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Area 23 (Barkley Sound, Alberni Inlet) Sockeye Forecast for the 2021 Return
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SUMMARY

- For 2021 fishery management purposes, the Area 23 Roundtable has agreed to begin fisheries in the "Low" zone (350,000–500,000) for early season harvest management. Based on the forecast models considered, the forecast adopted for management purposes is **350,000** adult Sockeye. Henderson Lake Sockeye remain a stock of concern in the "Very Low" zone.
- There is uncertainty in the 2021 forecast. The model predictions (Table 3) vary between 324,000 (Sea Surface Temperature), 367,000 (Sibling model), 523,000 based on Coho survivals in the same ocean entry year (CLI model), 680,000 (Sea Surface Salinity model), and 370,000 for a multivariate model, which takes into account the environmental co-variates sea surface temperature and salinity as well as the sibling returns. Model forecasts for the 2021 aggregate Somass Sockeye return are described in Appendix A.
- A return to more equal abundance of Sproat and Great Central in 2020, and as forecasted for 2021, supports management of the aggregate abundance into the Somass. However, the Sea Surface Temperature and Sea Surface Salinity models suggest Great Central returns may dominate; in-season assessment should be aware and ensure adequate sampling to determine stock proportions. A precautionary management approach for early season fisheries is proposed until the total run size and stock composition can be more accurately determined. The first reforecast is expected 24 June. Management may adapt sooner if in-season assessment data indicates larger or small returns, or a dominant return to one Somass lake over the other.
- 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 factors influencing this outlook are the low spawner abundances in the main contributing brood years (2016, 2017), as well as potentially low marine survival rates. There were no surveys in Henderson Lake to estimate juvenile production from either of the main contributing brood years.

BACKGROUND

Great Central Lake, Sproat Lake, and Henderson Lake are the three main Sockeye stocks returning to Barkley Sound (Area 23). Status of each stock is assessed as a separate Conservation Unit (CU) for implementation of Canada's Wild Salmon Policy. From 1980–2020, the average adult terminal returns (catch and escapement) of Great Central, Sproat and Henderson Lake Sockeye are 373,000, 324,000 and 29,000, respectively (see Table 5).

When the Great Central Lake and Sproat Lake stocks are both contributing similar proportions (e.g. within 40-60%) to the Somass return, management is based on the aggregate stock management unit referred to as Somass Sockeye. When one stock is considerably lower than the other (≤ 35%), a lower aggregate abundance should be the basis for management, based on factors such as abundance of each stock relative to a limit reference point, environmental factors, productivity considerations, etc.

Area 23 sockeye fisheries target Somass Sockeye while limiting harvest of the Henderson Lake Sockeye stock.

The pre-season biological forecasts for Somass Sockeye inform a *management forecast* that guides effort-limited harvest plans in June (Table 5). The run size forecasts are revised weekly starting in the third week of June based on in-season indicators described later in this report. The first in-season forecast revision is anticipated no earlier than Thursday, 24 June 2021.

Data limitations preclude a statistical forecast for Henderson Sockeye. Instead, a management zone is set based on an outlook that considers spawner abundances and smolt abundances (when available) 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, which are more likely to intercept Henderson Sockeye (Table 6).

2021 SOMASS SOCKEYE BIOLOGICAL FORECASTS

Several indicators of varying accuracy (see Appendix A) are used to inform the pre-season Somass Sockeye biological forecasts. These include: abundances of younger siblings from the same brood and smolt years as returning 2021 age classes, average sea surface temperatures and sea surface salinities recorded in outer Barkley Sound during the juvenile outmigration period (March–May), and estimates of winter smolt abundances in Great Central and Sproat Lakes. The predicted Somass aggregate return is further broken down into stock-specific forecasts in Table 3.

Model forecasts for the 2021 aggregate Somass Sockeye return are described in detail in Appendix A and summarized below.

