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Area 23 (Barkley Sound, Alberni Inlet) Sockeye Forecast for the 2022 Return

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SUMMARY

- For 2022 fishery management purposes, the Area 23 Roundtable has agreed to begin fisheries in the "Low" zone (350000–500000) for early season harvest management. Based on the models considered, the forecast adopted for management purposes is **400000** adult Sockeye. Henderson Lake Sockeye remain a constraining stock in the "Very Low" zone.
- There is uncertainty among the 2022 forecast models. Predictions (Table 3) vary between 170000 (Sea Surface Temperature), 351000 (Sea Surface Salinity model), 358000 (Coho Leading Indicator model), 412000 (multivariate model), and 451000 (sibling model). Forecast models for the 2022 aggregate Somass Sockeye return are described in Appendix A.
- A majority of the forecast models suggest an unbalanced Somass return likely to be dominated by Sproat Lake Sockeye. In 2018 and 2019 (broods returning as age 4 and 3 fish, respectively in 2022), escapements of Great Central Lake Sockeye were the lowest ever observed (Figure 5). In addition, the estimated juvenile Sockeye abundance in Great Central Lake in the 2020 sea-entry year (age 4_2 and 5_3 fish returning in 2022) was near the historic low. Therefore, a precautionary management approach for early season fisheries is warranted until the total run size and stock composition can be more accurately determined. In-season estimates of stock composition will be available during the second and third weeks of June; the first run size reforecast is expected 23 June.
- The recommended management outlook for Henderson Sockeye is the "Very Low" zone for harvest management, corresponding to an expected return of less than 15000 (Table 4). The key consideration influencing this outlook is low marine survival rates in the main contributing sea-entry years 2019–2020. Juvenile surveys were conducted in Henderson Lake in 2019 and 2020, but these data have not yet been analyzed.

BACKGROUND

Great Central Lake, Sproat Lake, and Henderson Lake are the three main Sockeye stocks returning to Barkley Sound (Area 23). The status of each stock is assessed as a separate Conservation Unit (CU) for implementation of Canada's Wild Salmon Policy. From 1980–2021, the median adult terminal returns (catch and escapement) of Great Central Lake, Sproat Lake, and Henderson Lake Sockeye are 323000, 235000 and 23000, respectively (Table 5). In the Somass Sockeye return, the historical median split between Great Central Lake and Sproat Lake abundance is 55% Great Central (inter-quartile range: 46–62% Great Central).

The pre-season biological forecasts for Somass Sockeye (outlined in this bulletin) inform a *management forecast* that guides June fishing plans (Table 8). The run size forecasts are revised weekly starting in the third week of June based on in-season indicators described later in this bulletin. The first in-season reforecast is anticipated no earlier than Thursday, 23 June 2022.

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 rates 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 9).

2022 SOMASS SOCKEYE BIOLOGICAL FORECASTS

Several indicators of varying accuracy are used to inform the pre-season Somass Sockeye biological forecasts: abundances of younger siblings from the same brood and smolt years as returning 2022 age classes, average sea surface temperatures and sea surface salinities recorded in outer Barkley Sound during the juvenile outmigration period (March–May), survival rates in Coho from the same brood year that return as adults one year earlier, and estimates of winter smolt abundances in Great Central and

Sproat Lakes. The predicted Somass aggregate return is further broken down into age- and stock-specific forecasts in Table 3.

Model forecasts for the 2022 aggregate Somass Sockeye return are described in detail in Appendix A and summarized here:

- The Multivariate forecast (Table 3, Figure 1) predicts a total return to the Somass river of 412000 (75% prediction interval: 300000–690000) adult Sockeye. The predicted returns to Great Central and Sproat Lakes are 170000 and 242000 adult Sockeye, respectively (41% GCL).
- The Sibling forecast (Table 3) predicts a total return to the Somass river of 451000 adult Sockeye. The predicted returns to Great Central and Sproat Lakes are 244000 and 207000 adult Sockeye, respectively (54% GCL). The majority of adults predicted to return to GCL are in the 5+ year-old age range, whereas the strength of the SPL return is predicted to come as 4 year-olds (Table 3).
- The sea-surface-temperature-based SStM forecast (Table 3) predicts a total return to the Somass river of 170000 adult Sockeye. The predicted returns to Great Central and Sproat Lakes are 81000 and 89000 adult Sockeye, respectively (48% GCL). Spring marine temperatures at Amphitrite Point were above average in 2019 and 2020, the predominant sea entry years contributing to the 2022 return, which results in a “low” survival estimate of 2.5%. Indications from the 2019–2020 sea-entry years suggest marine survivals are likely below average for these cohorts (Figure 6).
- The surface salinity (SSM) forecast predicts a total return to the Somass river of 351000 adult Sockeye. The predicted returns to Great Central and Sproat Lakes are 217000 and 134000 adult Sockeye, respectively (62% GCL). This model utilizes 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. The relatively high predicted proportion of GCL in the return is due to the much higher estimated abundance of GCL compared to SPL smolts in the 2019 sea entry year (Figure 4), combined with relatively high surface salinities observed at Amphitrite Point, which are driving a high marine survival rate prediction of 7.3%.
- The Coho Leading Indicator (CLI) model predicts a total return to the Somass river of 358000 adult Sockeye. The predicted returns to Great Central and Sproat Lakes are 106000 and 252000 adult Sockeye, respectively (30% GCL). 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. Coho survival rates were below average in 2019 (4.5%) but slightly above average in 2020 (6.9%).

