Fisheries and Oceans Canada
Pêches et Océans Canada
Canada

WCVI Salmon Bulletin
Area 23 (Barkley Sound, Alberni Inlet) Sockeye Forecast for the 2020 Return
9 April 2020

Bryan Rusch, Erin Porszt, and Karin Mathias

Cat. No. Fs144-68/2020E-PDF

ISBN 978-0-660-48538-6

Correct citation for this publication:

Rusch, B, Porszt, E., and Mathias, K.. 2023. Area 23 (Barkley Sound, Alberni Inlet) Sockeye Forecast for the 2020 Return. West Coast of Vancouver Island Stock Assessment Bulletins. 17 p.

SUMMARY

- For 2020 fishery management purposes, the Area 23 Roundtable has agreed to begin fisheries in the "critical" zone for early season harvest management The management forecast for Somass Sockeye is *less than 200,000* adult Sockeye based on the best performing forecast model.
- There is considerable uncertainty in the 2020 forecast, similar to recent years. The forecasts (Table 3) vary between 169,000 (Sibling model), to 992,000 based on Coho survivals in the same ocean entry year (CLI model).
- Model forecasts for the 2020 aggregate Somass Sockeye return are described in Appendix A. The point forecasts for 2020 are 169,000 (Sibling); 476,000 (Sea Surface temperature); 601,000 (Sea Surface Salinity), 857,000 (SEP Biostandards), 992,000 (Coho Leading Indicator).
- Based on recent year model performance and the very low observed production to date from the 2015 brood year, The Area 23 Roundtable accepted the management forecast for 2020 of less than 200,000 Sockeye based on the best performing model (Sibling).
- The forecast from the Sibling Model also predicts a low proportion (23%) of Great Central Lake Sockeye in the 2020 return and predicts that the total return to Great Central Lake will fall well below the fishery reference point of 100,000, and is near the lower biological benchmark of 29,290 spawners. This requires a precautionary management approach for early season fisheries until the total run size and stock composition can be determined. The first reforecast is expected June 25 but actions may be taken earlier if in-season assessment data indicates larger or small returns.
- The recommended management outlook for Henderson Sockeye is the "very low" zone for harvest management, corresponding to an expected return of less than 15,000 (Table 5). The key factors influencing this outlook are the low spawner abundances in the main contributing brood years (2015, 2016), as well as apparently low marine survival rates experienced by these two brood years. There were no surveys in Henderson Lake to estimate juvenile production from either of the main contributing brood years (2017 and 2018 sea-entry years). Based on the spawner abundances in 2015 and 2016, the smolt abundances in the 2017 and 2018 sea-entry years are estimated to be low (less than 1M).

BACKGROUND

The three main Sockeye stocks returning to Barkley Sound (Area 23) include the Great Central Lake, Sproat Lake and Henderson Lake stocks. Status of each stock is assessed as a separate Conservation Unit (CU) for implementation of Canada's Wild Salmon Policy. From 1980 to 2019, the average adult terminal returns (catch and escapement) of Great Central, Sproat and Henderson Lake Sockeye are 379,000, 328,000 and 30,000, respectively (see Table 6).

When the Great Central and Sproat Lake stocks are both contributing similar proportions (e.g. within 60-40%) then management is based on the aggregate stock management unit referred to as Somass Sockeye. When one stock is considerably lower than the other (e.g. <40%) then a lower aggregate abundance should be the basis for management, based on factors such as abundance of each stock relative to an LRP, environmental factors, productivity considerations, etc.

Area 23 sockeye fisheries target Somass Sockeye while limiting impact on the Henderson Lake Sockeye stock.

The pre-season biological forecasts for Somass Sockeye inform a 'management' forecast which guides June effort-limited harvest plans (Table 9). The run size forecasts are revised weekly starting in late June based on the evaluation of in-season indicators described later in this report. The first in-season forecast revision is anticipated no earlier than June 25, 2020.

Statistical forecast models for Henderson Sockeye are not generated due to data limitations. A management zone is produced based on spawner and smolt abundance and indicators related to marine

survival rate for the contributing brood years. This outlook informs the amount and timing of commercial gillnet openings in outer areas of Barkley Sound where the fishery is more likely to intercept Henderson Sockeye (Table 10).

2020 Somass Sockeye Biological Forecasts

The biological forecasts (Table 3) vary considerably, between 169,000 (Sibling model) to 992,000 based on Coho survivals in the same ocean entry year (CLI Model). The individual point forecasts (Table 3) are: 169,000 (Sibling); 476,000 (Sea Surface temperature); 601,000 (Sea Surface Salinity), 857,000 (SEP Biostandards), and 992,000 (Coho Leading Indicator). The predicted Somass aggregate return is further broken down into stock-specific forecasts in Table 3.

Model forecasts for the 2020 aggregate Somass Sockeye return are described in detail in Appendix A and summarized below.

- The Sibling forecast (Table 4) for Great Central Lake is estimated a total adult return of 38,412 (23% GCL) and for Sproat Lake a return of 130,376 (77%) for a total of 168,788 based on low jack and age 4 returns in 2019. The Sibling model's forecast of a low proportion of Great Central Lake in 2020 returns is the result of low proportions of Great Central Lake stock (26%, and 13%, respectively,
- Table 7) from both of the main contributing brood years (2015 and 2016). The Sibling forecast for the Great Central Lake return is well below the fishery reference point of 100,000 for this stock (based on 50% of the 200,000 minimum reference point for the aggregate Somass stock) and is near the lower biological benchmark of 29,290 (the upper biological benchmark is 91,640).
- The Sea Surface Temperature (SStM; Table 4) based forecast is 476,254 (71% GCL). This model uses a stepped marine survival rate calculated based on the average marine temperature over the March to May period which is applied to the estimates smolt abundance. Marine temperatures have been above average for all sea entry years contributing to the 2020 return, resulting in a "low" survival estimate of 2.5%. Indications from the 2015 brood year returning as 4 year olds in 2019 suggest that the marine survival has been much lower for this brood (Figure 4). Additionally, the estimates of juvenile Sockeye abundance for the 2017 sea-entry year (age 4_2 and 5_3 fish returning in 2019) were more uncertain than usual. Juvenile surveys conducted for the 2018 sea entry year are considered to be more reliable, however the estimate for GCL is one of the highest in the time series (Table 8) at 16.8 million which results in a prediction for greater numbers of GCL Sockeye compared to SPL, contrary to the prediction from the Sibling model.

