

Response to Marine Stewardship Council

Indicators for Principle 1 - Stock Assessment and Stock Status

Pacific Wild Salmon Fishery

Barkley Sound Sockeye

Fisheries and Oceans Canada

Pacific Region

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Introduction

The BC Salmon Marketing Council (BCSMC) has applied for certification of the BC wild salmon fishery to the Marine Stewardship Council. In June 2003, accredited certifier Scientific Certification Systems Inc. published the evaluation team's units of certification, performance indicators and scoring guidelines which describe in detail how the fishery will be evaluated. SCS has defined a total of 47 indicators under the three Principles.

This document, prepared with the assistance of Fisheries and Oceans Canada, is the BCSMC's technical submission on the indicators for Barkley Sound sockeye for all three principles. Principle 1 examines the stock assessment procedures and examines whether the procedures in place are adequate to ensure that the fishery is sustainable.

The Scoring Guideposts as identified by MSC have been colour coded to indicate the level of agreement with the statements.

Green - The requirements of the guidepost have been met.

Red - The requirements of the guidepost have not been met.

Orange - The requirements of the guidepost have partially been met.

Black - The requirements of the guidepost are not applicable to the Barkley Sound sockeye fishery

An overview of the management of the Barkley Sound sockeye fishery is provided in Appendix A of this document.

Indicator 1.1.1.1

The stock units are well defined for the purposes of conservation, fisheries management and stock assessment.

DFO Response

Current Situation

There are three stocks contributing to the Barkley Sound sockeye fishery: Great Central, Sproat and Henderson Lakes (Figure 1).

The stocks are defined geographically, according to their lake of origin.

While the stocks are genetically distinct, there is no indication of further population sub-structure within the lakes.¹ Genetic samples of different spawning locations within the lakes were statistically indistinguishable (Figure 2). The migration timing of Great Central and Sproat Lake stocks is quite protracted but spawning occurs over a limited period from October

¹ Analysis results from DNA marker sampling will be reviewed in the Barkley Sound sockeye stock assessment paper scheduled for May, 2004 PSARC meetings.

to December. For the Henderson Lake stock, the run timing is relatively contracted and spawning locations are also limited.

Conservation

From a conservation point of view, the stock units are reasonable. There is biological information to distinguish the stocks, but no evidence of population sub-structure to warrant further division².

Fisheries Management & Stock Assessment

Both in-season and post-season, the status of each stock is assessed independently and forecasts also predict return by stock. The fisheries are managed to ensure the persistence of each stock.

Sockeye from Great Central and Sproat Lakes originate from the Somass River watershed and are managed under the Somass sockeye management plan. They migrate with similar timing through the same fisheries.³ Escapement targets and allowable harvest rates are combined for both stocks. These targets are subject to modification if the pre-season forecast or in-season stock assessment data suggests one of the stocks has declined significantly relative to the other. However, this method has been worked reasonably well because stock abundance and abundance trends for both populations are correlated (Figure 3).

The Henderson Lake sockeye population is much less productive and fisheries are managed to avoid these fish.⁴ Sockeye from Henderson Lake tend to be larger and older relative to the Somass stocks. Their peak migration occurs later than the Somass stocks and they are not as vulnerable to fisheries occurring 'inside' Alberni Inlet because they migrate to Henderson Lake through Uchukleshat Inlet. Henderson Lake sockeye are genetically distinct from Somass sockeye and fisheries potentially harvesting Henderson sockeye are sampled to determine presence of Henderson fish through DNA analysis.

² Analysis results from DNA marker sampling will be reviewed in the Barkley Sound sockeye stock assessment paper scheduled for May, 2004 PSARC meetings.

³ See page 21 in Steer, G.J. and K.D. Hyatt. 1987. Use of a Run Timing Model to Provide In-Season Estimates of Sockeye Salmon (*Oncorhynchus nerka*) Returns to Barkley Sound, 1985. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1557. 39p.

⁴ K.Hyatt and L. Gordon, personal communication. Stock data summary and status assessment of Henderson Lake sockeye is currently in progress: K. Hyatt, D.P. Rankin, P.J. Tschaplinski, I. Miki, 2003 in prep. PSARC Working Document S2003-08: Assembly of standardized estimates of juvenile and adult sockeye salmon (*Oncorhynchus nerka*) abundance associated with the 1976-2001 brood years in Henderson Lake and Clemens Creek, British Columbia.

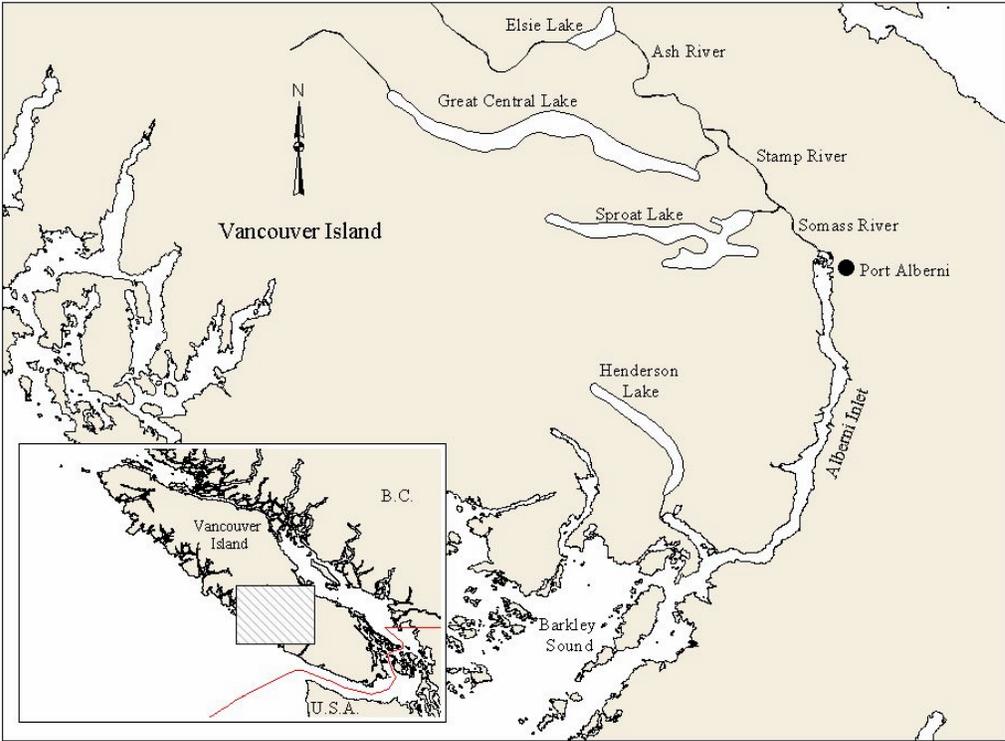


Figure 1. Barkley Sound / Alberni Inlet and Somass River system. Sockeye producing lakes include Henderson Lake located off outer Uchuckleshat Inlet as well as Sproat and Great Central lakes located in the Somass watershed at the head of the Alberni Inlet.

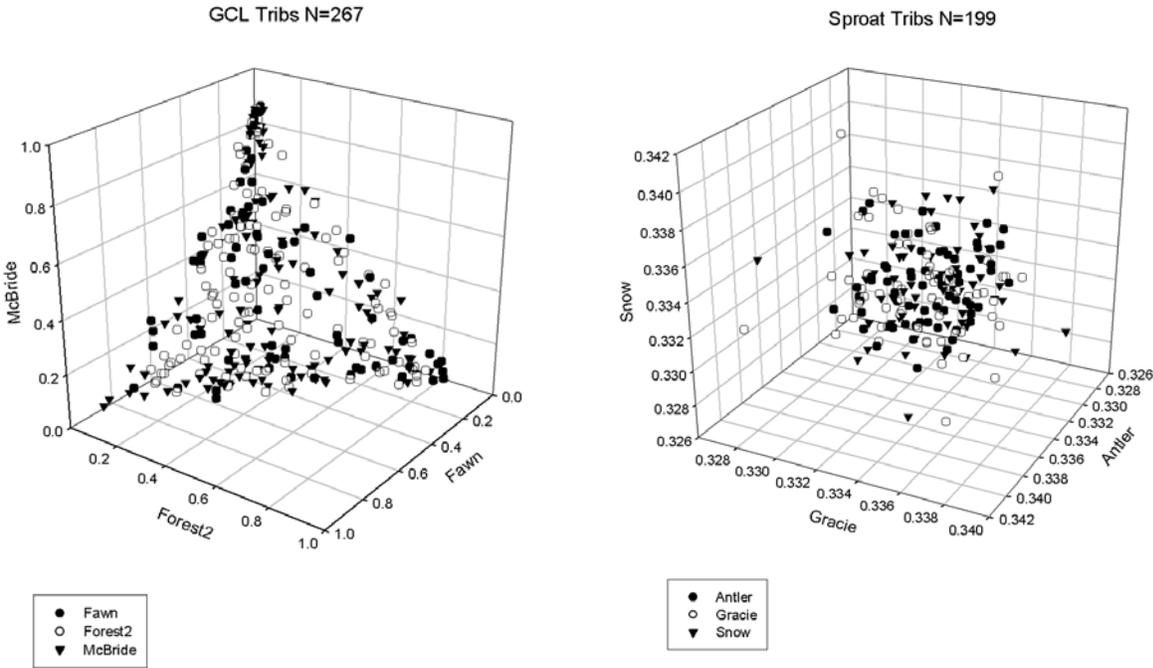


Figure 2. Scatter plots of genetic correlation of samples within lake systems.

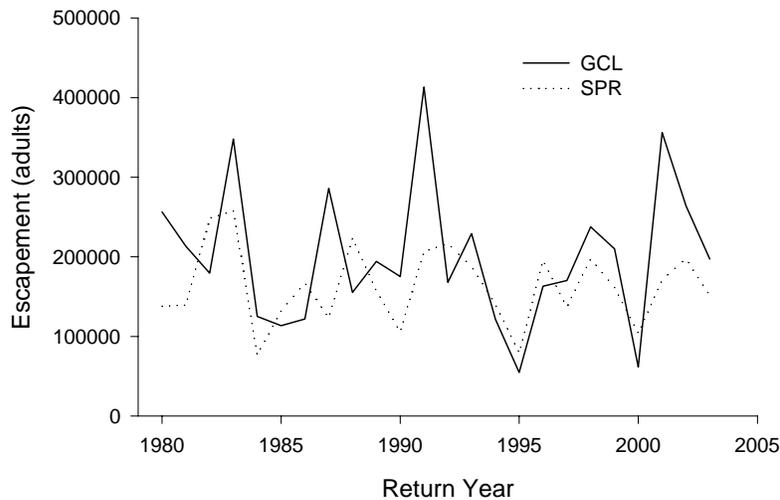


Figure 3. Escapement to Great Central and Sproat Lakes, 1980-2003.