2022 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 8) corresponding to an expected return of approximately **400000** 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.

In-season indicators that will be applied to inform management in 2022:

- 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 to predict the final Somass Sockeye adult return.

- Scale samples collected from the 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 affect escapement timing, pre-spawn natural mortality, and susceptibility to fisheries.

2022 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 15000 (Table 4). Spawner abundances in the main contributing brood years were near the historical median of 13000 (22000 Sockeye in 2017, 12000 Sockeye in 2018; Table 4). Based on sea surface temperatures and salinities observed at Amphitrite Point during the spring of 2019 and 2020 (the main sea-entry years), marine survival rates are likely to be low. Therefore, expectations are for a continued low Henderson sockeye return in 2022.

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APPENDIX A. FORECAST METHODOLOGY

Statistical forecast models

Four models have historically been used to forecast Sockeye 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 regression 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, 5, and 6 returns based on the abundance of earlier returning age 3, 4, and 5 fish from matching brood years; Peterman 1982, DFO 2012). In 2021, a multivariate multiple regression model was developed that integrates data from younger sibling abundances, smolt abundances, and sea-entry conditions. The multivariate regression model considers not only the individual effects of each predictor, but also their interactions (*e.g.* smolt abundance is likely predictive of adult returns only when sea-entry conditions are favorable).

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 measured off Amphitrite Point, Ucluelet, respectively) to estimate returns (Hyatt et al. 2003).

The CLI model is based on the observation that marine survivorships for both juvenile Sockeye and Coho migrating through Barkley Sound and up the West Coast of Vancouver Island are expected to covary 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 can be 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 errors (MAPE) of 58% and 61%, respectively (Figure 7). Over the past 5 years the Sibling and SSM models have performed the best (MAPEs of 40% and 82% respectively), while the SStM and CLI models have performed poorly over the past 5 years (MAPEs of 91%, 208%, respectively; Figure 7). The Multivariate model appears to improve on the Sibling model, with a retrospective MAPE of 33% (Figure 8). The multiple regression analysis applied by the Multivariate model suggests that much of the variation in survival rates ascribed to sea-entry conditions in the smolt-based models is 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.

2021 forecast performance

The pre-season management forecast was in the “Low” zone with a predicted return of approximately 350000 adult Somass Sockeye (Table 2).

There was a near historical median return of approximately 510000 adult Somass Sockeye observed in 2021 (Table 1, Table 5, Figure 2). Fish from the 2015–2018 brood years returned in 2021, with the majority contributed from 2016 and 2017. The proportion of age 4_2 fish (28%) was well above the sibling model prediction (13%), but below predictions from the Multivariate, CLI, and SStM models (39%, 44%, and 45%, respectively). The 2021 return included an above average jack (ages 3_2 and 4_3) return to Sproat, but a very low jack return to GCL.

The proportion of Great Central Lake in the total return (66%) was much higher than expected pre-season (42%). The returns from the 2017 brood year appear to be weighted toward Great Central Lake (62% Great Central in the 2017 brood returns) but returns from the 2018 brood year are heavily dominated by Sproat Lake (94% Sproat in the 2018 brood returns; Table 6).

All models except the CLI under-predicted the 2021 return (Table 2). The prediction from the CLI was closest to the observed return (CLI absolute percentage error: 6%). The Multivariate, sibling, and SStM models were under by 41%, 45%, and 59%, respectively (Table 2). Only the SStM model predicted that

GCL would comprise the majority of the run; however, its prediction of 84% GCL erred more substantively than the sibling model, which predicted a 50/50 split between GCL and SPL. Both the CLI and Multivariate model predicted Sproat Lake would be the dominant stock in the 2021 return, likely due to relatively high age 3 and 4 returns to Sproat Lake in 2020. In the 2018 sea-entry year (age 5_2 and 6_3 Sockeye returning in 2021), the smolt abundance in GCL was at an all-time high, and 2019 GCL smolt abundance was average; these abundances translated to a strong adult return to GCL in 2021.

The return of approximately 19,000 Henderson Lake Sockeye in 2021 exceeded the 10-year median of *c.* 16,000 (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), 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 33–208%. Retrospective analysis suggests the Multivariate model is the best performing forecast (Table 3; Figure 7). On average, the observed return is about 33% higher or lower than the return predicted by the Multivariate model. Factors that contribute to forecast uncertainty include, but are not limited to: model structure, assumptions about the relationships between returns and the 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 and therefore catch of Henderson Sockeye may be underestimated.

