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Assessment of Rivers and Smith Inlet Sockeye Salmon, with Commentary on Small Sockeye Salmon Stocks in Statistical Area 8

D. Rutherford and C. Wood

Fisheries and Oceans Canada
Stock Assessment Division
Science Branch
Pacific Biological Station
Nanaimo, B.C. V9R 5K6

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ABSTRACT

Rivers Inlet (Owikeno Lake) and Smith Inlet (Long Lake) sockeye salmon stocks have shown recent dramatic declines in total abundance. Similar declines in total abundance of sockeye originating from Statistical Area 8 are also documented. All available data indicate that the critically low sockeye returns to both Rivers and Smith Inlet in 1999 and 2000 resulted from very poor marine survival for three consecutive brood years (1994-1996), not a failure in freshwater productivity. Marine survival indices for Owikeno and Long Lake indicate that marine survival has generally been poor for all brood years entering the ocean in 1992-1998. The critically low escapements in 1999 and 2000 are a result of the compounding effect of poor marine survival and low brood year escapements. If marine survival continues to be poor for Rivers and Smith Inlet sockeye, drastic measures may be required to prevent a downward spiral to extirpation. On the other hand, if marine survival returned to normal for sea-entry year 1999, returns to Rivers Inlet will exceed the escapement target in 2001 as a result of the above target escapement in 1997. This is not the case for Smith Inlet where escapements have been well below target since 1995.

RÉSUMÉ

L'abondance totale des stocks de saumon rouge de Rivers Inlet (lac Owikeno) et de Smith Inlet (Long Lake) a récemment connu une forte baisse. De telles chutes dans l'abondance totale sont aussi documentées pour le saumon rouge de la zone statistique 8. Toutes les données disponibles révèlent que le taux dangereusement faible de remontées de saumon rouge dans Rivers Inlet ainsi que dans Smith Inlet en 1999 et en 2000 découlait de la survie en mer très faible au cours de trois années consécutives de ponte (de 1994 à 1996), et non d'un échec de la production en eau douce. Les indices du taux de survie en mer pour le lac Owikeno et Long Lake indiquent qu'en général, la survie en mer a été faible pour toutes les années de ponte qui ont atteint l'océan de 1992 à 1998. L'effet cumulé de la faible survie en mer et des faibles échappées des jeunes de l'année est à l'origine de la faiblesse critique des échappées en 1999 et en 2000. Afin d'empêcher la disparition de l'espèce, des mesures draconiennes devront peut-être être appliquées si la survie en mer du saumon rouge de Rivers Inlet et de Smith Inlet reste faible. Par contre, si elle revient à la normale pour l'année d'avalaison 1999, les remontées dans Rivers Inlet dépasseront l'échappée cible en 2001 en raison de l'échappée cible supérieure de 1997, ce qui n'est pas le cas pour Smith Inlet où les échappées ont été largement inférieures à l'objectif depuis 1995.

1.0 INTRODUCTION

Sockeye salmon stocks in Rivers and Smith Inlet have declined dramatically in total abundance. The decline in Rivers Inlet has culminated in total closure of the commercial fishery since 1996 and a record low reported escapement of only 3,600 sockeye salmon in 1999. In neighbouring Smith Inlet, the commercial fishery has been closed since 1997 and a record low escapement of 5,900 sockeye salmon was recorded in 1999. The decline and status of the Rivers Inlet sockeye salmon stock was reviewed by the Pacific Stock Assessment Review Committee (PSARC) in 1995 and 1998 (Rutherford et al. 1995, Rutherford et al. 1998). The status of the Smith Inlet sockeye salmon stock was last reviewed by PSARC in 1994 (Rutherford and Wood 1994) prior to the decline in adult returns. In addition, a comprehensive recovery plan (Holtby 2000) was developed for both Rivers and Smith Inlet sockeye salmon because of the recent critically low sockeye salmon escapements. This document has been prepared in response to a request to provide an update on the status of sockeye salmon stocks in Rivers and Smith Inlet and smaller sockeye stocks in statistical Area 8 and to review our current understanding of the reasons for their decline.

Almost all sockeye salmon production from Rivers Inlet (Statistical Area 9) originates from spawning grounds associated with Owikeno Lake, a deep, cold, and typically oligotrophic coastal lake (Ruggles 1965: Narver 1969). Owikeno lake is large by coastal standards (96 km^2) and comprises four distinct basins, each separated by shallow narrows (Fig. 1). The two lowermost basins (stations 1-3) account for approximately 90% of the total lake area, and these are deep and highly turbid; the two uppermost basins are much smaller, shallower and less turbid. Many streams flow into Owikeno Lake. The two largest the Machmell and Sheemahant, are very turbid and carry the bulk of the silt in to the main basins of Owikeno Lake. The 5-km long Wannock River drains Owikeno Lake into Rivers Inlet.

Similarly, almost all sockeye salmon production from Smith Inlet (Area 10) originates from spawning areas associated with Long Lake. The lake is clear, cold and typically oligotrophic (Hyatt and Stockner 1985). The lake is long, narrow and has a surface area of 21 km^2. Two main streams, Canoe and Smokehouse flow into Long Lake near the top end. The 2-km long Docee River drains Long Lake in to Wyclees lagoon. This lagoon is influenced by tides and drains into Smith Inlet through Quashella Narrows. An adult salmon counting fence is located on the Docee River at the outlet end of Long Lake (Fig. 2).

Long Lake has been subject to nutrient enrichment through the Lake Fertilization Program (Hyatt and Stockner 1985). Long Lake was initially fertilized in 1977 to 1979. Fertilization did not take place in 1980 and 1981 but resumed again for years 1982 to 1997. The lake was not fertilized in 1998, 1999, and 2000. Fertilization application normally occurs between April and September of a calendar year thus making the 1976 sockeye brood the first to be treated.

Little is known about the status of the small sockeye salmon stocks in the southern central coast (Statistical Area 8, Fig. 3) other than the estimates of escapement reported in the Salmon Escapement Database System (SEDS; Serbic 1991). The Atnarko system is the largest contributor to sockeye production for Area 8 with reported escapements ranging from a high of 150,000 in 1957 to a low of 13,000 in 1965. Based on escapement information Kimsquit, Koeye, Namu, and Port John Lake support the next largest sockeye stocks in Area 8. Of these Kimsquit is the largest with escapements ranging from a high of 55,000 in 1971 to a low of 1,000 in 1999. Reported annual escapements have not exceeded 14,000 for other lakes in Area 8.

2.0 METHODS

2.1 Spawning Escapements

The glacial turbidity of Owikeno Lake and its major spawning streams preclude reliable estimation of spawning escapements by visual survey methods (Walters et al. 1993, Rutherford et al. 1995). Nevertheless, estimates of spawning escapement to Area 9 are recorded for years 1948-1999. Escapements for years 1948 to 1951 are from Wood et al. (1970). Escapement for years 1952-1999 are available from SEDS summary data files maintained by DFO staff in Prince Rupert on the DFO internal public drive (file: 9esc.xls, Appendix 1b). There is evidence that this escapement data is biased and that the bias has been changing with time. For unknown reasons, the proportion of total escapement attributed to glacial streams has increased over time from approximately 33% to 67% (McKinnell et al. 2001; Rutherford et al. 1998).

To avoid problems of bias and inconsistency in estimating sockeye escapement to the glacially turbid rivers, we use a “clear stream escapement index” (CSI) based only on reported escapements to the clear streams of Owikeno Lake that are easily accessible. This index is the sum of the escapement estimates for the Ashlum, Dallery, Genesee, Inziana and Washwash rivers (Table 1). Commencing in 1996 salmon escapement to the clear streams was estimated using an “area under the curve” (AUC) procedure. Individual stream visit logs are available for clear streams for a limited number of years (1983-1996) and we have constructed estimates of escapement using a standardized AUC procedure. We then compared our estimates with the previously reported SEDS escapement for each of the clear rivers. In 1997 the SEDS escapement for Owikeno Lake (Rivers Inlet) was estimated by regressing the previous estimates of escapement (for the period 1948-1996) on the clear stream escapement index in order to mimic the historical process used to extrapolate from clear streams to the entire system. The resulting equation was y=1.76x +139563. However, in 1998 the clear stream escapement index was very low, and we were unwilling to assume that relatively large numbers of fish spawned in turbid streams when so few were observed in the preferred clear streams. Accordingly the SEDS escapement was estimated by simply assuming that the total escapement was 4.3 times the clear stream index as was reported in 1995. Commencing in 1999, once it was recognized that the historical estimates were seriously flawed because of unknown and inconsistent bias (see McKinnell et al. 2001), we adopted a standard multiplier of 3X the

CSI to derive “total” sockeye escapements for Owikeno Lake. This 3 x multiplier was derived empirically from a sockeye salmon mark-recapture study carried out in the single largest turbid tributary of Owikeno Lake, the Sheemahant River (Mattock and Frederiksen 1999). This study indicated that the escapement to the Sheemahant River in 1999 was approximately equivalent to the total clear stream escapement. Although the uncertainty is high, it indicates that the clear stream escapement is < 50% of total escapement. Considering the size of the remaining streams, we reasoned that the clear stream escapement index probably accounts for about one third of the total escapement (see details in McKinnell et al. 2001). For all analysis in this report requiring Area 9 escapement data we have used this more consistent “3x CSI” for a total estimate of escapement instead of the escapement reported in SEDS.

Estimates of spawning escapements to Area 10 are available for years 1950-1999 (Appendix 1a) and preliminary data are available for 2000. Escapements for 1972 to 2000 were counted past a weir and are considered very reliable. Prior to 1963, sockeye escapements to Long Lake were estimated from visual surveys of Smokehouse River and Canoe Creek. In 1963 a count of sockeye entering Long Lake was conducted from a tower on the Docee River as an experimental program to provide timely escapement estimates for in-season management (Wood et al. 1970). After a lapse of four years the tower was once again operational for 1968, 1970, and 1971. Visual enumeration of the two spawning areas were made during the years the tower was not operational. A counting facility (fence) was constructed and operational for the 1972 return year and has operated annually since inception.

From 1972 to 1997 the Docee Fence was normally operational from the end of June through to the second week of August for the enumeration of sockeye salmon. All fish counted through the fence during this period were assumed to be sockeye. Commencing in 1998 operation of the fence was extended to the end of September to allow for the enumeration of coho. Because no trap facilities are built into the fence and the counting tower is approximately 8m above the river it is not possible to visually distinguish between sockeye and coho as they pass over the counting plate. From 1998 to 2000 species composition was determined from dip net catches made on the downstream side of the fence and from identification of moribund fish that occasionally drift back onto the fence panels. This sampling was used to apportion the total daily count past the fence into daily sockeye and coho salmon counts.

Estimates of sockeye salmon spawning escapement to the Atnarko River system are available for years 1950 to 1999 (Appendix 1c). Escapement estimates since the early 1970’s are considered to be a reliable index because enumeration has been carried out using consistent aerial overflight techniques (Lyle Enderud, DFO Fisheries Manager, Bella Coola B.C. pers com). Conversely, estimates of sockeye escapement to Koeye, Namu, Port John, and Kimsquit from the SEDS database and are fraught with all the reliability issues associated with undocumented effort and methodology.

2.2 Catch

Commercial catch data for Rivers and Smith Inlet are considered reliable. Sockeye enter the mouths of Rivers and Smith Inlet in late June to early July and peak in abundance about mid-July (Starr et al. 1984). Tagging studies (English et al. 1984, Gazey and English 2000) have suggested that these stocks are not caught in northern fisheries operating outside of Areas 9 and 10. However, results from a central coast tagging study (Anonymous 1982) indicate that 80% of Rivers Inlet sockeye migrate directly into Area 9 and 20% pass through Area 7 and 8 fisheries where some interception has occurred (Starr et al. 1994). Starr et al. (1984) in their stock reconstruction, for the period 1970 to 1980, estimated that these interception fisheries have imposed harvest rates ranging from 1 to 25% (average <10%) on Rivers Inlet sockeye. These interception fisheries were drastically reduced in 1984 with the closing of the Loredo and Milbanke sound areas to commercial salmon harvest. For the purposes of this report we have not attempted to reconstruct Area 9 catch and have used catch estimates as reported in the Regional Catch Database (Holmes and Whitfield 1991).

Data presented in Bachen et al. (1997) suggests that some interception of non-Area 10 sockeye in the outer fishing areas of Area 10 (Statistical Area 10-3, Fig. 2) has occurred, again we have not attempted to reconstruct catch for this Area and have used catch estimates from the Regional Catch Database. Catch data is reported in Table 1 and 2. Commercial catch estimates for years 1998 to 2000 are preliminary and were obtained from hailed sales slip information. Troll catch landed in Areas 9 and 10 has not been included because fish landed are harvested from unknown areas outside of Area 9 and 10.

Up to 1990 First Nation sockeye salmon catch has not been considered or included in the total catch estimates because First Nation catch has been estimated to be less than 1% of the total stock and catch reporting is intermittent. However commencing with the closures of the commercial gillnet fisheries in Rivers and Smith Inlet in 1997 and 1998 respectively a concerted effort was made to obtain and include First Nation catches when estimating total returning stock size. Recent First Nation catches are reported in Tables 1 and 2.

For the purposes of this report total commercial catch reported for Statistical Area 8 was used. Catch data for years 1952 to 1999 was obtained from the region catch database and recent data was extracted from sales slip information collected through the Charter Patrol Program (Table 3). Terminal First Nation fisheries occur within the Bella Coola River but they have not been considered in this report.

2.3 Total Stock

Total stock size for Rivers Inlet has been calculated as *3xCSI* escapement + catch. For Smith Inlet and Area 8, total sockeye salmon stock size has been calculated as escapement (as reported in SEDS) + catch. For Rivers Inlet this measure or estimate of total stock size is considered very unreliable because the estimate of escapement to

Owikeno Lake is considered very unreliable. Because the ratio of catch to escapement has changed dramatically through regulation of fishing effort, estimates of total stock are very sensitive to the multiplier used to convert clear stream indices into absolute counts. In contrast, total stock size for Smith Inlet since 1972 is considered reliable because both catch and escapement are direct counts. The total stock size for Area 8 sockeye has been calculated as catch + estimated escapement to all sockeye stocks in Area 8. The accuracy of total stock size for Area 8 is unknown. The two main reasons for this uncertainty is firstly, there is some uncertainty in levels of escapement to the many small stocks, and secondly, sockeye caught commercially in lower Area 8 (Fisher Fitz Hugh Sound) may be returning to other streams besides those in Area 8.

