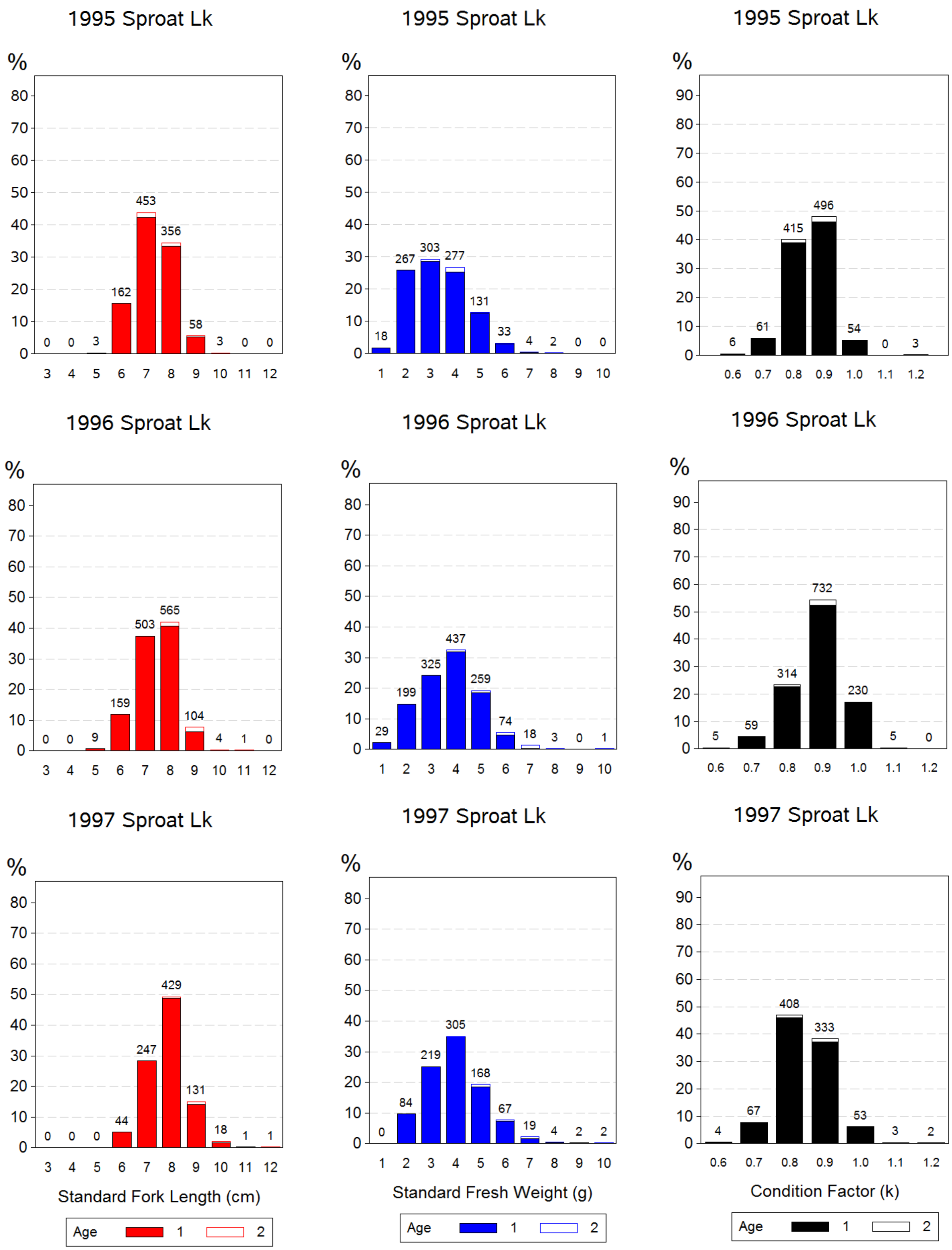

1980 Sproat Lk
%
0 0 0 5 124 260 48 2 0 0
3 4 5 6 7 8 9 10 11 12
1981 Sproat Lk
%
0 0 1 3 73 333 143 9 0 1
3 4 5 6 7 8 9 10 11 12
1982 Sproat Lk
%
0 0 0 24 215 153 6 0 0 0
3 4 5 6 7 8 9 10 11 12
Standard Fork Length (cm)
Age 1 2
1980 Sproat Lk
%
0 13 96 197 96 29 6 1 1 0
1 2 3 4 5 6 7 8 9 10
1981 Sproat Lk
%
0 12 69 173 189 92 21 3 2 2
1 2 3 4 5 6 7 8 9 10
1982 Sproat Lk
%
3 49 143 155 46 2 0 0 0 0
1 2 3 4 5 6 7 8 9 10
Standard Fresh Weight (g)
Age 1 2
1980 Sproat Lk
%
1 3 126 263 44 2 0
0.6 0.7 0.8 0.9 1.0 1.1 1.2
1981 Sproat Lk
%
5 52 215 239 46 4 2
0.6 0.7 0.8 0.9 1.0 1.1 1.2
1982 Sproat Lk
%
5 54 131 69 100 35 4
0.6 0.7 0.8 0.9 1.0 1.1 1.2
Condition Factor (k)
Age 1 2

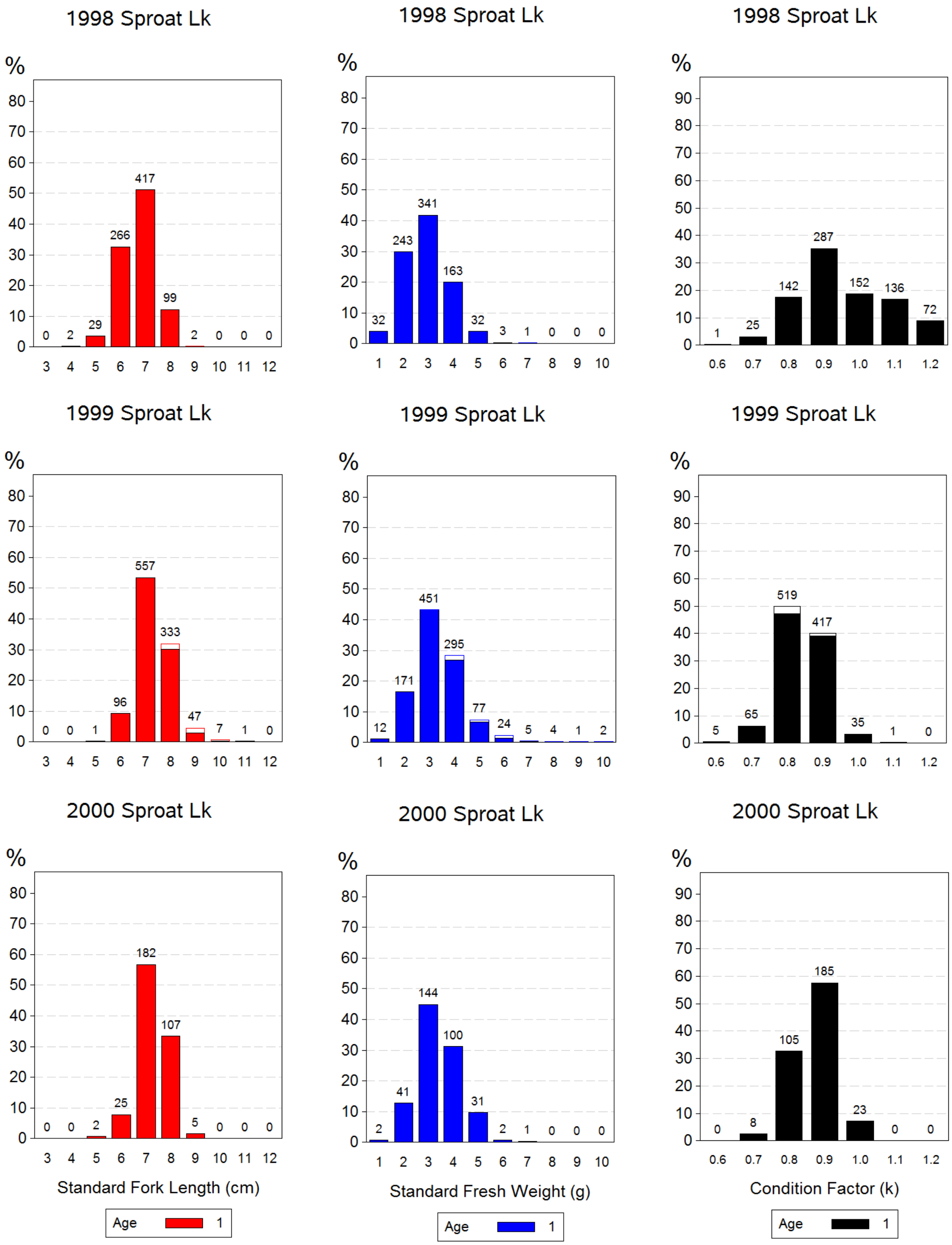

1983 Sproat Lk
%
0 0 0 12 199 174 16 0 0 0
3 4 5 6 7 8 9 10 11 12
1983 Sproat Lk
%
0 28 188 133 44 5 3 0 0 0
1 2 3 4 5 6 7 8 9 10
1983 Sproat Lk
%
2 8 216 170 5 0 0
0.6 0.7 0.8 0.9 1.0 1.1 1.2
1984 Sproat Lk
%
0 0 0 3 101 305 82 6 0 0
3 4 5 6 7 8 9 10 11 12
1984 Sproat Lk
%
0 11 84 199 145 48 6 4 0 0
1 2 3 4 5 6 7 8 9 10
1984 Sproat Lk
%
2 7 176 286 22 2 2
0.6 0.7 0.8 0.9 1.0 1.1 1.2
1985 Sproat Lk
%
0 0 4 159 145 5 0 0 0 0
3 4 5 6 7 8 9 10 11 12
Standard Fork Length (cm)
Age 1 2
1985 Sproat Lk
%
12 230 66 4 1 0 0 0 0 0
1 2 3 4 5 6 7 8 9 10
Standard Fresh Weight (g)
Age 1 2
1985 Sproat Lk
%
1 14 198 94 6 0 0
0.6 0.7 0.8 0.9 1.0 1.1 1.2
Condition Factor (k)
Age 1 2