The impact of the ocean conditions on juvenile Sockeye survival is uncertain. While there are weak statistical relationships between spring sea surface temperatures and salinities measured at Amphitrite Point and Somass Sockeye survival, some years with seemingly excellent ocean conditions (e.g. 2002) have not yielded high smolt-to-adult survivorship. Smolt estimates for the 2018–2020 sea-entry years were derived from a revamped acoustic-trawl survey program and are considered to have better accuracy compared to previous years in the historical record.

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APPENDIX B. TABLES AND FIGURES

Table 1. Total return of Sockeye to Barkley Sound in 2021.

Conservation Unit	Age at Return						Total	Adults
	3_2	4_2	4_3	5_2	5_3	6s		
Great Central Lake	4595	116047	1964	127906	34408	53936	338857	332298
Sproat Lake	75731	47620	2236	103233	9511	14137	252468	174502
Henderson Lake	261	5472	8	8601	1694	3016	19051	18783
Combined Barkley Sound	**80586**	**169139**	**4208**	**239740**	**45613**	**71089**	**610377**	**525582**

Table 2. Forecast performance of Somass Sockeye models for 2021. Absolute Percentage Error (APE) is the absolute value of (Forecast return – Observed return) × (Observed return)$^{-1}$.

2021 Management forecast: Low zone (*c.* 350000 adults)				
506909 observed	**Forecast 2021**			
	SStM	**CLI**	**Sibling**	**Multivariate**
Expected	324960	523934	367007	380403
Obs. − Exp.	181949	−17025	139902	126506
APE	59%	6%	45%	41%

Table 3. Predictions by age and lake for 2022 from the four best-performing Somass Sockeye forecast models.

Forecast		Age at return				% of return
		4_2	**5_2**	**5_3 and 6_3**	**Total**	
Sibling	GCL	21,492	199,959	22,640	**244,091**	54%
	SPL	161,297	32,472	13,521	**207,290**	46%
	Total	182,789	232,431	36,161	**451,381**	
	% at age	13%	76%	10%		
		4s	**5s**		**Total**	
SStM	GCL	11,688	69,388		**81,076**	48%
	SPL	78,750	9,750		**88,500**	52%
	Total	90,438	79,138		**169,576**	
	% at age	53%	47%			
		4_2	**5_2**	**5_3**	**6_3**	**Total**
CLI	GCL	27,180	47,736	18,533	12,173	**105,622**	30%
	SPL	165,799	66,104	15,056	5,134	**252,093**	70%
	Total	192,979	113,840	33,589	17,307	**357,715**	
	% at age	54%	32%	9%	5%		
		4_2	**5_2**	**5_3**	**6_3**	**Total**
Multivariate	GCL	49,154	88,722	21,511	10,656	**170,043**	41%
	SPL	193,581	33,405	11,964	3,069	**242,019**	59%
	Total	242,735	122,127	33,475	13,725	**412,062**	
	% at age	68%	34%	9%	4%		

Table 4. Factors considered in the 2022 outlook for the Henderson Sockeye return.

Return Year	Age at Return	Brood year	Spawner abundance	Smolt Year	Smolt Abundance	Marine Survival
2022	4	2018	12k (avg)	2018	no survey	below average
	5	2017	23k (above avg)	2017	no survey	low

Table 5. Terminal adult return of Area 23 Sockeye; 1980–2021. All catch includes Henderson Sockeye.