- The Multivariate forecast (Table 3, Figure 1) predicts a total return to the Somass river of 369,000 (95% prediction interval: 71,703–1,899,970) adult Sockeye. The predicted returns to Great Central and Sproat Lakes are 160,435 and 208,568 adult Sockeye, respectively (ratio = 43%/57%).
- The Sibling forecast (Table 3) predicts a total return to the Somass river of 367,000 adult Sockeye. The predicted returns to Great Central and Sproat Lakes are 184,176 and 182,833 adult Sockeye, respectively (ratio = 50%/50%).
- The sea-surface-temperature-based SStM forecast (Table 3) predicts a total return to the Somass river of 324,960 adult Sockeye. The predicted returns to Great Central and Sproat Lakes are 273,000 and 51,960 adult Sockeye, respectively (ratio = 84%/16%). Marine temperatures have been above average for all sea entry years contributing to the 2021 return, resulting in a “low” survival estimate of 2.5%. Indications from the 2016 brood year returning as 4 year olds in 2020 suggest that the marine survival has been much lower for this brood (Figure 5). Additionally, the estimates of juvenile Sockeye abundance for the 2018 sea-entry year (age 52 and 63 fish returning in 2020) were more uncertain than usual. Juvenile surveys conducted for the more recent sea entry years are considered to be more reliable.
- The surface salinity (SSM) forecast predicts a total return to the Somass river of 683,810 adult Sockeye. The predicted returns to Great Central and Sproat Lakes are 550,026 and 133,784 adult Sockeye, respectively (ratio = 80%/20%). 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. As with the SStM forecast, the high (80%) predicted proportion of GCL in the return is due to an exceptionally low smolt abundance estimate for Sproat Lake in the 2018 sea entry year (Figure 4).
- The Coho Leading Indicator (CLI) predicts a total return to the Somass river of 523,935 adult Sockeye. The predicted returns to Great Central and Sproat Lakes are 239,844 and 284,091 adult Sockeye, respectively (ratio = 46%/54%). 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.

2021 SOMASS SOCKEYE MANAGEMENT FORECAST

For fishery management purposes, the Area 23 Roundtable has agreed to manage to a forecast in the “Low Zone” (see Table 5) corresponding to an expected return of approximately 350,000 adult Sockeye.

Based on the projected return, 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 either population appears to comprise significantly less (*e.g.* ≤ 35%) of the Somass aggregate in early season fisheries and escapement.

In-season indicators that will be applied to inform management in 2021:

- Stock compositions from samples collected by 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.
- 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 cumulative accounting (escapement, catch, Alberni inlet abundance estimate, and lower river abundance estimate) and estimated run timing will be used as an additional indicator of the final Somass Sockeye adult return.
- Scale samples collected from test boat, fisheries, and escapement at the fishways will inform the predicted age composition of the return.
- River temperatures and inlet conditions will inform holding patterns and migration conditions, which can affect escapement timing and pre-spawn natural mortality.

2021 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 factors influencing this outlook are the low spawner abundances in the main contributing brood years (9,700 Sockeye in 2016; 22,000 Sockeye in 2017; Table 4) for the 2021 return, as well as low marine survival rates experienced by these two brood years.

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APPENDIX A. FORECAST METHODOLOGY

Statistical forecast models

Four models have previously been used to forecast returns to Great Central and Sproat Lakes: the Survival Stanza Method (SStM), Surface Salinity Method (SSM), Salmonid Enhancement Program Biostandard Method (SEPB), and Coho Leading Indicator Method (CLI) (Hyatt et al. 2003). 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). New for 2021, a "Multivariate" multiple regression model has been developed that assimilates data from younger sibling abundances and sea-entry conditions. The multiple regression model considers not only the individual effects of each predictor, but also their degree of collinearity (*i.e.* their correlations with one another).

The SStM and SSM use annual estimates of the numbers of smolts from Great Central and Sproat Lakes and predictors of early marine survival (marine temperature and salinity, respectively) to estimate 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 are 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 following 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 (Figure 6). Over the past 5 years the Sibling and SStM models have performed the best (MAPE values of 41% and 64% respectively), while the SSM and CLI models have performed poorly over the past 5 years (MAPE values of 94%, 210%, respectively). When applied retroactively, the Multivariate model appears to perform similarly to or slightly better than the Sibling model, with a MAPE of 37% (Figure 6). The multiple regression analysis applied by the Multivariate model suggests that much of the variation attributed to sea-entry conditions in the SStM and SSM models is already captured in the returning sibling abundances.

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.

2020 forecast performance

The preseason management forecast was in the "very low" zone with an expected return of 169,000 adult Somass Sockeye (Table 2).

There was a below average return of about 308,000 adult Somass Sockeye (Great Central and Sproat Lake stocks) observed in 2020 (Table 1, Table 5, Figure 2). Fish from the 2014-2017 brood years returned in 2020, with the majority contributed from 2015 and 2016.

The proportion of age 4_2 fish (64%) was much higher than predicted pre-season in the Sibling model (13%) and in the CLI (27%), but similar to the SStM prediction (72%). The 2020 return included an above average jack (ages 3_2 and 4_3) return.