2.4 Age Composition and Total Returns by Brood Year

Estimates of total returns from brood year escapements are required to evaluate survival and productivity. Total returns for Area 9 and 10 sockeye were computed by decomposing the total stock size estimates in consecutive years by brood year using the available data on age composition. Age composition data is collected routinely from the escapement assessment programs in Owikeno Lake and Docee River. Data from spawning sites in Owikeno Lake was pooled to estimate the overall age composition of the escapement to Rivers Inlet. Due to low returns in 1999 limited age data was available from spawning sockeye, and this was supplemented with age data obtained from sockeye salmon captured in a fishwheel as they migrated up the Wannock River to Owikeno Lake (Mattock and Frederiksen 1999). For 1972 to 2000 all age samples collected at the Docee Fence have been stratified by date within a given year and then weighted appropriately by run size. Age samples were stratified by week if sufficient age samples were available (n>15); otherwise weekly periods were pooled until n>15. Age data from the commercial fisheries was pooled by statistical area (Table 5).

Age data from fisheries and spawning grounds in Area 8 has been collected only intermittently. Consequently, the time series of data available is too incomplete to warrant analysis in this report.

2.5 Juvenile Abundance

Estimates of juvenile abundance are required to identify whether changes in survival originate in freshwater or at sea. In many years, including all recent brood years (1994-1999) juvenile sockeye salmon abundance in Owikeno Lake was measured directly by night-time surface trawling at stations 1-3 during July and August using standardized methods described by Wood and Schutz (1970). The size and number of juvenile sockeye caught in standardized trawl surveys provides an index of fry recruitment and smolt production. Late summer trawl surveys began in 1960, were discontinued in 1969, and were reinstated in 1995 with the creation of the Stock Assessment Division. The July-August sampling period was selected because the majority of juveniles are vulnerable to the surface trawl gear at this time (Hyatt et al. 1989).

We recognize that a juvenile index based on surface trawling would be inconsistent if the vertical distribution of sockeye changed between surveys. To address this concern trawling at depth was carried out in years 1998-2000. Individual surface trawl catches can vary considerably and appear to be lognormally distributed. For this reason, individual catches have been $\log_e$-transformed and averaged within stations. For years in which surface trawling was not carried out, juvenile abundance indices have been inferred from either pre-smolt weight (Rutherford et al. 1995) or freshwater scale growth (McKinnell et al. 2001). To evaluate trends in freshwater survival rates, indices of juvenile abundance within Owikeno Lake were converted to absolute pre-smolt abundance as follows:

Pre-smolt abundance=average catch per m^2 *lake surface area (m^2)

Where average catch = $e^{(\text{juvenile index})}$ /surface area swept (m^2)

and surface area swept = net opening (m)*distance travelled (m)
net opening = $0.6m^2$
lake surface area = $96*10^6\ m^2$

Within Long Lake juvenile abundance is measured using hydro-acoustic and trawl techniques (Hyatt et al. 2000).

Pre-smolt abundance estimates were used to estimate freshwater and marine survival rates for both Owikeno and Long Lake as follows:

Freshwater Survival Rate = juvenile abundance/ potential egg deposition

Where potential egg deposition is estimated as the escapement * 50% females * 3,500 eggs.

Marine Survival Rate = brood year return/ juvenile abundance estimate

The freshwater and marine survival rates for Owikeno Lake must be considered as crude indications of relative survival. Both indices are the ratio of measurements that may be biased or imprecise. Recall for example that the total escapement estimate for Owikeno Lake is estimated rather arbitrarily as 3X the clear stream index. Similarly, juvenile abundance is determined by trawling only in the surface layer Although this provides a reasonably consistent index for monitoring trends in abundance, absolute abundance and hence freshwater survival will be underestimated to the extent that some juveniles are not vulnerable either because they occur deeper in the water column or because they can evade the net.

These measurement problems are reduced for Long Lake where the escapement is counted through a fence, and juvenile abundance is determined hydro-acoustically. However, hydroacoustic estimates often underestimate pre-smolt abundance and the occurrence of limnetic sticklebacks in Long Lake poses special problems (Hyatt et al. 2000). Currently, no programs exist to estimate juvenile abundance in Namu, Koeye, Port John or Kimsquit lakes.

2.6 Outlook

Returns in 2001 for Owikeno and Long lakes were predicted under two different scenarios; (1) a pessimistic scenario where recent poor survival rates (as measured for sea entry years 1996 and 1997) will continue for sea-entry years 1998 to 2001; and (2) a more optimistic scenario that takes into account the observed poor survival for sea-entry year 1997 and possibly 1998 but assumes an average return/spawner rate for sea-entry years 1999-2001. At the time of writing only data required for Long Lake, to measure the survival rate of smolts entering the ocean in 1997, was available, so the survival rate measured in 1996 sea entry year ("like 1996") was used to project returns to Owikeno Lake in 2001 under the "pessimistic" scenario.

It is important to note that these projections do not convey levels of uncertainty and are not presented as conventional "forecasts" of stock size. Data necessary for forecasting stock size returns to Owikeno and Long Lake in 2001 is still being collected and forecasts will be presented at a later date. The projections are provided here only to guide management decisions as they pertain to the recovery planning in place for Owikeno and Long Lake sockeye (Holtby 2000).

3.0 RESULTS

3.1 TRENDS IN ABUNDANCE

3.1.1 Escapement Trends

The reliability of SEDS escapement data for clear streams was assessed by comparing them with AUC estimates derived systematically from individual stream inspection notes. A strong positive correlation was observed between the reported escapement and the systematically reconstructed estimates of all clear streams except the Amback River (Fig 5). For this reason the Amback River has not been included in computing the *CSI*. The SEDS data for Owikeno Lake as a whole shows a general increasing trend in escapement from 1960 until 1992. In contrast, the *CSI* has not shown a corresponding increase although it does indicate increased escapements during phase 1 of the adaptive management plan when fisheries were greatly restricted (Fig 4). A dramatic drop in escapement to Area 9 was observed in 1994 and the decline has continued with the exception of 1997 when the *3xCSI* escapement (249,300) exceeded the target level of 200,000 sockeye. Escapement in 1999 set a record low of only 3,600 sockeye. The preliminary *CSI* in 2000 is approximately 7,000 sockeye. Using the 3X multiplier implies a *3xCSI* escapement of 21,000 sockeye. This is larger than the 1999 escapement but still below the provisional LRP of 30,000.

Total sockeye escapement to Area 10 (as measured through the Docee Fence) increased from 1972 to 1993, then dropped dramatically in 1994, and the decline has continued (Table 2, Fig. 6). The preliminary estimate of escapement in 2000 is only 1430 sockeye, a record low. Sockeye escapements in 1994-1998 were low but always above the 1979 count of 20,257.

Escapement data suggests that sockeye escapements to Koeye, Namu and Port John lakes have been declining. Conversely Kimsquit sockeye escapement appears to be increasing with the exception of a record low escapement in 1999. Sockeye escapement to the Atnarko River has been variable from 1970 to present, but shows no increasing or decreasing trend (Table 3, Fig. 7).

3.1.2 Catch Trends

Area 9 sockeye catch was variable and without trend from 1948-1969. Some outstandingly high catches were recorded in 1968 and 1973 (2,727,552 and 1,760,156 respectively). Beginning in the early to mid-1970's the average catch declined significantly, driven by poor catches in 1970, 1974 and 1975 (Fig. 8). An adaptive management plan implemented in 1979 restricted commercial catch from 1979 through to 1988 (Walters et al. 1993). Even after the adaptive management plan was discontinued commercial catch remained poor and the fishery has been closed since 1996. The Owikeno Nation has a food, social and ceremonial sockeye fishery in the Wannock River. Catch estimates are fragmentary but considered only to comprise a negligible amount of the total stock up to 1996. As a result of the drastic decline in total stock First Nation harvest rate has become moderate. Total sockeye catch in 1998 and 1999 was 2,161 and 657 respectively implying harvest rates of 6 and 16% respectively (Fig. 11).

Prior to 1972, Smith Inlet sockeye catch ranged from a low of 63,647 in 1957 to a high of 454,106 in 1968, with a mean annual catch of approximately 250,000 sockeye. Harvest rates for this period are uncertain as these catches predated the installation of the Docee Fence before which escapement estimates are considered unreliable. The commercial sockeye catch from 1972 to 1996 has been variable, but generally without trend up to 1993 (Fig. 9). The 1994 to 1996 catches of 57169, 25946, and 8513 respectively are well below the mean catch of 200,000 for the 1972-1995 period. The Smith Inlet commercial sockeye fishery has been closed since 1997. There was a First Nation harvest of 170 sockeye in 1998 and no harvest in 1999 and 2000.

Area 8 sockeye catch has been variable from 1960 to the mid-1990's, but has been at record lows from 1996 to present (Fig. 10). The recent decline in catch can only be partially attributed to time, area, and gear restriction recently implemented to reduce possible interception of Rivers and Smith Inlet sockeye. The restrictions were also implemented because of uncertainty in the status of the small sockeye stocks in lower Area 8.

3.1.3 Total Stock Trends

Total stock size (catch + escapement) for both Rivers and Smith Inlet sockeye showed a dramatic decline in return year 1994 and this decline has continued. This decline is also evident in total stock size of Area 8 sockeye. The congruence of all these declines suggests that all central coast sockeye stocks have experienced poor marine survival during the 1990's (Fig. 12).

3.2 Age Composition

Age composition of Owikeno and Long Lake sockeye is variable but normally dominated by age 1.3 sockeye based on calendar year returns. Both Owikeno and Long lake age composition, by brood year, averages 35% age 4 (1.2) and 65% age 5 (1.3) but has been quite variable in recent years (Table 6 and 7). In both lakes, virtually all smolts emigrate as yearlings (age 1.*).

3.3 Juvenile Abundance and Size

Pre-smolt samples collected from 1994 to present indicate that the previously documented density-dependent relationship still holds (Fig. 13). This relationship indicates that food supply is limiting growth in Owikeno Lake, and confirms that the late summer trawl catches are a reliable index of juvenile abundance.

No juvenile data are available for Owikeno Lake for brood years 1992 and 1993. The juvenile abundance index for brood year 1994 was slightly above the historic long term mean of 4.75 suggesting that freshwater production potential had not declined from historic levels (Fig. 14, Table 8). On the other hand the juvenile abundance index measured for brood year 1997 was slightly below the long term mean. However, the 1997 estimate is lower than expected based on mean pre-smolt weight which indicates a higher juvenile index, more consistent with the high parent escapement (Fig. 13). Abundance indices for brood years 1998 and 1999 are well below historical levels, consistent with pre-smolt weights and the record low parent escapements.

Estimates of freshwater survival (egg to pre-smolt) for Owikeno Lake sockeye are highly variable, but those for the 1994 and 1995 brood (which made up the 1999 return year) were above the long term average. Similarly, freshwater survival of the 1994 and 1995 brood measured in Long Lake were also above the long term mean (Fig 15). In contrast, marine survival measurements for the 1994 and 1995 broods for both lakes are at record low levels (Fig. 16). The 1990 brood year from both Owikeno and Long Lake appears to have experienced below average freshwater survival. Note however that actual abundance is likely underestimated using surface trawl techniques. Such would lead us to underestimate freshwater survival and overestimate marine survival.

3.4 Outlook

We have no information on the early marine survival of any of the central coast sockeye salmon stocks in sea-entry year 1999, and consequently have no basis for choosing between optimistic or pessimistic scenarios for survival. The projected sockeye returns to Owikeno Lake in 2001 range from a critical low of less than 5,600 (pessimistic scenario) to a high of approximately 240,000 sockeye (optimistic scenario) which is above the previous management target of 200,000. The range in the projected returns of sockeye to Long Lake is much smaller with a critical low of 1,768 (pessimistic) and a high of only 27,000 sockeye (optimistic). Under either scenario the projected return for Long Lake is well short of the management target of 200,000 sockeye. The possible outcomes in stock size for Owikeno and Long Lake sockeye from either continued poor survival or normal survival are summarized in Table 9.

The strong return of age-3 (1.1) coho as measured through the Docee Fence in 2000 (Appendix 3) combined with anecdotal reports of a strong return of age-2 (0.1) pink salmon to Owikeno Lake in 2000 suggests that survival of juveniles entering the sea in 1999 may have been above average. We are unsure how much weight to put on the coho and pink returns as an indicator for sockeye in sea-entry year 1999. However, these observations are consistent with oceanographic data in suggesting that marine conditions for central coast salmon entering the sea have now returned to normal.

4.0 DISCUSSION

Our assessment of factors affecting the status of Area 9 sockeye has not changed since the last PSARC review (Rutherford et al. 1998). Assessment of Area 9 sockeye production is still limited by the unknown precision and reliability of the adult escapement estimates. A pilot fishwheel program operated on the Wannock River in 1999 and 2000 to attempt to address the escapement reliability issue. This pilot was funded by Fisheries Renewal B.C. and the operation co-ordinated by a local partnership group. The objective of this program was to develop an alternative method for estimating escapement to Owikeno Lake. Preliminary results from the 1999 fishwheel program were encouraging although no escapement estimate was generated, preliminary results from 2000 are less encouraging. Continuation of this program is dependent on non-DFO sources. The reinstatement of the juvenile trawl program has addressed some of the uncertainties of using escapement data and total stock to monitor long term trends in sockeye production for Owikeno Lake. The juvenile abundance data for brood year 1994 was above the long-term mean suggesting that freshwater production potential has not declined from historic levels. However, the declining escapements have now resulted in reduced fry recruitment in recent years.

Our assessment of Long Lake sockeye salmon is more definitive than that for Owikeno Lake sockeye given the reliability of Long Lake sockeye catch, escapement and total stock data. For Long Lake, where our assessment data is more reliable we have also seen the sockeye stock decline to a record low level. There are two weaknesses in the Area 10 data: first, uncertainty exists about whether other sockeye stocks are intercepted in the Area 10 commercial fishery. Area 10 sockeye stocks are not thought to be intercepted in other fisheries but there was some indication from a 1996 sampling program that the fishery near the outer boundary of Area 10 (sub area 10-3) intercepts some non-Smith Inlet sockeye (Bachen et al. 1997). Second, precision and accuracy of juvenile sockeye abundance estimated by hydro-acoustic techniques is unknown, but currently being addressed in a companion paper. Nevertheless, the error attributed to these weaknesses is considered a small component of the overall variation in recruitment.

It should be noted that the Docee Fence was originally built as a temporary counting structure with an expected operational life span of 10 years (W. Peterson HEB Engineering, pers. com.). It has been operating for 19 years and has now deteriorated to the point that it may no longer be “fish proof”. This compromises the Department’s ability to continue to provide reliable estimates of escapement to Long Lake. A major upgrade is required to ensure continued reliable total counts of salmon to Long Lake. The incorporation of a fish trap would improve species identification. The addition of a smolt counting facility would improve our ability to estimate smolt abundance at time of migration improving the partioning of freshwater and marine survival and growth.