RETURN YEAR	TEST FISHERY	FIRST NATIONS CATCH				COMMERCIAL CATCH					RECREATIONAL	ESCAPEMENT				TOTAL RETURN	HED 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	-	246,041	124,943	21,000	391,984	**1,074,874**	**21,000**
1981	-	17,000	-		17,000	391,950	617,474	-	-	1,009,424	-	195,124	118,710	40,000	353,834	**1,380,258**	**40,000**
1982	-	23,500	-		23,500	229,271	246,673	-	-	475,944	-	155,579	213,477	56,000	425,057	**924,501**	**56,000**
1983	-	30,000	-		30,000	315,478	603,827	-	-	919,305	-	339,204	239,763	45,000	623,967	**1,573,272**	**45,000**
1984	-	21,000	-		21,000	454,813	463,971	-	-	918,784	-	131,000	76,373	61,000	268,374	**1,208,158**	**61,000**
1985	77*	15,987	-		15,987	249,814	190,038	-	-	439,852	1,731	112,339	113,688	16,000	242,027	**699,597**	**16,000**
1986	2,885*	12,800	-		12,800	30,461	13,640	-	-	44,101	17	119,820	173,915	3,000	296,735	**353,653**	**3,000**
1987	6,993*	23,395	-		23,395	19,921	189,643	-	-	209,564	21,424	277,562	105,457	26,000	409,019	**663,402**	**26,000**
1988	10,470*	21,292	-		21,292	146,391	146,603	-	-	292,994	348	195,327	210,518	35,000	440,845	**755,479**	**35,000**
1989	648	23,395	-		23,395	4,145		-	-	4,145	139	171,652	133,349	36,000	341,000	**368,679**	**36,000**
1990	7,211*	10,480	-		10,480	3,617	8,062	-	-	11,679	14,430	163,320	93,631	32,000	288,952	**325,541**	**32,000**
1991	8,505*	36,523	-		36,523	282,833	762,634	-	-	1,045,467	78,551	402,976	140,123	37,000	580,099	**1,740,640**	**37,000**
1992	-	53,662	-		53,662	203,890	211,938	-	-	415,828	101,408	149,898	192,641	35,000	377,539	**948,437**	**35,000**
1993	11,997*	58,020	10,000		68,020	258,957	346,246	-	-	605,203	107,407	227,694	187,860	150,000	565,553	**1,346,183**	**150,000**
1994	10,475	53,656	10,000		63,656	74,981	-	-	-	74,981	30,261	113,121	142,162	18,000	273,282	**452,655**	**18,000**
1995	146	23,782	-		23,782	-	-	-	-	-	6,519	40,940	43,254	4,000	88,195	**118,642**	**4,000**
1996	4,513	28,139	-		28,139	-	-	-	-	-	28,033	157,087	207,716	56,000	420,804	**481,489**	**56,000**
1997	10,493	29,508	12,098		41,606	52,241	-	2,100	-	54,341	36,531	174,088	126,349	49,000	349,437	**492,408**	**49,000**
1998	17,522	45,200	30,859		76,059	49,924	-	9,003	-	58,927	55,421	184,542	142,360	82,000	408,902	**616,831**	**82,000**
1999	4,445	39,820	1,000		40,820	53,800	-	8,819	-	62,619	7,870	203,969	162,776	12,000	378,745	**494,499**	**12,000**
2000	6,904	36,649	16,500		53,149	16,260	-	5,236	-	21,496	24,315	52,043	108,568	23,000	183,611	**289,475**	**23,000**
2001	7,004	58,245	20,000		78,245	46,640	-	21,022	-	67,662	67,190	307,106	158,923	11,000	477,029	**697,130**	**11,000**
2002	9,207	99,014	41,575		140,589	131,176	202,893	51,087	-	385,156	58,718	259,482	190,971	18,000	468,453	**1,062,123**	**18,000**
2003	10,577	64,908	25,651		90,559	149,499	209,823	-	-	359,322	61,610	223,546	163,807	3,000	390,352	**912,421**	**3,000**
2004	10,318	119,522	28,673		148,195	46,420	48,041	-	-	94,461	81,836	213,021	113,798	3,000	329,819	**664,629**	**3,000**
2005	9,233	49,213	3,745		52,958	11,305	-	-	-	11,305	31,292	172,962	131,949	2,000	306,911	**411,700**	**2,000**
2006	11,188	35,808	5,000		40,808	5,449	-	-	-	5,449	30,514	135,493	61,940	3,000	200,433	**288,391**	**3,000**
2007	885	8,706	-		8,706	-	-	-	-	-	-	67,717	52,837	12,000	132,554	**142,145**	**12,000**
2008	-	-	-		-	-	-	-	-	-	-	59,589	65,333	11,000	135,921	**135,921**	**11,000**
2009	-	55,345	12,963		68,308	9,138	14,735	-	-	23,873	55,218	203,858	130,289	30,000	364,148	**511,547**	**30,000**
2010	-	85,596	20,915		106,511	240,170	495,495	-	-	735,665	77,462	255,339	296,956	30,000	582,296	**1,501,934**	**30,000**
2011	-	109,369		17,081	126,450	231,442	192,333	-	-	423,775	42,799	431,213	381,980	20,423	833,616	**1,426,640**	**27,388**
2012		154,951		18,047	172,998	116,106	79,550	-	-	195,656	16,940	147,440	192,226	17,133	356,800	**742,393**	**23,075**
2013	5,313	31,208		11,851	43,059	11,390	9,128	-	-	20,518	13,274	66,688	119,849	12,500	199,037	**281,201**	**13,625**
2014	9,636	164,319		19,659	183,978	169,685	243,937	-	5,190	418,812	16,313	66,298	159,751	11,837	237,885	**866,624**	**33,493**
2015	11,298	319,351		25,267	344,618	329,505	521,003	-	15,000	865,508	88,232	417,774	312,265	6,400	736,440	**2,046,096**	**11,592**
2016	8,887	170,326		26,765	197,091	161,607	228,329	-	13,124	403,060	51,680	220,952	211,926	10,700	443,578	**1,104,297**	**33,811**
2017	3,328	36,305		14,672	50,977	9,879	16,461	-	-	26,340	12,420	125,846	142,684	22,704	291,234	**384,299**	**25,921**
2018	4,837	35,886		18,278	54,164	10,785	6,075	-	-	16,860	5,566	36,418	146,312	12,203	194,933	**276,360**	**12,829**
2019	3,409	27,770		12,792	40,562	6,482	-	-	-	6,482	2,193	35,982	91,245	13,549	140,776	**193,422**	**13,703**
2020	6,314	35,890		7,876	43,766	6,961	-	-	-	6,961	6,575	109,174	131,529	4,589	245,292	**308,908**	**5,032**
2021	7,272	51,306		20,795	72,101	35,777	35,110	-	-	70,887	36,410	220,319	105,441	14,520	340,280	**526,950**	**18,879**
MEDIAN 92+	6,609	50,260	10,000	18,047	58,910 #	46,530	7,602	-	-	60,773	30,903	165,025	142,522	13,025	344,858	503,023	23,038
10 YR MED	6,314	43,806	#NUM!	18,163	63,133 #	23,584	25,786	-	-	48,613 #	14,794	117,510	144,498	12,352	268,263	455,624	16,291
5 YR MED	4,837	35,890	#NUM!	14,672	50,977 #	9,879	6,075	-	-	16,860 #	6,575	109,174	131,529	13,549	245,292	308,908	13,703

