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Some sockeye are reported to spawn outside the Babine Lake watershed in the Skeena drainage.

Skip M[c]Kinnell
Dennis Rutherford

Note citable

PSARC Working papers document the scientific basis for fisheries management advice in the Pacific Region. As such, they provide one component of the assessment process, and are not intended as comprehensive treatments of stock management.

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4.	**Ken Pitre**	for providing some useful historical literature.
5.	**Cole Shirvell**	for his daily 1992 sockeye salmon counts in the Sustut River. These are some of the few recent data collected from a non-Babine Lake sockeye population.

1.0 Introduction

This report attempts to address the request to assess status of all anadromous sockeye salmon (*Oncorhynchus nerka*) populations that spawn within the Skeena River watershed (Fig. 1), excluding those populations that spawn within the Babine Lake watershed. Hereafter, we identify these as non-Babine sockeye populations. Smith and Lucop (1966) identified about 57 distinct non-Babine spawning populations in the Skeena River watershed. A similar catalogue was developed in 1983 by the Enhancement Services Branch of D.F.O. (Hancock et al. 1983a, 1983b). The current S.E.D.S. database (Serbic, 1991) contains 51 reporting strata for non-Babine populations (Table 1). Some streams (eg. Williams Creek on Lakelse Lake) are reported to have distinctly separate run timing components (Smith and Lucop 1966) but these are not recorded as separate spawning populations in the historical data.

Up to the mid-1980's, management of the Skeena River sockeye fishery identified 3 stock aggregates that are thought to be separated by run timing (Sprout and Kadowaki 1987). The early run consists of the Lakelse and Alastair Lake systems, the Nanika River, and the small tributaries of Babine Lake. These are thought to have peak abundance in the commercial fishing area in late June, prior to the start of commercial fishing in most years. The middle timed group is from Babine Lake with peak abundance in the commercial fishery in mid-July. The later run consists of Babine River spawners and lake spawners. Peak abundance in the commercial fishery is in late July or early August. More recently, 5 groups have been identified (D. Peacock, pers. comm). Early non-Babine, Early Babine, Pinkut-Fulton, Middle non-Babine, and late Babine. ~~Early non-Babine includes 10 stocks, one of which is *actively* managed, Middle non-Babine includes 34 stocks of which 1 is *actively* managed.~~

In this report, we attempted to review as many published and unpublished accounts of sockeye biology and production in non-Babine Lake sockeye systems in the Skeena River watershed. Not unexpectedly, the number of studies directed specifically at these systems is near zero, particularly in recent decades. The best improvement in recent years has been the development of a stock identification program for sockeye within the Skeena River, although this is not without problems. We also recognized that the non-Babine Lake sockeye assessment has a strong signal:noise problem. The Babine Lake sockeye complex is the noise and we need to detect about 50 to 60 smaller non-Babine signals (or their aggregate) in the catch and test fishery.

A recent assessment of Tahltan Lake sockeye (Wood et al. 1993) provided some indication of the kinds of data that are needed to do good assessments of freshwater sockeye productivity: fence counts of adults, sex ratios for potential egg deposition, weir counts of smolts, stock identification programs to separate catches in fisheries, monthly water chemistry, abundance of prey size and species, and hydroacoustic surveys of fry densities. These data permitted the authors to compute optimum productivity levels for Tahltan Lake juvenile production. Smolt production and adult returns allowed a gross overview of marine effects on production. None of these data are available for non-Babine Lake sockeye populations. Recognizing that the determination of productive status of non-Babine Lake sockeye is impossible with the available data, the majority of this report is dedicated to the task of determining the magnitude of adult sockeye returns of non-Babine Lake origin using as many independent methods as possible.

2.0 Non-Babine lakes in the Skeena River watershed

Pritchard (1948) reported the first major assessment of Skeena River sockeye and other salmon species. The multi-year project was initiated as a result of declining catches of sockeye during the 1930s (Fig. 2). The project was and is the most comprehensive study of salmon and their environment in the Skeena River watershed. Pritchard et al. (1948: appendix 7a) described the physical and chemical nature of 20 sockeye producing lakes in the Skeena River watershed. They classified the Skeena River sockeye producing lakes into 3 groups based on physical and chemical measurements:

Deep, Cold, Glacial (1)	Shallower, Clear, Warmer (2)	Intermediate (3)
Johnston	Lakelse	Alastair
Kitsumgallum	Kitwanga	Swan
Morice	Stephens	Babine
Motase	Nilkitkwa	Bear
Kluayaz	Morrison	Johanson
	Azuklotz	
	Sustut	
	Asitka	
	Damshilgwit	
	Slamgeesh	
	Kluatantan	

Pritchard et al. (1948: appendix 7a) assigned relative importance to these lakes based on their estimated escapements prior to 1948. Group 1 was thought to account for 15% of total Skeena River escapement, Group 2 for 20% and Group 3 for 55-65%. In reviewing a freshwater habitat based mechanism for the declines in sockeye abundance in the Skeena River, the authors concluded in 1948 that:

1. No direct limiting factor of a physical nature was evident, with the exception of a midsummer oxygen depletion in the hypolimnion of Kitwanga lake.

2. No indication of any particular change in the physical features during the present century can be demonstrated by this study of past records. No particular fire or flood has left a demonstrable modification.

3. Production in lakes is the product of many subtle and interacting forces which may be

found to unite or disunite for particular patterns of fish survival.

4. The presence of high turbidity appears directly related with low production, and in this respect, delineates the lakes in Group 1 as of poor production and of little feasible improvement possibilities.

5. Low temperature is also directly related to low production. It may be that the whole area is limited by a low heat income.

6. The lack of stable thermoclines appears to be an asset in that it does not result in stagnant hypolimnions.

7. A water level in the lake in September equal to that of the freeze-up may result in better production.

8. Lakes of Group 2 hold the greatest promise for improvement from fertilization if that were attempted as a possible means of increasing production.

3.0 Historical assessments or comments on stock status

Pritchard et al. (1948) concluded that there was no evidence of apparent habitat changes that might have brought about a reduction of the spawning beds of Skeena River streams. The commercial fishery was identified as the most important factor in reducing sockeye populations in the Skeena River. In summarizing that early work, Brett (1952) reported that non-Babine Lake sockeye salmon accounted for 29.2% of the average Skeena River sockeye escapement in 1946 and 1947 (See Table 2).

Shepard and Withler (1958) estimated that the Babine Lake watershed (including the Nilkitkwa) accounted for 75% of the Skeena River sockeye escapement. They reported that Morice and Alastair lakes accounted for 13% of the total sockeye escapement to the Skeena River. They also noted that the observed fluctuations in yield over the 50 year period prior to 1958 are consistent with the observed changes in exploitation rate with the spawner-recruit relationship.

Aro and McDonald (1968) considered that the Babine system accounted for 90% of the total run of sockeye to the Skeena River. They commented that the Morice Lake run, historically the second largest in the Skeena system, was severely reduced between 1955 and 1960 with slight increases between then and 1968. Moderate sized runs were reported to spawn in the Alastair, Lakelse, Swan-Stephens, and Bear Lake systems. Small runs were reported in the Johnston, Kitsumkalum, McDonell, Kitwanga, Maxan, Sustut, Asitka, Johanson, and several other small lakes.

Larkin and McDonald (1968) reported that the Babine Lake watershed accounted for 90% of the sockeye production in the Skeena River and that between 1948 and 1967, the proportion of non-Babine Lake sockeye had decreased from 30% to 7% of the total. They postulated (and supported their argument using simulation rather than data) that the non-Babine Lake sockeye stocks were less productive and were more susceptible to over-exploitation.

West and Mason (1987) estimated the average total returns of non-Babine sockeye salmon for the periods 1958-1971 and 1973-1985 as 97,035 (6.7%) and 58,710 (2.4%), respectively. Average escapements for these two periods were estimated as 47,934 and 28,209, respectively. These are the lowest reported estimates of non-Babine sockeye salmon abundance in the literature.

In the most recent assessment of Skeena River sockeye, Jantz and Henderson (1988) reported that the Skeena River sockeye stock complex is composed of 72 distinct spawning populations with approximately 90% of the total escapement to the Babine Lake system. They report that, since enhancement began, the Babine system has accounted for 95% of the total Skeena sockeye escapement and that prior to enhancement, it accounted for 85% of the total Skeena sockeye escapement. The authors provided target and projected sockeye returns for the years 1988 to 1991 for coastal, Lakelse, Kitsumkalum, Other lower river, Kispiox, Bulkley/Morice, Other middle Skeena, Babine, Bear and other upper Skeena sockeye stocks. Target escapements for non-Babine sockeye stocks were largely determined by Fishery Officers based on historical escapement estimates and the resulting returns.

The advice generated by the Salmon Subcommittee as a result of the 1988 assessment indicated that: 1) detailed re-evaluations of escapement goals and enhancement impacts are required in the Skeena River; 2) studies to estimate the Alaskan catch of Skeena River sockeye must be completed and extended back as far in time as possible; 3) Skeena sockeye exploitation rates in Area 4 should range from 50 to 55%. Reviewers of the assessment suggested that: 1) the analytical basis for escapement targets should be presented; 2) more details on the escapement distribution among sockeye populations and escapement trends by stock; 3) a separate evaluation of the enhanced production from Pinkut and Fulton Rivers; and 4) an explanation of how the Skeena forecast is decided when several methods provide conflicting estimates.

In summary, the estimates of the contribution of non-Babine sockeye salmon to the total sockeye production in the Skeena River are variable with the tendency for authors to attribute larger proportions to non-Babine sockeye production during earlier periods in the historical record.

4.0 Abundance - Adult

The systematic collection of abundance data of known quality for non-Babine Lake sockeye salmon in the Skeena River watershed is, for the most part, absent for all life history stages. Adult escapements are determined by aerial surveillance or from foot surveys. The accuracy of these data are unknown (Sprout and Kadowaki 1987). Juvenile surveys are not done. Smolt outmigrations are not measured.

Throughout the historical record, there have been few fence counts of adult sockeye in non-Babine systems. Without exception, for those periods when a fence is active, the escapements are substantially higher than the years preceding the installation of the fence. Counting fences appear to create sockeye spawners in the Skeena River. With the installation of a counting fence on the Sustut River in 1992, the annual sockeye escapement increased about 5 fold over the counts in previous years (C. Shirvell, unpublished data). The escapement may actually have increased 5 fold in 1992, however, this seems highly coincidental as the 1993 escapement was also much higher than the years prior to 1992. Counting fences, operated by the Fisheries Research Board of Canada, were installed on Williams and Scully Creeks in the Lakelse Lake watershed from 1962 to 1967. The counts obtained, particularly on Williams Creek, were decadal high counts when compared with the Fishery Officer counts that precede or follow these years and were similar in magnitude to a fence count at Williams Creek in 1939 of 24,085 sockeye (Brett 1952).

The best example of underestimating sockeye abundance on the Skeena River is from the Babine River. The installation of the counting fence in 1946 demonstrated that adult sockeye escapements based on stream counts were less than 50% of the number reported passing the fence for the years 1946 and 1947 despite a conscientious effort of stream surveys. *"That stream counts will be minimal is apparent by their very nature, but the discrepancy [at Babine Lake] is beyond such expectations"* Brett (1952). Tschaplinski and Hyatt (1991) compared various methods of estimating sockeye escapement in Henderson Lake in 1989. Estimates varied from 5,525 using fixed wing aircraft to 45,630 using Peterson mark-recapture (carcasses). This leads us to conclude that most escapements recorded in the S.E.D.S. database are not accurate. Some believe the data can be used to indicate trends.

To evaluate the abundance of non-Babine Lake sockeye salmon in the Skeena River, we developed several independent techniques for describing the contribution of non-Babine Lake sockeye salmon to the total production of sockeye in the Skeena River watershed. Babine and non-Babine sockeye populations have a number of characteristics that independently, or in combination, appear to be useful in distinguishing them from each other. We examined freshwater age structure, protein electrophoresis, and infections by the parasites *Myxobolus arcticus, Philonema oncorhynchi* to estimate the contributions of Babine Lake and non-Babine Lake sockeye in the Skeena River.

4.1 Abundance - Freshwater age structure

The age structure of returning adult sockeye is an important diagnostic for estimating the relative proportions of Babine and non-Babine sockeye. There are few two year old smolts produced in Babine Lake (C. Wood, unpublished data, Johnson 1958) while some of the larger non-Babine systems have high proportions of 2 year old smolts (C. Wood, unpublished data, Larkin and McDonald 1968, Shepard and Withler 1958). Jantz et al. (1990) reported that the Morice, Nanika, Alastair and Johanson are the main systems producing two year old smolts.

Over the 81 year period from 1912 to 1992, the proportion of two year freshwater sockeye in the catch has varied from a couple of percent to near 30% (Fig. 3). Since the mid-1970's, the proportion has been consistently the lowest in the recorded history, however, the trend has been increasing steadily from a low in 1985 of 1.8% to a recent high of 18.2% in 1992. This recent trend is also apparent in the test fishery (Fig. 4). Higher proportions (>= 20%) of two year freshwater sockeye appear to be infrequent events in the historical record.

The following illustrates our thinking about freshwater age structure and non-Babine Lake sockeye abundance. The freshwater age structure of the Area 4 catch in 1992 was 81.8% one year olds and 18.2% two year olds. Such a high proportion of two year old freshwater ages has rarely been seen since the Babine Lake sockeye were clobbered by the 1951 Babine River slide. The catches and escapements of two year freshwater fish in 1955 were 26% and 21% 'Other Ages', respectively. This says to us that, if you erase the Babine Lake component, the freshwater age structure of total Skeena sockeye return is altered because of the high proportions of two year old smolts in some larger non-Babine Lake systems.

4.2 Abundance - Freshwater age structure - methods

Suppose that in 1992 the contribution of Babine Lake smolts to the catch of 2 year freshwater fish was near nil. This is reasonable as none of the large Babine system sockeye producers (especially the channels) show any two year old smolts in the adult returns (C. Wood, unpublished data) and the estimated proportion of two year freshwater returns at the Babine Fence was 0.73% in 1992. The catch of non-Babine sockeye had to be 289,995 (.1823*1,657,112-.0073*1,657,112) just to account for the two year freshwater returns alone. Add to that some unknown contribution (maybe 50%) of non-Babine one year freshwater returns and one can speculate that the contribution of non-Babine Lake systems to the Area 4 sockeye catch was over 500,000 in 1992. The proportion of two year freshwater returns in the escapement was similar to that of the catch (14.91%) or 231,211 sockeye so the escapement 'to the test fishery' of non-Babine Lake sockeye in 1992 could have been approximately 400,000 for a total run size of 900,000.

We asked the general question: What mixture of Babine and non-Babine Lake sockeye production is consistent with the abundance of two year old smolts in the catch (Fig. 3) or at the test fishery (Fig. 4)? Let S_{B1} and S_{B2} represent the proportions of one and two year old smolts produced by Babine Lake. Let S_{NB1} and S_{NB2} represent the proportions of one and two year old smolts produced by non-Babine Lake systems. Let P_1 and P_2 be the proportions of one and two year old smolts, respectively, in the catch (or test fishery). Let W_B and W_{NB} represent the quantities to be computed i.e. the relative contributions of Babine and non-Babine smolts to the mixture. The freshwater age structure for Babine Lake sockeye is known. If the freshwater age structure non-Babine smolts was known, this problem could be solved as two equations with two unknowns as follows:

$$S_{B1} * W_B + S_{NB1} * W_{NB} = P_1$$
$$S_{B2} * W_B + S_{NB2} * W_{NB} = P_2.$$

Unfortunately, we have 3 unknowns, as the weighted freshwater age structure of non-Babine sockeye is not known and probably varies annually depending on the relative contributions of the larger non-Babine systems. Rather than give up, we bounded the problem using a range of freshwater age structure values for the non-Babine systems (See Table 3 taken from Larkin and McDonald 1968). We fixed the proportions of one year old smolts from all non-Babine stocks

(S_{NBi}) at 25, 50, and 75%. We solved for the annual proportions of non-Babine sockeye in the catch and in the test fishery at these fixed levels. The results are plotted in Figure 5. The LOWESS trend lines for both the catch and the escapement to the test fishery show an increasing proportion of non-Babine sockeye since the mid to late 1980's.

4.3 Abundance - Freshwater age structure - results

There has been a longterm variation in the proportion of two year freshwater sockeye in the catch since 1912 (Fig. 3). The overall trend decreased sharply beginning in about 1940 to the mid 1950s. The period from 1975 to 1985 is the lowest period in the record. Beginning in 1985, there has been a near monotonic increase in the proportion of two year old freshwater sockeye. By varying the assumed proportions of one year old smolts produced by non-Babine systems from 25% to 75%, one can estimate ranges of possible returns of non-Babine sockeye (Fig. 5). Note that by assuming the freshwater age structure of non-Babine sockeye to be 75% one year old smolts, the required contributions of non-Babine sockeye to the catch must be greater than 1 in some years. This is a good indication that the true age structure of non-Babine smolts is something less than 75% one year olds.

4.4 Abundance - Freshwater age structure - discussion

Although this technique is interesting, it has a number of obvious drawbacks. We need to believe the historical age structure data. There is some evidence that this is a safe assumption. Bilton et al. (1967) reported that from 1912 to 1956, attempts were made to sample a fixed proportion of the daily catch (1%). From 1957 to 1967, 200-300 samples were taken per week. That the effects of the Babine River slide show up so well in the catch in 1955 and 1959 gives us confidence that the age structure data is accurate enough to pick up the big signals in the Skeena sockeye run. That the effects of the slide were only seen in 1955 and not in 1959 in the test fishery is a bit mystifying. In those years with much higher proportions of 2 freshwater year sockeye in the catch and not in the test fishery (eg. 1959,63,73), Nass River fish may have been sampled as Skeena River fish. Since the mid-1970s, the proportion of two freshwater year sockeye in the test fishery is correlated with the proportion in the Area 4 catches. For a period during the late 1960's through the mid-1970's, Area 4 catches showed higher proportions of 2 freshwater sockeye than did the test fishery. The proportions of two year freshwater sockeye in 1912,13,14,15,18 and 1948,50,51,52 are unexpectedly constant for biological data.

We need to make the assumption that marine survivals are similar between Babine and non-Babine populations. One can imagine that a small decrease in Babine Lake marine survivals relative to non-Babine could inflate the observed proportion of two year old smolts in the catch. Finally, we need to assume that Babine and non-Babine sockeye are equally vulnerable in the fishery.

In conclusion, varying ratios of non-Babine Lake:Babine Lake sockeye seem to be the best explanation for the one - two order of magnitude decrease in proportions of two year freshwater sockeye between the test fishery and the Babine fence. Another alternative explanation is that sockeye of Nass River origin routinely migrate up the Skeena River as far as the test fishery, then return.

4.5 Abundance - Test Fishery Stock Composition and Escapement Estimates

Sockeye stock composition of the Skeena River test fishery was estimated using three techniques: 1) Maximum likelihood solution to the finite mixture problem, 2) incidence of the body cavity parasite *Philonema oncorhynchi*, and 3) maximum likelihood analysis using assumed *Philonema* infection rates. Sockeye escapements, by stock, to the test fishery were estimated from these stock composition estimates. Methods 1 and 2, above, for estimating stock composition are independent in that they use independent markers for stock identification, however, annual expansions of these estimates all require weighting by the test fishery CPUE.

4.5.1 Abundance - Maximum Likelihood Analysis

Stock composition of the Skeena River sockeye test fishery was estimated by maximum likelihood analysis using baseline data from 18 sockeye stocks in the Skeena River. These data included allozyme allele frequencies at five loci (*PGM-1**, *PGM-2**, *sIDHP-1**, *LDH-B2**, *ALAT**), differences in the prevalence of the myxosporean brain parasite *Myxobolus arcticus*, and differences in freshwater age composition among stocks. The 18 reference stocks used were: Williams Ck., Scully Ck., Alastair L., Bear L., McDonnell L., Motase L., Nanika R., Swan L., Fulton R., Four Mile Ck. Grizzly Ck., Lower Babine R., Morrison R., Pierre Ck., Pinkut R., Tahlo R., Twain Ck., Upper Babine R. Baseline data were usually available for two different years, and were pooled prior to solving the stock composition analysis.

Stock composition was estimated for both weekly and annual test fishery samples. All fish sampled within a given week were included in the weekly mixture sample. Annual samples were derived by pooling random subsamples from each week's sampled catch where subsample size was proportional to the weekly CPUE in the test fishery. The stock composition estimate reported for each test fishery sample is the maximum likelihood estimate; its standard deviation was estimated by bootstrap resampling both the test fishery sample and the reference samples to generate an additional 100 estimates of stock composition. Stock proportions to the 18 reference stocks were then pooled to 8 stock groupings useful for management purposes (Table 4).