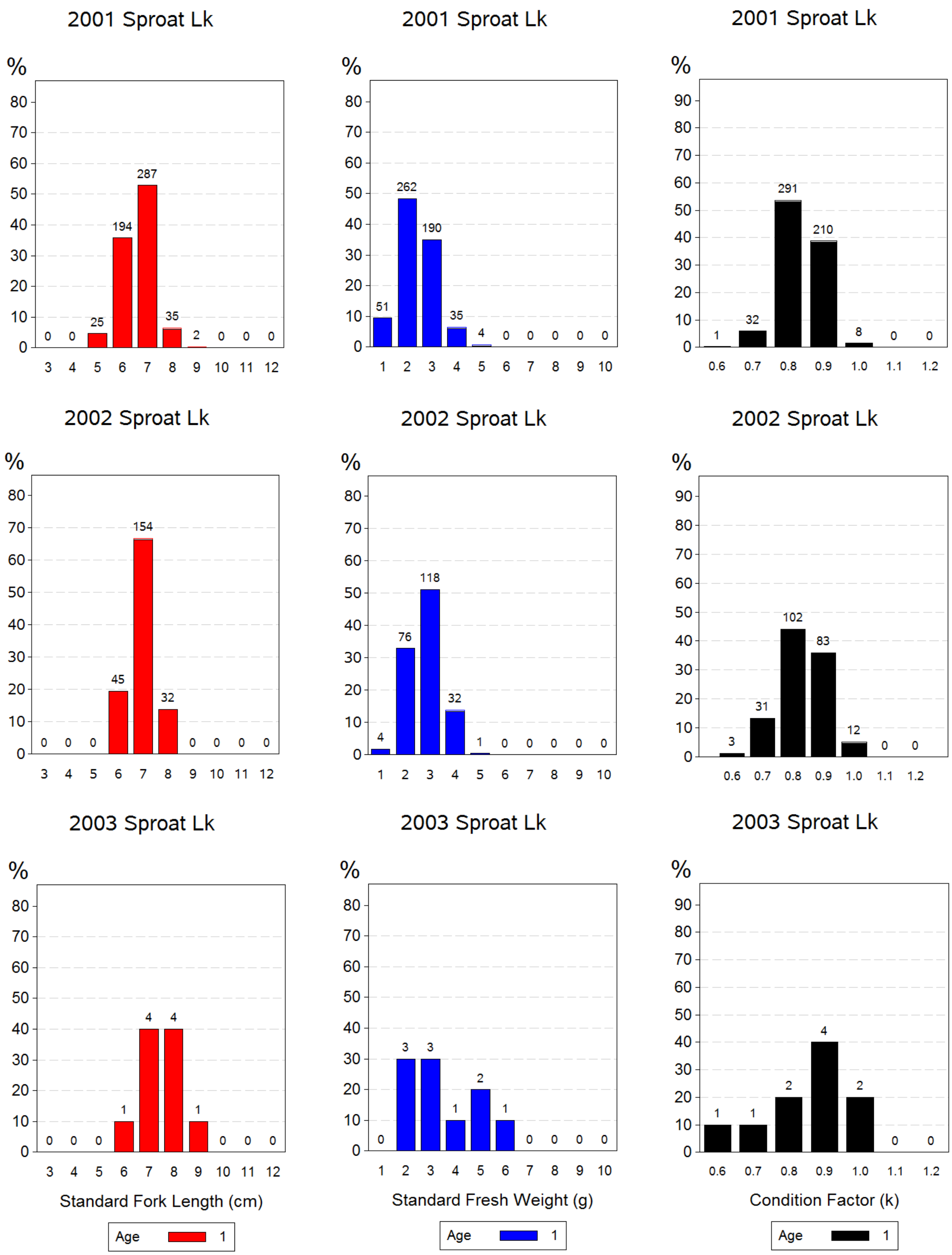

1986 Sproat Lk
%
0 0 0 0 29 93 75 15 3 1
3 4 5 6 7 8 9 10 11 12
1986 Sproat Lk
%
0 3 32 61 59 38 14 5 0 4
1 2 3 4 5 6 7 8 9 10
1986 Sproat Lk
%
3 16 150 45 1 0 1
0.6 0.7 0.8 0.9 1.0 1.1 1.2
1987 Sproat Lk
%
0 0 0 10 151 321 76 8 0 0
3 4 5 6 7 8 9 10 11 12
1987 Sproat Lk
%
0 14 104 201 167 58 15 4 3 0
1 2 3 4 5 6 7 8 9 10
1987 Sproat Lk
%
0 2 44 400 120 0 0
0.6 0.7 0.8 0.9 1.0 1.1 1.2
1988 Sproat Lk
%
0 0 3 71 624 434 14 4 0 0
3 4 5 6 7 8 9 10 11 12
Standard Fork Length (cm)
Age 1 2
1988 Sproat Lk
%
6 111 502 408 111 7 2 3 0 0
1 2 3 4 5 6 7 8 9 10
Standard Fresh Weight (g)
Age 1 2
1988 Sproat Lk
%
0 9 305 687 143 6 0
0.6 0.7 0.8 0.9 1.0 1.1 1.2
Condition Factor (k)
Age 1 2

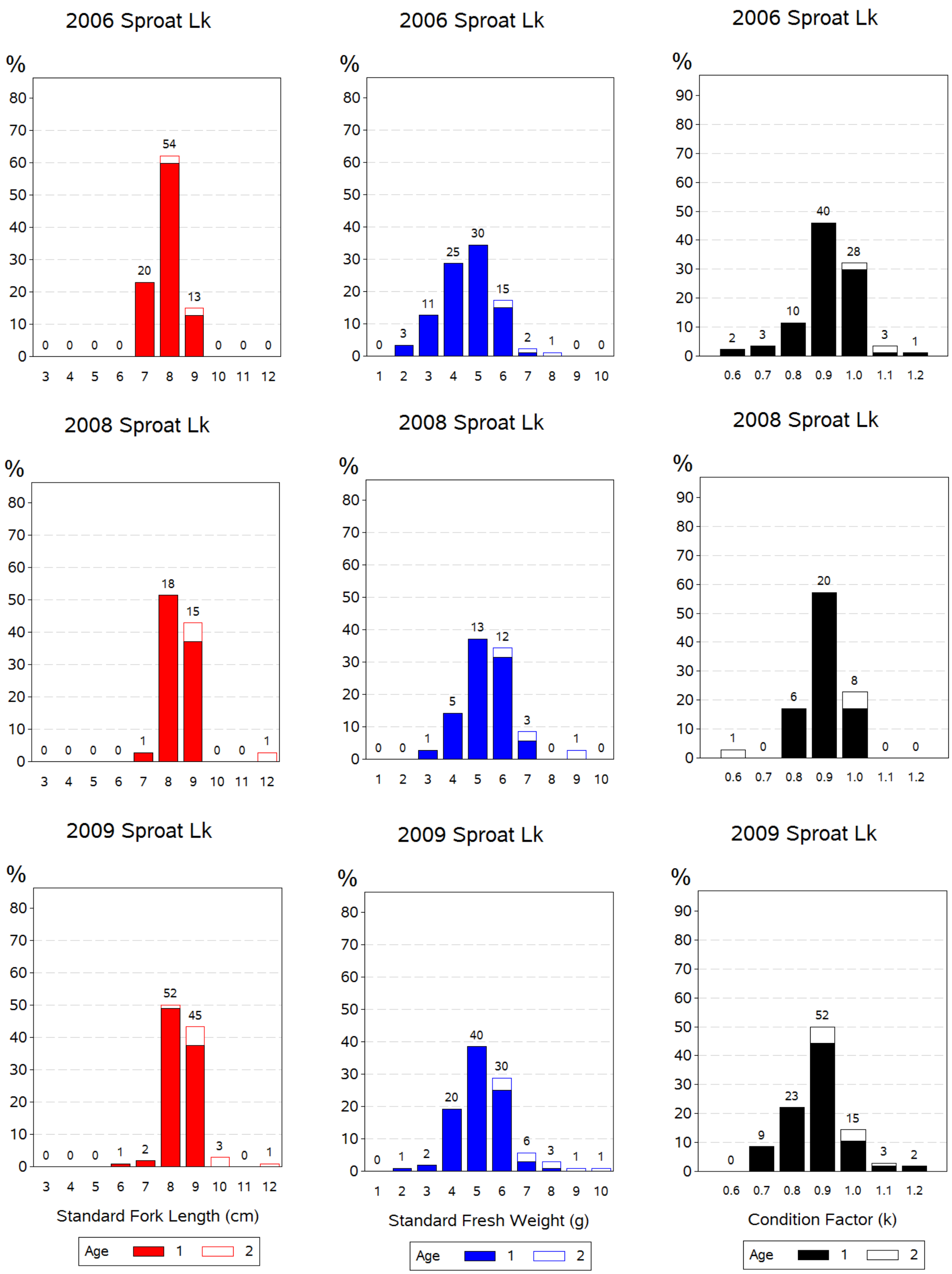

1989 Sproat Lk
%
0 0 0 14 492 560 45 9 6 0
1989 Sproat Lk
%
0 18 383 518 160 27 6 6 2 6
1989 Sproat Lk
%
0 9 229 786 97 4 1
1990 Sproat Lk
%
0 0 0 11 160 379 58 1 0 0
1990 Sproat Lk
%
0 22 104 252 181 38 11 0 1 0
1990 Sproat Lk
%
1 1 81 421 104 1 0
1991 Sproat Lk
%
0 0 2 85 498 401 74 13 2 0
1991 Sproat Lk
%
2 125 401 368 106 40 21 7 2 3
1991 Sproat Lk
%
0 11 307 621 131 4 1
Standard Fork Length (cm)
Age 1 2
Standard Fresh Weight (g)
Age 1 2
Condition Factor (k)
Age 1 2


1992 Sproat Lk
%
213
157
47
15
0 0 0 1 0 0
1992 Sproat Lk
%
152
109
84
40
41
3
4
0 0 0
1992 Sproat Lk
%
221
197
8
6
1
0 0
1993 Sproat Lk
%
514
238
86
83
0 0 1 1 0 0
1993 Sproat Lk
%
332
235
172
117
53
9
4
1 0 0
1993 Sproat Lk
%
543
241
115
19
5
0 0
1994 Sproat Lk
%
508
236
197
64
10
2
0 0 1 0
1994 Sproat Lk
%
330
252
148
143
92
34
7
5 5 2
1994 Sproat Lk
%
636
275
99
13
0 0 0
Standard Fork Length (cm)
Age 1 2
Standard Fresh Weight (g)
Age 1 2
Condition Factor (k)
Age 1 2

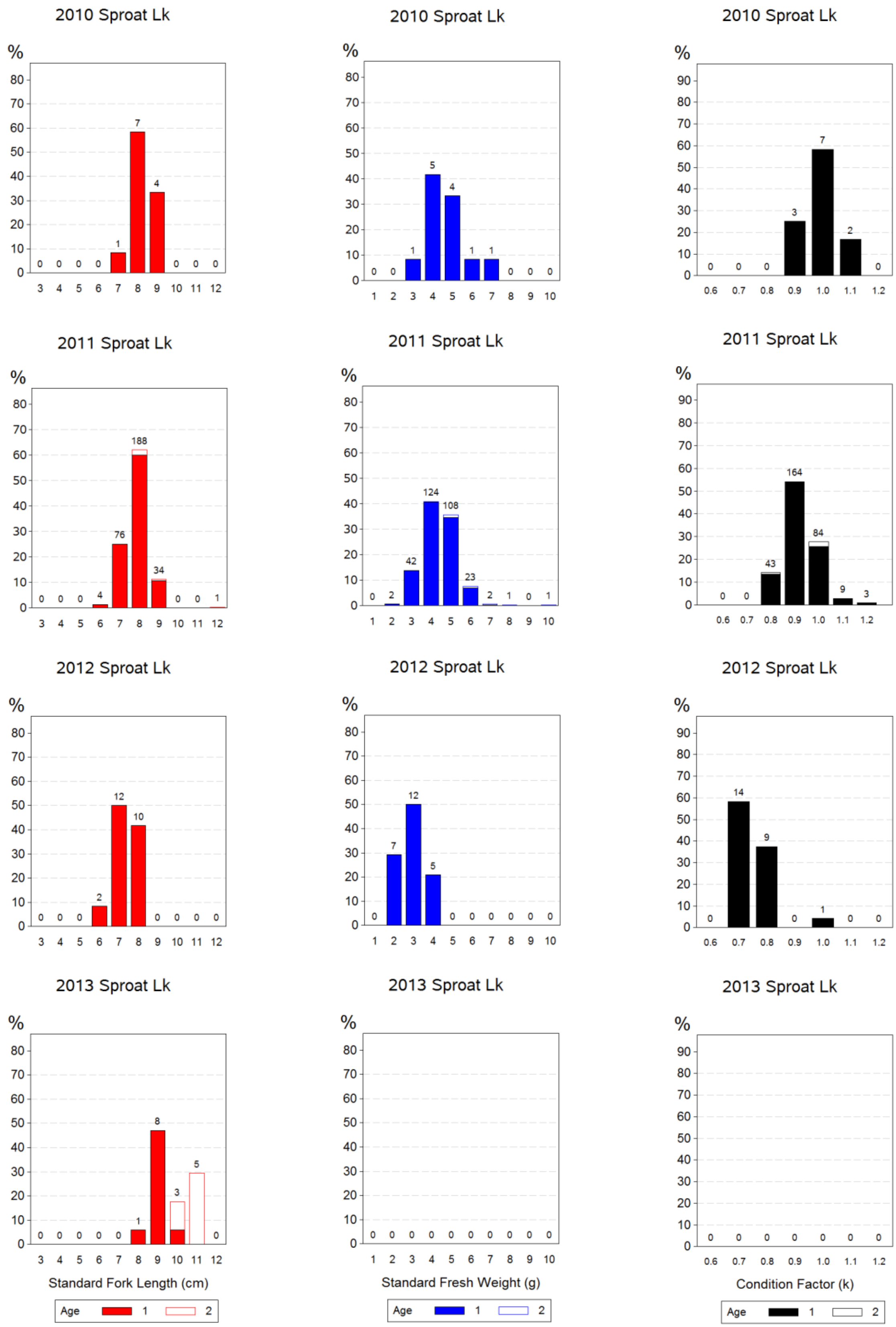

1995 Sproat Lk
%
0 0 3 162 453 356 58 3 0 0
3 4 5 6 7 8 9 10 11 12
1995 Sproat Lk
%
18 267 303 277 131 33 4 2 0 0
1 2 3 4 5 6 7 8 9 10
1995 Sproat Lk
%
6 61 415 496 54 0 3
0.6 0.7 0.8 0.9 1.0 1.1 1.2
1996 Sproat Lk
%
0 0 9 159 503 565 104 4 1 0
3 4 5 6 7 8 9 10 11 12
1996 Sproat Lk
%
29 199 325 437 259 74 18 3 0 1
1 2 3 4 5 6 7 8 9 10
1996 Sproat Lk
%
5 59 314 732 230 5 0
0.6 0.7 0.8 0.9 1.0 1.1 1.2
1997 Sproat Lk
%
0 0 0 44 247 429 131 18 1 1
3 4 5 6 7 8 9 10 11 12
Standard Fork Length (cm)
Age 1 2
1997 Sproat Lk
%
0 84 219 305 168 67 19 4 2 2
1 2 3 4 5 6 7 8 9 10
Standard Fresh Weight (g)
Age 1 2
1997 Sproat Lk
%
4 67 408 333 53 3 2
0.6 0.7 0.8 0.9 1.0 1.1 1.2
Condition Factor (k)
Age 1 2