Table 6. Escapement, catch, and total return-at-age to date from brood years contributing to the 2022 Somass Sockeye return. *Note*.—data from each brood year span multiple return years; *e.g.* fish from the 2016 brood year returned as age 3s in 2019, 4s in 2020, and 5s in 2021.

		2016 brood year			2017 brood year			2018 brood year		
	Age	GCL	SPL	TOTAL	GCL	SPL	TOTAL	GCL	SPL	TOTAL
Escapement	3_2	5207	35796	41003	22388	35746	58134	2958	74697	77655
	4_2	38160	110475	148634	85200	28397	113597			
	4_3	8414	2169	10583	1903	2202	4105			
	5_2	79375	73309	152684						
	5_3	22677	2364	25041						
	TOTAL	*153833*	*224113*	*377946*	*109491*	*66345*	*175836*	*2958*	*74697*	*77655*
Catch	3_2	220	1511	1731	4423	4587	9010	1547	973	2520
	4_2	21323	25320	46642	30754	19142	49896			
	4_3	731	762	1493	61	34	95			
	5_2	48101	29575	77676						
	5_3	12330	7522	19852						
	TOTAL	*82704*	*64690*	*147395*	*35238*	*23763*	*59001*	*1547*	*973*	*2520*
Total Return	3_2	5427	37308	42734	26811	40333	67144	4505	75670	80175
	4_2	59482	135794	195277	115954	47539	163493			
	4_3	9145	2932	12077	1964	2236	4200			
	5_2	127476	102884	230360						
	5_3	35007	9886	44893						
	TOTAL	**236537**	**288804**	**525341**	**144729**	**90108**	**234837**	**4505**	**75670**	**80175**
% of Somass return		45%	55%		62%	38%		**6%**	**94%**	

Table 7. Estimates of juvenile Sockeye abundance (millions) in Great Central, Sproat, and Henderson Lakes for smolt years 1980–2020. Most Sockeye returning in 2022 went to sea in 2019 and 2020.

Sea-entry year	Great Central Lake			Sproat Lake			Henderson Lake
	Age 1s	Age 2s	Total	Age 1s	Age 2s	Total	Total
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	4.65	0.52	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	0.61
2016			3.79			4.15	
2017			17.06			5.50	
2018			17.12			5.73	
2019			8.90			1.95	
2020			0.85			4.67	
Average	*7.46*	*0.98*	*8.50*	*7.53*	*0.20*	*7.47*	*1.41*

Table 8. Excerpt from the management plan: 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 9. Excerpt from the management plan: 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.*