Scoring Summary

Both 60 Scoring Guideposts have been met.

Both 80 Scoring Guideposts have been met.

Both 100 Scoring Guideposts have been met.

Future Changes

A Wild Salmon Policy is under development. This Policy will describe the future framework for identifying conservation units for all species of salmon that will be used for both assessment and management purposes. A draft policy paper was publicly released in 2000 that outlined many elements of this new approach and this is presently being reviewed and revised while operational guidelines are developed. The operational guidelines will be the subject of consultation in 2004. Work is underway under the auspices of the Wild Salmon Policy to establish benchmark reference points for all Barkley Sound sockeye stocks.

100 Scoring Guidepost

- There is an unambiguous description of each stock unit, including: its geographic location, run timing, details on all the component stocks, and rationale for its definition.
- The rationale for each stock unit is clear with regard to conservation, fisheries management and stock assessment requirements.

80 Scoring Guidepost

- The stock units are well defined and include details on the major component stocks.

- The rationale for each stock unit for the target species is clear with regard to conservation, fisheries management and stock assessment requirements.

60 Scoring Guidepost

- The majority of stock units are defined.
- The rationale for the majority of stock units for the target species is clear with regard to conservation, fisheries management and stock assessments.

Indicator 1.1.1.2

There is general scientific agreement that the stock units are appropriate.

DFO Response

Current Situation

Stock units are described in Indicator 1.1.1.1.

While the appropriateness of the stock units has not been specifically reviewed by PSARC, there has never been any disagreement about the units when stock status reports are presented. The stock status of Somass sockeye populations are reviewed annually⁵. The status of Henderson Lake sockeye was assessed in 2003⁶.

PSARC documents for Barkley Sound sockeye are available at:

http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2002/RES2002_116e.pdf

The status of non-target stocks (Somass chinook⁷ and coho⁸ populations) are reviewed through the PSARC process. It appears the stock units are generally agreed upon as reasonable as this issue has not been raised.

The management of local steelhead populations falls under the jurisdiction of the BC provincial Ministry for Sustainable Resource Management.

⁵ For example, see and similar papers: Hyatt, K., Luedke, W., Rankin, P., Till, J. and D. Lewis. 2003. Review of the year 2002 return of Barkley Sound sockeye salmon and forecasts for 2003. PSARC Working Paper S2003-06.

⁶ Hyatt, K., D.P. Rankin, P.J. Tschaplinski, I. Miki. 2003. Assembly of standardized estimates of juvenile and adult sockeye salmon (*Oncorhynchus nerka*) abundance associated with the 1976-2001 brood years in Henderson Lake and Clemens Creek, British Columbia, PSARC Working Paper S2003-08.

⁷ Tompkins, A W. Luedke, J. Till, S. Taylor, D. Lewis. 2003. Review of 2002 chinook returns to the west coast Vancouver Island, forecast of the 2003 returns to the Stamp River/ Robertson Creek hatchery indicator stock, and outlook for other WCVI chinook stocks. PSARC Working Paper S2003-13.

⁸ Simpson, K., D. Dobson, J. R. Irvine, L. B. Holtby and R. W. Tanasichuk. 2001. Forecast for southern British Columbia coho salmon in 2001. PSARC Working paper S2001-04. 49 p.

Scoring Summary

The 60 Scoring Guidepost has been met.

The 80 Scoring Guideposts have been met.

The three 100 Scoring Guideposts have been met.

100 Scoring Guidepost

- The stock units for target species have been reviewed and found to be scientifically defensible and appropriate by the Pacific Scientific Advice Review Committee or the appropriate Pacific Salmon Commission technical committee.
- There is general agreement among regional fisheries scientists outside the management agency that the stock units are appropriate.
- There is general scientific agreement regarding the stock units for non-target species.

80 Scoring Guidepost

- There is general agreement among regional fisheries scientist within the management agency that the stock units are appropriate for target species.
- There is no significant scientific disagreement regarding the stock units used by the management agency to formulate management decision for the fishery.

60 Scoring Guidepost

- There is general agreement among regional fisheries scientist within the management agency that the majority of stock units are appropriate for target species.

Indicator 1.1.1.3

The geographic range for harvest of each stock unit in the fishery is known.

DFO Response

Current Situation

Barkley sockeye are harvested within a relatively localised area restricted to Barkley Sound and Alberni Inlet⁹. It assumed these terminal fisheries account for all or a significant portion

⁹ Total catch estimates are reviewed annually by PSARC, which are available at <http://sci.info.pac.dfo.ca/PSARC/resdocs/03-diad-wp.htm>. See, for example: K. Hyatt, W. Luedke, P. Rankin, J. Till and D. Lewis. 2003. Review of the year 2002 return of Barkley Sound Sockeye Salmon and Forecasts for 2003. PSARC Working Paper S2003-06.

of the total exploitation of these populations. However, as the fish are not marked there are no data regarding high seas interceptions.

To avoid gear conflicts, gear types are restricted to specific catch areas. The catch, by gear and area, is estimated each week during the fishing season¹⁰.

Stock composition of the catch is estimated either through DNA analysis (in-season) or by a 'boxcar' model (ie, backing up escapement by stock into the fisheries according to an assumed migration time).¹¹ This information is used to tune fisheries as necessary. For example, Henderson Lake sockeye are vulnerable to fisheries occurring 'outside' Alberni Inlet. These fishing areas are closed by mid-July, before Henderson sockeye begin migrating through the area.

. See also: Steer, G. J., N. B. F. Cousens, H. Stiff and K. D. Hyatt. 1986. An analysis of gear selectivity and sources of bias in estimates of age and stock composition of the 1980-1984 Barkley Sound sockeye salmon (*Oncorhynchus nerka*) catch. Can. Tech. Rep. Fish. Aquat. Sci. No 1445. 77 p.

¹⁰ Hyatt, K. D. and G. J. Steer. 1987. Barkley Sound sockeye salmon (*Oncorhynchus nerka*): Evidence for over a century of successful stock development, fisheries management, research, and enhancement efforts. Can. Spec. Publ. Fish. Aquat. Sci. 96: 435-457.

¹¹ A thorough review of Barkley Sound sockeye stock status, assessment methods and fishery management is in preparation for May, 2004 PSARC review.

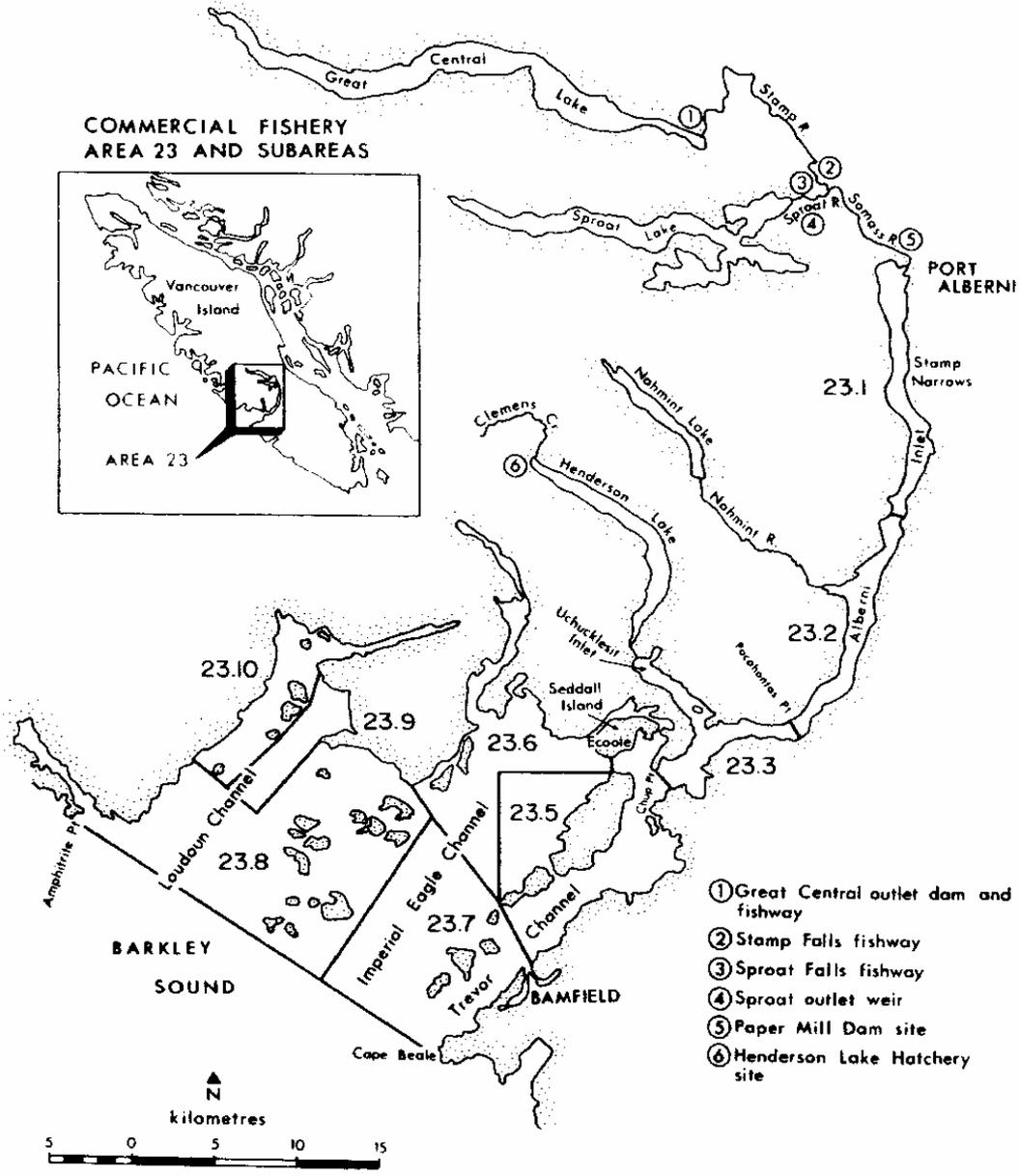


Figure 4. Location of Barkley Sound and Statistical Area 23 on the west coast of Vancouver Island. The ten statistical subareas in which openings and closures are used to control fisheries for sockeye are labelled 23.1 - 23.10.