Other than the apparent downward trend in escapement to Koeye, Namu, Port John, and the recent low escapement to Kimsquit Lake little is known about the status of these stocks. Even so, the available evidence of low escapements and low catches indicates a decline in total abundance of Area 8 sockeye in recent years, congruent with that of Owikeno and Long lake sockeye. This suggests that Area 8 sockeye are experiencing below average survival as well. The relatively stable escapements to the Atnarko River over the last five years testifies to sound management actions that have reduced catch appropriately in the face of declining adult returns.

All available data indicate that critically low sockeye returns to both Rivers and Smith Inlet in 1999 and 2000 resulted from very poor marine survival for three consecutive brood years, not a failure in freshwater production. Sockeye smolts going to sea in 1996, 1997 and 1998 (brood year 1994 to 1996) appear to have experienced very adverse ocean conditions. In addition, marine survival indices for Owikeno and Long Lake indicate that marine survival has generally been poor for all brood years entering the ocean since 1991. The critically low 2000 escapements are a result of the compounding effect of poor marine survival on two consecutive generations. It appears the brood years 1990 and 1991 (at least for Long Lake) provided normal pre-smolt production (Table 8b), but these smolts experienced poor marine survival in 1992 and 1993, so that escapements were low in 1994 through 1996. Reduced escapement in 1994 and 1995 led to reduced smolt production in 1996 and 1997, and these smolts experienced even worse marine survival conditions, resulting in the extremely low adult returns in 1999 and 2000. It now seems possible that marine survival may have improved for sockeye in sea-entry year 1999, in which case strong returns to Owikeno Lake in 2001 and 2002 may be realized as a result of the relatively large escapement recorded in 1997. This is not the case for Long Lake where escapements have been relatively low since 1995.

Suggested courses of action for both fisheries management and recovery planning are proposed for each of the possible stock size outcomes illustrated in Table 10. Projected stock sizes range from levels exceeding previous targets to levels so low as to warrant an intensive recovery involving captive broodstock. Unfortunately for decision makers we cannot refine these predictions until the abundance of age-4 returns surviving sea entry year 1999 is measured in 2001. A program to gauge age-4 returns in 2001 will be an essential component of the in-season assessment for central coast sockeye in 2001.

If marine survival returned to normal in 1999, Owikeno Lake sockeye returns are expected to exceed the LRP and the target escapement, suggesting a possible harvestable surplus. Because of the recent trend of poor sockeye escapements to Owikeno Lake combined with the fact that escapement to Owikeno Lake cannot be measured or estimated until most fish have reached the spawning grounds, we suggest that the risk associated with opening a commercial fishery in 2001 is too high. If early indications of survival were wrong, and a fishery was prosecuted, an important opportunity for stock recovery would have been squandered. Even if the optimistic projection of 318,000 sockeye were realized, there is no indication that any harm will result from overspawning. Historically, escapements exceeding 500,000 sockeye have produced resulting good returns. Even with one good return year, the rate of recovery will be slow given the critically low escapements in 1999 and 2000. Because most of Rivers Inlet sockeye mature at age 5, commercial harvest should not be contemplated until recovery is assured by consistently exceeding the provisional LRP (30,000) for 5 consecutive years. In contrast, even if marine survival has returned to normal, Long Lake sockeye returns are expected to remain below the target escapement because brood year escapements were poor, although above the provisional LRP. Decisions on whether or not enhancement is advisable at this escapement level will need to be made by the Technical Coordinating Committee “TCC” for the recovery plan.

If survival for sea entry year 1999 was again poor (comparable to sea entry years 1996 and 1997) such that the stocks cannot sustain themselves naturally, drastic measures will be needed to prevent a downward spiral to extirpation. With continued poor survival, returns in 2001 are projected to be well below the LRP levels for both stocks. Continued “supplementation” as defined in the draft Recovery Plan will probably not be sufficient to ensure the continued viability of these stocks while marine survival remains at levels observed in 1996-1998. A captive brood program may be the only way to ensure the viability of these stocks if marine survival remains poor in 1999 despite a return to normal temperatures. (i.e. if adverse marine conditions remain poor and unpredictable).

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Table 1. Commercial catch, escapement, total stock size, and clear stream escapement index for Area 9 sockeye salmon, 1948-2000.

Year	Catch	"Total" Escapement	Total Stock	Clear Stream Index
1948	451727	135000	586727	45000
1949	603120	250500	853620	83500
1950	1549338	666000	2215338	222000
1951	1016495	493500	1509995	164500
1952	938722	915000	1853722	305000
1953	1522285	840000	2362285	280000
1954	575664	275400	851064	91800
1955	584245	346500	930745	115500
1956	1072332	348000	1420332	116000
1957	373976	278700	652676	92900
1958	1017545	408000	1425545	136000
1959	439419	591000	1030419	197000
1960	516503	137700	654203	45900
1961	842953	193500	1036453	64500
1962	1035917	528000	1563917	176000
1963	437459	1500000	1937459	500000
1964	1053591	805500	1859091	268500
1965	644974	135225	780199	45075
1966	528212	222000	750212	74000
1967	1102838	437250	1540088	145750
1968	2727552	855000	3582552	285000
1969	727330	84750	812080	28250
1970	19019	84750	103769	28250
1971	402538	269400	671938	89800
1972	379006	186000	565006	62000
1973	1760156	1372500	3132656	457500
1974	118574	484500	603074	161500
1975	40631	409500	450131	136500
1976	613067	190500	803567	63500
1977	659819	187800	847619	62600
1978	577908	420000	997908	140000
1979	28328	196500	224828	65500
1980	528	211500	212028	70500
1981	98706	444000	542706	148000
1982	39180	699000	738180	233000
1983	35161	481500	516661	160500
1984	53879	299100	352979	99700
1985	184543	652275	836818	217425
1986	337443	555000	892443	185000
1987	398854	459600	858454	153200
1988	372018	256500	628518	85500
1989	63746	127800	191546	42600
1990	234281	277500	511781	92500
1991	168226	237000	405226	79000
1992	508068	271500	779568	90500
1993	82529	201000	283529	67000
1994	40320	78000	118139	26000
1995	45426	109500	154926	36500
1996	2697[a]	45600	48312	15205
1997	1984[a]	249300	251284	82767
1998	2161[a]	35900	38041	11960
1999	657[a]	3600	4257	1190
2000		21000[b]		7000[b]

[a] First Nation catch

[b] Very preliminary estimate

Table 2. Catch, escapement, and total stock size for Area 10 sockeye salmon, 1948-2000.

Year	Catch	Escapement	Total Stock
1951	439095	82500	521595
1952	342243	67500	409743
1953	367070	70000	437070
1954	190760	85000	275760
1955	325478	110000	435478
1956	442256	90000	532256
1957	63647	22575	86222
1958	223702	22575	246277
1959	113329	50000	163329
1960	219341	18525	237866
1961	213277	22525	235802
1962	252058	110075	362133
1963	174996	68686	243682
1964	236432	50200	286632
1965	289821	11000	300821
1966	172091	50000	222091
1967	286000	50000	336000
1968	454106	197930	652036
1969	166998	110200	277198
1970	82677	70065	152742
1971	142955	135068	278023
1972	59397	76248	135645
1973	294619	169753	464372
1974	347705	91013	438718
1975	52673	62967	115640
1976	92201	60919	153120
1977	54855	128601	183456
1978	233381	84105	317486
1979	11022	20257	31279
1980	2349	129435	131784
1981	154355	214345	368700
1982	292958	213674	506632
1983	131212	199653	330865
1984	21160	89012	110172
1985	369178	250000	619178
1986	369854	199000	568854
1987	194926	200000	394926
1988	301731	207000	508731
1989	71821	166810	238631
1990	58579	149000	207579
1991	574550	260000	834550
1992	722816	220000	942816
1993	284156	220000	504156
1994	57830	100000	157830
1995	15944	56244	72188
1996	7918	54000	61918
1997	0	32000	32000
1998	170[a]	76000	76170
1999	0	5900	5900
2000	0	1430	1430

[a] First Nation catch

Table 3. Catch, escapement, and total stock size for Area 8 sockeye salmon.

Year	Commercial Catch	Atnarko	Kimsquit	Koeye	Namu	Port John	Total Stock
1950	.	75000	7500	3500	3500	717	.
1951	.	75000	7000	1200	2500	1300	.
1952	.	90000	10300	1500	2000	1087	.
1953	.	65000	7500	2000	1500	1500	.
1954	.	53000	12000	1500	4500	750	.
1955	.	75000	5000	2000	1000	2566	.
1956	.	75000	7500	3500	3500	1332	.
1957	.	150000	7500	7500	750	1353	.
1958	.	15000	.	750	1500	1248	.
1959	.	75000	3500	3500	7500	1000	.
1960	86947	35000	7500	1500	3500	268	135465
1961	126525	35000	.	750	3500	126	166301
1962	163881	75000	3500	.	1500	.	245381
1963	151808	55000	.	.	1500	.	208308
1964	306359	31000	.	750	750	750	339909
1965	77756	13000	.	750	1500	.	93006
1966	82892	16000	.	750	1500	25	101167
1967	234087	36000	15000	1500	1500	650	289887
1968	95298	8000	3500	750	750	.	109048
1969	43686	40000	3500	750	1500	.	89436
1970	99837	25000	3500	1500	.	.	129837
1971	167053	100000	55000	3500	8000	.	336253
1972	85620	32500	13500	3500	.	.	135545
1973	221619	85000	3500	3000	.	750	314944
1974	125049	55000	5000	2500	.	300	188274
1975	225969	45000	35000	3500	.	400	310619
1976	202152	30000	25000	9000	600	250	268777
1977	88337	30000	10000	3500	.	750	134182
1978	50865	20000	12000	300	350	300	83915
1979	220134	18000	8000	14000	3500	400	264709
1980	161439	24000	7500	2500	.	1000	196739
1981	179113	40000	5000	5000	1500	75	231694
1982	36409	20000	12000	2000	2000	500	73964
1983	132482	25000	30000	.	1500	300	190457
1984	43470	45000	10000	2300	4000	750	107805
1985	148800	50000	15000	1700	1800	250	219670
1986	132206	19975	16000	2900	1450	285	172954
1987	213903	30780	22000	2500	160	10	269473
1988	166607	30000	10000	2500	1700	300	211262
1989	33511	15000	12200	1200	750	60	62849
1990	122937	20000	7400	.	20	20	151392
1991	106078	52500	27000	525	450	150	186947
1992	109475	41000	13000	600	500	10	164956
1993	61767	15000	13000	250	1000	155	91469
1994	222804	25000	.	1000	400	.	249245
1995	69494	55000	.	.	.	.	124510
1996	24988	45350	20000	300	550	.	91873
1997	31576	20000	5000	.	.	.	56878
1998	21924	30000	.	.	.	.	52090
1999	5229	25000	1000	1200	2000	.	34529
2000							

Table 4. Age composition of Area 9 sockeye salmon sampled from the commercial catch and escapement, 1948-1999.

	Proportion of catch			Proportion of escapement		
Year	Age 1.2	Age 1.3	Other	Age 1.2	Age 1.3	Other
1948	0.55	0.45	0.00			
1949	0.84	0.15	0.01			
1950	0.13	0.87	0.00			
1951	0.38	0.61	0.01			
1952	0.41	0.59	0.00			
1953	0.73	0.27	0.00			
1954	0.60	0.40	0.00			
1955	0.45	0.55	0.00			
1956	0.10	0.90	0.00			
1957	0.65	0.35	0.00			
1958	0.28	0.71	0.01			
1959	0.19	0.79	0.02			
1960	0.38	0.57	0.05	0.43	0.57	0.00
1961	0.49	0.49	0.02	0.31	0.69	0.00
1962	0.90	0.09	0.01	0.53	0.47	0.00
1963	0.37	0.60	0.03	0.47	0.52	0.01
1964	0.13	0.79	0.08	0.12	0.86	0.02
1965	0.69	0.27	0.04	0.36	0.64	0.00
1966	0.34	0.65	0.01	0.42	0.58	0.00
1967	0.78	0.20	0.02	0.40	0.60	0.00
1968	0.07	0.90	0.03			
1969	0.35	0.61	0.04			
1970	0.40	0.49	0.11	0.40	0.50	0.10
1971	0.75	0.23	0.02	0.76	0.22	0.02
1972	0.48	0.45	0.07	0.81	0.14	0.05
1973	0.06	0.94	0.00	0.06	0.94	0.00
1974	0.19	0.78	0.03	0.19	0.78	0.03
1975	0.47	0.52	0.01	0.47	0.52	0.01
1976	0.47	0.51	0.02			
1977	0.44	0.54	0.02			
1978	0.04	0.94	0.02	0.03	0.95	0.02
1979	0.57	0.41	0.02	0.57	0.41	0.02
1980	0.17	0.83	0.00	0.17	0.83	0.00
1981	0.34	0.65	0.01	0.34	0.65	0.01
1982	0.12	0.85	0.03			
1983	0.19	0.80	0.01	0.19	0.80	0.01
1984	0.74	0.26	0.00	0.62	0.38	0.00
1985	0.38	0.62	0.00	0.21	0.79	0.00
1986	0.34	0.66	0.00	0.17	0.83	0.00
1987	0.42	0.58	0.00	0.09	0.87	0.04
1988	0.18	0.82	0.00	0.04	0.96	0.00
1989	0.39	0.61	0.00	0.56	0.44	0.00
1990	0.11	0.86	0.03	0.12	0.88	0.00
1991	0.26	0.71	0.03	0.39	0.61	0.00
1992	0.09	0.90	0.01	0.17	0.76	0.07
1993	0.34	0.63	0.03	0.18	0.82	0.00
1994	0.34	0.63	0.03	0.14	0.84	0.02
1995	0.35	0.65	0.00	0.06	0.94	0.00
1996				0.38	0.59	0.03
1997				0.14	0.84	0.02
1998				0.04	0.96	0.00
1999				0.48	0.52	0.00
2000						

Table 5. Age composition of Area 10 sockeye salmon sampled from the commercial catch and escapement, 1972-2000.