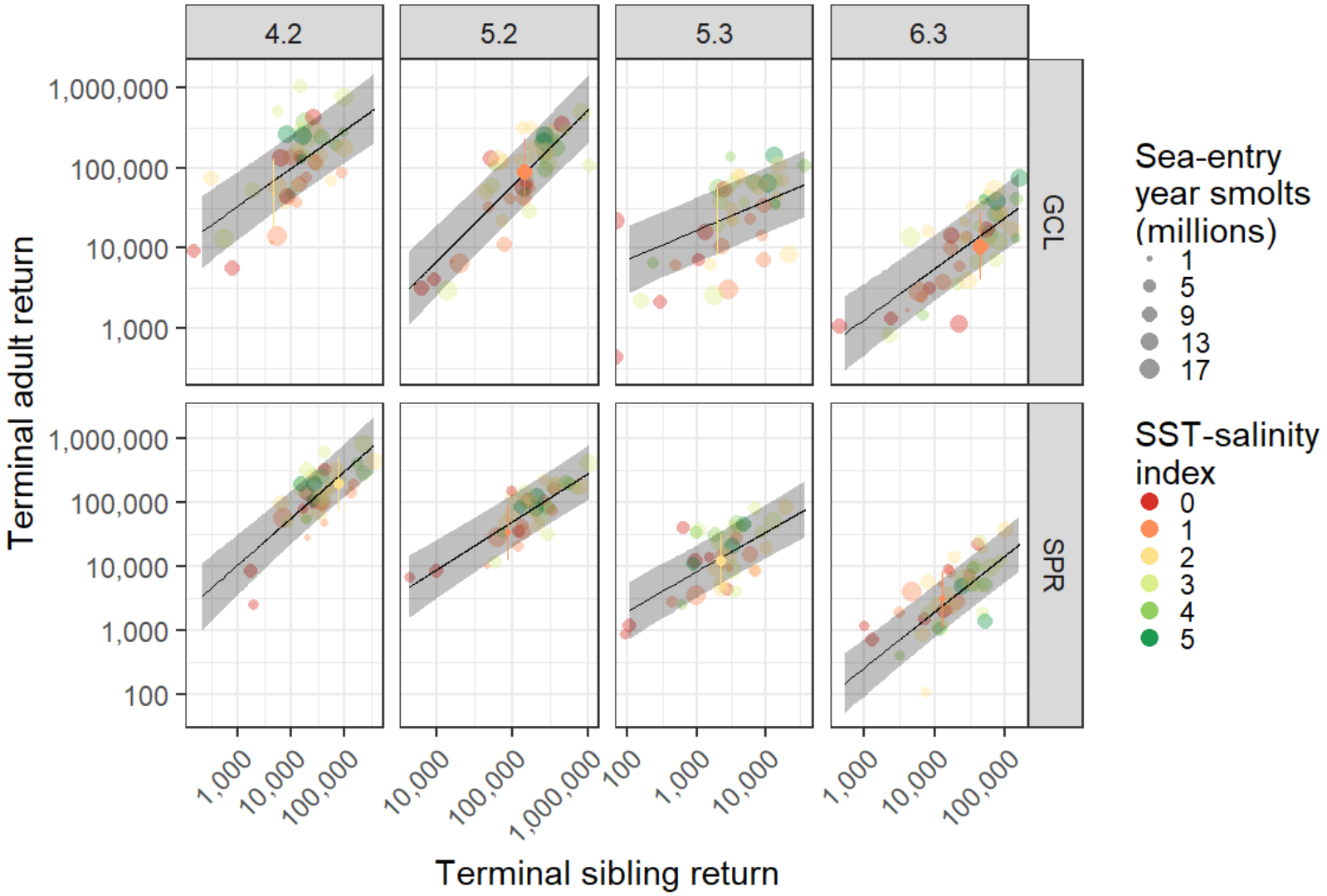

Figure 1. Multivariate model predictions and observed returns by age (Gilbert-Rich; columns) and lake (rows). Black lines and the shaded areas around them show the mean predictions and 75% prediction interval, respectively. Point forecasts and prediction intervals for 2022 are overlaid on each panel as dots with whiskers. The 6-point SST-salinity index was developed to reflect the relative hospitability of ocean conditions for juvenile Somass Sockeye during their Spring outmigration period; higher values reflect lower sea surface temperatures and higher salinities.

