

Response to Marine Stewardship Council

Indicators for Principle 1 - Stock Assessment and Stock Status

Pacific Wild Salmon Fishery

Fraser River 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 Fraser River 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 Fraser River sockeye fishery

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

Stock units are currently defined at four levels of resolution.

- Run timing.
- In-season stock groups.
- Post-season production stock groups.
- Populations censused for escapement.

Stock unit definitions are used for four purposes.

- Pre-season management.
- In-season management.
- Assessment.

- Conservation.

Stock unit definitions are arrayed by purpose in the following table.

Purpose	Stock Resolution			
	Run Timing (4 stock units)	In-season (7-10 stock units)	Production (18 stock units)	Escapement (37-41 stock units)
Pre-season Mgmt.	X	X	X	
In-season Mgmt.	X	X		
Assessment	X		X	
Conservation	X	X	X	X

The stock resolution levels are as follows:

Run Timing Stock Groups

Fraser River sockeye are managed in four run timing aggregates:

- Early Stuart.
- Early Summer.
- Summer.
- Late.

With few exceptions, fisheries that harvest Fraser River sockeye operate on a highly mixed stock aggregate. Because the fisheries form a gauntlet on migrating sockeye, there are few opportunities to isolate component stocks spatially (eg, terminal fisheries for the component stocks). Therefore, the primary management determinant is the identification and isolation of stock components based on their run timing and abundance in-season as detailed by Woodey (1987)¹.

In-Season Stock Groups

In-season scale pattern analysis is used to identify stock groups in mixed stock fisheries that intercept Fraser sockeye² and to apportion the daily estimates of escapement past Mission.

The methods are described in detail by Gable and Cox-Rogers (1993). The discriminate function models applied to the scale data and stock definitions are dependent on cycle year for the returning sockeye.

¹ Woody, J.C. 1987. In-season management of Fraser River sockeye (*Oncorhynchus nerka*): meeting multiple objectives, p. 367-374. In H.D. Smith, L. Margolis, and C.C. Wood [eds] Sock-eye Salmon (*Oncorhynchus nerka*) Population Biology and Future Management. Can. Spec. Publ. Fish. Aquat. Sci. 96. See especially page 368, right hand column, first full paragraph ("In-season management required...") and page 371, section entitled "Decision-Making" especially the second paragraph ("Escapement goals were achieved...").

² That is, virtually all fisheries: marine commercial, in-river commercial, marine First Nations, in-river First Nations, in-river recreational, test fisheries and miscellaneous non-commercial fisheries.

As well, DNA analyses are increasingly used in the identification of stock groups.

The stock groups for each cycle year are shown in the following table.³

1997 Cycle Year (7 stock units)	1998 Cycle Year (9 stock units)	1999 Cycle Year (10 stock units)	2000 Cycle Year (8 stock units)
Early Stuart	Early Stuart	Early Stuart	Early Stuart
Early Miscellaneous	Fennell/Bowron/Raft	Fennell/Bowron/Raft	Bowron/Fennell/Upper Adams
Nadina/Gates/Pitt	Nadina/Gates/Pitt	Nadina/Gates/Pitt	Nadina/Raft/Gates/Pitt
Quesnel/Chilko	Scotch/Seymour	Scotch/Seymour	Chilko
Late Stuart/Stellako	Quesnel/Chilko	Chilko	Quesnel/Late Stuart/Stellako
Birkenhead	Late Stuart/Stellako	Quesnel	Birkenhead
Weaver/Portage/Misc	Birkenhead	Late Stuart/Stellako	Weaver/Cultus
	Adams/Lower Shuswap	Birkenhead	Portage/Adams/Misc
	Weaver/Portage/Misc	Adams/Lower Shuswap	
		Weaver/Portage	

The stock abundance estimates at Mission are used directly to gauge conservation targets.

In-season data collection and analysis are described in detail in Woodey (1987)⁴. Further details are provided in Pacific Salmon Commission (1995)⁵.

Very similar stock definitions are used in a simulation model to determine how spawning escapement, exploitation rate (for late run timing stocks), domestic allocation and international allocation goals can be achieved through the development of pre-season fishing plans.⁶

Production Stock Groups

Post-season racial scale pattern analysis using revised baseline standards (see page 22 for a definition of baseline standards) is conducted to partition the in-season groupings into 18 stock groups (with minor variations among cycle years)⁷.

Annual estimates of escapement, effective females, returns by age, smolt enumeration (where available) and other biological information are available in a Microsoft Access database maintained by the Pacific Salmon Commission⁸.

³ Fraser River Panel Report to the Pacific Salmon Commission. 1997: Table 10, p. 32 (7 stocks). 1998: Table 10, page 28 (9 stocks). 1999: Table 10, p. 29 (10 stocks). 2000: , Table 10, p.28, 8 stocks). Stocks identified for each specific cycle years changes across years within cycle lines, as well as across cycle lines) in response to changes in the freshwater scale characters that form the basis for the discriminate function analysis classification modles.

⁴ Woody, J.C. 1987. page 368, section titled "Data Collection". Page 370, section titled "Data Analysis".

⁵ Pacific Salmon Commission. 1995. Pacific Salmon Commission Run-size Estimation Procedures: An Analysis of the 1994 Shortfall in Escapement of Late-run Fraser River Sockeye Salmon. PSC Tech. Rep. No. 6. Section titled "Estimation Methods" pages 6-12.

⁶ Cave, J.D. and W.J. Gazey. 1994. A pre-season simulation model for fisheries on Fraser River sockeye salmon (*O. nerka*). Can. J. Fish. Aquat. Sci. 51(7): 1535-1549.

⁷ The methods are described in detail by Gable and Cox-Rogers (1993).

A very large proportion of the return can be explained by the 18 stock units (shown in the table at the right⁹). They are called the *Production Stock Groups* or *Modeled Stock Groups*.

The historical record on these 18 stock units is sufficient to allow pre-season run forecasts and stock recruitment assessment. The same 18 stock units are used for all cycle years with only the most minor of additions in 1999 and 2000 cycle years¹⁰.

The only conservation application at this stock resolution has been for an assessment of Cultus Lake sockeye¹¹.