The proportion of Great Central Lake in the total return (46%) was much better than expected pre-season (17%). The returns from the 2016 and 2017 brood years appear to be weighted toward higher Sproat Lake returns (70% Sproat in the 2016 brood returns and 60% in the 2017 brood returns).

While the Sibling model under-predicted the 2020 return, its prediction was closest—within 45% of the observed value (Table 2). In contrast, all other models over-predicted the return, by 54%, 95%, and 221% for the SStM, SSM, and CLI, respectively (Table 2). Smolt-based models (SStM, SSM, CLI) greatly over-predicted the return to GCL and slightly under-predicted the return to SPL. In both the 2017 and 2018

sea-entry years (4 and 5 years olds returning in 2020, respectively), smolt abundances in GCL were at an all-time high, but these high abundances did not translate to a strong adult return to GCL in 2020. The CLI model over-predicted the returns to both GCL and SPL by 249% and 149%, respectively, which suggests survival rates of Somass Coho and Sockeye have decoupled in recent years.

The return of Henderson Lake Sockeye in 2020 was approximately half of the 10-year average and estimated at about 5,000 (Table 1, Table 5, Figure 3). The pre-season outlook was for a management zone of "very low" (*i.e.*, < 15,000 Sockeye). Pre-season expectations were based on the low spawner abundances in the main contributing brood years (2016, 2017; Table 4), and low marine survival rates experienced by these two brood years.

Sources of uncertainty

The mean absolute percentage errors (MAPEs) for the five forecast models used to predict Somass Sockeye range from about 37% to over 100%, with the best performing forecast model (Multivariate model) averaging about 37% (Table 3; Figure 6). That is, on average, the observed return is about 37% higher or lower than the predicted return. Factors that contribute to forecast uncertainty include, but are not limited to: model structure, assumptions about the relationships between predictor variables, and uncertainty associated with model inputs (*i.e.* source data).

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 and 2019 sea-entry years 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 2021 (SStM, SSM, CLI).

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APPENDIX B. TABLES AND FIGURES

Table 1. Total return of Sockeye to Barkley Sound in 2020.

Conservation Unit	Age at Return						Total	Adults
	3.2	4.2	4.3	5.2	5.3	6.3		
Great Central Lake	26,811	59,482	9,145	3,022	61,788	13,889	174,138	138,182
Sproat Lake	40,333	135,794	2,932	11,837	16,148	1,908	208,952	165,687
Henderson Lake	867	2,553	157	210	1,038	211	5,036	4,012
Combined Barkley Sound	**68,011**	**197,829**	**12,234**	**15,069**	**78,974**	**16,008**	**388,126**	**307,881**

Table 2. Forecast performance of Somass Sockeye models for 2020. Absolute Percentage Error (APE) is calculated as (Forecast-Return)/Return (adult fish).

2020 Management forecast: Very Low zone (< 170 k adults)				
308,868	**Forecast 2020**			
observed	**SStM**	**SSM**	**CLI**	**Sibling**
Expected	476,254	601,379	992,047	168,788
Obs.-Exp.	-167,386	-292,511	-683,179	140,080
APE	54%	95%	221%	45%

Table 3. Forecasts by age for 2021 from Somass Sockeye models.

Forecast		Age at return				% of return
		4.2	**5.2**	**5.3 and 6.3**	**Total**	
Sibling	GCL	140,886	34,115	9,174	**184,175**	50%
	SPL	115,062	57,897	9,873	**182,832**	50%
	Total	255,948	92,012	19,047	**367,007**	
	% at age	13%	76%	10%		
		4s	**5s**		**Total**	
SStM	GCL	123,200	149,800		**273,000**	84%
	SPL	23,310	28,650		**51,960**	16%
	Total	146,510	178,450		**324,960**	
	% at age	45%	55%			
		4.2	**5.2**	**5.3**	**6.3**	**Total**	
CLI	GCL	87,915	99,190	28,995	23,743	**239,843**	46%
	SPL	140,664	114,666	21,244	7,517	**284,091**	54%
	Total	228,579	213,856	50,239	31,260	**523,934**	
	% at age	44%	41%	10%	6%		
		4.2	**5.2**	**5.3**	**6.3**	**Total**	
Multivariate	GCL	80,123	38,091	38,028	4,193	**160,435**	43%
	SPL	122,374	70,747	14,187	1,266	**208,574**	57%
	Total	202,497	108,838	52,215	5,459	**369,009**	
	% at age	39%	21%	10%	1%		

Table 4. 2021 outlook for the Henderson Sockeye return.