1998 Sproat Lk
%
0 2 29 266 417 99 2 0 0 0
1998 Sproat Lk
%
32 243 341 163 32 3 1 0 0 0
1998 Sproat Lk
%
1 25 142 287 152 136 72
1999 Sproat Lk
%
0 0 1 96 557 333 47 7 1 0
1999 Sproat Lk
%
12 171 451 295 77 24 5 4 1 2
1999 Sproat Lk
%
5 65 519 417 35 1 0
2000 Sproat Lk
%
0 0 2 25 182 107 5 0 0 0
2000 Sproat Lk
%
2 41 144 100 31 2 1 0 0 0
2000 Sproat Lk
%
0 8 105 185 23 0 0
Standard Fork Length (cm)
Age 1
Standard Fresh Weight (g)
Age 1
Condition Factor (k)
Age 1


2001 Sproat Lk
%
0 0 25 194 287 35 2 0 0 0
3 4 5 6 7 8 9 10 11 12
2001 Sproat Lk
%
51 262 190 35 4 0 0 0 0 0
1 2 3 4 5 6 7 8 9 10
2001 Sproat Lk
%
1 32 291 210 8 0 0
0.6 0.7 0.8 0.9 1.0 1.1 1.2
2002 Sproat Lk
%
0 0 0 45 154 32 0 0 0 0
3 4 5 6 7 8 9 10 11 12
2002 Sproat Lk
%
4 76 118 32 1 0 0 0 0 0
1 2 3 4 5 6 7 8 9 10
2002 Sproat Lk
%
3 31 102 83 12 0 0
0.6 0.7 0.8 0.9 1.0 1.1 1.2
2003 Sproat Lk
%
0 0 0 1 4 4 1 0 0 0
3 4 5 6 7 8 9 10 11 12
Standard Fork Length (cm)
Age 1
2003 Sproat Lk
%
0 3 3 1 2 1 0 0 0 0
1 2 3 4 5 6 7 8 9 10
Standard Fresh Weight (g)
Age 1
2003 Sproat Lk
%
1 1 2 4 2 0 0
0.6 0.7 0.8 0.9 1.0 1.1 1.2
Condition Factor (k)
Age 1



2006 Sproat Lk
2006 Sproat Lk
2006 Sproat Lk
2008 Sproat Lk
2008 Sproat Lk
2008 Sproat Lk
2009 Sproat Lk
2009 Sproat Lk
2009 Sproat Lk
%
Standard Fork Length (cm)
Standard Fresh Weight (g)
Condition Factor (k)
Age 1 2
Age 1 2
Age 1 2


2010 Sproat Lk
2010 Sproat Lk
2010 Sproat Lk
2011 Sproat Lk
2011 Sproat Lk
2011 Sproat Lk
2012 Sproat Lk
2012 Sproat Lk
2012 Sproat Lk
2013 Sproat Lk
2013 Sproat Lk
2013 Sproat Lk
%
Standard Fork Length (cm)
Standard Fresh Weight (g)
Condition Factor (k)
Age 1 2
Age 1 2
Age 1 2

APPENDIX V – Annual Length/Weight Relations

Appendix V. Sproat Lake Sockeye smolt length-to-weight relationships
(model: Std Weight = a · ForkLength ^{b}) by ocean entry year and age class.

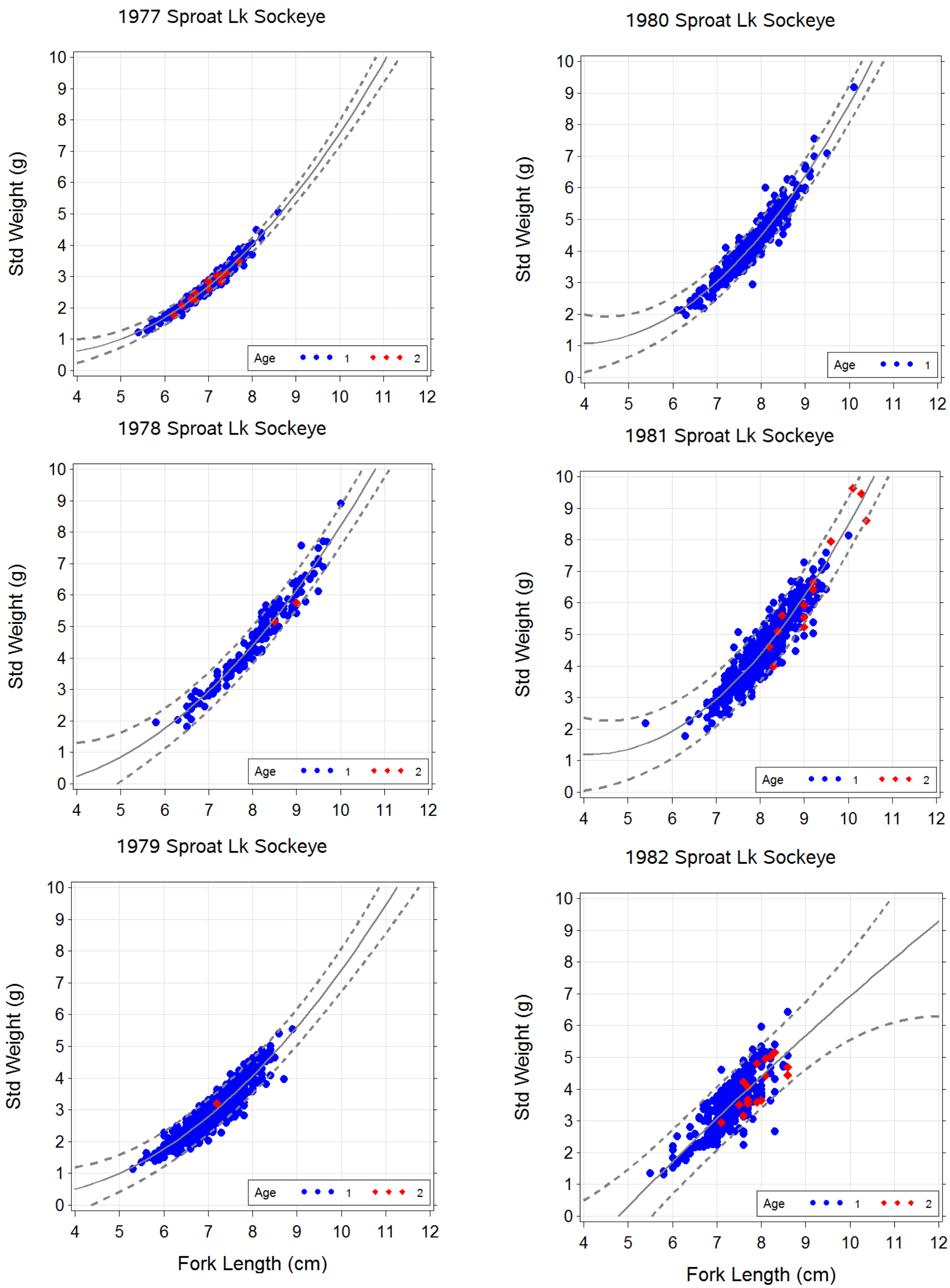
Stock Sproat Lk

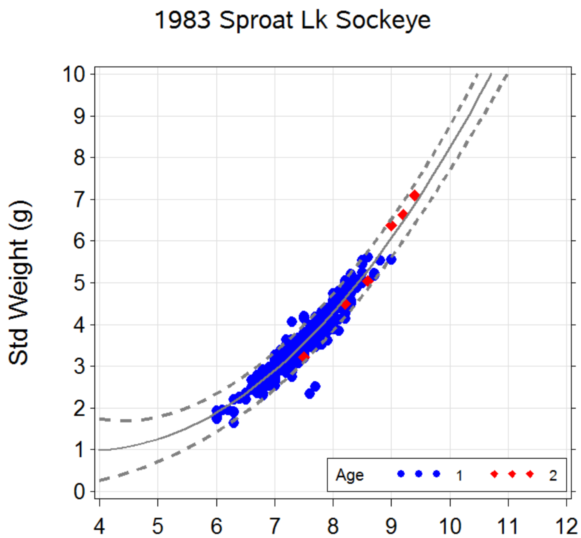
	Age							
	1				2			
	a	b	Rsq	N	a	b	Rsq	N
Year								
1977	0.0076	3.013	0.97	241	0.0089	2.935	0.95	11
1978	0.0091	2.967	0.96	166	0.0778	1.959	1.00	0
1979	0.0099	2.892	0.86	636	3.2000	0.000		0
1980	0.0096	2.958	0.92	437				
1981	0.0086	2.991	0.84	547	0.0046	3.260	0.90	11
1982	0.0076	3.069	0.68	380	0.0187	2.602	0.58	14
1983	0.0096	2.931	0.91	392	0.0025	3.549	0.99	5
1984	0.0097	2.944	0.88	481	0.0097	2.933	0.90	12
1985	0.0095	2.929	0.91	311				
1986	0.0083	2.991	0.93	209	0.0344	2.364	1.00	0
1987	0.0077	3.079	0.95	516	0.0179	2.690	0.96	46
1988	0.0098	2.947	0.93	1133	0.0218	2.568	0.96	13
1989	0.0132	2.801	0.91	1097	0.0121	2.838	0.95	22
1990	0.0082	3.046	0.93	579	0.0209	2.596	0.89	26
1991	0.0132	2.794	0.92	967	0.0125	2.831	0.90	104
1992	0.0079	3.038	0.95	410	0.0550	2.140	0.51	19
1993	0.0078	3.062	0.95	907	0.0112	2.874	0.73	12
1994	0.0074	3.086	0.97	986	0.0087	3.011	0.95	31

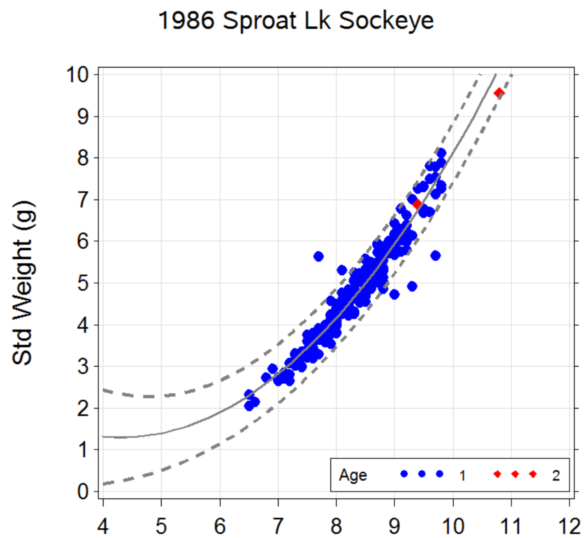
(Continued)