A table showing stock units in three groups—Run, Stock Group and

Component Stocks—used by the Pacific Salmon Commission is included in the *Report of the Fraser River Panel to the Pacific Salmon Commission on the 1997 Fraser River Sockeye and Pink Salmon Fishing Season*.¹²

1997 Cycle Year (17 stock units)	1998 Cycle Year (17 stock units)	1999 Cycle Year (20 stock units)	2000 Cycle Year (18 stock units)
Early Stuart	Early Stuart	Early Stuart	Early Stuart
Early Summer	Early Summer	Early Summer	Early Summer
Fennell	Fennell	Fennell	Fennell
Bowron	Bowron	Bowron	Bowron
Raft	Raft	Raft	Raft
Gates	Gates	Gates	Gates
Nadina	Nadina	Nadina	Nadina
Pitt	Pitt	Pitt	Pitt
Seymour	Seymour	Seymour	Seymour
Scotch	Scotch	Scotch	Scotch
Mid Summers	Mid Summers	Miscellaneous	Upper Adams
Chilko	Chilko	Mid Summers	Mid Summers
Quesnel	Quesnel	Chilko	Chilko
Stellako	Stellako	Quesnel	Quesnel
Late Stuart	Late Stuart	Stellako	Stellako
Late Summer	Late Summer	Late Stuart	Late Stuart
Birkenhead	Birkenhead	Late Summer	Late Summer
Late Shuswap	Late Shuswap	Birkenhead	Birkenhead
Cultus	Cultus	Late Shuswap	Late Shuswap
Portage	Portage	Cultus	Cultus
Weaver	Weaver	Portage	Portage
		Weaver	Weaver
		Misc Shuswap	
		Misc Non-Shuswap	

⁸ Pacific Salmon Commission. Production Database, 1952 - , Vancouver, BC. Copies of the database and a memo describing its contents, structure and data sources are available.

⁹ Stock units listed in Pacific Salmon Commission. Report of the Fraser River Panel to the Pacific Salmon Commission on the Fraser River Sockeye and Pink Salmon Fishing Season. **1977**: Table 1 (page 37). **1998**: Table 1 (page 41). **1999**: Table 10 (page 49). **2000**: Table 1 (page 38).

¹⁰ The methods and preseason estimates by production unit for the 2000 to 2003 cycle-years are provided by Cass 2000, 2001a, 2001b and 2002, respectively. Slight changes in the methods and treatment of input data are cycle-year dependent.

¹¹ Schubert, N. et al. 2002. Status of Cultus Lake Sockeye Salmon (*Oncorhynchus nerka*). Canadian Stock Assessment Secretariat. Research Doc. 2002/064.

¹² Report of the Fraser River Panel to the Pacific Salmon Commission on the 1997 Fraser River Sockeye and Pink Salmon Fishing Season. Table 8, page 27.

Censused Escapement Stock Groups

The Reports of the Fraser River Panel to the Pacific Salmon Commission on the Fraser River Sockeye and Pink Salmon Fishing Season detail escapement estimates for 37-41 stock units¹³.

1997 Cycle Year (40 stock units)	1998 Cycle Year (40 stock units)	1999 Cycle Year (41 stock units)	2000 Cycle Year (37 stock units)
NORTHEAST Upper Bowron River STUART Early Driftwood River Takla Lake Streams Middle River Streams Trembleur Lake Streams Late Kazchek Creek Kuzkwa Creek Middle River Tachie River Miscellaneous NECHAKO Nadina River (late) Nadina Channel Stellako River QUESNEL Upper Horsefly River Lower Horsefly River Horsefly Channel McKinley Creek Mitchell River Miscellaneous CHILCOTIN Chilko River Chilko Channel Chilko Lake-South End SETON-ANDERSON Gates Creek Gates Channel Portage Creek NORTH THOMPSON Raft River Fennell Creek SOUTH THOMPSON Summer Seymour River Scotch Creek Anstey River Eagle River Late Adams River/Little River	NORTHEAST Upper Bowron River STUART Early Takla Lake Streams Middle River Streams Trembleur Lake Streams Late Middle River Tachie River Miscellaneous NECHAKO Nadina River (late) Nadina Channel Stellako River QUESNEL Horsefly River Horsefly Channel McKinley Creek Mitchell River Miscellaneous CHILCOTIN Chilko River & Lake Chilko Channel SETON-ANDERSON Gates Creek Gates Channel Portage Creek NORTH THOMPSON Raft River Fennell Creek SOUTH THOMPSON Summer Seymour River Scotch Creek Anstey River Eagle River Late Adams River/Little River	NORTHEAST Upper Bowron River STUART Early Driftwood River Takla Lake Streams Middle River Streams Trembleur Lake Streams Late Middle River Tachie River Miscellaneous NECHAKO Nadina River (late) Nadina Channel Stellako River QUESNEL Upper Horsefly River Lower Horsefly River Horsefly Channel McKinley Creek Mitchell River Miscellaneous CHILCOTIN Chilko River Chilko Channel Chilko Lake-South End SETON-ANDERSON Gates Creek Gates Channel Portage Creek NORTH THOMPSON Raft River Fennell Creek SOUTH THOMPSON Summer Seymour River Scotch Creek Anstey River	NORTHEAST Upper Bowron River STUART Early Takla Lake Streams Middle River Streams Trembleur Lake Streams Late Middle River Tachie River Miscellaneous NECHAKO Nadina River (late) Nadina Channel Stellako River QUESNEL Horsefly River area Mitchell River CHILCOTIN Chilko River Chilko Lake-South End Taseko Lake SETON-ANDERSON Gates Creek Gates Channel Portage Creek NORTH THOMPSON Raft River Fennell Creek SOUTH THOMPSON Summer Seymour River Scotch Creek Eagle River Upper Adams River Momich/Cayenne Creeks Late Lower Adams River Lower Shuswap River

¹³ Report of the Fraser River Panel to the Pacific Salmon Commission on the Fraser River Sockeye and Pink Salmon Fishing Season. 1997: Table 13, page 46. 1998: Table 7, page 65. 1999: Table 13, page 53. 2000: Table 7, page 48.

1997 Cycle Year (40 stock units)	1998 Cycle Year (40 stock units)	1999 Cycle Year (41 stock units)	2000 Cycle Year (37 stock units)
Scotch Creek Late Lower Adams River Lower Shuswap River HARRISON-LILLOOET Birkenhead River Harrison River Weaver Creek Weaver Channel LOWER FRASER Nahatlatch River & Lake Cultus Lake Upper Pitt River MISCELLANEOUS	Adams Channel Lower Shuswap River Middle Shuswap River Miscellaneous HARRISON-LILLOOET Birkenhead River Harrison River Weaver Creek Weaver Channel LOWER FRASER Nahatlatch River & Lake Cultus Lake Upper Pitt River Chilliwack Lake MISCELLANEOUS	Eagle River Late Adams River Little River Lower Shuswap River Miscellaneous HARRISON-LILLOOET Birkenhead River Harrison River Weaver Creek Weaver Channel LOWER FRASER Nahatlatch River & Lake Cultus Lake Upper Pitt River MISCELLANEOUS	HARRISON-LILLOOET Birkenhead River Big Silver Creek Harrison River Weaver Creek Weaver Channel LOWER FRASER Nahatlatch River & Lake Cultus Lake Upper Pitt River Chilliwack Lake MISCELLANEOUS

Escapements for Fraser River sockeye are enumerated at numerous spawning areas¹⁴. A total of 293 census locations have been sampled historically¹⁵. In any given year, however, far fewer locations are sampled. For example, in 1994, 158 sites were sampled¹⁶; in 2001, 218 sites were sampled¹⁷; and in 2002, 158 sites were sampled¹⁸.

Roll-ups of escapement estimates are made by production group and by run timing group. Cass reports that the 18 production stocks accounted for 96% of the total estimated escapement to the river in 1999¹⁹. The extent of coverage in other years has not been reported.

