



WCVI Salmon Bulletin 2017 Area 23 Sockeye Forecast April 3, 2017

SUMMARY

- There was an abundant return of about 1.1M Somass sockeye (Great Central and Sproat Lake stocks) in 2016. The majority of the abundance was 5₂ year olds produced from the record 2011 brood year escapement that experienced above-average marine survival for the associated 2013 sea entry year.
- The return of Henderson Lake sockeye in 2016 was moderate; estimated at about 34,000 adults. Similar to the Somass stocks, the majority of the return was associated with the 2011 brood year.
- For 2017, the recommended management forecast for Somass sockeye is the “critical” zone for harvest management; corresponding to an expected return of less than 200,000 adult fish. Key factors in the sharp decline of expected abundance relative to recent return years are i) very low observed smolt production and ii) relatively low marine survival rate for the 2014 and 2015 key sea-entry years associated with this year’s adult return.
- For 2017, the recommended management outlook for Henderson sockeye is in the “very low zone” for harvest management; corresponding to an expected return of less than 15,000. Similar to Somass sockeye, key factors in the low expected abundance for 2017 are the decline in the marine survival rate associated with recent sea-entry years and relatively low smolt production in 2015.

BACKGROUND

- Three sockeye stocks return to Barkley Sound (Area 23) annually: the Great Central Lake, Sproat Lake and Henderson stocks. Status of each stock is assessed as a separate Conservation Unit (CU) for implementation of Canada’s Wild Salmon Policy. From 1980 to 2016, the average terminal returns (catch and escapement) of Great Central, Sproat and Henderson Lake sockeye are 400,000, 335,000 and 30,000, respectively.
- For fishery implementation and forecasting purposes, the Great Central and Sproat Lake stocks are aggregated as one stock management unit referred to as Somass sockeye. With the exception of Maanulth Treaty fisheries, Area 23 sockeye fisheries target Somass sockeye while managed to limit impacts on the Henderson stock.
- The pre-season management forecast for Somass sockeye guides early-season fishery planning and effort-limited harvest plans in June (Table 6). The run size forecasts are revised in late June based on the evaluation of in-season stock assessment results. The first in-season forecast revision is anticipated no earlier than June 29, 2017.
- Statistical forecast models for Henderson sockeye are not generated due to data limitations. A heuristic outlook is produced based on spawner and smolt abundance and indicators related to marine survival rate for the contributing brood years. This outlook determines 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 7).

FORECAST

Methodology

Four models have been used to forecast Somass sockeye returns for between 14 and 25 years with relative accuracy. These models include: the Survival Stanza Method (SStM), Surface Salinity Method (SSM), Salmonid Enhancement Program Biostandard Method (SEPB), and Coho Leading Indicator Method (CLI). 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 CLI model uses marine survival estimates for coho salmon from corresponding sea-entry years to predict return from average returns per adult sockeye spawner. In general, the SStM and CLI forecasts have provided the most accurate forecasts over the long term. More recently, a “sibling” model has been developed that uses relationships between the returns at age from past brood years to predict future returns from earlier returning age classes.

The forecasts generated from all methods are compared and based on their correspondence, relative accuracy at predicting past returns, and other relevant information (e.g. marine observations) a heuristic management forecast is produced to guide early season fisheries. This forecast sets pre-season expectations and guides early-season harvest planning.

2016 Return and Forecast Performance

There was an abundant return of about 1.1M Somass sockeye (Great Central and Sproat Lake stocks) observed in 2016 (Table 1, Table 5, Figure 1). About 82% of this return resulted from the abundance of 5 year olds that smolted during the 2013 sea entry year. Ocean conditions for this sea entry year were favorable promoting an above average marine survival rate of about 10%. However, marine survival rate alone does not explain the abundance. The 5-year old return which contributed to 82% of the overall production in 2016 also results from the record high spawner abundance in the corresponding 2011 brood year. The Sibling and CLI forecast models were the best performing models, overestimated the return by 11 and 12%, respectively. All other models under-estimated the final run size (Table 2).