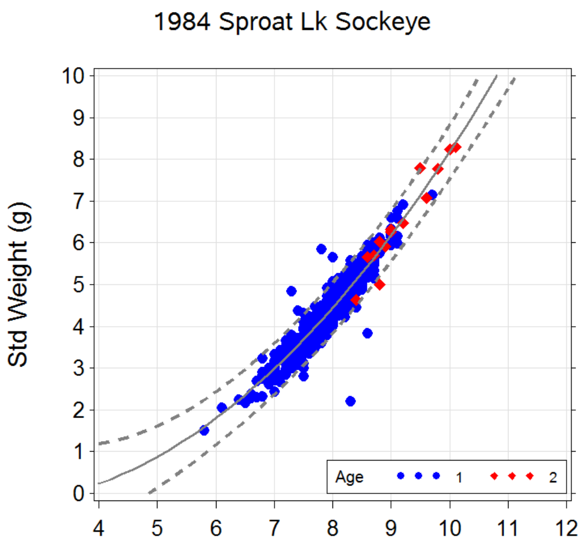
Stock Sproat Lk

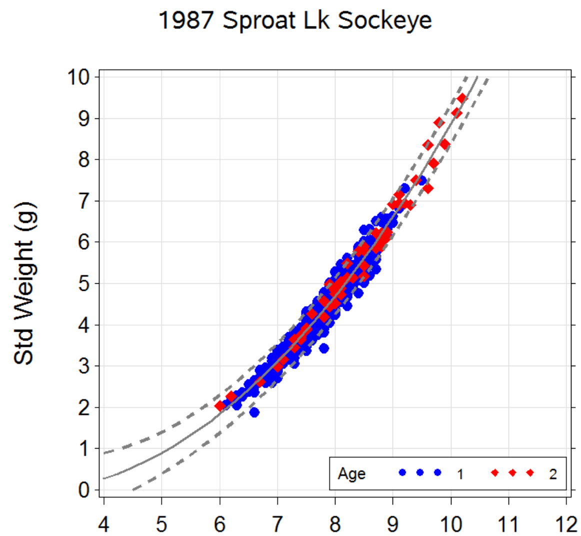
	Age							
	1				2			
	a	b	Rsq	N	a	b	Rsq	N
Year								
1995	0.0057	3.205	0.95	1003	0.0104	2.914	0.96	28
1996	0.0051	3.271	0.95	1291	0.0081	3.039	0.89	50
1997	0.0112	2.861	0.91	847	0.0233	2.535	0.89	17
1998	0.0120	2.878	0.83	812	6.6182	0.000		0
1999	0.0065	3.129	0.93	986	0.0186	2.624	0.93	51
2000	0.0075	3.074	0.95	318	4.0624	0.000		0
2001	0.0078	3.035	0.95	534	0.0535	2.110	0.99	4
2002	0.0080	3.018	0.85	228	3.9151	0.000		0
2003	0.0019	3.749	0.91	8				
2006	0.0072	3.109	0.82	81	0.0476	2.294	0.98	2
2008	0.0188	2.649	0.86	30	0.6923	1.040	0.97	1
2009	0.0326	2.376	0.75	91	0.0342	2.417	0.89	8
2010	0.0140	2.773	0.91	10				
2011	0.0271	2.471	0.88	292	0.2410	1.508	0.28	6
2012	0.0228	2.439	0.88	22				
Average	0.0107	2.957	0.90	514	0.6872	2.201	0.87	18

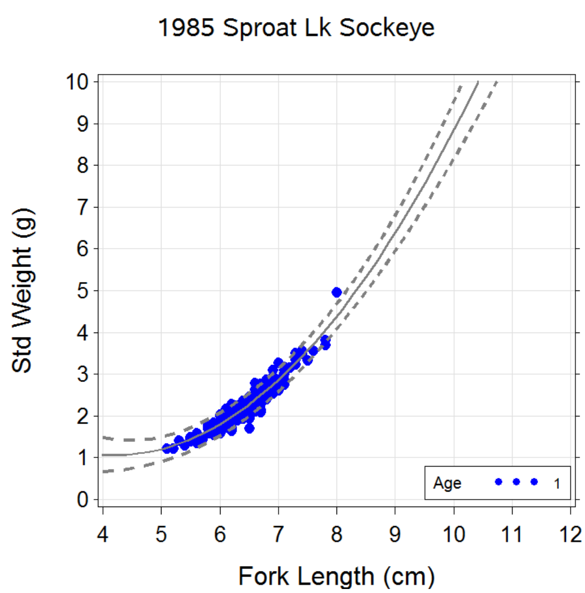

1977 Sproat Lk Sockeye
1980 Sproat Lk Sockeye
1978 Sproat Lk Sockeye
1981 Sproat Lk Sockeye
1979 Sproat Lk Sockeye
1982 Sproat Lk Sockeye
Std Weight (g)
Fork Length (cm)
Age 1 2