Scoring Summary

There is an unambiguous description of each production stock unit considered and the rationale for its definition is clear as required for the 100 guidepost. Some stocks (comprising a very small proportion of total return) are not defined or assessed except through the four run timing groups.

Both the 60 Scoring Guideposts have been met.

¹⁴ Collection methods and estimation procedures are given by Schubert, N.D. 1998. The 1994 Fraser River sockeye salmon (*Oncorhynchus nerka*) escapement. Can. Tech. Rep. Fish. Aquat. Sci. 2201: 62 p.

¹⁵ Blair Holtby, DFO Science, Head of Stock Assessment, pers comm.

¹⁶ Schubert 1998, Table 2.

¹⁷ Department of Fisheries and Oceans. 2002. Fraser River sockeye escapement estimates 2002, Near final estimates. Table 1.

¹⁸ Department of Fisheries and Oceans. 2002. Fraser River sockeye escapement estimates 2002, Near final estimates. Table 1.

¹⁹ Cass, A. 2002. Pre-Season Run Forecast for Fraser River Sockeye and Pink Salmon in 2003. CSAS, DFO Research Document 2002/116. Abstract, first paragraph, fifth sentence, lines 6-7 (page 2).

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 Fraser River 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.

Literature Cited

Cass, A. 2000. Run size forecasts for Fraser River sockeye in 2000. Canadian Stock Assessment Secretariat. Research Doc. 1999/129.

http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2000/PDF/2000_107e.pdf

Cass, A. 2001a. Run size forecasts for Fraser River sockeye and pink salmon in 2001. Canadian Stock Assessment Secretariat. Research Doc. 2001/063

http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2001/RES2001_063e.pdf

Cass, A. 2001b. Run size forecasts for Fraser River sockeye in 2002. Canadian Stock Assessment Secretariat. Research Doc. 2001/147.

http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2001/RES2001_147e.pdf

Cass, A. 2002. Run size forecasts for Fraser River sockeye and pink salmon in 2003. Canadian Stock Assessment Secretariat. Research Doc. 2002/116.

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

Cave, J.D. and W.J. Gazey. 1994. A pre-season simulation model for fisheries on Fraser River sockeye salmon (*O. nerka*). Can. J. Fish. Aquat. Sci. 51(7): 1535-1549.

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<http://www.psc.org/Pubs/frp97-webb.pdf>

Pacific Salmon Commission. 2000. Report of the Fraser River Panel to the Pacific Salmon Commission on the 1998 Fraser River Sockeye Salmon Fishing Season.

<http://www.psc.org/Pubs/Frp98-webb.pdf>

Pacific Salmon Commission. 2001. Report of the Fraser River Panel to the Pacific Salmon Commission on the 1999 Fraser River Sockeye Salmon Fishing Season.

<http://www.psc.org/Pubs/Frp99-webb.pdf>

Schubert, N.D. 1998. The 1994 Fraser River sockeye salmon (*Oncorhynchus nerka*) escapement. Can. Tech. Rep. Fish. Aquat. Sci. 2201: 62 p.

Schubert, N. D., T.D. Beacham, Al J. Cass, T.E. Cone, B.P. Fanos, M. Foy, J.H. Gable, J.A. Grout, J.M.B. Hume, M. Johnson, K.F. Morton, K.S. Shortreed, M.J. Staley and R.E. Withler. 2002. Status of Cultus Lake Sockeye Salmon (*Oncorhynchus nerka*). Canadian Stock Assessment Secretariat. Research Doc. 2002/064.

Woody, J.C. 1987. In-season management of Fraser River sockeye (*Oncorhynchus nerka*): meeting multiple objectives, p. 367-374. In H.D. Smith, L. Margolis, and C.C. Wood [eds] Sockeye Salmon (*Oncorhynchus nerka*) Population Biology and Future Management. Can. Spec. Publ. Fish. Aquat. Sci. 96.

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.

Members of the Fraser River Panel²⁰ unanimously agree that these stock unit definitions are sufficient to achieve the management objectives mandated under the Pacific Salmon Treaty²¹.

The bi-lateral Fraser River Technical Committee of the Pacific Salmon Commission includes 10 scientists from within and outside the management agencies. There is general agreement among the members of the Technical Committee that the stock unit definitions are appropriate²², given that large component stocks within timing groups are also considered by the management system in making decisions. As well there is work underway to further refine the management units from the current run timing groups to smaller aggregates for management purposes.

Data sources and methods have been extensively reviewed by PSARC.²³

The above-referenced 2003 stock assessment for Fraser River sockeye (Cass, A.) is available at the following web site.

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

The 2003 stock assessment includes references to previous years of stock assessments done and also approved by PSARC. It also includes a reference to Blackburn, D. J. 1992. This paper compares two examples of methods used in forecasting stock abundance and adult migration behaviour in some stocks of pink, chum and sockeye salmon.²⁴

Scoring Summary

The information presented establishes that, while there are professional biologists who do not agree that the stock unit definitions are appropriate, there is general and widespread agreement that they are appropriate.

²⁰ Pacific Salmon Treaty (Treaty mandate) Chapter 4, paragraph 10

²¹ Woodey, J. C., 1987. In-season Management of Fraser River Sockeye Salmon: Meeting Multiple Objectives. Pages 376-374. In: H. D. Smith, L. Margolis and C. C. Wood (ed). Sockeye Salmon Biology and Future Management. Can. Spec. Publ. Fish Aquat. Sci.

²² Pacific Salmon Treaty, Chapter 4, paragraph 9.

²³ Cass, A. 2002. Pre-Season Run Forecast for Fraser River Sockeye and Pink Salmon in 2003. CSAS, DFO Research Document 2002/116. Section 2 Data Sources and Methods, first sentence, page 6.

²⁴ PSARC Working Paper S92-12.

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

DFO and the Pacific Salmon Commission²⁵ collect information on the geographic range of all major and many minor stock units harvested in the Fraser River sockeye fishery each year. These stocks represent on average more than 90% of the Fraser River production.

²⁵ Report of the Fraser River Panel to the Pacific Salmon Commission on the Fraser River Sockeye and Pink Salmon Fishing Season (see references to 1997, 1998, 1999 and 2000 volumes following).

1997: Section III, page 8, last paragraph, lines 3-12 ("A highly unusual catch..."); section VII, first paragraph, fifth sentence, lines 8-9 ("Data obtained from this program..."), page 26 and second paragraph, second sentence, ("These data are also used to account for international and domestic catches of Fra-

This information is monitored during the fishing season and used when making in-season management decisions.²⁶

In general, the geographic range of non-target stocks and species harvested in Fraser River sockeye fisheries is known or harvest levels for these stocks or species are very low²⁷.

Scales and DNA samples are taken during sockeye fisheries for non-target stocks²⁸ and species upon the request from other agencies²⁹. Exploitation rates on non-target stocks (e.g. Early Stuart sockeye) are calculated and communicated to fishery managers' in-season. In the case of non-target species actual levels of total harvest is calculated and reported to Managers.

ser River sockeye salmon in coastal waters ..."); page 27, last paragraph ("scale analyses of commercial and test fishing catches...").