Scoring Summary

If the assumption that Barkley sockeye are not harvested at high rates in high seas fisheries is accepted, then the information presented establishes that the geographic range of Barkley Sound sockeye salmon harvest is known.

All 60, 80 and 100 Scoring Guideposts have been achieved.

100 Scoring Guidepost

- The geographic range for harvests of each stock unit in the fishery is estimated and documented each year.
- The information on the geographic range of harvests is monitored during the fishing season and used when making in-season management decisions.

80 Scoring Guidepost

- The geographic range for harvests of target stocks is defined.
- The information on the geographic range of the harvests of target stocks is monitored during the fishing season and is sufficient to prevent the over harvesting of these stocks.
- The information available on the geographic range for harvest of non-target stocks is sufficient to prevent the over-harvesting of these stocks.

60 Scoring Guidepost

- The information available on the geographic range for harvests of target or non-target stocks is sufficient to prevent the over-harvesting for the majority of the stocks within each stock unit.

Indicator 1.1.1.4

Where indicator stocks are used as the primary source of information for making management decisions on a larger group of stocks in a region, the status of the indicator stocks reflects the status of other stocks within the management unit.

DFO Response

Current Situation

Indicator 1.1.1.4 is not relevant to the management of Barkley Sound sockeye.

All target stocks are assessed and reviewed.

Scoring Summary

The 60, 80 and 100 Scoring Guidelines are not applicable.

100 Scoring Guidepost

- The status of the indicator stocks is well correlated with the stocks that are most at risk from a conservation point of view, not just correlated with the most productive stocks in the region.

- The indicator stocks used have been reviewed and found to be scientifically defensible and appropriate by the Pacific Scientific Advice Review Committee or the appropriate Pacific Salmon Commission technical committee.
- There is general agreement among regional fisheries scientists outside the management agency that the indicator stocks are appropriate.
- The relationships between indicator stocks and stocks of interest are assessed every three to five years.

80 Scoring Guidepost

- There is general agreement among regional fisheries scientists within the management agency that the status of indicator stocks reflects the status of other stocks within the management unit.
- There is no significant scientific disagreement regarding the indicator stocks used by the management agency to formulate management decisions for the fishery.

60 Scoring Guidepost

- There is a scientific basis for the indicator stocks used in the management of the fishery.

Indicator 1.1.1.5

Where stock units are composed of significant numbers of fish from enhancement activities, the management system provides for identification of the enhanced fish and their harvest without adversely impacting the diversity, ecological function or viability of unenhanced stocks.

DFO Response

Current Situation

The 100 guideposts are not directly applicable to this fishery since there is no enhancement of this stock. There is fertilization of Great Central Lake to increase the productivity of the Lake, but no enhancement activity of the actual fish stock.

The target stocks from Great Central and Sproat Lakes are not directly enhanced through hatchery releases.

The productivity of Great Central Lake is augmented through annual lake fertilisation. Sproat Lake is naturally more productive than Great Central Lake so the lake fertilisation reduces productivity differences between the lakes. By lessening productivity differences between the lakes, the mixed stock fishery is more easily managed¹².

¹² Stockner, J.G. 1987. Lake fertilization: the enrichment cycle and lake sockeye salmon (*Oncorhynchus nerka*) production, p. 198-215. In H.D. Smith, L. Margolis, and C.C. Wood [ed.] Sockeye salmon (*Oncorhynchus nerka*) population biology and future management. Can. Spec. Publ. Fish. Aquat. Sci. 96.

Henderson Lake, on the other hand, is very unproductive and forestry-induced damage to and loss of habitat has reduced stock size.¹³ There is a sockeye hatchery that releases approximately 200,000 fry per year into the lake. In past years, the lake was enhanced through fertilisation. Neither enhanced nor un-enhanced Henderson sockeye are targeted in fisheries due to the overall low abundance of the population. However, in recent years hatchery fish have been strontium marked in order to potentially estimate interception rates in the fishery should the abundance of Henderson Lake sockeye increase.

Scoring Summary

The 60, 80 and 100 Scoring Guidelines are not applicable.

100 Scoring Guidepost

- Fisheries targeting enhanced stocks are geographically removed from unenhanced stocks and separate terminal harvest areas are established for these fisheries.
- Times and areas have been identified where the majority of enhanced fish migrate through the general fishery.
- There is real time mark recovery program during the prosecution of the fishery that allows determination of harvest rates of the enhanced component of the run and this data is used in regulation of the fishery.

80 Scoring Guidepost

- In fisheries where both enhanced and unenhanced stocks are harvested at the same time, the harvest guidelines are based on the goals and objectives established for the un-enhanced stocks.
- There are adequate data and analyses to determine that the presence of enhanced fish in the management units do not adversely impact the unenhanced fish stocks.

60 Scoring Guidepost

- There is general scientific agreement within the management agency regarding the impacts of enhanced fish on the resultant harvest rates or escapements of un-enhanced fish stocks.
- Managers have some scientific basis for assuring that harvest rates for enhanced stocks are not adversely affecting the majority of un-enhanced stocks within each stock unit.

¹³ Hyatt, K., D.P. Rankin, P.J. Tschaplinski, I. Miki. 2003. Assembly of standardized estimates of juvenile and adult sockeye salmon (*Oncorhynchus nerka*) abundance associated with the 1976-2001 brood years in Henderson Lake and Clemens Creek, British Columbia, PSARC Working Paper S2003-08.

Indicator 1.1.2.1

Estimates exist of the removals for each stock unit.

DFO Response**Current Situation**

Estimates of catch in all First Nation, sport, commercial and test fisheries are made daily.

Commercial catch and by-catch estimates are gathered through hail-ins, boat counts, and landing slips and verified by observers.

The sport fishery is monitored by the creel survey and catch is estimated by boat counts and catch-per-unit-effort data gathered through landing interviews.

First nation catch is estimated through either direct reporting, as in the commercial fishery, or observer counts.

The presence of Henderson Lake sockeye in the catch is determined through DNA analysis of catch samples from fisheries.¹⁴ Henderson Lake sockeye are not caught in the Inlet fisheries, but are vulnerable to fisheries occurring 'outside' the Inlet in the path of their migration. DNA sampling to date has shown no evidence of Henderson fish in Inlet fisheries.¹⁵

Catch of non-target species in this fishery is fairly limited (Table 1). Fisheries and Oceans Canada has studied release mortality rates of bycatch of non-target species for all gear types for majority of species.¹⁶ The rates are applied to estimate total mortality of released by-catch in the fishery. Where empirical studies are not available, professional judgement is used to estimate mortality rates.

Table 1. Reported and Observed Releases During the Somass Sockeye Commercial Fisheries, 1998-2002.

<i>Species</i>	<i>SALMON GILL NET</i>				<i>SALMON SEINE</i>	
	<i>1998</i>	<i>1999</i>	<i>2000</i>	<i>2001</i>	<i>2002</i>	<i>2002</i>
ALBATROSSES				12		
AMERICAN SHAD					3	106
ANCHOVIES					2	

¹⁴ A full review of these and other Barkley sockeye assessment methods is in preparation for May, 2004 PSARC meetings.

¹⁵ This subject will be reviewed in PSARC papers currently in progress regarding Henderson Lake sockeye. For more information, contact Dr. Kim Hyatt, DFO Pacific Biological Station, Salmon Assessment Section.

¹⁶ Mortality Rates: http://www-comm.pac.dfo-mpo.gc.ca/pages/selective/pdfs/prmsreport_e.pdf

<i>Species</i>	<i>SALMON GILL NET</i>				<i>SALMON SEINE</i>	
	<i>1998</i>	<i>1999</i>	<i>2000</i>	<i>2001</i>	<i>2002</i>	<i>2002</i>
ATLANTIC SALMON					5	
BASKING SHARK					1	
BLACK ROCKFISH					1	
CHINOOK SALMON	6	16	20	27	24	48
CHUB MACKEREL				20	27	
CHUM SALMON					13	
CODFISHES				1		
COHO SALMON	30	36	21	194	83	17
COPPER ROCKFISH					1	
DOGFISH SHARKS				3		
DOLLY VARDEN					1	
EARED SEALS & WALRUSES						1
FLATFISHES					2	
HERRINGS					30	
JACK MACKEREL				30	6	
LINGCOD					4	
MACKERELS AND TUNAS			8			15
NORTHERN ANCHOVY				1	5	
PACIFIC HAKE					10	3
PACIFIC HERRING				1	20	
PACIFIC OCEAN PERCH					9	100
PACIFIC SARDINE			5	1452	1013	70
PINK SALMON						2
RAINBOW TROUT (aka Steel-head)	163	246	116	225	342	230
ROCKFISHES				3	4	

<i>Species</i>	<i>SALMON GILL NET</i>				<i>SALMON SEINE</i>	
	<i>1998</i>	<i>1999</i>	<i>2000</i>	<i>2001</i>	<i>2002</i>	<i>2002</i>
SALMONIDS						1
SOCKEYE SALMON			2	4	2	
SPINY DOGFISH			17	100	1164	1
SQUIDS					2	
STURGEONS			1		3	
SURFPERCHES					2	
UNKNOWN BIRD						
UNKNOWN FISH			3		505	
WHITE SEABASS					1	
Grand Total	199	298	193	2073	3285	594

Scoring Summary

The information presented establishes that estimates exist of the removals for each stock unit.

Two of the 100 Scoring Guideposts have been met.

All of the Scoring Guideposts for the 60, 80 levels have been met.

Future Changes

Work is ongoing to improve methods to detect the presence of Henderson sockeye in the catch. For example, sockeye fry released from the Henderson Lake hatchery have been strontium marked in recent years.¹⁷

100 Scoring Guidepost

- Catch estimates are available for all fisheries in Canadian waters that harvest the target and non-target stocks harvested in the fishery being evaluated.
- Mortality rates are available for the fish released or discarded during the fishery.
- Catch estimates are available for fisheries outside Canadian waters that harvest the stocks that are the target of the fishery being evaluated.

¹⁷ pers. comm., Mel Sheng, DFO Habitat Biologist.