Return Year	Age at Return	Brood Year	Spawner Abundance	Smolt Year	Smolt Abundance	Marine Survival	Outlook
2021	4	2017	22K	2019	No survey	LOW (<2%)	**Very Low**
	5	2016	9.7K	2018	No survey	LOW (<2%)	**< 15,000**

Table 5. Terminal adult return of Area 23 Sockeye; 1980–2020. All 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	13,549	140,776	**193,422**
2020	6,314	35,890		7,876	43,766	6,961	-	-	-	6,961	6,575	63,616	109,174	131,529	4,589	245,292	**308,908**
AVG 92+	6,248	72,834	12,578	18,953	87,300	88,528	104,666	3,741	11,105	198,030	41,068	332,184	174,597	161,018	24,663	360,278	692,462
10 YR AVG	4,811	116,266	16,939	18,953	134,815	128,971	180,705	-	11,105	313,007	37,991	490,142	197,183	209,424	17,390	423,996	914,139
5 YR AVG	7,597	145,237		20,928	166,166	136,292	203,161	-	11,105	346,116	34,842	554,721	173,458	194,587	12,769	380,814	935,535

Table 6. 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	
2015	Great Central Lake	515	8,326	7,631	2,117	56,096	74,684	27	5,191	322	906	5,692	12,138	542	13,516	7,953	3,022	61,788	86,822	49%
	Sproat Lake	8,074	36,603	2,315	10,730	9,639	67,361	431	13,940	98	1,107	6,509	22,085	8,505	50,543	2,413	11,837	16,148	89,445	51%
	TOTAL	8,589	44,928	9,946	12,846	65,735	142,045	458	19,130	420	2,013	12,201	34,223	9,047	64,059	10,366	14,859	77,936	176,268	
2016	Great Central Lake	5,207	38,160	8,414			51,781	220	21,323	731			22,273	5,427	59,482	9,145			74,054	30%
	Sproat Lake	35,796	110,475	2,169			148,440	1,511	25,320	762			27,593	37,308	135,794	2,932			176,034	70%
	TOTAL	41,003	148,634	10,583			200,221	1,731	46,642	1,493			49,867	42,734	195,277	12,077			250,088	
2017	Great Central Lake	22,388					22,388	4,423					4,423	26,811					26,811	40%
	Sproat Lake	35,746					35,746	4,587					4,587	40,333					40,333	60%
	TOTAL	58,134					58,134	9,010					9,010	67,144					67,144	

Table 4. Estimates of juvenile Sockeye abundance in Great Central, Sproat, and Henderson Lakes for smolt years 1978-2019 (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			17.06			5.50	
2018			17.12			5.73	
2019			7.93			1.95	

Table 5. 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.