- The Sea Surface Salinity (SSM) model forecast is 601,000 (69% GCL). This model utilizes a an exponential relationship to predict marine survival for each sea entry year based on average surface salinity for the March to May time period. The predicted survival is then applied to the estimated smolt abundances for each sea entry year. This model also appears to be significantly overestimating survival of the 2017 sea entry year and is predicting only slightly below average survival for the 2018 sea entry year. The predicted proportion of GCL of 69% is due to the large smolt abundance estimate for the 2018 sea entry year.

- The SEP Biostandards (SEPB) model forecast is 857,000 (71% GCL). This model applies a standard survival rate of 4.5% to the estimated smolt abundances for each sea entry year. This survival rate is much higher than what has been observed to date for the 2017 sea entry year and is likely to over predict the 2018 sea entry survival based on recent observations and indications from other models. Overall, this model has not performed well in recent years and is expected to be an over prediction of the 2020 Somass return.

- The Coho Leading Indicator (CLI) forecast is 992,000 (56% GCL) total return. The CLI model accounts for spawner abundances in the contributing brood years, as well as the survival rate of Coho from the contributing sea-entry years. The estimated survival rate of Coho from the 2017 sea-entry years was above average and Somass Sockeye escapement in 2015 was above average (the second highest escapement on record). However, Sockeye survival from the 2015

brood has been very poor (age 4 returns in 2019) and well below average (Figure 4). This forecast model predicts high returns of age 5 Sockeye in 2020 based on the above average Coho survival from the 2017 sea entry year and the forecast is therefore expected to be overly optimistic for 2020 returns. The performance of this model has been poor in recent years where the Coho and Sockeye survival from the same sea entry years has not followed similar trends.

2020 Somass Sockeye Management Forecast

For fishery management purposes, the Area 23 Roundtable has agreed that the management forecast in the "critical" zone corresponding to an expected return of less than 200,000 adult Sockeye (see Table 9).

Based on a projected return of less than 200,000 adult Sockeye, a precautionary approach to fisheries management will be required until in-season information can inform run size estimates.

The Area 23 Sockeye management plan assumes the Somass stock composition averages about 56% Great Central and 44% Sproat, with the productivity of the two populations similar enough that they can withstand a similar harvest rate. Actions will be taken if GCL is assessed to be significantly less (e.g. 30 to 40% or less) of the Somass aggregate in early season fisheries and escapement.

In-season indicators that will be applied to inform management in 2020:

- The stock composition from the test fishery in June – will be used as an indicator of the relative proportions of Great Central and Sproat Lake at the end of the run.
- If fisheries occur, Area D gillnet catch in Area 23 in the fourth week of June—will be used as an indicator of the final Somass Sockeye adult return
- The total accounting to date (escapement, catch, Alberni inlet abundance estimate, and lower river abundance estimate) and assumed run-timing and early estimated run timing—will be used as an indicator of the final Somass Sockeye adult return
- Scale samples collected from test boat, fisheries and escapement at the fishways—will inform on the age composition of the return
- River temperatures and inlet conditions – will inform holding and pre-spawn conditions which may impact returns

2020 Henderson Sockeye Outlook

The recommended management outlook for Henderson Sockeye is the "very low" zone for harvest management, corresponding to an expected return of less than 15,000 (Table 5). The key factors influencing this outlook are the low spawner abundances in the main contributing brood years (2015, 2016) for the 2020 return, as well as low marine survival rates experienced by these two brood years.

For further information contact:

Bryan Rusch
WCVI Stock Assessment Biologist
Phone: (250) 756-7003
Email: bryan.rusch@dfo-mpo.gc.ca

Appendix A. FORECAST METHODOLOGY

Four models have been used to forecast returns to Great Central Lake and Sproat Lake (Hyatt et al. 2003). These models include: the Survival Stanza Method (SStM), Surface Salinity Method (SSM), Salmonid Enhancement Program Biostandard Method (SEPB), and Coho Leading Indicator Method (CLI). More recently, a "sibling" model has been developed that uses the relationships between the returns of Sockeye at earlier ages to predict future returns of their older siblings (i.e. predicts age-4 and age-5 returns based on the abundance of age-3 and age-4 returns respectively) (DFO 2012).

Three of the four models (SStM, SSM, SEPB) use annual estimates of the numbers of smolts from Great Central and Sproat Lakes and correlates of early marine survival to predict returns. The SStM forecast correlates marine survival with marine temperature, and the SSM forecast correlates marine survival with marine salinity (Hyatt et al. 2003). The SEPB forecast applies a Salmonid Enhancement Program biostandard survival rate of 4.5% to the estimate of smolts to predict returns (Hyatt et al. 2003).

The CLI model is based on the observation that changes in marine survival variations for both juvenile Sockeye and Coho migrating through Barkley Sound and up the west coast of Vancouver island may be expected to co-vary because both species face similar physical and biological conditions at sea-entry in a given year (Hyatt et al. 2003). Because Coho return one year earlier than most Sockeye, Coho survival values observed in one year are used to predict survival of Sockeye returning the next year.