		Proportion of catch				Proportion of escapement		
Year	N	Age 1.2	Age 1.3	Other	N	Age 1.2	Age 1.3	Other
1972	517	0.71	0.28	0.01	81	0.64	0.28	0.08
1973	831	0.15	0.83	0.02	460	0.15	0.84	0.01
1974	425	0.09	0.83	0.08	65	0.11	0.86	0.03
1975	245	0.23	0.76	0.01	65	0.35	0.60	0.05
1976					57	0.74	0.25	0.01
1977	164	0.71	0.28	0.01	29	0.31	0.69	0.00
1978	468	0.03	0.97	0.00		0.04	0.95	0.01
1979								
1980					56	0.20	0.77	0.03
1981	18	0.56	0.44	0.00	175	0.66	0.31	0.03
1982	290	0.15	0.85	0.00	89	0.07	0.93	0.00
1983								
1984	93	0.53	0.47	0.00		0.63	0.37	0.00
1985						0.79	0.20	0.01
1986					111	0.32	0.69	0.00
1987	19	0.32	0.68	0.00	84	0.16	0.82	0.02
1988	578	0.28	0.72	0.00	284	0.42	0.57	0.01
1989	223	0.28	0.72	0.00	109	0.59	0.41	0.00
1990	223	0.17	0.83	0.00	51	0.57	0.43	0.00
1991	272	0.40	0.60	0.00	379	0.42	0.57	0.01
1992	193	0.04	0.96	0.00	214	0.33	0.62	0.05
1993	526	0.22	0.76	0.02	173	0.36	0.61	0.03
1994	68	0.20	0.79	0.01	243	0.30	0.68	0.02
1995	161	0.28	0.70	0.02	74	0.11	0.88	0.01
1996	195	0.48	0.51	0.01	107	0.49	0.51	0.00
1997	0	.	.	.	119	0.20	0.79	0.01
1998	0	.	.	.	279	0.03	0.96	0.01
1999	0	.	.	.	80	0.25	0.68	0.07
2000	0	.	.	.	79	0.47	0.46	0.07

Table 6. Area 9 sockeye escapement, total returns, and age composition by brood year.

Brood Year	Total Escapement	Adult Returns	Proportion returning at Age 4	Proportion returning at Age 5
1948	135000	1397843	0.54	0.46
1949	250500	2064894	0.84	0.16
1950	666000	1031856	0.49	0.51
1951	493500	1697134	0.25	0.75
1952	915000	370470	0.38	0.62
1953	840000	1436376	0.30	0.70
1954	275400	1213184	0.33	0.67
1955	346500	568675	0.34	0.66
1956	348000	802044	0.32	0.68
1957	278700	814425	0.58	0.42
1958	408000	2254641	0.54	0.46
1959	591000	2391927	0.36	0.64
1960	137700	494314	0.47	0.53
1961	193500	965811	0.51	0.49
1962	528000	755750	0.36	0.64
1963	1500000	4259410	0.24	0.76
1964	805500	746147	0.34	0.66
1965	135225	335922	0.85	0.15
1966	222000	193359	0.21	0.79
1967	437250	703240	0.72	0.28
1968	855000	3277280	0.10	0.90
1969	84750	658357	0.29	0.71
1970	84750	348652	0.33	0.67
1971	269400	621381	0.34	0.66
1972	186000	835391	0.45	0.55
1973	1372500	1315186	0.28	0.72
1974	484500	127896	0.28	0.72
1975	409500	304135	0.42	0.58
1976	190500	388804	0.09	0.91
1977	187800	811973	0.23	0.77
1978	420000	501910	0.18	0.82
1979	196500	225832	0.43	0.57
1980	211500	855026	0.26	0.74
1981	444000	890466	0.23	0.77
1982	699000	840268	0.25	0.75
1983	481500	760177	0.27	0.73
1984	299100	172340	0.45	0.55
1985	652275	542111	0.18	0.82
1986	555000	323081	0.18	0.82
1987	459600	799770	0.17	0.83
1988	256500	308694	0.30	0.70
1989	127800	155047	0.41	0.59
1990	277500	157024	0.16	0.84
1991	237000	50973	0.44	0.56
1992	271500	229437	0.08	0.92
1993	201000	71699	0.49	0.51
1994	78000	3735	0.41	0.59
1995	109500			

Table 7. Area 10 sockeye escapement, total returns, and age composition by brood year.

Brood Year	Escapement	Adult Returns	Proportion returning at Age 4	Proportion returning at Age 5
1972	76248	216944	0.52	0.48
1973	169753	385093	0.20	0.80
1974	91013			
1975	62967			
1976	60919	160058	0.16	0.84
1977	128601	676922	0.34	0.66
1978	84105			
1979	20257			
1980	129435	191128	0.35	0.65
1981	214345	878816	0.56	0.44
1982	213674	475939	0.38	0.62
1983	199653	429441	0.22	0.78
1984	89012	292649	0.59	0.41
1985	250000	230867	0.51	0.49
1986	199000	587669	0.16	0.84
1987	200000	1170283	0.29	0.71
1988	207000	452771	0.23	0.77
1989	166810	256180	0.56	0.44
1990	149000	101709	0.40	0.60
1991	260000	42333	0.25	0.75
1992	220000	55325	0.54	0.46
1993	220000	79663	0.08	0.92
1994	100000	6221	0.36	0.64
1995	56244	2133	0.69	0.31
1996	54000			
1997	32000			
1998	76000			
1999	5900			
2000	1430			

Table 8a. Area 9 sockeye escapement, juvenile abundance index, and pre-smolt weight by brood year.

Brood	Total	Juvenile Abundance			Pre-smolt weight (g)	
Year	Escapement	Index	Source[a]	(SE)	Mean	(SD)
1948	135000					
1949	250500					
1950	666000					
1951	493500	4.99	C			
1952	915000	4.60	C			
1953	840000	5.04	C			
1954	275400	3.37	C			
1955	346500	3.33	C			
1956	348000	3.52	C			
1957	278700	2.34	C			
1958	408000	4.90	B		1.28	0.66
1959	591000	5.27	A	1.03	1.18	0.44
1960	137700	4.63	A	1.12	1.44	0.36
1961	193500	4.55	A	0.92	1.39	0.40
1962	528000	3.92	A	1.13	1.46	0.44
1963	1500000	5.85	A	0.72	0.85	0.33
1964	805500	6.14	A	0.74	1.11	0.46
1965	135225	3.28	A	1.13	1.82	0.51
1966	222000	5.45	A	1.00	1.03	0.41
1967	437250	3.12	A	0.98	1.61	
1968	855000	6.14	B		0.87	
1969	84750	5.60	B		1.05	
1970	84750	5.57	B		1.06	
1971	269400	4.45	B		1.43	
1972	186000	5.21	B		1.18	
1973	1372500	5.96	B		0.93	
1974	484500	5.66	B		1.03	
1975	409500	4.87	B		1.29	
1976	190500					
1977	187800					
1978	420000					
1979	196500					
1980	211500					
1981	444000	5.56	C			
1982	699000	6.32	C			
1983	481500					
1984	299100	5.54	C			
1985	652275	6.90	C			
1986	555000					
1987	459600	6.57	C			
1988	256500	4.03	B		1.57	
1989	127800	1.97	B		2.25	
1990	277500	4.56	C			
1991	237000	4.84	B		1.30	
1992	271500					
1993	201000					
1994	78000	4.94	A	0.41	1.41	
1995	109500	3.93	A	0.98	1.73	0.410
1996	45600	2.08	A	1.20	2.74	0.627
1997	249300	4.16	A	1.30	1.21	0.363
1998	35900	1.57	A	1.25	2.83[b]	
1999	3600	1.04	A	1.50		

[a] Source; A= index measured directly, B= index inferred from pre-smolt weight, C= index inferred from scale growth (McKinnell et al. 2001)

[b] preliminary fresh weight

Table 8b. Area10 sockeye escapement and estimates of juvenile sockeye abundance. (Juvenile data from Hyatt et al. 2000)

Brood Year	Sockeye Escapement	No. of juveniles
1972	76248	
1973	169753	
1974	91013	
1975	62967	
1976	60919	3190000
1977	128601	3060000
1978	84105	1490000
1979	20257	380000
1980	129435	1890000
1981	214345	3250000
1982	213674	6070000
1983	199653	2380000
1984	89012	2220000
1985	250000	2120000
1986	199000	3180000
1987	200000	2730000
1988	207000	3070000
1989	166810	650000
1990	149000	3560000
1991	260000	4750000
1992	220000	1570000
1993	220000	2040000
1994	100000	3140000
1995	56244	1230000
1996	54000	1960000
1997	32000	3680000
1998	76000	6320000
1999	5900	2300000
2000	1430	

Table 9. Projected returns to Owikeno and Long Lake based on pessimistic and optimistic survival rates.

OWIKENO LAKE

Scenario [a]	Brood Year	Escapement [b]	Sockeye Returns in Calendar Year 2001	2002	2003	2004
Pessimistic	1996	45600	1398			
	1997	249300	4197	7642		
	1998	35900		604	1100	
	1999	3600			60	109
	2000	20000				337
	Combined		**5,595**	**8,246**	**1,160**	**109**
Optimistic	1996	45600	1398			
	1997	249300	238720	434695		
	1998	35900		34357	62563	
	1999	3600			3390	6173
	2000	20000				19151
	Combined		240,118	469,052	65,953	**25,324**

LONG LAKE

Scenario [a]	Brood Year	Escapement [b]	Sockeye Returns in Calendar Year 2001	2002	2003	2004
Pessimistic	1996	54000	1349			
	1997	32000	419	778		
	1998	76000		995	1847	
	1999	5900			72	133
	2000	1430				18
	Combined		**1,768**	**1,773**	**1,919**	**151**
Optimistic	1996	54000	1349			
	1997	32000	25648	47632		
	1998	76000		60914	113126	
	1999	5900			4729	8782
	2000	1430				1074
	Combined		26,997	108,546	117,855	9,856

[a] Pessimistic scenario assumes continued poor survival (as measured for sea-entry year 1996)
Optimistic scenario assumes a return to the long term average survival rate
[b] Escapement target is 200,000 sockeye
Bold type indicates projected stock sizes that fall below the provisional Limit Reference Points (LRP's)
Provisional LRP's are 30,000 and 8,000 for Owikeno and Long Lake sockeye respectively (Holtby 2000)

Table 10. Possible stock size outcomes in relation to LRP and Target escapements with suggested courses of action.

	Returns	
	Optimistic[a]	Pessimistic[b]
Owikeno	>>LRP >>Target Minimal Harvest Fry supplementation not warrranted (as per recovery plan)	<<LRP <<Target No Harvest Fry supplementation warrranted (as per recovery plan). Consider captive brood
Long	>LRP <<Target Minimal Harvest Fry supplementation not warrranted (as per recovery plan)	<<LRP <<Target No Harvest Fry supplementation warrranted (as per recovery plan). Consider captive brood

[a] Optimistic survival scenario assumes an average survival rate

[b] Pessimistic survival scenario assumes continued poor survival as measured for sea-entry 1996

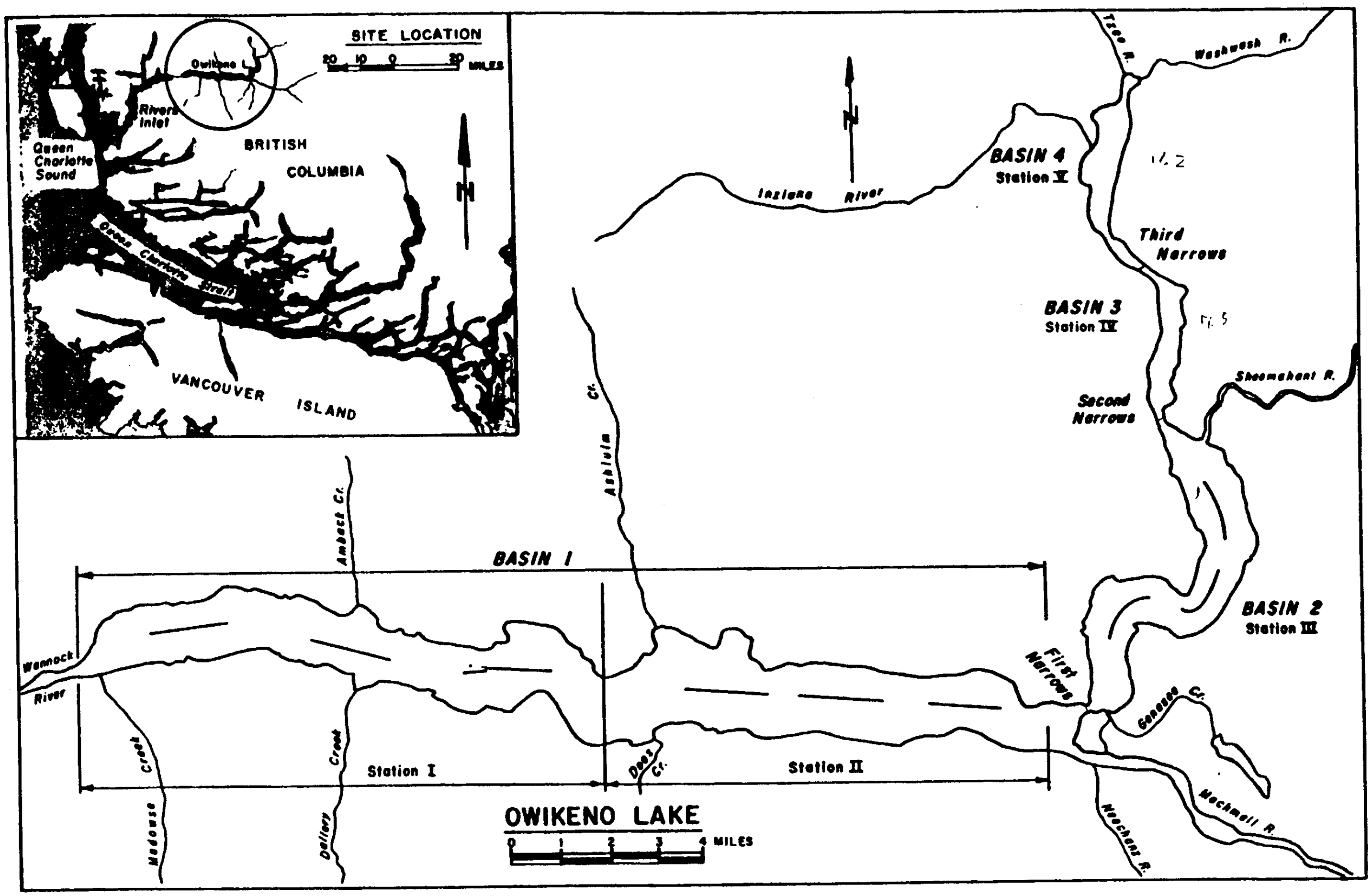


Figure 1. Map showing location of Owikeno Lake, its principal tributaries, and the juvenile survey stations.

