Fraser River Sockeye Salmon

2014 Planning Memo

(Option Comparison)

DRAFT / 14-Mar-2014 v3

Prepared by the FRSSI Working Group

Note that this document incorporates updated sections from earlier FRSSI-related materials, such as annual planning memos and published reports.

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Outline

This document summarizes the 2014 pre-season planning information for Fraser River Sockeye.

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- Chapter 2 outlines the context for 2014 planning, covering 3 topics:
  - Recent spawner abundances compared to the observed range (by stock)
  - Indications of improved productivity (total)
  - Integrated biological status under the *Wild Salmon Policy* (by conservation unit)
- Chapter 3 describes 2 options and compares expected outcomes (by management group and by stock)
- Chapter 4 discusses additional considerations:
  - Potential fisheries to harvest *Excess Salmon to Spawning Requirements* (ESSR)
  - Potential modifications to the Management Adjustment (MA) for very large run sizes
  - Recovery Objectives for Cultus Lake Sockeye

1. Introduction

Planning Process

The Fraser River Sockeye Spawning Initiative has been a multi-year collaborative planning process to develop a long-term escapement strategy.

In 2003 Fisheries and Oceans Canada (DFO) committed to reviewing the rebuilding plan which had been in place since 1987, and established a collaborative planning process for incorporating new information and emerging policies.

The technical groundwork was laid through the development of a simulation model which was refined over three years and six workshops, leading up to an intensive two-year planning exercise that merged the FRSSI model into a pilot implementation of the integrated management processes envisioned under the Wild Salmon Policy (WSP). This combined approach was the logical next step in determining an integrated escapement and harvest strategy for Fraser River sockeye while implementing the WSP and responding to the 2002 Ministerial review of Fraser River sockeye fisheries.

Since 2006, the FRSSI simulation model has been fully integrated into the annual management cycle for Fraser River sockeye, which is bracketed by two phases of public consultation, the post-season review in the fall and pre-season planning in the spring. Annual consultations occur with First Nations and stakeholders as part of the IFMP development process.

The References section on page 42 lists key publications resulting from the FRSSI process. A summary document, called *A Brief History of Fraser Sockeye Harvest Planning: 2003-2013* has been prepared as a companion document to this memo, and is available from Kelly Binning (Kelly.Binning@dfo-mpo.gc.ca).

During the annual IFMP planning process, the Department reviews possible adjustments to harvest decision rules based on feedback from consultation and expected performance of individual conservation units. Typically, a shortlist of 2 to 5 harvest rule options (with different fishery reference points) for each management group has been provided in past years for discussion during pre-season consultations. The final IFMP incorporates the final harvest rule/fishery reference points selected for each management unit. These harvest rules and fishery reference points then shape the in-season management of fisheries.

The ultimate goal of this work was to converge on a long-term strategy so that an annual process would not be needed. The collaborative nature of the FRSSI model and CSAS reviews was intended to reduce scientific disagreement. However, each year there has been additional work identified through in-season implementation, post-season reviews, and pre-season consultations. One reason for this is that small changes in harvest strategy, that have little effect on long-term performance and trade-offs, can have substantial implications for fisheries planning in a given year (e.g. due to overlap in run timing)

Expectations for 2014

The 2014 pre-season forecast generally predicts (three in four chance) of an above cycle average return, given the large total spawner abundance in the 2010 brood year for a number of stocks; survival (recruits-per-spawner) has returned to average generally for most stocks following the 2009 poor returns (amongst the lowest survival on record for most stocks). However, there are stock-specific differences in forecasted abundance that need to be considered in the planning and implementation of fisheries

Major challenges for 2014 harvest planning are:

- *Uncertainty in forecasts:* Higher than usual, because for several of the stocks the brood year abundance exceeded the previously observed range, and there is no available data on returns from these abundances (Scotch, Seymour, Harrison, Late Shuswap and Portage Creek).). Although juvenile data do provide support for the overcompensation (lower freshwater survival) predicted by adult stock-recruitment models. Note that the Chilko does not fall into this category, because the forecast is based on smolt data, which did not fall outside the observed range.
- *Uncertain en-route mortality:* Fraser sockeye can experience substantial mortality during their upstream migration, depending on river conditions (water temperature and discharge) and timing of peak migration. This en-route mortality occurs upstream of most of the major fisheries, and in-season projections of mortality are used to adjust the allowable exploitation rate in an attempt to achieve escapement objectives. The adjustments tend to be small for Summer Run sockeye (except for 1998, 2006 and 2013), but can be substantial for the other management groups (e.g. 20-30%, out of a total allowable mortality of 60%)
- *Availability of in-season information*: In-season estimates of abundance are generated for the management groups and larger stocks with current stock ID methodology (i.e. scale patterns, DNA). Estimates become better as more of the stocks migrate past the major fisheries and enter the river, and weekly in-season run size updates/modifications typically occur shortly after the peak migration of each management group through Area 20.
- *Aggregate harvest of multiple stocks*: Populations of Fraser Sockeye differ in terms of their productivity, which also changes over time. In past years, the aggregate harvest plan has been constrained to 60% total allowable mortality to protect less productive stocks in a management group. One option for 2014, given the large expected run size, is to increase the cap to 65%.
- *Uncertainty in capacity*: Given all of the challenges listed above, it is likely that spawner abundances in 2014 will be large to very large for several of the stocks. This raises concerns regarding potential capacity limits of the nursery lakes, but it is difficult to estimate optimal levels of spawner abundance, either as a long-term average or for a specific year. Alternative estimates can differ widely, and this uncertainty needs to be taken into account (e.g. when planning ESSR-type fisheries).

Based on these challenges, DFO has included 2 options in the draft *Integrated Fisheries Management Plan*:

- *Option 1 – Like Cycle Year*: Same TAM rules as in 2010, except that the Fishery Reference Points were adjusted to account for Raft now being managed as part of the Summer group, and Harrison and North Thompson being managed as miscellaneous Summer stocks. In addition the Early Stuart Fishery Reference Points were changed to those used durting the last two years.
- *Option 2 – Increase TAM cap*: Increase TAM cap to 65% due to large expected run size for Early Summer, Summers and Lates. Lower FRP stay the same, but Upper FRP increase due to the gradual increase in TAM until it reaches the cap.

Chapter 2 of this memo summarizes the planning context for 2014, in terms of recent spawner abundances, patterns in productivity, and integrated biological status. Chapter 3 describes the 2 options in detail and compares their expected outcomes, given pre-season estimates of abundance and en-route mortality. Chapter 4 outlines additional considerations that are likely to shape the 2014 fishing season.

2. Context for 2014 Planning

Overview

This Chapter covers 3 topics:

- Recent spawner abundances compared to the observed range (by stock)
- Indications of improved productivity (total)
- Integrated biological status under the Wild Salmon Policy (by of conservation unit)

Recent spawner abundances compared to observed time series and to various benchmarks

The FRSSI model is useful for evaluating the long-term expected performance of alternative strategies. This section looks at the other side of the equation: *What is the observed performance of the recent harvest strategies in terms of spawner abundance?*

Table 1 to Table 3 summarize observed spawner abundances for the 19 modelled stocks and show comparisons in different contexts.

Key points to note in **Table 1** are:

- Fraser sockeye stocks cover a very wide range of abundances. Median spawner abundances since 1952 range from less than 10,000 (Bowron, Fennel, Gates, Nadina, Scotch, Raft, Harrison, Cultus, Portage) to more than 300,000 (Chilko). (Col 1E)
- Fraser sockeye stocks fluctuate greatly over time. The largest observed spawner abundance (Col 1G) is typically many times larger than the median (as high as 150 times for Scotch and 230 times for Late Shuswap). Figure 11 (p35) and Figure 12 (p36) show the patterns over time.
- Some of the stocks, which typically account for a large part of the annual abundance, show strong cyclic patterns, with the dominant years 10 to 100 times larger than the off-cycle years (Cols 1H to 1K).
- Even the generational averages, which smooth out the annual fluctuations and cyclic pattern, are highly variable over time (compare min in Col 1M to avg in Col 1L).
- Note: The generational average used throughout the tables and figures in this memo is the arithmetic 4yr mean calculated as A+B+C+D/4. This is more sensitive to large outliers than the geometric mean calculated as Root(A*B*C*D), but the resulting values are more in line with the common interpretation of a central value. This makes the most difference for cyclic stocks. To illustrate for 2009 to 2012:

Stock	Spawners	Arithmetic Mean	Geometric Mean
Stellako	27,793 / 204,414 / 85,628/ 137,993	113,957	90,517
Late Shuswap	32,481 / 7,519,018 / 165,695 / 12	1,929,302	26,398

- Two sets of benchmarks have been used to evaluate Fraser River Sockeye. The FRSSI BM for all stocks (source= Pestal, Huang and Cass 2011) and the WSP BM for non-cyclic stocks (source = Grant and Pestal 2012). These are listed in columns 1N to 1Q.
  - The two sets of benchmarks cover a similar range for 5 of the 11 stocks (Bowron, Fennel, Pitt, Harrison, Weaver). But note that both sets of benchmarks are outdated for Harrison, given recent spawner abundances.
  - WSP lower BM are roughly **half** the FRSSI BM 2 for 2 of the stocks (Chilko, Birkenhead).
  - WSP lower BM are roughly **double** the FRSSI BM 2 for 3 of the stocks (Nadina, Stellako, Cultus).
  - WSP lower BM is roughly **4 times** the FRSSI BM 2 for Raft.

Key points to note in **Table 2** are:

- For 14 of the 19 stocks, the most recent generational average (2009-2012) is close to or larger than the average of all the observed generational averages (Col 4C). The exceptions are Early Stuart, Bowron, Late Stuart, Quesnel, and Cultus. For all stocks, the latest gen avg is larger than their lowest observed generational average (Col 4D).
- For 16 of the 19 stocks, the most recent generational average (2009-2012) is close to or larger than the FRSSI Benchmark 2, which has been used to identify low spawner abundance (Col 4F). The exceptions are Early Stuart, Quesnel, and Cultus.
- Lower WSP benchmarks have been developed for 11 stocks without persistent cyclic patterns. For 10 of the 11 stocks with WSP BM, the most recent generational average (2009-2012) is close to or larger than the lower end of the uncertainty range in BM estimates (Col 4G). The exception is Cultus.). 8 of 11 stocks are at or above the upper end of the uncertainty range for the Lower WSP BM (Col 4H). The exceptions are Bowron, Raft, and Cultus.

Key points to note in **Table 3** are:

- Despite the large spawner abundance in 2010, the most recent generational average (2009-2012) falls below the highest observed generational average for 12 of the 19 stock (shaded grey in Col 5H), and is smaller than the upper quarter of the observed generational averages for 6 stocks (shaded grey in Col 5G).
- For 5 of the stocks, the most recent generational average (2009-2012) was the highest observed generational average since 1955 (as marked by 1.00 in Col 5H). These stocks are Scotch, Seymour, Chilko, Harrison, and Late Shuswap.
- For 6 stocks of the 11 non-cyclic stocks for which WSP BM are available, the most recent generational average (2009-2012) is substantially below the upper end of the range of estimates for the Upper WSP BM (shaded in Col 5D).

Table 1: Observed ranges, averages, and benchmarks for Fraser Sockeye stocks.

All ranges and averages are for all available data from the period 1952 to 2012. Num Obs is the number of years with an escapement estimate, since 1952. Generational Average is the 4-yr moving average (arithmetic). Avg (Col 1L) here is the average of all the available generational averages. Min (Col 1M) is the lowest obs gen avg. L. Shuswap is sum of Adams and Shuswap time series in PSC file. FRSSI BM are the lower and upper end for a range spanning 5 alternative values (Min obs generational avg, and 4 SR-based estimates, such as spawner abd that creates 40% of max recruits). FRSSI Benchmarks have not been re-estimated with recent data. This is most pronounced for Harrison, which has increased substantially, but applies more generally for all stocks. A clear process for regular review and updating needs to be established to incorporate new information. WSP Lower BM are estimates of the spawner abundance needed to return to Smsy in one generation in the absence of fishing (Sgen), which should be compared to the generational average. These have not been finalized for highly cyclic populations and for stocks that are combined into a CU (Scotch and Seymour are both part of the Shuswap-ES CU.) WSP BM Source: Grant & Pestal (2012)

	1A	1B	1C	1D	1E	1F	1G	1H	1I	1J	1K	1L	1M	1N	1O	1P	1Q
			Observed Range of Total Spawners					**Cycle Line Averages** (since 1952)				**Generational Averages**		**FRSSI BM Low Spawners** Compare to Generation Avg (4yr)		**WSP Lower BM Range**	
	Stock	Num Obs	Min	Lower Quarter	**Median**	Upper Quarter	Max	2011	2012	2013	**2014**	Avg	Min	BM1	BM2	From	To
	E. Stuart	61	758	21,044	**35,816**	109,655	687,967	50,974	40,017	210,335	**36,466**	85,575	10,218	10,200	50,300		
Early Summer	Bowron	61	59	2,500	**4,919**	10,463	35,000	17,585	6,066	4,812	**5,432**	8,395	1,593	1,500	4,900	4,000	5,000
Early Summer	Fennell	50	5	1,142	**4,599**	9,760	32,279	7,510	7,021	2,468	**4,198**	7,305	483	500	2,200	510	2,000
Early Summer	Gates	61	45	930	**5,374**	12,921	99,998	7,973	28,779	6,379	**2,804**	11,317	1,576	1,100	3,500		
Early Summer	Nadina	61	901	2,802	**9,499**	22,603	200,294	20,163	25,082	24,916	**4,939**	18,859	7,603	2,000	9,100	17,000	20,000
Early Summer	Pitt	61	3,560	13,637	**19,023**	37,542	131,481	28,006	32,161	28,561	**26,655**	27,958	11,229	3,400	11,200	6,000	10,000
Early Summer	Scotch	47	7	922	**3,395**	9,157	522,367	5,224	973	5,441	**66,329**	32,605	2,186	900	4,000		
Early Summer	Seymour	61	824	5,692	**14,355**	44,588	552,149	40,969	7,882	6,151	**109,452**	39,905	9,661	9,100	19,000		
Summer	Raft	61	464	2,714	**6,244**	10,040	66,292	5,119	16,113	8,371	**5,839**	8,900	2,576	2,500	5,200	4,000	19,000
Summer	Chilko	61	34,296	138,464	**363,389**	555,226	2,459,946	501,259	464,529	248,038	**456,312**	410,068	164,485	66,400	164,500	31,000	63,000
Summer	Late Stuart	61	35	7,117	**28,715**	146,569	1,356,737	19,972	55,296	412,608	**45,538**	134,140	44,081	29,500	78,300		
Summer	Quesnel	61	63	624	**39,841**	278,961	3,510,789	58,225	8,667	1,042,469	**405,148**	389,392	27,840	7,800	154,500		
Summer	Stellako	61	21,826	42,099	**85,628**	141,613	372,456	118,732	128,577	58,600	**124,541**	108,640	37,018	22,700	45,400	42,000	96,000
Summer	Harrison	61	313	4,239	**8,577**	21,030	805,617	74,915	10,474	55,328	**76,004**	44,444	3,555	2,000	4,100	200	9,000
Late	Birkenhead	61	11,998	31,681	**49,586**	95,141	335,630	100,074	64,279	50,710	**124,503**	84,630	23,175	19,700	39,300	11,000	27,000
Late	Cultus	61	82	1,063	**5,942**	16,725	47,779	18,987	6,854	3,885	**10,296**	9,926	1,189	1,000	7,300	12,000	14,000
Late	Portage	58	9	1,080	**3,499**	9,084	58,086	4,180	934	5,126	**17,216**	7,804	1,301	100	1,300		
Late	Weaver	61	924	17,167	**35,556**	57,092	295,014	34,944	29,690	34,748	**66,272**	41,876	8,892	8,600	19,800	4,000	13,000
Late	L. Shuswap	61	12	3,472	**32,481**	1,144,569	7,519,018	357,094	4,190	7,016	**2,652,143**	738,523	320,615	111,100	320,500		

Table 2: Recent Spawners compared to earlier generations, FRSSI benchmarks, and Lower WSP benchmarks.