The return of Henderson Lake sockeye in 2016 was moderate and estimated at about 34,000 (Table 1, Table 5 Figure 2). The pre-season outlook was for a very low return of less than 15,000 sockeye. Pre-season expectations were based on the observation of relatively few 4-year olds in 2015 (brood year 2011). However, the majority of the return in 2016 was 5-year olds associated with this brood year. Therefore, the survival rate for the 2013 sea entry year was apparently higher than initially estimated, although still much lower than observed for the Somass stocks.

2017 Somass Sockeye Forecast

The age of return for Somass sockeye ranges from 3 to 6 years with age 4 and 5 fish predominant. Sockeye produced from brood years 2011 to 2014 will return in 2017. Model forecasts for the Somass return range from a low of about 136,000 (SStM) to a high of about 511,000 (CLI Forecast Model, Table 3). The ‘sibling model’ forecast return for 2017 is 172,000. On average, this model has performed the best in recent years.

The sharp decline of expected abundance relative to recent return years is explained by the following factors. One is the low level of smolt production observed in Sproat Lake in 2014 and the very low level observed for both stocks for 2015 (Figure 3). A second factor is an apparently low marine survival rate for those same sea-entry years (Figure 4). Correspondingly, relatively low numbers of “jacks” (or age 3₂) fish were observed from these broods so far (i.e. in both the 2015 and 2016 return years). The highest forecast prediction of 511,000 (CLI model) is discounted because that model does not incorporate observations of juvenile production¹. Therefore, for fishery management purposes, the recommended

¹ The very low level of juvenile production observed in 2015 was apparently associated with higher than usual freshwater mortality during the over-winter period of lake rearing prior to sea-entry. Earlier fall surveys showed levels of juvenile abundances more commensurate with expectations given spawner abundances in the main associated brood year 2013 (GCL – 66K, SPL – 118K).

management forecast is precautionary and in the “critical” for harvest management; corresponding to an expected return of less than 200,000 adult fish

The expected Somass sockeye stock composition is about 37% Great Central and 63% Sproat Sockeye.

The expected Somass sockeye age composition is about 50%, 37%, 7%, and 6% of age 4₂, 5₂, 5₃ and 6₃ adults, respectively.

2017 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 4). The key factor influencing this outlook is the apparently low marine survival rate experienced by the two brood years (2012, 2013) that contribute to the 2017 return. Also, similar to Somass sockeye, the juvenile production from the 2013 (2015 sea entry year) was below average.

SOURCES OF UNCERTAINTY

The mean absolute percentage error (MAPE) for the forecast models used to predict Somass sockeye range from about 38 to over 100% for the years when the models have been applied, with best performing forecasts averaging about 38%. That is, on average, the observed return is about 38% 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 also 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.

Table 1. Total return of sockeye to Barkley Sound in 2016.

Conservation Unit	Age at return						Total	Total Adults
	3.2	4.2	4.3	5.2	5.3	6.3		
Great Central Lake	4,353	44,240	-	494,701	15,618	12,058	570,970	566,617
Sproat Lake	19,660	80,987	2,339	399,033	14,071	9,476	525,566	503,567
Henderson Lake	30	3,406	-	29,874	591	247	34,148	34,118
Combined Barkley Sound	24,043	128,633	2,339	923,608	30,280	21,781	1,130,684	1,104,302

Table 2. Forecast performance of alternative Somass sockeye models for 2016. Absolute Percentage Error (APE) is calculated as (Forecast-Return)/Return (adult fish).

1,069,731 Observed	Forecast 2016				
	SStM	SSM	SEPB	CLI	Sibling
Expected	607,907	312,442	724,533	1,203,450	1,192,281
Obs-Exp	462,277	757,742	345,651	- 133,266	- 122,097
APE	43%	71%	32%	12%	11%

Table 3. Forecast results for 2017 from alternative Somass sockeye models. Mean Absolute Percentage Error (MAPE) is the average APE over years the forecast method has been used.