1998: Table 5, page 18; Table 6, page 19; section V, sub-section A, part ii, first two paragraphs, page 19 plus Table 7, page 20; section VII, first paragraph, first sentence ("PSC staff conduct programs designed to identify the stock proportions of Fraser River sockeye salmon in commercial and test fishing catches."), page 24; see also the remainder of that paragraph and the paragraph following it ("Analyses of scale samples from commercial and test fishery catches were conducted daily...") at the bottom of page 24.

1999: Table 3, page 18; Table 4, page 19, Table 5, page 19; section VII, first paragraph, first sentence ("PSC staff conduct programs designed to identify the stock proportions of Fraser River sockeye and pink salmon in commercial, test and First Nations' catches.") and the remainder of that paragraph (page 27); section VII, sub-section A, first paragraph ("Analyses of scale samples from catches in commercial and test fisheries were conducted daily...") and the remainder of that paragraph (also page 27).

2000: Table 4, page 18; Table 6, page 20; Table 7, page 21; section VII, sub-section A, first two paragraphs (page 25).

²⁶ Report of the Fraser River Panel to the Pacific Salmon Commission on the Fraser River Sockeye and Pink Salmon Fishing Season. 1996 Section VIII, page 21-22. 1997 Section VI, page 19. 1998 Section VI, page 21. 1999: Section VI, page 24.

²⁷ Report of the Fraser River Panel to the Pacific Salmon Commission on the Fraser River Sockeye and Pink Salmon Fishing Season (see references to 1997, 1998, 1999 and 2000 volumes following).

1997: Table 10, page 42 shows a summary of the Pacific Salmon Commission's estimates of geographic range of harvest for Fraser River sockeye salmon.

1998: Table 10, page 28 shows the Pacific Salmon Commission's estimates of the geographic range of harvest of Fraser River sockeye in 1998.

1999: The Pacific Salmon Commission's estimates of the range of harvest of Fraser River sockeye in 1999 are shown in Table 11, page 31.

2000: Table 10, page 28 shows the Pacific Salmon Commission's estimates of the geographic range of harvest of Fraser River sockeye in 2000.

²⁸ Jim Gable, Pacific Salmon Commission, pers comm.

²⁹ DFO Lee Kearey, personnel communication

Scoring Summary

The information presented establishes that the geographic range of Fraser River sockeye salmon is very well 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

Run size forecasts for 18 "Production" or "Modeled" Fraser River sockeye stocks (see Production Stock Units listed in the table on page 5) are prepared by DFO³⁰ and reviewed by PSARC³¹

³⁰ Cass, A. 2002. Pre-Season Run Forecast for Fraser River Sockeye and Pink Salmon in 2003. CSAS, DFO Research Document 2002/116.

annually. According to the Pacific Salmon Commission³², the modeled stocks are not used as indicator stocks (at least not in the classic sense).

The 18 Production Stocks for which pre-season forecasts of returning abundance are made by DFO contribute significantly to total returning abundance in a given year (eg, the 18 Production stocks accounted for 96% of total escapement in 1999³³).

The Pacific Salmon Commission utilises 7-10 stock units for in-season management each year (see In-season stock units in table on page 3). Production stocks that have similar scale traits and migratory timing are grouped together into in-season stock units. Exploitation rates are assumed to be the same for each Production stock that is a component of a larger in-season stock unit³⁴.

The use of Late run stock is an example of an indicator stock used to guide management decisions for meeting a conservation exploitation rate objective on Cultus Lake sockeye and Late run stocks in general. Cultus Lake sockeye are a genetically distinct, making stock discrimination theoretically possible. However, the abundance of Cultus Lake sockeye in relation to other co-migrating Late run stocks is so small (e.g. <1%) makes discrimination practically impossible. Therefore in order to meet conservation objectives it is necessary to make assumptions about Cultus either based upon historical data or timing and abundance of co-migrating stocks. In this case the decision was to conduct management via the latter option.

Scoring Summary

All of the 60 and 80 Scoring Guidelines have been met.

Two of the four 100 Scoring Guidepost have been met.

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.

³¹ Cass, A. 2002. Pre-Season Run Forecast for Fraser River Sockeye and Pink Salmon in 2003. CSAS, DFO Research Document 2002/116. Section 2 (Data Sources and Methods), first sentence (page 6).

³² Jim Gable, Pacific Salmon Commission, pers comm.

³³ Cass, A. 2002. Pre-Season Run Forecast for Fraser River Sockeye and Pink Salmon in 2003. CSAS, DFO Research Document 2002/116. Abstract, first paragraph, fifth sentence, lines 6-7 (page 2).

³⁴ Jim Gable, Pacific Salmon Commission, pers comm.

- 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

Enhancement activity in the drainage is limited³⁵. There is little enhancement done to Fraser River sockeye stocks. There are four spawning channels—Nadina River, Horsefly River, Gates Creek and Weaver Creek—one hatchery program working with the Upper Pitt River stock and fertilization of, and fry release into, Adams Lake in 1997 and 2001.

In the Fraser, for the most part enhanced stocks are not significant contributors to any of the stock timing groups. The one exception to this is the contribution of enhanced Weaver sockeye which historically has been a relatively significant contributor to the Late run time Group in 2 of the four cycle years (cycle lines 2000 and 2001).

There has been minimal marking of enhanced sockeye largely because there is no mark sampling program for sockeye in the commercial fishery. Marking programs are not adequate to derive the proportion of enhanced sockeye in fisheries or escapement but an estimate of the proportion of enhanced fish can be made based on juvenile outputs, average survival and numbers of wild spawners. Using this method:

- The proportion of enhanced fish in the escapement to Nadina, Gates and Weaver is likely over 90% because of poor natural spawning conditions.

³⁵ Cross, C. Fraser River Sockeye Enhancement Projects.

- The proportion of enhanced fish in the escapement to the Upper Adams and the Horsefly is significantly lower, and minor in dominant years.
- The proportion of enhanced fish in the fishery would be inconsequential for Nadina and Gates as these are small stocks relative to others and, as noted, the proportion of enhanced fish in the Upper Adams and Horsefly is negligible in dominant years.³⁶

In the case of Weaver Creek, some concerns have been raised regarding its impact on weaker stocks.

Cultus sockeye are managed as part of a late run group that includes much larger and more productive stocks such as Adams (wild) and Weaver (enhanced). The Department's management policy establishes fishery objectives and escapement targets for the dominant stocks in the group (either Weaver or Adams), resulting in exploitation rates on other less productive stocks such as Cultus being too high³⁷.