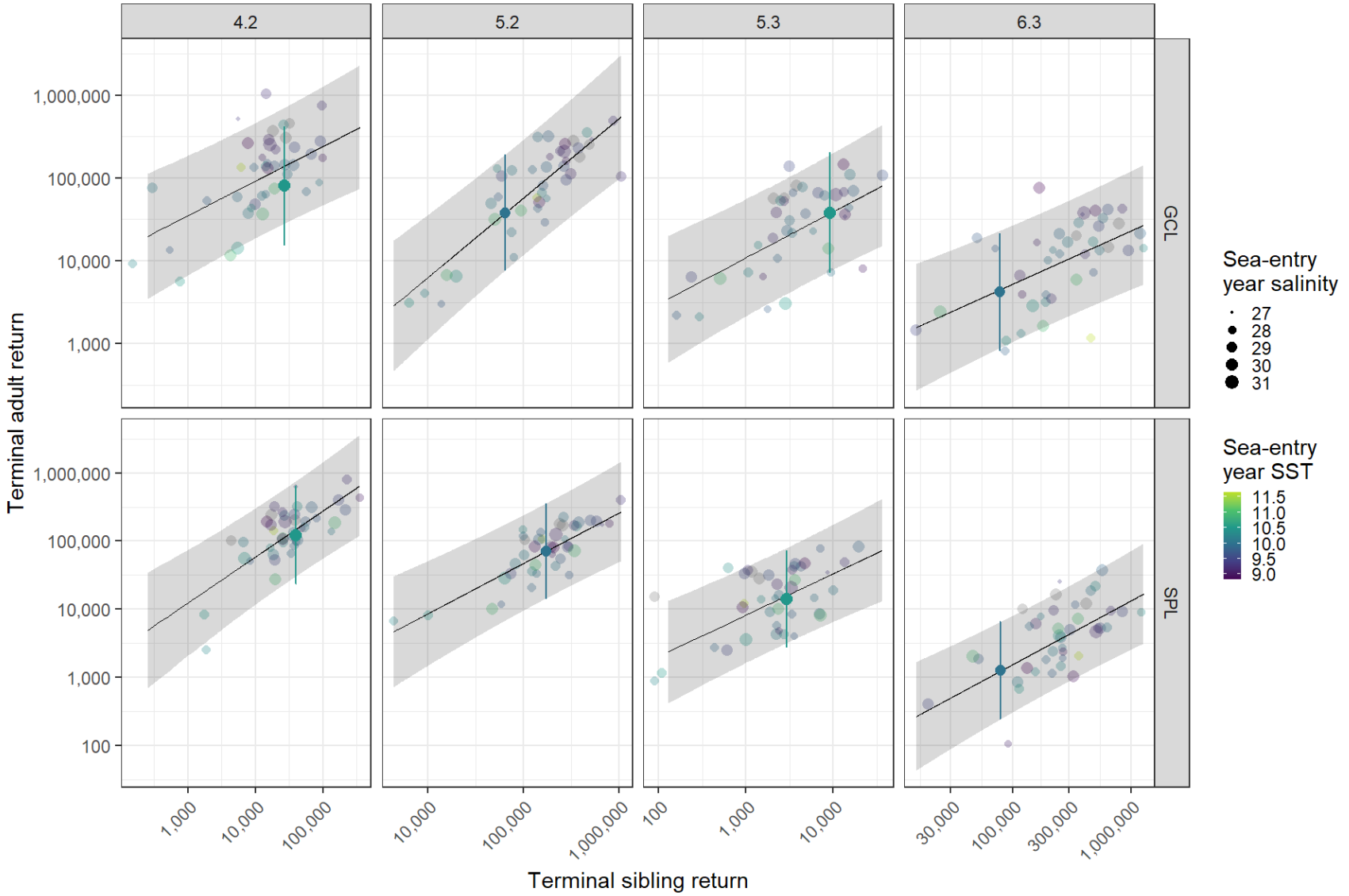
MANAGEMENT ZONE	FORECAST RUN SIZE	MAANULTH FIRST NATIONS	RECREATIONAL	TSUMASS ECONOMIC OPPORTUNITY	COMMERCIAL SEINE*	COMMERCIAL GILLNET
1 - Critical	**Less than 200,000**	no harvest	no harvest	no harvest	no harvest	no harvest
2 - Very Low	**200,000 to 350,000**	Open, fishing to target through limited 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 6. 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. Multivariate model predictions compared to observed returns. Black lines and the shaded areas around them show the mean predictions and 95% prediction interval, respectively. Point forecasts and prediction intervals for 2021 are overlaid on each panel.



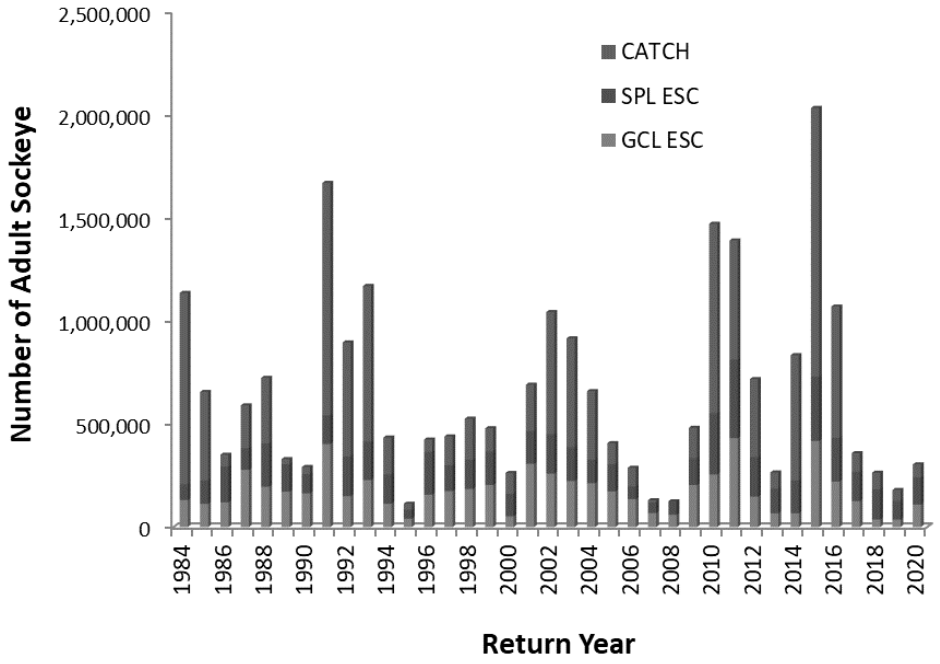


Figure 2. Estimated adult returns of Somass (Great Central and Sproat Lake) Sockeye, 1984-2020.