Probability of a lower return	Forecast Method				
	SStM	SSM	SEPB	CLI	Sibling
0.75	416,917	739,681	576,792	757,042	468,526
0.5	136,214	148,740	245,185	510,986	172,326
0.25	-	-	-	263,772	-
MAPE	52%	114%	81%	52%	37%

Table 4. 2017 outlook for the Henderson sockeye return.

Return Year	Age at Return	Brood year	Spawner Abundance	Smolt Year	Smolt Abundance	Marine Survival	Outlook
2017	4s	2013	LOW (12K)	2015	LOW (0.6M)	LOW (<2%)	Very Low
	5s	2012	Moderate (20K)	2014	AVG (1.2M)	LOW (<2%)	< 15,000

Table 5. Terminal Return of Area 23 adult sockeye; 1980 to 2016. (Estimates do not include jacks. Catch includes Henderson sockeye.)

RETURN YEAR	TEST FISHERY	FIRST NATIONS CATCH				COMMERCIAL CATCH					RECREATIONAL	TOTAL CATCH	ESCAPEMENT				TOTAL RETURN
		Tseshah / Hupacasath Total Catch	Barkley Bands (FSC)	Maanulth First Nation	Total First Nations	Comm GN	Comm SN	Troll	Special Use	Total Comm Catch			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	66,491	119,849	12,500	198,840	281,004
2014	9,636	164,319	-	19,659	183,978	169,685	243,937	-	5,190	418,812	16,313	628,739	73,647	175,401	11,837	260,885	889,624
2015	11,298	319,351	-	25,267	344,618	329,505	521,003	-	15,000	865,508	88,232	1,309,656	414,134	310,716	6,400	731,250	2,040,906
2016	8,897	170,326	-	26,765	197,091	161,607	228,329	-	13,124	403,060	51,680	660,719	220,959	211,925	10,700	443,584	1,104,303
AVG 92+	6,437	75,773	12,578	19,778	90,079	94,783	112,138	4,863	11,105	212,145	43,634	351,779	182,215	162,903	25,240	370,358	722,137
10 YR AVG	4,392	121,163	-	19,778	138,113	141,005	198,279	-	11,105	342,985	40,213	525,215	208,075	209,408	16,666	434,149	959,363
5 YR AVG	8,784	168,031	-	20,318	188,349	157,659	216,389	#DIV/0!	11,105	380,711	37,288	613,374	184,534	202,023	11,714	398,272	1,011,646

Table 6. 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 7. 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. As well, a box-closure is applied at the entrance of Uchucklesit Inlet.

MANAGEMENT ZONE	HENDERSON RUN SIZE	REFERENCE POINT	TAC¹	HARVEST REGIME²		
				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.