In general, the Sibling and SStM forecasts have provided the most accurate forecasts over the long term with mean absolute percentage error (MAPE) values of 39% and 53%, respectively (Table 3). Over the past 5 years the Sibling and SStM models have performed the best (MAPE values of 34% and 53% respectively), while the SSM,SEPB and CLI models have performed poorly over the past 5 years (MAPE values of 87%, 66% and 168% respectively).

The forecasts generated from all methods are evaluated based on their relative accuracy at predicting past returns along with other relevant information (e.g. marine environmental conditions or observations). A heuristic management forecast for the Somass aggregate return is produced to guide early season fisheries. This forecast sets pre-season expectations and guides early-season harvest planning.

2019 FORECAST PERFORMANCE

The preseason management forecast was in the "low" zone with an expected return of 350,000 adult Somass Sockeye (Table 2).

There was a below average return of about 180,000 adult Somass Sockeye (Great Central and Sproat Lake stocks) observed in 2019 (Table 1, Table 6, Figure 1). Fish from the 2013-2016 brood years returned in 2019, with 2014 and 2015 being the main contributing brood years.

The proportion of age 4 fish (36%) was higher than expected pre-season in the Sibling model, but lower than expected based on all other model predictions. The 2019 return included a low (below average) return of jack (age 3) Sockeye from both the Sproat Lake and Great Central 2016 brood and 2018 sea entry year.

The low proportion of Great Central Lake in the total return (28%) was better than expected pre-season (19%). The returns from the 2015 and 2016 brood years appear to be heavily weighted to Sproat Lake returns (74% Sproat in the 2015 brood returns and 87% in the 2016 brood returns, Table 7). The returns are still incomplete, but suggest a disproportionate return to Sproat Lake in 2020 relative to the historic proportions between these two lakes.

While all models over predicted the 2019 return, the Sibling Model was within 9% of the observed value and was the best performing model (Table 2). In contrast, the CLI model over predicted the return by 645% (Table 2). All other models over-estimated the final run size by varying degrees (Table 2). Smolt based models (SStM, SSM and SEPB) all over predicted primarily due to a lower than expected return of age 4 fish from the 2015 brood year. The large over prediction of the CLI model was the result of roughly average survival of Coho from the 2017 smolt year which did not reflect to survival of Sockeye from the same smolt year.

The return of Henderson Lake Sockeye in 2019 was approximately half of the 10 year average and estimated at about 6,000 (Table 1, Table 6, Figure 2). The pre-season outlook was for a management zone of “very low return” (i.e., less than 15,000 Sockeye). Pre-season expectations were based on the low spawner abundances in the main contributing brood years (2015, 2016), low marine survival rates experienced by these two brood years.

SOURCES OF UNCERTAINTY

The mean absolute percentage error (MAPE) for the five forecast models used to predict Somass Sockeye range from about 39% to over 100%, with the best performing forecast model (Sibling model) averaging about 39% (Table 3). That is, on average, the observed return is about 39% higher or lower than the predicted return. Factors that contribute to forecast uncertainty include, but are not limited to: model structure, uncertainty associated with model inputs (i.e. source data), etc.

For the Henderson Sockeye outlook, there is considerable uncertainty due to lower quality assessment data relative to the Somass stocks. There are less complete age data, relatively high uncertainty in the estimates of spawner abundance and uncertainty in catch estimates. Catch estimates are particularly uncertain in recent years when the abundance of Henderson Sockeye is very low relative to the Somass stocks. Under these circumstances, the probability of detection of Henderson Sockeye in catch samples is lower therefore catch of Henderson Sockeye may be underestimated.

The impact of the ocean conditions on juvenile Sockeye survival is uncertain and there is greater uncertainty in the estimates of smolt abundance for Great Central, Sproat and Henderson Lakes for the 2017 sea-entry year because fewer juvenile surveys were conducted than in other years, the surveys were undertaken by a new group, and the surveys did not inform on species composition and age classes. Smolt estimates for the 2018 sea-entry year were derived from a renewed acoustic/trawl survey program and should result in better estimates moving forward. The uncertainty in smolt survey estimates affects all smolt based forecast models in 2020 (SStM, SSM, and SEPB).

REFERENCES:

DFO. 2012. Assessment of Area 23 Sockeye and 2010 Forecast (Barkley Sound and Alberni Inlet). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/033.

Hyatt, K. D., W. Luedke, D. P. Rankin, J. Till and D. Lewis 2003. Review of the year 2002 return of Barkley Sound Sockeye salmon and forecasts for 2003. Fisheries and Oceans Canada. Canadian Science Advisory Secretariat. Research Document. 2003/033. iv + 34p. http://www.dfo-mpo.gc.ca/csas-sccs/publications/resdocs-docrech/2003/2003_033- eng.htm

Table 1. Total return of Sockeye to Barkley Sound in 2019.

Conservation Unit	Age at return						Total	Total Adults
	3.2	4.2	4.3	5.2	5.3	6.3		
Great Central Lake	5,427	13,516	7,953	31,770	2,592	2,424	63,683	50,303
Sproat Lake	37,308	50,543	2,413	72,769	4,036	2,068	169,136	129,416
Henderson Lake	29	2,205	4	3,415	72	273	5,999	5,966
Combined Barkley Sound	**42,763**	**66,264**	**10,370**	**107,955**	**6,701**	**4,765**	**238,819**	**185,685**

Table 2. Forecast performance of alternative Somass Sockeye models for 2019. Absolute Percentage Error (APE) is calculated as (Forecast-Return)/Return (adult fish).

2019 Management forecast : low/moderate zone (350,000 adult fish)					
179,719 Observed	Forecast 2019				
	SStM	SSM	SEPB	CLI	Sibling
Expected	312,766	378,940	562,979	1,339,596	196,486
Obs-Exp	- 133,047	- 199,221	- 383,260	- 1,159,877	- 16,767
APE	74%	111%	213%	645%	9%

Table 3. Forecast results for 2020 from alternative Somass Sockeye models. Mean Absolute Percentage Error (MAPE) is the average APE over years the forecast method has been used. The forecast from each model (at the 50% probability level) for the Somass Sockeye aggregate is further broken down into stock-specific forecasts.