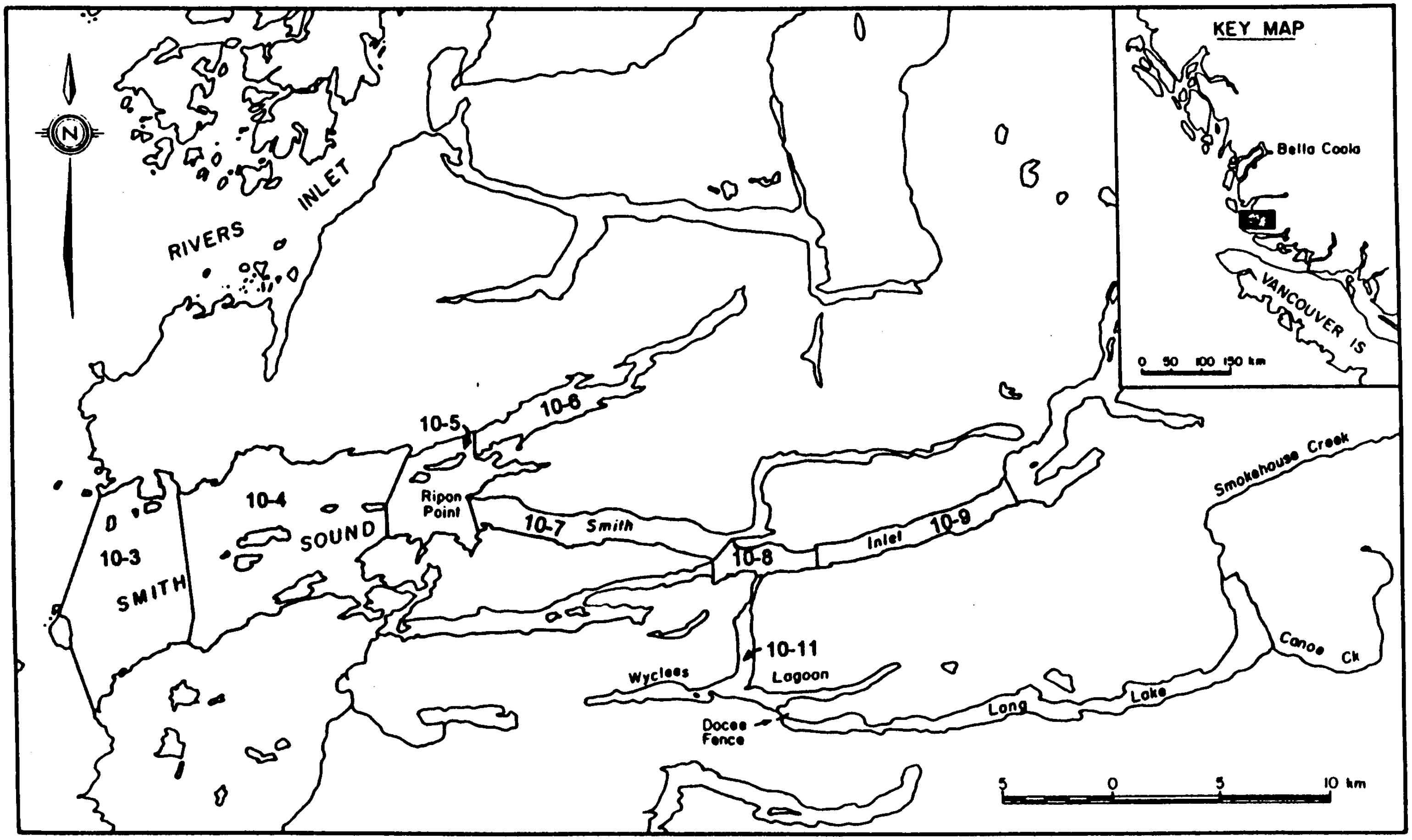


Figure 2. Map of Smith Inlet showing location of Long Lake and the Docee Fence.

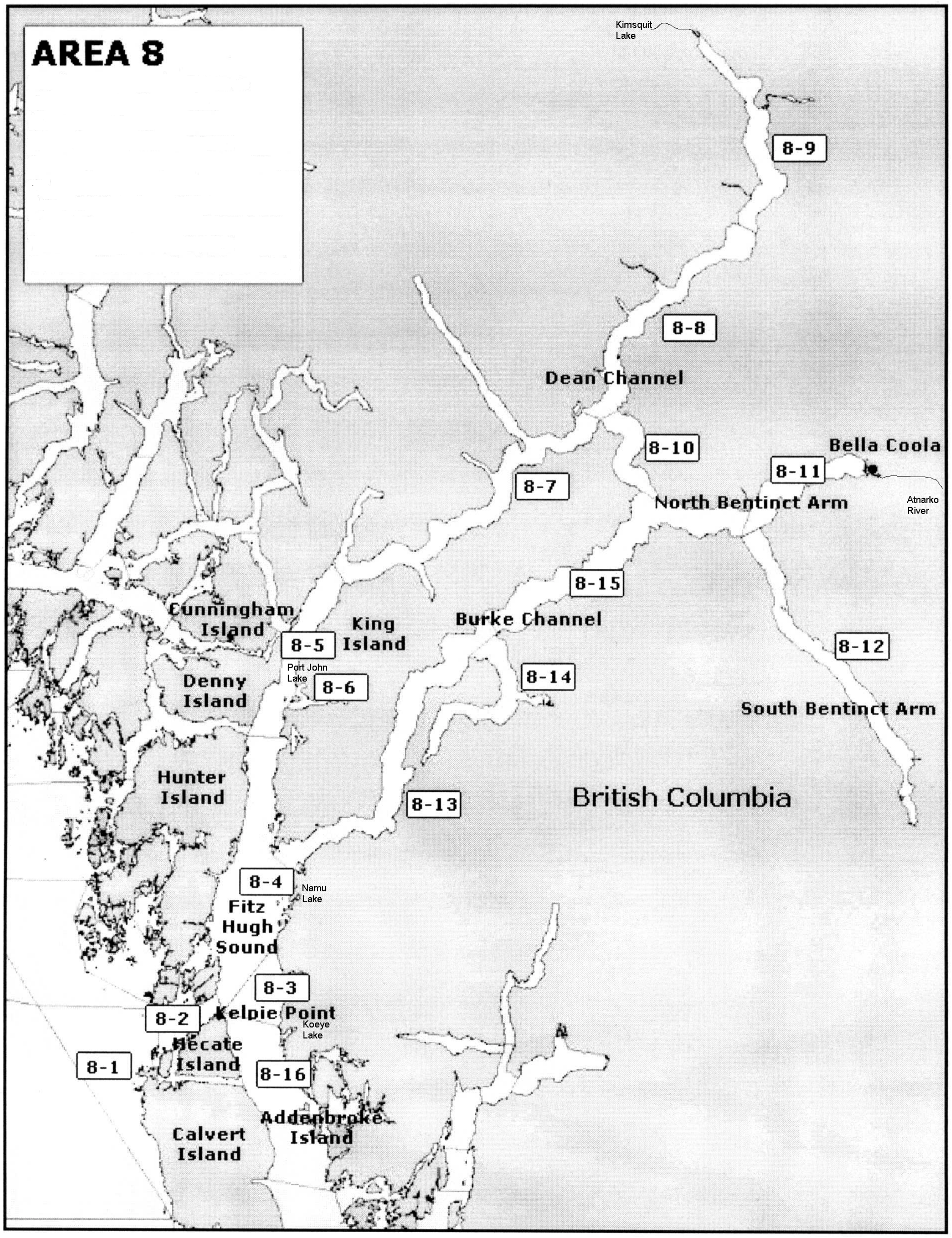
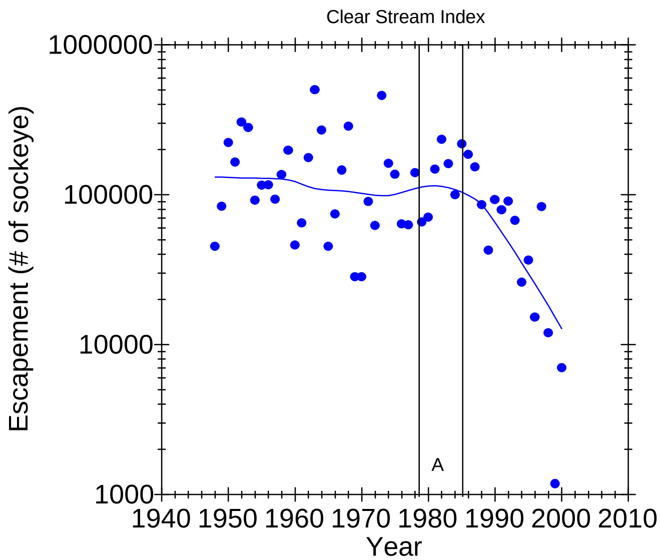


Figure 3. Map of Statistical Area 8 showing location of Atnarko River, Kimsquit, Koeye, Namu, and Port John lakes.



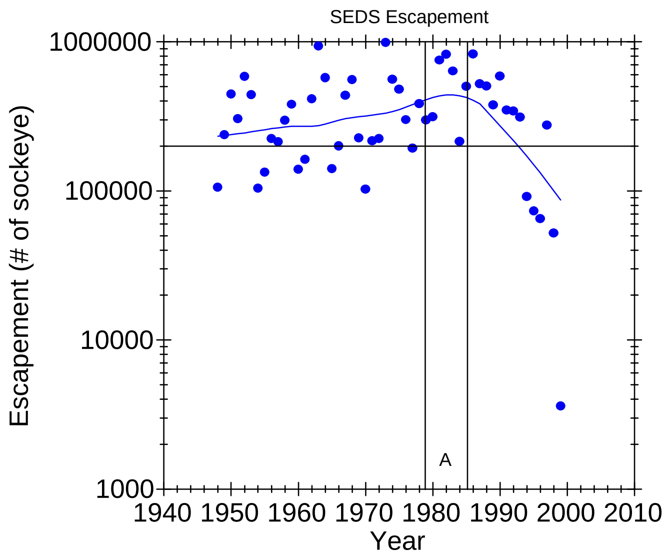


Figure 4. Comparison of trends in Owikeno Lake (Area 9) SEDS and clear stream sockeye escapement indices. Lowess line fitted to data. Horizontal lines indicate target escapement and "A" indicates phase one of adaptive mangement plan (Walters et al. 1993).

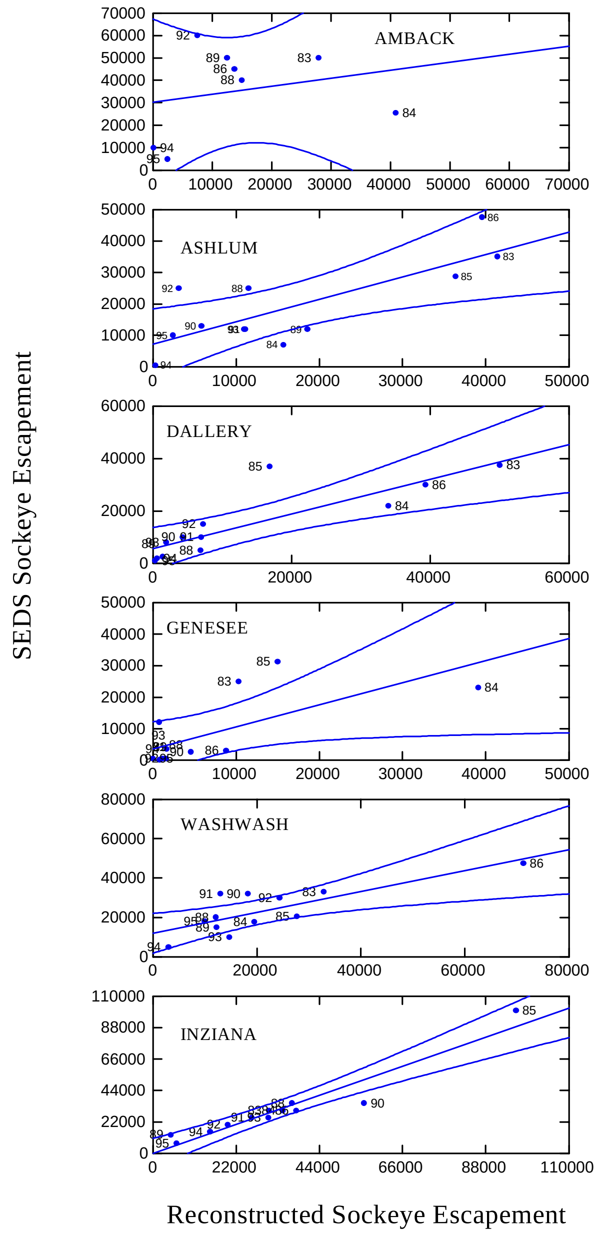


Figure 5. Relationship between SEDS and reconstructed escapement indices to clear water streams.

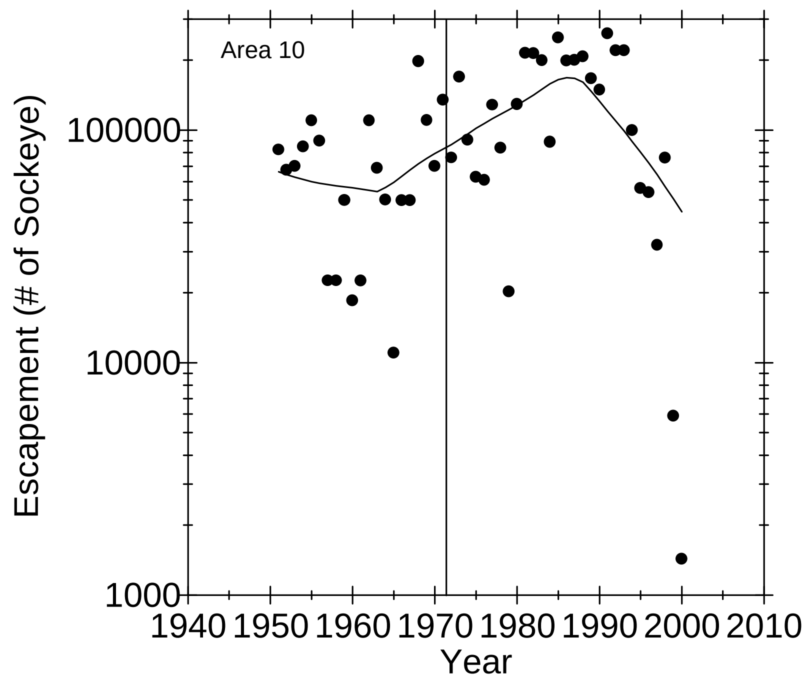


Figure 6. Trend in sockeye salmon escapements to Smith Inlet (Area 10). Vertical line indicates start of Docee Fence counts. Lowess line fitted to data.