80 Scoring Guidepost

- Catch estimates are available for all target stocks harvested in the fishery.
- Catch estimates are available for non-target stocks where the catch of the non-target stock may represent a significant component of the harvest of that stock.
- Mechanisms exist to ensure accurate catch reporting and these mechanisms are evaluated at least once every 5 years.

60 Scoring Guidepost

- Catch estimates for the majority of target stocks are available.
- Catch estimates are available for non-target stocks where the catch of the non-target stocks may represent a significant component of that stock.
- Mechanisms exist to ensure accurate catch reporting and these mechanisms are evaluated at least once every 10 years.

Indicator 1.1.2.2

Estimates exist of the spawning escapement for each stock unit.

DFO Response

Current Situation

Escapement estimates are made in-season at counters installed at the Sproat Lake and Great Central Lake fishways and at the fence installed on Clemens Creek, the outlet of Henderson Lake.¹⁸

For Henderson Lake, independent escapement estimates are also made from stream walks during spawning periods later in the season.

Annual estimates of sockeye spawning escapement and returns by stock for the past 26 years are maintained in an Access database and available from Jeff Till, DFO South Coast.

Smolt abundance estimates for Great Central and Sproat lakes are made annually from lake surveys¹⁹. Smolt estimates have periodically been made for Henderson Lake sockeye. These are available from Paul Rankin, DFO Pacific Biological Station, Salmon Assessment Section.

¹⁸ Information on specific methodology regarding counters on the Somass system is available from Jeff Till, DFO South Coast, who is responsible for maintaining the counters and the Access database, 'Somaprog', which houses the data.

¹⁹ Hyatt, K.D.; D. Rutherford, T. Gjernes, P. Rankin, and T. Cone. 1984. Lake Enrichment Program: juvenile sockeye unit survey guidelines. Canadian manuscript report of fisheries and aquatic sciences; 1796, 84p

Escapement estimates are made of non-target stocks that may be caught in the fishery, such as Somass coho or chinook. Stamp River fish are counted electronically at the Stamp Falls fishery. For other stocks, observations of spawners made visually, through either stream walks or swims, are expanded through area-under-the-curve (AUC) analysis to estimate total escapement.²⁰

Scoring Summary

The information establishes that there are estimates of the spawning escapement for each stock unit.

Both of the 60 Scoring Guideposts have been met.

All of the 80 Scoring Guideposts has been met.

Both of the 100 Scoring Guideposts have been met.

100 Scoring Guidepost

- Estimates are available for the annual escapement for each stock unit harvested in the fishery.
- In-season escapement data are collected for all stock units and used to regulate the fishery.

80 Scoring Guidepost

- Estimates are available for the annual escapement of each target stock harvested in the fishery.
- Fishery independent indicators of abundance are available for the non-target species harvested in the fishery.
- In-season escapement data are collected for the target stocks and used to regulate the fishery.

60 Scoring Guidepost

- Escapement estimates for target stocks are available, where escapement estimates are necessary to protect the target stock from overexploitation.
- Fishery independent indicators of abundance are available for non-target stocks where the fishery harvests may represent a significant component of the harvest of that stock.

²⁰ Full details on West Coast Vancouver Island salmon enumeration programs are available from Seaton Taylor, DFO South Coast.

Indicator 1.1.2.3

The age and size of catch and escapement have been considered, especially for the target stocks.

DFO Response

Current Situation

For the two target stocks, Great Central Lake and Sproat Lake sockeye, weekly or biweekly samples of catch and escapement are processed to determine age composition, sex and size composition of the run.

Age composition is determined through real-time scale analysis conducted during the fishing season.

For escapement, age and sex composition of the run as well as average length by age are estimated.

The test fishery samples age and size composition of the catch weekly.

Samples from major commercial fisheries are taken opportunistically depending on funding availability for the sampling program.

Scoring Summary

All of the Scoring Guideposts have been met.

100 Scoring Guidepost

- Annual monitoring programs collect data on the age and size of the catch and escapement for target and non-target stocks where there is a clear scientific basis for collecting these data.

80 Scoring Guidepost

- Periodic monitoring programs collect data on the age and size of the catch and escapement for target stocks, and for non-target stocks where the fishery harvests may represent a significant component of the harvest of those non-target stocks.
- There is a scientific basis for the frequency of the sampling program to collect age and size data where there is a clear scientific basis for collecting these data.

60 Scoring Guidepost

- The information on age and size of catch and escapement is adequate, where there is general scientific agreement that these data are important to assess the status of the stocks or adjust fisheries management decisions For example: information on the age distribution of pink salmon harvests would not be considered important for stock assessment or fisheries management decisions where as age information would be impor-

tant for the assessment and management related to most chinook and sockeye fisheries. Monitoring programs should be in place to detect changes in the size of the fish harvested for each salmon species.

Indicator 1.1.2.4

The information collected from catch monitoring and stock assessment programs is used to compute productivity estimates for the target stocks and management guidelines for both target and non-target stocks.

DFO Response

Current Situation

The Somass Sockeye Management Plan takes into account variable productivity of the stocks. The plan includes a variable harvest rate strategy. After a minimum escapement target is met, the allowable harvest rate increases with production. Decision guidelines for Barkley Sound sockeye are described in the IFMP.²¹

Annual data from catch monitoring and stock assessment programs are used to estimate pre-season forecasts of abundance. These forecasts, based on either stock-recruit relationships or smolt survival rate relationships, predict return by age and stock.²² Given the predicted productivity of each stock, pre-season fishery plans are made accordingly.

Adjustments to the total allowable catch (TAC) are made annually according to pre-season forecasts of expected return.

The TAC is adjusted in-season based on in-season indicators of abundance (test fishery, weekly analysis of catch and escapement estimates). If conditions are deemed unfavourable for spawner survival (ie, there are indications of high pre-spawn mortality in Alberni Inlet or the river due to, for example, high water temperature, low flows, prevalence of disease or parasites), the TAC is further adjusted downward.

The relative productivity of non-target stocks is known. The Henderson Lake sockeye stock is far less productive than either Great Central Lake or Sproat Lake stocks. The biological characteristics of the Henderson Lake stock and recent stock status assessments have recently been reviewed by PSARC.²³ The status and productivity of non-target stocks of other species, such as coho or chinook populations, are also reviewed periodically by PSARC.²⁴

²¹ See IFMP 2003, pps 49-51.

²² K. Hyatt, W. Luedke, P. Rankin, J. Till and D. Lewis. 2003. Review of the year 2002 return of Barkley Sound Sockeye Salmon and Forecasts for 2003. PSARC Working Paper S2003-06.

²³ Hyatt, K., D.P. Rankin, P.J. Tschaplinski, I. Miki. 2003. Assembly of standardized estimates of juvenile and adult sockeye salmon (*Oncorhynchus nerka*) abundance associated with the 1976-2001 brood years in Henderson Lake and Clemens Creek, British Columbia, PSARC Working Paper S2003-08.

²⁴ Tompkins, A.W. Luedke, J. Till, S. Taylor, D. Lewis. 2003. Review of 2002 chinook returns to the west coast Vancouver Island, forecast of the 2003 returns to the Stamp River/ Robertson Creek hatchery indicator stock, and outlook for other WCVI chinook stocks. PSARC Working Paper S2003-13.;

The Department employs an intensive in-season management regime to achieve domestic catch allocation goals and escapement objectives for Barkley Sound sockeye stocks. Fishery managers rely on rapid acquisition and analysis of data from commercial and test fisheries, and in-season escapement estimates, to make informed decisions on appropriate weekly balances between catch and escapement.

Each week through the management season, analyses are conducted on commercial, test fishery and escapement samples. These analyses, along with production data, enable Department staff to assess in-season run-timing and return strength of Barkley Sound sockeye salmon stocks. Escapement goals of each stock group are monitored and fishing plans are developed that address stock-specific escapement and catch requirements.

Scoring Summary

The information presented above establishes that management agencies respond well to Indicator 1.1.2.4.

Both 60 Scoring Guideposts have been met.

All three 80 Scoring Guideposts have been met.

One of two 100 Scoring Guideposts has been met.

100 Scoring Guidepost

- Scientifically defensible productivity estimates (eg, stock/recruitment relationships) have been derived for all target stocks and the relative productivity of non-target stocks is known.
- Risk assessment has been conducted to determine the impact of alternative harvest strategies on non-target stocks. The risk assessment should include an assessment of the uncertainties with estimates of stock productivity for both the target and non-target stocks.

80 Scoring Guidepost

- There is adequate information to identify the harvest limitations and production strategies required to maintain the high productivity of the target stocks.
- There is adequate information to estimate the relative productivity of the non-target stocks where the fishery harvests may represent a significant component of those non-target stocks.
- The harvest limitations for target stocks take into consideration the impacts on non-target stocks and the uncertainty of the productivity for these stocks.

60 Scoring Guidepost

- The available information and analyses are adequate to identify the harvest limitations and production strategies required to maintain the productivity of the majority of target stocks.
- The relative productivity of the non-target stocks is considered in the management strategy, where the fishery harvests may represent a significant component of those non-target stocks.

Indicator 1.1.3.1

Limit Reference Points or operational equivalents have been set and are appropriate to protect the stocks harvested in the fishery.

The Limit Reference Point (LRP) or operational equivalent set by the management agency has been defined as *“the state of a fishery and/or a resource, which is not considered desirable. Fishery harvests should be stopped before reaching it. If an LRP is inadvertently reached, management action should severely curtail or stop fishery development, as appropriate, and corrective action should be taken. Stock rehabilitation programs should consider an LRP as a very minimum rebuilding target to be reached before the rebuilding measures are relaxed or the fishery is re-opened.”*

DFO Response

Current Situation

Limit Reference Points (LRPs) for Barkley Sound target stocks have not been formally set.

An interim LRP²⁵ for the Somass sockeye has been established. The interim LRP was derived from an analysis of smolt-recruit relationships. At a forecast return of 200,000 or less, no fisheries are permitted on Somass sockeye. The permitted harvest rate increases with expected abundance.

For the non-target Henderson Lake sockeye stock, reference points are dependent on whether the lake is fertilised or not.

Scoring Summary

DFO has not established Limit Reference Points for each Barkley Sound sockeye stock.

An operational equivalent has been established for Somass sockeye

The sole 60 Scoring Guidepost has been met.