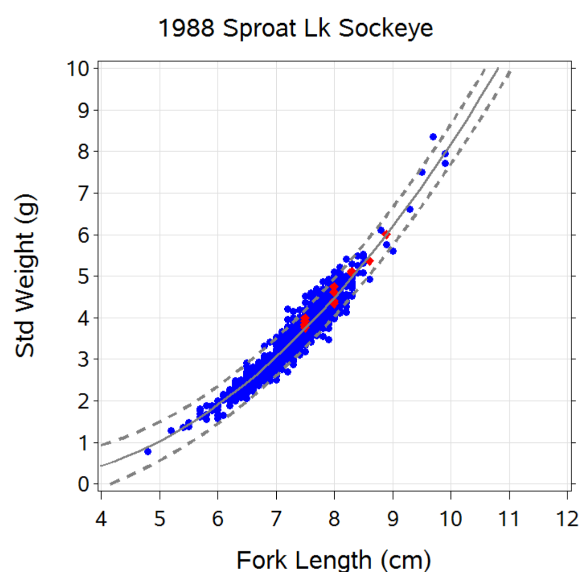

1983 Sproat Lk Sockeye
Std Weight (g)
Age 1 2


1986 Sproat Lk Sockeye
Std Weight (g)
Age 1 2

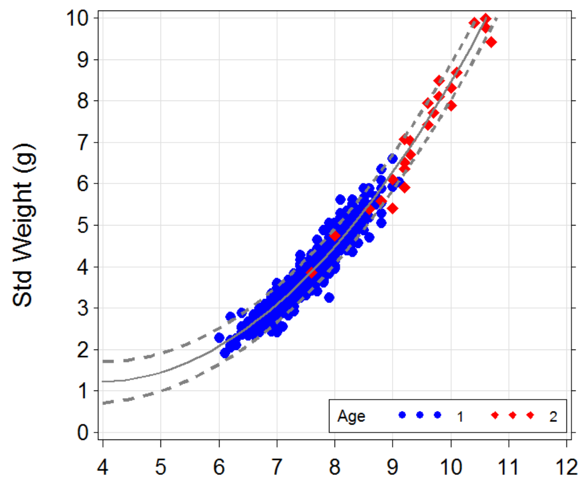

1984 Sproat Lk Sockeye
Std Weight (g)
Age 1 2


1987 Sproat Lk Sockeye
Std Weight (g)
Age 1 2

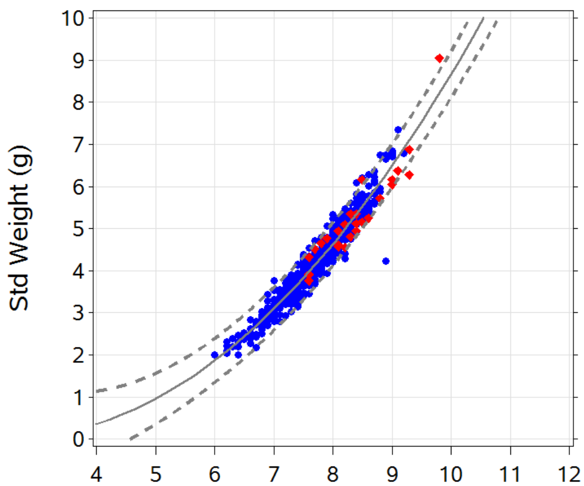

1985 Sproat Lk Sockeye
Std Weight (g)
Age 1
Fork Length (cm)


1988 Sproat Lk Sockeye
Std Weight (g)
Fork Length (cm)

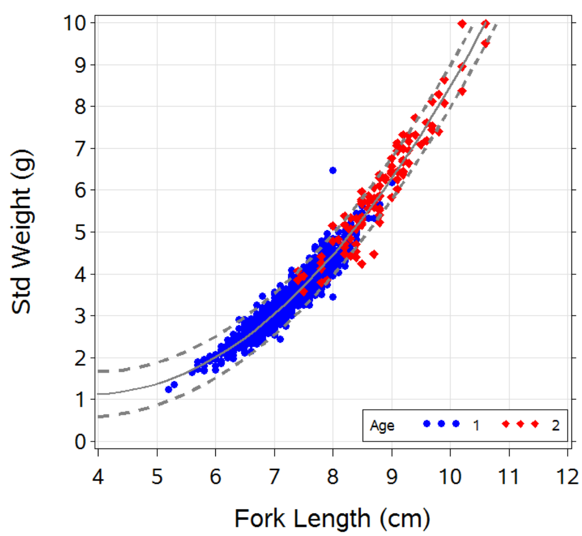
1989 Sproat Lk Sockeye



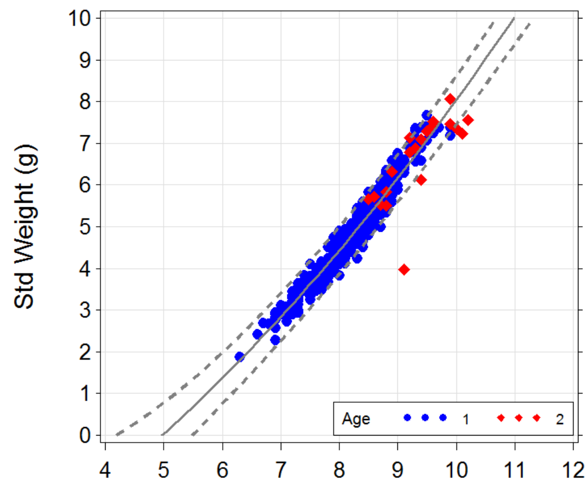
1990 Sproat Lk Sockeye



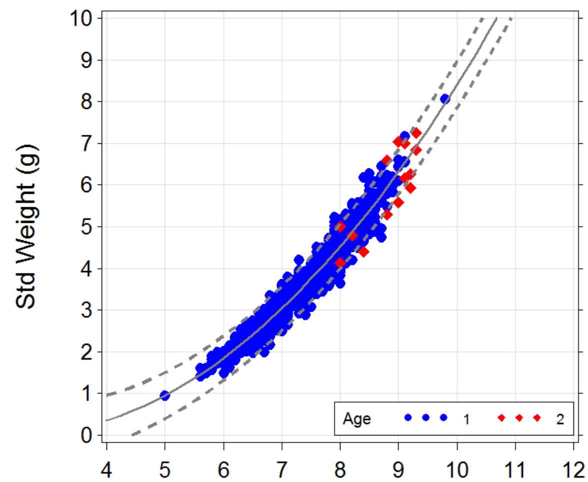
1991 Sproat Lk Sockeye



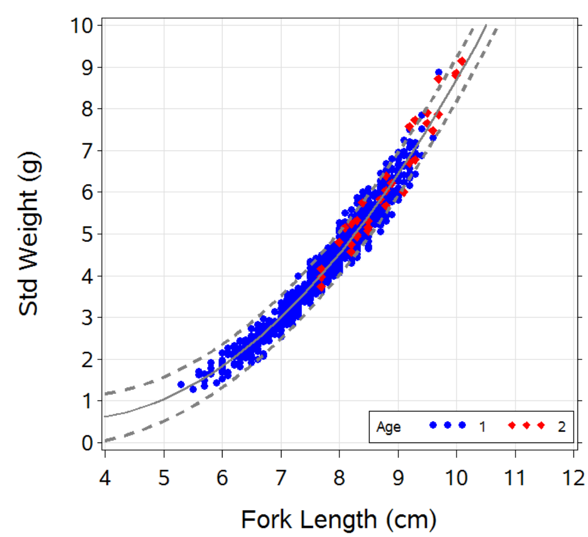
1992 Sproat Lk Sockeye



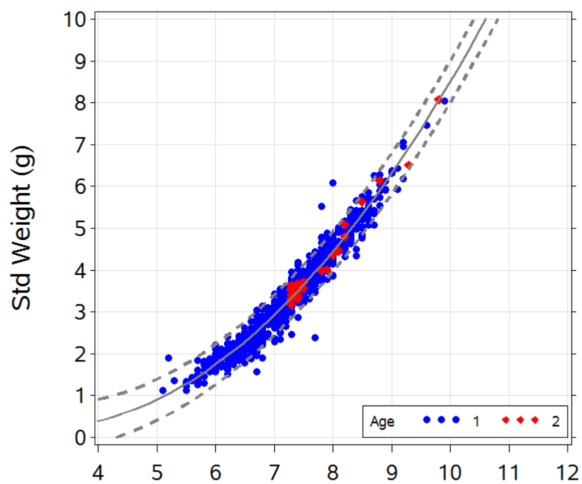
1993 Sproat Lk Sockeye



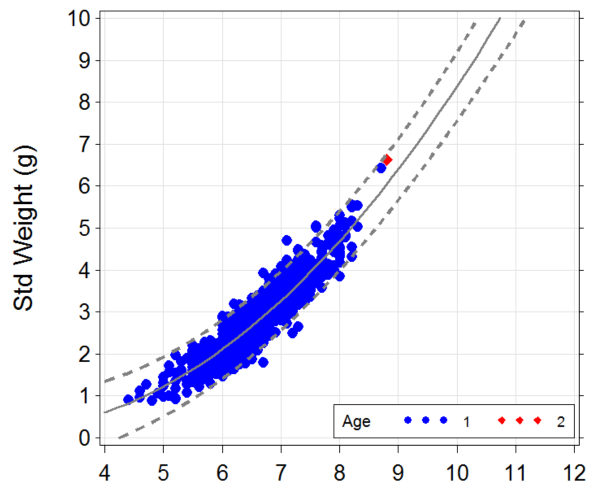
1994 Sproat Lk Sockeye



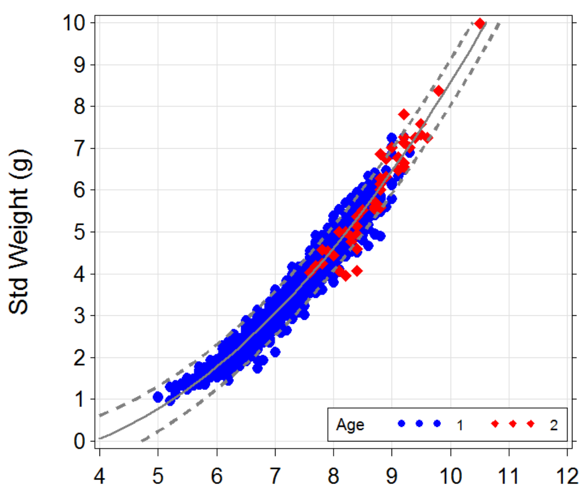
1995 Sproat Lk Sockeye



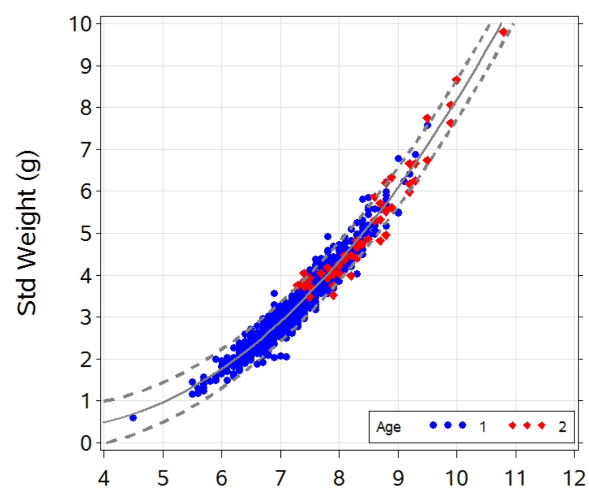
1998 Sproat Lk Sockeye



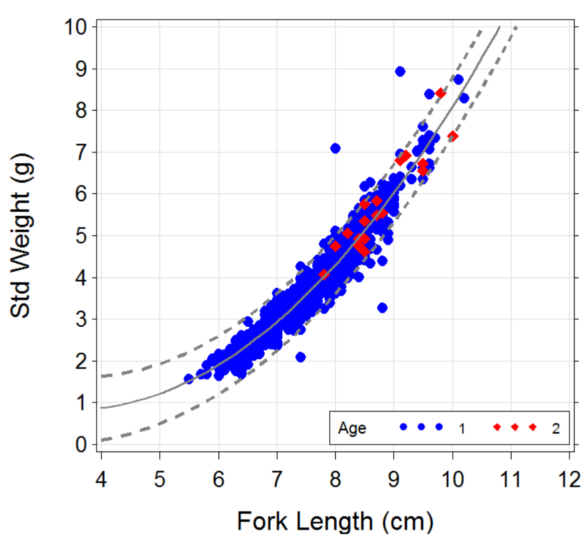
1996 Sproat Lk Sockeye



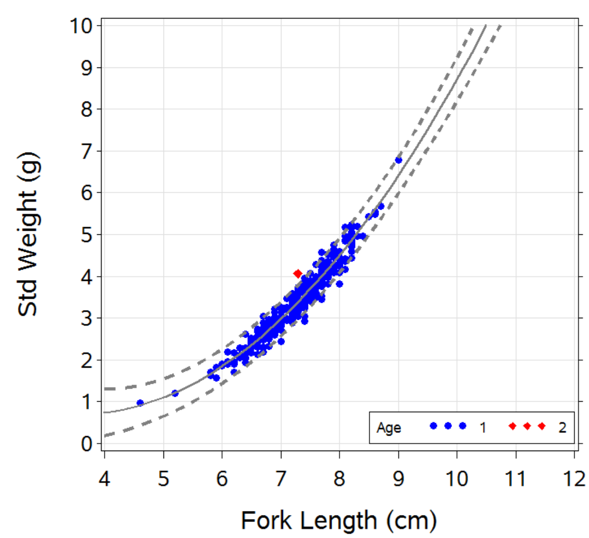
1999 Sproat Lk Sockeye



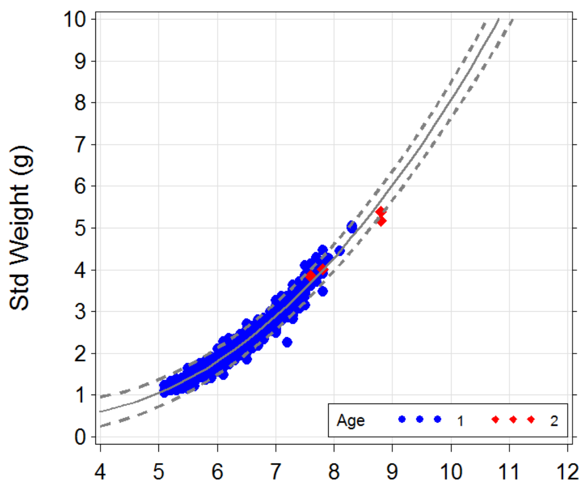
1997 Sproat Lk Sockeye



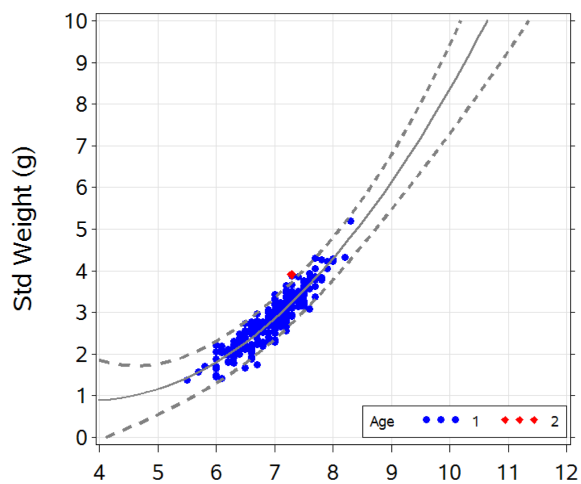
2000 Sproat Lk Sockeye



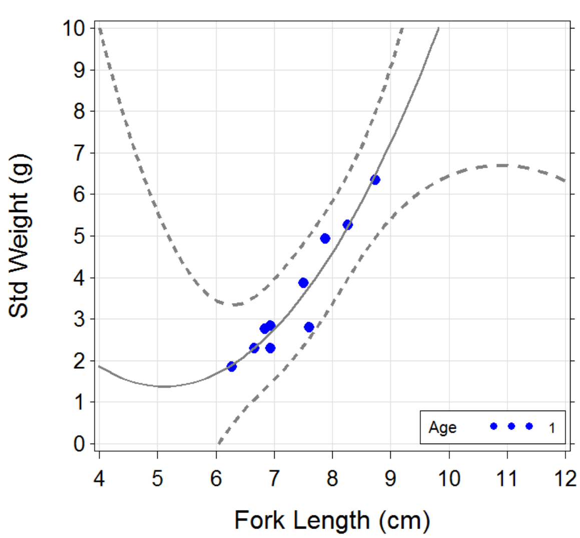
2001 Sproat Lk Sockeye



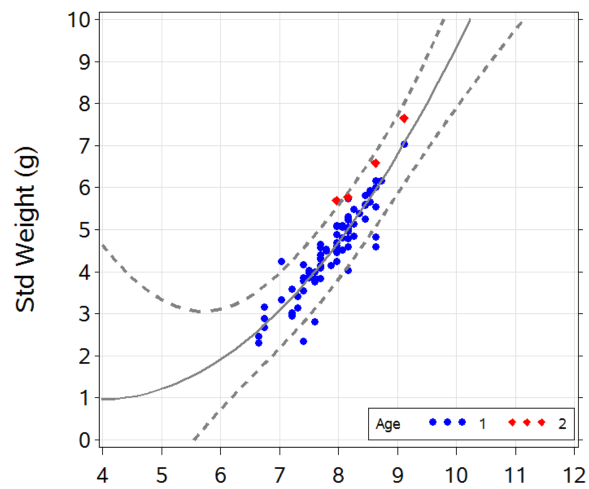
2002 Sproat Lk Sockeye



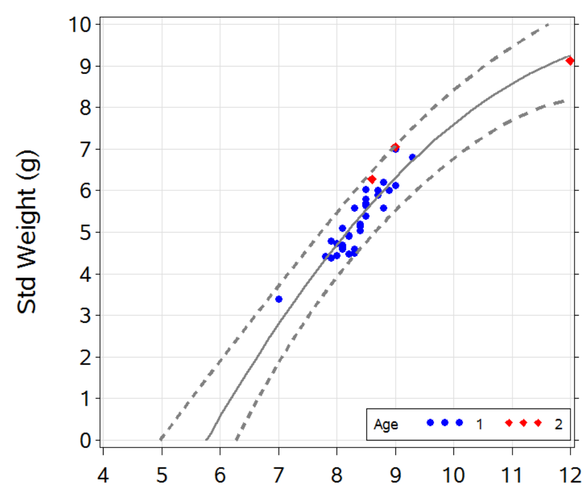
2003 Sproat Lk Sockeye



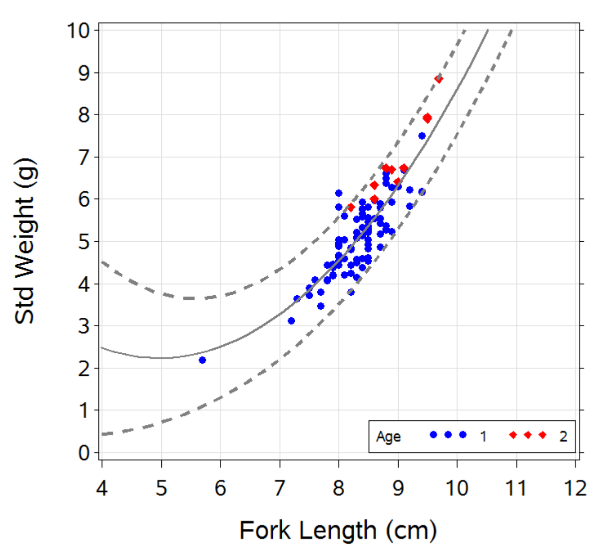
2006 Sproat Lk Sockeye

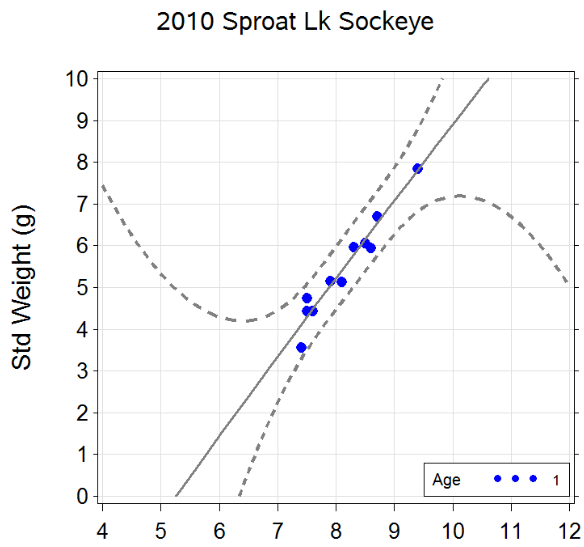


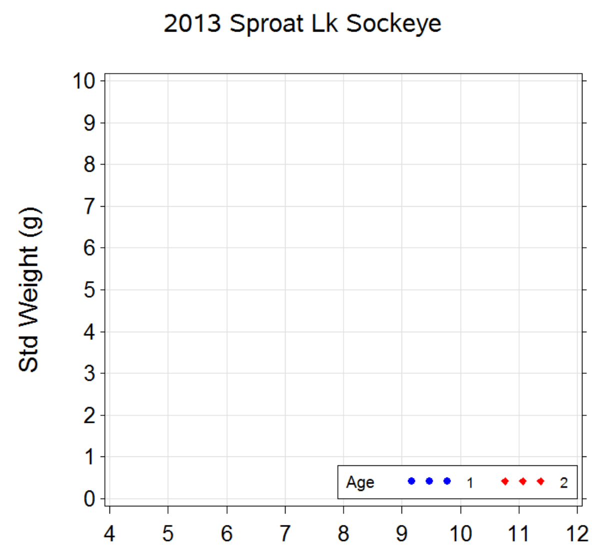
2008 Sproat Lk Sockeye

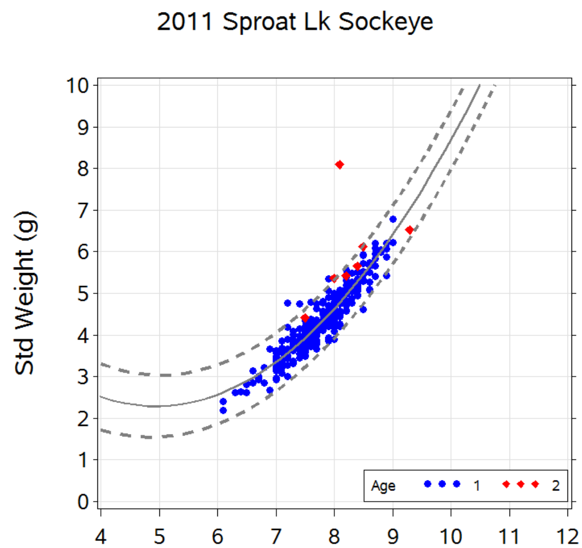


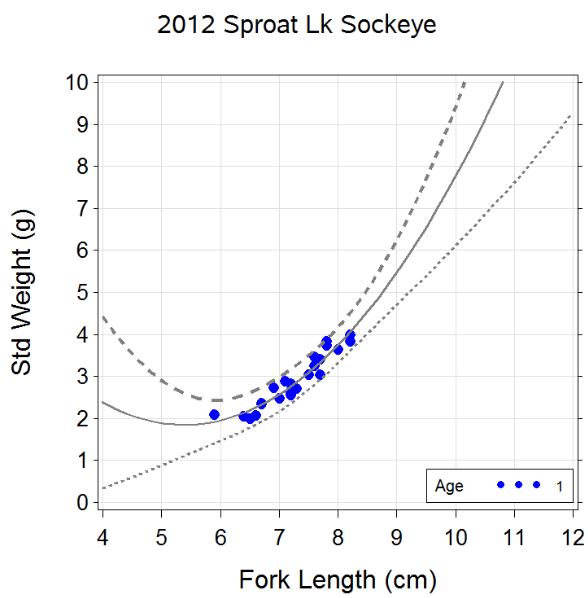
2009 Sproat Lk Sockeye




2010 Sproat Lk Sockeye
Std Weight (g)
0 1 2 3 4 5 6 7 8 9 10
4 5 6 7 8 9 10 11 12
Age 1


2013 Sproat Lk Sockeye
Std Weight (g)
0 1 2 3 4 5 6 7 8 9 10
4 5 6 7 8 9 10 11 12
Age 1 2


2011 Sproat Lk Sockeye
Std Weight (g)
0 1 2 3 4 5 6 7 8 9 10
4 5 6 7 8 9 10 11 12
Age 1 2


2012 Sproat Lk Sockeye
Std Weight (g)
0 1 2 3 4 5 6 7 8 9 10
4 5 6 7 8 9 10 11 12
Age 1
Fork Length (cm)

APPENDIX VI – Annual Pre-Smolt & Smolt Statistics

Appendix VI. Annual Sockeye smolt size statistics and pre-smolt size and abundance (K. D. Hyatt and D. P. Rankin unpub. data). Stepwise regression analysis retains only pre-smolt length (P = 0.001) and an interaction term for pre-smolt forklength x week of ATS sample date (P = 0.07).

Annual Smolt and Pre-Smolt Size Data

Smolt Year	ATS Date	Week Since July	Juvenile Sockeye Abundance	Juvenile Sockeye Density	PreSmolt Forklength	Smolt Forklength	Smolt Weight (g)
1980	26FEB80	35	4,624,000	1,220	69	77	4.1
1981	20JAN81	30	5,684,000	1,550	70	81	4.6
1982	03DEC81	23	8,336,000	2,210	.	72	3.5
1983	02MAR83	36	8,427,000	2,230	63	74	3.5
1984	28NOV83	23	9,639,000	2,550	64	79	4.3
1985	01OCT84	14	19,564,000	5,180	52	64	2.2
1986	27SEP85	13	6,970,000	1,850	.	83	4.7
1987	30OCT86	18	5,037,000	1,320	64	77	4.3