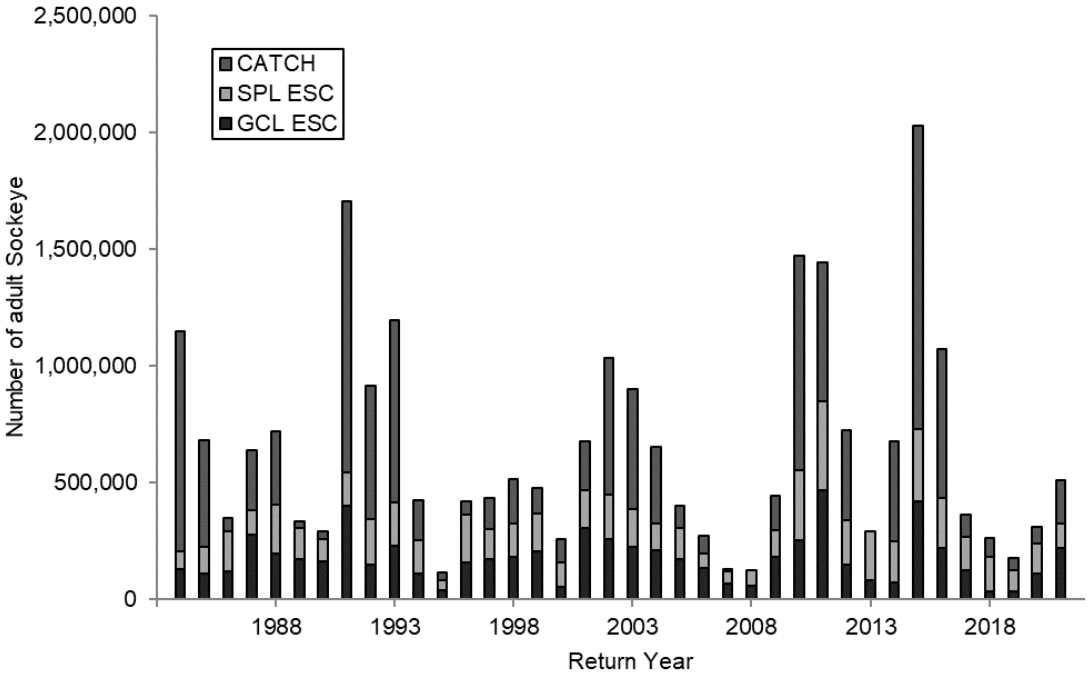

Figure 2. Estimated adult returns of Somass (Great Central and Sproat Lake) Sockeye, 1984–2021.

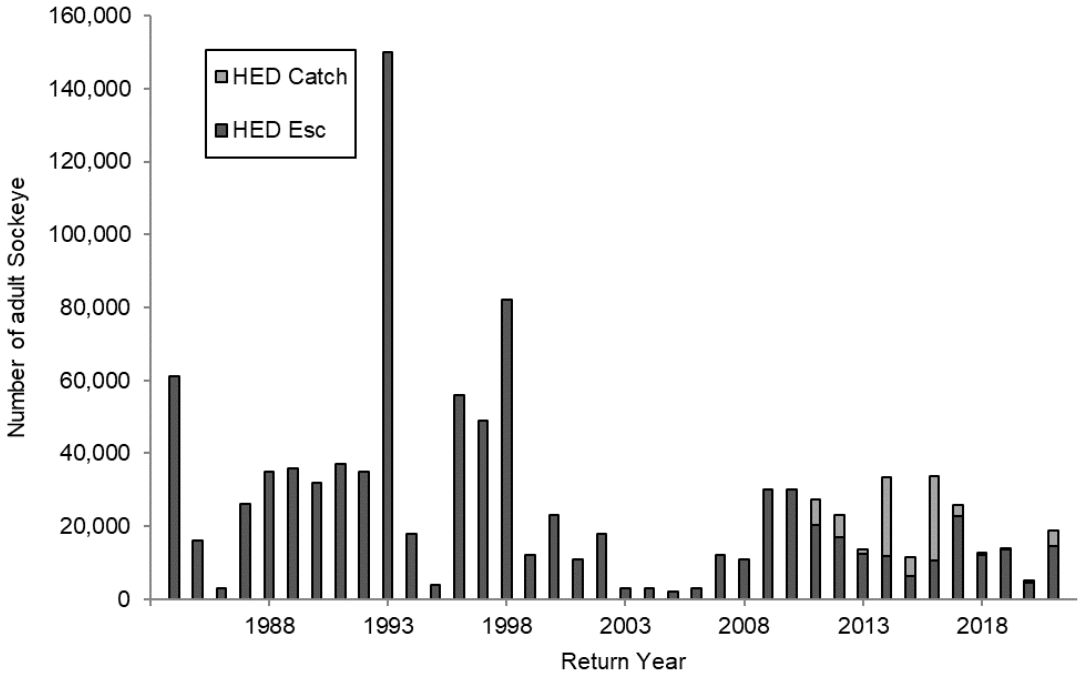

Figure 3. Estimated adult returns of Henderson Lake Sockeye, 1984–2021.