Generational Average = 4-yr moving average (arithmetic). FRSSI BM are the lower and upper end for a range spanning 5 alternative values (Min obs generational avg, and 4 SR-based estimates, such as spawner abd that creates 40% of max recruits). FRSSI Benchmarks have not been re-estimated with recent data. This is most pronounced for Harrison, which has increased substantially, but applies more generally for all stocks. A clear process for regular review and updating needs to be established to incorporate new information. WSP Lower BM are estimates of the spawner abundance needed to return to Smsy in one generation in the absence of fishing (Sgen), which should be compared to the generational average. These have not been finalized for highly cyclic populations and for stocks that are combined into a CU (Scotch and Seymour are both part of the Shuswap-ES CU.) WSP BM Source: Grant & Pestal (2012)

Comparison to Obs Gen Avg is the last available Gen Avg divided by the arithmetic mean of all gen averages (Col 4A / Col 1L) or the lowest observed gen Avg (Col 4A / Col 1M). Shaded cells with bold font mark any instance where the comparison is less than 0.75 (e.g. if last available average is less than 3/4 of FRSSI BM 2)

	4A	4B	4C	4D	4E	4F	4G	4H	4I
		Generational Average	Gen Avg Compared To						
			Obs Gen Avg		FRSSI		WSP Lower BM		CU Match
	Stock	2009-2012	Avg	Min	BM 1	BM 2	From	To	
	E. Stuart	33,138	**0.39**	3.24	3.25	**0.66**			Takla-Trembleur-EStu
Early Summer	Bowron	3,828	**0.46**	2.40	2.55	0.78	0.96	0.77	Bowron-ES
Early Summer	Fennell	5,923	0.81	12.27	11.85	2.69	11.61	2.96	North Barriere-ES (de novo)(also incl. Misc)
Early Summer	Gates	28,564	2.52	18.12	25.97	8.16			Anderson-Seton-ES
Early Summer	Nadina	19,636	1.04	2.58	9.82	2.16	1.16	0.98	Nadina-Francois-ES (new mixed CU)
Early Summer	Pitt	45,474	1.63	4.05	13.37	4.06	7.58	4.55	Pitt-ES
Early Summer	Scotch	140,713	4.32	64.38	156.35	35.18			Part of Shuswap-ES
Early Summer	Seymour	143,555	3.60	14.86	15.78	7.56			Part of Shuswap-ES
Summer	Raft	8,959	1.01	3.48	3.58	1.72	2.24	**0.47**	Kamloops-ES (also incl. Misc)
Summer	Chilko	959,795	2.34	5.84	14.45	5.83	30.96	15.23	Chilko-S & Chilko ES
Summer	Late Stuart	64,854	**0.48**	1.47	2.20	0.83			Takla-Trembleur-Stuart-S
Summer	Quesnel	111,537	**0.29**	4.01	14.30	**0.72**			Quesnel-S
Summer	Stellako	113,957	1.05	3.08	5.02	2.51	2.71	1.19	Francois-Fraser-S
Summer	Harrison	486,374	10.94	136.80	243.19	118.63	2,431.87	54.04	Harrison River (River-Type)
Late	Birkenhead	116,655	1.38	5.03	5.92	2.97	10.61	4.32	Lillooet-Harrison-L
Late	Cultus	4,755	**0.48**	4.00	4.75	**0.65**	**0.40**	**0.34**	Cultus-L
Late	Portage	15,293	1.96	11.76	152.93	11.76			Seton-L (de novo)
Late	Weaver	42,239	1.01	4.75	4.91	2.13	10.56	3.25	Harrison (U/S)-L
Late	L. Shuswap	1,929,302	2.61	6.02	17.37	6.02			Shuswap Complex-L

Table 3: Recent Spawners compared to high end of earlier generations and Upper WSP benchmarks.

Generational Average = 4-yr moving average (arithmetic). WSP Upper BM are estimates of the 80% Smsy, which should be compared to the generation average, rather than a single year. These have not been finalized for highly cyclic populations and for stocks that are combined into a CU (Scotch and Seymour are both part of the Shuswap-ES CU.) WSP BM Source: Grant & Pestal (2012)

Comparison to Obs Gen Avg is the last available Gen Avg divided by the upper quartile of all gen averages (1/4 of gen avg have been higher) or the highest observed Gen Avg. Shaded cells with bold font mark any instance where the comparison is less than 0.75 (e.g. if last available generational average is less than 3/4 of WSP Upper BM)

	5A	5B	5C	5D	5E	5F	5G	5H	5I	5J	5K
		Generational Average	**Gen Avg Compared To**						**WSP Upper BM** Range		
			WSP Upper BM		**Smsy**		**Obs Gen Avg**				**CU Match**
	Stock	2009-2012	From	To	From	To	Upper Q	Max	From	To	
	E. Stuart	33,138					**0.32**	**0.13**			Takla-Trembleur-EStu
Early Summer	Bowron	3,828	**0.64**	**0.23**	**0.51**	**0.18**	**0.37**	**0.24**	6,000	17,000	Bowron-ES
Early Summer	Fennell	5,923	1.18	0.85	0.95	**0.68**	**0.60**	**0.37**	5,000	7,000	North Barriere-ES (de novo)(also incl. Misc)
Early Summer	Gates	28,564					1.56	0.89			Anderson-Seton-ES
Early Summer	Nadina	19,636	**0.41**	**0.34**	**0.33**	**0.27**	0.97	**0.29**	48,000	58,000	Nadina-Francois-ES (new mixed CU)
Early Summer	Pitt	45,474	2.67	1.68	2.14	1.35	1.59	**0.50**	17,000	27,000	Pitt-ES
Early Summer	Scotch	140,713					5.01	1.00			Part of Shuswap-ES
Early Summer	Seymour	143,555					3.83	1.00			Part of Shuswap-ES
Summer	Raft	8,959	**0.41**	**0.15**	**0.33**	**0.12**	0.88	**0.28**	22,000	60,000	Kamloops-ES (also incl. Misc)
Summer	Chilko	959,795	4.32	3.52	3.46	2.81	1.72	1.00	222,000	273,000	Chilko-S & Chilko ES
Summer	Late Stuart	64,854					**0.43**	**0.16**			Takla-Trembleur-Stuart-S
Summer	Quesnel	111,537					**0.19**	**0.06**			Quesnel-S
Summer	Stellako	113,957	1.27	**0.58**	1.01	**0.46**	0.87	**0.46**	90,000	197,000	Francois-Fraser-S
Summer	Harrison	486,374	48.64	11.31	38.91	9.05	26.44	1.00	10,000	43,000	Harrison River (River-Type)
Late	Birkenhead	116,655	2.29	1.46	1.83	1.17	1.03	**0.52**	51,000	80,000	Lillooet-Harrison-L
Late	Cultus	4,755	**0.30**	**0.15**	**0.24**	**0.12**	**0.32**	**0.18**	16,000	32,000	Cultus-L
Late	Portage	15,293					1.56	0.99			Seton-L (de novo)
Late	Weaver	42,239	0.98	**0.56**	0.79	**0.44**	0.77	**0.37**	43,000	76,000	Harrison (U/S)-L
Late	L. Shuswap	1,929,302					2.30	1.00			Shuswap Complex-L

Recent Improvements in Productivity

Assumptions about the productivity of Fraser Sockeye stocks are a major driver in both the annual planning and the long-term evaluation in the simulation model. The FRSSI process was initiated after a period of declining productivity led to calls for a review of the 1987 Rebuilding Strategy, and the associated strict rebuilding trajectory. Productivity continued to decline during the initial implementation phase of the FRSSI TAM rules, and hit the lowest point since the 1950s in the 2009 return year. Beginning in 2010, returns of Fraser River sockeye began a reversal of the downward trend in productivity that culminated in the historic low returns per spawner in 2009 (1.6 million return from brood escapement of 3.3 million equalled 0.5 recruits per spawner). Returns in the last 4 years are back to levels more similar to long-term averages. (Figure 1, Table 4).

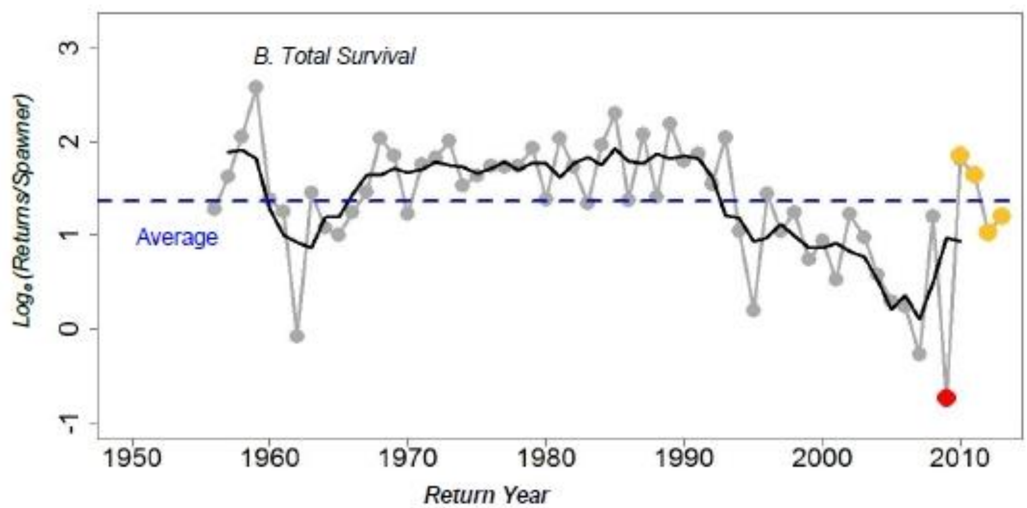


Figure 1: Productivity Pattern (Log)

Showing pattern in total returns per spawner (without adjusting for underlying population model).Figure taken from DFO. 2014. Pre-season run size forecasts for Fraser River Sockeye (*Oncorhynchus nerka*) salmon in 2014. DFO Can. Sci. Advis. Sec. Sci. Resp. 2014/nnn.

Table 4: Returns per Spawner 2010 -2013

Year	Comment
2010	29 million sockeye salmon returned to the Fraser River from a brood stock of 4.7 million; approximately 6 adult returns per spawner (i.e. six salmon returned to the Fraser River for every fish that made it to the spawning grounds in 2006)
2011	5 million sockeye salmon returned to the Fraser River from a brood of 900,000 fish; approximately 5 adult returns per spawner.
2012	overall return of Fraser River sockeye salmon is currently estimated at 2.3 million fish, from a brood of 800,000 sockeye that made it to their spawning grounds in 2008; approximately 3 adult returns per spawner.
2013	final inseason estimated returns was 3.73 million from 1.0 million spawners in the brood year; nearly 4 adult returns per spawner

Integrated Biological Status Under *Wild Salmon Policy*

A key element of the *Wild Salmon Policy* (DFO 2005) is a formal status evaluation of conservation units. Sockeye conservation units are generally based on rearing lake and migration timing, and for Fraser sockeye, stocks and conservation units line up closely (Figure 2). The WSP defines 3 status zones (Red / Amber / Green), and describes assessment actions and management considerations for each zone (DFO 2005)

The biological status of Fraser River sockeye conservation units was assessed through an expert-based process in 2011 (Grant and Pestal 2012). Evaluations of integrated status took into account three formal status metrics (abundance relative to WSP benchmarks, long-term trend, and short-term trend) as well as additional information (absolute abundance, data quality, patterns of exploitation rate).

Note that these status evaluations were based on information up to the 2010 return year, but also note that the individual metrics are designed to be robust to annual fluctuations (e.g. using generational averages)

Final integrated status for each of the 24 Fraser Sockeye CUs included the following: seven Red, four Red/Amber, four Amber, two Amber/Green, five Green, one Data Deficient, and one Undetermined (Table 5). Detailed status results for each of the groups and expert commentary (which identified key metrics and associated data that guided these status determinations) are published separately (Appendix 2 of Grant and Pestal 2012), and are necessary for CU status interpretation in WSP Strategy 4.

Integrated status determination for cyclic CUs presented the largest challenge to participants. Specifically, the appropriate method for estimating benchmarks for the relative-abundance metric of cyclic CUs was debated. Since this issue could not be resolved at the workshop, these metrics for cyclic CUs were excluded from status evaluations. However, the group felt that there remained sufficient data for status evaluations, particularly when compared to other non-Fraser Sockeye CUs, to assess status for cyclic CUs. The unique population dynamics of these CUs further added complexity to cyclic CU status evaluations.

Note that the WSP Benchmarks for Relative Abundance are **not** management references points (i.e. not designed to trigger specific annual harvest measures). Rather, they are intended as part of an integrated status evaluation.