1988	27JAN88	31	8,890,000	2,350	66	72	3.5
1989	01NOV88	19	9,187,000	2,430	67	75	3.8
1990	18OCT89	16	11,183,000	2,960	.	77	4.2
1991	06FEB91	32	8,541,000	2,260	.	72	3.4
1992	16OCT91	16	5,883,000	1,560	73	82	4.8
1993	26OCT92	18	3,373,000	890	68	77	3.9
1994	27JUL93	5	5,990,000	2,700	.	79	4.4
1995	31JAN95	31	5,895,000	1,560	67	73	3.3
1996	30JAN96	31	9,780,000	1,720	58	74	3.7
1997	26FEB97	35	4,761,000	1,270	73	77	4.0
1998	19NOV97	21	18,123,000	4,970	51	66	2.9
1999	01DEC98	23	8,233,000	2,180	64	73	3.6
2000	30NOV99	23	8,462,000	2,240	67	73	3.4
2001	28NOV00	23	9,679,000	2,560	55	67	2.4
2002	05DEC01	23	7,478,000	2,070	68	68	2.8
2003	16JAN03	29	4,773,000	1,264	74	74	3.5
2004	19JAN04	30	8,637,000	2,290	67	.	.
2005	26JAN05	31	6,703,000	1,775	74	.	.
2006	04JAN06	27	3,525,000	934	74	79	4.6
2007	07FEB07	32	3,660,000	970	67	.	.
2008	09NOV07	19	5,048,000	1,351	73	84	5.4
2009	01DEC08	23	6,017,000	1,594	72	83	5.3
2010	30NOV09	23	4,980,000	600	.	81	5.5
2011	30NOV10	23	14,526,189	3,848	66	78	5.0
2012	21NOV11	22	13,444,391	3,561	62	72	2.9
2013	26FEB13	35	14,526,189	3,848	60	.	.
2014	19NOV13	21	3,687,000	1,000	70	.	.
2015	17FEB15	34	1,210,000	321	76	.	.
2016	17FEB16	34	4,150,000	1,099	75	.	.

(Continued)

Annual Smolt and Pre-Smolt Size Data

The REG Procedure
Model: MODEL1
Dependent Variable: SmoltForklength SmoltForklength

Number of Observations Read	37
Number of Observations Used	24
Number of Observations with Missing Values	13

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	372.50708	372.50708	31.23	<.0001
Error	22	262.45126	11.92960		
Corrected Total	23	634.95833			

Root MSE	3.45393	R-Square	0.5867
Dependent Mean	74.95833	Adj R-Sq	0.5679
Coeff Var	4.60779		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	34.59493	7.25759	4.77	<.0001
PreSmoltForklength	PreSmoltForklength	1	0.61304	0.10971	5.59	<.0001

Annual Smolt and Pre-Smolt Size Data

The REG Procedure
Model: MODEL4
Dependent Variable: SmoltForklength SmoltForklength

Number of Observations Read	37
Number of Observations Used	24
Number of Observations with Missing Values	13

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	417.91714	139.30571	12.84	<.0001
Error	20	217.04119	10.85206		
Corrected Total	23	634.95833			

Root MSE	3.29425	R-Square	0.6582
Dependent Mean	74.95833	Adj R-Sq	0.6069
Coeff Var	4.39477		

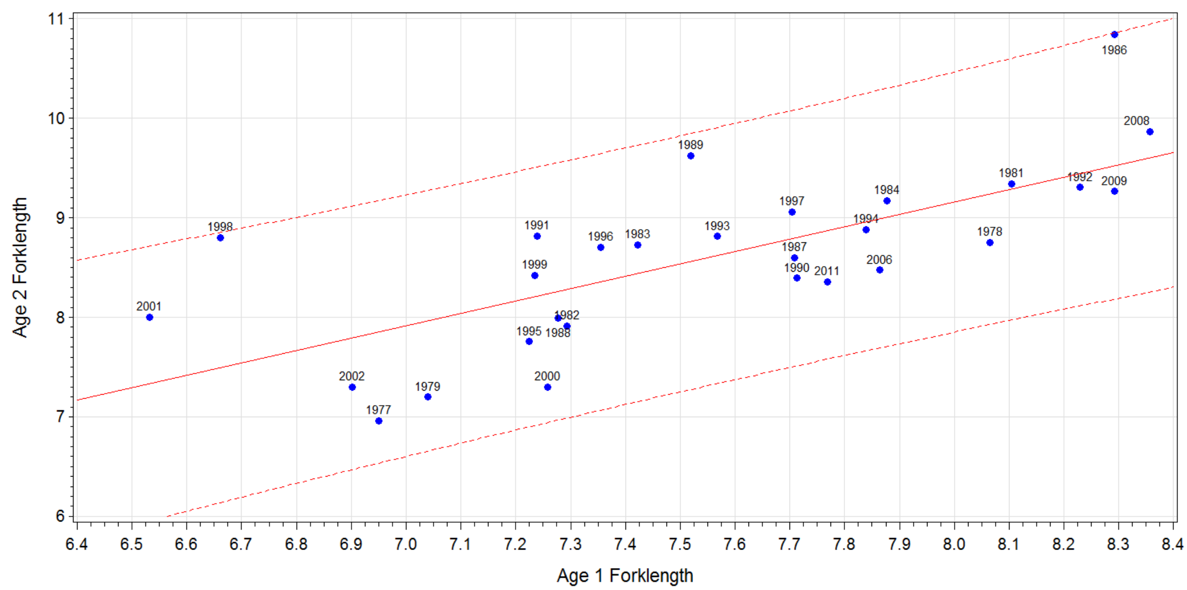
Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	181.72125	143.86638	1.26	0.2211
Year	Smolt Year	1	-0.05310	0.07207	-0.74	0.4698
STD_PreSmoltForklength	PreSmoltForklength	1	3.47447	0.75856	4.58	0.0002
STD_Presmolt_Inter_Time	Presmolt x Week	1	-1.64743	0.83956	-1.96	0.0638

APPENDIX VII – Annual Size-at-Age Correlation

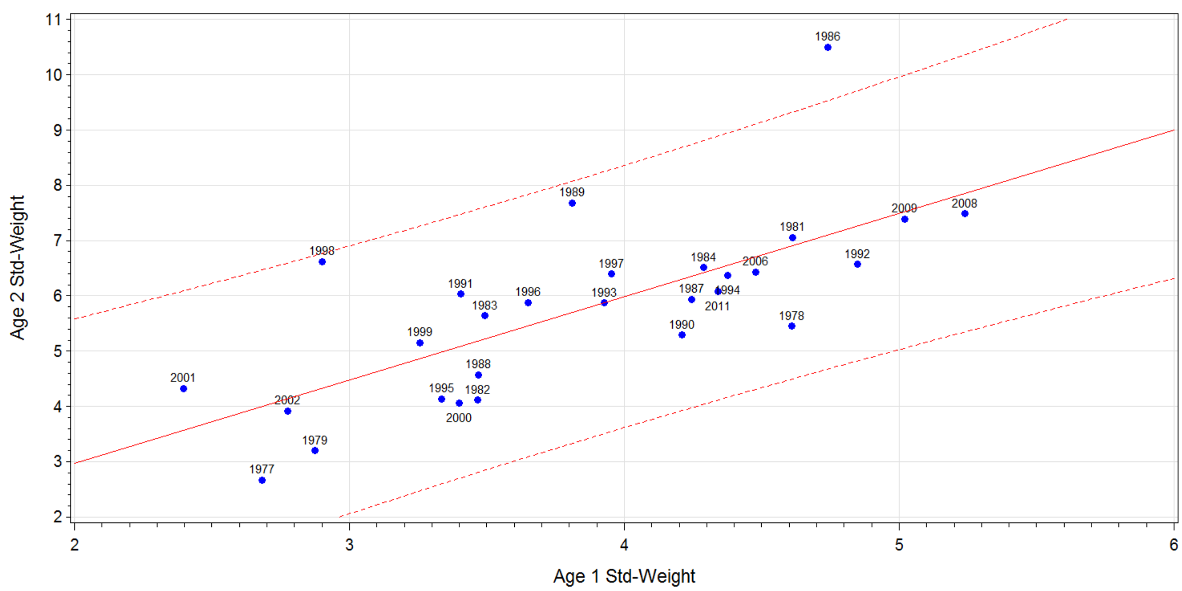
Appendix VII. Correlation of mean annual age 2 versus age 1 smolt forklength (cm; top) and standard weight (grams; bottom), 1977 - 2012. For use in estimating missing mean annual age 2 size (see Appendix VIII).