For Cultus, generally, exploitation rates have exceeded 75% except in the early 1960's and the 1990's. Cycle-specific exploitation rates differ depending on the stock that triggers management actions. Cultus management is driven by Adams sockeye, a wild stock, in two of the four cycle years, and by Weaver, an enhanced stock, in the remaining two.³⁸

The management regime in recent years has been modified to address conservation concerns. Alternate harvest arrangements for Weaver stock have been used in recent years. For Cultus, beginning in 1995, exploitation rates decreased by over 40% to a mean of 36% as a result of conservation measures (eg, fishery restrictions) to protect all late-run stocks.³⁹

Harvests on Weaver stock take place in both mixed-stock and in terminal areas that have minimal impacts on other stocks. Weaver stock is harvested in both the approach areas and the lower Fraser River. These are mixed-stock areas and have the potential to impact upon weaker co-migrating sockeye stocks like Cultus Lake. Careful management of this enhanced stock is required to ensure that any impacts upon co-migrating stocks are minimized. Weaver stock is also harvested at the facility as an ESSR⁴⁰ and by beach seine in the Harrison after Birkenhead stocks have passed.

³⁶ Cross, C. Impacts of Weaver on Cultus & Enhanced Proportion of Returning Abundance.

³⁷ Schubert et al. 2002. Cultus Lake Sockeye Recovery Planning Process, section 4.10.4, paragraph 4, first paragraph (page 27).

³⁸ Schubert, N et al. Status of Cultus Lake sockeye salmon (*Oncorhynchus nerka*). Document attached. Section 1.5.1, two bullets following second paragraph (page 12).

³⁹ Schubert, N et al. Status of Cultus Lake sockeye salmon (*Oncorhynchus nerka*). Document attached. Section 4.7, first paragraph (page 47).

⁴⁰ This fishery occurs when salmon stocks return to a system after passing through the various fisheries and are at a level in excess of the capacity of the spawning grounds or enhancement facility, usually a hatchery, to receive them.

Scoring Summary

The information presented establishes that, while enhancement on the Fraser River system is relatively limited and enhanced production remains a negligible part of returning abundance, concerns do exist for Cultus Lake sockeye. Some concerns would remain even if exploitation rates were negligible. The impact of harvesting Weaver Creek enhanced production on Cultus Lake sockeye, whose migration timings are similar and that are harvested in some of the same fisheries, remains a concern.

Both of the 60 Scoring Guideposts have been met.

Both of the 80 Scoring Guideposts have been met

One of three 100 Scoring Guideposts has been achieved, one has been partially met and one is thought not to be 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.

Indicator 1.1.2.1

Estimates exist of the removals for each stock unit.

DFO Response**Current Situation**

DFO⁴¹ and the Pacific Salmon Commission⁴² use a variety of methodologies to evaluate the rate of removal for each stock unit.

DFO and the Pacific Salmon Commission have used DNA analysis to identify Fraser River sockeye stocks⁴³.

Annual estimates of sockeye spawning escapement and returns by stock (for the past fifty years) are maintained in an Access database available from the Pacific Salmon Commission⁴⁴. Differences between these two data sets for each stock unit provide estimates of removals.

Mechanisms exist to ensure accurate catch reporting and these mechanisms are evaluated annually⁴⁵.

Fisheries and Oceans Canada has done studies on mortality rates for the majority of released species for all sectors. Mortality rates are available from Fisheries and Oceans Canada. Where empirical studies are not available professional judgment is used in the estimation of mortality rates. Except for individual stocks for which DFO has exploitation rate ceilings, there is no explicit consideration of these mortality rates⁴⁶.

Scoring Summary

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

All of the Scoring Guideposts for the 60, 80 and 100 level have been met.

⁴¹ Gable J. and S. Cox-Rogers. 1993. Stock Identification of Fraser River Sockeye Salmon: Methodology and Management Application. Pacific Salmon Commission, Technical Report No. 5.

⁴² Report of the Fraser River Panel to the Pacific Salmon Commission on the Fraser River Sockeye and Pink Salmon Fishing Season. 1997: Section VII, second paragraph, page 26; Section VIII, sub-section A, pages 33-36. 1998: Section VIII, sub-section A, pages 30-32. 1999: Section VIII, sub-section A, pages 33-36. 2000: Section VIII, sub-section A, pages 30-32.

⁴³ Beacham, T.D., R.E. Withler, and C.C. Wood. 1995. Stock identification of sockeye salmon by means of mini-satellite DNA variation. N. Amer. J. Fish. Manage. 15: 249-265.

⁴⁴ Cass, A. 2002. Pre-Season Run Size Forecast for Fraser River sockeye and pink salmon in 2003. section 2 "Data Sources and Methods", first paragraph, second sentence (page 6).

⁴⁵ Kearey, L et al. Observer Log Book and Catch Reporting Summary 1998-2002.

⁴⁶ Bert Jonson, Fisheries and Oceans Canada, pers comm.

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.

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

DFO annually assesses the spawning escapement for each stock unit⁴⁷.

Annual estimates of sockeye spawning escapement and returns by stock (for the past fifty years) are maintained in an Access database available from the Pacific Salmon Commission⁴⁸.

⁴⁷ Report of the Fraser River Panel to the Pacific Salmon Commission on the Fraser River Sockeye and Pink Salmon Fishing Season. 1997: Table 13, page 46. 1998: Table 7, page 65. 1999: Table 13, page 53. 2000: Table 7, page 48.

⁴⁸ Cass, A. 2002. Pre-Season Run Size Forecast for Fraser River sockeye and pink salmon in 2003. section 2 "Data Sources and Methods", first paragraph, second sentence (page 6).

In-season, estimates of escapement past the Mission hydro-acoustic facility in the lower river are provided daily. These escapement estimates in conjunction with test fisheries, racial analyses and licensed fishery catches are used to regulate the fishery.

Annual escapement estimates are made for the majority of non-target sockeye stocks that are harvested in Fraser sockeye fisheries. These stocks include those of NE Vancouver Island, Johnstone Strait, the lower Mainland Inlets, Georgia Strait, and Puget Sound⁴⁹.

Escapement estimates of non-target species taken in Fraser River sockeye fisheries are made as part of DFO's escapement enumeration program⁵⁰.

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.

⁴⁹ Schubert, N. D. 1994 Fraser River Sockeye (*Oncorhynchus nerka*) Escapements. Can. Tech. Rep. Fisheries and Oceans #2201.

⁵⁰ Neil Schubert, Fisheries and Oceans Canada, pers comm.

- 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.

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

The Pacific Salmon Commission and DFO provide estimates of age and size as part of its ongoing analyses⁵¹ (see response to Indicator 1.1.2.4).

Pre-season forecasts of returning stock abundance are made using regression models that use spawning escapement to predict returning age-4 and age-5 sockeye⁵²

In post-season assessments conducted by the Pacific Salmon Commission, in-season stocks (7-10 per year) are evaluated⁵³. Catch and escapement data by age class are available for each of these stocks⁵⁴.

⁵¹ Report of the Fraser River Panel to the Pacific Salmon Commission on the Fraser River Sockeye and Pink Salmon Fishing Season (see references to 1997, 1998, 1999 and 2000 volumes following)..

1997: section III, fourth paragraph (page 5); page 7, last paragraph, third sentence, lines 4-6 ("The high velocities ... with smaller-than-average size...").