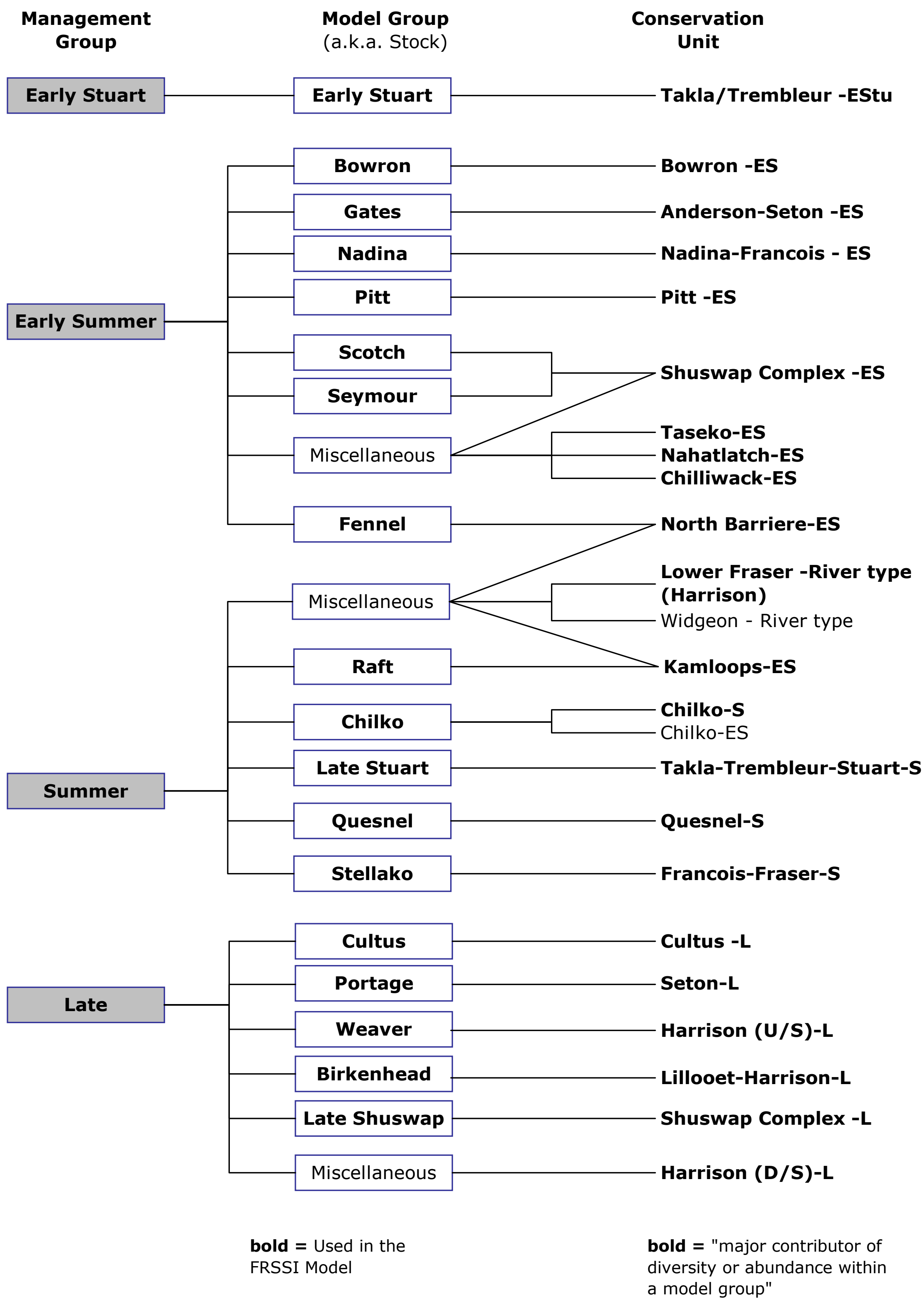


Figure 2: Matching Fraser Sockeye stocks to Conservation Units (CU)

Table 5: Integrated status designations for the 24 Fraser River sockeye CUs

R/A = Red/Amber, A/G = Amber/Green, DD = Data deficient, Undet = Undetermined. * indicates provisional status designations. Table from Grant and Pestal (2012). Note that these status evaluations were based on information up to the 2010 return year, but also note that the individual metrics are designed to be robust to annual fluctuations (e.g. using generational averages)

Status	Conservation Unit	Cyclic	Stock
Red	Takla-Trembleur-EStu	cyclic	Early Stuart
Red	Nadina-Francois-ES		Nadina
Red*	Taseko-ES		Miscellaneous Early Summers
Red	Nahatlatch-ES		Miscellaneous Early Summers
Red	Bowron-ES		Bowron
Red	Cultus-L		Cultus
Red	Widgeon – River		Miscellaneous Lates
R/A	Chilliwack-ES		Miscellaneous Early Summers
R/A	Francois-Fraser-S		Stellako
R/A	Quesnel-S	cyclic	Quesnel
R/A	Takla-Trembleur-Stuart-S	cyclic	Late Stuart
Amber	North Barriere-ES		Fennel & Miscellaneous Early Summer
Amber	Anderson-Seton-ES	cyclic	Gates
Amber	Kamloops-ES		Raft & Miscellaneous Early Summers
Amber	Harrison (U/S)-L		Weaver
A/G	Pitt-ES		Pitt
A/G	Shuswap-ES	cyclic	Scotch, Seymour, Misc.E.Sum.
Green*	Chilko-S & Chilko-ES agg.		Chilko
Green*	Lillooet-Harrison-L		Birkenhead
Green	Shuswap Complex-L	cyclic	Late Shuswap
Green	Harrison – River		Harrison
Green	Harrison (D/S)-L		Miscellaneous Lates
? DD	Chilko-ES		Chilko
? Undet.	Seton-L	cyclic	Seton

3. Proposed Options for 2014

Overview

Pre-season planning for 2014 is focusing on 2 proposed options. This chapter describes the options and compares expected outcomes for this year, based on pre-season assumptions about run size and en-route mortality. The first set of comparisons is by management group, the second set then looks at expectations for individual stocks. Expected outcomes will be updated as in-season information becomes available.

2 Options for 2014

TAM rules in place for 2010, the last dominant cycle year, served as the starting point for this year's options:

- *Option 1 – Like Cycle Year* (Table 6): Same TAM rules as in 2010, except that the Fishery Reference Points were adjusted to account for Raft now being managed as part of the Summer group, and Harrison and North Thompson being managed as miscellaneous Summer stocks.
- *Option 2 – Increase TAM cap* (Table 7): Increase TAM cap to 65% due to large expected run size for Early Summer, Summers and Lates. Lower FRP stay the same, but Upper FRP increase due to the gradual increase in TAM until it reaches the cap.

Table 6: Option 1 for 2014 – Like Cycle Year

	Harvest Rule Parameters				
Management Unit	Low Abundance ER (LAER)	TAM Cap	Lower Fishery Reference Point	Upper Fishery Reference Point	Pre-season pMA
Early Stuart	10%	60%	108,000	270,000	0.67
Early Summer (w/o misc)	10%	60%	180,000	450,000	0.43
Summer (w/o misc)	10%	60%	1,020,000	2,550,000	0.10
Late (w/o misc)	20-30%	60%	1,100,000	2,750,000	0.61

Table 7: Option 2 for 2014 – Increase TAM Cap

	Harvest Rule Parameters				
Management Unit	Low Abundance ER (LAER)	TAM Cap	Lower Fishery Reference Point	Upper Fishery Reference Point	Pre-season pMA
Early Stuart	10%	60%	108,000	270,000	0.67
Early Summer (w/o misc)	10%	65%	180,000	514,286	0.43
Summer (w/o misc)	10%	65%	1,020,000	2,914,286	0.10
Late (w/o misc)	20-30%	65%	1,100,000	3,142,857	0.61

The expected long-term performance of the fishery reference points shown in Table 6 and Table 7 was evaluated in simulations for the stocks that have a long term stock-recruit relationship. For the Early Summers, Summers, and Lates, the fishery reference points are then scaled up annually to account for the expected contribution of the unforecasted, or "miscellaneous", stocks to the management group.

ESSR fisheries for individual Fraser sockeye spawning populations may be considered under both options if the projected number of effective spawners is expected to exceed the freshwater productive capacity of the system for spawners or juvenile rearing. Given inherent uncertainties about freshwater capacity, a decision on whether an ESSR will proceed will be made by the Department and amounts specified for harvest may take into account available information and associated uncertainties on a range of factors including: stock-specific run size, projected spawner abundances, productive capacity of the system, stock composition in fishing area, and selectivity of fishing gear. Given uncertainties in in-season information, the Department may permit only a portion of any estimated surplus to be harvested. See section 6.1 of the IFMP for general information on ESSR fisheries. Chapter 4 of this memo has some additional information about capacity estimates and considerations that would shape potential ESSR fisheries.

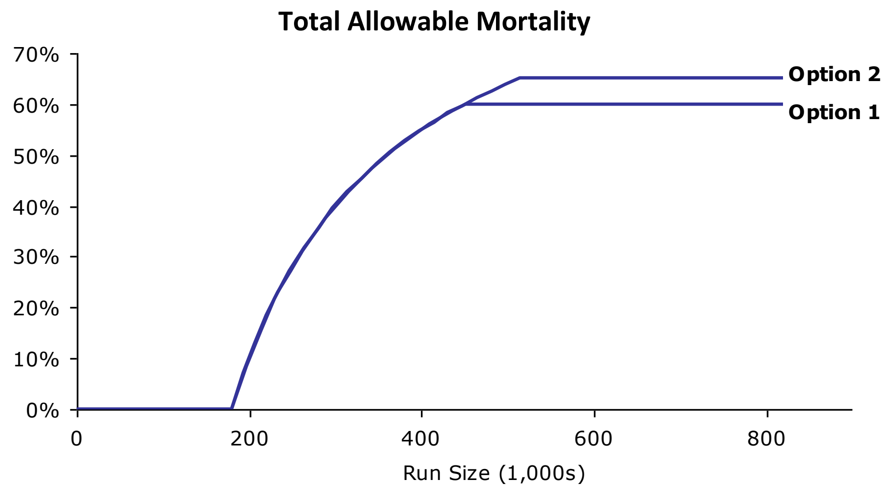


Figure 3: Basic difference between Option 1 and Option 2 - Illustration

Several changes have been implemented since 2010, and are reflected in both options:

- The Early Stuart TAM rule was changed based on feedback from First Nations groups after the 2010 season and the TAM rule shown in both options was implemented in 2011 and 2013.
- Until 2013, the planning process and resulting TAM rules covered 19 modelled stocks. However, due to drastic changes in population dynamics since the 2005 return year, Harrison is no longer one of the modelled stocks. Some recent spawner abundances have been 20 times larger than the largest observed since the 1950s, and it is not possible to fit meaningful spawner-recruit relationships to the data at this time. In a few years, once return data is available for these recent brood years with large abundance, SR models will be re-eveluated. In the meantime, Harrison is now managed as a “miscellaneous” stock with the Summer group, and the Summer FRPs are adjusted to account for the forecasted contribution of Harrison to the total aggregate. Note that Harrison used to be managed as part of the Late Run.
- Widgeon (River type) is now part of the Summer miscellaneous (re-assigned from Lates together with Harrison).
- Raft / North Thompson are now part of the Summer Run (re-assigned from Early Summer)
- As in recent years, the Low Abd ER for Early Stuart, Early Summer, and Summer Run timing groups is 10% and 20% for Late Run and Cultus Lake sockeye. If the return of Late-run sockeye is at or above the p75 forecast, consideration will be given to increasing the Late-run LAER up to 30%. Management objectives for Cultus Lake are described in Section 5.1.6 of the draft IFMP.

Comparing Expected Outcomes for Options 1 and 2 – By Management Group

Actual outcomes for the harvest strategy will depend strongly on the observed run size, implementation of the fishing plan, and observed en-route mortality.

Table 9 to Table 12 show the range of expected outcomes (i.e. exploitation rates, available harvest, and expected numbers of spawners to the grounds) under each of the 2 options for the plausible range of abundance forecast and a pre-season management adjustment to account for migration conditions and associated en-route mortality. For pre-season planning purposes, proportional management adjustments (pMAs) used for illustration are:

- Early Stuart: median of the long term pMA dataset to 2012.
- Early Summer: median of the Scotch-Seymour dominant and subdominant pMA dataset to 2012
- Summer: median of the long term pMA dataset to 2012
- Lates – for the Birkenhead component, the median of the long term pMA dataset to 2012. For the remainder of the Late run: the average of a) the median of the Adams dominant and subdominant pMA dataset to 2012 and b) the modelled pMA based on in-river timing predictions.

The pMAs for Early Stuart, Early Summer, Summer and Late Run sockeye will likely change in-season with updated information on environmental conditions and migration timing. The pre-season pMA and method for determining pMA for Late Run in 2014 has yet to be decided. The pre-season pMA values for all management groups will continue to be reviewed and updated by the Fraser Panel prior to the start of the fishing season. The "MA" (management adjustment) values in the tables are the escapement goals multiplied by the pMA.

The Fraser Panel will review MA models with particular emphasis on understanding the sources of bias in forecasts of river temperatures, potential alternative models and approaches including models based on subsets of years and/or component stocks, and conceptual approaches to quantifying the relative impacts of measure error and en-route mortality.

Note that these values do not take into account the pre-spawn mortality which can occur after spawners reach the grounds. We currently do not have any methods to predict pre-spawn mortality rates. Table 8 describes the types of information shown in Table 9 to Table 12.

Key points to note in the aggregate projections:

- Over the full range of forecasts (p10 to p90), **Early Stuart** spawner abundance is expected to be well over the brood year abundance as well as the average spawner abundance for this cycle line, even after the large expected en-route mortality (Table 9). The upper half of the forecast range falls above the upper FRP, resulting in a TAM of 60% under Option 1 or 65% under Option 2 (Figure 4). The lower end of the forecast range falls below the Upper FRP, resulting in a TAM that decreases with run size. A substantial share of the TAM is taken up by the management adjustment, and the target ER is much smaller than the total allowable mortality.
- At the low end of the forecast range (p10 and p25), **Early Summer** spawner abundance will be well below 2010 brood year but around or above cycle average, under both options (Table 10). At the mid-point of the forecast range (p50), Early Summer spawner abundance is expected to be roughly half of the 2010 brood year, but about 5 times as large as the cycle average. The forecast range is clearly above the Upper FRP, as even the low end (p10) exceeds the FRP, resulting in a TAM of 60% under Option 1 (Figure 5) or 65% under Option 2 (Figure 6). Under both options, a substantial share of the TAM is taken up by the management adjustment, and the target ER is much smaller than the total allowable mortality.