Sproat Lake Sockeye - Mean Annual Forklength



Regression Equation:
FL_Age2 = -0.773883 + 1.241411*FL_Age1

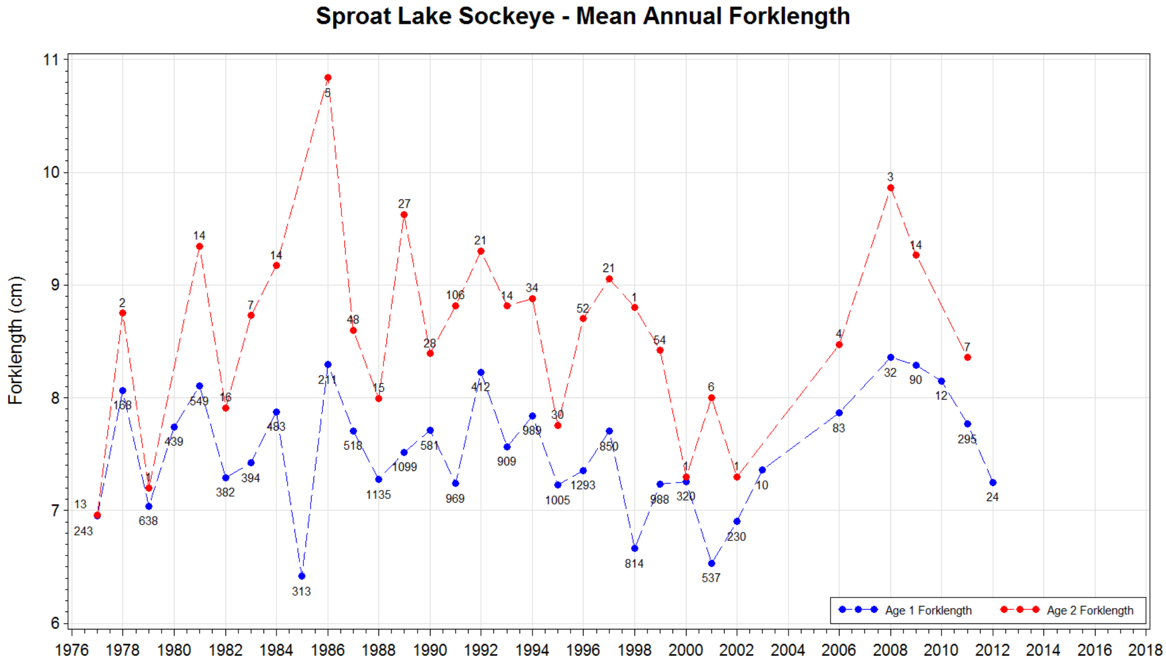
Sproat Lake Sockeye - Mean Annual Std Weight

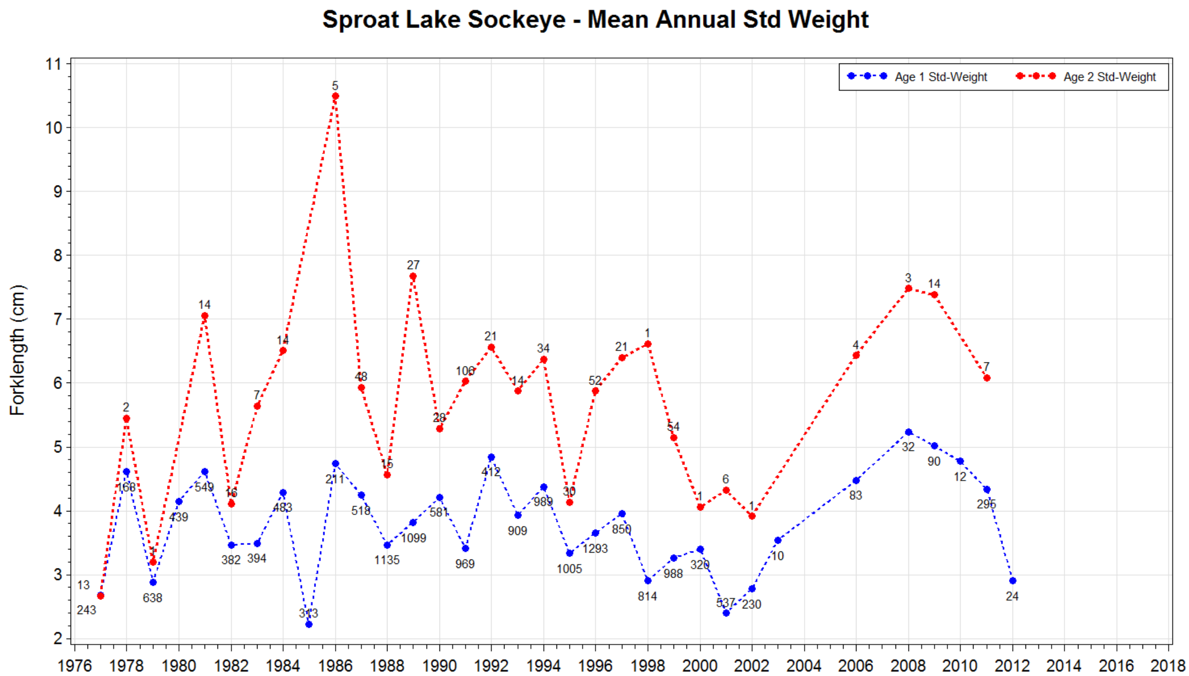


Regression Equation:
Wt_Age2 = -0.040794 + 1.506959*Wt_Age1

APPENDIX VIII – Mean Annual Size Statistics by Age Class

Appendix VIII. Observed mean annual smolt forklength (cm; top) and standard weight (grams; bottom), 1977 – 2012, with sample sizes, by age class. For use in estimating missing mean annual age 2 size (see Appendix VII). Note years where N<10 for age 2 fish.





APPENDIX IX - Sample Meta-Data

Appendix IX. Sample meta-data, including total catch (where available) and total fish sampled by sample date, sample site, gear type, agency (sampling crews: PBS-DFO, consultants) and fish preservative code and type.

Sproat River

				FYKE	
				Catch	Sampled
Year	Date	Agency	Preservative		
1977	05MAY77	PBS	99 Formalin		10
	06MAY77	PBS	99 Formalin		87
	11MAY77	PBS	99 Formalin		141
	25MAY77	PBS	99 Formalin		8
	26MAY77	PBS	99 Formalin		10
1978	25APR78	PBS	99 Formalin		99
	10MAY78	PBS	99 Formalin		16
	17MAY78	PBS	99 Formalin		55
1979	18APR79	PBS	01 Formalin		108
	25APR79	PBS	01 Formalin		115
	01MAY79	PBS	01 Formalin		100
	09MAY79	PBS	01 Formalin		100
	15MAY79	PBS	01 Formalin		104
	23MAY79	PBS	01 Formalin		106
	30MAY79	PBS	01 Formalin		7
1980	21APR80	PBS	01 Formalin		108
	28APR80	PBS	01 Formalin		85
	05MAY80	PBS	01 Formalin		100
	15MAY80	PBS	01 Formalin		75
	26MAY80	PBS	01 Formalin		71
1981	28APR81	PBS	01 Formalin		140
	05MAY81	PBS	01 Formalin		58
	11MAY81	PBS	01 Formalin		148
	19MAY81	PBS	01 Formalin		62
	25MAY81	PBS	01 Formalin		100
	02JUN81	PBS	01 Formalin		55
1982	30APR82	PBS	01 Formalin		100
	13MAY82	PBS	01 Formalin		100
	26MAY82	PBS	01 Formalin		198
1983	19APR83	PBS	01 Formalin		100
	26APR83	PBS	01 Formalin		99
	10MAY83	PBS	01 Formalin		100
	17MAY83	PBS	01 Formalin		67
	25MAY83	PBS	01 Formalin		35
1984	16APR84	PBS	01 Formalin		100
	25APR84	PBS	01 Formalin		100
	07MAY84	PBS	01 Formalin		99
	16MAY84	PBS	01 Formalin		98
	28MAY84	PBS	01 Formalin		100
1985	24APR85	PBS	01 Formalin		152
	01MAY85	PBS	01 Formalin		13
	15MAY85	PBS	01 Formalin		148
1986	05MAY86	PBS	01 Formalin		113
	13MAY86	PBS	01 Formalin		103
1987	14APR87	PBS	01 Formalin	23	29
	21APR87	PBS	01 Formalin	180	191
	29APR87	PBS	01 Formalin	85	119
	05MAY87	PBS	01 Formalin	95	100
1987	12MAY87	PBS	01 Formalin	87	98
	20MAY87	PBS	01 Formalin	25	27
	28MAY87	PBS	01 Formalin	1	1
	04JUN87	PBS	01 Formalin	1	1
1988	05APR88	PBS	01 Formalin		4
	13APR88	PBS	01 Formalin		200
	20APR88	PBS	01 Formalin		200
	28APR88	PBS	01 Formalin		200
	04MAY88	PBS	01 Formalin		200
	11MAY88	PBS	01 Formalin		123
	18MAY88	PBS	01 Formalin		168
	25MAY88	PBS	01 Formalin		47
	02JUN88	PBS	01 Formalin		8
1989	06APR89	PBS	01 Formalin		20
	13APR89	PBS	01 Formalin		102
	19APR89	PBS	01 Formalin		69
	27APR89	PBS	01 Formalin		288
	03MAY89	PBS	01 Formalin		223
	10MAY89	PBS	01 Formalin		199
	17MAY89	PBS	01 Formalin		179
	25MAY89	PBS	01 Formalin		13
	01JUN89	PBS	01 Formalin		6
1990	04APR90	PBS	01 Formalin		4
	10APR90	PBS	01 Formalin		69
	18APR90	PBS	01 Formalin		136
	25APR90	PBS	01 Formalin		164
	02MAY90	PBS	01 Formalin		15
	03MAY90	PBS	01 Formalin		5
	10MAY90	PBS	01 Formalin		145
	16MAY90	PBS	01 Formalin		45
	24MAY90	PBS	01 Formalin		13
	31MAY90	PBS	01 Formalin		9
	06JUN90	PBS	01 Formalin		1
	13JUN90	PBS	01 Formalin		3
1991	10APR91	PBS	01 Formalin	238	200
	17APR91	PBS	01 Formalin	108	106
	24APR91	PBS	01 Formalin	177	166
	01MAY91	PBS	01 Formalin	228	200
	08MAY91	PBS	01 Formalin	563	200
	15MAY91	PBS	01 Formalin	169	170
	22MAY91	PBS	01 Formalin	8	7
	29MAY91	PBS	01 Formalin	27	26
1992	31MAR92	PBS	01 Formalin		3
	07APR92	PBS	01 Formalin		4
	14APR92	PBS	01 Formalin		7
	21APR92	PBS	01 Formalin		152

(Continued)