Test fishery escapement estimates were computed using stock composition estimates from the annual test fishery samples in conjunction with the Babine fence counts and in-river catch data as follows:

1. The total Babine run past the test fishery was estimated by summing the Babine fence count with the estimated in-river Babine sockeye catch. In-river Babine catch was estimated by multiplying the annual proportion of Babine sockeye (from stock composition estimates) by the total in-river catch reported from the Lower Skeena, Terrace, and Hazelton sub-district offices. This was necessary because the catch was reported by year and was not location specific (ie Hazelton catch includes catches from Skeena, Bulkley and Babine Rivers). The Smithers sub-district catch was assumed to

include only Babine sockeye and was added directly to the Babine in-river catch.

2. The total sockeye run past the test fishery was calculated by dividing the total Babine run by the estimated proportion of Babine sockeye in the test fishery.

3. Test fishery escapements to other stocks (Table 5) were calculated by multiplying the in-river run by their respective mixing proportions in the test fishery.

Spawning ground escapements for non-Babine stocks could not be estimated because the in-river sockeye catch was not reported weekly and was not sufficiently site-specific.

4.5.2 Abundance - Philonema Prevalence

The stock composition of the Skeena River sockeye run was estimated using the prevalence of the body cavity parasite *Philonema oncorhynchi* (Table 6). Reference data for this parasite is currently only available from Babine Lake and three non-Babine sockeye stocks. Babine Lake is 100% infected while Alastair and Lakelse Lakes are not infected. All other non-Babine stocks have not been sampled. A minimum non-Babine contribution was estimated by assuming that all infected fish sampled in the test fishery were from Babine Lake. This will result in an underestimate of the proportion of non-Babine sockeye if some of the unsampled non-Babine stock are infected. Minimum estimates of non-Babine sockeye were calculated by weighting the weekly proportion of *Philonema* negative fish by the CPUE in the test fishery.

Test fishery escapements of non-Babine sockeye (Table 6) were estimated by dividing the total run of Babine Lake sockeye (as described previously) by the annual proportion of Babine sockeye and then multiplying by the non-Babine proportion.

4.5.4 Abundance - Maximum Likelihood Method Using Simulated Philonema Data

Annual stock composition of the test fishery was also estimated using *Philonema* in addition to the traits described in Section 4.5.1, above. All unsampled stocks were assumed to be infected with *Philonema*. This assumption was primarily made to help resolve the perceived Lakelse/Babine allocation problems associated with the traits used in the maximum likelihood method. Also this assumptions seems prudent because the probability of all unsampled non-Babine Lake stocks not being infected is low. These results reflect a maximum non-Babine contribution in the test fishery catches (Table 7). Test fishery escapements were estimated from the combined M.L.E + *Philonema* using the same procedure outlined in method 1 (Table 7).

4.6 Abundance - S.E.D.S.

The detailed sockeye escapement reports for non-Babine Lake systems are reported in Table 8. We totalled all observed records by year (Fig. 6), and at a somewhat finer geographic resolution (Fig. 7). What is evident is that many systems are not surveyed annually, and in some cases, decadally. The non-Babine Lake total has not been corrected for effort i.e. they are just the totals of non-zero numbers in the database. Of the various methods we used to examine adult abundance for the most recent years (Table 9), the S.E.D.S. system numbers were, not unexpectedly, the lowest.

4.7 Abundance - Juvenile

On September 24, 1993, a juvenile sockeye survey was done on Morice Lake, a deep, cold, glacial system. Morice Lake/Nanika River is reported to support one of the larger spawning populations of sockeye outside of the Babine Lake watershed. The results confirm that Morice Lake is not a highly productive sockeye rearing lake. Age-0 fry averaged 0.8 g in weight (n=42, s.d.=0.09) at the end of the growing season. Compare this with Babine Lake 3 days later where age-0 fry weights were 4.33 g (n=480). Stratified hydroacoustic estimates of total fish and age-0 sockeye fry were 903,559 (95% c.i.: 651,029-1,156,129) and 699,144 (95% c.i.: 537,622-860,666) individuals, respectively. Trawl sampling found only 2 age-1 fry weighing 5 and 7 g each. Sockeye do not smolt in Morice Lake until 2 years of age. No other species of fish was found in the trawl samples, however, lake trout (*Cristivomer namaycush*), dolly varden (*Salvelinus malma*), rainbow trout (*Oncorhynchus mykiss*), Rocky mountain whitefish (*Prosopium williamsonii*) and a few other species have been reported in Morice Lake (Brett and Pritchard 1946b). Age-0 densities in Morice Lake were estimated to be 73/ha compared with 1,447/ha in the main basin of Babine Lake. Zooplankton biomass in Morice Lake in late September 1993 was low for all taxa. The dominant zooplankton taxon was *Cyclops* sp. at approximately 3 mg/m^3. All other taxa were found at densities less than 2 mg/m^3. Babine Lake, at the same time, had *Cyclops* sp. and *Diaptomus* sp. densities ranging from 7 to over 20 mg/m^3.

5.0 Run Timing

5.1 Run timing - Marine Fisheries

When reliable estimates of stock composition in fisheries are unavailable, stock specific run timing data are essential for reconstructing sockeye runs (and estimating productivities). Jantz and Henderson (1988) reconstructed the runs of sockeye to the Nass and Skeena Rivers. They used the convention that *all sockeye caught in Area 3 prior to the Sunday nearest July 15 are considered to be of Nass origin.* We examined sockeye tagging data from 1966 (Table 10) and 1967 (Table 11) which indicate that more Skeena River sockeye can be present in Area 3 prior to mid-July than the convention would suggest. Pella et al. (1993) reported 9% to 30% Skeena origin sockeye in June 1982 and 20% to 72% Skeena origin sockeye in Area 3 in early to mid-July. The magnitude of the bias introduced by this assumption is of unknown magnitude. Hopefully, the run reconstruction model currently under development by L.G.L. Limited will resolve some of these problems.

In reviewing the results of sockeye tagging programs carried out from 1944 to 1948 and from 1955 to 1959, Aro and McDonald (1968) concluded that although there were differences in sockeye run timing, the runs overlapped such that, at any one time, several runs were in abundance in the fishery. They reported that during June and early July, the sockeye in the fishery were bound mainly for Alastair, Lakelse, Babine Lakes and the Bulkley River. During the middle and latter part of July, sockeye were mainly bound for Babine Lake and the Bulkley River. Sockeye tagged in August were reported to be almost entirely bound for Babine Lake.

5.2 Run Timing - The Tyee Test Fishery

Any statistical estimates derived from biological sampling at the Tyee test fishery must be weighted by the test fishery catch to account for variations in passing abundance. Cox-Rogers and Jantz (1993) reviewed many of the potential problems associated with the test fishery and the utility of the test fishery index as a measure of passing sockeye abundance. We examined the daily patterns of the sockeye index at the test fishery with the daily patterns of the run at the Babine Fence for any sign of regularity or structure in these data. We computed cross-correlations between the daily index of sockeye abundance at the Tyee test fishery and the daily counts of sockeye through the Babine fence from 1956 to 1993 (Fig. 8). For each year, we recorded the value of the maximum cross-correlation and the lag (days). We found that the lag period between the test fishery and the Babine fence at the point of maximum cross-correlation has been decreasing (p=0.034, omitting one outlier) over the years examined. We found that the maximum cross-correlation between the two series has been decreasing from a recent peak ($r > 0.8$) in the mid 1980s. Maximum cross-correlations between the test fishery and the Babine fence generally range from about 0.65 to 0.85 over the history of the two series.

Cumulative run timing curves at the Tyee test fishery were calculated by normalizing weekly stock-specific CPUE estimates so that they summed to one over the entire season. Stock-specific CPUE was calculated by multiplying the mixing proportion for a given stock (or stock group) by the corresponding weekly CPUE in the test fishery. Independent run timing curves were generated using the maximum likelihood method (Fig. 9) and the *Philonema* method (Fig. 10).

Run timing based on *Philonema* method indicated that Lakelse Lake and Alastair Lake stocks are early migrating relative to Babine stocks. Maximum likelihood method indicates most non-Babine stocks are early but Lakelse Lake also shows a late component. The addition of simulated Philonema data to the maximum likelihood method reduces the allocation to Lakelse and based on the Philonema only method this reduction is probably in the late component that is evident using the maximum likelihood method.

5.3 Run Timing - The Sustut River Fence

In 1992, sockeye began passing through the fence on August 5 (Fig. 11) and were still entering the system when the fence was removed on September 22. Daily counts of migrating sockeye at the Sustut River fence in 1992 suggest a pattern that is both similar to and different from the Babine River fence. The series is multimodal suggestive of fishery removals from the run. The pattern is quite different in that it does not build to a peak. The peak and the first mode are coincident. This suggests that either a fishery removed the entire first half of the distribution, or that the early component of the run accumulated at some staging area downstream before proceeding upstream to the fence.

Median migration speeds for sockeye salmon between Smith Island and the Babine River fence were 35, 27, and 29 days in 1955, 1956, and 1957, respectively for the 378 km distance. These correspond to average daily speeds of 10.8, 14, and 13 km/day. Were these migration speeds applied to the Sustut/Johanson sockeye, median migration durations from the fishery to the Sustut River fence (a 525 km distance) would have been 49, 38, and 40 days. Only one tagged sockeye has been reported from this region. Aro and McDonald (1968) reported a tag recovered August 20, 1945 from a Johanson Lake sockeye that had been tagged in the Skeena River mouth on July 21, 1945, an migration duration of only 30 days.

Using the migration duration from the single tag return suggests that this population was in the area of the fishery from July 6 through August 23. Using migration rates from the Babine River fish, the first Sustut River sockeye in the region of the fishery from mid to late June through late July to the end of the first week in August, depending on which travel rate is used. The multimodal structure of the Sustut River fence count suggests that the fishery is affecting most of the run.

5.4 Run timing - The Williams Creek Fence

Daily sockeye counts through the Williams Creek fence from 1962-1967 confirm the presence of an early and a late run (Fig. 12). The peak of the early run passed the fence was near August 10th while the later run passed from early to late September, depending on the year. The daily counts through the fence do not show the cyclical weekly (approximate) abundance patterns seen at the test fishery or at the Sustut River fence. Lakelse Lake sockeye are considered an early stock (generally avoiding the Area 4 gillnet fishery) with an extended residency period in the lake prior to entry into the streams. Whether the late spawning component enters that lake at the same time as the early spawners is not clearly documented but all tagging to date suggest that no Lakelse Lake sockeye are present in the latter part of the fishery. Total counts through the Williams Creek fence are reported in Table 12.

6.0 Age Structure

The majority of adult sockeye returning to the Skeena River have spent only one year in freshwater prior to smolting. Most return to the Babine Lake system. We examined the correlations between the historical proportions returning in different age classes and found that the proportions of 1.2 and 1.3 adults in the catch are very highly correlated in the catch (Fig. 13) and in the test fishery (Fig. 14) and have, in the catch at least, become increasingly more correlated since the 1920s. By decade, beginning in 1922, we used principal component analysis to examine the correlations between 1.2 and 1.3 age sockeye in the catch. If all 1.2 fish had only 2 maturity options: returning as 1.2 or 1.3, then the correlation between would be r=1.0. However, if 1.x fish have other options (1.1, 1.4), then the correlation between 1.2 and 1.3 would be less. The catch data have a monotonic increase in the value of the dominant eigenvalue from the 1920's to the 1960's; accounting for 94.9% of the variance in the first decade to 99.5% since the 1960's. This indicates to us that the system has become less complex during this century.

We examined the ratio of 2.3:2.2 catches by brood year (Fig. 15). Data are only available up to the 1958 brood year as the complete age structure of the return is unavailable after 1963. With few exceptions, the ratio is less than one from 1908 to 1958. This indicates that the contributions of 2.2 sockeye from each brood year is greater than age 2.3 sockeye. We prepared a similar plot for 1.x aged sockeye (Fig. 16) but over a longer period. This indicates that a much higher proportion of sockeye will remain in the ocean for a third year, if they leave freshwater after only one year than if they leave freshwater after one year. This pattern also appears to be episodic (1909-10, 1939-43, and variable since 1953). The reasons for this pattern are unclear but may be environmental.

7.0 Aboriginal fisheries for sockeye on the Skeena River

Anonymous (1962) reported that assessment of the magnitude of early aboriginal fisheries is impossible. They suggested, however, that with traps and barricades on the Babine, Bulkley and Bear Rivers that the annual catch of sockeye may have approached 500,000 in some years. We examined the reported sockeye catches in aboriginal fisheries in the Skeena River from the past two decades (Table 13). The proportion of the terminal run taken in these fisheries decreases with increasing run size from about 13% at the smallest run size to less than 5% at the largest run size (Fig. 17). 1993 is a significant outlier from that relationship with catches higher than the reported data from 1974 to 1991 would have predicted. We are unable to attribute any these catches to specific non-Babine Lake systems because the reporting stratification is by D.F.O. sub-district and not by river system. Catches in any sub-district can include both Babine and non-Babine origin sockeye in unknown proportions. There is a loose relationship between aboriginal sockeye catch and sockeye abundance at the Babine River fence (Fig. 18).

8.0 Marine Habitats and Distribution

We examined lagged cross-correlations between Skeena River sockeye catches in Area 4 by brood year from 1912 to 1957 with an Aleutian Low Pressure Index (Beamish and Bouillon 1993). There were no significant correlations. Beamish and Bouillon (1993) reported that salmon production (catches) of sockeye in the North Pacific may be correlated with the intensity of the major annual winter climatic event in the North Pacific.

Most Skeena River sockeye spend greater than 50% of their life in the ocean. Little is known of the effects of the marine environment on salmon production but clearly, it is important. Shepard et al (1964) noted that the 1958 brood "suffered an unusually great mortality at sea." West and Mason (1987) reported that smolt to adult survivals dropped from 5.1% prior to BLDP to 3.0% after. They were particularly concerned about the continuing poor knowledge of coastal zone juvenile sockeye dynamics.

9.0 Discussion

Stock composition estimates using the maximum likelihood method does well under ideal conditions using simulated mixtures of known composition. (100% Fulton mixture - allocated 99% to Babine group and less than 1% to all other groups). Statistically the Babine group is quite similar to the Lakelse group so in practice a misrepresented baseline stock may diminish our capability of uniquely identifying the Babine component. The addition of *Philonema* as a marker would separate out the Babine/Lakelse groups. Unfortunately the *Philonema* baseline is incomplete for the Skeena River stocks so this marker could only be included into the maximum likelihood method by making gross assumptions about Philonema distribution.

The procedures for estimating stock composition and test fishery escapement have some other potentially major errors. Of particular concern is the extent to which catch in the test fishery, from which samples were taken for stock identification, may not be proportional to abundance of the different stocks. Factors such as gear saturation at the peak of the run, size selectivity, and vulnerability of fish to the gear may be affecting catchability (Rogers and Jantz 1993). Errors in stock composition will also result if stocks which contribute to production and are not represented in the baseline. The stock identification results suggest that Lakelse Lake sockeye are a later migrating stock, accounting for little or none of the run in June up to approximately 20% of the run by late August. This is inconsistent with almost all previous previous reports. Brett and Pritchard (1946a) concluded that the main part of the run was into the river before the fishery began on the last Sunday in June. It is unclear when the sockeye that constitute the second peak on Williams Creek enter Lakelse Lake.

Recent indicators (since 1990) suggest that the contributions of non-Babine Lake sockeye have increased. In aggregate, the non-Babine sockeye populations have become a large, economically important sockeye stock aggregate (PSARC salmon subcommittee planning workshop, 1993). It is not possible to attribute these increases to any one factor and the historical record suggests that it will not last at typical exploitation rates. Since 1983, Area 4 fisheries have been restricted to a maximum of 4 fishing days/week and since 1989, net fisheries in the first two weeks of August have been restricted to a maximum of 2 days/week. The latter is not likely to have had much of an effect on sockeye and the former does not appear to have changed Babine Lake sockeye exploitation rates in Area 4. It appears that good management is not the cause of the increase. Sockeye catches in North America have increased substantially in the last decade in many areas, particularly Western and Central Alaska and to a lesser degree in British Columbia and southern Southeast Alaska. Skeena River catches have varied considerably over the last decade, however, some of the highest observed catches since the 1920's have been observed in the last decade. Improved survivals seem to be one of the more likely candidates for the observed increases in non-Babine sockeye production.

Throughout this manuscript, we have often referred to non-Babine sockeye as though it was a single stock. In fact it is made up of many small stocks, some with multiple run timings. That non-Babine sockeye abundance trends vary synchronously seems highly unlikely. One of the obvious dangers with small population sizes is the threat to the conservation of the populations from overexploitation or environmental chaos.

April 1994

PSARC Reviewer Comments - Johannes

Re: McKinnell and Rutherford - " Some sockeye are reported to spawn outside the Babine lake watershed in the Skeena drainage".

General Comments:

The paper is generally well written and presents a good review of previous work conducted in the Skeena system. I was encouraged by the amount of data available in these systems and this manuscript does compile these data to provide useful groundwork on these sockeye stocks.

I think the authors can summarize the historical data set better (a single system specific table) and provide PSARC with an understanding of what data are missing and what approaches should be taken to support improved assessment work. This paper should lead into a second document (or a strongly revised one) in support of the following objectives including: (1) can any major limitations to sockeye production be identified from past assessments (early data), (2) what is the production potential of these systems during the freshwater life history of the sockeye stocks, and (3) what possible rehabilitation or enhancement alternatives are available for these stocks. This means that sockeye freshwater production can be limited by: (i) spawner abundance, (ii) spawning habitat availability and quality, and (iii) in-lake rearing constraints. If any of the early data can be believed, then I feel that they could be used as a basis of analysis to address the above objectives. These objectives and derived conclusions are the questions of fundamental importance to managers, commercial fishers and native groups and should provide the focus for technical advice.

Specific Comments:

(A) Many literature sources are available which support an approach to useful assessments in sockeye systems, not just Wood et al. 1993. Specific information for the non Babine Skeena systems exist from early Lake Enrichment Program work by Simpson et al. 1981, Hyatt and Rankin, Stockner and Shortreed during 1978, 1979 and 1980. During 1980 Morice lake was fertilized to enhance sockeye production.

This means that for non Babine systems including: Alastair (1978), Azuklotz (1978), Bear (1978), Morice (1978, 1993), Stephens (1978) and Swan (1978) that acoustic and trawl surveys (year) exist and provide estimates (with known statistical properties) of juvenile abundance and production in these lakes. These data can provide independent back calculated estimates of spawner abundance for comparison with escapement estimates given in the present paper.

(B) Pritchard (1948) developed an approach to classifying lakes in the Skeena system. I think this lake classification can be improved by including our present knowledge of sockeye spawning and rearing habitat requirements in freshwater to develop an understanding of PRODUCTION POTENTIAL in each of the systems presented. i.e. -- Are there spawning limits through barriers, poor quality or availability of spawning habitat, are the lake systems tannin stained or glacially turbid enough to inhibit primary and secondary production (there is a some data available for these lakes and it would be quite simple to put together a qualitative ranking among systems).

(C) The review of past assessment data to these Skeena lakes is good. However, I don't think that all the extra figures in their present state support the review of past work. I would eliminate many of them. Most figures are not well used or cited in the text of this document (see text for specific comments).

(D) Most the of tabular data are fine (see text for specific comments).

(E) The stock ID work needs to be supported better with sample sizes, collection locations and times for reference stocks etc. - much like some of the other work Wood and Rutherford have presented.

(F) Data compilations presented throughout this paper use apples and oranges type comparisons of data from different time periods using vastly different techniques. As the authors point out, estimates of non Babine sockeye production are variable. These types of data problems likely invalidate statistical assumptions behind analyses presented. I would limit the extent of the analyses (i.e. Maximum Likelihood Methods) used to develop escapement estimates.

(G) There appear to be many problems with the past and present (Cox-Rogers & Jantz 1993) stock assessments in the Skeena and particularly the non

Babine stocks. I think the authors should attempt to provide their view of adequacy of these data sources and where improvements or calibration can and should be made.