- At the low end of the forecast range (p10 and p25), **Summer** spawner abundance will be well below 2010 brood year but around or above cycle average, under both options (Table 11). At the mid-point of the forecast range (p50), Early Summer spawner abundance is expected to be roughly half of the 2010 brood year, but about double the cycle average. The forecast range is clearly above the Upper FRP, as the low end (p10) falls between the Lower and Upper FRP. The p25 forecast level is above the Upper FRP, such that for most of the forecast range TAM is 60% under Option 1 (Figure 7) and 65% under Option 2 (Figure 8). The management adjustment for Summer Run is usually much smaller than for the other management groups, resulting in target ER close to TAM.
- At the lower half of the forecast range (p10 to p50), **Late** spawner abundance will be well below the 2010 brood year. However, spawner abundance will be at or above the cycle average for most of the forecast range (p25 and up) under both options (Table 12). The forecast range is clearly above the Upper FRP, as even the low end (p10) exceeds the FRP, resulting in a TAM of 60% under Option 1 (Figure 9) or 65% under Option 2 (Figure 10). Under both options, a substantial share of the TAM is taken up by the management adjustment, and the target ER is much smaller than the total allowable mortality.

Table 8: Description of values shown in pre-season projection tables for management groups

Abbreviations: TAM = Total Allowable Mortality, MA = Management Adjustment, esc. Goal = escapement goal, LAER = Low Abundance Exploitation Rate, ER = Exploitation Rate, S = Spawners, BY = Brood Year, avg = Average

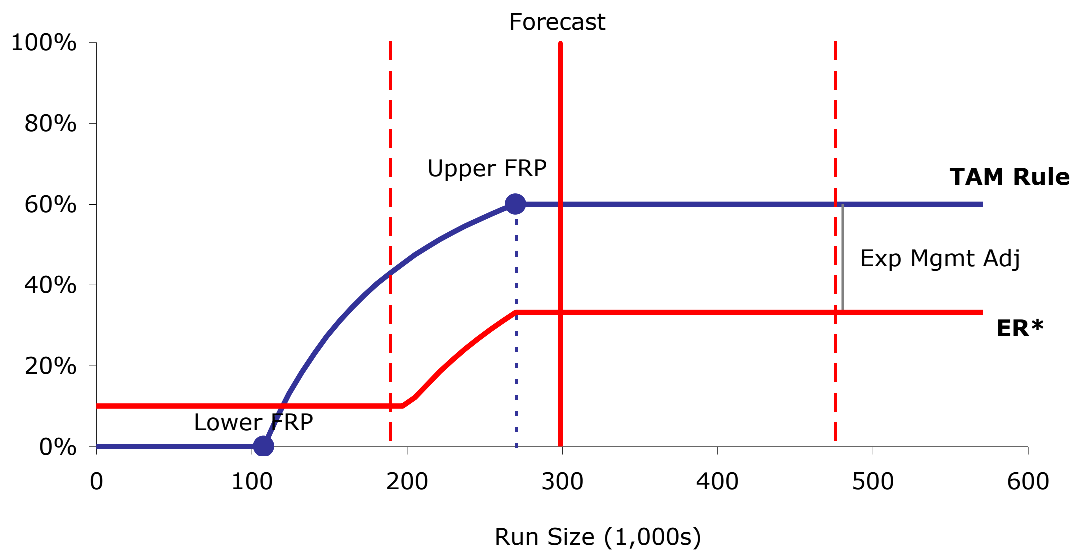
From Escapement Options Table		Description
	p10	run size forecast probability level being used for calculations in this column
forecast	132,000	forecast associated with p-level (above) and this management group
TAM Rule (%)	18%	total allowable mortality (TAM) at this run size forecast
Escapement Goal	108,000	escapement goal at this run size
MA	72,400	management adjustment (= pMA x escapement target)
Esc. Goal + MA	180,400	adds up previous two rows
LAER	10%	low abundance exploitation rate
ER at Return	0%	exploitation rate given TAM rule, run size, escapement target & MA
Allowable ER	10%	larger of the values in the two previous rows
available harvest	13,200	harvest available for test fish, US & Canada (= allowable ER * run size)
2014 Performance		IF run size, MA, and ER are all as described as above, the projected outcomes:
Projected S (after MA)	71,000	total number of spawners to the grounds (NOT accounting for pre-spawn mortality (PSM))
BY Spawners	60,300	number of spawners four year previous (compare to line above)
Proj. S as % BY S	118%	projected spawners as a percentage of brood year spawners
cycle avg S	36,500	average number of spawners to the grounds on this cycle line (NOT accounting for PSM)
Proj. S as % cycle S	195%	projected spawners as a percentage of the cycle year average spawners

Note: example shown is the p10 for Early Stuart (which is the same in both Options)

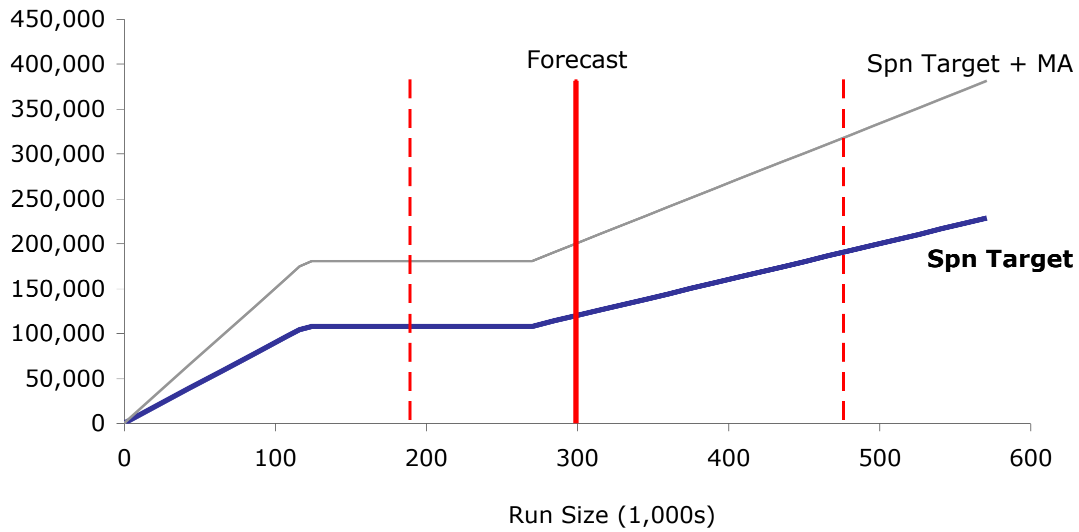
Table 9: Aggregate Projection under Options 1 and 2 – EARLY STUART

Option 1- Like Cycle Year and Option 2 – Increase TAM Cap (but keep same for Early Stuart)

	Pre-season Forecast Return				
	p10	p25	**p50**	p75	p90
forecast	132,000	189,000	**299,000**	476,000	709,000
TAM Rule (%)	18%	43%	**60%**	60%	60%
Escapement Target	108,000	108,000	**119,600**	190,400	283,600
MA	72,400	72,400	**80,100**	127,600	190,000
Esc. Target + MA	180,400	180,400	**199,700**	318,000	473,600
LAER	10%	10%	**10%**	10%	10%
ER at Return	0%	5%	**33%**	33%	33%
Allowable ER	10%	10%	**33%**	33%	33%
available harvest	13,200	18,900	**99,300**	158,000	235,400
2014 Performance					
Projected S (after MA)	71,000	102,000	**120,000**	190,000	284,000
BY Spawners	60,300	60,300	**60,300**	60,300	60,300
Proj. S as % BY S	118%	169%	**199%**	315%	471%
cycle avg S	36,500	36,500	**36,500**	36,500	36,500
Proj. S as % cycle S	195%	279%	**329%**	521%	778%



* ER = expected ER based on TAM, expected Mgmt Adj, and applying Low Abd ER



At low run size, expected spawners is less than the spawner target resulting from the TAM rule, because of en-route mortality and the Low Abd ER. At larger run sizes, all of the en-route mortality can be absorbed in the Total Allowable Mortality, and the spawner target can be achieved.

Figure 4: TAM Rule and Spawner Plot for Early Stuart – Options 1 and 2 (same)
Plot showing the same information as Table 9. Forecast range is p25 to p75.

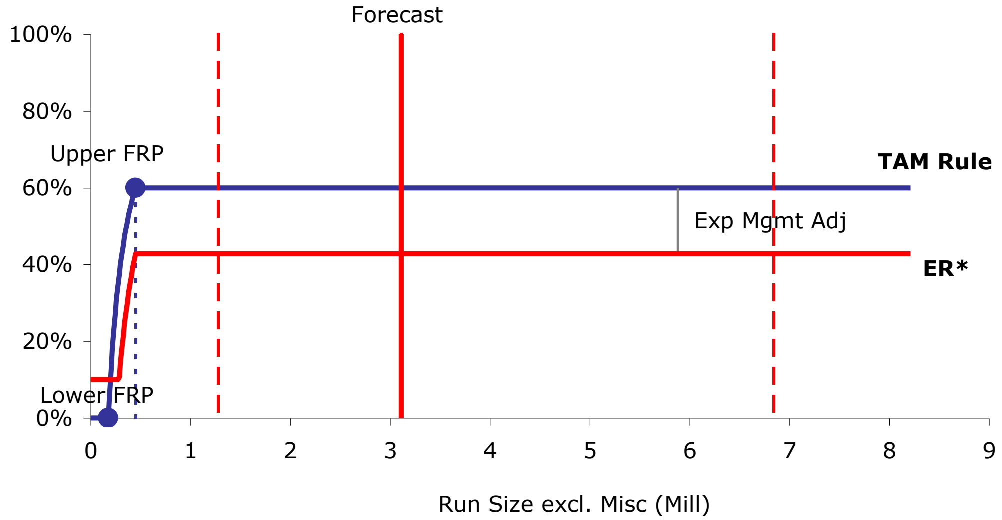
Table 10: Aggregate Projection under Options 1 and 2 – EARLY SUMMER

Option 1- Like Cycle Year

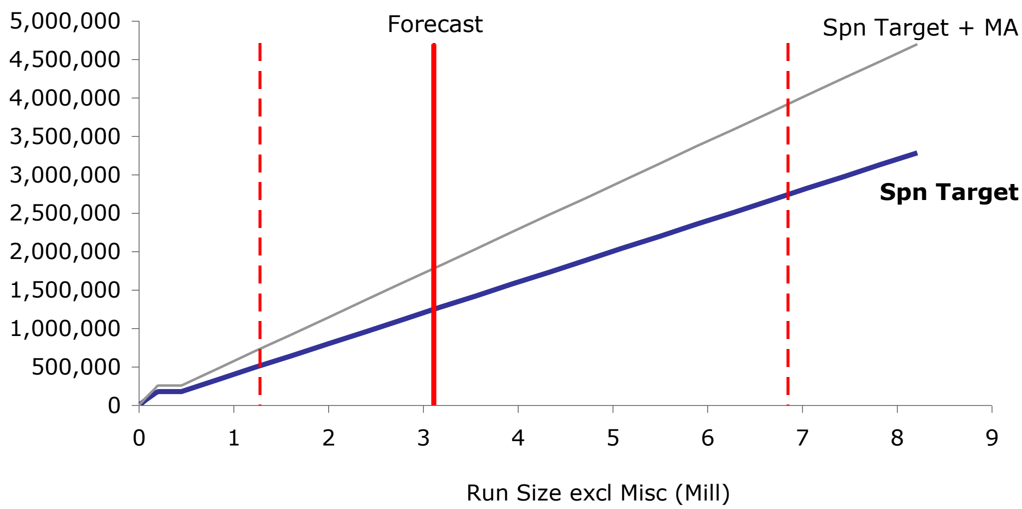
	Pre-season Forecast Return				
	p10	p25	**p50**	p75	p90
lower ref. pt. (w misc)	251,000	245,000	239,000	223,000	218,000
upper ref. pt. (w misc)	628,000	613,000	597,000	557,000	544,000
forecast (incl. misc)	730,000	1,741,000	4,126,000	8,470,000	16,805,000
TAM Rule (%)	60%	60%	**60%**	60%	60%
Escapement Target	292,000	696,400	**1,650,400**	3,388,000	6,722,000
MA	125,600	299,500	**709,700**	1,456,800	2,890,500
Esc. Target + MA	417,600	995,900	**2,360,100**	4,844,800	9,612,500
LAER	10%	10%	**10%**	10%	10%
ER at Return	43%	43%	**43%**	43%	43%
Allowable ER	43%	43%	**43%**	43%	43%
available harvest	312,400	745,100	**1,765,900**	3,625,200	7,192,500
2014 Performance					
Projected S (after MA)	292,000	696,000	**1,650,000**	3,388,000	6,722,000
BY Spawners	1,524,700	1,524,700	**1,524,700**	1,524,700	1,524,700
Proj. S as % BY S	19%	46%	**108%**	222%	441%
cycle avg S	291,400	291,400	**291,400**	291,400	291,400
Proj. S as % cycle S	100%	239%	**566%**	1163%	2307%

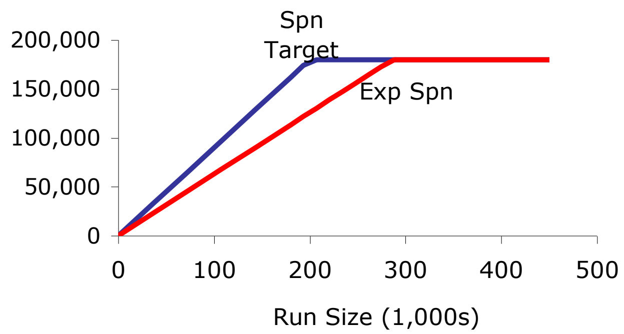
Option 2 – Increase TAM Cap

	Pre-season Forecast Return				
	p10	p25	**p50**	p75	p90
lower ref. pt. (w misc)	251,000	245,000	239,000	223,000	218,000
upper ref. pt. (w misc)	718,000	700,000	682,000	636,000	622,000
forecast (incl. misc)	730,000	1,741,000	4,126,000	8,470,000	16,805,000
TAM Rule (%)	65%	65%	**65%**	65%	65%
Escapement Target	255,500	609,350	**1,444,100**	2,964,500	5,881,750
MA	109,900	262,000	**621,000**	1,274,700	2,529,200
Esc. Target + MA	365,400	871,350	**2,065,100**	4,239,200	8,410,950
LAER	10%	10%	**10%**	10%	10%
ER at Return	50%	50%	**50%**	50%	50%
Allowable ER	50%	50%	**50%**	50%	50%
available harvest	364,600	869,650	**2,060,900**	4,230,800	8,394,050
2014 Performance					
Projected S (after MA)	256,000	609,000	**1,444,000**	2,964,000	5,882,000
BY Spawners	1,524,700	1,524,700	**1,524,700**	1,524,700	1,524,700
Proj. S as % BY S	17%	40%	**95%**	194%	386%
cycle avg S	291,400	291,400	**291,400**	291,400	291,400
Proj. S as % cycle S	88%	209%	**496%**	1017%	2019%