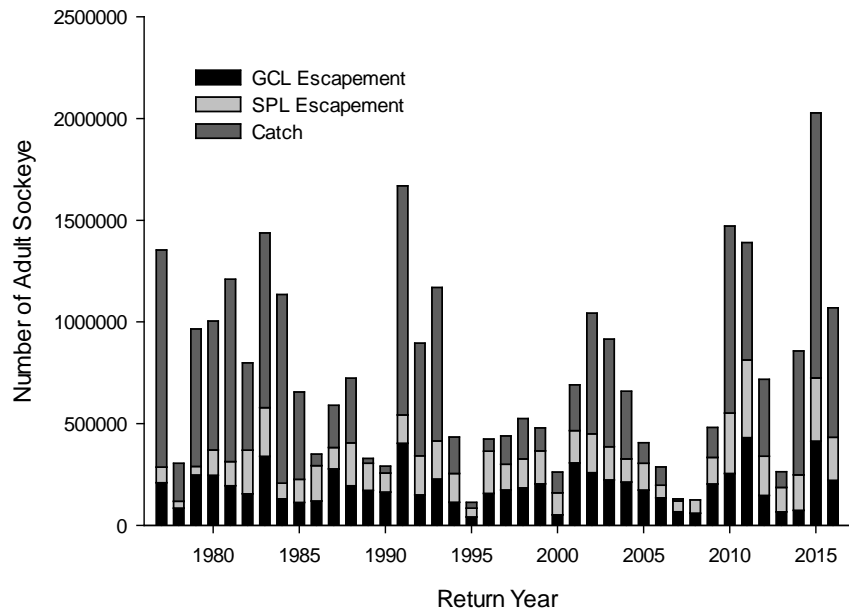


Figure 1. Estimated return of Somass (Great Central and Sproat Lake) sockeye, 1978-2016.

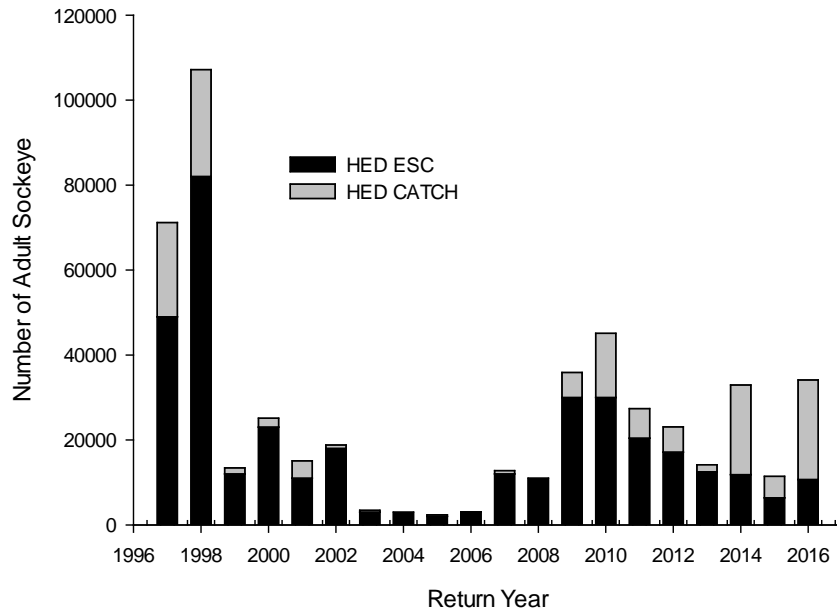


Figure 2. Estimated return of Henderson Lake sockeye, 1997-2016.