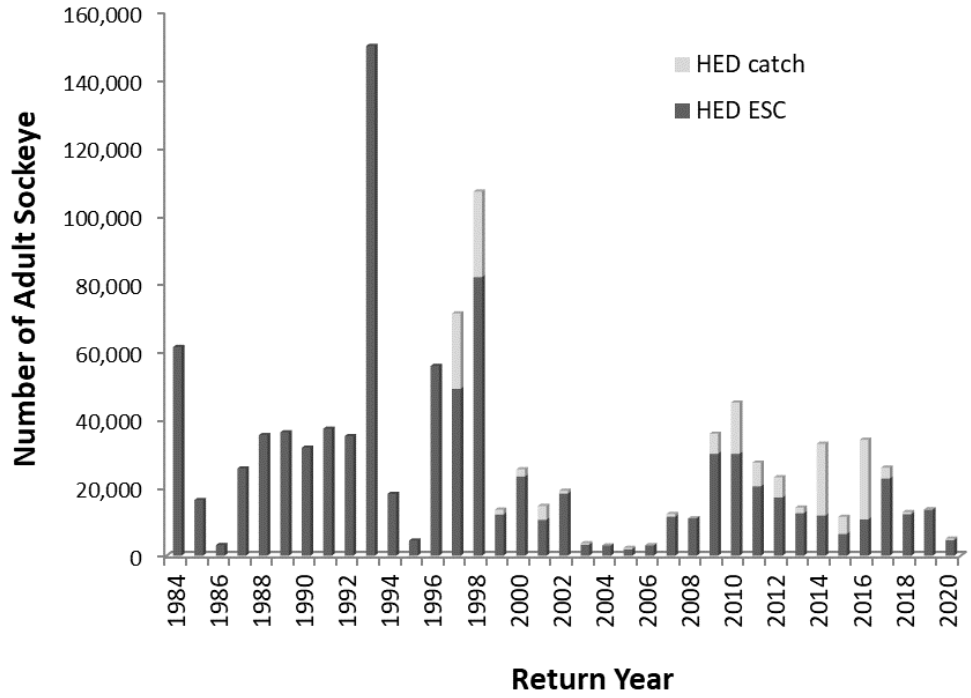


Figure 3. Estimated adult returns of Henderson Lake Sockeye, 1984-2020.