Probality of a lower return	Forecast Method				
	SStM	SSM	SEPB	CLI	Sibling
0.75	747,141	1,165,358	1,179,178	1,286,726	451,635
0.5	**476,254**	**601,379**	**857,258**	**992,047**	**168,788**
0.25	204,092	-	533,824	695,981	-
MAPE	53%	112%	82%	74%	39%
GCL	**336,560**	**414,447**	**605,807**	**556,043**	**38,412**
SPR	**139,695**	**186,931**	**251,451**	**436,004**	**130,376**

Table 4. Stock and age composition for 2020 forecast results from three Somass Sockeye models (Sibling forecast, SStM forecast, and CLI forecast).

Forecast		Age at return					% of return
			4.2	**5.2**	**5.3 and 6.3**	**Total**	
Sibling	GCL		28,516	7,997	1,899	**38,412**	23%
	SPL		106,431	20,470	3,475	**130,376**	77%
	Total		134,947	28,467	5,374	**168,788**	
	% at age		13%	76%	10%		
			4s	**5s**		**Total**	
SStM	GCL		231,142	105,418		**336,560**	71%
	SPL		110,108	29,587		**139,695**	29%
	Total		341,250	135,005		**476,254**	
	% at age		72%	28%			
		4.2	**5.2**	**5.3**	**6.3**	**Total**	
CLI	GCL	111,632	332,019	107,971	4,421	**556,043**	56%
	SPL	152,115	253,763	25,255	4,872	**436,004**	44%
	Total	263,746	585,782	133,226	9,293	**992,047**	
	% at age	27%	59%	13%	1%		

Table 5. 2020 outlook for the Henderson Sockeye return.

Return Year	Age at Return	Brood year	Spawner Abundance	Smolt Year	Smolt Abundance	Marine Survival	Outlook
2020	4s	2016	11K	2018	No Survey	LOW (<2%)	**Very Low**
	5s	2015	6K	2017	No Survey	LOW (<2%)	**< 15,000**

Table 6. Terminal Return of Area 23 adult Sockeye; 1980 to 2019. (Estimates do not include jacks. Catch includes Henderson Sockeye.)