1998: Executive Summary, paragraph 12 (page 2), second sentence ("However, the return of age 4 fish..."); section IV, sub-section A, first paragraph (page 9), third sentence ("The run size forecasts...incorporated detailed forecasts of age-4 and age-5 returns..."); there are numerous references to the age of returning fish on page 13; page 21, last paragraph, sixth sentence, lines 9-11 ("While the total run returned...81% of the run was comprised (sic) of age 5 fish...and only 19% age 4 fish..."); page 26, third paragraph, second sentence, lines 3-7 ("In 1998, ...age composition data were used to provide in-season estimates of Fraser River sockeye contribution rates..."); page 31, third paragraph, last sentence ("Age 5 fish were important in the 1998 spawning of both Nadina and Stellako sockeye populations.").

1999: section V, sub-section A, last paragraph, last sentence ("The average weight of age 4₂ Fraser sockeye caught in purse seine test fisheries in Area 20 was 2.54 kg (5.59 lb).").

2000: page 19, last paragraph before Table 5 ("The average weight of age 4 Fraser sockeye caught in purse seine test fisheries in Area 20 was 2.78 kg (6.1 lbs.).").

⁵² Cass, A. 2002. Pre-Season Run Forecast for Fraser River Sockeye and Pink Salmon in 2003. CSAS, DFO Research Document 2002/116. Section 1, second paragraph, second sentence, lines 1-3.

⁵³ Gable and Cox-Rogers. 1993. page 28, first paragraph under heading "Post-Season Racial Analysis", first sentence of that paragraph.

⁵⁴ Pacific Salmon Commission. Production database, 1952 -. Vancouver BC.

In-season scale pattern analysis results are re-visited using revised baseline standards (see definition of baseline standards on page 22) collected from spawning ground escapements in the year being analysed. In some cases, this involves age-specific and sex-specific length data⁵⁵.

Catch by age data are available for (commercial and non-commercial) catches occurring in Panel Area and Non-Panel Area waters⁵⁶. Non-commercial catches include First Nations, recreational and test fishing. These data are documented annually in Fraser River Sockeye Salmon Racial Analyses. Data records are not current: the 1996 assessments are the most recent published (July 2003)⁵⁷.

More detailed descriptions are available in the Pacific Salmon Commission Technical Report No 5⁵⁸.

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-

⁵⁵ Gable and Cox-Rogers. 1993. page 28, penultimate paragraph on page.

⁵⁶ Fraser River Sockeye Salmon Racial Statistics, 1952-1995. Hard copies are available.

⁵⁷ Jim Gable, Pacific Salmon Commission, pers comm.

⁵⁸ Gable J. and S. Cox-Rogers. 1993. Stock Identification of Fraser River Sockeye Salmon: Methodology and Management Application. Pacific Salmon Commission Technical Report No 5.

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 Pacific Salmon Commission uses scale pattern analysis and DNA to identify Fraser River sockeye salmon stocks harvested in fisheries from Alaska to Washington⁵⁹. Scale pattern analysis is particularly useful because (1) scales are relatively easy to collect and (2) not requiring extensive preparation or preservation, can be analysed to provide estimates of stock composition within hours of being sampled⁶⁰. In recent years scale pattern analysis has been supplemented by additional DNA analysis to discriminate stocks. The use of DNA while more costly provides improved stock discrimination analysis in mixed stock fishery situations.

In using scale patterns to identify stocks in mixed stock fisheries, scale samples from each of the contributing stocks (baseline standards) must first be collected⁶¹.

In addition, DFO uses the information from catch monitoring to develop management plans for non-target stocks as well as target stocks. For example, this information is used to develop management guidelines that will harvest target stocks of sockeye while protecting Interior Fraser Coho". Historically, similar guidelines have been in place to protect Fraser Late timed chinook.

Information Collected from Catch Monitoring and Stock Assessment Programs

Two sampling programs for scale collection are initiated by the Pacific Salmon Commission each year⁶².

1. Spawning ground (baseline) scale sampling conducted by Fisheries and Oceans Canada staff.

⁵⁹ Gable, J. and S. Cox-Rogers. 1993. Stock Identification of Fraser River Sockeye Salmon: Methodology and Management Application. Pacific Salmon Commission Technical Report No 5. page 1, first paragraph, first sentence.

⁶⁰ Gable, J. and S. Cox-Rogers. 1993. page 1, penultimate paragraph, last sentence.

⁶¹ Gable and Cox-Rogers. 1993. page 4, first paragraph after heading "Scale Pattern Analysis: Methods", fourth sentence, lines 5-7 ("In using scale patterns...").

⁶² Gable and Cox-Rogers. 1993. page 6, second paragraph after heading "Scale Collection".

2. Commercial and test fishery scale sampling conducted by Pacific Salmon Commission staff in Fraser River Panel and Non-Panel waters.

In spawning ground scale sampling, matching otoliths are collected for most stocks (for aging)⁶³. Sex and two length measurements are collected for all samples⁶⁴.

In a typical year, commercial fishery scale sampling begins in late June and continues to the end of September or early October. Both adults and jacks are sampled. Samples are taken from fisheries in Alaska, BC and Washington⁶⁵. Separate samples are conducted for each gear type actively fishing during a scheduled opening⁶⁶.

As many as 12 commercial fisheries are sampled each week during the period of active commercial fishing⁶⁷. For adult samples, 240-360 scales are sampled, often with matching data on sex, weight and length (post-orbital/fork)⁶⁸. In addition, 120 scale samples per day are collected from test fisheries operating in Panel and Non-Panel waters throughout the fishing season⁶⁹.

Through the period of active in-season management, over 30,000 scales are aged and analysed⁷⁰. The Pacific Salmon Commission scale database is complete back to the 1950s⁷¹. In 2000 the Pacific Salmon Commission began using DNA analysis, along with scale analysis, to provide a more powerful analytical tool to identify Fraser River sockeye stocks in mixed stock fisheries.

Productivity Estimates for Target Stocks

Recruitment forecasts are based on brood year data using several models (eg, Ricker, Non-linear power, Geometric mean recruits per spawner, Juvenile, pooled)⁷².

Run size forecasts for 2003 and the model used to obtain the forecast for each stock unit are summarized in Table 1 of Cass⁷³

⁶³ Gable and Cox-Rogers. 1993. page 7, first paragraph, penultimate sentence.

⁶⁴ Gable and Cox-Rogers. 1993. page 7, first paragraph, last sentence.

⁶⁵ Gable and Cox-Rogers. 1993, page 7, second paragraph.

⁶⁶ Gable and Cox-Rogers. 1993. page 7, fourth paragraph, first sentence.

⁶⁷ Gable and Cox-Rogers. 1993, page 7, fourth paragraph, second sentence.

⁶⁸ Gable and Cox-Rogers. 1993, page 7, fourth paragraph, fourth sentence, lines 4-5.

⁶⁹ Gable and Cox-Rogers. 1993, page 7, fourth paragraph, fifth sentence, lines 5-8.

⁷⁰ Gable and Cox-Rogers. 1993, page 7, fourth paragraph, sixth sentence, lines 8-9.