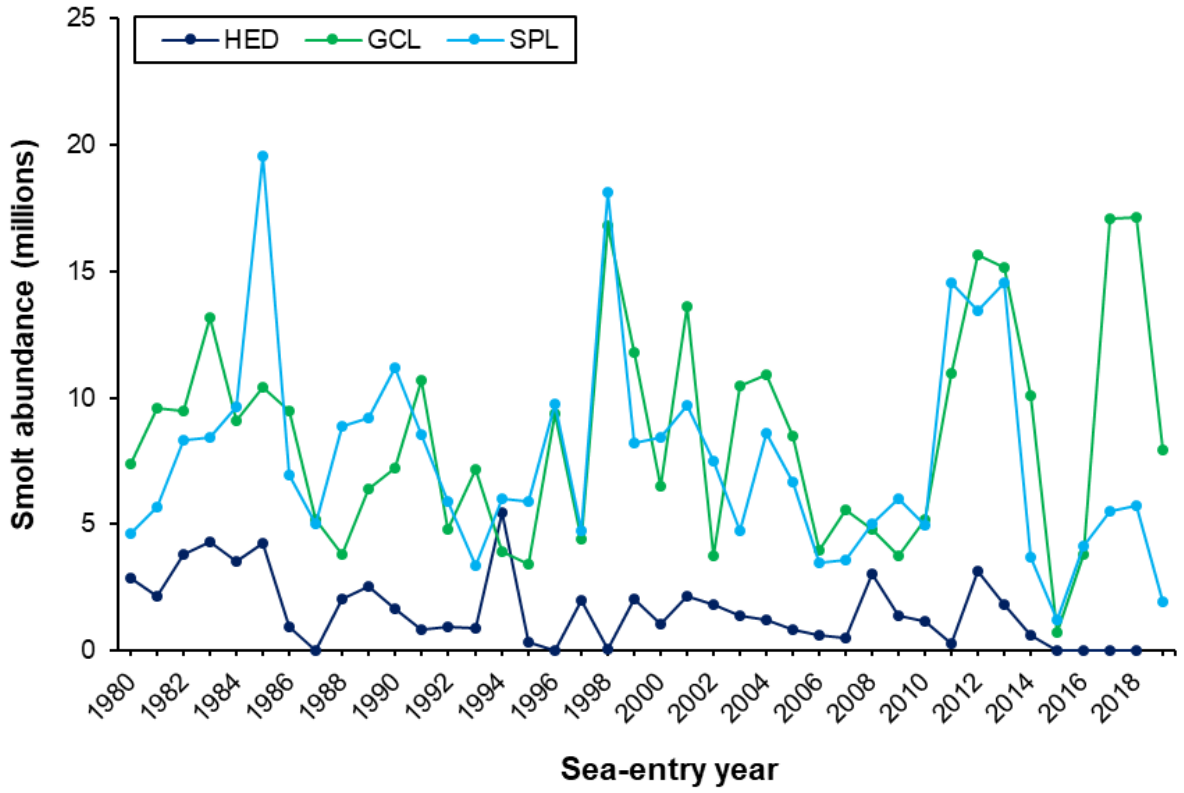


Figure 4. Estimated Sockeye "pre-smolt" juvenile abundances for Great Central, Sproat, and Henderson Lakes by sea-entry year. Most adult Sockeye returning in 2020 are associated with the production from the 2017 and 2018 sea-entry years.

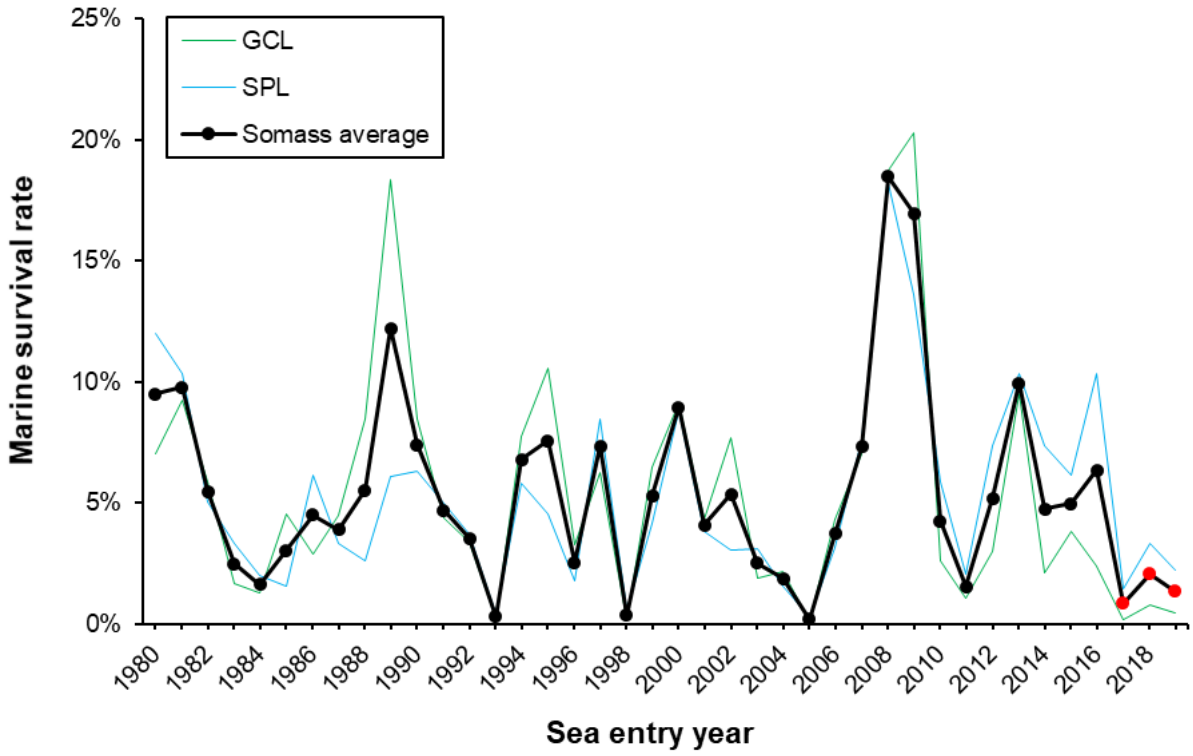


Figure 5. Time series of the marine survival rate index for Somass Sockeye stocks. Red dots indicate he sea-entry years associated with the 2021 return; most adult Sockeye returning in 2021 belong to the 2018 and 2019 sea-entry years. Although the survival rate index for those years is incomplete, as it does not yet account for older fish that will return in 2021, observed survivorships for the 2018 and 2019 sea-entry years have been very low.