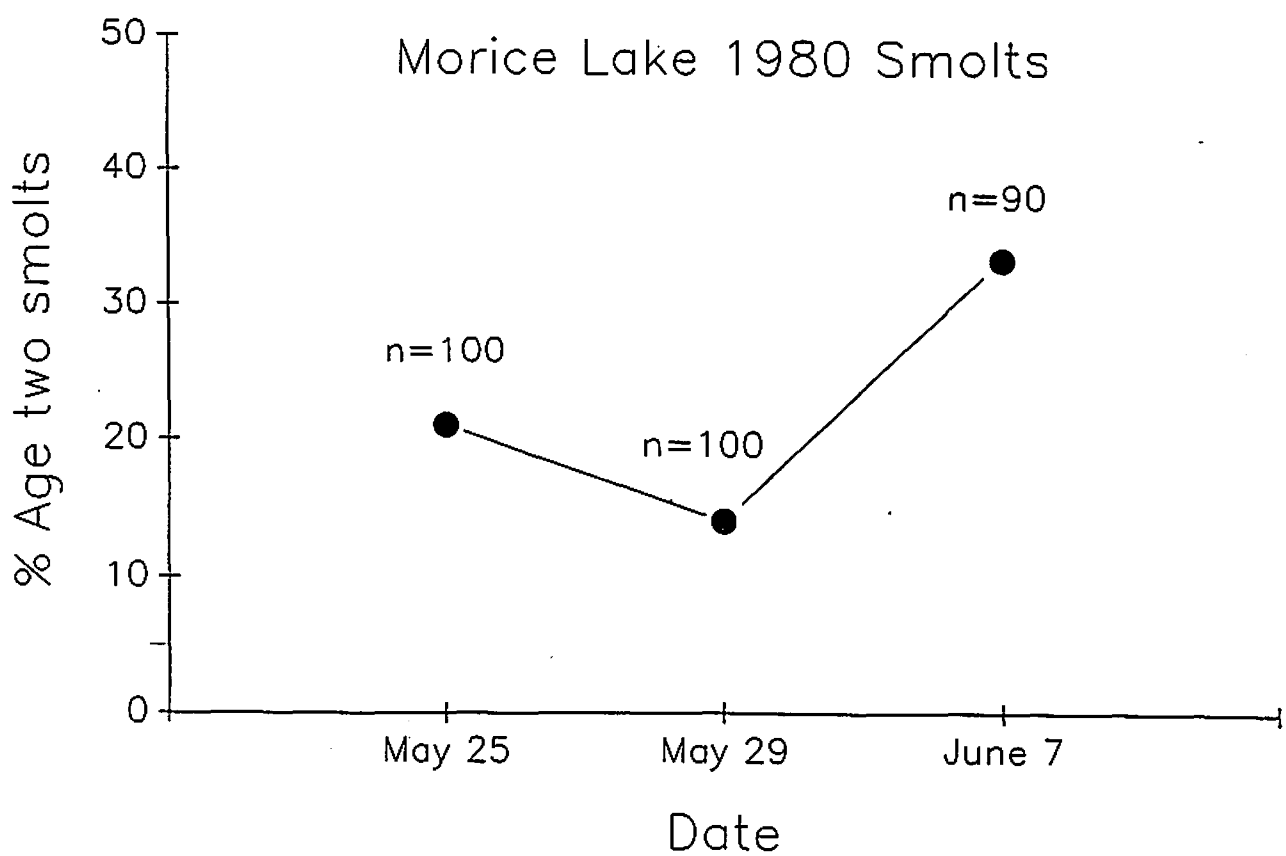
Recommendations

The recommendations developed in this paper address general issues pertinent to most sockeye stocks across the coast. I think that data are available to provide at least a qualitative appraisal of specific stock status and production potentials.

(A) The recommendations as presented focus on escapement issues and may have little probability of being effective in addressing assessments to improve information on production of non Babine Skeena sockeye. Escapement estimation to all these systems would require a brut force effort for assessment at very high costs. The benefits of this type of assessment approach are questionable given costs and effort for either short term stock status assessments or more importantly long term data base development.

(B) Application of stock identification techniques in the test fishery (and from spawning grounds) appear to permit differentiation of Babine versus all non Babine stocks, but offer little prospect for reliable assessments of relative abundance differences among individual stocks of non Babine sockeye (Table 4,5,7). Test fishery data are often difficult to interpret due to the selective properties of the fishery and will need to validated and calibrated to aid further development of stock ID techniques for possible use in the Skeena.

(C) The cost and effectiveness of the two above approaches suggest a third alternative approach to assessments in the Skeena. The Skeena is a mixed stock aggregate dominated by the Babine stock. The best approach to developing assessments in the Skeena and therefore long term data sets at low costs may be to develop standardized Acoustic and Trawl Surveys (ATS) to each system, once or twice a year for the twelve largest systems [Babine, Morice, Swan (Stephens), Bear (Azuklotz), Lakeelse, Kitsumkallum, Kitwanga, Alastair, Sustut, McDonnell and probably Johnston lakes]. Acoustic and trawl surveys provide affordable estimates (with known statistical properties) of juvenile production from which back calculations of abundance of brood year or forecasts of return year adults may be generated. Results from application of ATS for over a decade to SEP sockeye index stocks (Hyatt et al. pers. comm.) suggests considerable potential for ATS observations to provide cost effective assessments of annual variations in both juvenile abundance and escapement of adults for a diverse array of sockeye stocks. In the Skeena, an initial set of ATS observations on both Babine and non Babine stocks could be employed to: (1) rigorously index the relative contributions of all stocks to production of the Skeena aggregate in a fashion that is fishery independent, (2) serve as a basis for an assessment of individual stock status relative to freshwater rearing habitat potential.


Morice Lake 1980 Smolts
% Age two smolts
50
40
30
20
10
0
n=100
n=100
n=90
May 25
May 29
June 7
Date

10.0 Recommendations

10.1 Data

10.1.1 Detailed data on the age structure of the Area 4 catch is reported in Bilton et al. (1967). Unfortunately, these data end in 1963 and biological records obtained from the North Coast Division for the catch or the test fishery do not distinguish 5_3 ages from 6_3. These data are pooled as 'Other ages'. This prevents brood year reconstructions of non-Babine sockeye for the recent period. The biological database must include more detailed recording of the age structure of the catch, the test fishery, and the Babine fence. The historical data should be reviewed to determine whether more complete age structure information is available.

10.1.2 One of the challenges we encountered during the preparation of this manuscript was the availability and/or accessibility of data. Current methods of storage and access to Skeena River sockeye data are primitive, inefficient, and need to be radically improved. We recommend that the Region undertake to develop a Skeena River database that meets the needs of the various interested parties in the Region, or as a minimum, make commonly used data accessible to regional users through existing DFO networks.

10.1.3 The recording of catch in in-river fisheries does not currently permit the catch to be attributed to individual watersheds. As a result, it is not possible to determine gross escapements to watersheds by taking an escapement estimate from the test fishery and subtracting off the in-river catch. In future in-river catches should be reported weekly by watershed, whenever possible.

10.2 Sampling

10.2.1 Stable biological markers (allozymes, *Philonema*, freshwater age structure) are providing some of the only information on the contributions of non-Babine origin sockeye to the fishery and the escapements. Unfortunately, the sampling of many of the non-Babine Lake sockeye populations is incomplete and various untested assumptions are required to undertake various analyses. As these sampling programs would not require long term commitments, we recommend that surveys be undertaken to complete the baseline data for non-Babine Lake populations. Our stock composition analysis of the test fishery samples also suggests that *Philonema* infection rates in Lakelse sockeye should be verified.

10.2.2 The 1988 comparison of weekly stock identification results from the fishery and from the test fishery were interesting and informative. More often than not, the stock composition estimates from the test fishery were correlated with stock composition estimates in the fishery. Given the concerns about the test fishery, it might be informative to repeat this sampling.

10.2.3 Evaluate test fishery catchability (including stock specific vulnerability, selectivity etc)

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12.0 List of figures

Table 1. SEDS list of non-Babine Lake rivers/streams in the Skeena River drainage with at least one non-zero report of sockeye salmon.

Survey Site	R.A.B. Code
1. ECSTALL RIVER	40-0100
2. JOHNSTON CREEK	40-0100-140
3. JOHNSTON LAKE	40-0100-140-000-000-000-991
4. KASIKS RIVER	40-0500
5. ALASTAIR LAKE	40-0600-000-000-000-000-991
6. WEST SIDE CREEK	40-0600-080
7. SOUTHEND CREEK	40-0600-090
8. EXSTEW RIVER	40-0700
9. KLEANZA CREEK	40-1100
10. KITWANGA RIVER	40-2200
11. SLAMGEESH RIVER	40-3400
12. MOTASE LAKE	40-3600
13. KLUATANTAN RIVER	40-4100
14. KLUAYAZ CREEK	40-4100-420
15. EXCHAMSIKS RIVER	41-0000
16. ANDALAS CREEK	42-0800
17. CLEARWATER CREEK	42-0900
18. SCHULBUCKHAND CREEK	42-1000
19. NORTH HATCHERY CREEK	42-1150
20. BLACKWATER CREEK	42-1190
21. WILLIAMS CREEK	42-1200
22. SOCKEYE CREEK	42-1200-010
23. KITSUMKALUM LAKE	43-0000-000-000-000-000-991
24. KITSUMKALUM RIVER	43-0000-000-000-000-000-992
25. GOAT CREEK	43-0800
26. WESACH CREEK	43-1200
27. DOUGLAS CREEK	43-1300
28. CLEAR CREEK	43-1400
29. CEDAR RIVER	43-1500
30. ZYMOETZ RIVER	44-0000-000-000-000-000-991
31. ZYMOETZ RIVER	44-0000-000-000-000-000-992
32. KITSEGUECLA RIVER	45-0000
33. BULKLEY RIVER	46-0000-000-000-000-000-991
34. BULKLEY RIVER	46-0000-000-000-000-000-992
35. MORICE RIVER	46-5500
36. MORICE LAKE	46-5500-000-000-000-000-991
37. NANIKA RIVER	46-5500-190
38. ATNA LAKE	46-5500-240
39. MAXAN CREEK	46-6800
40. KISPIOX RIVER	47-0000
41. NANGEESE RIVER	47-1400
42. STEPHENS CREEK	47-1800
43. CLUB CREEK (LOWER)	47-1800-030-000-000-000-991
44. CLUB CREEK (UPPER)	47-1800-030-000-000-000-992
45. SUSTUT LAKE	49-0000
46. BEAR RIVER	49-0400
47. BEAR LAKE	49-0400-000-000-000-000-991
48. SALIX CREEK	49-0400-040
49. AZUKLOTZ CREEK	49-0400-100
50. ASITKA LAKE	49-0600
51. JOHANSON CREEK	49-1100

Slangeesh?
Damshilgwet?

Table 2. Average escapement of sockeye to lakes in the Skeena River drainage for 1946 and 1947 (from Brett 1952).

System	(,000)
Babine Lake	480
Morice Lake	70
Bear Lake	42
Lakelse Lake	29
Alastair Lake	22
Lac-da-dah Lakes	10
Kitsumkallum Lake	6
Kitwanga Lake	5
Sustut Lakes	5
McDonnell Lake	5
Slamgeesh Lakes	2
Bulkley Lakes	1
Johnston Lake	1
Total	678

Table 3. Age composition of Skeena River sockeye stocks (from Larkin and McDonald 1968).

Stock	Years of sampling	Sample size	3_2	4_2	5_2	6_2	5_3	6_3	Other	4_2+5_2	5_3+6_3	Sub 2s	Sub3s
Babine	9	2045	1.7	45.7	49.1	1.6	0.7	1.1	0.1	94.8	1.8	98.0	1.8
Morice	9	2456	0.5	11.0	17.6	0.4	44.9	25.5	0.7	28.6	70.4	29.5	70.5
Lakelse	8	1671	0.1	21.0	76.2	0.1	0	2.5	0	97.3	2.5	97.5	2.5
Bear	4	97										100	0
	4	193	0	40.9	59.1	0	0	0	0	100	0	100	0
Alastair	3	61										64.2	35.8
	1	39	0	2.6	5.1	0	87.2	5.1	0	7.7	92.3	7.7	92.3
Kitwanga	1	45										84.5	15.5
Sustut	2	22										90	10
	1	90	0	24.4	44.5	1.1	16.7	13.3	0	68.9	30	70	30
Johanson	1	10										90	10
	1	35	0	0	0	0	31.4	65.7	2.9	0	0	[illegible]	97.1
Asitka	1	7										85.7	14.3
Stephens/Swan	3	11										83.4	16.6
	1	6	0	100						100	0	100	0

Table 4. Stock composition estimates for the Skeena River test fishery, 1987 to 1992. Standard deviations in parentheses. The composition for all weeks combined was estimated after pooling subsamples from each week.

1987 SKEENA RIVER SOCKEYE TEST FISHERY: Stock Composition

Week	N	Lakelse	McDonnell	Alastair	Swan	Bear	Nanika	Motass	BabineG
		Proportion							
Jun 11 - Aug 22	917	0.133 (0.053)	0.038 (0.023)	0.020 (0.018)	0.046 (0.010)	0.002 (0.002)	0.000 (0.000)	0.006 (0.008)	0.760 (0.065)

1988 SKEENA RIVER SOCKEYE TEST FISHERY: Stock Composition

Week		N	Lakelse	McDonnell	Alastair	Swan	Bear	Nanika	Motass	BabineG
Jun 13 - 26	gn	47	0.010 (0.083)	0.091 (0.080)	0.337 (0.161)	0.099 (0.047)	0.053 (0.066)	0.115 (0.058)	0.001 (0.001)	0.294 (0.185)
	sn	79	0.016 (0.073)	0.064 (0.077)	0.180 (0.114)	0.093 (0.031)	0.026 (0.041)	0.105 (0.040)	0.003 (0.014)	0.514 (0.146)
Jun 27 - Jul 3	gn	81	0.209 (0.122)	0.014 (0.041)	0.336 (0.140)	0.178 (0.043)	0.005 (0.016)	0.031 (0.026)	0.023 (0.070)	0.201 (0.189)
	sn	69	0.011 (0.038)	0.036 (0.044)	0.007 (0.021)	0.108 (0.037)	0.038 (0.028)	0.003 (0.014)	0.002 (0.003)	0.799 (0.081)
Jul 4 - Jul 10	gn	105	0.006 (0.063)	0.156 (0.103)	0.002 (0.030)	0.095 (0.025)	0.001 (0.026)	0.022 (0.022)	0.003 (0.016)	0.716 (0.117)
	sn	105	0.036 (0.085)	0.070 (0.052)	0.066 (0.039)	0.035 (0.020)	0.001 (0.001)	0.000 (0.012)	0.001 (0.002)	0.791 (0.108)
Jul 11 - 17	gn	96	0.003 (0.035)	0.004 (0.030)	0.001 (0.010)	0.045 (0.024)	0.000 (0.009)	0.000 (0.000)	0.003 (0.001)	0.952 (0.047)
	sn	105	0.055 (0.099)	0.110 (0.072)	0.001 (0.002)	0.046 (0.020)	0.000 (0.001)	0.000 (0.006)	0.001 (0.009)	0.789 (0.122)
Jul 18 - 24	gn	89	0.147 (0.101)	0.091 (0.078)	0.001 (0.003)	0.000 (0.012)	0.000 (0.014)	0.000 (0.000)	0.000 (0.001)	0.760 (0.121)
	sn	105	0.044 (0.090)	0.096 (0.063)	0.088 (0.065)	0.000 (0.000)	0.001 (0.004)	0.000 (0.000)	0.001 (0.011)	0.770 (0.136)
Jul 25 - 31	gn	105	0.090 (0.091)	0.090 (0.074)	0.003 (0.009)	0.001 (0.007)	0.028 (0.030)	0.001 (0.010)	0.002 (0.009)	0.785 (0.128)
	sn	101	0.014 (0.109)	0.002 (0.013)	0.001 (0.018)	0.000 (0.000)	0.001 (0.004)	0.011 (0.011)	0.000 (0.001)	0.972 (0.110)
Aug 1 - Aug 7	gn	105	0.007 (0.029)	0.088 (0.086)	0.009 (0.039)	0.000 (0.000)	0.001 (0.003)	0.000 (0.000)	0.002 (0.010)	0.894 (0.098)
	sn	105	0.130 (0.101)	0.006 (0.022)	0.119 (0.096)	0.021 (0.018)	0.005 (0.018)	0.000 (0.000)	0.001 (0.001)	0.725 (0.138)
Aug 8 - 14	gn	105	0.214 (0.154)	0.059 (0.061)	0.006 (0.023)	0.000 (0.001)	0.001 (0.001)	0.000 (0.011)	0.001 (0.003)	0.721 (0.154)
	sn	105	0.211 (0.142)	0.107 (0.077)	0.080 (0.045)	0.000 (0.000)	0.001 (0.003)	0.000 (0.016)	0.001 (0.018)	0.600 (0.165)
Aug 15 - 21	gn	105	0.210 (0.128)	0.009 (0.049)	0.003 (0.027)	0.000 (0.000)	0.007 (0.028)	0.000 (0.000)	0.001 (0.006)	0.771 (0.132)
	sn	90	0.010 (0.077)	0.043 (0.069)	0.001 (0.004)	0.000 (0.000)	0.000 (0.001)	0.000 (0.000)	0.000 (0.000)	0.947 (0.104)
Aug 22 - 28	gn	48	0.546 (0.219)	0.314 (0.161)	0.003 (0.045)	0.000 (0.000)	0.002 (0.026)	0.000 (0.006)	0.001 (0.015)	0.135 (0.271)
	sn	60	0.351 (0.184)	0.000 (0.010)	0.000 (0.002)	0.000 (0.013)	0.064 (0.057)	0.000 (0.000)	0.000 (0.001)	0.585 (0.180)
Jun 13 - Aug 28	gn	492	0.022 (0.049)	0.138 (0.055)	0.006 (0.024)	0.036 (0.009)	0.010 (0.009)	0.001 (0.004)	0.001 (0.005)	0.785 (0.067)
	sn	474	0.132 (0.070)	0.024 (0.023)	0.027 (0.025)	0.021 (0.011)	0.001 (0.002)	0.009 (0.004)	0.001 (0.002)	0.786 (0.082)

1989 SKEENA RIVER SOCKEYE TEST FISHERY: Stock Composition

Week	N	Lakelse	McDonnell	Alastair	Swan	Bear	Nanika	Motass	BabineG
		Proportion							
Jun 11 - 17	16	0.001 (0.115)	0.001 (0.025)	0.502 (0.350)	0.000 (0.000)	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	0.490 (0.351)
Jun 18 - 24	37	0.008 (0.125)	0.285 (0.188)	0.351 (0.172)	0.080 (0.049)	0.129 (0.088)	0.100 (0.055)	0.004 (0.081)	0.043 (0.185)
Jun 25 - Jul 1	68	0.004 (0.022)	0.182 (0.105)	0.269 (0.131)	0.055 (0.027)	0.002 (0.036)	0.022 (0.020)	0.002 (0.016)	0.468 (0.171)
Jul 2 - 8	151	0.012 (0.046)	0.146 (0.084)	0.124 (0.080)	0.067 (0.023)	0.008 (0.035)	0.019 (0.014)	0.004 (0.016)	0.621 (0.118)
Jul 9 - 15	165	0.049 (0.062)	0.013 (0.039)	0.004 (0.023)	0.000 (0.004)	0.001 (0.004)	0.026 (0.014)	0.002 (0.017)	0.905 (0.084)
Jul 16 - 22	175	0.127 (0.069)	0.013 (0.018)	0.011 (0.024)	0.003 (0.006)	0.004 (0.014)	0.016 (0.013)	0.002 (0.009)	0.827 (0.078)
Jul 23 - 29	175	0.055 (0.079)	0.000 (0.003)	0.000 (0.018)	0.000 (0.000)	0.000 (0.001)	0.000 (0.000)	0.032 (0.029)	0.914 (0.084)
Jul 30 - Aug 5	175	0.080 (0.111)	0.002 (0.009)	0.002 (0.003)	0.000 (0.000)	0.001 (0.009)	0.000 (0.006)	0.000 (0.006)	0.915 (0.115)
Aug 6 - 12	124	0.147 (0.079)	0.001 (0.013)	0.165 (0.083)	0.000 (0.002)	0.003 (0.001)	0.020 (0.019)	0.041 (0.046)	0.632 (0.120)
Aug 13 - 19	129	0.000 (0.075)	0.001 (0.026)	0.055 (0.038)	0.000 (0.000)	0.000 (0.001)	0.000 (0.000)	0.020 (0.015)	0.924 (0.089)
Aug 20 - 26	33	0.020 (0.059)	0.001 (0.002)	0.156 (0.152)	0.000 (0.032)	0.000 (0.001)	0.001 (0.027)	0.152 (0.116)	0.672 (0.200)
Jun 11 - Aug 26	812	0.035 (0.056)	0.000 (0.000)	0.074 (0.040)	0.014 (0.005)	0.005 (0.006)	0.012 (0.007)	0.000 (0.000)	0.860 (0.067)

Table 4 continued.