⁷¹ Gable and Cox-Rogers. 1993, page 8, first paragraph, last sentence (first two lines appearing on the page).

⁷² Cass, A. 2002. Pre-Season Run Forecast for Fraser River Sockeye and Pink Salmon in 2003. CSAS, DFO Research Document 2002/116. Section 3 (Forecast Models), page 7, first sentence.

Management Guidelines for Target and Non-Target Stocks

DFO uses run size forecasts to develop pre-season management guidelines which are described in the IFMP⁷⁴.

Run timing and speed of migration were recognised as important information for stock management by the early 1960s⁷⁵. Data sources for stock timing include: marine tagging studies, spawning ground arrival curves, weir counts and stock-specific peak catch data. Migration speeds are estimated from tagging studies and by tracking daily abundances between adjacent areas using commercial and test fishery data⁷⁶.

The Pacific Salmon Commission employs an intensive in-season management regime to achieve domestic and international catch allocation goals and escapement objectives for Fraser River sockeye stocks. Fishery managers rely on rapid acquisition and analysis of data from commercial and test fisheries, and escapement estimates, to make informed decisions on appropriate weekly balances between catch and escapement⁷⁷.

Weekly scale samples and other biological data including fish length and weight are obtained from commercial fishery catches by each major gear type that potentially intercepts Fraser River sockeye salmon. Multiple samples are taken each week from Pacific Salmon Commission test fisheries to monitor changes in stock composition in key areas. For example, daily assessments of stock composition in test fisheries conducted in the Fraser River are applied to daily gross escapement estimates to provide managers with daily estimates of escapement by stock grouping⁷⁸.

Each week through the management season, analyses are conducted on commercial and test fishery samples from a wide range of areas. These analyses, along with production data, enable Pacific Salmon Commission staff to assess in-season run-timing and return strength of major Fraser River sockeye salmon stocks. Escapement goals of each stock group are monitored and fishing plans are developed that address stock-specific escapement and catch requirements. When discriminant function analyses are applied to in-season estimates of commercial catch, daily updates of catch by stock group, area and user group are tabulated⁷⁹.

⁷³ Cass, A. 2002. Pre-Season Run Forecast for Fraser River Sockeye and Pink Salmon in 2003. CSAS, DFO Research Document 2002/116. Table 1, page 17.

⁷⁴ See, for example, IFMP 2003, sections 4.1.1 and 4.1.2 (page 23).

⁷⁵ Gable and Cox-Rogers. 1993. page 14, first paragraph under heading "Review of Run Timing and Speed of Travel", second sentence, lines 3-6.

⁷⁶ Gable and Cox-Rogers. 1993. first paragraph under heading "Review of Run Timing and Speed of Travel", last two sentences of that paragraph (=last two sentences on that page).

⁷⁷ Gable and Cox-Rogers. 1993. page 21, first paragraph after heading "In-Season Racial Analysis.

⁷⁸ Gable and Cox-Rogers. 1993. page 24-25, paragraph ending on page 24 and continuing at top of page 25.

⁷⁹ Gable and Cox-Rogers. 1993. page 28, first full paragraph.

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 have not yet been formally defined.

Operational equivalents of Limit Reference Points (returning abundances at which the exploitation rate would effectively be set to zero) have been defined⁸⁰.

An operational equivalent of a Limit Reference Point has been defined for Early Stuart sockeye⁸¹.

Operational equivalents for other run timing groups (Early Summer, Summer and Late Run) have been established within a range⁸².

These operational equivalents of Limit Reference Points are appropriate to protect stocks harvested in the fishery⁸³.

The operational equivalents of Limit Reference Points for target species have been reviewed and found to be defensible and have been adopted by Canada and the Fraser River Panel for management purposes⁸⁴.

The basis for the operational equivalents of the Limit Reference points is consensus-based policy⁸⁵.

Scoring Summary

DFO has not established Limit Reference Points for each Fraser River sockeye stocks. However, an operational equivalent exists for Early Stuart sockeye and a range estimate exists for the other three run timing groups.

⁸⁰ Report of the Fraser River Panel to the Pacific Salmon Commission on the Fraser River Sockeye and Pink Salmon Fishing Season (see references to 1997, 1998, 1999 and 2000 volumes following). **1997:** Appendix A, Table 2 (page 38). **1998:** Appendix A, Table 2 (page 38). **1999:** Appendix A, Table 2 (page 43). **2000:** Appendix A, Table 2 (page 39).

⁸¹ IFMP 2003, Table 5, page 44.

⁸² IFMP 2003, Table 5, page 44.

⁸³ Wayne Saito, Fisheries and Oceans Canada, pers comm.

⁸⁴ Wayne Saito, Fisheries and Oceans Canada, pers comm.

⁸⁵ Wayne Saito, Fisheries and Oceans Canada, pers comm.

The sole 60 Scoring Guidepost has been met.

Both of the 80 Scoring Guideposts have been met.

None of three 100 Scoring Guideposts have been met.

Future Changes

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 a total stock abundance at or over the target reference point. A 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 risk⁸⁶.

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.

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.

⁸⁶ Fisheries and Oceans Canada, 2000. Wild Salmon Policy: Discussion Paper. Principle 3, page 3.

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 have not yet been formally defined.

Operational equivalents of Target Reference Points have been defined⁸⁷.

These operational equivalents are based on stock recruitment and productivity assessments done for Fraser sockeye⁸⁸.

Where data and information exists, individual populations within a management stock group are taken into account when establishing a Target Reference Point for a management stock group⁸⁹.

Target Reference Points for target species have been reviewed and found to be scientifically defensive and appropriate⁹⁰. DFO is currently undertaking a review of the Target Reference Points by updating analyses with additional data.

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 three 60 Scoring Guideposts have been met.

Both 80 Scoring Guideposts have been met.

All three 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

⁸⁷ Fisheries and Oceans Canada. 1995. Fraser River Sockeye Salmon. Appendix 5, page 55.

⁸⁸ Fisheries and Oceans Canada. 1995. Fraser River Sockeye Salmon. Section 6, pages 40-43.

⁸⁹ Wayne Saito, Fisheries and Oceans Canada, pers comm.

⁹⁰ Fisheries and Oceans Canada. 1995. Fraser River Sockeye Salmon. Section 6, pages 40-43, especially page 43, first full paragraph.

units to assist in fisheries planning. The eventual 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.

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.⁹¹

Stock aggregates are allowed to recover to more than 125% of the Target Reference Point for abundance before any fisheries are permitted that target these stocks⁹².

The current management plan is a continuing effort to rebuild sockeye populations following river blockages early in the last century.

This plan has led to the current policy of continually expanding escapements whenever possible⁹³.

For the four run timing groups the 7-10 in-season stock units, there are well defined strategies or pre-specified time frames for rebuilding. Depending on the cycle year, most rebuilding strategies reach the Target Reference Point in 3-4 cycles (12-16 years)⁹⁴. There is a current initiative to re-examine this strategy⁹⁵.

Recovery plans are developed as required and have consisted of fisheries restrictions to varying degrees.