* ER = expected ER based on TAM, expected Mgmt Adj, and applying Low Abd ER

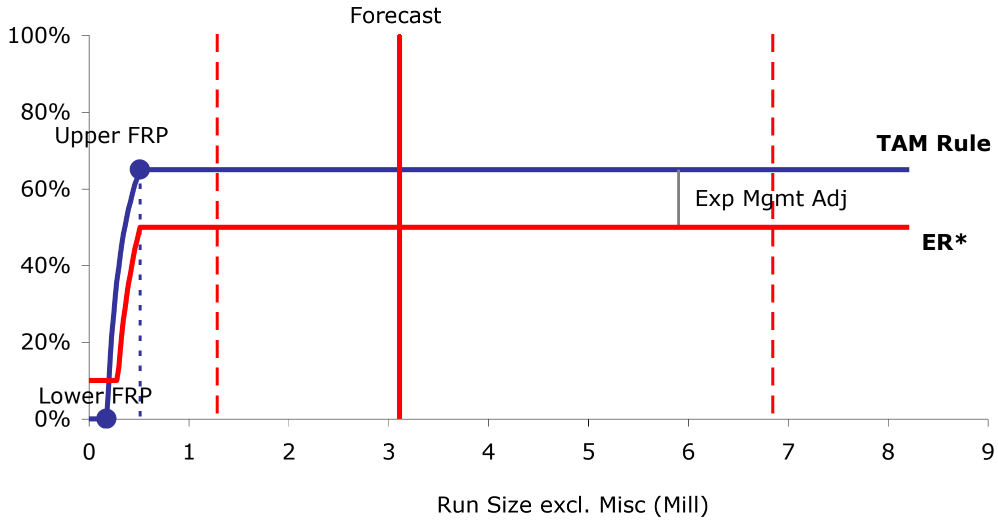




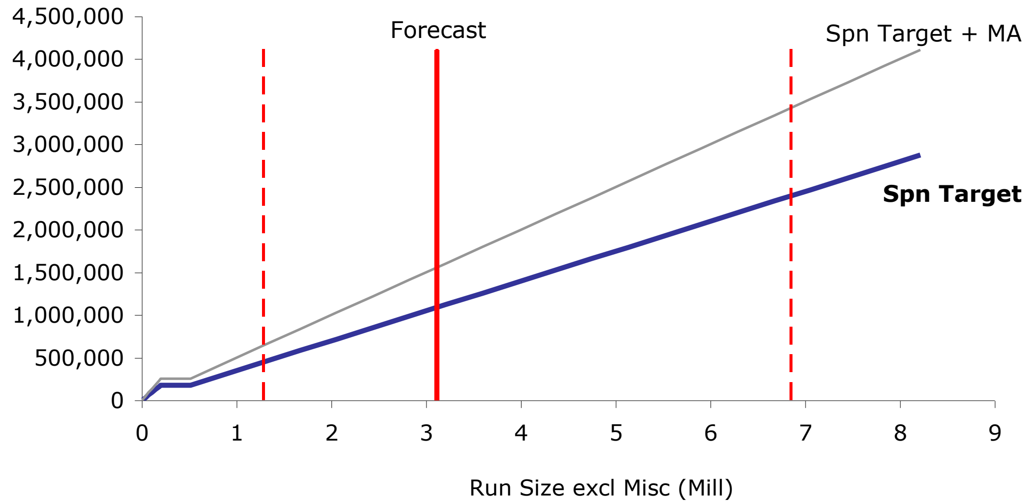
At low run size, expected spawners is less than the spawner target resulting from the TAM rule, because of en-route mortality and the Low Abd ER. At larger run sizes, all of the en-route mortality can be absorbed in the Total Allowable Mortality, and the spawner target can be achieved.

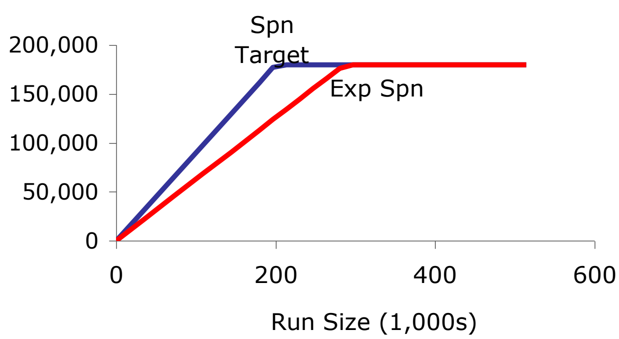
Figure 5: TAM Rule and Spawner Plot for Early Summer – Option 1 - Like Cycle Year

Plots showing the same information as Table 10. * ER = expected ER based on TAM, expected Mgmt Adj, and applying Low Abd ER. Forecast range is p25 to p75.



* ER = expected ER based on TAM, expected Mgmt Adj, and applying Low Abd ER





At low run size, expected spawners is less than the spawner target resulting from the TAM rule, because of en-route mortality and the Low Abd ER. At larger run sizes, all of the en-route mortality can be absorbed in the Total Allowable Mortality, and the spawner target can be achieved.

Figure 6: TAM Rule and Spawner Plot for Early Summer – Option 2 - Increase TAM Cap

Plots showing the same information as Table 10. * ER = expected ER based on TAM, expected Mgmt Adj, and applying Low Abd ER. Forecast range is p25 to p75.

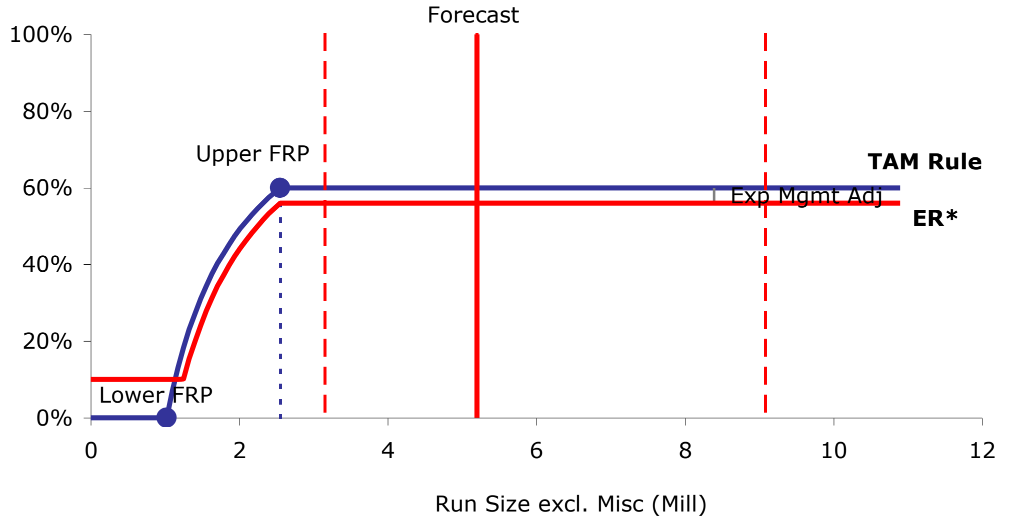
Table 11: Aggregate Projection under Options 1 and 2 – SUMMER

Option 1- Like Cycle Year

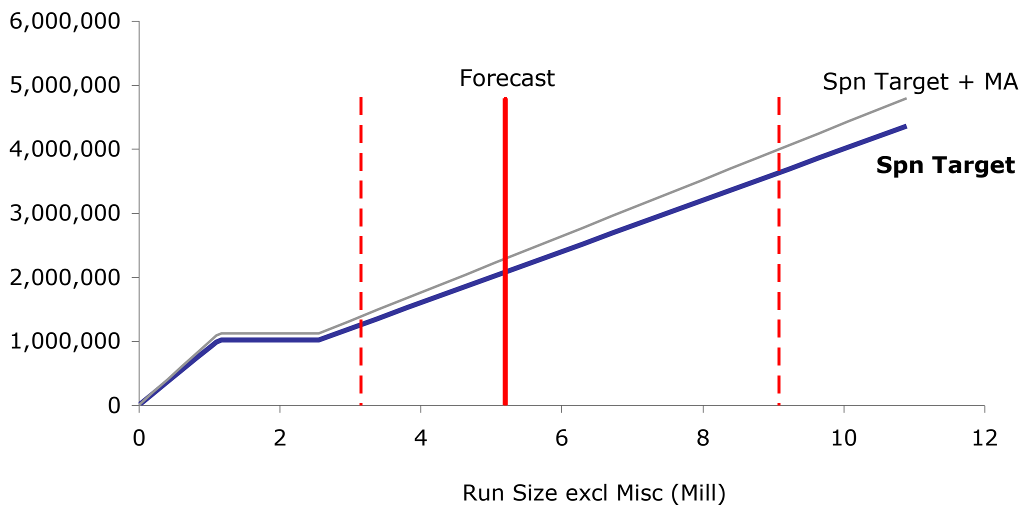
	Pre-season Forecast Return				
	p10	p25	**p50**	p75	p90
lower ref. pt. (w misc)	1,119,000	1,119,000	**1,119,000**	1,119,000	1,119,000
upper ref. pt. (w misc)	2,796,000	2,796,000	**2,796,000**	2,796,000	2,796,000
forecast	2,127,000	3,393,000	**5,699,000**	10,116,000	17,781,000
TAM Rule (%)	47%	60%	**60%**	60%	60%
Escapement Target	1,119,000	1,357,200	**2,279,600**	4,046,400	7,112,400
MA	111,900	135,700	**228,000**	404,600	711,200
Esc. Target + MA	1,230,900	1,492,900	**2,507,600**	4,451,000	7,823,600
LAER	10%	10%	**10%**	10%	10%
ER at Return	42%	56%	**56%**	56%	56%
Allowable ER	42%	56%	**56%**	56%	56%
available harvest	896,100	1,900,100	**3,191,400**	5,665,000	9,957,400
2014 Performance					
Projected S (after MA)	1,119,000	1,357,000	**2,280,000**	4,046,000	7,112,000
BY Spawners	3,757,100	3,757,100	3,757,100	3,757,100	3,757,100
Proj. S as % BY S	30%	36%	**61%**	108%	189%
cycle avg S	1,113,200	1,113,200	**1,113,200**	1,113,200	1,113,200
Proj. S as % cycle S	101%	122%	**205%**	363%	639%

Option 2 – Increase TAM Cap

	Pre-season Forecast Return				
	p10	p25	**p50**	p75	p90
lower ref. pt. (w misc)	1,119,000	1,119,000	**1,119,000**	1,119,000	1,119,000
upper ref. pt. (w misc)	3,196,000	3,196,000	**3,196,000**	3,196,000	3,196,000
forecast	2,127,000	3,393,000	**5,699,000**	10,116,000	17,781,000
TAM Rule (%)	47%	65%	**65%**	65%	65%
Escapement Target	1,119,000	1,187,550	**1,994,650**	3,540,600	6,223,350
MA	111,900	118,800	**199,500**	354,100	622,300
Esc. Target + MA	1,230,900	1,306,350	**2,194,150**	3,894,700	6,845,650
LAER	10%	10%	**10%**	10%	10%
ER at Return	42%	61%	**61%**	61%	62%
Allowable ER	42%	61%	**61%**	61%	62%
available harvest	896,100	2,086,650	**3,504,850**	6,221,300	10,935,350
2014 Performance					
Projected S (after MA)	1,119,000	1,188,000	**1,995,000**	3,541,000	6,223,000
BY Spawners	3,757,100	3,757,100	3,757,100	3,757,100	3,757,100
Proj. S as % BY S	30%	32%	**53%**	94%	166%
cycle avg S	1,113,200	1,113,200	**1,113,200**	1,113,200	1,113,200
Proj. S as % cycle S	101%	107%	**179%**	318%	559%



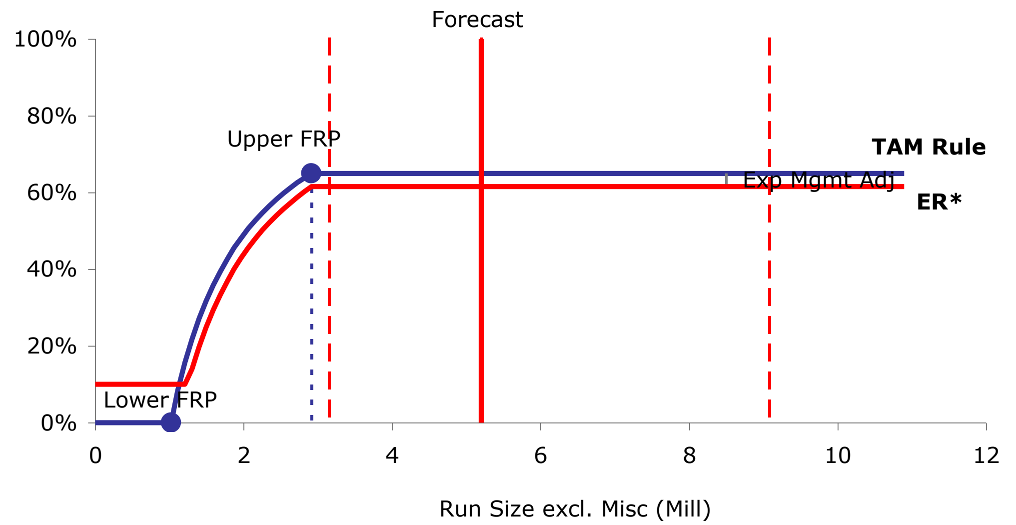
* ER = expected ER based on TAM, expected Mgmt Adj, and applying Low Abd ER



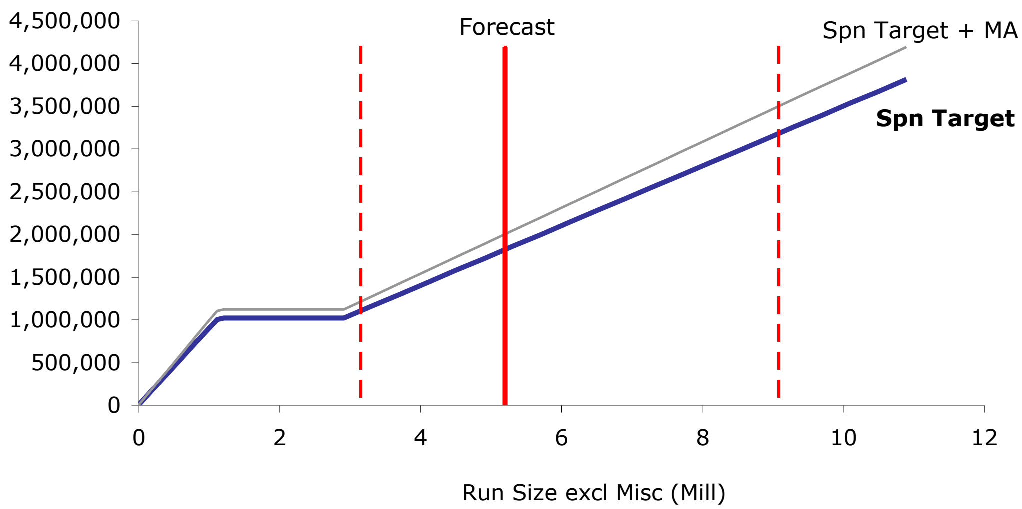
At low run size, expected spawners is less than the spawner target resulting from the TAM rule, because of en-route mortality and the Low Abd ER. At larger run sizes, all of the en-route mortality can be absorbed in the Total Allowable Mortality, and the spawner target can be achieved.