1990 SKEENA RIVER SOCKEYE TEST FISHERY: Stock Composition

Week	N	Lakelse	McDonnell	Alastair	Swan	Bear	Nanik	Motass	BabineG
Jun 17 - 30	66	0.000 (0.003)	0.000 (0.024)	0.000 (0.129)	0.000 (0.000)	0.000 (0.014)	0.130 (0.069)	0.000 (0.083)	0.869 (0.176)
Jul 1 - 7	81	0.002 (0.015)	0.141 (0.109)	0.001 (0.050)	0.084 (0.030)	0.001 (0.020)	0.076 (0.043)	0.002 (0.058)	0.693 (0.146)
Jul 8 - 14	96	0.005 (0.048)	0.047 (0.068)	0.002 (0.033)	0.000 (0.000)	0.000 (0.001)	0.073 (0.047)	0.002 (0.050)	0.871 (0.096)
Jul 15 - 21	170	0.009 (0.047)	0.059 (0.050)	0.003 (0.016)	0.017 (0.011)	0.000 (0.000)	0.055 (0.019)	0.002 (0.022)	0.853 (0.070)
Jul 22 - 28	161	0.135 (0.077)	0.000 (0.021)	0.008 (0.071)	0.000 (0.007)	0.000 (0.003)	0.080 (0.025)	0.014 (0.035)	0.768 (0.101)
Jul 29 -Aug 4	175	0.180 (0.101)	0.001 (0.020)	0.002 (0.029)	0.000 (0.005)	0.000 (0.001)	0.000 (0.003)	0.120 (0.049)	0.695 (0.111)
Aug 5 - 11	165	0.171 (0.118)	0.001 (0.009)	0.003 (0.013)	0.000 (0.000)	0.008 (0.034)	0.030 (0.019)	0.001 (0.018)	0.786 (0.129)
Aug 12 - 18	175	0.030 (0.082)	0.000 (0.016)	0.002 (0.034)	0.000 (0.003)	0.046 (0.032)	0.060 (0.013)	0.001 (0.029)	0.921 (0.085)
Aug 19 - 25	100	0.280 (0.130)	0.004 (0.019)	0.004 (0.002)	0.001 (0.008)	0.002 (0.000)	0.001 (0.006)	0.052 (0.041)	0.657 (0.140)
Jun 17 - Aug 25	726	0.077 (0.045)	0.015 (0.016)	0.040 (0.037)	0.008 (0.006)	0.005 (0.007)	0.039 (0.013)	0.059 (0.039)	0.744 (0.075)

1991 SKEENA RIVER SOCKEYE TEST FISHERY: Stock Composition

Week	N	Proportion							
		Lakelse	McDonnell	Alastair	Swan	Bear	Nanika	Motass	BabineG
Jun 9 -Jul 6	110	0.172 (0.118)	0.020 (0.027)	0.210 (0.112)	0.113 (0.033)	0.001 (0.002)	0.063 (0.031)	0.001 (0.007)	0.422 (0.133)
Jul 7 - 13	175	0.004 (0.016)	0.048 (0.038)	0.056 (0.038)	0.163 (0.025)	0.001 (0.001)	0.060 (0.022)	0.002 (0.010)	0.669 (0.054)
Jul 14 - 20	175	0.005 (0.053)	0.067 (0.060)	0.123 (0.068)	0.077 (0.021)	0.000 (0.015)	0.086 (0.026)	0.096 (0.054)	0.55 (0.115)
Jul 21 - 27	175	0.037 (0.062)	0.029 (0.054)	0.002 (0.005)	0.047 (0.016)	0.002 (0.003)	0.048 (0.023)	0.018 (0.027)	0.821 (0.085)
Jul 28 -Aug 3	175	0.054 (0.081)	0.091 (0.064)	0.000 (0.008)	0.024 (0.015)	0.002 (0.030)	0.025 (0.020)	0.001 (0.030)	0.805 (0.102)
Aug 4 - 10	175	0.134 (0.089)	0.005 (0.029)	0.001 (0.012)	0.016 (0.012)	0.001 (0.006)	0.017 (0.010)	0.024 (0.031)	0.803 (0.097)
Aug 11 - 17	175	0.188 (0.090)	0.002 (0.011)	0.002 (0.027)	0.000 (0.001)	0.001 (0.002)	0.012 (0.015)	0.019 (0.025)	0.779 (0.103)
Aug 18 - 24	144	0.351 (0.129)	0.001 (0.003)	0.000 (0.022)	0.005 (0.006)	0.000 (0.003)	0.000 (0.005)	0.100 (0.043)	0.542 (0.140)
Jun 9 - Aug 24	865	0.069 (0.034)	0.062 (0.030)	0.059 (0.030)	0.069 (0.010)	0.000 (0.006)	0.045 (0.013)	0.034 (0.021)	0.664 (0.066)

1992 SKEENA RIVER SOCKEYE TEST FISHERY: Stock Composition

Week	Stat Wk.	N	Proportion							
			Lakelse	McDonnell	Alastair	Swan	Bear	Nanika	Motass	BabineG
Jun 21 - Jul 4	26&27	75	0.009 (0.080)	0.010 (0.036)	0.009 (0.051)	0.079 (0.030)	0.025 (0.024)	0.193 (0.059)	0.001 (0.011)	0.675 (0.119)
Jul 5 - 11	28	148	0.048 (0.075)	0.012 (0.035)	0.142 (0.082)	0.090 (0.028)	0.004 (0.011)	0.213 (0.041)	0.005 (0.022)	0.485 (0.123)
Jul 12 - 18	29	125	0.053 (0.055)	0.006 (0.031)	0.066 (0.045)	0.073 (0.026)	0.004 (0.025)	0.142 (0.038)	0.001 (0.015)	0.655 (0.086)
Jul 19 - 25	30	125	0.113 (0.087)	0.153 (0.091)	0.001 (0.015)	0.034 (0.016)	0.002 (0.035)	0.157 (0.039)	0.001 (0.019)	0.541 (0.133)
Jul 26 - Aug 1	31	88	0.334 (0.150)	0.164 (0.109)	0.002 (0.045)	0.012 (0.011)	0.000 (0.019)	0.131 (0.042)	0.000 (0.010)	0.358 (0.206)
Aug 2 - 8	32	124	0.306 (0.104)	0.001 (0.031)	0.000 (0.001)	0.001 (0.010)	0.084 (0.050)	0.060 (0.024)	0.001 (0.034)	0.547 (0.117)
Aug 9 - 22	33-34	134	0.165 (0.107)	0.017 (0.041)	0.019 (0.056)	0.001 (0.011)	0.001 (0.017)	0.014 (0.016)	0.042 (0.045)	0.735 (0.118)
Aug 23 - Sep 5	35-36	128	0.121 (0.093)	0.000 (0.007)	0.000 (0.042)	0.000 (0.010)	0.000 (0.004)	0.015 (0.012)	0.000 (0.010)	0.861 (0.099)
Jun 21 - Sep 5	26-36	471	0.030 (0.051)	0.027 (0.034)	0.037 (0.020)	0.044 (0.011)	0.017 (0.016)	0.147 (0.021)	0.006 (0.032)	0.692 (0.081)

Table 5. Sockeye test fishery escapements, by stock, estimated from stock composition of the test fishery samples.

Year	Lakelse	McDonnell	Alastair	Swan	Bear	Nanika	Motase	BabineG
1987	248254	70930	37331	85862	3733	0	11199	1418596
1988	42645	267503	11631	69784	19384	1938	1938	1521668
1989	51448	0	108775	20579	7350	17639	0	1264141
1990	114000	22208	59221	11844	7403	57740	37351	1101506
1991	132834	119358	113583	132834	0	86631	65454	1278286
1992	56409	50768	69572	82734	31965	276406	11282	1301177

Table 6. Weekly and annual minimum "non-Babine" sockeye stock composition and annual "non-Babine" sockeye escapements estimated from Philonema prevalence in the Skeena River sockeye test fishery. ('Prop -ve' = minimum non-babine contribution)

Year	Week	N	+ve	-ve	Index	Escapement
1987	Jun 11-Aug 22		917	741	0.19	332,757
1988	Jun 13-26	47	16	0.66	0.06	
	Jun 27-Jul 3	81	55	0.32	0.19	
	Jul 4-10	105	86	0.18	0.67	
	Jul 11-17	96	87	0.09	0.78	
	Jul 18-24	89	81	0.09	0.39	
	Jul 25-31	105	97	0.08	1	
	Aug 1-7	105	99	0.06	0.53	
	Aug 8-14	105	100	0.05	0.67	
	Aug 15-21	105	98	0.07	0.18	
	Aug 22-28	48	47	0.02	0.11	
	Jun 13-Aug 28[a]			0.11		188,071
1989	Jun 11-17	16	3	0.81	0.083	
	Jun 18-24	37	12	0.68	0.122	
	Jun 25-Jul 1	68	42	0.38	0.19	
	Jul 2- 8	151	122	0.19	0.559	
	Jul 9-15	160	133	0.17	1	
	Jul 16-22	172	157	0.09	0.804	
	Jul 23-29	173	156	0.10	0.945	
	Jul 30-Aug 5	174	164	0.06	0.906	
	Aug 6-12	123	119	0.03	0.435	
	Aug 13-19	127	126	0.01	0.297	
	Aug 20-26	32	30	0.06	0.083	
	Jun 11-Aug 26[a]			0.14		205,790
1990	Jun 17-30	66	38	0.42	0.05	
	Jul 1- 7	80	67	0.16	0.13	
	Jul 8-14	93	87	0.06	0.31	
	Jul 15-21	169	160	0.05	1	
	Jul 22-28	161	151	0.06	0.72	
	Jul 29-Aug 4	174	165	0.05	0.75	
	Aug 5-11	165	159	0.04	0.45	
	Aug 12-18	174	167	0.04	0.26	
	Aug 19-25	100	98	0.02	0.15	
	Jun 17-Aug 25[a]			0.06		70,309

[a] Weighted by test fishery CPUE

Table 6 Continued.

Year	Week	N	+ve	-ve	Index	Escapement
1991	Jun 9-Jul 6	110	66	0.40	0.14	
	Jul 7-13	175	142	0.19	0.82	
	Jul 14-20	175	164	0.06	1	
	Jul 21-27	173	160	0.08	0.9	
	Jul 28-Aug 3	175	167	0.05	0.58	
	Aug 4-10	175	173	0.01	0.42	
	Aug 11-17	175	175	0.00	0.49	
	Aug 18-24	144	143	0.01	0.18	
	Jun 9-Aug 24[a]			0.08		111,155
1992	Jun 21-Jul 4	47	36	0.23	0.104	
	Jul 5-11	148	122	0.18	0.5	
	Jul 12-18	125	113	0.10	1	
	Jul 19-25	125	120	0.04	0.659	
	Jul 26-Aug 1	88	86	0.02	0.368	
	Aug 2- 8	124	123	0.01	0.404	
	Aug 9-22	134	131	0.02	0.211	
	Aug 23-Sep 5	128	126	0.02	0.099	
	Jun 21-Sep 5[a]			0.08		113,146
1993	Jun 6-26	16	8	0.50	0.052	
	Jun 27-Jul 3	111	94	0.15	0.289	
	Jul 4-10	82	76	0.07	0.526	
	Jul 11-17	126	123	0.02	0.637	
	Jul 18-24	110	107	0.03	0.629	
	Jul 25-31	87	86	0.01	0.488	
	Aug 1-7	125	124	0.01	1	
	Aug 8-14	88	86	0.02	0.504	
	Aug 15-21	20	19	0.05	0.139	
	Jun 6-Aug 21[a]			0.04		84,336

[a] Weighted by test fishery CPUE

Table 7. Sockeye test fishery escapements, by stock, estimated from stock composition of test fishery samples using the MLE+Philonema method.

	Lakelse	McDonnell	Alastair	Swan	Bear	Nanika	Motass	BabineG
1987	112865	40865	252973	72000	11676	0	35027	1418596
1988	43352	292628	208091	73699	13006	2168	2168	1521668
1989	75246	1505	135444	9030	0	12039	15054	1264141
1990	2574	21876	83642	10294	1287	43751	27023	1101506
1991	75395	66827	102811	95957	1714	44552	59973	1278286
1992	1730	34606	77863	70942	31145	200713	8651	1301177

Table 8. S.E.D.S. database contents for non-Babine Lake sockeye: 1953-1993. System codes are found in Table 1.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1953	0	-2	500	0	3000	1000	12000	0	0	0	-1	-1	-1	-1	0	0	0
1954	0	0	600	0	2500	1500	15000	0	0	0	-1	-1	-1	-1	0	0	0
1955	0	0	25	0	2500	750	15000	-1	0	0	-1	-1	-1	-1	0	0	0
1956	-1	0	5	0	7500	3500	15000	0	0	0	-1	-1	-1	-1	0	0	0
1957	0	0	-1	0	7500	600	35000	-1	0	0	-1	-1	-1	-1	0	0	0
1958	0	0	50	0	7500	1500	15000	-1	-1	0	-1	-1	-1	-1	0	0	0
1959	0	0	-1	-1	7500	-1	15000	-1	0	0	-1	-1	-1	-1	-1	-1	-1
1960	0	0	-1	0	500	600	3000	-1	-1	600	-1	-1	-1	-1	-1	0	-1
1961	0	0	-1	0	750	1000	12500	-1	3	200	-1	-1	-1	-1	0	-1	0
1962	0	0	-1	0	1500	450	8615	-1	-1	200	-1	-1	-1	-1	0	-1	-1
1963	0	0	-1	0	1500	-1	7500	-1	0	0	-1	-1	-1	-1	0	0	0
1964	0	0	-1	0	600	0	1500	-1	-1	200	200	-1	-1	-1	0	-1	200
1965	0	-1	3	0	600	-1	7500	-1	-1	600	500	-1	-1	-1	0	-1	600
1966	0	0	25	0	600	-1	6000	-1	0	300	-1	-1	-1	-1	0	-1	300
1967	0	0	750	400	5000	-1	7500	300	0	-1	-1	-1	-1	-1	600	150	100
1968	0	0	750	0	7500	-1	7500	0	0	200	-1	-1	-1	-1	0	25	600
1969	0	0	600	0	1500	-1	1500	0	0	-1	-1	0	-1	-2	0	25	75
1970	0	0	2500	0	1500	-1	750	0	0	-1	50	600	50	600	0	25	75
1971	0	0	5000	0	600	-1	750	0	0	-1	-1	-1	-1	-1	0	25	25
1972	0	0	7500	0	1500	-1	2500	0	0	-1	500	300	-1	-1	0	25	25
1973	250	0	3000	0	1500	-1	2500	0	0	-1	-1	3000	-1	-1	0	25	25
1974	0	0	750	0	750	-1	1000	0	0	-1	-1	-2	-2	-2	0	25	25
1975	0	0	1000	0	200	-1	400	0	0	0	-1	33	-2	400	0	25	75
1976	0	0	3000	0	1500	-1	1500	0	0	0	-1	-2	-1	-2	0	25	25
1977	0	0	500	0	3500	-1	3500	0	0	25	-1	-1	-1	-1	0	25	25
1978	0	0	500	0	1500	-1	7500	0	0	75	4000	-2	-1	-1	0	25	25
1979	0	0	-1	0	3000	-1	7000	0	0	0	900	-2	-2	-2	0	20	40
1980	0	0	-1	0	4500	-1	10500	0	3	100	-1	-1	-1	-1	0	20	25
1981	0	0	500	0	500	-1	400	0	-1	-1	2000	-2	-1	-2	0	20	25
1982	0	0	500	25	750	-1	4000	0	0	0	-2	-2	-1	-2	0	25	300
1983	0	0	-1	1	1500	-1	5000	0	0	0	-2	-2	-2	-2	0	25	10
1984	0	0	-2	-1	1500	-1	2500	0	0	0	0	-1	-1	-1	0	10	-1
1985	-1	-1	900	-1	1500	-1	3500	-1	-1	2200	0	0	0	0	-1	-1	-1
1986	75	0	150	0	2000	0	8500	0	-1	0	100	-2	-2	-2	0	0	0
1987	1600	0	800	0	1500	-2	3500	0	0	0	400	750	-2	-2	0	0	-2
1988	500	0	700	0	1500	0	5000	0	0	0	0	50	0	0	0	0	-1
1989	75	-2	300	-2	-2	-1	5500	-1	-1	-2	-1	200	-1	-1	-2	-2	-1
1990	50	-2	-1	-2	3000	-1	3000	-2	-1	500	-2	30	-2	-2	-2	-1	-2
1991	-2	-2	600	-2	5000	-1	6000	-2	-2	-2	-2	150	-2	-2	-2	-2	-2
1992	-1	0	-2	0	3000	0	6000	0	0	0	-2	250	-2	-2	0	100	0

	18	19	20	21	22	23	24	25	26	27	28	29
1953	750	-1	-1	6500	-1	3000	-1	0	500	200	300	-1
1954	750	-1	-1	7500	-1	3500	0	0	75	300	1500	-1
1955	300	-1	-1	3500	-1	1500	-1	0	750	300	-1	-1
1956	75	-1	-1	3500	-1	3500	-1	0	7500	75	750	750
1957	300	-1	-1	7500	-1	750	-1	0	1500	25	200	-1
1958	750	-1	-1	7500	-1	1500	-1	0	1500	300	1500	750
1959	750	-1	-1	7500	-1	1500	-1	0	400	300	750	-1
1960	1000	-1	-1	3500	-1	300	-1	-1	200	25	600	600
1961	600	-1	-1	5500	-1	600	-1	0	-1	200	750	400
1962	600	-1	-1	7500	25	600	0	0	-1	200	750	750
1963	600	-1	-1	7500	-1	600	-1	0	25	0	1500	1500
1964	2767	-1	-1	10000	-1	500	0	-1	600	-1	1500	1000
1965	2667	-1	-1	20711	7500	600	0	-1	600	600	750	1500
1966	1500	-1	-1	12711	3000	500	-1	0	25	25	750	1500
1967	8600	-1	-1	6500	75	600	-1	25	-1	25	500	1500
1968	3500	-1	-1	7500	400	600	-1	0	-1	75	750	1500
1969	1500	-1	-1	3500	1500	600	200	0	-1	200	75	1500
1970	300	-1	-1	3500	1500	600	1500	0	-1	75	75	1500
1971	750	-1	-1	3500	750	600	750	0	-1	200	750	1500
1972	750	-1	-1	3500	600	1500	600	0	25	200	600	1500
1973	600	-1	-1	1000	600	1500	600	0	-1	200	600	1500
1974	700	-1	-1	1500	200	1500	600	0	-1	200	600	750
1975	400	-1	-1	1500	400	750	600	0	-1	200	300	750
1976	750	-1	-1	1500	750	600	600	0	-1	75	200	600
1977	750	-1	-1	1500	75	1500	600	0	-1	200	750	600
1978	2500	-1	-1	1500	600	600	300	0	-1	75	25	600
1979	1200	-1	-1	6000	300	150	150	0	-1	60	25	200
1980	2068	12	250	8600	1800	150	200	0	-1	75	25	200
1981	2600	10	200	6000	500	100	150	0	-1	75	25	100
1982	5500	15	1500	7300	967	200	150	-1	150	75	750	200
1983	5000	300	300	3000	600	200	150	0	-1	25	150	500
1984	1200	100	300	3000	150	250	100	0	-1	75	75	300
1985	4000	25	150	12000	600	300	1000	-1	200	-1	250	1000
1986	2000	100	200	2000	100	500	0	0	0	0	200	2000
1987	1600	25	300	500	150	1000	0	0	-1	-1	-1	200
1988	1000	25	300	1600	175	600	0	0	-1	-1	-1	-1
1989	600	10	300	3000	50	600	-1	0	-1	-1	-1	200
1990	550	-1	300	650	30	1500	-1	-1	-1	-1	-1	200
1991	-2	-1	300	2700	100	1500	-1	-1	-1	-1	-1	300
1992	1200	0	60	3400	150	4000	0	0	0	0	0	200