RETURN YEAR	TEST FISHERY	FIRST NATIONS CATCH				COMMERCIAL CATCH					RECREATIONAL	TOTAL CATCH	ESCAPEMENT				TOTAL RETURN
		Tseshaht / Hupacasath Total Catch	Barkley Bands (FSC)	Maanulth First Nation	Total First Nations	Comm GN	Comm SN	Troll	Special Use	Total Comm Catch	Recreational		GCL adults	SPR adults	HED	Ttl Adult Esc	
1980	-	15,791	-		15,791	292,339	374,760	-		667,099	-	682,890	246,041	124,943	21,000	391,984	**1,074,874**
1981	-	17,000	-		17,000	391,950	617,474	-		1,009,424	-	1,026,424	195,124	118,710	40,000	353,834	**1,380,258**
1982	-	23,500	-		23,500	229,271	246,673	-		475,944	-	499,444	155,579	213,477	56,000	425,057	**924,501**
1983	-	30,000	-		30,000	315,478	603,827	-		919,305	-	949,305	339,204	239,763	45,000	623,967	**1,573,272**
1984	-	21,000	-		21,000	454,813	463,971	-		918,784	-	939,784	131,000	76,373	61,000	268,374	**1,208,158**
1985	77*	15,987	-		15,987	249,814	190,038	-		439,852	1,731	457,570	112,339	113,688	16,000	242,027	**699,597**
1986	2,885*	12,800	-		12,800	30,461	13,640	-		44,101	17	56,918	119,820	173,915	3,000	296,735	**353,653**
1987	6,993*	23,395	-		23,395	19,921	189,643	-		209,564	21,424	254,383	277,562	105,457	26,000	409,019	**663,402**
1988	10,470*	21,292	-		21,292	146,391	146,603	-		292,994	348	314,634	195,327	210,518	35,000	440,845	**755,479**
1989	648	23,395	-		23,395	4,145		-		4,145	139	27,679	171,652	133,349	36,000	341,000	**368,679**
1990	7,211*	10,480	-		10,480	3,617	8,062	-		11,679	14,430	36,589	163,320	93,631	32,000	288,952	**325,541**
1991	8,505*	36,523	-		36,523	282,833	762,634	-		1,045,467	78,551	1,160,541	402,976	140,123	37,000	580,099	**1,740,640**
1992	-	53,662	-		53,662	203,890	211,938	-		415,828	101,408	570,898	149,898	192,641	35,000	377,539	**948,437**
1993	11,997*	58,020	10,000		68,020	258,957	346,246	-		605,203	107,407	780,630	227,694	187,860	150,000	565,553	**1,346,183**
1994	10,475	53,656	10,000		63,656	74,981	-	-		74,981	30,261	179,373	113,121	142,162	18,000	273,282	**452,655**
1995	146	23,782	-		23,782	-	-	-		-	6,519	30,447	40,940	43,254	4,000	88,195	**118,642**
1996	4,513	28,139	-		28,139	-	-	-		-	28,033	60,685	157,087	207,716	56,000	420,804	**481,489**
1997	10,493	29,508	12,098		41,606	52,241	-	2,100		54,341	36,531	142,971	174,088	126,349	49,000	349,437	**492,408**
1998	17,522	45,200	30,859		76,059	49,924	-	9,003		58,927	55,421	207,929	184,542	142,360	82,000	408,902	**616,831**
1999	4,445	39,820	1,000		40,820	53,800	-	8,819		62,619	7,870	115,754	203,969	162,776	12,000	378,745	**494,499**
2000	6,904	36,649	16,500		53,149	16,260	-	5,236		21,496	24,315	105,864	52,043	108,568	23,000	183,611	**289,475**
2001	7,004	58,245	20,000		78,245	46,640	-	21,022		67,662	67,190	220,100	307,106	158,923	11,000	477,029	**697,130**
2002	9,207	99,014	41,575		140,589	131,176	202,893	51,087		385,156	58,718	593,670	259,482	190,971	18,000	468,453	**1,062,123**
2003	10,577	64,908	25,651		90,559	149,499	209,823	-		359,322	61,610	522,069	223,546	163,807	3,000	390,352	**912,421**
2004	10,318	119,522	28,673		148,195	46,420	48,041	-		94,461	81,836	334,810	213,021	113,798	3,000	329,819	**664,629**
2005	9,233	49,213	3,745		52,958	11,305	-	-		11,305	31,292	104,788	172,962	131,949	2,000	306,911	**411,700**
2006	11,188	35,808	5,000		40,808	5,449	-	-		5,449	30,514	87,959	135,493	61,940	3,000	200,433	**288,391**
2007	885	8,706	-		8,706	-	-	-		-	-	9,591	67,717	52,837	12,000	132,554	**142,145**
2008	-	-	-		-	-	-	-		-	-	-	59,589	65,333	11,000	135,921	**135,921**
2009	-	55,345	12,963		68,308	9,138	14,735	-		23,873	55,218	147,399	203,858	130,289	30,000	364,148	**511,547**
2010	-	85,596	20,915		106,511	240,170	495,495	-		735,665	77,462	919,638	255,339	296,956	30,000	582,296	**1,501,934**
2011	-	109,369		17,081	126,450	231,442	192,333	-		423,775	42,799	593,024	431,213	381,980	20,423	833,616	**1,426,640**
2012		154,951		18,047	172,998	116,106	79,550	-		195,656	16,940	385,593	147,440	192,226	17,133	356,800	**742,393**
2013	5,313	31,208		11,851	43,059	11,390	9,128	-		20,518	13,274	82,164	66,688	119,849	12,500	199,037	**281,201**
2014	9,636	164,319		19,659	183,978	169,685	243,937	-	5,190	418,812	16,313	628,739	66,298	159,751	11,837	237,885	**866,624**
2015	11,298	319,351		25,267	344,618	329,505	521,003	-	15,000	865,508	88,232	1,309,656	417,774	312,265	6,400	736,440	**2,046,096**
2016	8,887	170,326		26,765	197,091	161,607	228,329	-	13,124	403,060	51,680	660,719	220,952	211,926	10,700	443,578	**1,104,297**
2017	3,328	36,305		14,672	50,977	9,879	16,461	-		26,340	12,420	93,065	125,846	142,684	22,704	291,234	**384,299**
2018	4,837	35,886		18,278	54,164	10,785	6,075	-		16,860	5,566	81,427	36,418	146,312	12,203	194,933	**276,360**
2019	3,409	27,770		12,792	40,562	6,482	-	-		6,482	2,193	52,646	35,982	91,245	5,874	133,101	**185,747**
AVG 92+	6,139	72,834	12,578	18,953	87,300	88,528	104,666	3,603	11,105	198,030	41,068	332,184	174,597	161,018	24,663	360,278	692,462
10 YR AVG	5,190	113,508	20,915	18,268	132,041	128,705	179,231	-	11,105	311,268	32,688	480,667	180,395	205,519	14,977	400,892	881,559
5 YR AVG	6,352	117,928		19,555	137,482	103,652	154,374	-	14,062	263,650	32,018	439,503	167,395	180,886	11,576	359,857	799,360

Table 7. Escapement, catch and total return at age from brood years contributing to the 2020 Somass Sockeye return

Brood Year	Conservation Unit	Escapement						Catch						Total Return						% of return
		3.2	4.2	4.3	5.2	5.3	TOTAL	3.2	4.2	4.3	5.2	5.3	TOTAL	3.2	4.2	4.3	5.2	5.3	TOTAL	
2014	Great Central Lake	12,467	24,148	1,687	23,394	2,295	63,991	320	12,927	90	8,376	297	22,011	12,787	37,074	1,777	31,770	2,592	86,002	17%
	Sproat Lake	146,818	131,896	3,427	50,272	3,247	335,660	3,711	56,652	183	22,497	789	83,832	150,529	188,547	3,610	72,769	4,036	419,492	83%
	TOTAL	159,286	156,044	5,114	73,666	5,542	399,651	4,031	69,578	273	30,874	1,087	105,842	163,317	225,622	5,387	104,540	6,629	505,493	
2015	Great Central Lake	515	8,326	7,631			16,471	27	5,191	322			5,540	542	13,516	7,953			22,012	26%
	Sproat Lake	8,074	36,603	2,315			46,992	431	13,940	98			14,468	8,505	50,543	2,413			61,460	74%
	TOTAL	8,589	44,928	9,946	0	0	63,463	458	19,130	420			20,009	9,047	64,059	10,366			83,472	
2016	Great Central Lake	5,207					5,207	220					220	5,427					5,427	13%
	Sproat Lake	35,796					35,796	1,511					1,511	37,308					37,308	87%
	TOTAL	41,003	0	0	0	0	41,003	1,731					1,731	42,735					42,735	

Table 8. Estimates of juvenile Sockeye abundance in Great Central, Sproat, and Henderson Lakes for smolt years 1978-2018 (units are in millions).