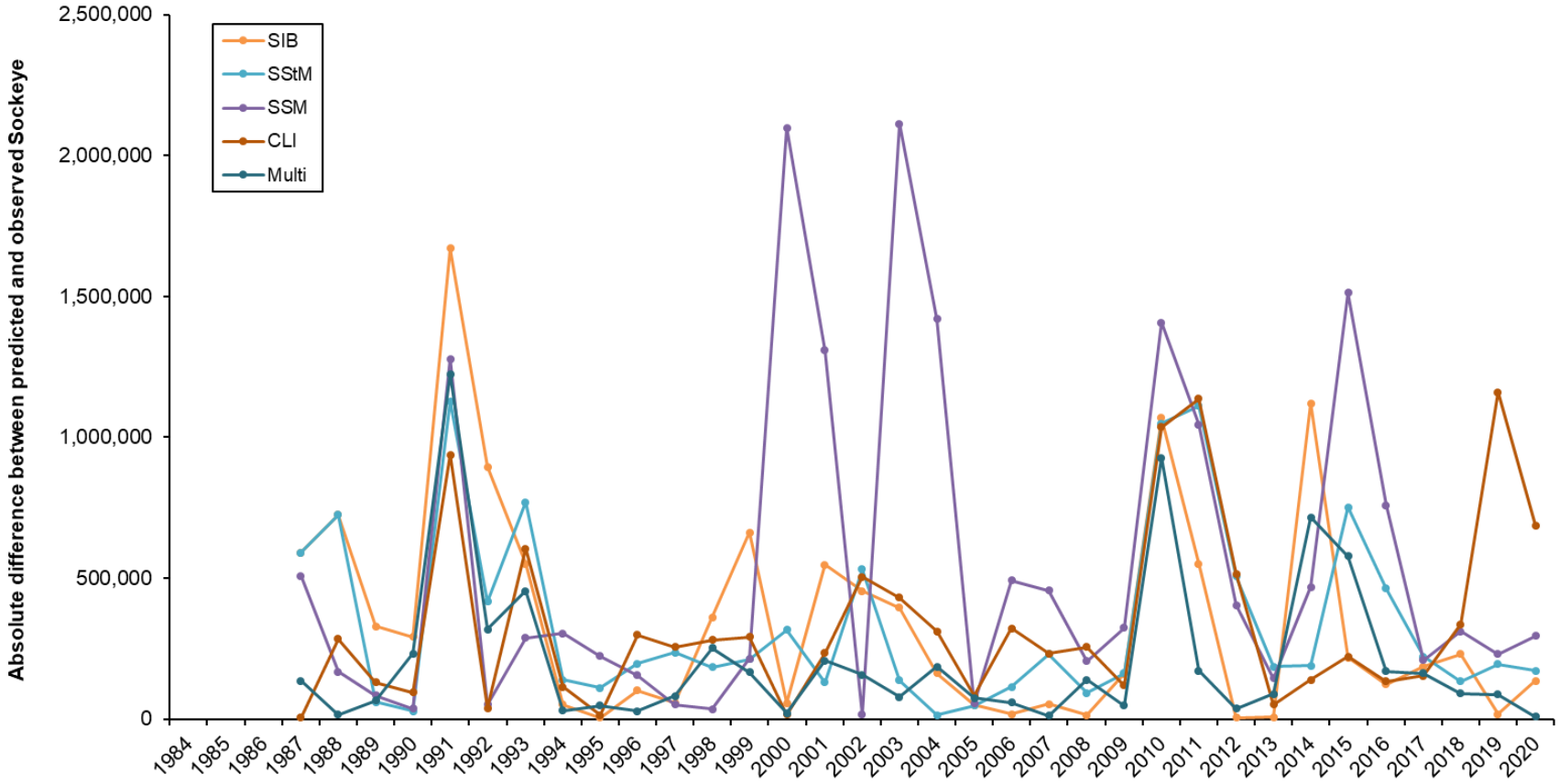


Figure 6. Time series of differences between predictions from the five leading forecast models and the observed Somass Sockeye returns.