	30	31	32	33	34	35	36	37	38
1953	0	500	-1	750	0	700	-1	35000	-1
1954	0	100	0	750	0	-1	-1	-1	-1
1955	-1	100	-1	75	0	-1	-1	6000	-1
1956	0	75	-1	-1	0	-1	-1	8000	-1
1957	-2	250	0	-1	0	-1	-1	400	-1
1958	-1	150	-1	0	0	-1	-1	25	-1
1959	0	75	-1	-1	-1	-1	-1	750	-1
1960	-1	75	-1	0	300	0	-1	3500	-1
1961	-2	75	0	0	-2	0	-1	3000	-1
1962	350	30	-1	0	600	-1	-1	3000	-1
1963	0	60	-1	0	400	1000	-1	1000	500
1964	250	50	-1	0	300	3000	-1	5000	500
1965	3000	300	0	0	100	300	300	10000	50
1966	250	400	0	0	0	100	300	6000	50
1967	200	20	0	0	0	0	-1	3600	50
1968	1500	250	0	0	0	0	300	3000	500
1969	1500	97	0	0	0	0	-2	3300	-1
1970	1500	150	0	0	50	0	-2	6700	-1
1971	1500	150	-1	0	0	0	-1	1300	-1
1972	1500	60	0	0	300	0	-2	1600	-1
1973	1500	200	0	0	300	0	-1	3000	200
1974	3000	100	0	0	200	0	-2	1200	-1
1975	600	30	0	-1	66	100	-2	225	-1
1976	600	-	-1	0	0	-1	-1	300	-1
1977	1500	60	-1	0	250	0	-1	600	-1
1978	3500	600	0	0	50	0	50	500	200
1979	600	110	0	-2	600	0	-1	700	250
1980	600	16	0	-1	0	0	-1	400	250
1981	100	150	0	-1	0	-1	-2	1000	300
1982	100	100	50	-1	0	0	-2	3000	-1
1983	150	500	-1	0	25	-1	-2	4000	-1
1984	75	50	-1	0	-1	-1	-1	3000	0
1985	-1	40	-1	0	0	0	0	2000	2
1986	-2	300	0	0	0	0	-2	1050	0
1987	-1	300	0	0	12	0	-1	4035	-2
1988	-2	200	0	0	-2	0	0	2050	0
1989	-2	-	-2	-2	0	-1	-2	5000	-1
1990	1500	150	-2	-1	0	-2	-2	6050	-1
1991	-2	60	-2	-1	-2	-1	-1	40000	-1
1992	0	-	0	-1	-1	-1	-1	27000	-1

	39	40	41	42	43	44	45	46	47	48	49	50	51
1953	-1	0	-1	0	500	300	-1	0	9000	300	75	-1	-1
1954	-1	0	-1	-1	200	25	-1	0	9000	200	1000	-1	-1
1955	-1	0	-1	-1	750	300	-1	-1	6500	-1	500	1	-1
1956	-1	0	-1	25	7500	750	-1	300	7500	25	750	-1	-1
1957	-1	0	-1	0	1500	750	750	-2	7500	-1	25	200	75
1958	-1	0	-1	0	3500	750	400	0	7500	-1	200	200	200
1959	-1	0	-1	0	750	75	-1	0	1500	-1	1500	-1	25
1960	-1	0	-1	0	3500	750	75	0	300	0	1500	0	25
1961	-1	-1	-1	1500	750	-1	250	0	500	256	563	300	150
1962	-1	0	-1	17	1	-2	250	100	500	0	1500	-1	250
1963	-1	-1	-1	75	3500	300	300	6000	500	200	6000	-1	100
1964	-1	0	-1	75	1500	1500	300	-1	450	200	5000	250	100
1965	0	0	0	75	750	750	3000	0	500	200	300	-1	100
1966	0	0	0	600	1500	1500	50	100	300	25	700	100	-1
1967	-1	0	0	-2	3000	1500	50	250	500	-1	155	-1	50
1968	0	0	0	-1	3500	-1	500	500	500	-1	300	300	600
1969	300	0	0	750	3500	1500	1500	-1	-1	-1	-2	-1	200
1970	-1	0	0	600	3500	600	2000	-1	500	50	50	50	500
1971	300	0	0	600	3500	1500	500	-1	300	-1	-1	-1	-1
1972	0	0	0	600	3500	1500	400	6000	3000	-1	-1	50	600
1973	-2	0	0	600	1500	750	3000	400	3000	-2	3000	500	100
1974	-2	0	0	600	3500	750	25	-1	-1	-1	-1	1	50
1975	-2	0	0	300	3500	750	12	250	50	-2	1000	-2	-2
1976	-1	0	0	300	600	25	-1	-2	-2	0	100	-2	-2
1977	100	0	0	600	3500	600	-1	600	-1	-1	-1	-1	60
1978	0	0	0	1500	300	-1	-1	300	50	200	1000	300	2
1979	-1	0	0	-1	3500	1500	100	750	-1	50	-1	-1	120
1980	0	0	0	100	3000	750	500	-1	-1	150	750	50	100
1981	-2	0	300	-1	3000	2000	300	0	70	150	300	-2	-1
1982	-2	-1	-1	3000	5000	3000	-1	0	-1	-2	-1	-1	0
1983	-2	0	0	-1	-1	-1	-2	-1	-2	-1	-1	-2	-2
1984	-1	0	-1	-2	3500	3500	0	-2	-1	-1	300	0	-1
1985	0	-2	-1	-1	5500	2200	0	0	0	200	1000	0	0
1986	0	0	0	250	3500	2500	-1	0	0	-2	1000	0	-1
1987	-2	0	0	-1	4000	3000	500	0	0	1000	4000	50	600
1988	0	0	0	-1	3000	6000	500	0	0	300	5000	-1	50
1989	-1	-1	-1	-1	3500	3000	-1	-2	26	50	700	-1	-1
1990	-2	-2	-2	-2	3500	2500	100	100	-1	60	1000	110	70
1991	-1	-2	-2	-1	6000	1500	-1	300	-1	150	1600	-1	-2
1992	-1	1000	12	250	6000	5000	2600	-1	0	200	2100	600	3600

Table 9. Estimates of "non-Babine" test fishery escapements determined by various methods.

Year	Freshwater Age Structure[a]	M.L.E.	Philonema	M.L.E. + Philonema	S.E.D.S.[b]
1987	85,848	457,309	n/a	332,757	31,158
1988	109,127	414,823	> 188,071	645,950	27,451
1989	105,421	205,791	> 205,790	240,789	22,656
1990	211,350	359,767	> 70,309	185,300	23,854
1991	233,950	650,694	> 111,155	185,300	67,930
1992	502,753[c]	579,136	> 113,146	429,112	64,496
1993			> 84,336		

[a] Proportion non-Babine at the test fishery is developed by assuming a 50:50 ratio of one:two year smolts from non-Babine Lakes. Annual non-Babine test fishery escapement= prop.NB * (Babine Fence count + IFF)/(1 -prop.NB) ....knowing that sockeye escapement to the test fishery= Babine Fence count + aboriginal catch + non-Babine escapement) and Non-Babine escapement at the test fishery= proportion non-Babine at the test fishery * total escapement at the test fishery.

[b] SEDS total does not include in-river catch (ie SEDS = spawning escapement)

[c] Food fishery assumed to be 100,000 sockeye in 1992.

Table 10. Percentage of tag recoveries by recovery (rows) and release location (columns) for migrating adult sockeye salmon tagged in 1966 prior to July 17th.

	Browning Inside	Browning Outside	Chacon	Dundas3x	Dundas3y Mainland	Langara Island	Muzon	NrthQCI	Ogden-Principe	Zayas	TOTAL	N
03	.00	.00	22.22	14.51	6.70	5.00	15.09	19.15	4.55	55.56	12.08	109.00
04	40.00	100.00	22.22	70.09	85.27	75.00	41.51	65.96	34.85	44.44	68.74	620.00
05	40.00	.00	11.11	7.14	6.25	10.00	15.09	4.26	59.09	.00	11.31	102.00
06	20.00	.00	.00	1.34	.45	2.50	1.89	.00	1.52	.00	1.22	11.00
07	.00	.00	.00	.22	.00	.00	1.89	.00	.00	.00	.22	2.00
08	.00	.00	.00	.00	.00	.00	1.89	.00	.00	.00	.11	1.00
61	.00	.00	22.22	6.25	1.34	5.00	11.32	8.51	.00	.00	4.99	45.00
62	.00	.00	.00	.22	.00	2.50	1.89	.00	.00	.00	.33	3.00
63	.00	.00	.00	.00	.00	.00	1.89	.00	.00	.00	.11	1.00
66	.00	.00	11.11	.00	.00	.00	5.66	2.13	.00	.00	.55	5.00
67	.00	.00	.00	.22	.00	.00	1.89	.00	.00	.00	.22	2.00
68	.00	.00	11.11	.00	.00	.00	.00	.00	.00	.00	.11	1.00
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	
N	5	1	9	448	224	40	53	47	66	9	902	

Table 11. Percentage of tag recoveries by recovery location (rows) and release location (columns) for migrating adult sockeye salmon tagged in 1967 prior to July 17th.

Rec. Area	Tagging Location: Chacon	Dundas3x	Dundas3y Mainland	Langara Island	Muzon	NrthQCI	Zayas	TOTAL	N
Unk.	.00	.00	.00	4.17	.00	.00	6.25	.63	2.00
01	.00	.00	.00	4.17	.00	.00	.00	.31	1.00
03	.00	12.75	24.59	8.33	20.00	19.63	12.50	16.88	54.00
04	60.00	80.39	62.30	75.00	40.00	77.57	62.50	73.75	236.00
05	.00	3.92	4.92	.00	.00	.93	.00	2.50	8.00
06	.00	.98	3.28	.00	.00	.00	6.25	1.25	4.00
15	.00	.98	.00	.00	.00	.00	.00	.31	1.00
61	.00	.98	4.92	4.17	.00	.93	12.50	2.50	8.00
66	20.00	.00	.00	.00	.00	.93	.00	.63	2.00
68	.00	.00	.00	.00	40.00	.00	.00	.63	2.00
80	20.00	.00	.00	4.17	.00	.00	.00	.63	2.00
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	
N	5	102	61	24	5	107	16	320	

Table 12. A comparison of Williams Creek (Lakelse Lake) sockeye counts through a fence with reported values from the S.E.D.S. database.

Year	Fence Count	S.E.D.S
1939	24,085	-
1962	10,174	7,500
1963	9,612	7,500
1964	17,440	18,000
1965	28,581	28,761
1966	12,731	12,731
1967	6,596	6,584

Table 13. Reported aboriginal catches of Skeena River sockeye as food fish from 1983 to 1993.

Year	Sockeye Catch	Jantz and Henderson[2]
1974		82,800
1975		85,955
1976		81,196
1977		104,143
1978		115,920
1979		151,500
1980		138,030
1981		116,340
1982		211,657
1983	140,566	137,916
1984	178,660	178,660
1985	208,080	208,080
1986	150,766	149,930
1987	139,307	
1988	135,436	
1989	149,378	
1990	156,185	
1991	139,069	
1992	-	
1993	322,012[1]	

[1] Includes catch of fish for commercial sale.
[2] From PSARC report S88-3.

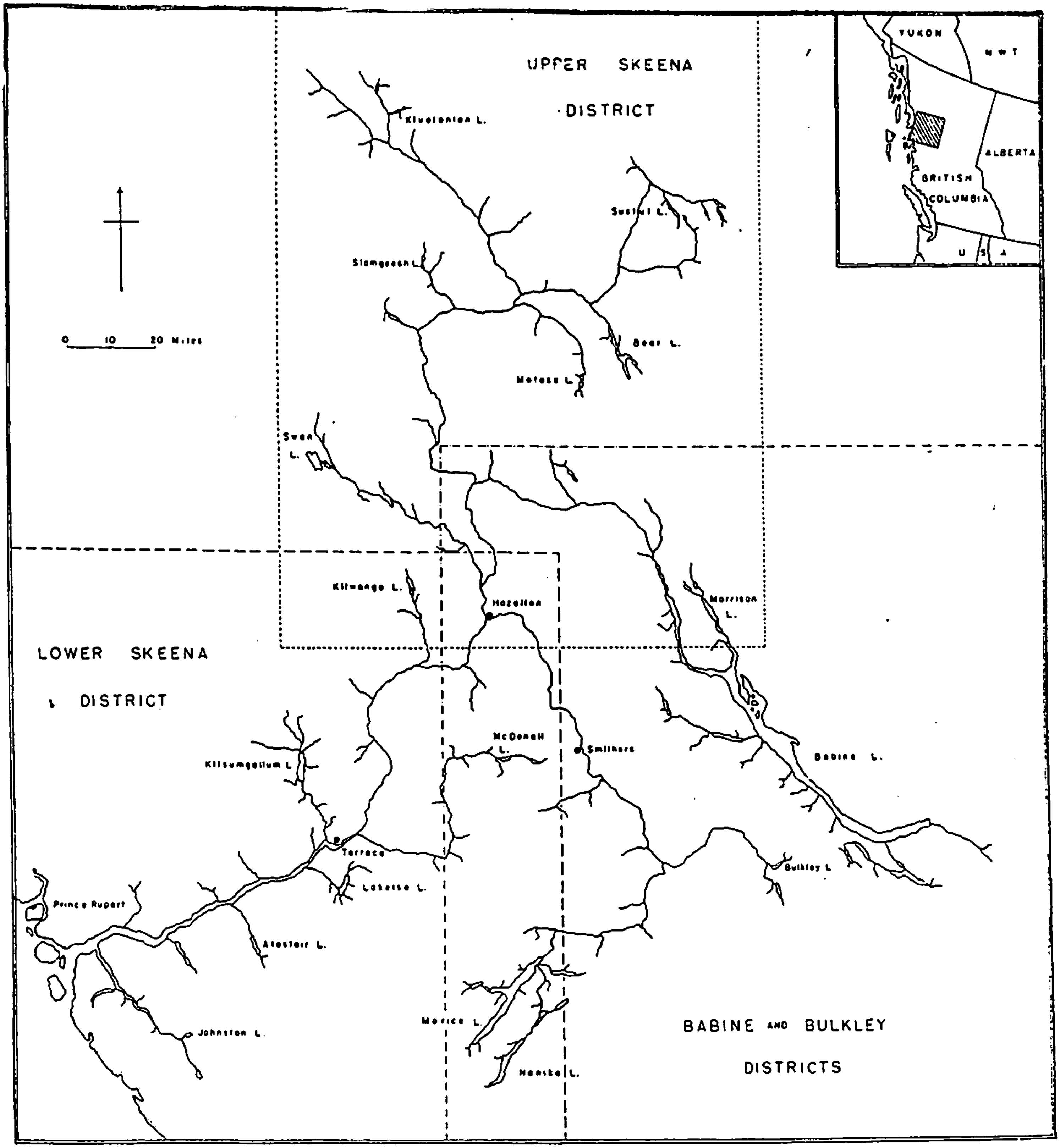
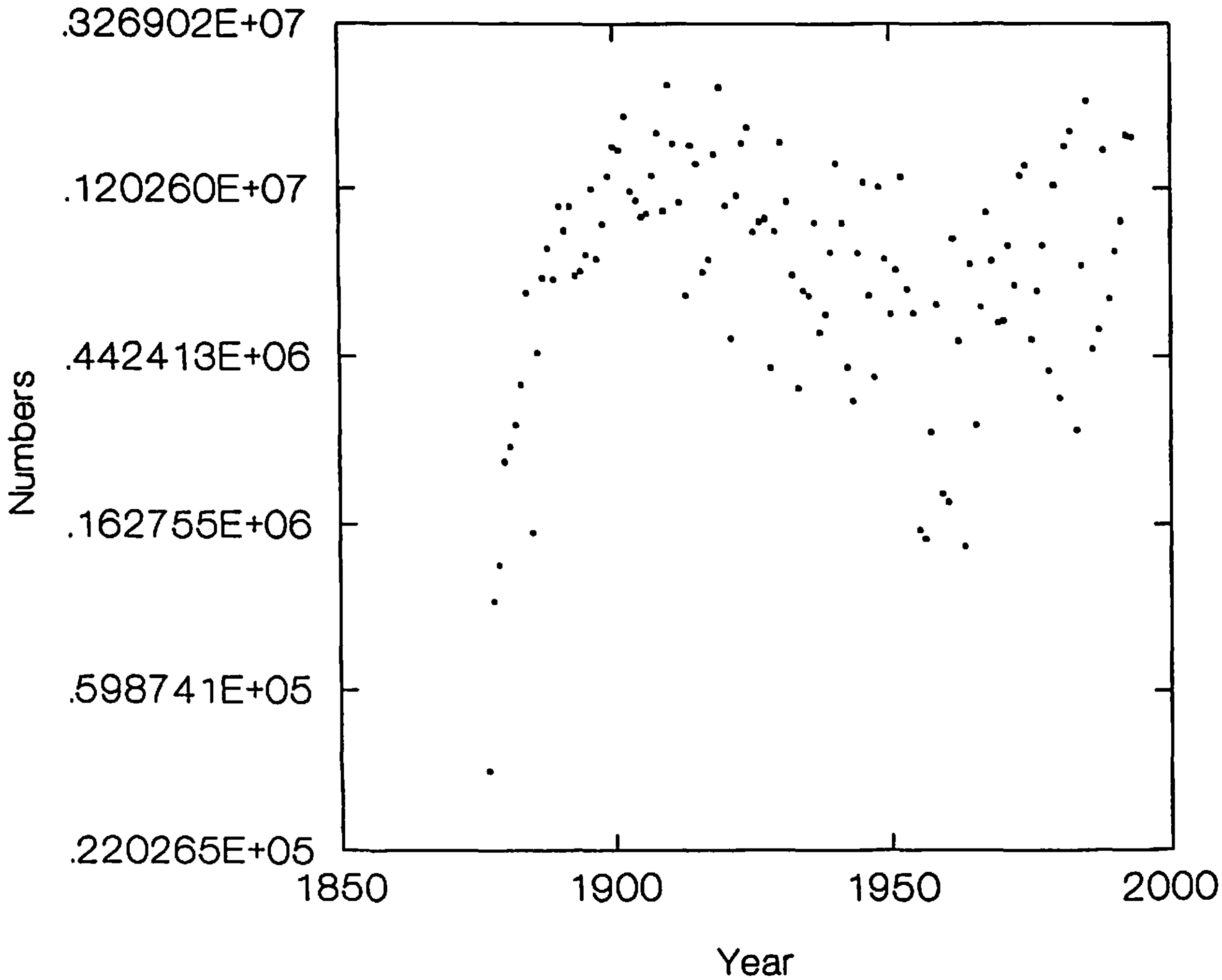
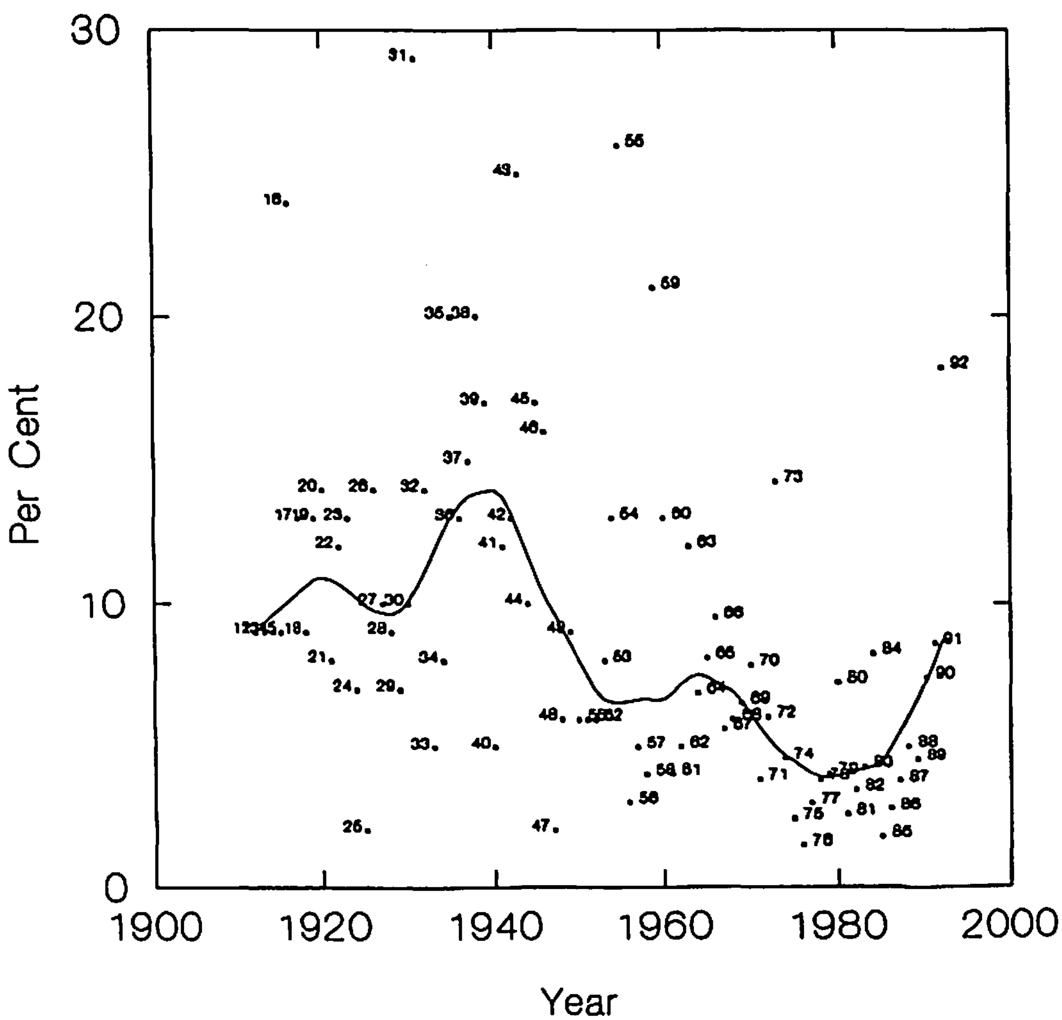


FIGURE 1. Map of Skeena river showing subdivision into districts.