²⁵ Anonymous. 1996. Overview of Alberni Inlet sockeye management: 1996 pre-season planning for Alberni Inlet sockeye. Unpublished document. Department of Fisheries and Oceans, South Coast Division, Stevenson Point Road, Nanaimo, B. C. 9 p

Both of the 80 Scoring Guideposts have been met.

None of three 100 Scoring Guideposts has been met.

Future Changes

The status of Henderson Lake sockeye is currently being reviewed by PSARC.²⁶ One objective of this paper is to determine a LRP for Henderson Lake sockeye.

For non-target species, such as chinook and coho, LRPs will be set as required under the departmental commitments to processes such as 'abundance-based management' under the Pacific Salmon Treatment. This work is currently in progress.

Operational targets and constraints will be expressed in measurable terms. A limit reference point (LRP) and one or more target reference points (TRP) will be specified for each conservation unit, based on estimates of productive capacity. The aim is to have total stock abundance at or over the target reference point. Total abundance below the target reference point but above the limit reference point implies that the conservation unit is secure, but requires rebuilding. A total abundance below the limit reference point implies a stock collapse, and indicates that the long-term viability of the conservation unit is at risk²⁷.

100 Scoring Guidepost

- The Limit Reference Point for target species have been reviewed and found to be scientifically defensible and appropriate by the Pacific Scientific Advice Review Committee or the appropriate Pacific Salmon Commission technical committee.
- There is general agreement among regional fisheries scientists outside the management agency that the LRPs are appropriate.
- There is general scientific agreement regarding the LRPs for non-target species.

80 Scoring Guidepost

- There is some scientific basis for the LRP's for target stocks and these LRPs are defined to protect the stocks harvested by the fisheries.
- There is no significant scientific disagreement regarding the LRPs used by the management agency to formulate management decisions for the fishery.

²⁶ Hyatt, K., D.P. Rankin, P.J. Tschaplinski, I. Miki. 2003. Assembly of standardized estimates of juvenile and adult sockeye salmon (*Oncorhynchus nerka*) abundance associated with the 1976-2001 brood years in Henderson Lake and Clemens Creek, British Columbia, PSARC Working Paper S2003-08. (also future papers are planned)

²⁷ Fisheries and Oceans Canada, 2000. Wild Salmon Policy: Discussion Paper. Principle 3, page 3.

60 Scoring Guidepost

- There is general agreement among regional fisheries scientists within the management agency that the LRP's or equivalents are appropriate to achieve the management goals for target stocks.

Indicator 1.1.3.2

Target Reference Points or operational equivalents have been set.

The Target Reference Point (TRP) or operational equivalent set by the management agency has been defined above as *"the state of a fishery and/or a resource, which is considered desirable. Management action, whether during a fishery development or stock rebuilding process, should aim at maintaining the fishery system at its level."*

DFO Response

Current Situation

Target reference points (TRP) for Barkley Sound target stocks have not been set.

An interim TRP has been established for the Somass stocks.²⁸

Scoring Summary

Target Reference Points have not yet been defined but their operational equivalents have. In scoring this Indicator we have assumed that the Scoring Guideposts can be interpreted as referring to these operational equivalents.

All 60 Scoring Guideposts have been met.

Both 80 Scoring Guideposts have been met.

All 100 Scoring Guideposts have been met.

Future Changes

Under the Wild Salmon Policy, consistent "reference points" of abundance as performance benchmarks will be expressed in measurable terms for all identified conservation units based on estimates of productive capacity. This will include lower reference points of abundance (set at precautionary levels) that identify zones of increasing conservation concern and higher reference points of abundance that identify zones of few conservation concerns. In addition, one or more potential target reference points (TRP) may be identified for some conservation units to assist in fisheries planning. The goal is to have stock abundance for each conservation unit at or over its established target reference point. A total abundance below the target reference point but above the lower reference point will imply that the conservation unit is secure, but requires rebuilding. A total abundance below the lower reference point implies a conservation concern, and urgently requires rebuilding.

²⁸ pps. 82-83 in Riddel, B. 1986. Advice on Barkley Sound Sockeye. PSARC Advisory Document 86-5.

100 Scoring Guidepost

- The Target Reference Point (TRP) for target species have been reviewed and found to be scientifically defensible and appropriate by the Pacific Scientific Advice Review Committee or the appropriate Pacific Salmon Commission technical committee.
- There is general agreement among regional fisheries scientist outside the management agency that the TRP's are appropriate.
- The TRP's for the target stocks take into account variability in the productivity of each component of the target stock and productivity of non-target stocks.

80 Scoring Guidepost

- There is no significant scientific disagreement regarding the TRP's used by the management agency to formulate management decision for the fishery.
- The TRP's for the target stocks take into account variability in the productivity of each component of the target stock and the productivity of non-target stocks.

60 Scoring Guidepost

- There is general agreement among fisheries scientists within the management agency that the TRP's are appropriate for the target stocks.
- Target reference points have been defined for the majority of target stocks harvested in the fishery and these target reference points are not scientifically disputed.
- The management agency has taken into account the relative productivity of non-target stocks when setting the TRP's for the majority of target stocks.

Indicator 1.2.1

There is a well-defined and effective strategy, and a specific recovery plan in place, to promote recovery of the target stock within reasonable time frames.

DFO Response

Current Situation

The IFMP annually provides for agreed upon responses to low stock sizes.²⁹

The management plan for Barkley Sound sockeye limits the allowable exploitation rate according to expected return and has a maximum allowable exploitation rate of 65%. Under this

²⁹ 2003 IFMP - p. 24 and p. 51.

strategy the stock has been managed back up to fishable levels from low levels numerous times within one brood cycle(Figure).

As the stock is currently in average to abundant status, a recovery plan is not necessary. The management objective is to maintain healthy stock status through abundance based fisheries - i.e. limiting total exploitation rate according the forecast abundance.

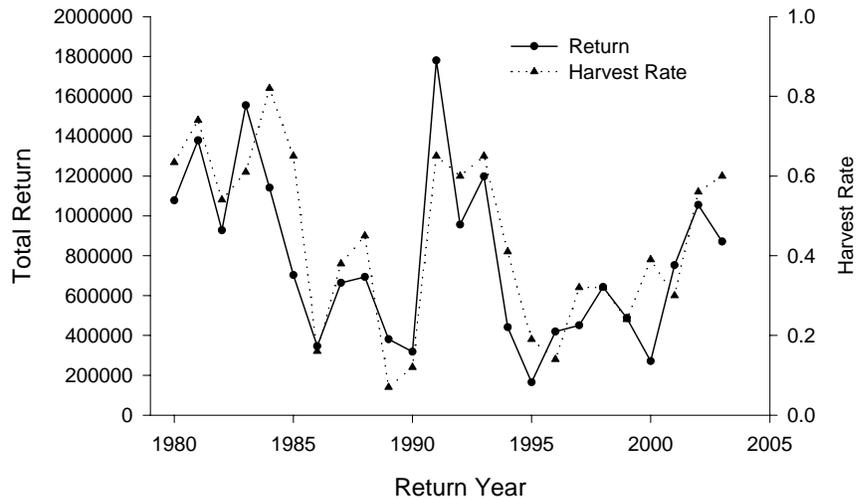


Figure 5. Total return and harvest rate of Somass sockeye by return year, 1980-2003.

Scoring Summary

Both 60 Scoring Guideposts have been met.

One of 80 Scoring Guideposts has been met and the other is not applicable.

Two of three 100 Scoring Guideposts have been met and the other is not applicable.

100 Scoring Guidepost

- There are comprehensive and pre-agreed responses to low stock size that utilize a range of management measures to ensure rapid recovery.
- Stocks are allowed to recover to the TRP before commercial fisheries are permitted that target these stocks.
- The management agency does not use artificial propagation as a substitute for maintaining or recovering wild stocks.

80 Scoring Guidepost

- In the event of severe depletion, recovery plans are developed and implemented to facilitate the recovery of the depleted stocks within 3 reproductive cycles.

- Stocks are allowed to recover to more than 150% of the LRP for abundance before any fisheries are permitted that target these stocks.

60 Scoring Guidepost

- In the event of severe depletion, recovery plans are developed and implemented to facilitate the recovery of the depleted stocks within 5 reproductive cycles.
- Stocks are allowed to recover to more than 125% of the LRP for abundance before any fisheries are permitted that target these stocks.

Indicator 1.2.2

Target stocks are not depleted and recent stock sizes are assessed to be above appropriate limit reference points for the target stocks.

In contrast to Indicator 1.2.1, which evaluates the strategy for stock recovery, this indicator evaluates the current status of the target species or stocks, and the basis for being reasonably certain about their status. The Scoring Guideposts are arranged hierarchically, so that evaluation of the current status depends on the assessment, which in turn depends on data and knowledge about the stocks and the fishery.

DFO Response

Current Situation

Methods for estimating escapement and exploitation rates of target stocks have been reviewed by PSARC several times.³⁰ They are scientifically defensible and therefore provide reasonable data to assess the status of target stocks.

Over the past three years, the Somass stocks have been quite productive, with total return exceeding the long term average of 760,000 pieces. With the exception of 2 years in the past decade (1995 and 2000), escapement levels have generally been maintained well above the provisional LRP (Figure). In six years in the past decade, adult escapement has been at or above the TRP.