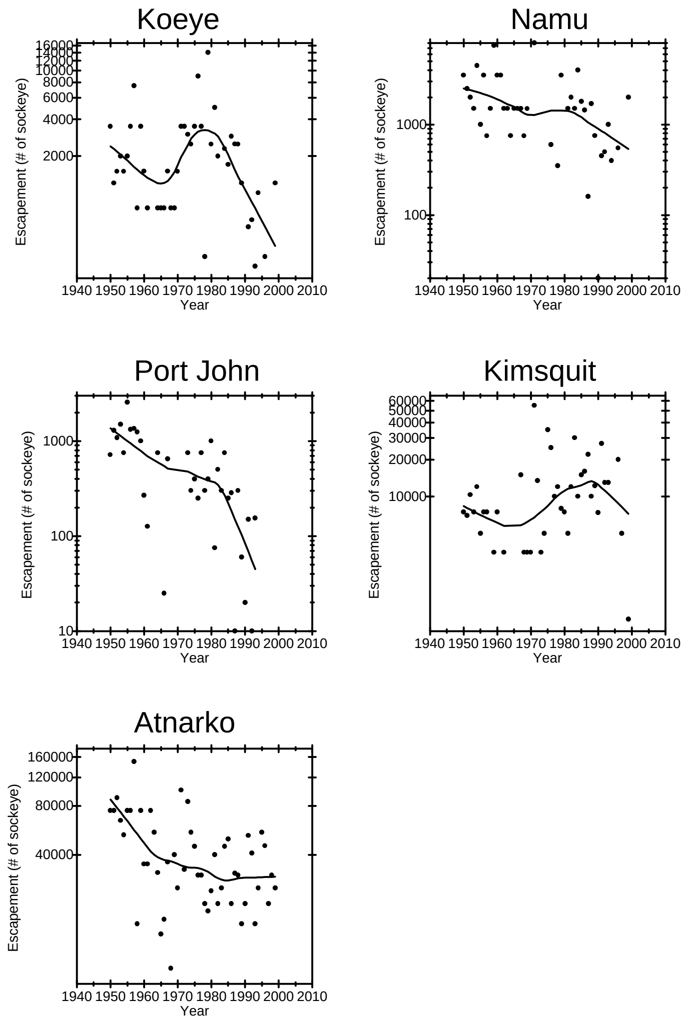


Figure 7. Trend in sockeye salmon escapements to lakes and rivers in Area 8. Lowess line fitted to data.

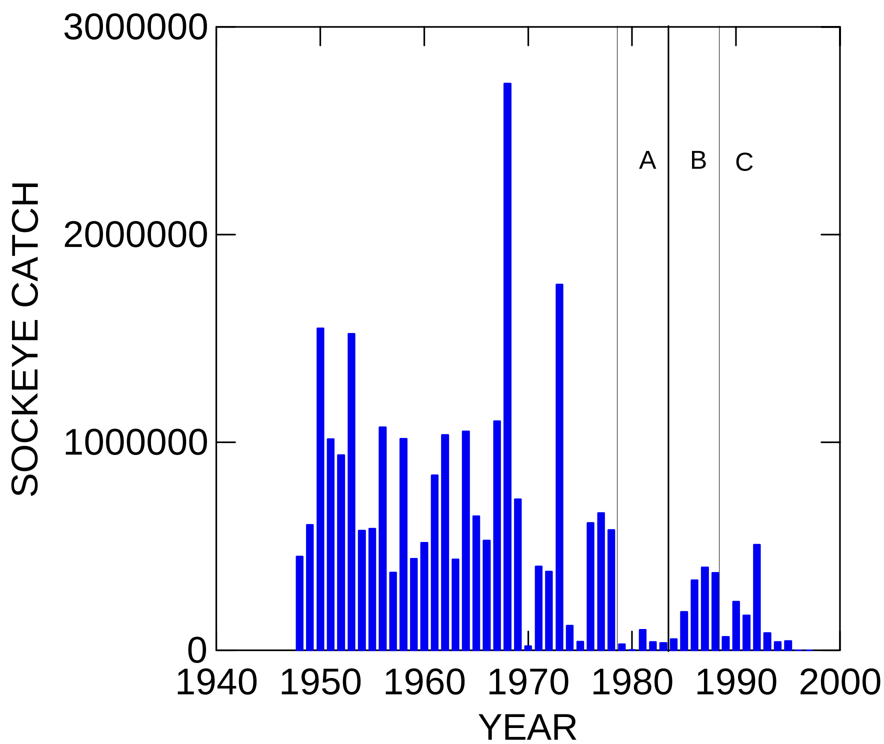


Figure 8. Trend in Area 9 commercial catch, 1948-2000. "A" indicates start of adaptive management plan (Walters et al. 1993), "B" indicates phase two of adaptive management plan, "C" indicates start of variable harvest rate plan (Goruk 1990).

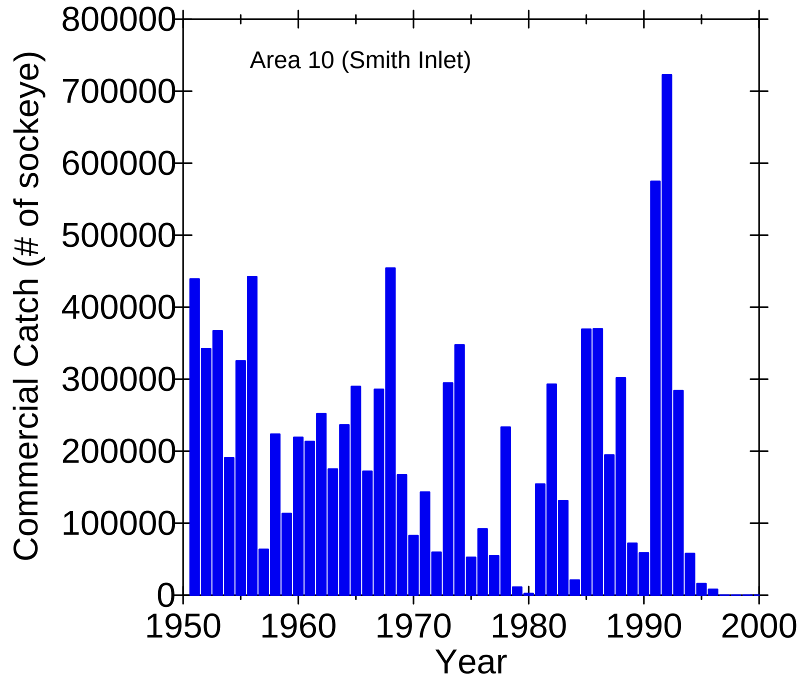


Figure 9. Trend in Area 10 commercial sockeye salmon catch, 1951-2000.

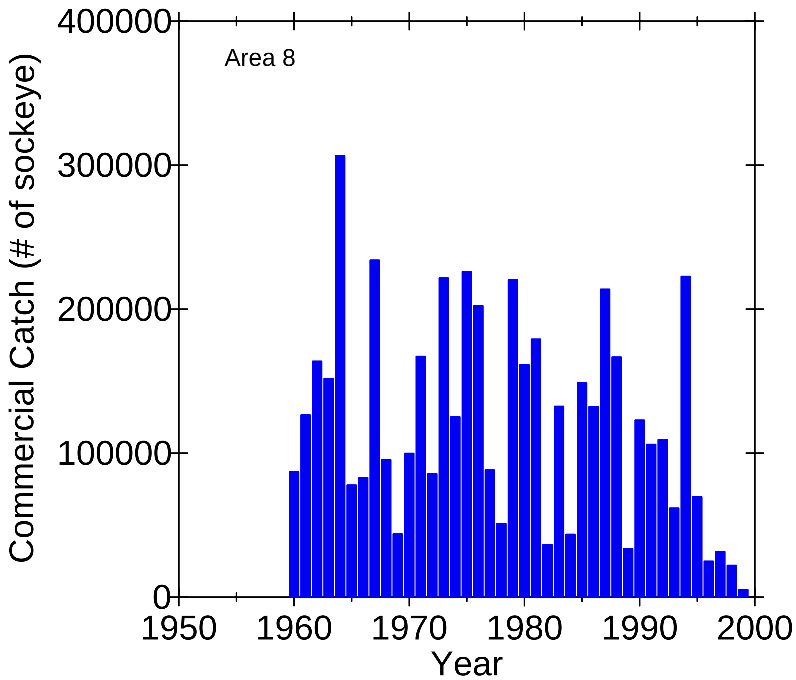


Figure 10. Trend in Area 8 commercial sockeye salmon catch, 1960-2000.

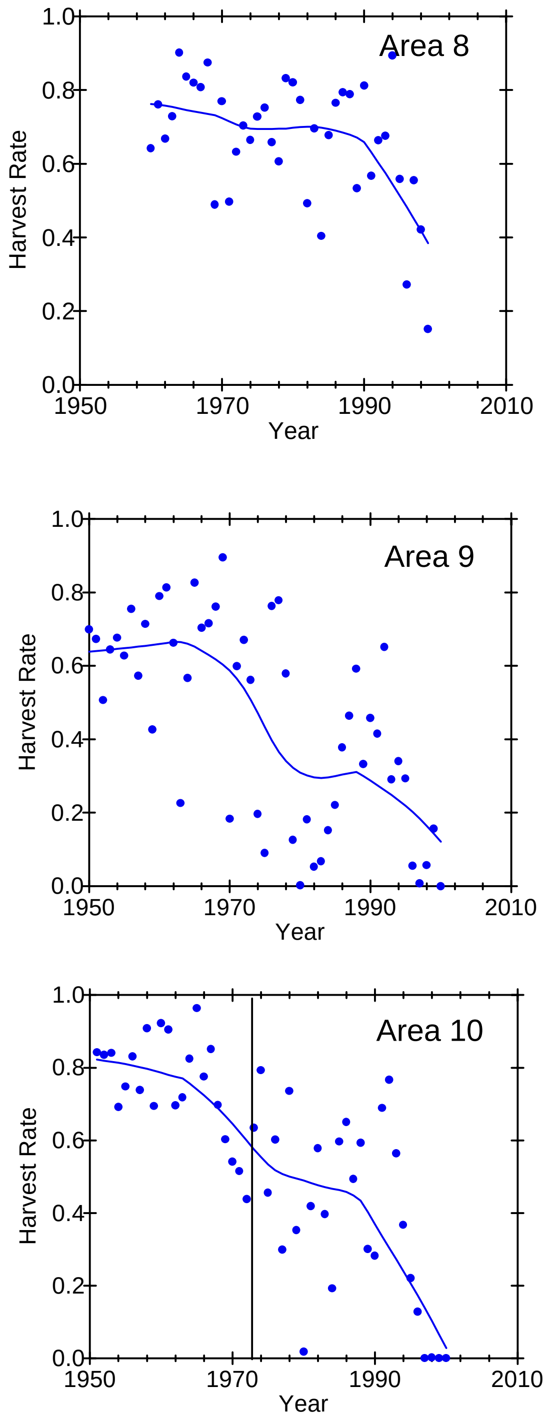


Figure 11. Trend in harvest rates of Area 8, 9, and 10 sockeye salmon. Horizontal line indicates start of Docee Fence counts.

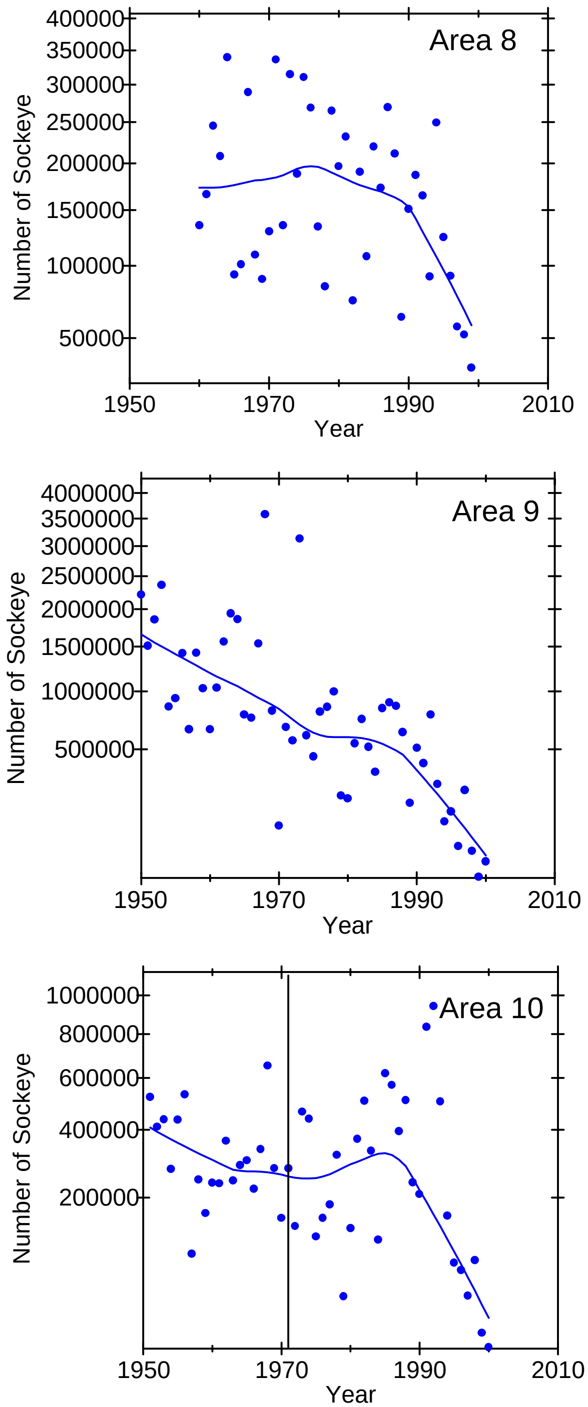


Figure 12. Trend in total stock size for Area 8, 9, and 10, sockeye salmon. Horizontal line indicates start of Docee Fence counts.

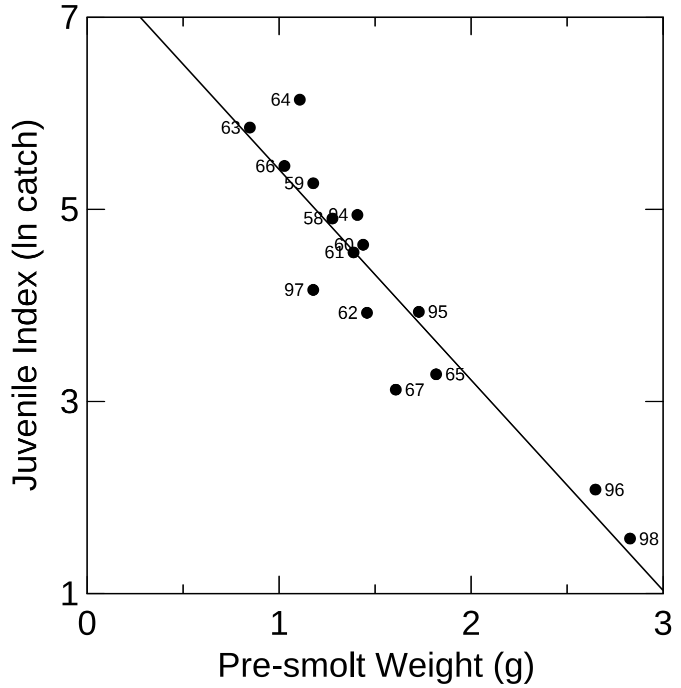


Figure 13. Juvenile abundance index (mean $\log_e$ catch) in summer trawls versus mean sockeye pre-smolt weight (g) for the corresponding brood year (indicated next to data points).