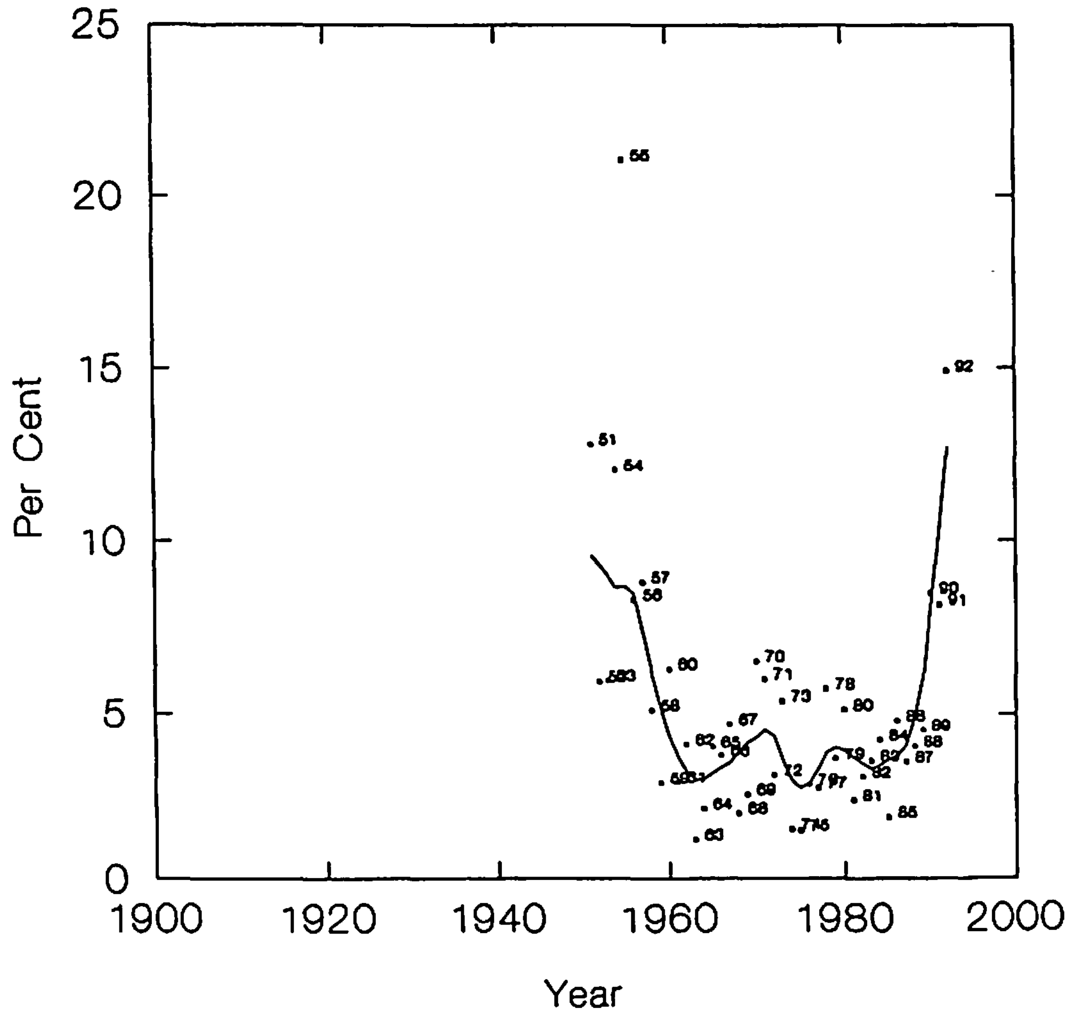
Skeena River Commercial Sockeye Catch

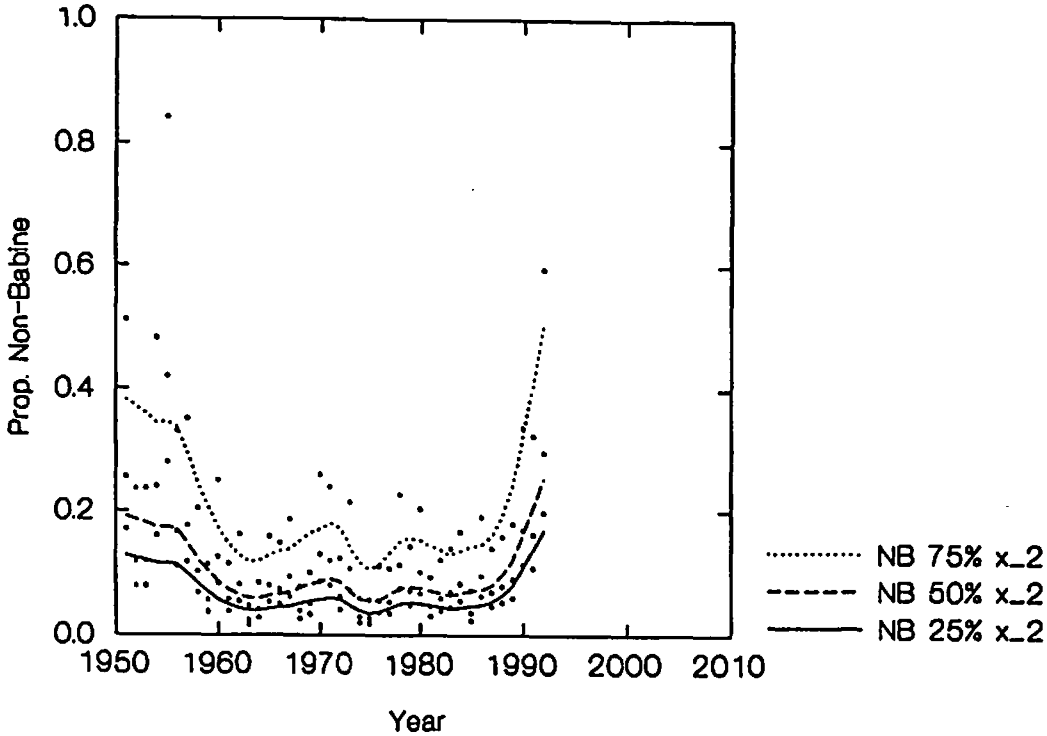


Sub-three returns in the Catch



Sub-three returns in the Test Fishery




1.0
0.8
0.6
0.4
0.2
0.0
Prop. Non-Babine
1950
1960
1970
1980
1990
2000
2010
Year
NB 75% x_2
NB 50% x_2
NB 25% x_2

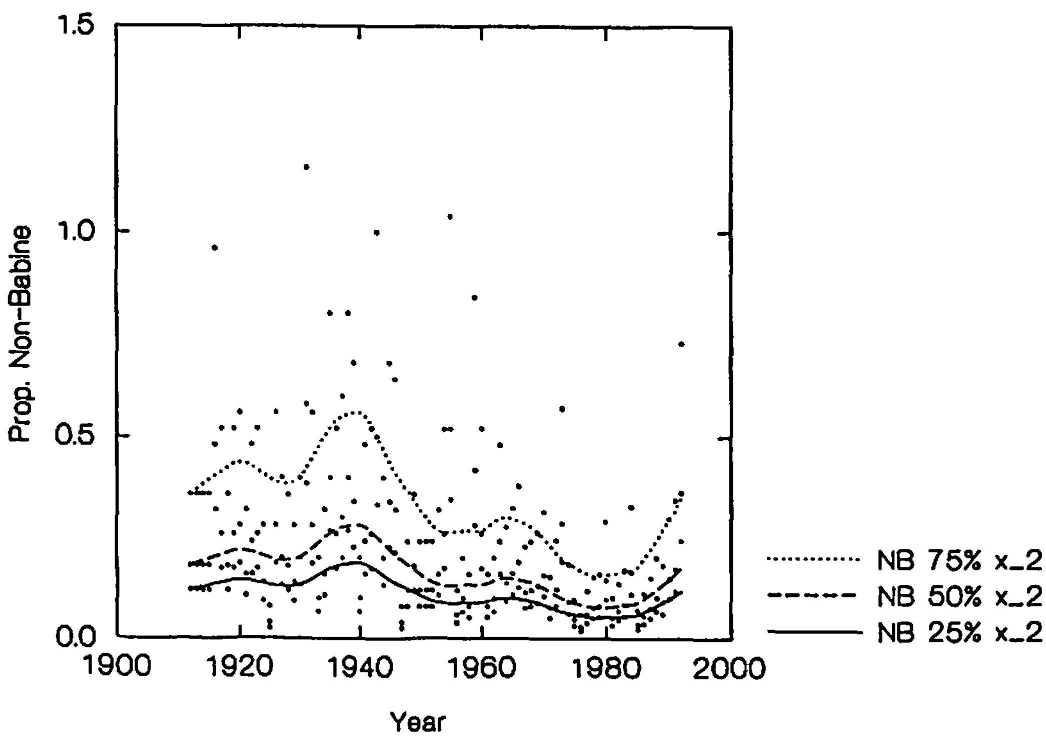
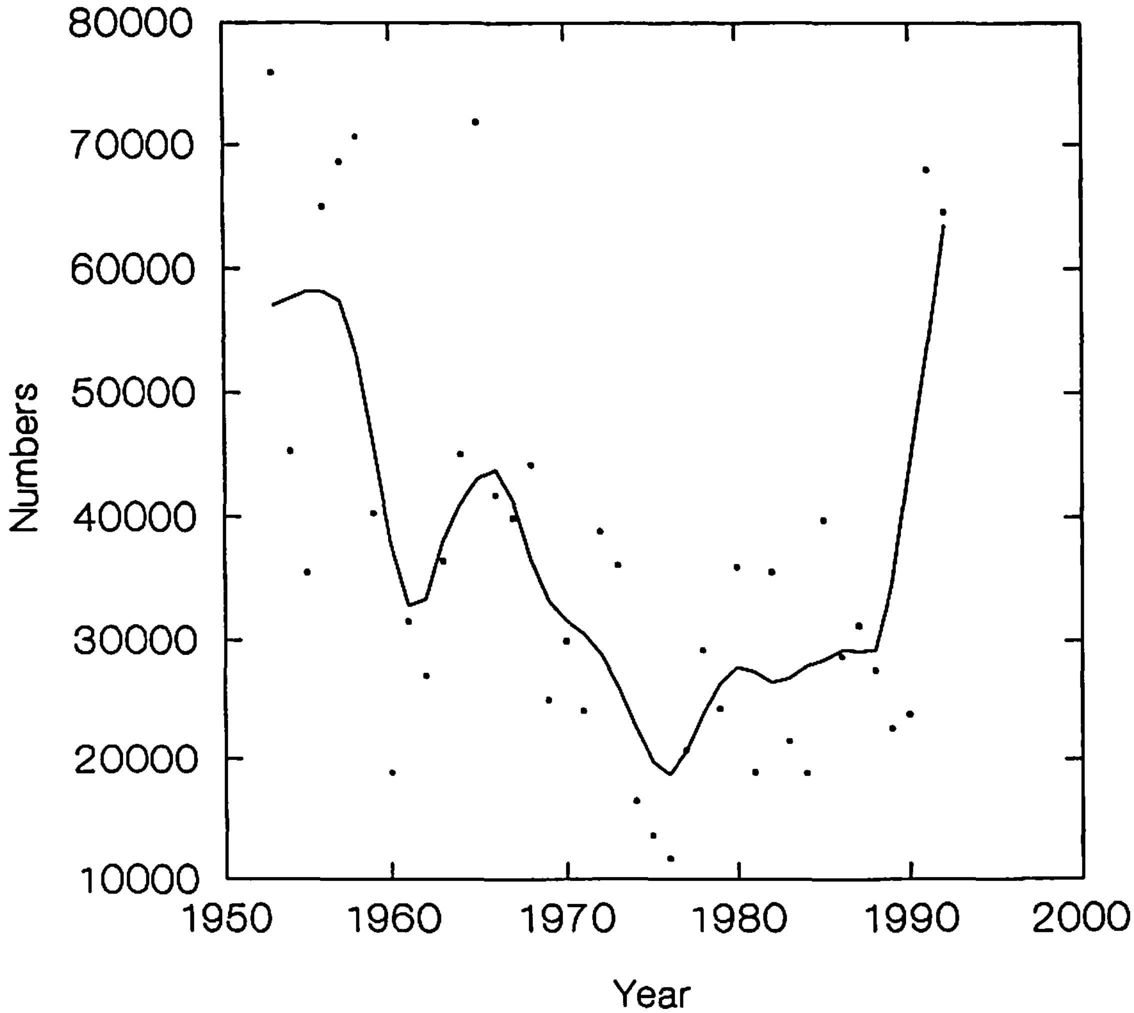
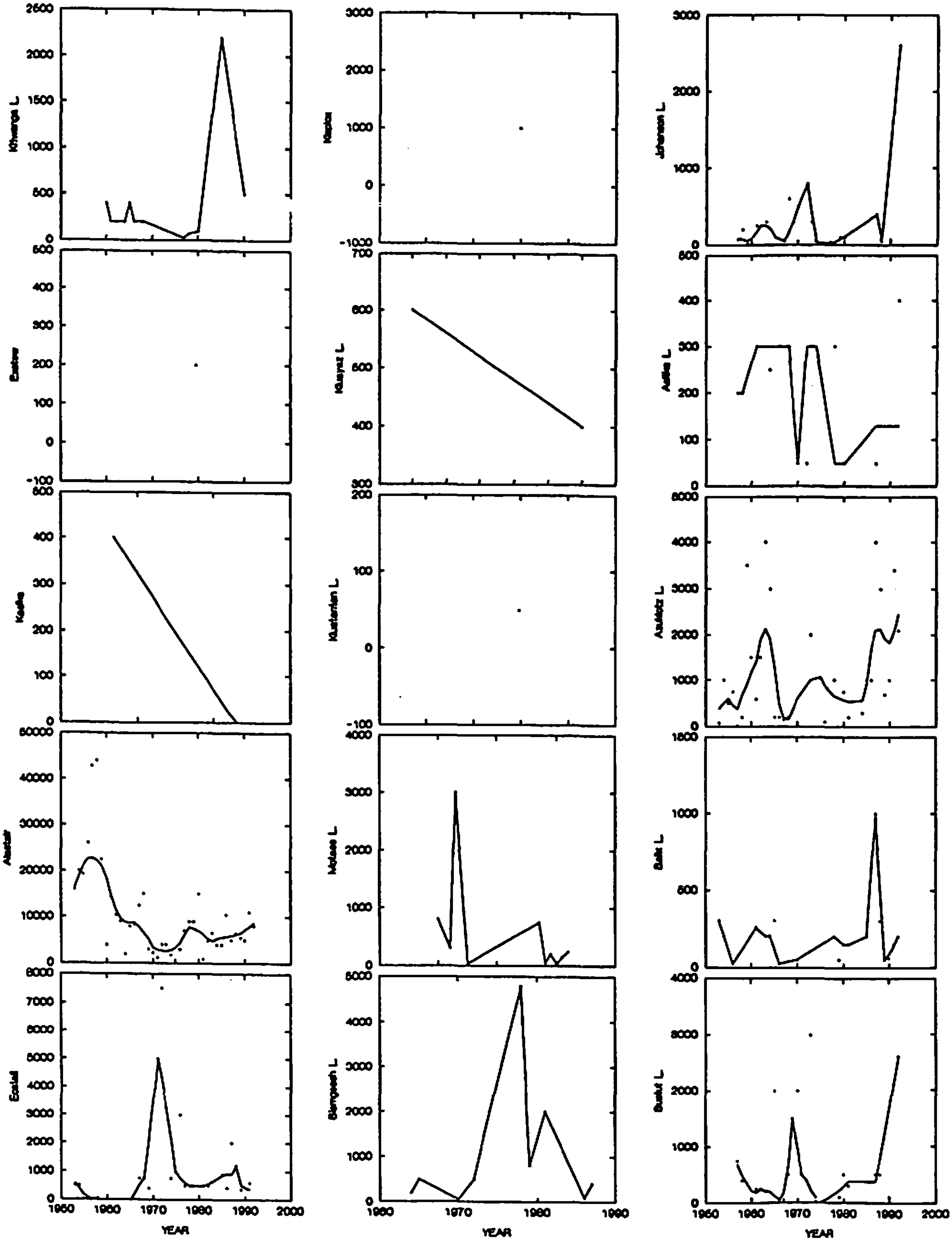
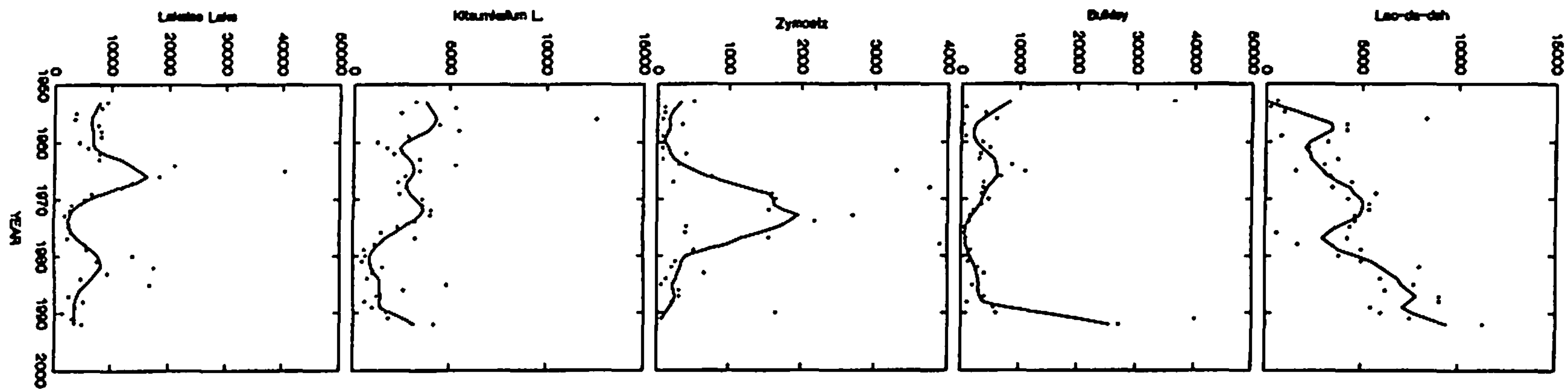

1.5
1.0
0.5
0.0
Prop. Non-Babine
1900
1920
1940
1960
1980
2000
Year
NB 75% x_2
NB 50% x_2
NB 25% x_2