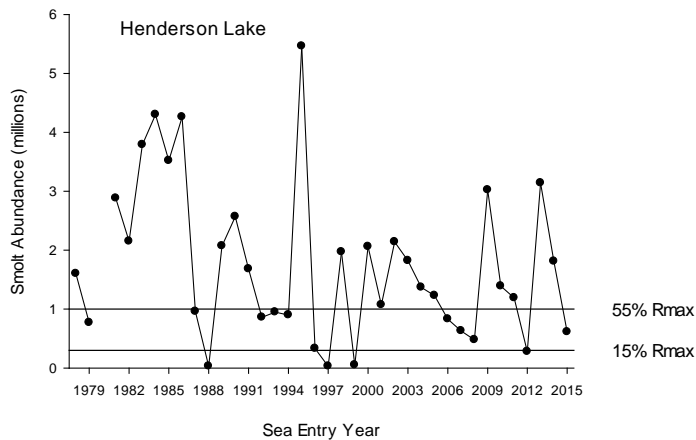
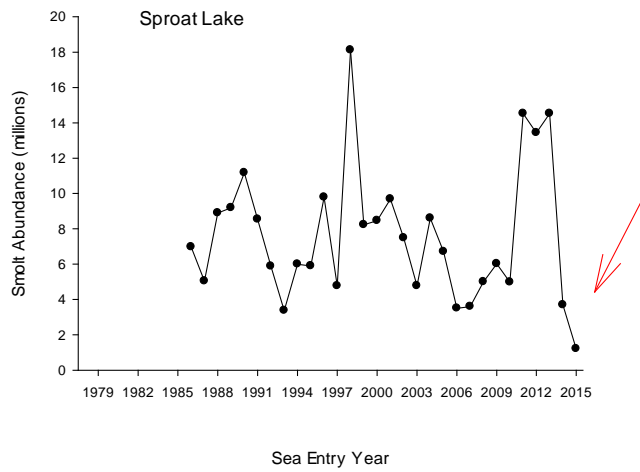
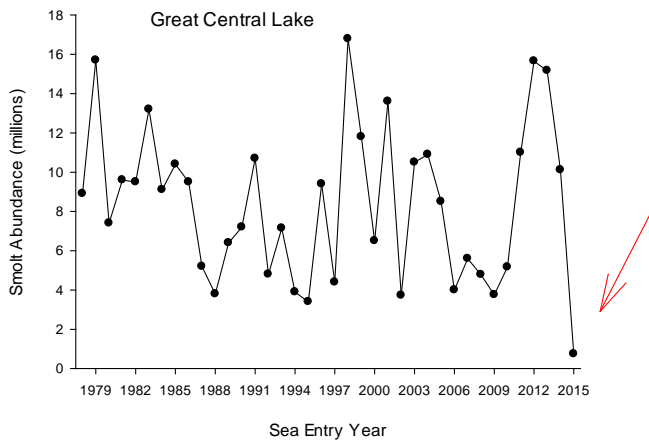


Figure 3. Estimated sockeye “pre-smolt” juvenile abundance for Great Central, Sproat and Henderson Lake by sea-entry year. Most adult sockeye returning in 2017 are associated with the production from the 2014 and 2015 sea-entry years.

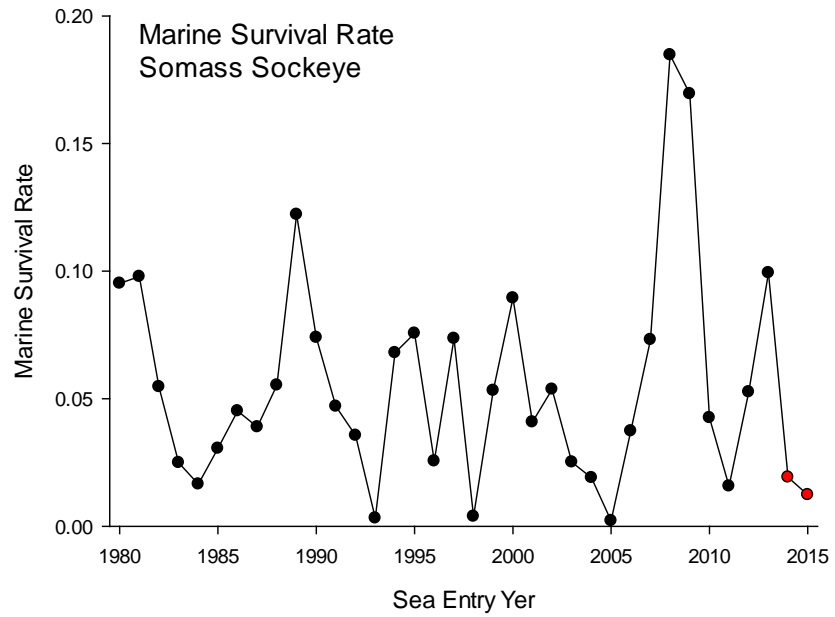


Figure 4. Marine survival rate index for the Somass sockeye stocks. Most adult sockeye returning in 2017 are associated with the 2014 and 2015 sea-entry years. Although the survival rate index for those years is preliminary (and incomplete as it does not yet account for older 5-year old fish that will return in 2017), the survival rate associated with those years was apparently below average.