Figure 7: TAM Rule and Spawner Plot for Summer – Option 1 – Like Cycle Year

Plots showing the same information as Table 11. * ER = expected ER based on TAM, expected Mgmt Adj, and applying Low Abd ER. Forecast range is p25 to p75.



* ER = expected ER based on TAM, expected Mgmt Adj, and applying Low Abd ER



At low run size, expected spawners is less than the spawner target resulting from the TAM rule, because of en-route mortality and the Low Abd ER. At larger run sizes, all of the en-route mortality can be absorbed in the Total Allowable Mortality, and the spawner target can be achieved.

Figure 8: TAM Rule and Spawner Plot for Summer – Option 2 – Increase TAM Cap

Plots showing the same information as Table 11. * ER = expected ER based on TAM, expected Mgmt Adj, and applying Low Abd ER. Forecast range is p25 to p75.

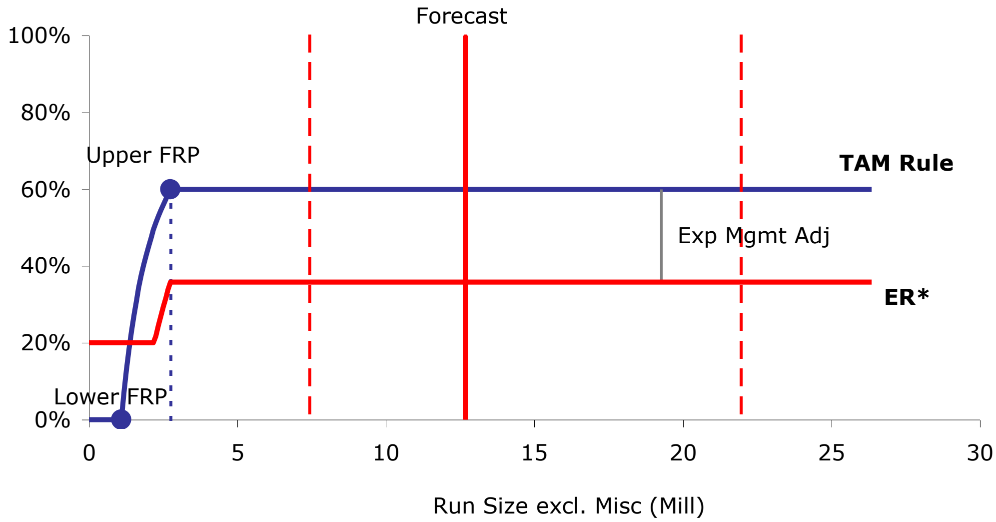
Table 12: Aggregate Projection under Options 1 and 2 – LATE

Option 1- Like Cycle Year

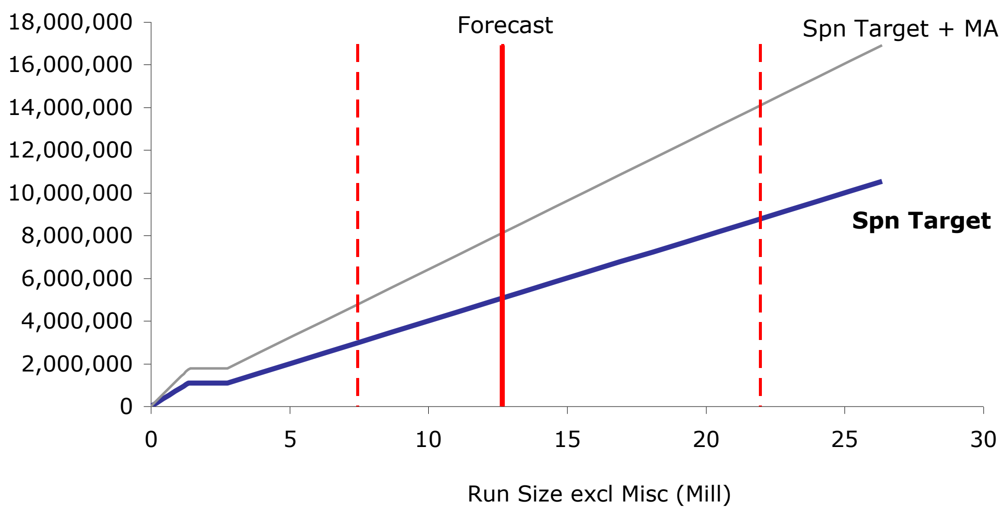
	Pre-season Forecast Return				
	p10	p25	**p50**	p75	p90
lower ref. pt. (w misc)	1,105,000	1,105,000	**1,105,000**	1,105,000	1,105,000
upper ref. pt. (w misc)	2,763,000	2,763,000	**2,763,000**	2,763,000	2,763,000
forecast	4,248,000	7,465,000	**12,730,000**	22,059,000	36,719,000
TAM Rule (%)	60%	60%	**60%**	60%	60%
Escapement Target	1,699,200	2,986,000	**5,092,000**	8,823,600	14,687,600
MA	1,028,000	1,806,500	**3,080,700**	5,338,300	8,886,000
Esc. Target + MA	2,727,200	4,792,500	**8,172,700**	14,161,900	23,573,600
LAER	20%	20%	**20%**	30%	30%
ER at Return	36%	36%	**36%**	36%	36%
Allowable ER	36%	36%	**36%**	36%	36%
available harvest	1,520,800	2,672,500	**4,557,300**	7,897,100	13,145,400
2014 Performance					
Projected S (after MA)	1,699,000	2,986,000	**5,092,000**	8,824,000	14,688,000
BY Spawners	7,788,900	7,788,900	7,788,900	7,788,900	7,788,900
Proj. S as % BY S	22%	38%	**65%**	113%	189%
cycle avg S	2,902,000	2,902,000	**2,902,000**	2,902,000	2,902,000
Proj. S as % cycle S	59%	103%	**175%**	304%	506%

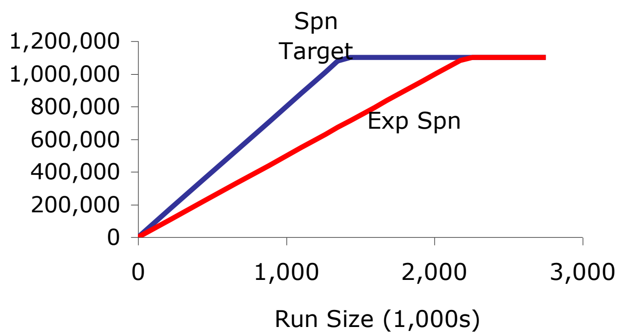
Option 2 – Increase TAM Cap

	Pre-season Forecast Return				
	p10	p25	**p50**	p75	p90
lower ref. pt. (w misc)	1,105,000	1,105,000	**1,105,000**	1,105,000	1,105,000
upper ref. pt. (w misc)	3,158,000	3,158,000	**3,158,000**	3,158,000	3,158,000
forecast	4,248,000	7,465,000	**12,730,000**	22,059,000	36,719,000
TAM Rule (%)	65%	65%	**65%**	65%	65%
Escapement Target	1,486,800	2,612,750	**4,455,500**	7,720,650	12,851,650
MA	899,500	1,580,700	**2,695,600**	4,671,000	7,775,200
Esc. Target + MA	2,386,300	4,193,450	**7,151,100**	12,391,650	20,626,850
LAER	20%	20%	**20%**	30%	30%
ER at Return	44%	44%	**44%**	44%	44%
Allowable ER	44%	44%	**44%**	44%	44%
available harvest	1,861,700	3,271,550	**5,578,900**	9,667,350	16,092,150
2014 Performance					
Projected S (after MA)	1,487,000	2,613,000	**4,456,000**	7,721,000	12,852,000
BY Spawners	7,788,900	7,788,900	7,788,900	7,788,900	7,788,900
Proj. S as % BY S	19%	34%	**57%**	99%	165%
cycle avg S	2,902,000	2,902,000	**2,902,000**	2,902,000	2,902,000
Proj. S as % cycle S	51%	90%	**154%**	266%	443%



* ER = expected ER based on TAM, expected Mgmt Adj, and applying Low Abd ER

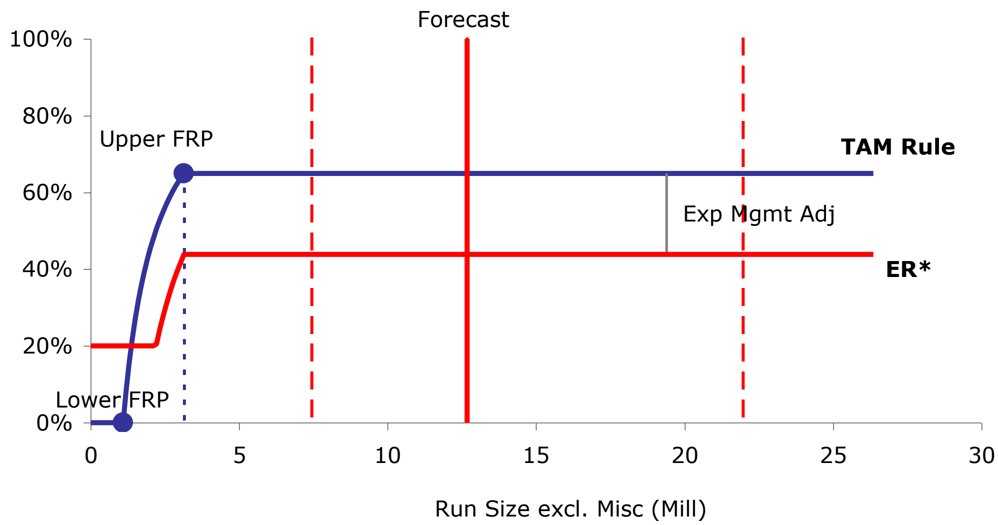




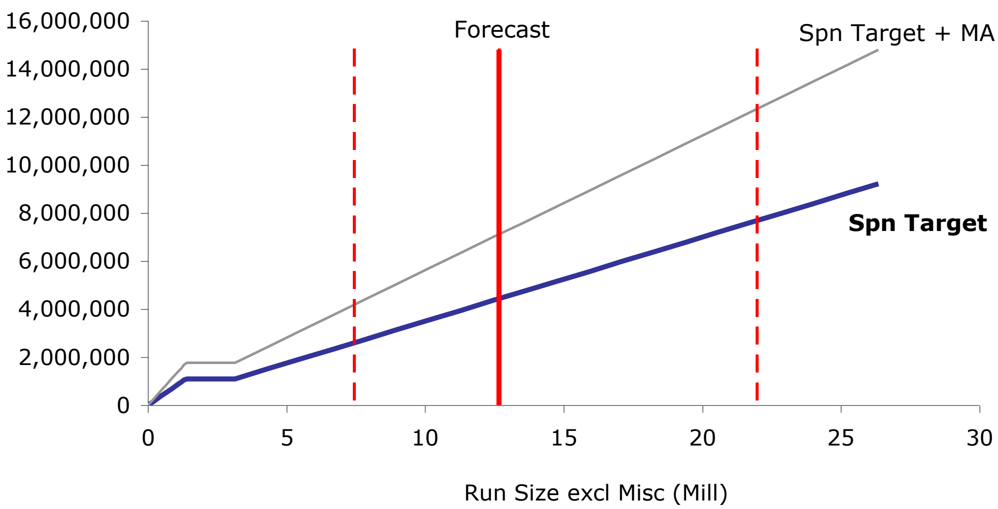
At low run size, expected spawners is less than the spawner target resulting from the TAM rule, because of en-route mortality and the Low Abd ER. At larger run sizes, all of the en-route mortality can be absorbed in the Total Allowable Mortality, and the spawner target can be achieved.

Figure 9: TAM Rule and Spawner Plot for Late – Option 1 – Like Cycle Year

Plots showing the same information as Table 12. * ER = expected ER based on TAM, expected Mgmt Adj, and applying Low Abd ER. Forecast range is p25 to p75.



* ER = expected ER based on TAM, expected Mgmt Adj, and applying Low Abd ER



At low run size, expected spawners is less than the spawner target resulting from the TAM rule, because of en-route mortality and the Low Abd ER. At larger run sizes, all of the en-route mortality can be absorbed in the Total Allowable Mortality, and the spawner target can be achieved.

Figure 10: TAM Rule and Spawner Plot for Late – Option 2 – Increase TAM Cap

Plots showing the same information as Table 12. * ER = expected ER based on TAM, expected Mgmt Adj, and applying Low Abd ER. Forecast range is p25 to p75.

Comparing Expected Outcomes for Options 1 and 2 – By Stock

Table 13 shows the projected spawner abundance for each forecasted stock over the range of forecast probability levels for each option and compares it long-term average spawners for that stock. Stock-specific projections are calculated from the "projected S (after MA)" in Table 9 to Table 12, which is distributed to the component stocks based on the proportion each stock contributes to the forecast at each p-level. Note that this makes the additional assumption that the exploitation rate will be distributed evenly within a management group.)

Table 13 compares projected spawner abundances to long-term mean and the cycle average. Table 14 compares projected spawner abundances to the high end of observed abundances. Figure 11 and Figure 12 show how projected spawner abundances for the 2 options compare to the observed time series pattern (line plot) and to the observed distribution (histogram).