Fig 6

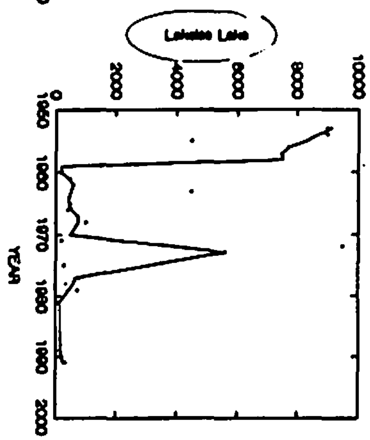
SEDS Sockeye - All Non-Babine Systems




YEAR

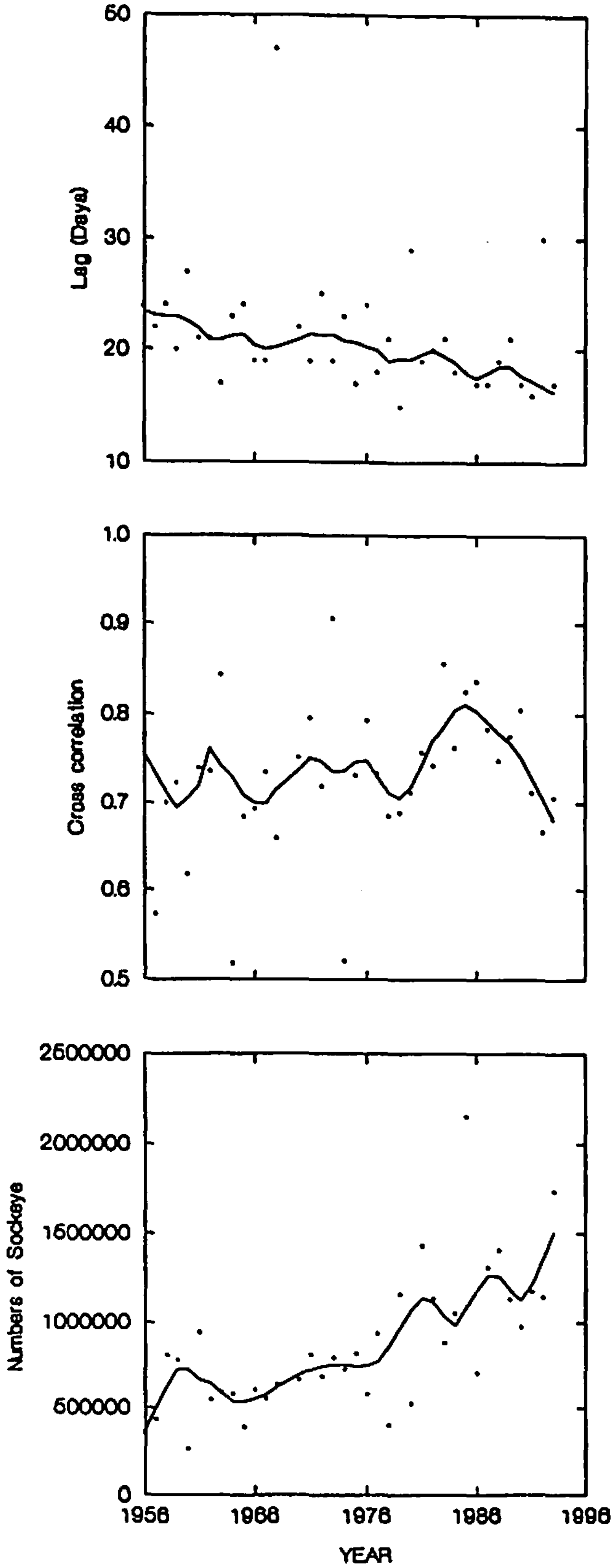


Lakelse Lake
Kitsumkalum L.
Zymoetz
Bulkley
YEAR
1960
1970
1980
1990
2000

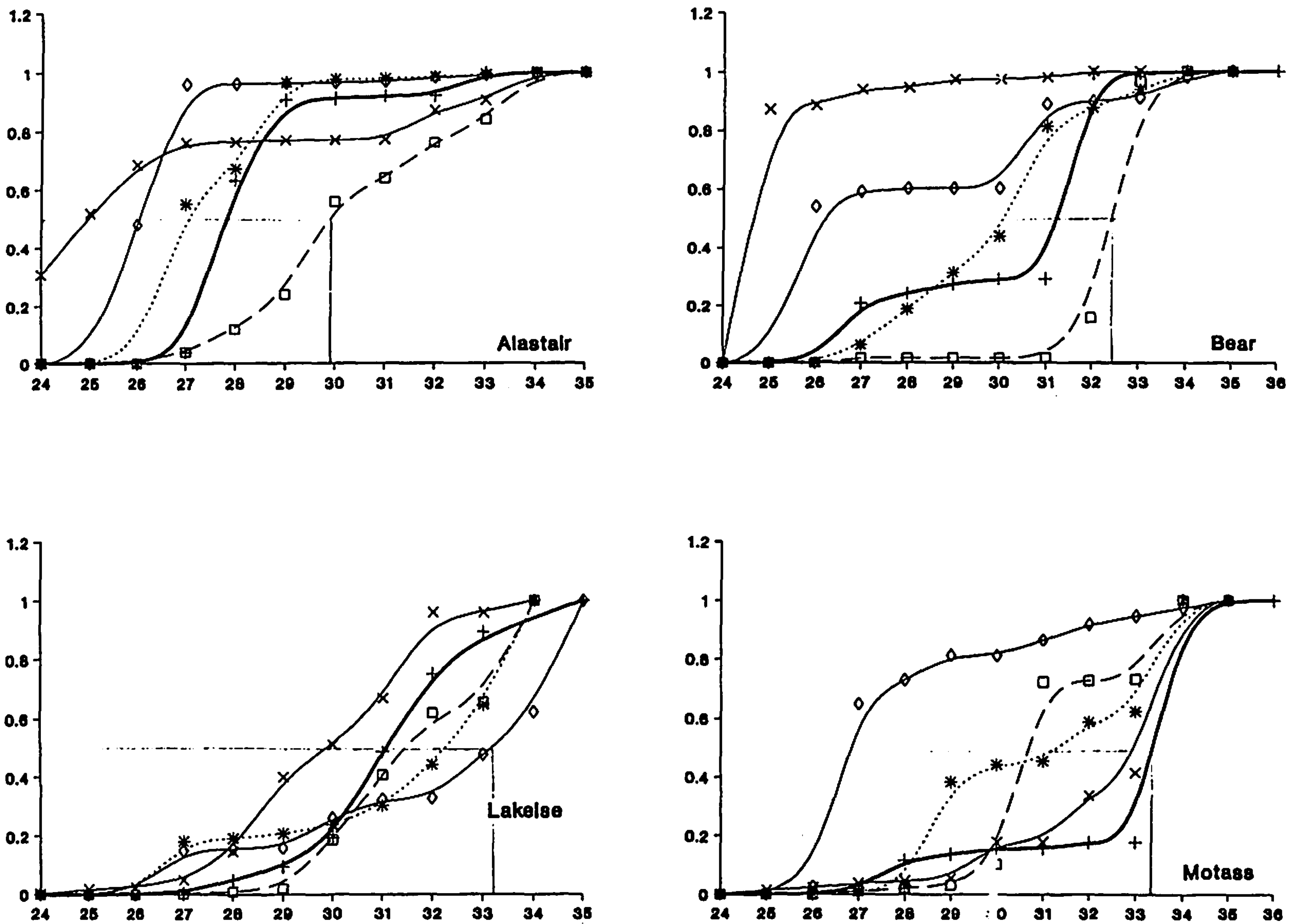


Lakelse Lake
YEAR
1950
1960
1970
1980
1990
2000

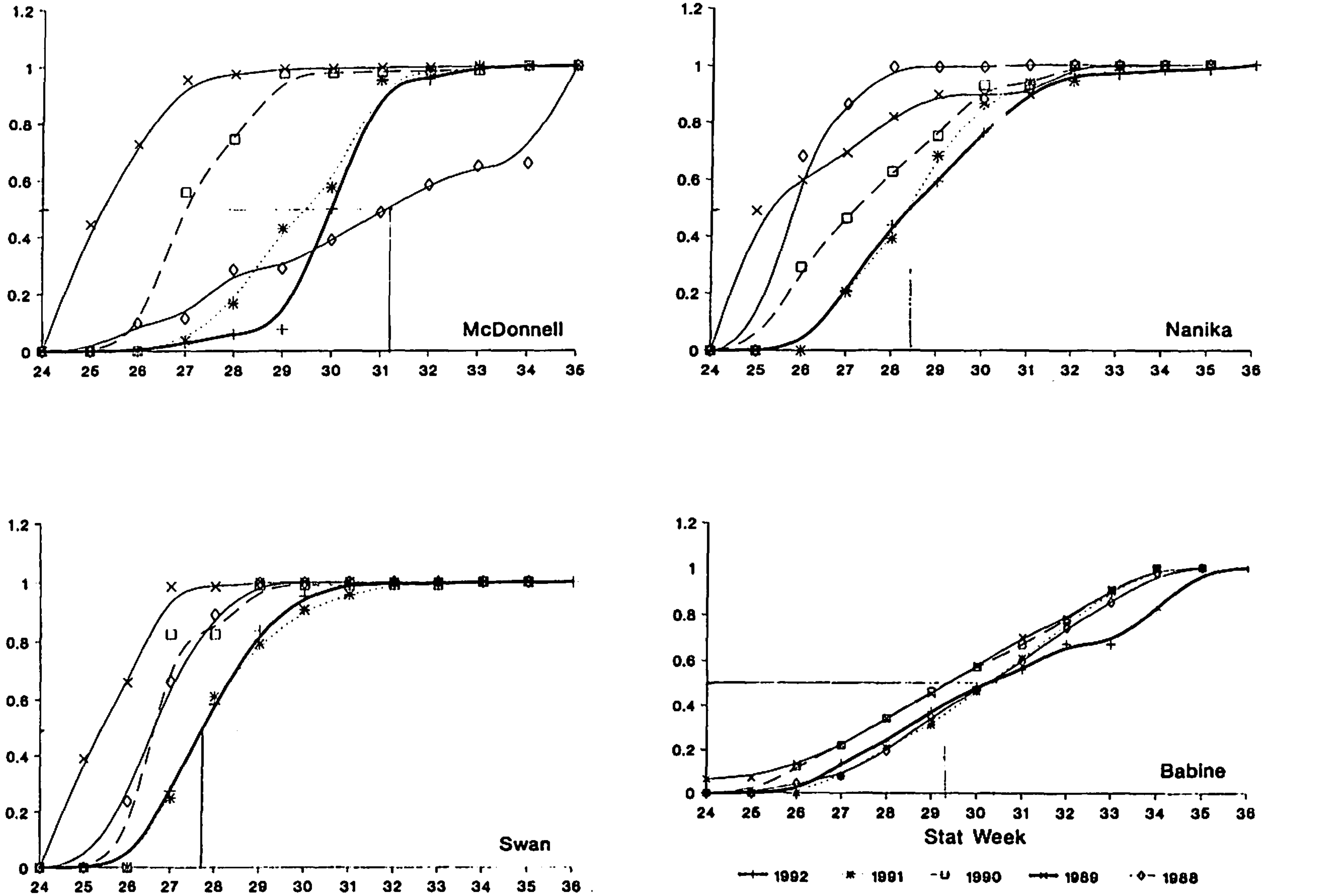
Fig 3

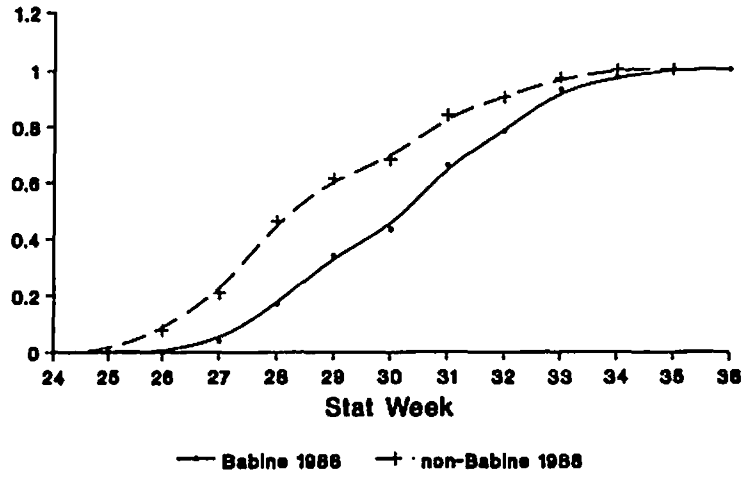


50
40
30
20
10
Lag (Days)
1.0
0.9
0.8
0.7
0.6
0.5
Cross correlation
2500000
2000000
1500000
1000000
500000
0
Numbers of Sockeye
1956
1966
1976
1986
1996
YEAR