Sproat River

Year	Date	Agency	Preservative	FYKE Catch	FYKE Sampled
1992	28APR92	PBS	01 Formalin		174
	05MAY92	PBS	01 Formalin		86
	12MAY92	PBS	01 Formalin		7
1993	30MAR93	PBS	01 Formalin	0	0
	06APR93	PBS	01 Formalin	2	2
	14APR93	PBS	01 Formalin	141	135
	21APR93	PBS	01 Formalin	428	195
	28APR93	PBS	01 Formalin	618	198
	05MAY93	PBS	01 Formalin	108	106
	12MAY93	PBS	01 Formalin	160	162
	19MAY93	PBS	01 Formalin	29	25
	27MAY93	PBS	01 Formalin	70	72
	02JUN93	PBS	01 Formalin	11	11
	08JUN93	PBS	01 Formalin	3	3
	16JUN93	PBS	01 Formalin	0	0
1994	31MAR94	PBS	01 Formalin		99
	07APR94	PBS	01 Formalin		89
	14APR94	PBS	01 Formalin		200
	20APR94	PBS	01 Formalin		72
	27APR94	PBS	01 Formalin		200
	05MAY94	PBS	01 Formalin		200
	12MAY94	PBS	01 Formalin		132
	18MAY94	PBS	01 Formalin		12
	26MAY94	PBS	01 Formalin		14
	02JUN94	PBS	01 Formalin		5
1995	05APR95	PBS	01 Formalin		33
	12APR95	PBS	01 Formalin		20
	19APR95	PBS	01 Formalin		200
	27APR95	PBS	01 Formalin		200
	04MAY95	PBS	01 Formalin	214	214
	10MAY95	PBS	01 Formalin		33
	18MAY95	PBS	01 Formalin		115
	25MAY95	PBS	01 Formalin		200
	01JUN95	PBS	01 Formalin		20
1996	02APR96	PBS	01 Formalin		1
	11APR96	PBS	01 Formalin		181
	18APR96	PBS	01 Formalin		200
	25APR96	PBS	01 Formalin		125
	30APR96	PBS	01 Formalin		200
	09MAY96	PBS	01 Formalin		180
	16MAY96	PBS	01 Formalin		217
	23MAY96	PBS	01 Formalin		200
	30MAY96	PBS	01 Formalin		41
1997	10APR97	PBS	01 Formalin	364	260
	15APR97	PBS	01 Formalin		60
	17APR97	PBS	01 Formalin	11	10
1997	24APR97	PBS	01 Formalin	306	200
	01MAY97	PBS	01 Formalin	143	138
	08MAY97	PBS	01 Formalin	100	59
	16MAY97	PBS	01 Formalin	25	18
	22MAY97	PBS	01 Formalin	175	126
1998	16APR98	PBS	01 Formalin		158
	23APR98	PBS	01 Formalin		50
	30APR98	PBS	01 Formalin		210
	07MAY98	PBS	01 Formalin		350
	13MAY98	PBS	01 Formalin		85
	21MAY98	PBS	01 Formalin		104
	28MAY98	PBS	01 Formalin		250
1999	14APR99	PBS	01 Formalin	200	200
	22APR99	PBS	01 Formalin	160	160
	28APR99	PBS	01 Formalin	400	230
	05MAY99	PBS	01 Formalin	190	190
	12MAY99	PBS	01 Formalin	130	130
	19MAY99	PBS	01 Formalin	183	183
	26MAY99	PBS	01 Formalin	104	104
	02JUN99	PBS	01 Formalin	6	0
2000	27APR00	Consultant	01 Formalin	62	55
	03MAY00	Consultant	01 Formalin	340	132
	10MAY00	Consultant	01 Formalin	100	100
	18MAY00	Consultant	01 Formalin	14	14
	31MAY00	Consultant	01 Formalin	20	20
2001	11APR01	PBS	01 Formalin	120	75
	18APR01	PBS	01 Formalin	400	200
	26APR01	PBS	01 Formalin	400	200
	13MAY01	PBS	01 Formalin	100	69
2002	02MAY02	PBS	02 Ethanol		113
	07MAY02	PBS	01 Formalin		38
	14MAY02	PBS	01 Formalin		5
	23MAY02	PBS	01 Formalin		22
	30MAY02	PBS	02 Ethanol		53
2003	07MAY03	PBS	12 Frozen		10
2006	08MAY06	PBS	12 Ethanol	87	87
2008	28APR08	PBS	02 Ethanol		35
2009	15APR09	PBS	02 Ethanol	146	92
	05MAY09	PBS	02 Ethanol	10	12
2010	19APR10	PBS	02 Ethanol	2	2
	05MAY10	PBS	02 Ethanol		10
2011	28APR11	PBS	02 Ethanol		204
	08MAY11	PBS	02 Ethanol		99
2012	23APR12	PBS	02 Ethanol		24
2013	02APR13	PBS	02 Ethanol		17
All				8,097	18,100

APPENDIX X – Data Issues

Smolt data collected over the years have been managed in a variety of ways, but data storage is divided into two basic formats:

1. **SAS Database** - For the years 1977-1996, smolt size, age and meta-data were keypunched and uploaded into structured SAS datasets. Subsequently, SAS programming procedures for smolt data management was replaced with unstructured spreadsheet workbook files.
2. **Excel Workbooks** - As of 1997, smolt size and age data were managed in Microsoft Excel spreadsheets, in different formats and data structures. Field trip meta-data were usually stored in separate Excel spreadsheets (Survey Trip Reports, or STRs) and/or in data spreadsheets specific to stock-year-sample-date. File naming conventions and data structures were not always adhered to.

To collate all datasets into one location for compilation and analysis, a spreadsheet-based inventory was created to track the file locations and contents of the Excel workbook files. **Smolt Data Inventory.xlsx** is a meta-data inventory spreadsheet documenting the existence of smolt survey datasets based on information collated from STRs and known smolt sample spreadsheets. The Inventory spreadsheet data is organized by smolt ocean entry year, lake/stock (GCL/Sproat/Henderson only), sample site and sample date. For each record, the following variables are listed (where available): Trip, Sample Number, Sample Type (1=Smolt, 2=ATS (excluded from smolt analyses)), #Sets, SoakTime, Total Catch, Total Retained (sample), Crew or Agency, fish Preservation Code and Preservative Type (used to identify appropriate conversion to “standard” fresh weight), Gear Code and Gear Type, Size Data Resolution (individual Fish, or summarized by Date or Year), Comments, and Data Source (filename and location).

This assisted in the compilation of the smolt survey observations, i.e. the individual fish meristics, standard weights, and age data. The raw data were organized in **Smolt Size Data 1997-2018.xlsx.** The individual fish size and age data, where available, have been retrieved from the data sources identified in **Smolt Data Inventory.xlsx** and consolidated into stock-specific tabs (GCL, SPR, etc) to structure the data by Stock, Sample Date, Sample Number and Fish Number. Meta-data include Species Code, Gear Code, Site Code, Lab Processor, and Notes. Size data include ForkLength (fresh only), and may include either Preserved Wet Weight or Fresh Standard Weight, or both. Age data include (where available) Scale Book Number, Scale Number, Scale Quality and Scale Age. In the absence of scale age data, an Assigned Age may be applied. The Final Age value is set to the Scale Age or Assigned Age, and is used as the fish’s age class in analyses.

Age Data - Between 1977 and 1986, all fish captured and retained were scale-sampled for age analysis. After 1986, scale sampling was reduced in scope, and focused on fish in the overlapping age range of 75 – 90 mm, with few fish <70 mm (assumed age 1) or >90 mm (assumed age 2) in fork length scale-sampled. In many cases, scale sampling did not occur at all, or was limited by sample size, or did occur but the scales were never aged. In-season analyses by sampling crews often assumed all unaged fish were age 1 (not unreasonable for Henderson Lake Sockeye, or perhaps Sproat Lake Sockeye, but potentially problematic for Great Central Lake Sockeye with its larger proportion of age

2 fish in the population), or assigned to age based on a conventional threshold that varied between years and stocks from 70 – 90 mm. The misclassification of fish age may lead to directional biases in annual smolt size summaries. If many average-sized fish are left unaged, while all small and big fish are assigned, then the mean size of age 1s will be biased downward, and age 2 mean size would be biased upward. To reduce the potential bias in age classification, the following procedures were applied to smolt survey data with missing ages (1987-2018):

1. Where Scale Age exists and is not ambiguous or erroneous, the Final Age was set to the Scale Age.
2. An Assigned Age can be used to overrule Scale Age (if erroneous or ambiguous).
3. In the absence of Scale Age or Assigned Age, Final Age is set for very small and very large fish based on unambiguous size rules associated with fork length (e.g. If Forklength < 70 mm, Final Age = 1; If ForkLength > 100 mm, Final Age = 2, etc).
4. For mid-range sizes (70-100 mm), bimodality in the size distributions can be used to classify unaged fish to age in some years. However, high overlap in size distributions between age classes, plus a general trend for larger fish emigrating earlier in the season, required some attention to sample timing and proportions by age at specific size classes. Thus:
    a. Year-specific age proportions from scale data by year, month (April versus May/June) and 5 mm length class were used to classify unaged fish to age class. For example, if scale analysis indicated 80% of aged fish 90-95 mm in length in April 1999 were age 1, then the smallest (by weight) 8 of 10 unaged fish in that size class in 1999 were assigned age 1, and the largest 2 of 10 fish were assigned age 2. Age proportions for May-June would be applied to classify unaged fish in subsequent months. For very low sample sizes of unaged fish (e.g. <10 fish), the default age assignment was age 1 since age 1 fish are predominant in the population. In the absence of age data from scale samples for a given year, the multi-year age proportions by forklength size class were used to assign age.
    b. Fish-specific age assignments were entered into the Assigned Age column in the spreadsheet, and thereby incorporated into the Final Age value.
    c. Assigned ages for the Excel spreadsheet data (1997-2018) are recorded and annotated in **Smolt Size Data 1997-2018.xlsx**.
    d. Unassigned age classes in mid-sized length range the **SAS database** data (1986-1996) were programmatically defaulted to age 1, with individual fish re-assignments to age 2 as tabulated below.

Data Omissions – Outliers and anomalies that were omitted from analyses included:

1. **Rare ages –** fish aged 0 omitted.
2. **Outliers**
   a. 08-May-11 – Fish# 1, forklength 170 mm, std weight 39 g

Other – In 1992 and 1994, smolt surveys occurred on March 31st. For plotting purposes, the survey date was reassigned to April 1st of the year for these samples.

Age Re-assignments – The following unaged fish were assigned to age 2 programmatically based on forklength, month, and available age proportion data, by sample date and fish number.

Year	Date	Fish	Metric	Size Class	Fork Length	Final Age
1987	21APR87	185	forklength	76-80	78	2
	29APR87	2	forklength	76-80	78	2
	05MAY87	64	forklength	76-80	79	2
	12MAY87	1	forklength	76-80	79	2
	20MAY87	14	forklength	76-80	78	2
		26	forklength	76-80	78	2
	28MAY87	1	forklength	76-80	79	2
	04JUN87	1	forklength	76-80	78	2
1988	13APR88	3	forklength	81-83	83	2
		17	forklength	76-80	80	2
		33	forklength	84-89	89	2
		34	forklength	76-80	80	2
		53	forklength	70-75	75	2
		78	forklength	70-75	75	2
		99	forklength	81-83	83	2
		103	forklength	76-80	80	2
		119	forklength	70-75	75	2
		134	forklength	84-89	86	2
		170	forklength	76-80	80	2
		179	forklength	81-83	83	2
		188	forklength	70-75	75	2
		189	forklength	70-75	75	2
		200	forklength	76-80	80	2
1991	10APR91	20	forklength	70-75	74	2
		80	forklength	70-75	74	2
		90	forklength	70-75	75	2
1994	14APR94	68	forklength	81-83	83	2
1995	05APR95	22	forklength	76-83	79	2
		27	forklength	76-83	82	2
	19APR95	28	forklength	70-75	74	2
		31	forklength	70-75	74	2
		51	forklength	70-75	74	2
		55	forklength	70-75	74	2
		56	forklength	70-75	73	2
		57	forklength	70-75	73	2
		65	forklength	70-75	73	2
		67	forklength	70-75	74	2
		86	forklength	70-75	74	2
		94	forklength	70-75	73	2
		96	forklength	70-75	73	2
		108	forklength	70-75	74	2
		118	forklength	70-75	73	2
		180	forklength	70-75	73	2
	27APR95	19	forklength	70-75	73	2
		181	forklength	70-75	73	2
1996	11APR96	7	forklength	76-83	92	2
		8	forklength	76-83	87	2
		72	forklength	76-83	80	2
		128	forklength	76-83	81	2
		154	forklength	76-83	80	2
1996	11APR96	181	forklength	76-83	81	2
	18APR96	62	forklength	87-97	92	2
		73	forklength	87-97	89	2