Key points to note in **Table 13** are:

- For 18 of the 19 stocks, the projected spawners under both options are near or above both the long-term median and the 2014 cycle average. The exception is Cultus (shaded in grey).
- For several of the stocks, the projected spawner abundance under both options is much larger than the long-term median (up to almost 400 times larger!) (Col 2E to 2G). These stocks are: Scotch, Seymour, Quesnel, Harrison, and Late Shuswap. Note however, that the median by definition gives lower numbers than the arithmetic mean for data sets with a few large outliers, such as the very large spawner abundances in the dominant cycle year. By contrast, the comparisons to cycle average indicate a less drastic difference. The same stocks have projected spawner abundances about 5-10 times larger than the cycle average.

Key points to note in **Table 14** are:

- At the upper half of the forecast range (p50 and up), the projected spawners are above the upper quarter of the observed range for 18 of the 19 stocks under Option 1 (Col 3C and 3D). The exception is Cultus. Under Option 2, projected spawners for Pitt also fall below the upper quartile at the p50 forecast level (Col 3I)
- Projected spawners for 12 of the 19 stocks fall below the highest observed spawner abundance under both options (Col 3E to 3G and 3K to 3M). The exceptions are Scotch, Seymour, Stellako, Birkenhead, Portage, Weaver, Late Shuswap. For these stocks, projected spawner abundance is roughly 1.5 to 2 times larger the largest previous observed.

Figure 11 and Figure 12 show the same information as the summary tables throughout this document, just in condensed form without the details.

Table 13: Stock-specific Projection under Options 1 and 2 compared to long-term averages

2014 Expectations = (Run Forecast) - (Harvest Plan at Run Forecast) - (Pre-season estimate of en-route mortality) . p25 = lower quarter of the forecast range, p50 = median of the forecast range, p75 = upper quarter of the forecast range. Long-term median is a robust measure of average abundance (i.e. half the years had lower abundance, half the years had higher abundance). Comparisons to long-term median show each of the 3 alternative p levels for expected spawners divided by the same long-term median. The values used for comparison are listed in Column 1E in Table 1. Cycle average is arithmetic mean of all available spawner observations for the cycle year (i.e. 2014 cycle average includes 2014, 2010, 2006, 2002, 1998 etc). Comparisons to long-term median show each of the p50 level for expected spawners divided by the same cycle average. The values used for comparison are listed in Column 1K in Table 1. Shaded cells with bold font mark any instance where the comparison is less than 0.75 (e.g. if expected spawners is less than 3/4 of long-term median)

	2A	2B	2C	2D	2E	2F	2G	2H	2I	2J	2K	2L	2M	2N	2O
		2014 Expected Spawners OPTION 1			Option 1 Expectations Comp. To Long-Term Median			Option 1 Expectations Comp. To Cycle Avg 2014	2014 Expected Spawners OPTION 2			Option 2 Expectations Comp. To Long-Term Median			Option 2 Expectations Comp. To Cycle Avg 2014
	Stock	p25	p50	p75	at p25	at p50	at p75		p25	p50	p75	at p25	at p50	at p75	
	E. Stuart	102,000	120,000	190,000	2.85	3.35	5.30	3.29	102,000	120,000	190,000	2.85	3.35	5.30	3.29
Early Summer	Bowron	6,000	12,000	24,000	1.22	2.44	4.88	2.21	5,200	10,500	21,000	1.06	2.13	4.27	1.93
Early Summer	Fennell	5,200	9,600	16,400	1.13	2.09	3.57	2.29	4,500	8,400	14,300	0.98	1.83	3.11	2.00
Early Summer	Gates	18,800	31,600	52,400	3.50	5.88	9.75	11.27	16,400	27,600	45,800	3.05	5.14	8.52	9.84
Early Summer	Nadina	20,400	43,600	93,200	2.15	4.59	9.81	8.83	17,800	38,100	81,500	1.87	4.01	8.58	7.71
Early Summer	Pitt	18,400	29,200	50,800	0.97	1.53	2.67	1.10	16,100	25,500	44,400	0.85	1.34	2.33	0.96
Early Summer	Scotch	271,000	616,700	1,331,200	79.82	181.65	392.11	9.30	237,200	539,700	1,164,600	69.87	158.97	343.03	8.14
Early Summer	Seymour	171,500	501,500	1,170,000	11.95	34.94	81.50	4.58	150,100	438,900	1,023,600	10.46	30.57	71.31	4.01
Summer	Raft	10,000	15,600	25,200	1.60	2.50	4.04	2.67	8,800	13,700	22,100	1.41	2.19	3.54	2.35
Summer	Chilko	667,900	1,046,200	1,709,400	1.84	2.88	4.70	2.29	584,700	915,400	1,496,100	1.61	2.52	4.12	2.01
Summer	Late Stuart	68,800	131,600	268,800	2.40	4.58	9.36	2.89	60,200	115,200	235,200	2.10	4.01	8.19	2.53
Summer	Quesnel	337,900	609,700	1,179,900	8.48	15.30	29.62	1.50	295,900	533,500	1,032,600	7.43	13.39	25.92	1.32
Summer	Stellako	174,800	276,000	447,600	2.04	3.22	5.23	2.22	153,000	241,500	391,700	1.79	2.82	4.57	1.94
Summer	Harrison	91,200	189,200	392,000	10.63	22.06	45.70	2.49	79,800	165,600	343,000	9.30	19.31	39.99	2.18
Late	Birkenhead	124,400	197,200	332,400	2.51	3.98	6.70	1.58	108,900	172,600	290,900	2.20	3.48	5.87	1.39
Late	Cultus	2,400	5,200	11,200	**0.40**	0.88	1.88	**0.51**	2,100	4,600	9,800	**0.35**	0.77	1.65	**0.45**
Late	Portage	18,000	44,400	106,000	5.15	12.69	30.30	2.58	15,800	38,900	92,800	4.52	11.12	26.53	2.26
Late	Weaver	70,400	129,200	236,400	1.98	3.63	6.65	1.95	61,600	113,100	206,900	1.73	3.18	5.82	1.71
Late	L. Shuswap	2,757,600	4,692,000	8,096,400	84.90	144.45	249.27	1.77	2,413,100	4,106,000	7,084,300	74.29	126.41	218.11	1.55

Table 14: Stock-specific Projection under Options 1 and 2 compared to high observations

2014 Expectations = (Run Forecast) - (Harvest Plan at Run Forecast) - (Pre-season estimate of en-route mortality) . p25 = lower quarter of the forecast range, p50 = median of the forecast range, p75 = upper quarter of the forecast range. Upper Q of annual observations is the observed upper quartile of the spawner abundances for all available years (i.e. 1 in 4 years had larger spn abd). The values used for comparison are listed in Column 1F in Table 1. Max of annual observations is the largest observed spawner abundance for all available years. The values used for comparison are listed in Column 1G in Table 1. Shaded cells with bold font mark any instance where the comparison is less than 0.75 (e.g. if expected spawners is less than 3/4 of long-term median)

	3A	3B	3C	3D	3E	3F	3G	3H	3I	3J	3K	3L	3M
		OPTION 1 Expectations Comp. To						OPTION 2 Expectations Comp. To					
		Upper Q of Annual Obs			Max of Annual Obs			Upper Q of Annual Obs			Max of Annual Obs		
	Stock	at p25	at p50	at p75	at p25	at p50	at p75	at p25	at p50	at p75	at p25	at p50	at p75
	E. Stuart	0.93	1.09	1.73	**0.15**	**0.17**	**0.28**	0.93	1.09	1.73	**0.15**	**0.17**	**0.28**
Early Summer	Bowron	**0.57**	1.15	2.29	**0.17**	**0.34**	**0.69**	**0.50**	1.00	2.01	**0.15**	**0.30**	**0.60**
Early Summer	Fennell	**0.53**	0.98	1.68	**0.16**	**0.30**	**0.51**	**0.46**	0.86	1.47	**0.14**	**0.26**	**0.44**
Early Summer	Gates	1.45	2.45	4.06	**0.19**	**0.32**	**0.52**	1.27	2.14	3.54	**0.16**	**0.28**	**0.46**
Early Summer	Nadina	0.90	1.93	4.12	**0.10**	**0.22**	**0.47**	0.79	1.69	3.61	**0.09**	**0.19**	**0.41**
Early Summer	Pitt	**0.49**	0.78	1.35	**0.14**	**0.22**	**0.39**	**0.43**	**0.68**	1.18	**0.12**	**0.19**	**0.34**
Early Summer	Scotch	29.60	67.35	145.38	**0.52**	1.18	2.55	25.91	58.94	127.19	**0.45**	1.03	2.23
Early Summer	Seymour	3.85	11.25	26.24	**0.31**	0.91	2.12	3.37	9.84	22.96	**0.27**	0.79	1.85
Summer	Raft	1.00	1.55	2.51	**0.15**	**0.24**	**0.38**	0.88	1.36	2.20	**0.13**	**0.21**	**0.33**
Summer	Chilko	1.20	1.88	3.08	**0.27**	**0.43**	**0.69**	1.05	1.65	2.69	**0.24**	**0.37**	**0.61**
Summer	Late Stuart	**0.47**	0.90	1.83	**0.05**	**0.10**	**0.20**	**0.41**	0.79	1.60	**0.04**	**0.08**	**0.17**
Summer	Quesnel	1.21	2.19	4.23	**0.10**	**0.17**	**0.34**	1.06	1.91	3.70	**0.08**	**0.15**	**0.29**
Summer	Stellako	1.23	1.95	3.16	**0.47**	**0.74**	1.20	1.08	1.71	2.77	**0.41**	**0.65**	1.05
Summer	Harrison	4.34	9.00	18.64	**0.11**	**0.23**	**0.49**	3.79	7.87	16.31	**0.10**	**0.21**	**0.43**
Late	Birkenhead	1.31	2.07	3.49	**0.37**	**0.59**	0.99	1.14	1.81	3.06	**0.32**	**0.51**	0.87
Late	Cultus	**0.14**	**0.31**	**0.67**	**0.05**	**0.11**	**0.23**	**0.13**	**0.28**	**0.59**	**0.04**	**0.10**	**0.21**
Late	Portage	1.98	4.89	11.67	**0.31**	0.76	1.82	1.74	4.28	10.22	**0.27**	**0.67**	1.60
Late	Weaver	1.23	2.26	4.14	**0.24**	**0.44**	0.80	1.08	1.98	3.62	**0.21**	**0.38**	**0.70**
Late	L. Shuswap	2.41	4.10	7.07	**0.37**	**0.62**	1.08	2.11	3.59	6.19	**0.32**	**0.55**	0.94

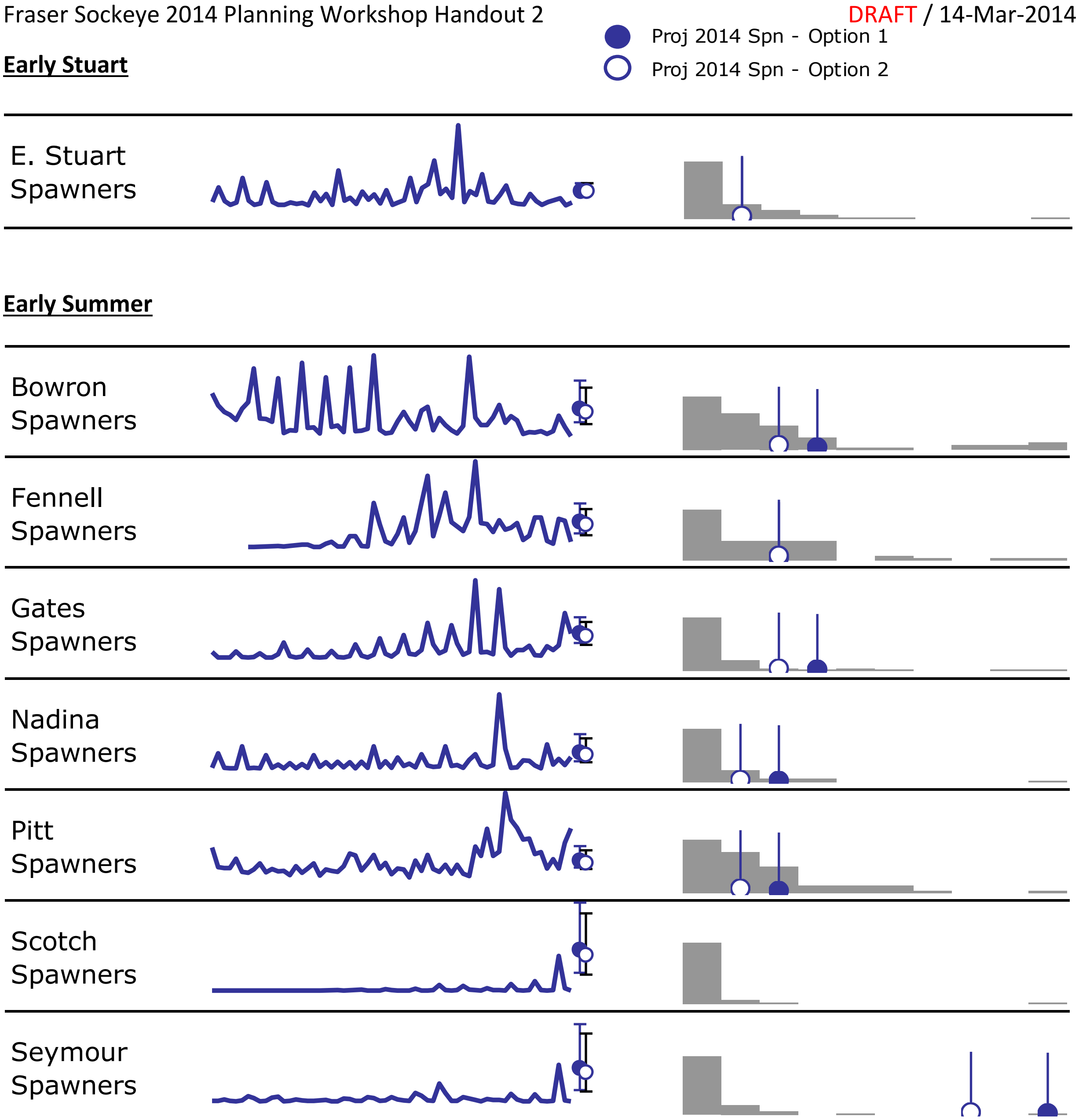


Figure 11: Projected spawner abundance compared to observed pattern and distribution by stock - 1

The left panels are time series of spawner estimates for each stock, compared to the projected spawner abundance. The right panel shows a 10-bin frequency plot and the markers show which bin the projected spawners fall into. Note that for Fennell the 2 options fall into the same bin, and their markers overlap. Also note that the option marker for Scotch is off the chart to the right (projected spawner abundance is larger than largest observation so far).