During years of low returns, such as 1995 or 2000, there is no evidence that over-harvesting and under-escapement have led to subsequent poor returns. The poor returns were more likely due to unfavourable marine conditions. During these years, estimates of smolt-to-adult survival rate are particularly low for the contributing brood years (Figure). Other local salmonid species, such as coho, experienced similar declines of smolt-to-adult survival rate for fish migrating during the same smolt period (Figure). It is thought that large-scale climatic

³⁰ Hyatt, K., W. Luedke, P. Rankin, J. Till and D. Lewis. 2003. Review of the year 2002 return of Barkley Sound sockeye salmon and forecasts for 2003. PSARC Working Paper S2003-06; Hyatt, K.D. and G.J. Steer. 1987. Barkley Sound sockeye salmon (*Oncorhynchus nerka*): Evidence for over a century of successful stock development, fisheries management, research, and enhancement efforts.. p. 435-457. *In* H.D. Smith, L. Margolis, and C.C. Wood [ed.] Sockeye salmon (*Oncorhynchus nerka*) population biology and future management. Can. Spec. Publ. Fish. Aquat.Sci. 96.

variation, such as El Nino events, has significant impact on the marine environment and subsequent survival rates of salmonid smolts.³¹

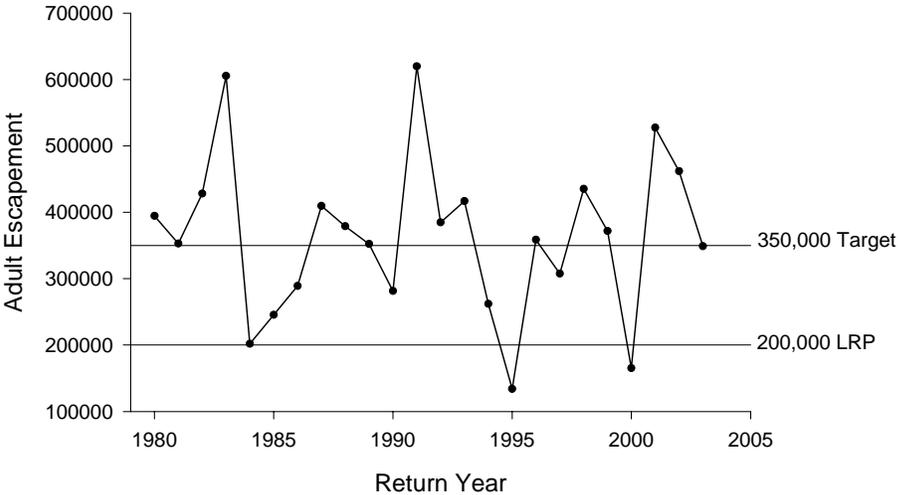


Figure 6. Combined adult escapement to Great Central and Sproat Lakes, 1980-2003.

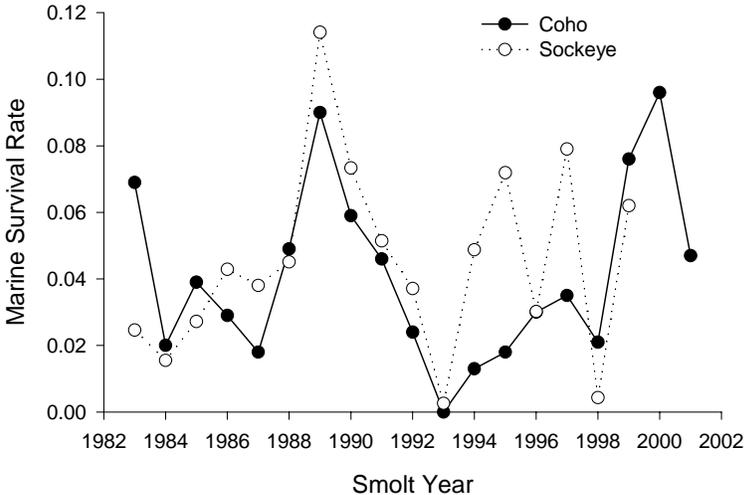


Figure 7. Estimates of marine survival rate for Somass sockeye and Robertson Creek coho stocks, 1983 to 2002. Robertson Creek hatchery is located in the Somass watershed. Note the bottom axis is 'smolt year'. For coho, smolt year t contributes to adult return in year $t+1$. For sockeye, smolt year t contributes to adult return in years $t+2$, $t+3$ and $t+4$.

³¹ Beamish, R.J., D. Noakes, G. McFarlane, W. Pinnix, R. Sweeting, J. King and M. Folkes. 1998. Trends in coho marine survival in relation to the regime concept. Canadian Stock Assessment Secretariat research document; 98/171, 26p.

Scoring Summary

The information presented above establishes that none of the Barkley Sound sockeye salmon stocks is depleted. Limit Reference Points have not been defined but operational equivalents are defined.

Both 60 Scoring Guideposts have been met.

Both 80 Scoring Guideposts have been met.

One of two 100 Scoring Guideposts has been met. Part of the other Scoring Guidepost has also been met.

100 Scoring Guidepost

- There is general agreement among regional fisheries scientist outside the management agency that the methods of estimating escapements and exploitation rates for the target stocks are scientifically defensible.
- Management actions have reduced fishing as the target stocks approach the LRP and fisheries have only resulted in escapements that approach or are below the LRP escapement goal in one year in a period of the most recent 10 consecutive years, for any of the target stocks.

80 Scoring Guidepost

- There is general agreement among regional fisheries scientist inside the management agency that the methods of estimating escapements and exploitation rates for the target stocks are scientifically defensible.
- Management actions have reduced fishing as the target stocks approach the LRP and fisheries have only resulted in escapements that approach or are below the LRP escapement goal in one year in a period of the most recent 5 consecutive years, for any of the target stocks.

60 Scoring Guidepost

- There is general agreement among regional fisheries scientist inside the management agency that the methods of estimating escapements and exploitation rates for the majority of target stocks are scientifically defensible.
- Management actions have reduced fishing as the target stocks approach the LRP and fisheries have only resulted in escapements that approach or are below the LRP escapement goal in no more than two years in a period of the most recent 5 consecutive years, for the majority of the target stocks.

Indicator 1.3.1

Information on biological characteristics such as the age, size, sex and genetic structure of the target stocks is considered prior to making management decisions and management actions are consistent with maintaining healthy age, size, sex and genetic structure of the target stocks.

DFO Response

Current Situation

Information is collected annually on the age, size and sex of the catch and escapement of Somass sockeye stocks.³² There is no evidence to suggest that fisheries are selecting for altered age composition of the target stocks. The proportion of the two predominant adult age classes (age 4.2 and 5.3 at return) returning to Sproat and Great Central Lakes is variable from year to year; there does not seem to be any deterministic trend over time (Figure , Figure). The sex and size compositions have remained fairly constant over time (Figure , Figure).

Although genetic samples from Barkley Sound target stocks are not monitored annually, there is no reason to believe that Barkley Sound fishing plans would have a negative impact on the genetic structure of the target stocks. Harvest rates are maintained at reasonably low levels over a protracted period of 4 to 8 weeks to ensure catch matches run timing (ie, weekly catch targets are set according to projected abundance to avoid loading the catch during a contracted period of the run). This action acts to maintain the age, sex and genetic structure of the stocks (Figure).

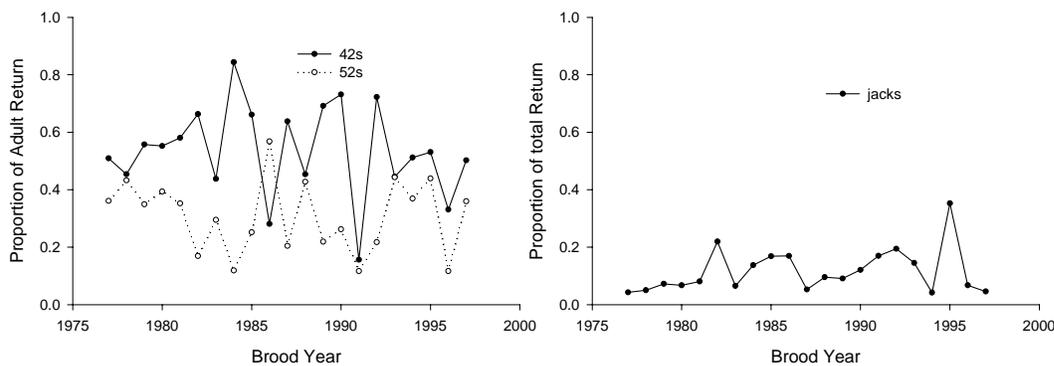


Figure 8. Age Composition of Sproat Lake return. Upper graph shows proportion of adults returning as age 4.2 or 5.2. Lower graph shows proportion of the total return that is jacks.

³² A full of review of Barkley Sound sockeye stock status, assessment methods and fisheries management is planned for the May , 2004 PSARC meetings.

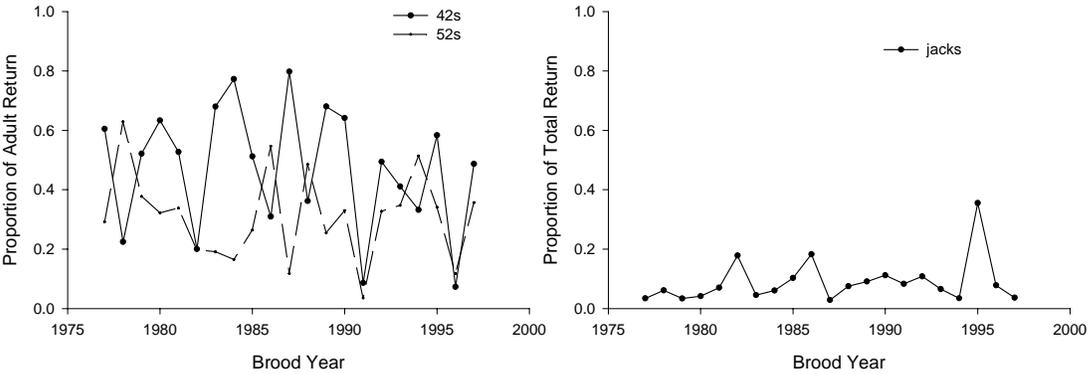


Figure 9. Age Composition of Great Central Lake return. Upper graph shows proportion of adults returning as age 4.2 or 5.2. Lower graph shows proportion of the total return that is jacks.