For the (7-10) in-season stock units per cycle year, the existence of strategies to rebuild compromised components depends entirely on the relative importance of the unit to the run-timing group. Where the in-season stock unit is a significant part of the run-timing group there are general rules to restrict harvest to allow recovery. Where the in-season stock unit is not a significant part of the run-timing group the general rules are not invoked.

Artificial enhancement may be used to supplement rebuilding measures.

Scoring Summary

Both 60 Scoring Guideposts have been met.

One of 80 Scoring Guideposts has been met and the other has been partially met.

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

⁹¹ 2003 IFMP – Table 5

⁹² Wayne Saito, Fisheries and Oceans Canada, pers comm.

⁹³ Fraser River Sockeye Management and Enhancement Plan. Summary Draft, December 1988. page 26, paragraph 1.

⁹⁴ Fisheries and Oceans Canada. 1988. Fraser River Sockeye Management and Enhancement Plan. Page 22, paragraph 1; page 22, paragraph 2; page 23, paragraph 1 and page 22, Table 8.

⁹⁵ Wayne Saito, Fisheries and Oceans Canada, pers comm.

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

The Fraser River Panel of the Pacific Salmon Commission⁹⁶ has set operational equivalents for Limit Reference Points as provided by DFO in their annual Fraser River Panel Reports⁹⁷. As indicated in the IFMP⁹⁸ the exploitation rate is reduced at lower abundance levels.

The majority of Fraser River stock groups are assessed to be above appropriate Limit Reference Points or their operational equivalents.

Spawning escapement levels for several of the target stocks on some cycle years have not met appropriate Limit Reference Points, specifically Early Stuart and Late Run management stock groups⁹⁹.

While high harvest levels have played a part in target stocks being at low levels, in recent years harvest rates have been significantly reduced in order to protect stocks that have experienced poor environmental conditions or high pre-spawn mortalities. The root cause of this situation is largely environmental in that the returning adults have recently experienced very high levels of pre-spawning mortalities due to adverse in-river migration conditions or atypical in-river migration timing¹⁰⁰.

In response to this situation, DFO has set exploitation targets for these stocks that will allow them to re-build to, and above, appropriate Target Reference Points¹⁰¹.

DFO is currently undertaking a review of its operational equivalents of its Target Reference Points¹⁰².

DFO has responded to these rebuilding targets (ie, its operational equivalents of Target Reference Points) by developing a rebuilding plan that could include such actions as closing fisheries¹⁰³.

⁹⁶ Report of the Fraser River Panel to the Pacific Salmon Commission on the Fraser River Sockeye and Pink Salmon Fishing Season. 1997: Appendix A Table 2 Page 38. 1998: Appendix A Table 2 Page 38. 1999: Appendix A Table 2 Page 43. 2000: Appendix A Table 2 Page 39.

⁹⁷ Wayne Saito, Fisheries and Oceans Canada, pers comm.

⁹⁸ IFMP 2003, Table 5, page 44.

⁹⁹ Wayne Saito, Fisheries and Oceans Canada, pers comm. Jeff Grout, Fisheries and Oceans Canada, pers comm. Jim Gable, Pacific Salmon Commission, pers comm.

¹⁰⁰ Report of the Fraser River Panel to the Pacific Salmon Commission on the Fraser River Sockeye and Pink Salmon Fishing Season. 2000: Executive Summary Section 9 Page 1.

¹⁰¹ Fisheries and Oceans Canada. 1995. Fraser River Sockeye Salmon. Appendix 5, page 55.

¹⁰² Wayne Saito, Fisheries and Oceans Canada, pers comm.

¹⁰³ Wayne Saito, Fisheries and Oceans Canada, pers comm.

Scoring Summary

The information presented above establishes that none of the Fraser River sockeye salmon stocks is depleted. Limit Reference Points have not been defined but operational equivalents are defined for one stock and ranges are used for the others.

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.

Future Changes

Efforts will continue to rebuild Early Stuart and Late Run stock groups to ensure their spawning escapements remain above Limit Reference Points. Success will depend upon significant improvements in recent environmental and in-river migration conditions as opposed to significant changes in how the fishery is managed.

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

See response to Indicator 1.1.2.3 on consideration of age and size data, especially the lengthy first footnote on page 20. Age, size and sex all figure significantly in in-season decision-making.

Age of fish is taken into account in the analyses yielding run size forecasts¹⁰⁴. Sex of fish ("effective females") also figures significantly in the run size forecast¹⁰⁵

Sampling of Fraser River sockeye catch for age and size is conducted annually according to a long-established sampling regime on a schedule determined by the timing of the fisheries. Sampling would appear to be driven primarily by sample requirements for the determination of stock composition and requirements to construct brood production used in stock/recruit relationships.

Changes in size and age of the Fraser sockeye stock components are used in forecasting and population (production) modeling and therefore indirectly in fisheries management.¹⁰⁶

In-season measures of size and age, other than as auxiliary information in determining stock composition, are generally not used by fisheries management. In-season estimates of fish size are being considered for inclusion in in-season models forecasting in-river mortality.

Forecasts of in-season mortality are used by the Pacific Salmon Commission to regulate fisheries where there is an escapement goal for the target stock components.

Age and size sampling are conducted on the spawning ground as part of escapement enumeration and independently by the Pacific Salmon Commission as part of their stock identification

¹⁰⁴ Cass, A. 2002. Pre-Season Run Forecast for Fraser River Sockeye and Pink Salmon in 2003. CSAS, DFO Research Document 2002/116. Section 1 (Introduction), second paragraph, first sentence (page 6).

¹⁰⁵ Cass, A. 2002. Pre-Season Run Forecast for Fraser River Sockeye and Pink Salmon in 2003. CSAS, DFO Research Document 2002/116. Section 2 (Data Sources and Methods), first paragraph, fourth sentence, lines 6-8 "The main explanatory variable ... is the effective female spawning escapement...", (page 6).

¹⁰⁶ Cass, A. 2002. Pre-Season Run Forecast for Fraser River Sockeye and Pink Salmon in 2003. CSAS, DFO Research Document 2002/116.

programs. This information is used in the reconstruction of brood production that is used in estimating stock/recruit relationships.

Sampling for age and size in non-target species is done where appropriate. For example, the size of early-migrating interior coho, which are caught in net fisheries directed at Fraser sockeye, is sampled at indicator sites throughout southern BC including the interior Fraser and the Thompson.

Sampling for age and size is generally not conducted for minor non-target sockeye stocks. Exceptions occur where monitoring of abundance in these stocks has indicated changes in status and where knowledge of changes in age and size would be useful in diagnosing the causes (eg, Sakinaw).

In the case of Fraser sockeye, enhanced stocks are not a significant contributing amount and therefore are not generally managed as a separate stock. The exception to this statement is Weaver sockeye as outlined in section 1.1.1.5. Careful management of this enhanced stock is required to ensure that any impacts upon co-migrating stocks are minimized.

Scoring Summary

All three 60 Scoring Guideposts have been met.

All three 80 Scoring Guideposts have been met.

All 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.