Smolt Year	Great Central Lake			Sproat Lake			Henderson Lake
	Age 1.0s	Age 2.0s	Total	Age 1.0s	Age 2.0s	Total	Total
1978	6.66	2.25	8.91				1.60
1979	14.86	0.83	15.70				0.77
1980	7.45	0.00	7.40	4.48	0.00	4.62	
1981	9.31	0.31	9.60	5.48	0.14	5.68	2.88
1982	6.79	2.75	9.50	7.93	0.33	8.34	2.15
1983	12.45	0.81	13.20	8.14	0.14	8.43	3.79
1984	7.66	1.46	9.10	9.37	0.27	9.64	4.30
1985	9.64	0.83	10.40	19.26	0.00	19.56	3.52
1986	7.11	2.45	9.50	5.79	0.14	6.97	4.26
1987	4.91	0.35	5.20	4.52	0.52	5.04	0.96
1988	3.41	0.43	3.80	8.69	0.00	8.89	0.03
1989	6.07	0.26	6.40	8.84	0.22	9.19	2.07
1990	6.75	0.51	7.20	10.10	0.49	11.18	2.57
1991	8.68	2.03	10.70	7.62	0.81	8.54	1.68
1992	4.58	0.21	4.80	5.42	0.28	5.88	0.86
1993	7.12	0.05	7.15	3.20	0.05	3.37	0.95
1994	3.13	0.77	3.90	9.69	0.36	5.99	0.90
1995	2.87	0.53	3.40	5.57	0.09	5.90	5.46
1996	6.71	2.69	9.40	9.33	0.32	9.78	0.33
1997	3.77	0.61	4.40	4.65	0.10	4.76	0.03
1998	16.71	0.09	16.79	17.21	0.02	18.12	1.97
1999	10.29	1.49	11.80	7.90	0.33	8.23	0.05
2000	6.34	0.16	6.50	8.33	0.00	8.46	2.06
2001	11.06	2.49	13.60	9.54	0.09	9.68	1.07
2002	3.31	0.03	3.73	7.10	0.22	7.48	2.14
2003	8.92	0.67	10.50	4.53	0.14	4.77	1.82
2004	8.27	1.35	10.90	8.21	0.26	8.60	1.37
2005	5.57	0.83	8.50	6.37	0.20	6.70	1.23
2006	2.35	1.27	4.00	3.35	0.11	3.50	0.83
2007	5.09	0.57	5.60	3.48	0.11	3.60	0.63
2008	4.15	0.65	4.78	4.86	0.14	5.00	0.48
2009	3.16	0.60	3.76	5.84	0.18	6.02	3.02
2010	4.653	0.517	5.17	4.83	0.15	4.98	1.39
2011	9.73	1.27	11.00	6.02	0.18	14.53	1.19
2012	14.32	1.34	15.66	13.00	0.19	13.44	0.28
2013	13.75	1.42	15.17	7.53	0.40	14.53	3.14
2014	8.59	1.52	10.11			3.69	1.81
2015			0.75			1.21	0.611
2016			3.79			4.15	-
2017			12.05			5.92	-
2018			16.81			6.99	-

Table 9. Standardized Area 23 Sockeye Fishing Regime for early-season (June) fisheries. Typically, commercial seine fisheries are not planned until late June. However, all fisheries may be adjusted depending on in-season assessment results.

MANAGEMENT ZONE	FORECAST RUN SIZE	MAANULTH FIRST NATIONS	RECREATIONAL	TSUMASS ECONOMIC OPPORTUNITY	COMMERCIAL SEINE*	COMMERCIAL GILLNET
1 - Critical	**Less than 200,000**	no harvest	no harvest	no harvest	no harvest	no harvest
2 - Very Low	**200,000 to 350,000**	Open, fishing to target through limited effort (designated g/n vessels)	2 fish/day + Area restrictions + Late opening	Community/elder seine 1 day/week g/n	no harvest	1 day/week starting 64 (1 day total)
3 - Low	**350,000 to 500,000**	Open, fishing to target through limited effort (designated g/n vessels)	2 fish/day + Area restrictions	Community/elder seine 2 days/week g/n	seine fishing to target	1 day/week starting 63 (2 days total)
4 - Moderate	**500,000 to 700,000**	Open, fishing to target through limited effort (designated g/n vessels)	4 fish/day (time-area closures if required)	Community/elder seine 3 days/week g/n	seine fishing to target	1 day/week starting 62 (3 days total)
5 - High	**700,000 to 1,000,000**	Open, fishing to target through limited effort (designated g/n vessels)	4 fish/day (time-area closures if required)	Community/elder seine 4 days/week g/n	seine fishing to target	1 day/week starting 62 (3 days total)
6 - Abundant	**1,000,000 +**	Open, fishing to target through limited effort (designated g/n vessels)	4 fish/day	Community/elder seine 5 days/week g/n	seine fishing to target	1 day/week starting 61 (4 days total)

Table 10. General guidelines for allowable fishery openings in the outside area (Barkley Sound) for Area D Gillnet associated with the Henderson Sockeye outlook. These guidelines are designed to reduce the exploitation rate of Henderson Sockeye as the expected abundance declines. Additional time and area measures may be applied in-season depending on environmental conditions and observed migration behavior.

MANAGEMENT ZONE	*HENDERSON RUN SIZE*	*REFERENCE POINT*	*TAC* [1]	*HARVEST REGIME* [2]		
				Outside Area Openings	*Outside Area Closure*	*Maximum Harvest Rate*
1 - Very Low	**UP to 15,000**		-	June only	July 1	9%
2 - Low	**15,000 to 25,000**	low end	1,317	June + up to 1 day July	July 8	9%
		high end	2,926			12%
3 - Moderate	**25,000 to 45,000**	low end	2,926	June + up to 2 days July (1 per week)	July 15	12%
		high end	7,900			18%
4 - High	**45,000 to 60,000**	low end	7,900	June + up to 3 days July (up to 2 per week)	July 15	18%
		high end	14,045			23%
5 - Abundant	**60,000 to 150,000**	low end	14,045	June + up to 4 days July (2 per week)	July 15	23%
		high end	43,890			29%