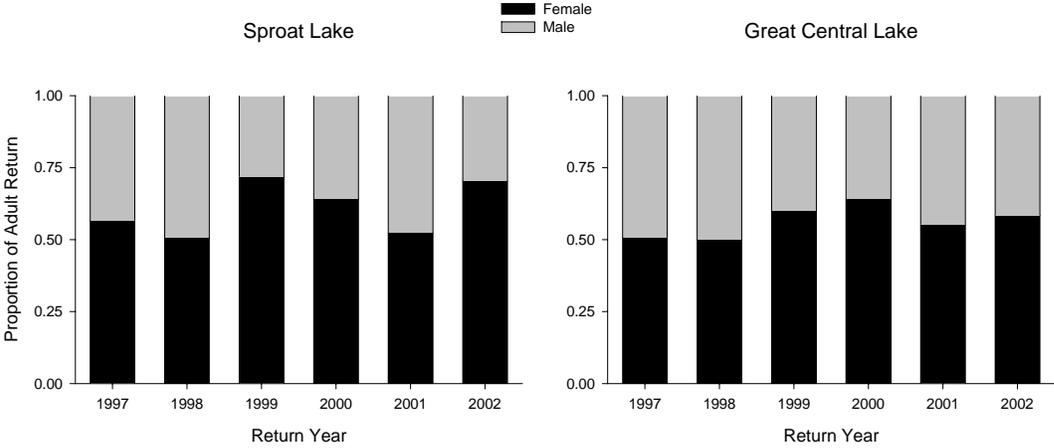


Figure 10. Observed sex ratios of returning adult sockeye, 1987-2002. **note... plan to update these graphs with data from previous years*

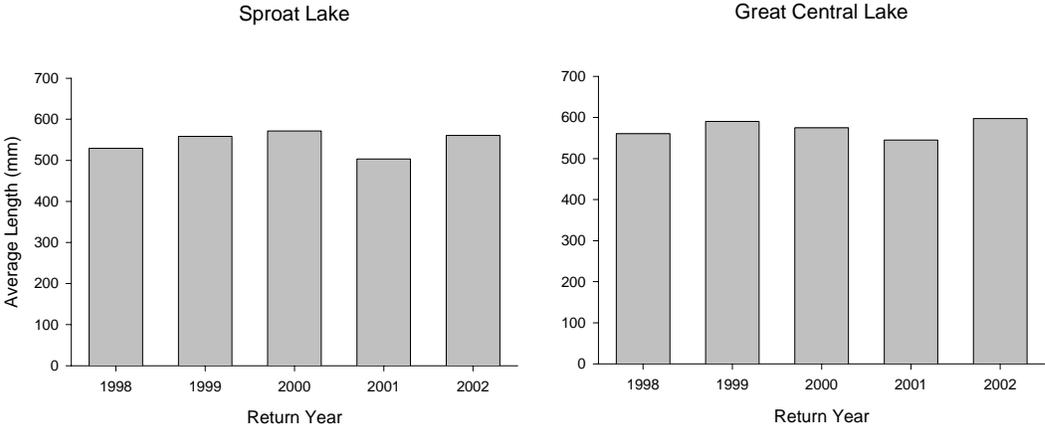


Figure 11. Average length of Sproat Lake and Great Central sockeye.

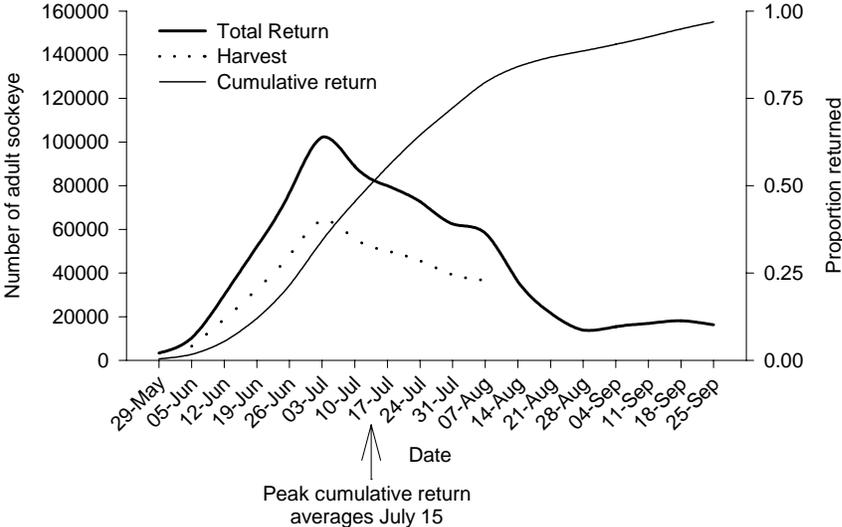


Figure 12. Typical harvest plan for Barkley Sound sockeye, shown for a predicted near-average return of 800,000 adults.

The fisheries occur over a protracted time and weekly catch targets are designed to reflect predicted abundance and to avoid loading of the catch on one particular time period. After the end of July, fisheries are curtailed to avoid by-catch of non-target stocks, such as Henderson Lake sockeye or wild chinook stocks.

Scoring Summary

All three 60 Scoring Guideposts have been met.

All three 80 Scoring Guideposts have been met.

Two of three 100 Scoring Guideposts have been met.

100 Scoring Guidepost

- There is comprehensive knowledge of the effect of fishing on biological characteristics such as the age, size, sex and genetic structure of the target stocks and the impact of changes in these factors on the reproductive capacity of the target stocks.
- Management actions are consistent with maintaining healthy target stocks relative to biological characteristics such as age, size, sex and genetic structure of all target stocks.
- Enhanced fish are identified and managed as separate target stocks.

80 Scoring Guidepost

- The knowledge of the effect of fishing on biological characteristics such as the age, size, sex and component stocks is adequate to detect threats to the reproductive capacity of the target stocks.
- Management actions are consistent with maintaining healthy target stocks relative to biological characteristics such as age, size, sex and genetic structure of all target stocks.
- The management system includes provisions to minimize any adverse impacts to the genetic structure of unenhanced stocks that may be due to the enhancement of other stocks.

60 Scoring Guidepost

- The knowledge of the effect of fishing on biological characteristics such as age, size, sex and component stocks is adequate to detect threats to the reproductive capacity of the majority of target stocks.
- Management actions are consistent with maintaining healthy target stocks relative to biological characteristics such as age, size, sex or genetic structure for the majority of target stocks.
- The management system includes provisions to minimize the major adverse impacts for the majority of unenhanced stocks that may be due to the enhancement of other stocks.

APPENDIX A: OVERVIEW: BARKLEY SOUND SOCKEYE FISHERY MANAGEMENT

Pre-season forecast:

Each year PSARC reviews forecasts of the predicted return of Barkley Sound sockeye by age and stock³³. The standard forecast methods rely on relationships between smolt-to-adult marine survival rate and environmental variables or time-series trends. New methods are under development. These rely on stock-recruit parameters and the observed marine survival rate of coho stocks as a predictor of sockeye marine survival rates. The forecast determines return expectations for pre-season fishery planning.

In-season Reforecast:

Starting in the 3rd week of June and weekly thereafter until the first week in August, the expected run size is re-forecast using observed catch and escapement data and average run timing. Fishing plans for the subsequent week are determined based on run size, remaining total allowable catch (TAC), and remaining gear/sector allocations. If run size increases or decreases, the TAC and gear/sector allocation change according to the Barkley Sound sockeye management plan. The process for determining the in-season re-forecast is illustrated in Figure .

Decision Points for In-Season management:

1. Below an expected run size of 200,000 no harvest is permitted; between 200-400,000 modest First Nation and sport catch is permitted; commercial opportunities begin at 400,000.
2. Based on the in-season reforecast, an increase or decrease in expected run size may change harvest plans depending on the remaining TAC and relative allocations among sectors.
3. The sport catch is based on an *expected* catch of 9% of the total return. If the observed catch exceeds 10% of the pre-season expectation, then measures (such as time-area closures or reduced bag limits) are implemented in order to reduce the sport harvest rate.

Constraints:

1. Henderson Lake sockeye protection.
2. Protection of non-target species, such as local chinook, coho and steelhead populations.
3. Environmental factors: such as those affecting sockeye migration timing through Alberni Inlet and into the Somass River (e.g. delayed migration rate may decrease survival of returning adults and/or result in higher than expected catch in the Alberni Inlet).

³³ Hyatt, K., W. Luedke, P. Rankin, J. Till, and D. Lewis. 2003. Review of the year 2002 return of Barkley Sound sockeye salmon and forecasts for 2003. PSARC Working Paper S2003-06.

4. Biological factors: such as those affecting stock integrity including sex ratio, age composition, and relative abundance of Great Central and Sproat Lake stocks.
5. Management factors: such as time/area conflicts between gear sectors, risk of exceeding TAC, and distributing harvest evenly over run.

In-season reforecast method:

Every week, the expected return of Somass system sockeye is re-forecast according to the return observed to date. The total return is the summed escapement and catch to date plus estimates of Alberni Inlet and river abundance. The primary tool used to re-forecast total return is historical run timing curves. These curves are based on the average early, on time and late historical run timing into the Alberni Inlet observed in previous years.

To re-forecast expected total return for the current year, the cumulative return to date is divided by the percentage normally observed at that time for early, on-time or late runs. A judgement is made about whether the run is early, on time or late using the weekly variation observed in the rate of migration into the inlet, fish condition and relative age class abundance. Generally, confidence in the estimate improves as the season progresses and more precise information is gathered.

There are several sources of uncertainty in the re-forecast, including the relative precision of data sources and also variability in biological and environmental factors, which affect run timing and total return size.

The run timing curves are based on migration timing into the inlet and therefore the reforecast relies heavily on the estimates of Inlet abundance made by the test fishery. Compared to catch and escapement data, the precision of these estimates is much lower. Normally as the season progresses and more fish are accounted for by catch and escapement, the relative importance of the test fishery estimates decrease and the precision of the re-forecast increases.

In addition, the average run timing curves assume a constant rate of migration from the outer Inlet to the river. However, environmental conditions in the Somass River or Alberni Inlet can have a major impact on escapement timing. For example, in the 2001 season, escapement rates remained well below target until the third week of July. The delayed migration into the river was likely due to high water temperatures in the Somass River, which reached up to 23°C in early July. In response, the fish pooled in Alberni Inlet for longer than usual and were subject to intense harvest pressure there. In 1990, a similar phenomenon of delayed migration resulted in significant pre-spawn mortality from sea lice infestation. On the other hand, cool and rainy conditions can lead to much contracted run timing and reduce catchability in the various fisheries.

Examples of other factors considered in the re-forecast assessment include the age composition of returning fish, relative abundance of Sproat Lake versus Great Central Lake escapement, and sex ratios.

Stock Assessment

Test Fishery

The test fishery generally operates on Monday and Tuesdays during the fishery season. The purpose is to estimate abundance of sockeye inside the Alberni Inlet. Two estimates of abundance are generated, one for 'inside', between Port Alberni and Ten Mile Point and one for 'outside', between 10-mile line and Chup Point. The estimates are generated through a series of acoustic soundings and seine sets throughout the Inlet. The outside estimate of abundance provides an indication of new fish entering the inlet. The test boat also gathers scale samples for age composition analysis and reports on the condition of fish. The combination of information about fish condition and observed influx of new fish, relative to escapement and catch estimates, provides some indication of migration timing from the inlet to the river.