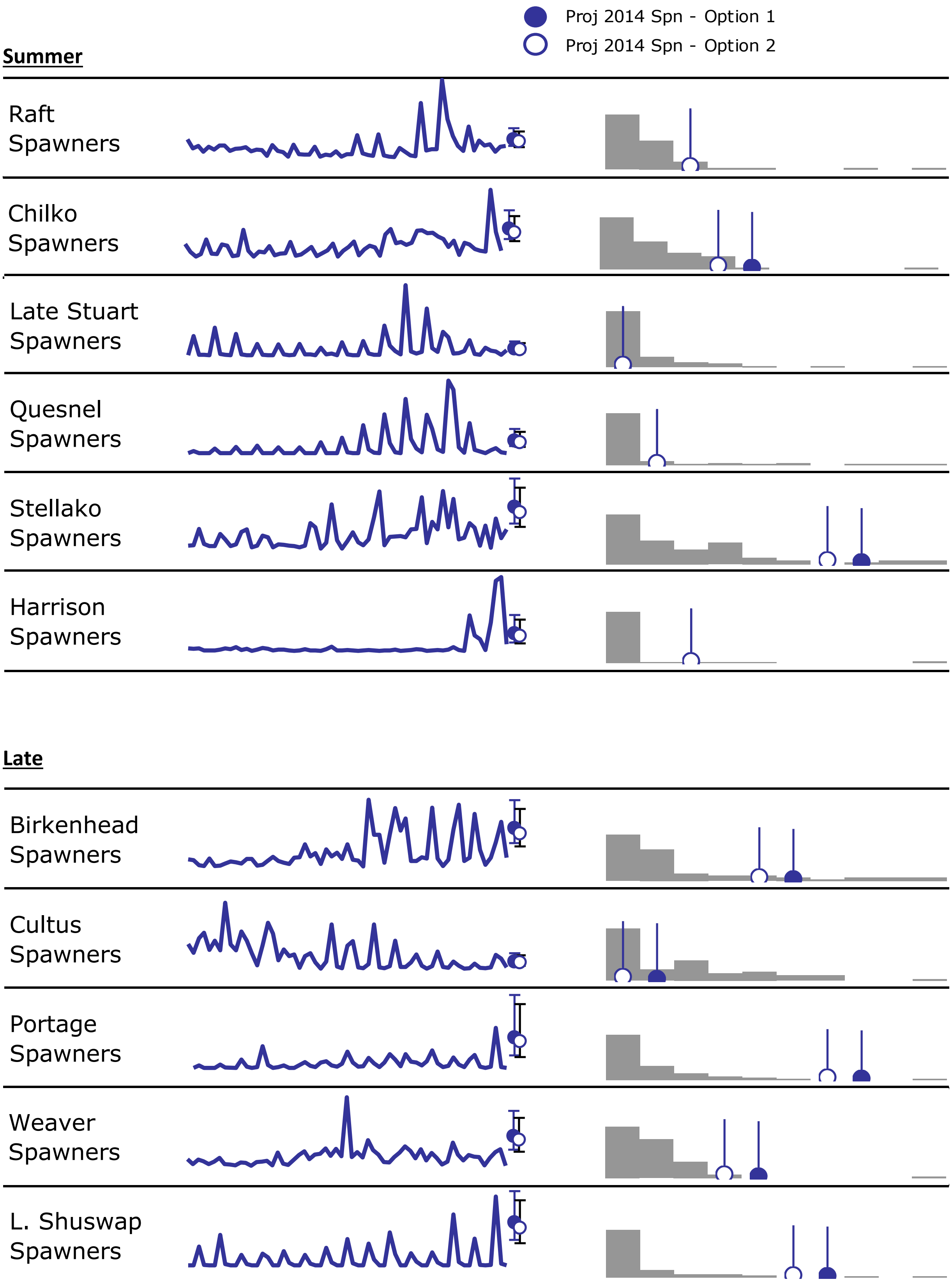


Figure 12: Projected spawner abundance compared to observed pattern and distribution by stock - 2

Same as Figure 11. Note that for Late Stuart, Quesnel, and Harrison) the 2 options fall into the same bin, and their markers overlap.

4. Additional Considerations

The two options presented in Chapter 3 describe the general harvest plan for Fraser Sockeye. However, the actual implementation will take additional considerations into account:

- Potential fisheries to harvest Excess Salmon to Spawning Requirements (ESSR)
- Potential modifications to the Management Adjustment (MA) for very large run sizes
- Recovery Objectives for Cultus Lake Sockeye

The rest of this chapter discusses the basis for each of these considerations and explains how they are being taken into account in the pre-season planning process.

Potential fisheries to harvest Excess Salmon to Spawning Requirements (ESSR)

Based on the 2014 return forecasts, if survival has been average to above-average and returns fall at the mid-to-higher forecast probability levels, returns will fall above cycle averages for a number of stocks, and may potentially be the largest on record. To prepare for the possibility that returns could fall at the higher end of the forecast distribution, opportunities for additional harvest on abundant stocks are being considered.

At the aggregate run-timing-group level, any decision to increase harvest levels should consider the individual survivals of each of the component stocks, as well as en-route mortality (assessed as management adjustments: MA's in-season). As a result, option 2 with increased TAM cap has been included, but this increases TAM by only by 5%.

At the stock-specific level, additional opportunities may be considered. The steps towards planning such a fishery should consider:

- Look at projected spawners after aggregate harvest and MA;
- Consider an ESSR if projected spawner abundance is much larger the estimated capacity for the system. (i.e. capacity estimate);
- The ceiling level for an ESSR harvest could be = x% of projected spawners in excess to above the capacity estimate, where x may be 50% (e.g. at very large run sizes, drop half the management adjustment)

The following information would assist in making a decision:

- Knowledge of what the limiting factor is (spawning habitat or rearing lake?);
- Capacity estimate for that limiting factor if available, including estimates of inter-annual variability and uncertainty;
- A potential buffer above capacity estimate to account for inter-annual variability and uncertainty;

In practice, however, we do not have firm capacity estimates and for many stocks we do not have any estimates. Instead, various alternatives such as the cycle average escapement, largest observed escapement, etc. could be considered. Table 15 summarizes available lake capacity data. Note that for some rearing lakes the sample size (N) is not good (in some cases only 1). Key points to remember are:

- spawning capacity might be limiting over rearing lake capacity, but we do not have spawning capacity estimates
- there are multiple stocks using rearing lakes that contribute to lake capacity; so can't look at one stock in isolation of others in these cases
- shift in lake-rearing capacity in recent years for particularly Chilko and Shuswap for different reasons;

Specific considerations related capacity 2014:

- Late Shuswap: exceptional escapements in 2010; key issue is we only have lake rearing capacity estimates for this system, and in recent years these values have changed (increased). So using historical Smax estimates for Fraser Sockeye for this system is problematic if you want to estimate the variation in these estimates, as this system is now in a new period of production. In addition, most fry rear in the main arm of Shuswap Lake and other stocks (early-timed Shuswap stocks) also use the rearing lake and will contribute lake-rearing fry densities.
- Early Shuswap: exceptional escapements in 2010; likely limited by spawning capacity rather than lake rearing capacity; we do not have estimates of spawning capacity for this system (the estimates in the FRAP report should not be used, as in the 2011 Fraser Sockeye Stock Status Canadian Science Advisory Secretariat process the Salmon Sub-Committee consensus was to not use them given the lack of documentation of methods and peer review of these values. Again, most fry rear in the main arm of Shuswap Lake and these stocks will contribute to the lake rearing fry densities.
- Chilko: exceptional escapements in 2010, however, given low freshwater survival, total smolt outmigration was above average but not exceptional; key issue is we only have lake rearing capacity estimates for this system, and in recent years these values have changed (increased), for different reasons from the Shuswap system. So using historical Smax estimates for Fraser Sockeye for this system is problematic if you want to estimate the variation in these estimates, as we are in a new period of production. Further, spawning capacity may have influenced carrying capacity of the system in 2010, and no information is available for this.
- Harrison: exceptional escapements in 2010 and 2011 and forecasts extremely uncertain given this stock has experienced large changes in production in recent years and modeling population dynamics for this current period is not possible; there is no empirical data to indicate the mechanisms for this shift in Harrison Sockeye production; given this stock is river-type (they do not rear as fry in freshwater lakes)spawning capacity is key, however, spawning capacity estimates for this system are not available;
- Portage: exceptional escapement in 2010; however, they co-rear in Seton Lake with the early time Gates (which also rear in Anderson Lake), so lake rearing capacity challenged by the fact that these two stocks rear in lakes.

Table 15: Lake Capacity

Lake-rearing capacity (number of spawners that result in maximum juvenile production: Smax) estimates used as carrying capacity (Ricker 'b' parameter) Bayesian priors in the abundance benchmark estimation process. The first column presents the CU, the second column presents the range of the stock-recruitment (SR) time series, the third column and fourth column present either the average and standard deviation of the capacity estimates, and the final (fifth column) presents the number of observations the estimate is based on. Note that Smax was used to estimate Ricker b (they're not equivalent. Smax=1/b, though this depends on form of the Ricker model used). (Source: revised from Grant et al. 2011)

CONSERVATION UNIT	SR Time Series (Brood Years)	S_{max}: Lake Rearing[1]		
		Average	SD	*N*
Anderson-Seton-ES	1968-2004	286,000	54,000	4
Bowron-ES	1950-2004	40,000	NA	1
Chilko-S & Chilko-ES	1950-2004	483,000	161,000	6
Cultus-L	1950-2000	85,000	17,000	3
Francois-Fraser-S	1950-2004	600,000	201,000	2
Harrison (U/S)-L	1966-2004	811,000	316,000	2
Harrison River (River-Type) (immediate migrants)	1950-2004	NA	NA	
Kamloops-ES	1967-2004	445,000	NA	1
Lillooet-Harrison-L	1950-2004	164,000	NA	1
Nadina-Francois-ES	1973-2004	1,350,000	453,000	2
North Barriere-ES (*de novo*)	1967-2004	NA	NA	
Pitt-ES	1950-2004	115,000	NA	1
Quesnel-S	1950-2004	1,115,000	315,000	10
Seton-L (*De Novo*)	1965-2004	188,000	31,000	4
Shuswap-ES	1980-2004	1,900,000	319,000	6
Shuswap Complex-L	1950-2004	1,900,000	319,000	6
Takla-Trembleur-EStu	1950-2004	778,000	165,000	3
Takla-Trembleur-Stuart-S	1950-2004	1,900,000	193,000	3

1. Source: J. Hume & L. Pon, Salmon Aquatic Freshwater Ecosystem Program, DFO; Appendix 3.

MA implementation approach / options

Is there a different way that should be considered in the implementation of MAs in-season where there is a very large run size and very large management adjustment which eliminates TAC?

Cultus Recovery Objectives

Management of Cultus Lake sockeye will be based on the Cultus Lake sockeye recovery objectives and an assessment of in-season information for the Late Run sockeye stock aggregate. For more information on the recovery objectives, refer to section 5.1.6 of the 2014 draft IFMP.

Due to the low numbers of Cultus Lake sockeye compared to the co-migrating stocks, the abundance and exploitation rate for Cultus Lake sockeye cannot be calculated directly in-season. For management purposes, the Cultus exploitation rate will be assumed to be the same as the exploitation rate for similarly timed Late Run stocks caught seaward of the confluence of the Fraser and the Vedder Rivers. Exploitation rates are based on DNA analysis of sockeye sampled either directly from fisheries or indirectly, from nearby test fisheries.

Preliminary pre-season assessments of the allowable exploitation rate for Cultus are highly sensitive to assumptions about en-route and pre-spawn mortality. Using median estimates of enroute mortality for Late Run on this cycle year and the average pre-spawn mortality estimates for Cultus since the inception of early upstream timing behaviour, the maximum ER that would meet the recovery objectives in 2014 is in the 30-35% range at the p50 run size forecast. Table 16 shows, for each escapement plan option, a range of exploitation rates which could be implemented for 2014, given an assumption of a pre-spawn mortality rate of approximately 40%, which is consistent with the average estimated PSM since early upstream migration of Late Run which began in 1996. The bolded numbers represent combinations of run size and pMAs which would result in meeting the minimum recovery objectives in 2014 under these assumptions.

Table 16: Stock-specific Projection under Options 1 and 2 compared to high observations

A range of maximum exploitation rates for Cultus Sockeye which could be implemented for 2014 and would meet minimum recovery objectives, assuming a pre-spawn mortality rate of approximately 40%

Option 1: Like Cycle Year

	Cultus run size (in-season, will use Lates as a proxy)									
pMA	7,000	8,000	9,000	10,000	11,000	12,000	13,000	14,000	15,000	16,000
0.43	20%	20%	20%	22%	29%	35%	36%	36%	36%	36%
0.47	20%	20%	20%	20%	27%	33%	36%	36%	36%	36%
0.52	20%	20%	20%	20%	25%	31%	36%	36%	36%	36%
0.56	20%	20%	20%	20%	23%	29%	34%	36%	36%	36%
0.61	20%	20%	20%	20%	20%	27%	32%	36%	36%	36%
0.67	20%	20%	20%	20%	20%	24%	30%	35%	36%	36%
0.72	20%	20%	20%	20%	20%	22%	28%	33%	36%	36%
0.79	20%	20%	20%	20%	20%	20%	25%	30%	35%	36%
0.85	20%	20%	20%	20%	20%	20%	22%	28%	33%	36%
0.92	20%	20%	20%	20%	20%	20%	20%	25%	30%	34%

Option 2: Increase TAM Cap

	Cultus run size (in-season, will use Lates as a proxy)									
pMA	7,000	8,000	9,000	10,000	11,000	12,000	13,000	14,000	15,000	16,000
0.43	20%	20%	20%	22%	29%	35%	40%	44%	44%	44%
0.47	20%	20%	20%	20%	27%	33%	38%	43%	44%	44%
0.52	20%	20%	20%	20%	25%	31%	36%	41%	44%	44%
0.56	20%	20%	20%	20%	23%	29%	34%	39%	43%	44%
0.61	20%	20%	20%	20%	20%	27%	32%	37%	41%	44%
0.67	20%	20%	20%	20%	20%	24%	30%	35%	39%	43%
0.72	20%	20%	20%	20%	20%	22%	28%	33%	37%	41%
0.79	20%	20%	20%	20%	20%	20%	25%	30%	35%	39%
0.85	20%	20%	20%	20%	20%	20%	22%	28%	33%	37%
0.92	20%	20%	20%	20%	20%	20%	20%	25%	30%	34%

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