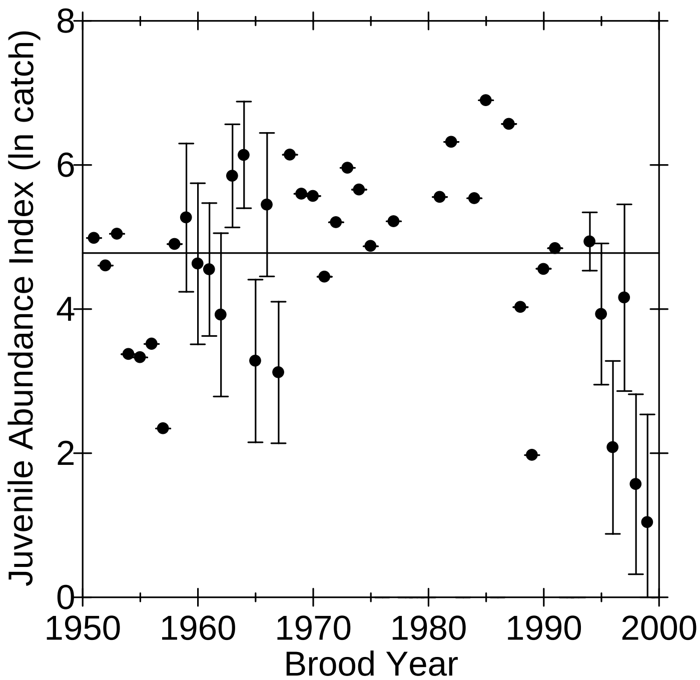
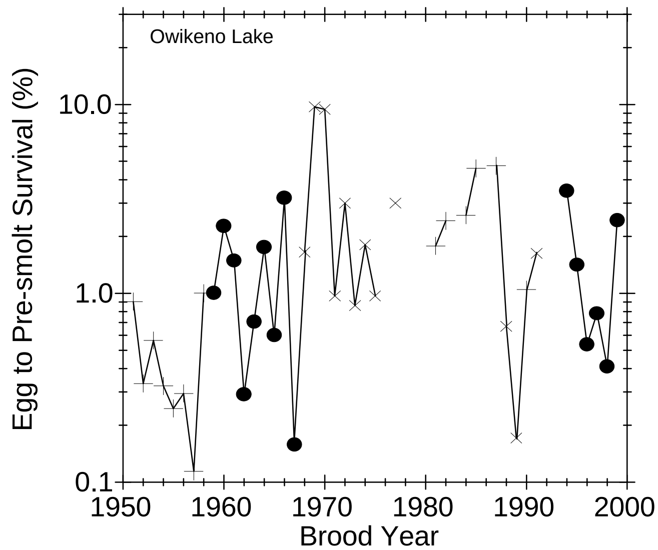


Figure 14. Variation in juvenile abundance index by year. Average index indicated by horizontal line. Circles with error bars indicate index measured directly, circles only indicate index inferred from either pre-smolt size or scale patterns.



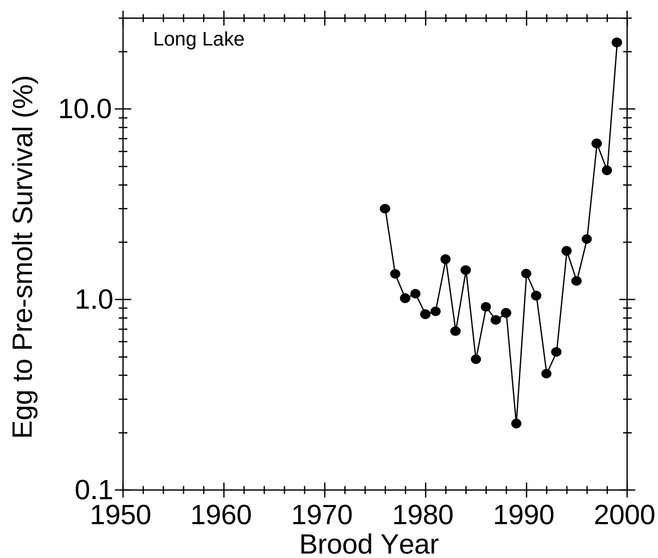
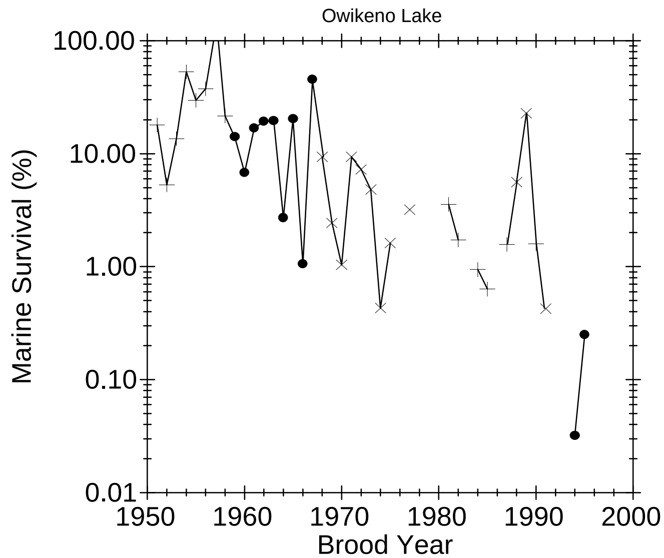


Figure 15. Freshwater survival trends for Owikeno and Long Lake sockeye salmon. For Owikeno Lake (+) indicates juvenile abundance inferred from scales, (.) trawl and, (x) pre-smolt weight.



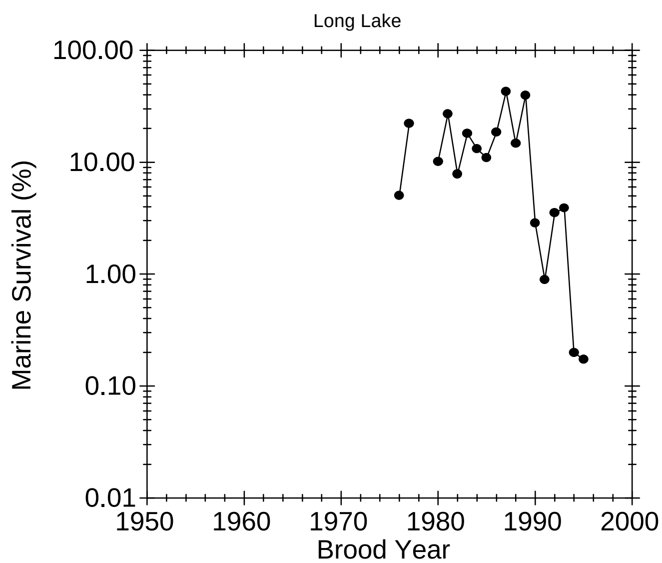


Figure 16. Marine survival trends for Owikeno and Long Lake sockeye salmon. For Owikeno Lake (+) indicates juvenile abundance inferred from scales, (.) trawl and, (x) pre-smolt weight.

Appendix 1a. Sockeye escapement 1950-1999, Area 10, from SEDS.

STREAM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	AVERAGE 1990-99
AREA 10											
BOSWELL CREEK	N/O	N/O	N/I	N/I	N/O						
CANOE CREEK	44,700	78,000	66,000	66,000	30,000	17,100	16,200	9,600	22,800	1,770	35,217
DOCEE RIVER	N/O	N/O	N/O							N/O	
NEKITE RIVER	10	N/O	N/O					N/O	N/O	N/O	10
NEKITE SPAWNING CHANNEL	10	N/O	N/O					N/O	N/O	N/O	10
SMOKEHOUSE CREEK	104,300	182,000	154,000	154,000	70,000	39,900	37,800	22,400	53,200	4,130	82,173
TAKUSH RIVER	N/O	N/O	N/O								
WALKUM CREEK	N/I	N/O	N/O					N/O	N/O		
AREA 10 TOTAL**	149,020	260,000	220,000	220,000	100,000	57,000	54,000	32,000	76,000	5,900	117,392

**ANNUAL ESCAPEMENT TOTALS ARE FROM DOCEE RIVER FENCE COUNTS AND MINOR STREAM ESCAPEMENTS.

Appendix 1a. Cont'd

STREAM	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	AVERAGE 1980-89
AREA 10											
BOSWELL CREEK					N/I		N/O			N/O	
CANOE CREEK	38,530	64,304	64,350	59,896	26,746	75,000	59,700	60,000	62,100	50,041	56,067
DOCEE RIVER											
NEKITE RIVER	N/O	N/O				2				5	4
NEKITE SPAWNING CHANNEL										N/O	
SMOKEHOUSE CREEK	89,905	150,041	150,150	139,757	62,408	175,000	139,300	140,000	144,900	116,763	130,822
TAKUSH RIVER										N/O	
WALKUM CREEK				1						1	1
AREA 10 TOTAL**	128,435	214,345	214,500	199,654	89,154	250,002	199,000	200,000	207,000	166,810	186,890

**ANNUAL ESCAPEMENT TOTALS ARE FROM DOCEE RIVER FENCE COUNTS AND MINOR STREAM ESCAPEMENTS.

Appendix 1a. Cont'd

STREAM	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	AVERAGE 1970-79
AREA 10											
BOSWELL CREEK											
CANOE CREEK	21,020	40,520	22,874	51,001	27,313	18,890	18,271	38,580	25,204	5,770	
DOCEE RIVER											
NEKITE RIVER										1,000	1,000
NEKITE SPAWNING CHANNEL											
SMOKEHOUSE CREEK	49,045	94,548	53,374	119,001	63,730	44,077	42,633	90,021	58,811	13,462	
TAKUSH RIVER											
WALKUM CREEK										25	25
AREA 10 TOTAL**	70,065	135,068	76,248	170,002	91,043	62,967	60,904	128,601	84,015	20,257	89,917

** 1) 1970 AND 1971 ESCAPEMENT TOTALS ARE FROM DOCEE RIVER TOWER COUNTS.

** 2) 1972 TO 1979 ESCAPEMENT TOTALS ARE FROM DOCEE RIVER FENCE COUNTS AND MINOR STREAM ESCAPEMENTS.

Appendix 1a. Cont'd

STREAM	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	AVERAGE 1960-69
AREA 10											
BOSWELL CREEK											
CANOE CREEK	3,500	7,500	35,000	20,606	15,000	3,500	15,000	15,000	59,379	35,000	20,949
DOCEE RIVER	25	25	75	N/I	200	N/O	N/O	N/O	N/I	200	105
NEKITE RIVER											
NEKITE SPAWNING CHANNEL											
SMOKEHOUSE CREEK	15,000	15,000	75,000	48,081	35,000	7,500	35,000	35,000	138,550	75,000	47,913
TAKUSH RIVER											
WALKUM CREEK											
AREA 10 TOTAL**	18,525	22,525	110,075	68,687	50,200	11,000	50,000	50,000	197,929	110,200	68,914

*1963 AND 1968 ESCAPEMENT TOTALS ARE FROM DOCEE RIVER TOWER COUNTS.

Appendix 1a. Cont'd

STREAM	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	AVERAGE 1950-59
AREA 10											
BOSWELL CREEK	N/R	N/R	N/R								
CANOE CREEK	15,000	22,500	25,000	35,000	50,000	35,000	15,000	7,500	7,500	15,000	22,750
DOCEE RIVER	N/R							75	75	75	75
NEKITE RIVER											
NEKITE SPAWNING CHANNEL											
SMOKEHOUSE CREEK	90,000	60,000	42,500	35,000	35,000	75,000	75,000	15,000	15,000	35,000	47,750
TAKUSH RIVER											
WALKUM CREEK											
AREA 10 TOTAL	105,000	82,500	67,500	70,000	85,000	110,000	90,000	22,575	22,575	50,075	70,523

Appendix 1b. Sockeye escapement 1950-1999, Area 9, from SEDS.

STREAM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	AVERAGE 1990-99
AREA 9											
ALLARD CREEK											
AMBACK CREEK	30,000	17,000	60,000	30,000	10,000	5,000	4,350	15,000	4,500	100	17,595
ASHLULM CREEK	13,000	12,000	25,000	12,000	500	10,000	650	8,500	1,650	25	8,333
BEAVER CREEK	10	N/O	5	N/O	N/O	N/I		UNK	10	UNK	8
CHUCKWALLA RIVER											
CLYAK, YOUNG & NEIL CREEKS											
DALLERY CREEK	10,000	10,000	15,000	8,000	2,000	1,000	250	4,400	450	130	5,123
DRANEY CREEK											
GENESEE CREEK	2,500		500	12,000	3,500	500	250	700	10	10	2,219
INZIANA RIVER	32,000	32,000	30,000	10,000	5,000	18,000	6,580	42,000	6,350	595	18,253
JOHNSTON CREEK	N/I										
KILBELLA RIVER											
LOCKHART-GORDON CREEK											
MACHMELL RIVER	20,000		5,000	5,000	5,000	2,500	3,000	N/I	UNK	UNK	6,750
MACNAIR CREEK											
MILTON RIVER											
NEECHANZ RIVER	25,000	20,000	30,000	20,000	8,000	10,000	10,645	20,000	10,000	200	15,385
NICKNAQUEET RIVER											
OATSOALIS CREEK				N/O							
OWIKENO LAKE SPAWNERS	5,000	3,000	2,500	4,000	2,000	500	100	UNK	550	100	1,972
SHEEMAHANT RIVER	300,000	100,000	50,000	80,000	20,000	10,000	16,000	83,000	14,000	970	67,397
TZEO RIVER	14,000	2,500	5,000	5,000	500	500	700	UNK	1,000	50	3,250
WANNOCK RIVER & FLATS	100,000	125,000	100,000	100,000	20,000	8,000	15,000	75,000	10,000	1,000	55,400
WASHWASH CREEK	35,000	25,000	20,000	25,000	15,000	7,000	7,475	27,500	3,500	420	16,590
OTHERS*	N/O	N/I	N/O	N/O	N/I	N/I	N/I				
AREA 9 TOTAL	586,510	346,500	343,005	311,000	91,500	73,000	65,000	276,100	52,020	3,600	214,824

NOTE: TRADITIONAL STREAM TARGETS ABOLISHED IN 1989. OWIKENO LAKE SYSTEM TARGET SET DEPENDANT UPON NEW MANAGEMENT PLAN.
*"OTHERS" INCLUDE HOGAN, NEWICHY AND TZEEISKAY STREAMS.

Appendix 1b. Cont'd

AREA 9 SOCKEYE ESCAPEMENT TABLE: 1980-1989.