Escapement Estimates

Escapement counters are installed at the Great Central and Sproat Lake fishways in May. These counters are automatic and record all fish entering the fishways 24 hours/day. The counts are calibrated twice a week for 2 hours at each site by observers who record the numbers of adults and jacks. Values obtained from the counters are adjusted for overall abundance, species composition and life stage (adult or jack) based on the manual calibrations. In addition, fish are sampled weekly in order to determine the age composition of the run through scale analysis and to determine sex ratios. There are 5 frequent age classes observed in the Somass system including jack 3₂'s and 4₃'s and adult 4₂'s, 5₂'s and 5₃'s. Previous years return of earlier age classes for a particular brood year provides information on brood class strength, for example, the lower than average return on 5₂'s in 2001 corresponds with the poor return of 4₂'s in 2000.

Catch Estimates

Estimates of catch in all First Nation, sport, commercial and test fisheries are made weekly. Commercial catch information is gathered through hail-ins and boat counts. The sport fishery is monitored through the creel survey and catch is estimated by boat counts and catch-per-unit-effort data gathered through landing interviews. First Nation catch is estimated through either direct reporting, as in the commercial fishery, or through observer monitoring.

<i>Somass sockeye biological statistics</i>	
Average return (adults), 1980-2001	760,000
Average escapement (adults), 1980-2001	360,000
Ratio Great Central Lake:Sproat Lake, 1980-2001	53%:47%
Avg. Age Composition, 1984-2001 (3 ₂ :4 ₃ :4 ₂ :5 ₂ :5 ₃ :6 ₃)	(9%:2%:45%:31%:10%:4%)
Average Sex Ratio (adults), 1997-2000	60% female: 40% male
Avg. peak cumulative run timing, 1990-2001	July 8

<i>Somass sockeye biological statistics</i>	
Run timing range	April to October
Average exploitation rate, 1980-2001	42%

Barkley Sound Sockeye Management Plan:

Barkley Sound sockeye are managed according to a variable harvest strategy (Figure). The lower escapement limit for the Somass system is 200,000 adult returns and below this run size no harvest is permitted. At run returns greater than 200,000, modest First Nation and sport opportunities are permitted. Commercial opportunities begin at run abundances greater than 400,000. The interim spawning escapement target is 350,000 adults and this spawning target level is reached when the total return is 500,000. However, for stock evaluation purposes³⁴, spawning escapement continues to increase with run size so that the total exploitation rate never exceeds 67%.³⁵

In addition to Great Central and Sproat Lake sockeye, Henderson Lake sockeye also migrate through Barkley Sound. Stock analysis has demonstrated that Henderson Lake sockeye stock is much less productive than Somass sockeye. Therefore, efforts are made to protect Henderson Lake sockeye from over-harvest in the fishery. Time and area restrictions are implemented when Henderson sockeye are considered more prevalent, generally in mid to late July.

Under the management plan, Barkley Sound sockeye are harvested in the following fisheries: test, First Nation food, social and ceremonial (FSC), First Nation pilot sales (i.e. First Nation fisheries that are licenced for sale of the harvest), recreational and regular commercial. Test fisheries are used for stock assessment purposes and the allocation ranges between 2,000 to 15,000, depending on run size. First Nation bands in the Barkley Sound area, other than Teshat or Hupacasath, are expected to catch 20,000 adult sockeye for food, social and ceremonial purposes. Other sectors have specific objectives for their fishery.

First Nation (SFSF - Social Food and Sales Fishery or Pilot Sales):

The object is harvest average of 55,000 adult sockeye annually over the long term. Note that this allocation is for the Hupacasath and Teshat bands combined and includes fish caught for both FSC and sales purposes.

Recreational Fishery:

The object is to have stable and predictable access to sport fishing opportunities. Bag limits depend on expected run size. For average runs, the daily limit is typically. For lower expected returns the limit may be reduced to 1 or 2. Under the management plan, sport catch is not a strict allocation, but an *expected* catch of 9% of the total adult run based on an analysis of trends in recent catch and effort data.

Commercial Fishery:

The object is to meet gear catch allocations laid out in the management plan. The commercial fishery is allocated remaining TAC after spawning escapement, First Na-

³⁴ For example, to determine what the production is possible at high levels of escapement.

³⁵ This was determined as the maximum sustainable harvest rate by Hyatt and Luedke memo based on S-R analysis I believe - don't have a copy.

tion and recreational objectives are met. The priority is first to meet to meet the allowable TAC and then to meet gear allocations for that TAC.

Once the weekly in-season re-forecast of run size has been made, the TAC is examined to determine what harvesting opportunities remain. Particularly when the remaining TAC is low, constraints emerge in terms of the type of fisheries that can be designed to meet catch targets. In some cases, there may be less risk of over harvest associated with different gear types or sectors. As the season progresses, harvesting opportunities are further limited by area constraints as protection is afforded to Henderson Lake stocks and non-target species, such as wild chinook and steelhead stocks. There is also a determined effort to distribute the harvest over the entire run to reduce the risk of over-harvest in the beginning of the season and also to maintain stock integrity.

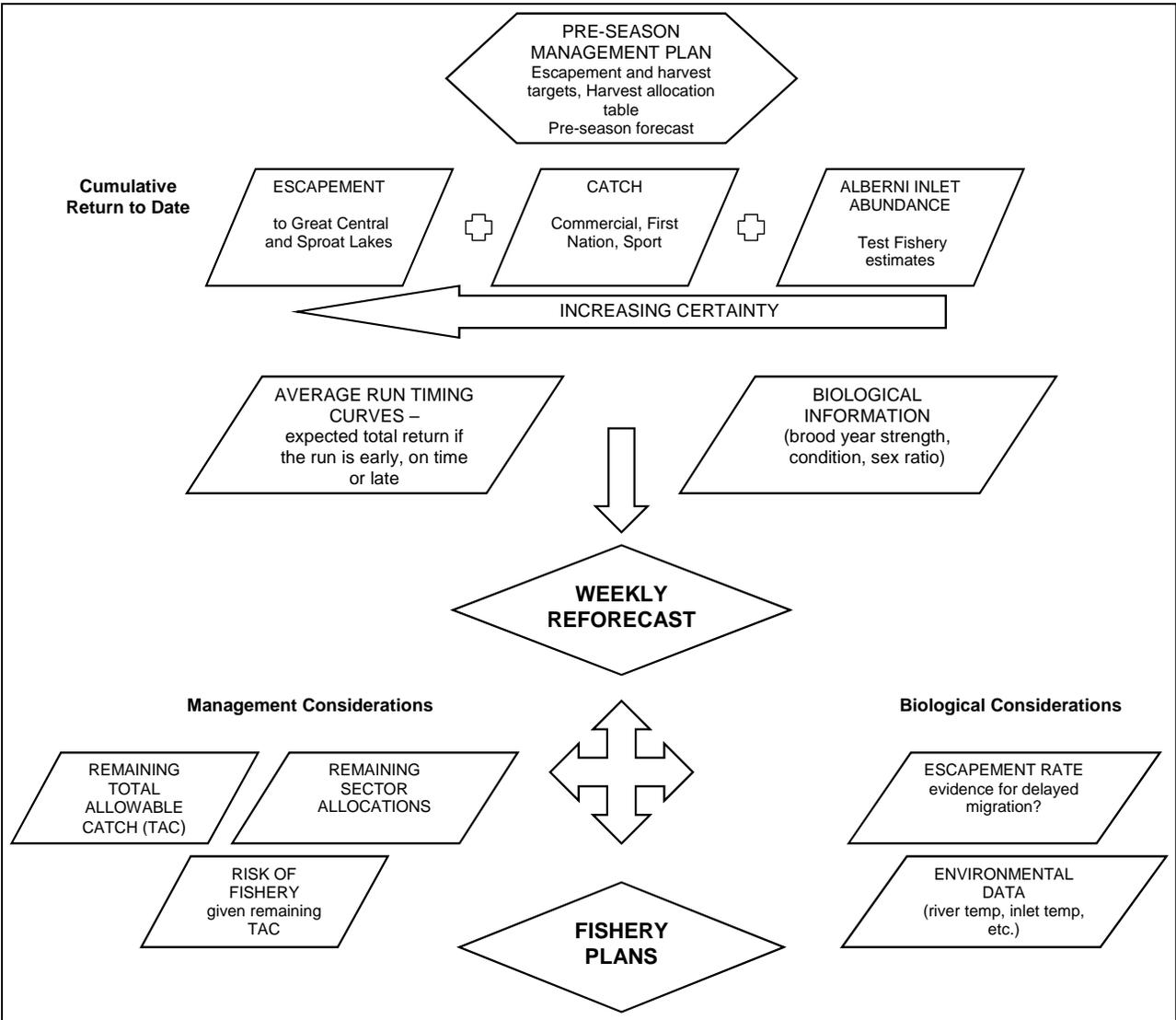


Figure 13. Barkley Sound in-season decision-making process.

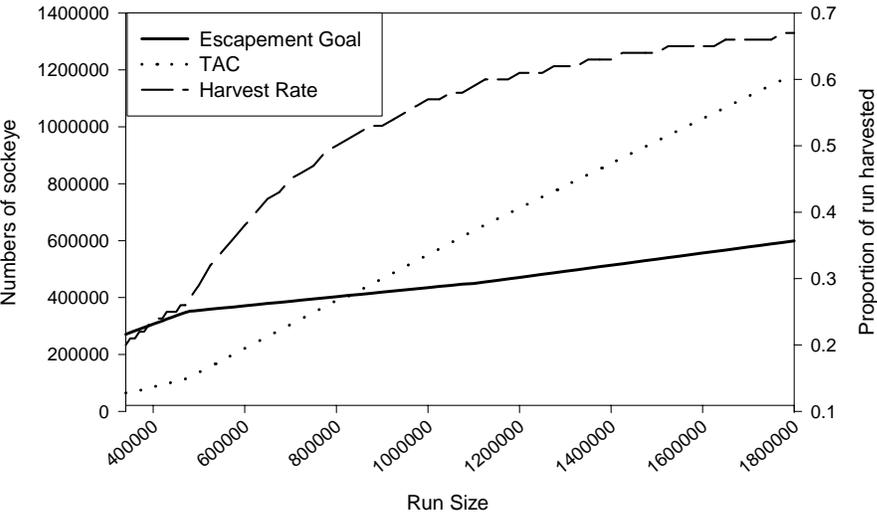


Figure 14. Somass sockeye variable harvest strategy.