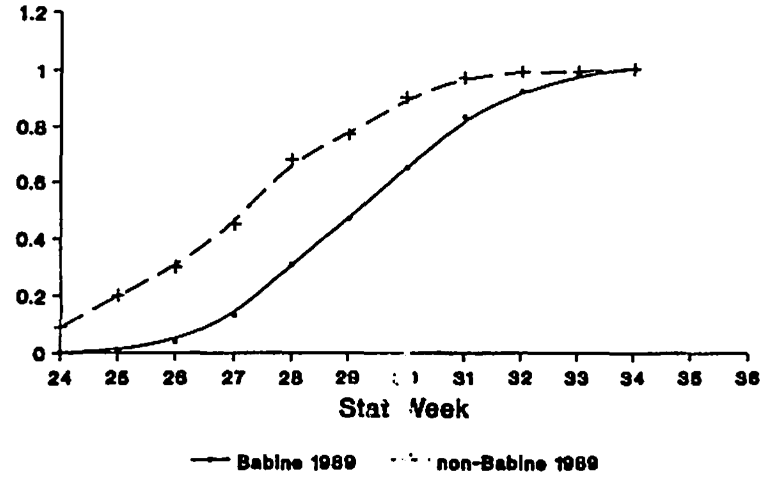


Alastair
Bear
Lakelse
Motass

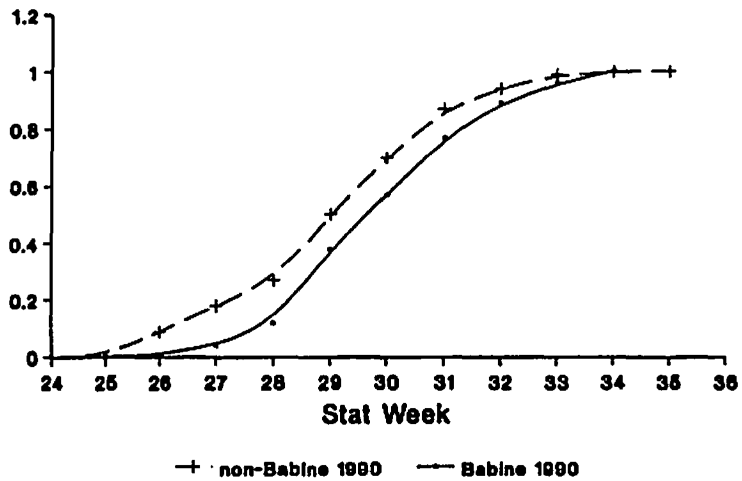

McDonnell
Nanika
Swan
Babine
Stat Week
1992
1991
1990
1989
1988



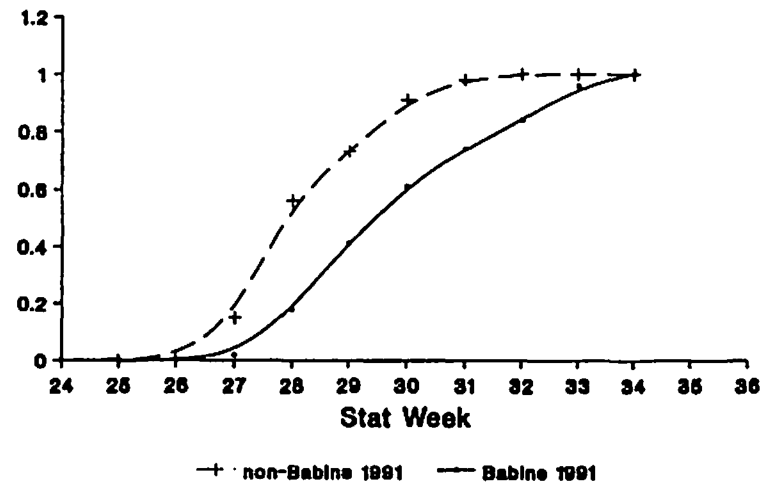
Philonema method



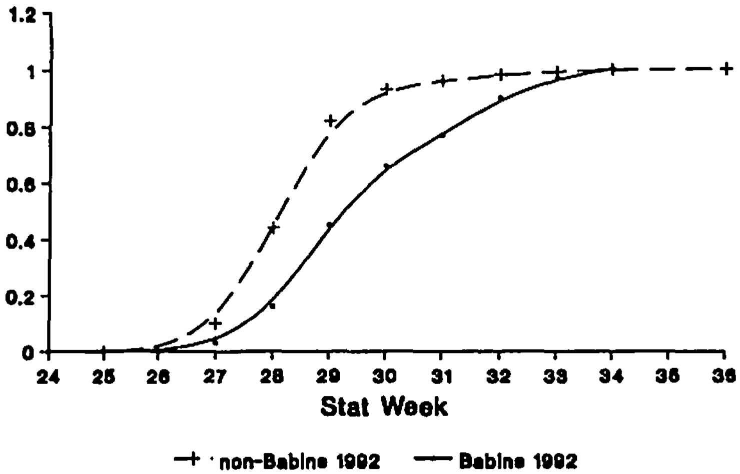
Philonema method



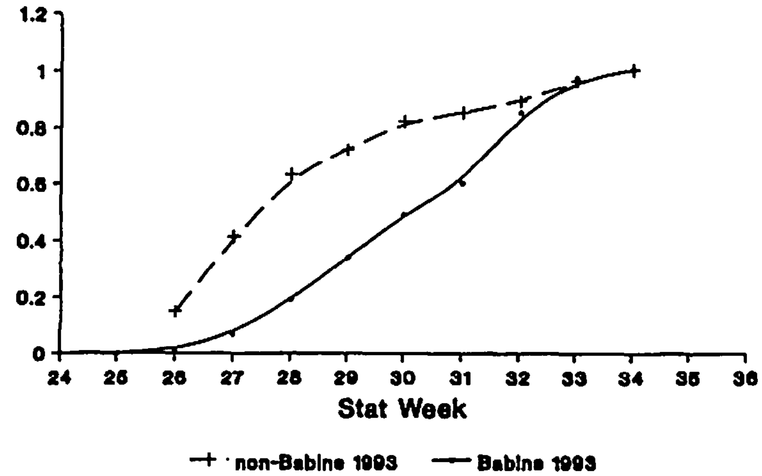
Philonema method



Philonema method



Philonema method



Philonema method

Sockeye Counts - Sustut Fence 1992

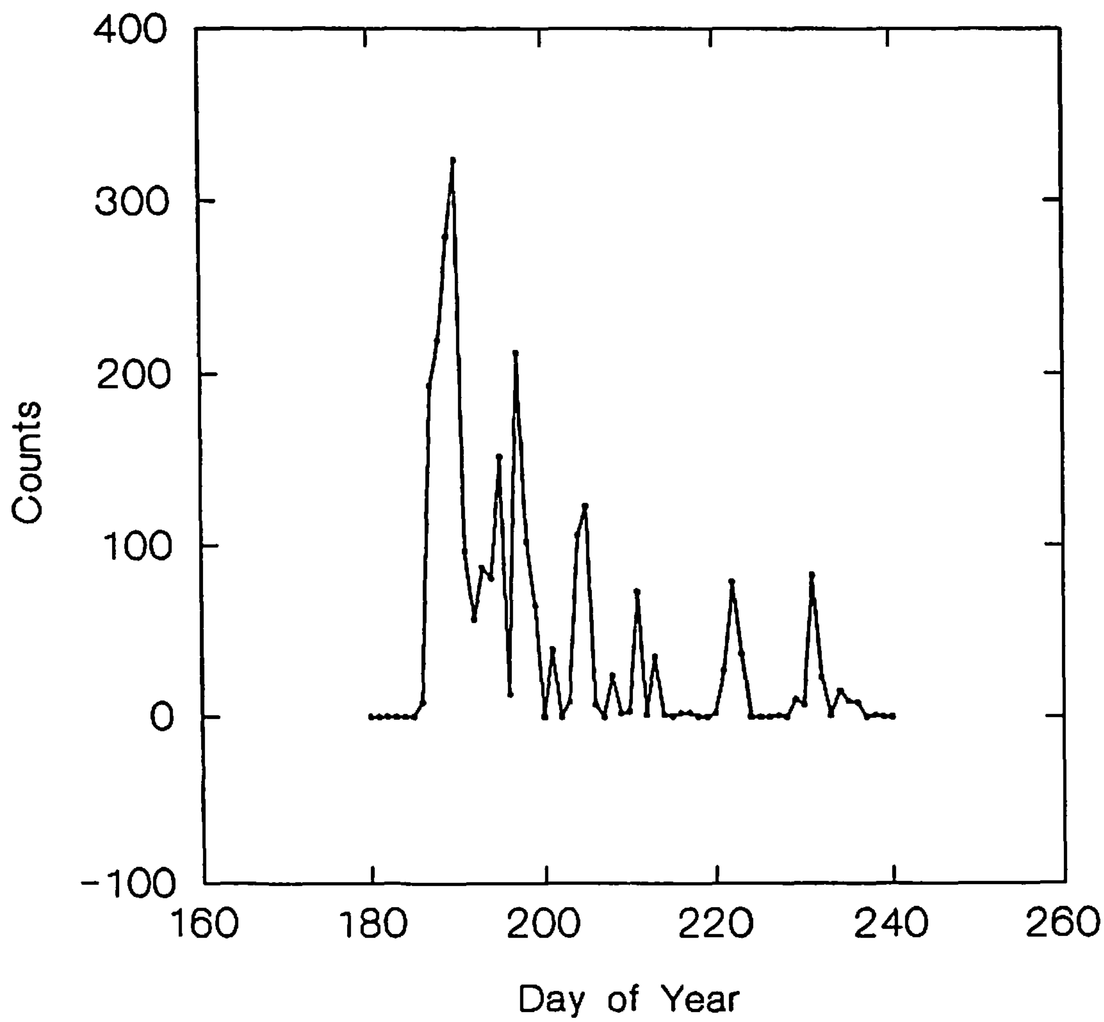
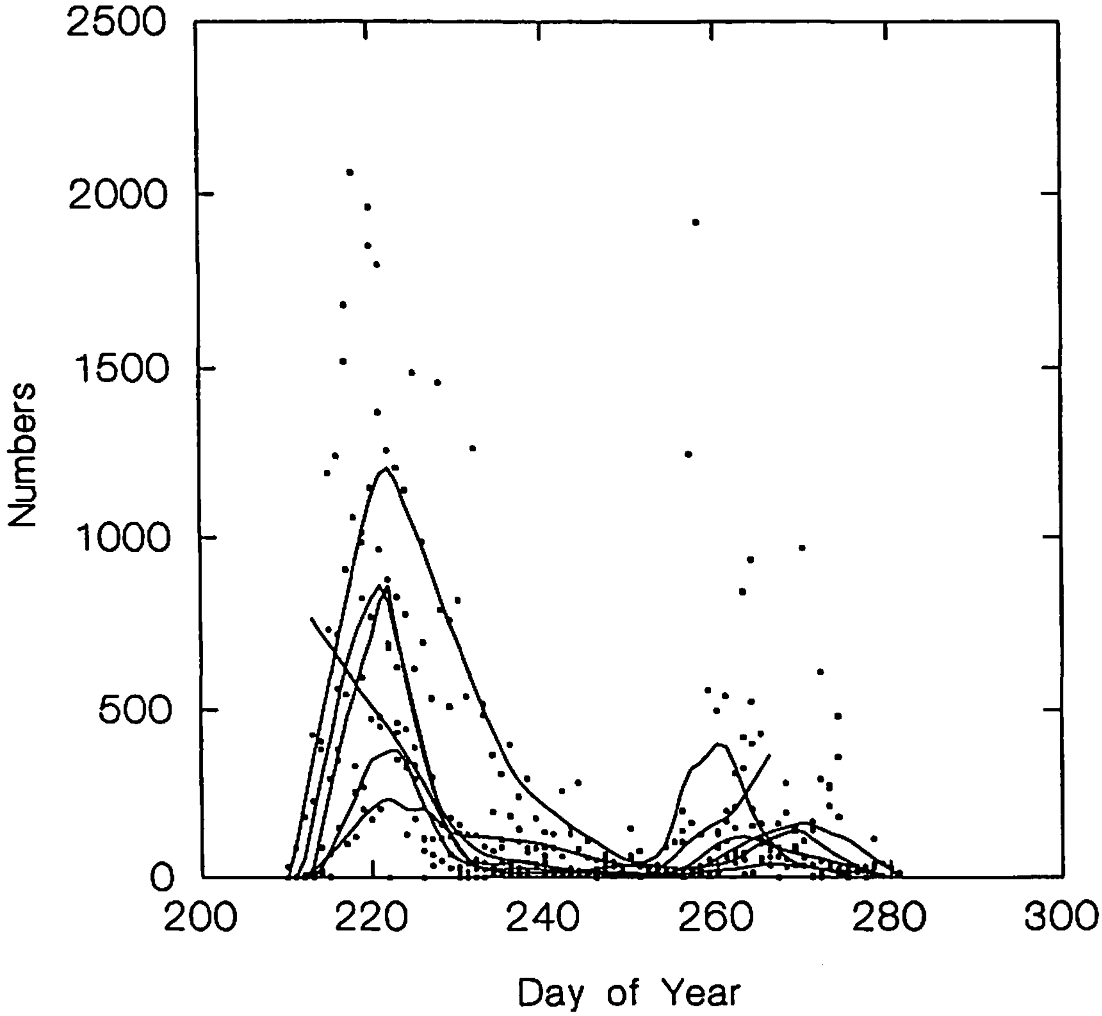
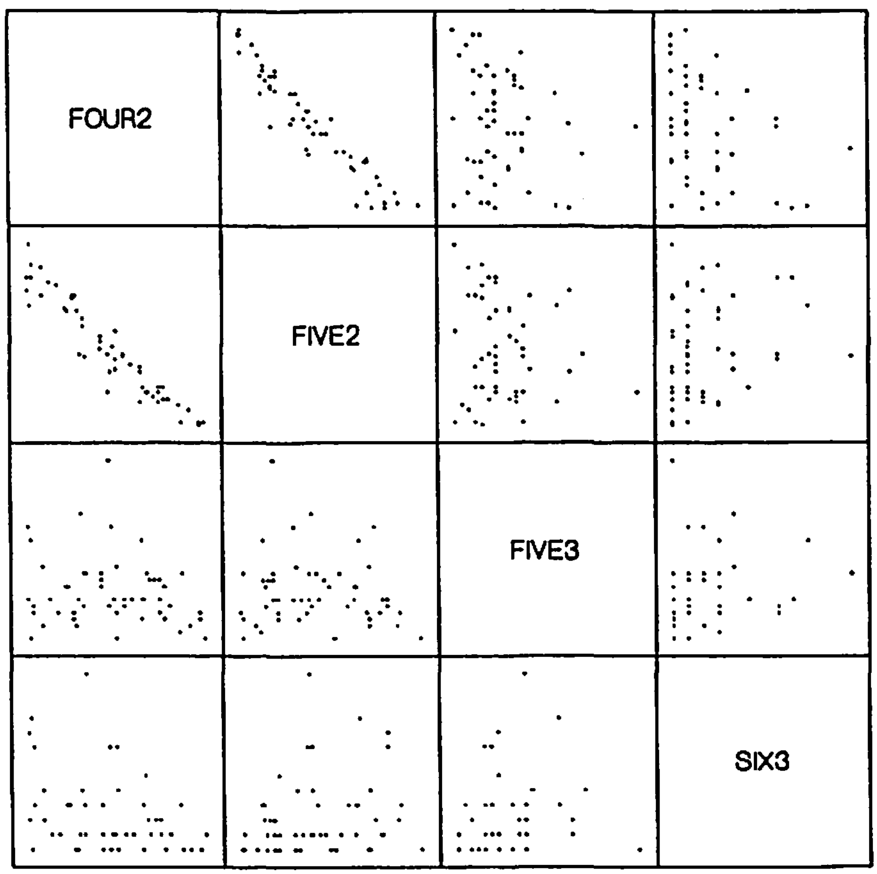


Fig 12

Williams Creek Fence Count (1962-1967)



Annual Proportions at Age in Catch



Annual Proportions at Age in Test Fishery

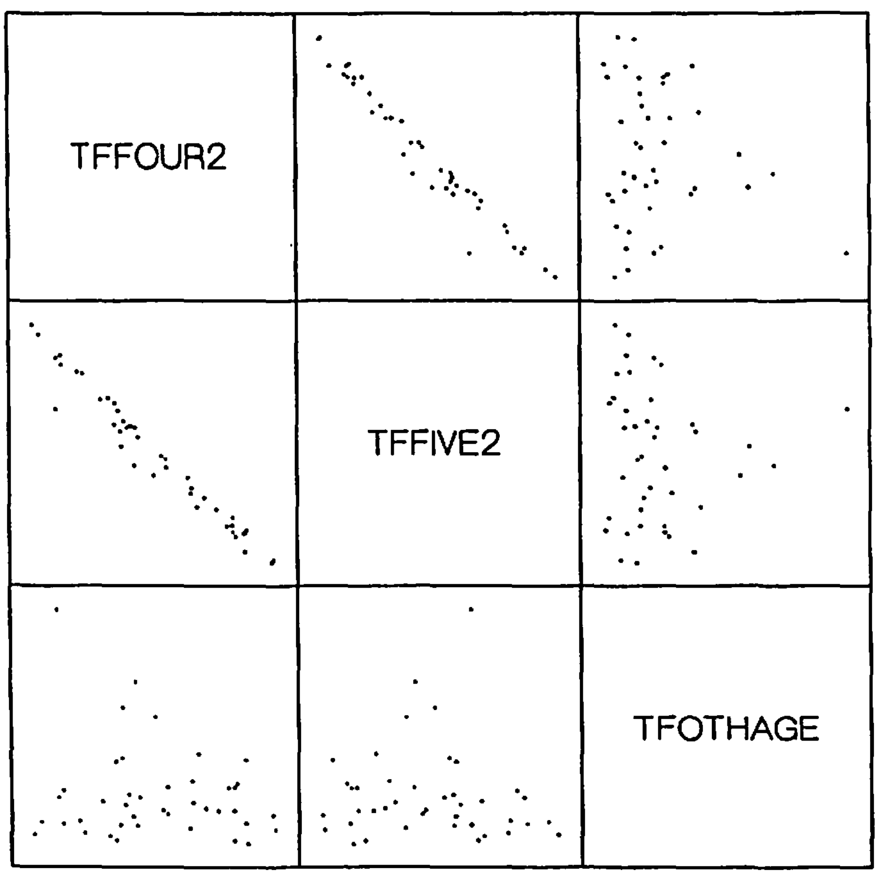
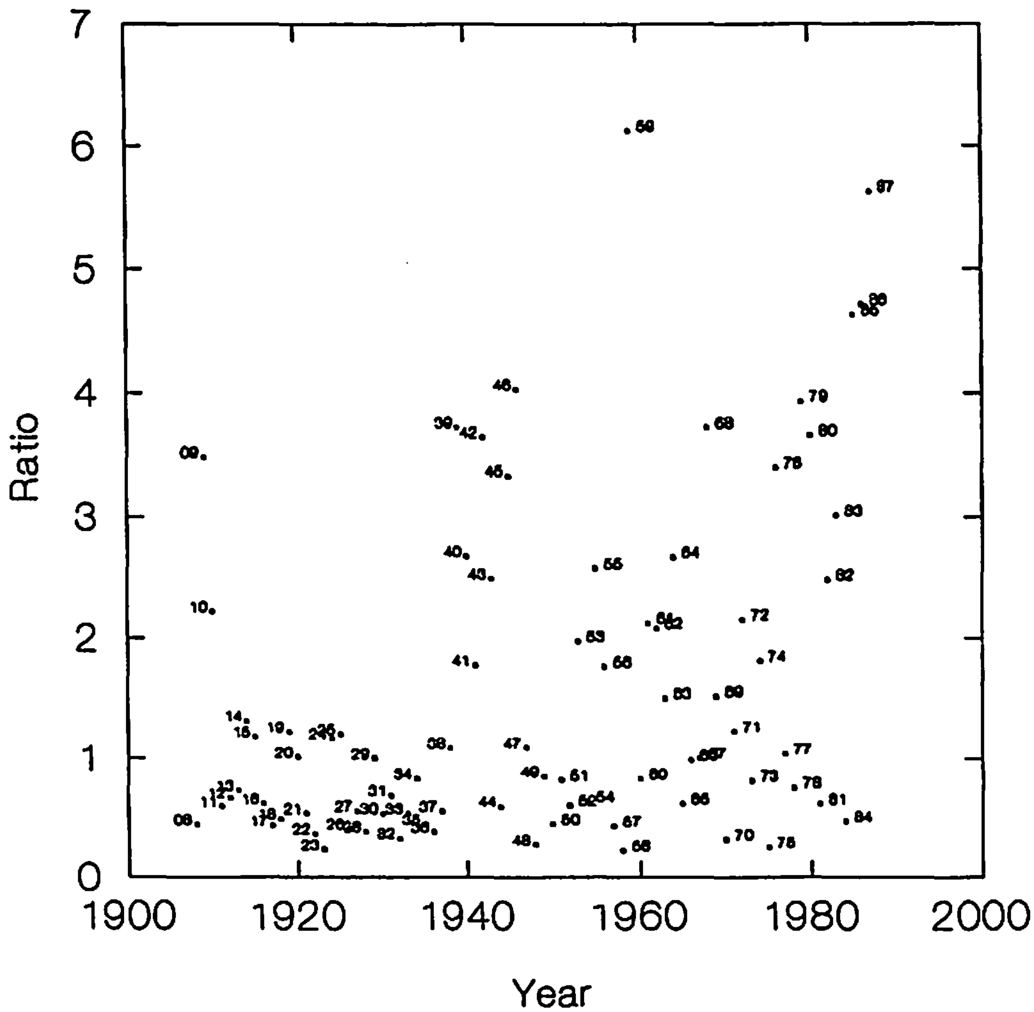


Fig 15

Catch Ratio (1.3 : 1.2)



Catch Ratio (2.3 : 2.2)

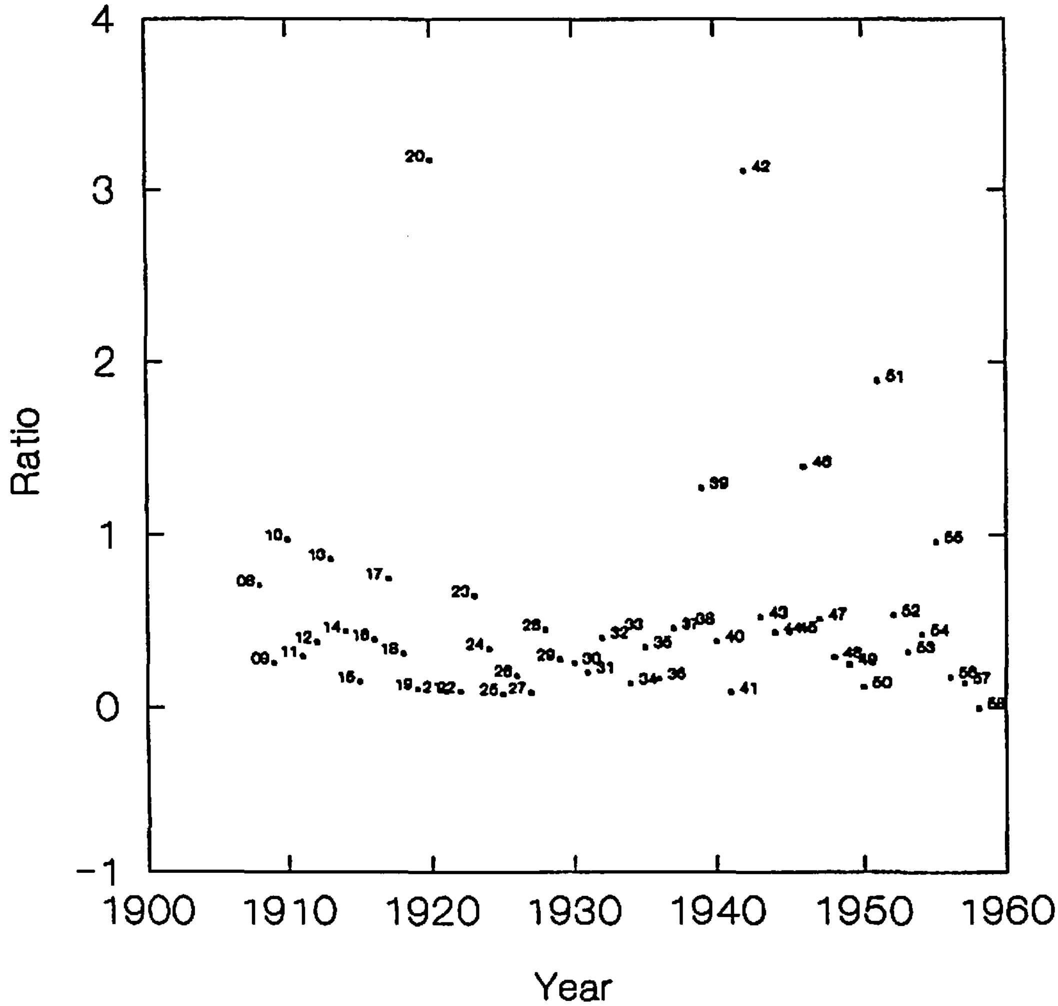


Fig 2

Aboriginal Sockeye Catch vs. Babine Fence Count

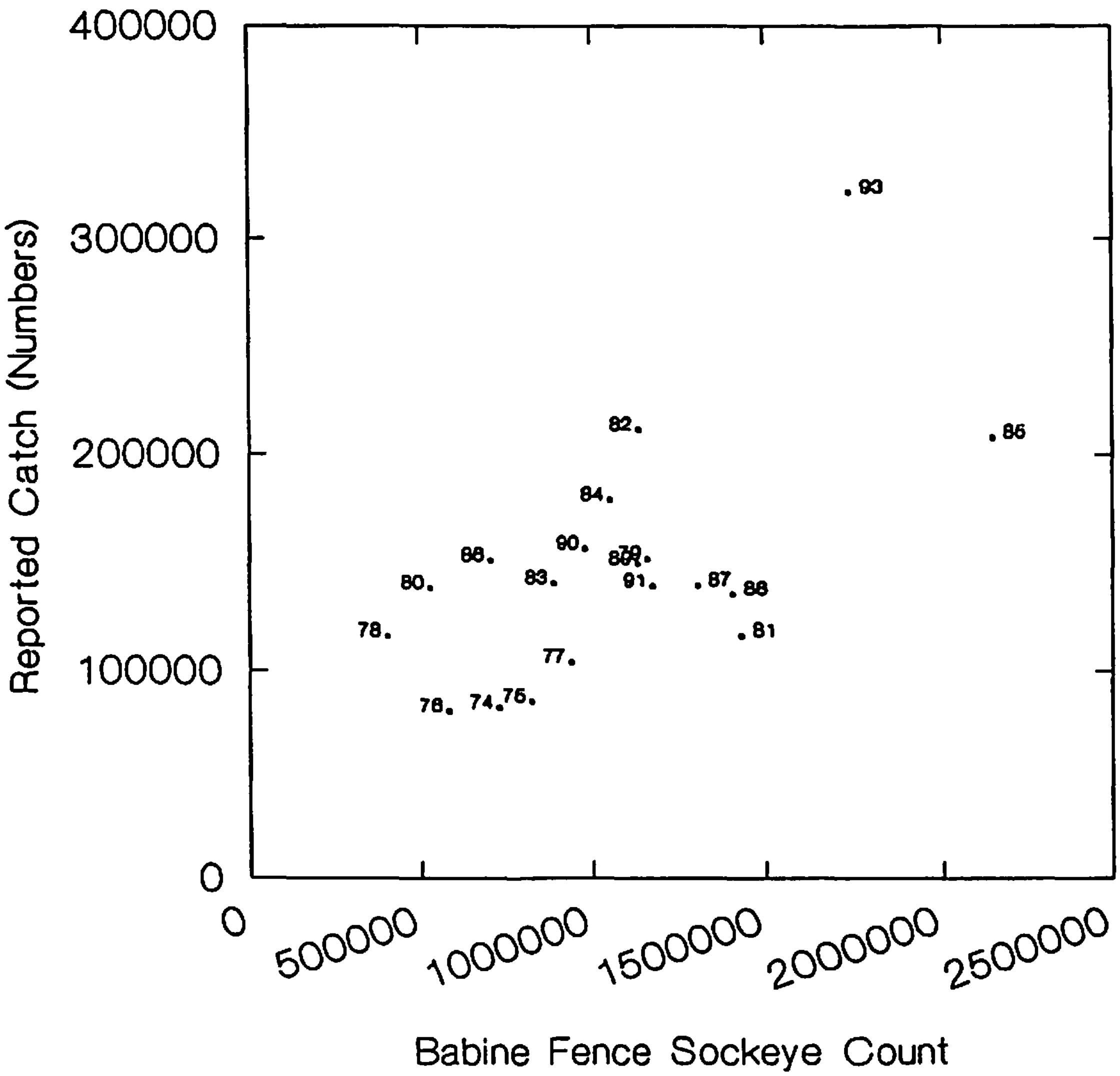


Fig 8

Aboriginal Catch of Skeena Sockeye