STREAM	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	AVERAGE 1980-89
AREA 9											
ALLARD CREEK										N/O	
AMBACK CREEK	75,000	180,000	90,000	50,000	25,500	52,000	45,000	17,000	40,000	50,000	62,450
ASHLULM CREEK	5,000	25,000	15,000	35,000	7,000	28,700	47,500	32,000	25,000	12,000	23,220
BEAVER CREEK		75		1	N/O	185	125	N/O		N/O	97
CHUCKWALLA RIVER						6				N/O	6
CLYAK YOUNG NEIL						2				N/O	2
DALLERY CREEK	25,000	40,000	60,000	37,500	22,000	37,000	30,000	21,500	5,000	2,500	28,050
DRANEY CREEK						1	1			N/O	1
GENESEE CREEK	4,500	15,000	8,000	25,000	23,000	31,300	30,000	200	500	100	13,760
INZIANA RIVER	22,500	18,000	40,000	33,000	17,700	20,425	47,500	44,800	20,000	15,000	27,893
JOHNSTON CREEK						5				N/O	5
KILBELLA RIVER										N/O	
LOCKHART-GORDON CR.				1	1	4				N/O	2
MACHMELL RIVER	17,500	20,000	80,000	37,000	5,000	10,000	5,000	1,500	30,000	5,000	21,100
MACNAIR CREEK										N/O	
MILTON RIVER						2				N/O	2
NEECHANZ RIVER	32,500	40,000	50,000	50,000	11,000	35,800	53,000	37,000	53,000	18,000	38,030
NICKNAQUEET RIVER										N/O	
OATSOALIS CREEK										N/O	
OWIKENO LAKE SPWNS	25,000	10,000	15,000	10,000	1,100	20,000	2,500	2,500	5,000	6,075	9,718
SHEEMAHANT RIVER	61,000	200,000	150,000	125,000	25,000	135,000	325,000	100,000	200,000	125,000	144,600
TZEO RIVER	4,000	5,000	55,000	4,000	2,000	10,000	10,000	10,500	9,500	3,500	11,350
WANNOCK R & FL	27,500	150,000	150,000	200,000	45,000	20,000	200,000	200,000	80,000	125,000	119,750
WASHWASH CREEK	13,500	50,000	110,000	30,000	30,000	100,000	30,000	54,700	35,000	13,000	46,620
OTHERS											
AREA 9 TOTAL	313,000	753,075	823,000	636,502	214,301	500,430	825,626	521,700	503,000	375,175	546,581

NOTE: TRADITIONAL STREAM TARGETS ABOLISHED IN 1989. OWIKENO LAKE SYSTEM TARGET SET DEPENDANT UPON NEW MANAGEMENT PLAN.
*"OTHERS" INCLUDE HOGAN, NEWICHY AND TZEEISKAY STREAMS.

Appendix 1b. Cont'd

AREA 9 SOCKEYE ESCAPEMENT TABLE: 1970-1979.

STREAM	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	AVERAGE 1970-79
AREA 9											
ALLARD CREEK											
AMBACK CREEK	15,000	55,000	37,500	62,500	100,000	55,000	65,000	32,500	25,000	45,000	49,250
ASHLULM CREEK	750	1,300	1,500	27,500	9,000	4,500	4,000	3,000	22,500	8,000	8,205
BEAVER CREEK	N/O	N/O	N/O	N/O	25	N/O			UNK	UNK	25
CHUCKWALLA RIVER											
CLYAK, YOUNG & NEIL CREEKS											
DALLERY CREEK	15,000	20,000	9,000	22,500	22,500	45,000	12,000	18,000	15,000	15,000	19,400
DRANEY CREEK*										25	25
GENESEE CREEK	7,500	55,000	27,500	45,000	15,000	14,500	2,500	600	5,000	5,000	17,760
INZIANA RIVER	1,500	3,500	1,500	162,500	40,000	30,000	25,000	6,000	32,500	22,500	32,500
JOHNSTON CREEK						2					2
KILBELLA RIVER											
LOCKHART-GORDON CREEK											
MACHMELL RIVER	N/O	N/O	2,500	12,500	10,000	7,500	7,000	2,000	15,000	35,000	11,438
MACNAIR CREEK											
MILTON RIVER											
NEECHANZ RIVER	15,000	4,000	3,000	50,000	45,000	45,000	25,000	8,000	18,000	42,500	25,550
NICKNAQUEET RIVER							N/I				
OATSOALIS CREEK	N/R	N/R	N/R	N/R	N/R	N/R					
OWIKENO LAKE SPAWNERS	N/R	N/R	5,000	10,000	8,000	102,500	20,000	10,000	5,000	7,500	21,000
SHEEMAHANT RIVER**	7,500	6,000	30,000	250,000	137,500	35,000	20,000	27,500	150,000	65,000	72,850
TZEO RIVER	1,500	1,100	1,500	55,000	32,500	11,000	12,000	4,000	10,000	2,000	13,060
WANNOCK RIVER & FLATS	35,000	60,000	80,000	87,500	62,500	87,500	87,500	45,000	20,000	35,000	60,000
WASHWASH CREEK	3,500	10,000	22,500	200,000	75,000	42,500	20,000	35,000	65,000	15,000	48,850
AREA 9 TOTAL	102,250	215,900	221,500	985,000	557,025	480,002	300,000	191,600	383,000	297,525	373,380

* 1950-1977 ESCAPEMENT FOR DRANEY CREEK LISTED WITH LOCKHART-GORDON CREEK.

**SHEEMAHANT FLATS LISTED WITH SHEEMAHANT RIVER FROM 1950-71, AND WITH OWIKENO LAKE SPAWNERS FROM 1972 ONWARDS.

Appendix 1b. Cont'd

AREA 9 SOCKEYE ESCAPEMENT TABLE: 1960-1969.

STREAM	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	AVERAGE 1960-69
AREA 9											
ALLARD CREEK											
AMBACK CREEK	15,000	15,000	75,000	75,000	75,000	3,500	15,000	3,500	35,000	15,000	32,700
ASHLULM CREEK	400	3,500	3,500	20,000	3,500	75	1,500	750	35,000	750	6,898
BEAVER CREEK		750		3,500	400	75		N/O	N/O	N/O	1,181
CHUCKWALLA RIVER											
CLYAK, YOUNG & NEIL CREEKS											
DALLERY CREEK	35,000	35,000	27,500	125,000	100,000	15,000	15,000	3,500	15,000	7,500	37,850
DRANEY CREEK*											
GENESEE CREEK	3,500	3,500	35,000	55,000	15,000		15,000	15,000	35,000	15,000	21,333
INZIANA RIVER	3,500	7,500	35,000	175,000	75,000	15,000	7,500	1,500	100,000	1,500	42,150
JOHNSTON CREEK											
KILBELLA RIVER											
LOCKHART-GORDON CREEK											
MACHMELL RIVER	UNK	UNK	UNK	UNK	UNK	N/O	UNK	UNK	UNK	UNK	
MACNAIR CREEK											
MILTON RIVER											
NEECHANZ RIVER	7,500	7,500	15,000	35,000	15,000	7,500	15,000	7,500	35,000	3,500	14,850
NICKNAQUEET RIVER											
OATSOALIS CREEK	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	
OWIKENO LAKE SPAWNERS	N/O	200	1,500	1,500	15,000	N/O	3,500	15,000	35,000	3,500	9,400
SHEEMAHANT RIVER**	UNK	35,400	42,500	82,500	110,000	15,000	50,000	135,000	75,000	75,000	68,933
TZEO RIVER	400	3,500	3,500	35,000	15,000	1,500	7,500	3,500	15,000	750	8,565
WANNOCK RIVER & FLATS	UNK	35,000	100,000	200,000	75,000	75,000	35,000	125,000	75,000	100,000	91,111
WASHWASH CREEK	3,500	15,000	75,000	125,000	75,000	7,500	35,000	125,000	100,000	3,500	56,450
AREA 9 TOTAL	68,800	161,850	413,500	932,500	573,900	140,150	200,000	435,250	555,000	226,000	370,695

* 1950-1977 ESCAPEMENT FOR DRANEY CREEK LISTED WITH LOCKHART-GORDON CREEK.

**SHEEMAHANT FLATS LISTED WITH SHEEMAHANT RIVER FROM 1950-71, AND WITH OWIKENO LAKE SPAWNERS FROM 1972 ONWARDS.

Appendix 1b. Cont'd

AREA 9 SOCKEYE ESCAPEMENT TABLE: 1950-1959.

STREAM	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	AVERAGE 1950-59
AREA 9											
ALLARD CREEK											
AMBACK CREEK	76,000	37,500	75,000	35,000	7,500	7,500	15,000	35,000	35,000	75,000	39,850
ASHLULM CREEK	9,000	25,000	40,000	15,000	300	3,500	15,000	15,000	35,000	3,500	16,130
BEAVER CREEK											
CHUCKWALLA RIVER											
CLYAK, YOUNG & NEIL CREEKS											
DALLERY CREEK	67,500	45,000	100,000	75,000	65,000	100,000	75,000	35,000	15,000	100,000	67,750
DRANEY CREEK*											
GENESEE CREEK	10,500	4,500	15,000	15,000	1,000	3,500	3,500	400	3,500	3,500	6,040
INZIANA RIVER	37,500	35,000	50,000	75,000	25,000	3,500	15,000	7,500	7,500	75,000	33,100
JOHNSTON CREEK											
KILBELLA RIVER											
LOCKHART-GORDON CREEK											
MACHMELL RIVER	N/R	N/R	N/R	N/R	N/I	UNK	UNK	UNK	UNK	UNK	
MACNAIR CREEK											
MILTON RIVER											
NEECHANZ RIVER	11,000	15,000	45,000	7,500	2,000	3,500	7,500	7,500	7,500	7,500	11,400
NICKNAQUEET RIVER						N/R					
OATSOALIS CREEK	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	
OWIKENO LAKE SPAWNERS	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	75,000	3,500	39,250
SHEEMAHANT RIVER**	57,500	45,000	75,000	35,000	UNK	UNK	35,000	35,000	UNK	7,500	41,429
TZEO RIVER	15,000	7,500	7,500	UNK	2,500	400	15,000	7,500	7,500	15,000	8,656
WANNOCK RIVER & FLATS	75,000	35,000	75,000	75,000	UNK	3,500	35,000	35,000	75,750	75,000	53,806
WASHWASH CREEK	97,500	55,000	100,000	100,000	500	7,500	7,500	35,000	75,000	15,000	49,300
AREA 9 TOTAL	456,500	304,500	582,500	432,500	103,800	132,900	223,500	212,900	336,750	380,500	316,635

* 1950-1977 ESCAPEMENT FOR DRANEY CREEK LISTED WITH LOCKHART-GORDON CREEK.

**SHEEMAHANT FLATS LISTED WITH SHEEMAHANT RIVER FROM 1950-71, AND WITH OWIKENO LAKE SPAWNERS FROM 1972 ONWARDS.

Appendix 1c. Sub set of sockeye escapement data 1950-1999, from SEDS

STREAM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	AVERAGE 1990-99
HOOK NOSE CREEK	20	150	10	155		N/I		UNK	UNK		84
KOEYE RIVER	N/I	525	600	250	1,000	N/I	300	UNK	UNK	1,200	646
NAMU RIVER	20	450	500	1,000	400	N/I	550	N/I	N/I	2,000	703
KIMSQUIT RIVER	7,400	27,000	13,000	13,000		N/I	20,000	5,000	UNK	1,000	12,343
ATNARKO SPAWNING CHANNEL*	3	48	5	10	25			UNK	N/I	N/I	18
BELLA COOLA RIVER	20,000	52,500	41,000	15,000	25,000	55,000	45,000	20,000	30,000	25,000	32,850

Appendix 1c. Cont'd.

STREAM	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	AVERAGE 1980-89
HOOK NOSE CREEK	1,000	75	500	300	750	250	285	10	300	60	353
KOEYE RIVER	2,500	5,000	2,000	N/I	2,300	1,700	2,900	2,500	2,500	1,200	2,511
NAMU RIVER	N/O	1,500	2,000	1,500	4,000	1,800	1,450	160	1,700	750	1,651
KIMSQUIT RIVER	7,500	5,000	12,000	30,000	10,000	15,000	16,000	22,000	10,000	12,200	13,970
ATNARKO SPAWNING CHANNEL*							25	20	100	10	39
BELLA COOLA RIVER	24,000	40,000	20,000	25,000	45,000	50,000	19,975	30,780	30,000	15,000	29,976

Appendix 1c. Cont'd.

STREAM	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	AVERAGE 1970-79
HOOK NOSE CREEK	N/O	N/O	N/O	750	300	400	250	750	300	400	450
KOEYE RIVER	1,500	3,500	3,500	3,000	2,500	3,500	9,000	3,500	300	14,000	4,430
NAMU RIVER	N/I	8,000	N/I	N/O	N/O	N/I	600	N/I	350	3,500	3,113
KIMSQUIT RIVER	3,500	55,000	13,500	3,500	5,000	35,000	25,000	10,000	12,000	8,000	17,050
ATNARKO SPAWNING CHANNEL*											
BELLA COOLA RIVER	25,000	100,000	32,500	85,000	55,000	45,000	30,000	30,000	20,000	18,000	44,050

Appendix 1c. Cont'd.

STREAM	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	AVERAGE 1960-69
HOOK NOSE CREEK	268	126	N/O	N/O	750	N/O	25	650	N/O	N/O	364
KOEYE RIVER	1,500	750	N/O	N/O	750	750	750	1,500	750	750	938
NAMU RIVER	3,500	3,500	1,500	1,500	750	1,500	1,500	1,500	750	1,500	1,750
KIMSQUIT RIVER	7,500	N/O	3,500	N/O	N/O	N/O	UNK	15,000	3,500	3,500	6,600
ATNARKO SPAWNING CHANNEL*											
BELLA COOLA RIVER	35,000	35,000	75,000	55,000	31,000	13,000	16,000	36,000	8,000	40,000	34,400

Appendix 1c. Cont'd.

STREAM	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	AVERAGE 1950-59
HOOK NOSE CREEK	717	1,300	1,087	1,500	750	2,566	1,332	1,353	1,248	1,000	1,285
KOEYE RIVER	3,500	1,200	1,500	2,000	1,500	2,000	3,500	7,500	750	3,500	2,695
NAMU RIVER	3,500	2,500	2,000	1,500	4,500	1,000	3,500	750	1,500	7,500	2,825
KIMSQUIT RIVER	7,500	7,000	10,300	7,500	12,000	5,000	7,500	7,500	UNK	3,500	7,533
ATNARKO SPAWNING CHANNEL*											
BELLA COOLA RIVER	75,000	75,000	90,000	65,000	53,000	75,000	75,000	150,000	15,000	75,000	74,800

Appendix 2. Trawl catch of Owikeno Lake juvenile sockeye by depth and year.

	Proportion sockeye caught at				
Year	Surface	2-4m	5-7m	6-8m	10-12m
2000	0.982	.	0.018	.	.
1999	0.692	.	0.166	.	0.142
1998	0.990	0.010	.	.	.

Appendix 3. Annual coho salmon counts past the Docee Fence, 1998-2000.

		Proportion	
Year	Escapement	Age 1.1	Age 2.1
1998	6,500	0.60	0.40
1999	4,600	0.93	0.07
2000	9,700	0.76	0.24