1. *Not including TAC associated with Maanulth Treaty or Maanulth Harvest Agreement.*
2. *The harvest regime may be adjusted based on the results of catch composition analysis.*

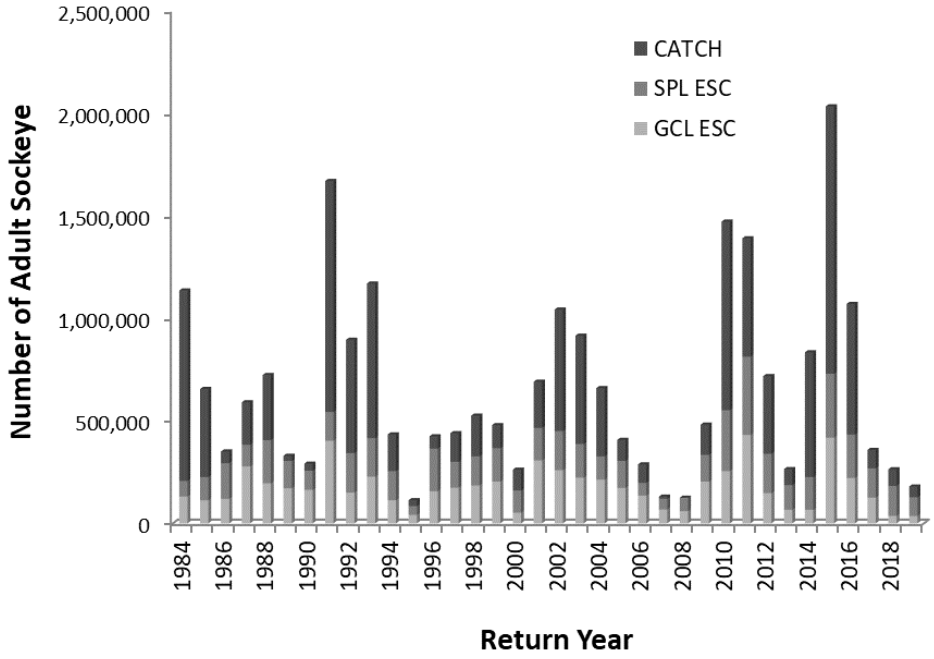

Figure 1. Estimated adult return of Somass (Great Central and Sproat Lake) Sockeye, 1984-2019.

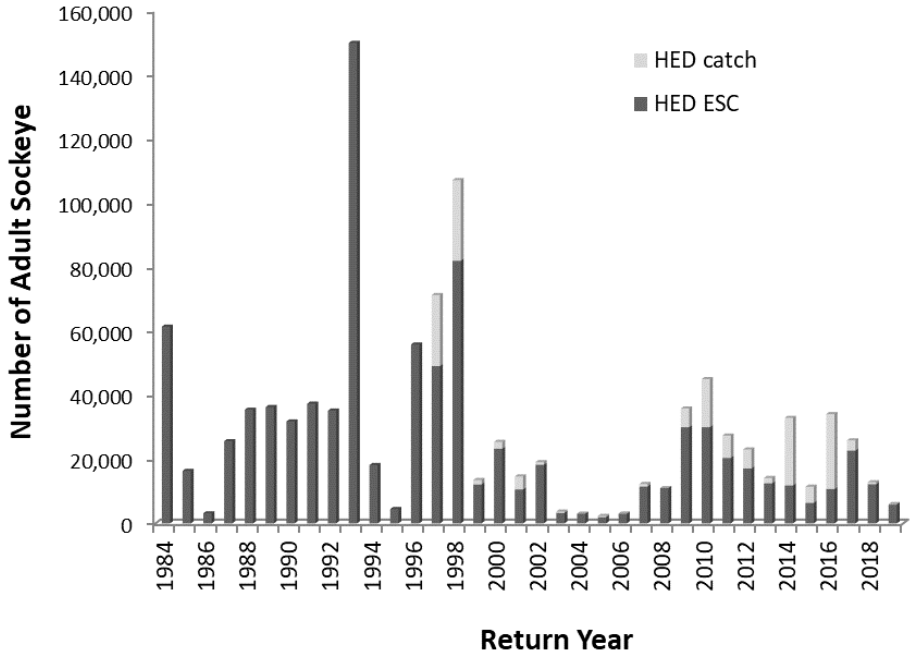

Figure 2. Estimated adult return of Henderson Lake Sockeye, 1984-2019.

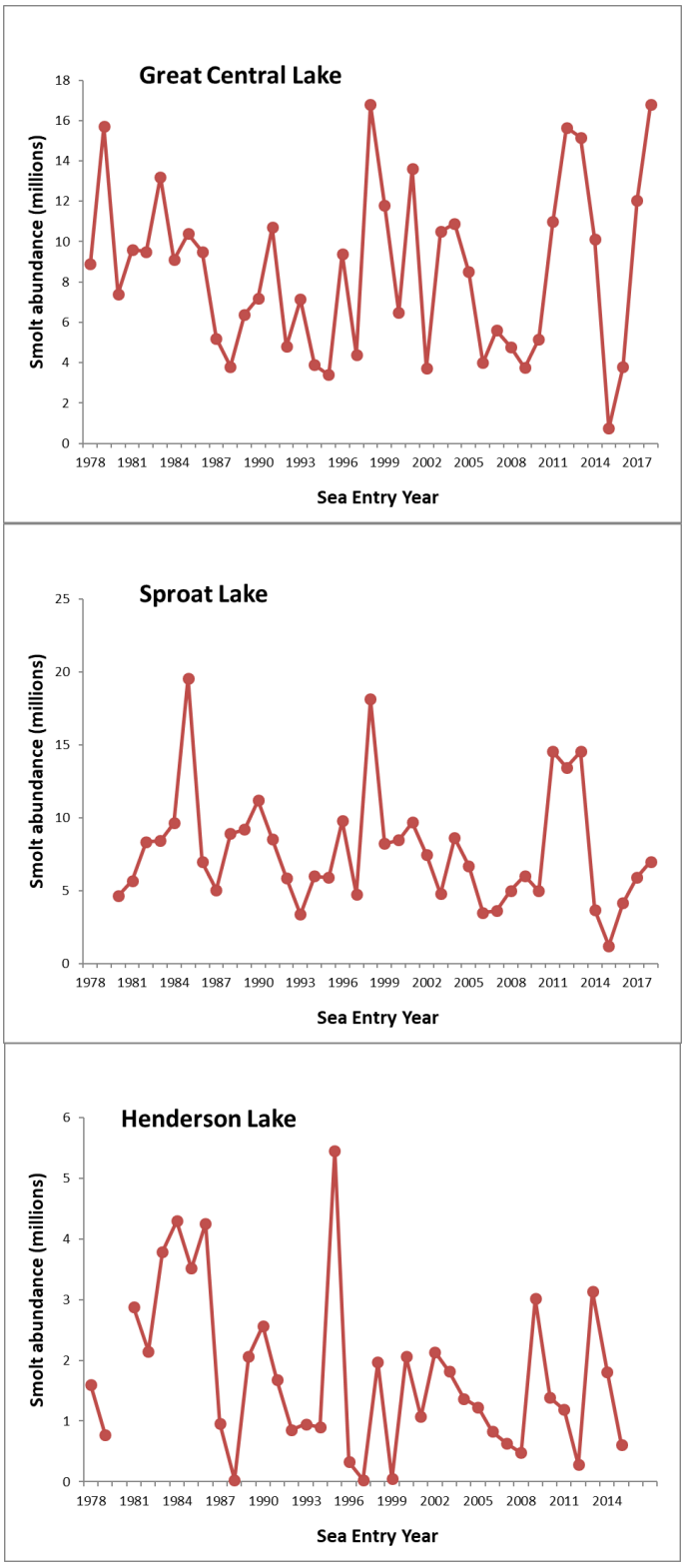

Figure 3. Estimated Sockeye "pre-smolt" juvenile abundance for Great Central, Sproat and Henderson Lake by sea-entry year. Most adult Sockeye returning in 2020 are associated with the production from the 2017 and 2018 sea-entry years.

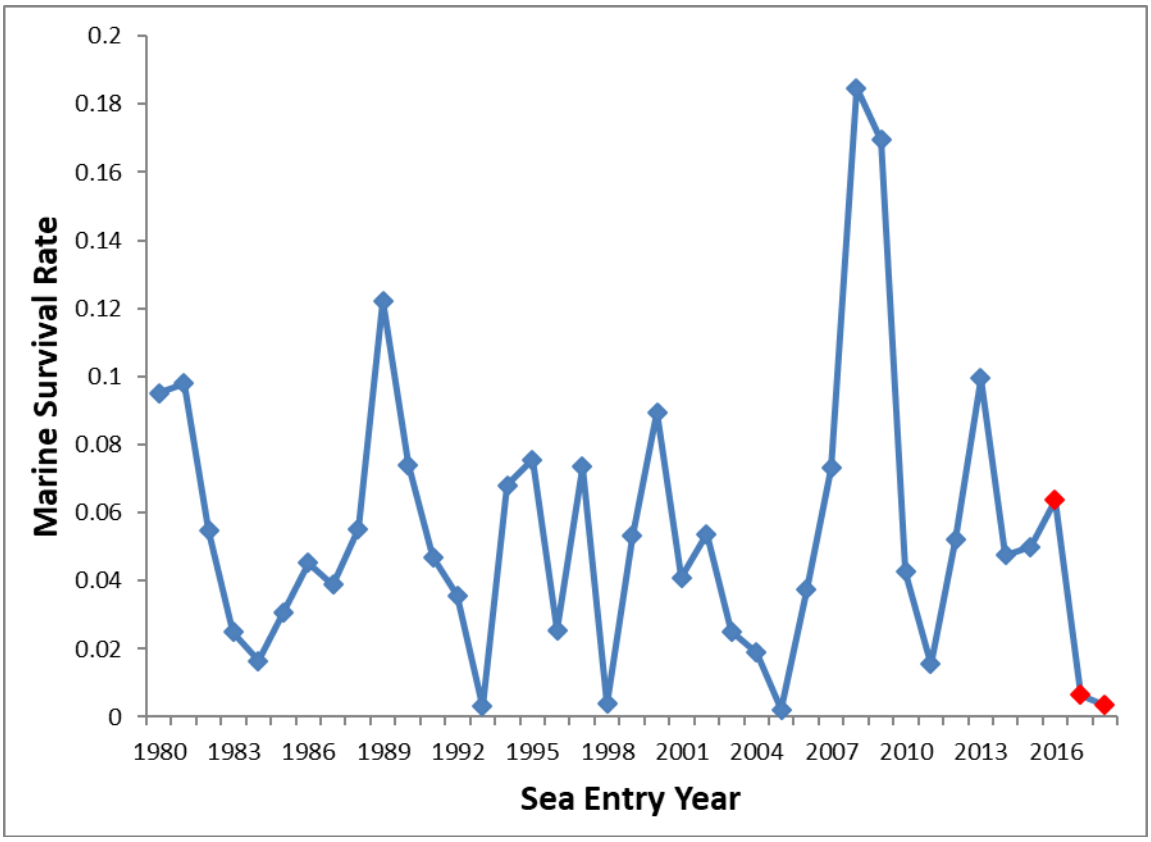

Figure 4. Marine survival rate index for the Somass Sockeye stocks. Most adult Sockeye returning in 2020 are associated with the 2017 and 2018 sea-entry years. Although the survival rate index for those years is preliminary (and incomplete as it does not yet account for older fish that will return in 2020), the survival rate associated with the 2017 and 2018 sea-entry year were very low.