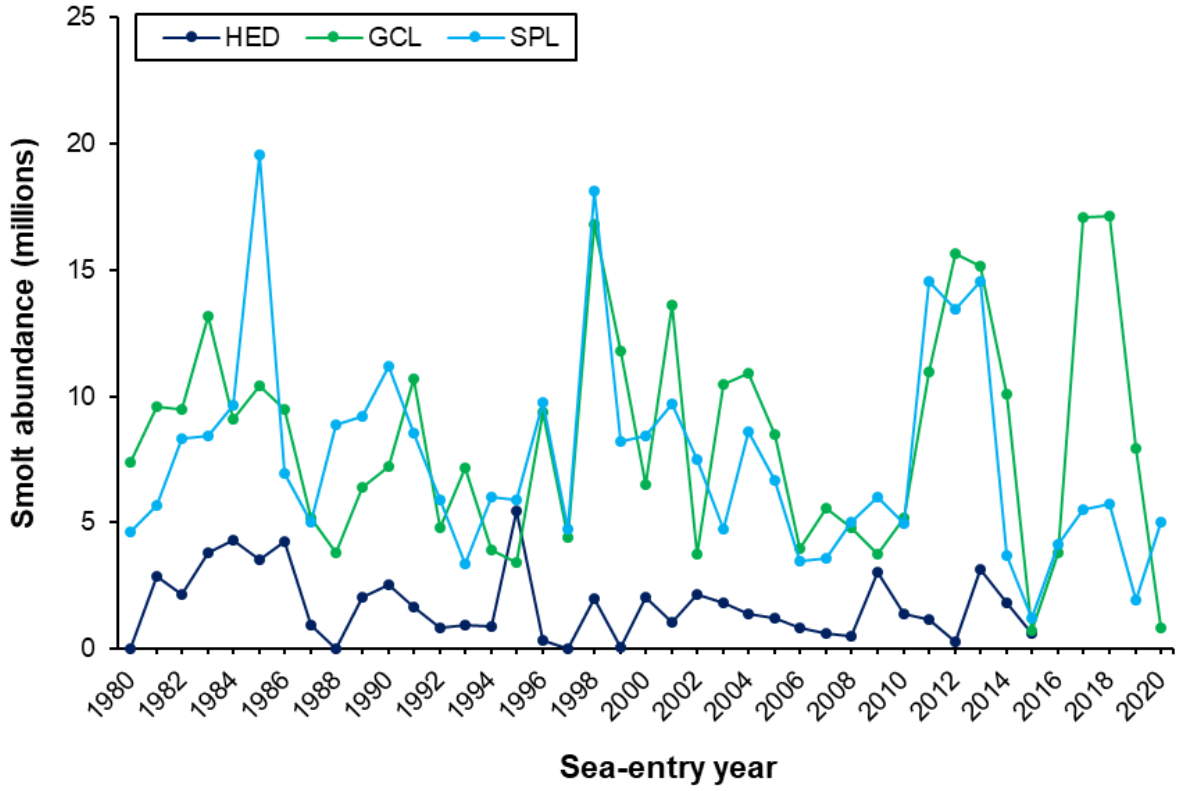

Figure 4. Estimated Sockeye "pre-smolt" juvenile abundances for Great Central, Sproat, and Henderson Lakes by sea-entry year. Most adult Sockeye returning in 2022 are associated with the production from the 2019 and 2020 sea-entry years.

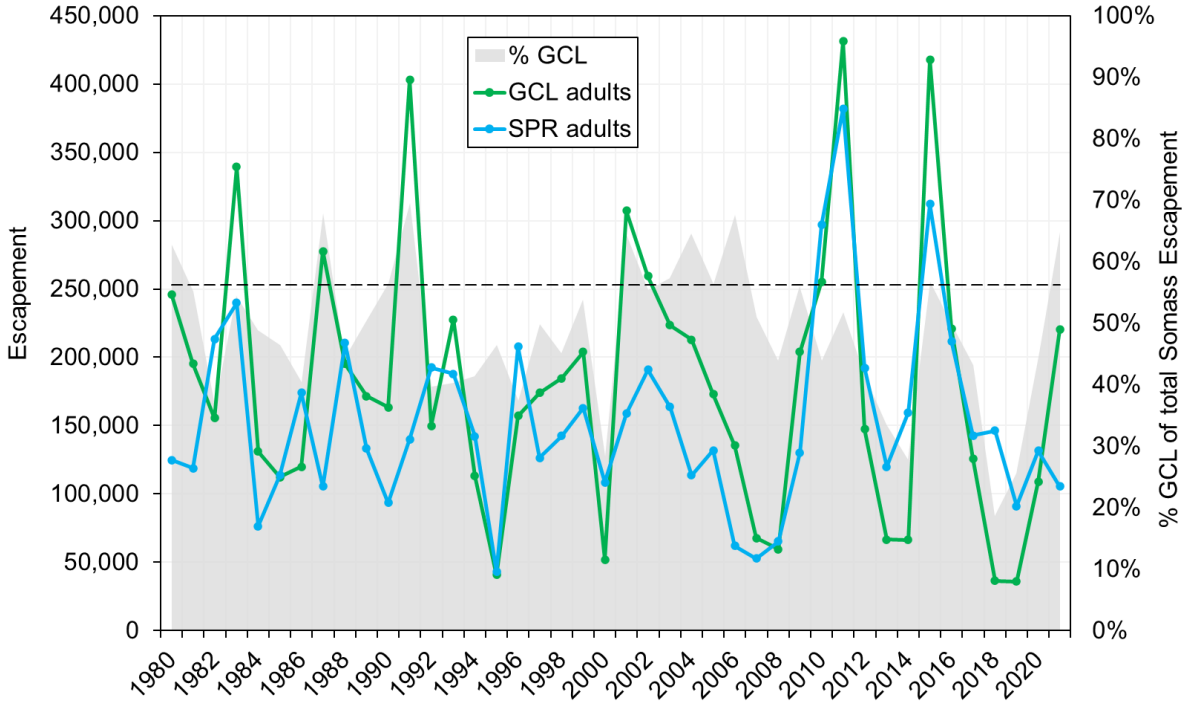

Figure 5. Time series of adult escapements to the Somass River. The black dashed line shows the historical median % GCL in the total return (55%).

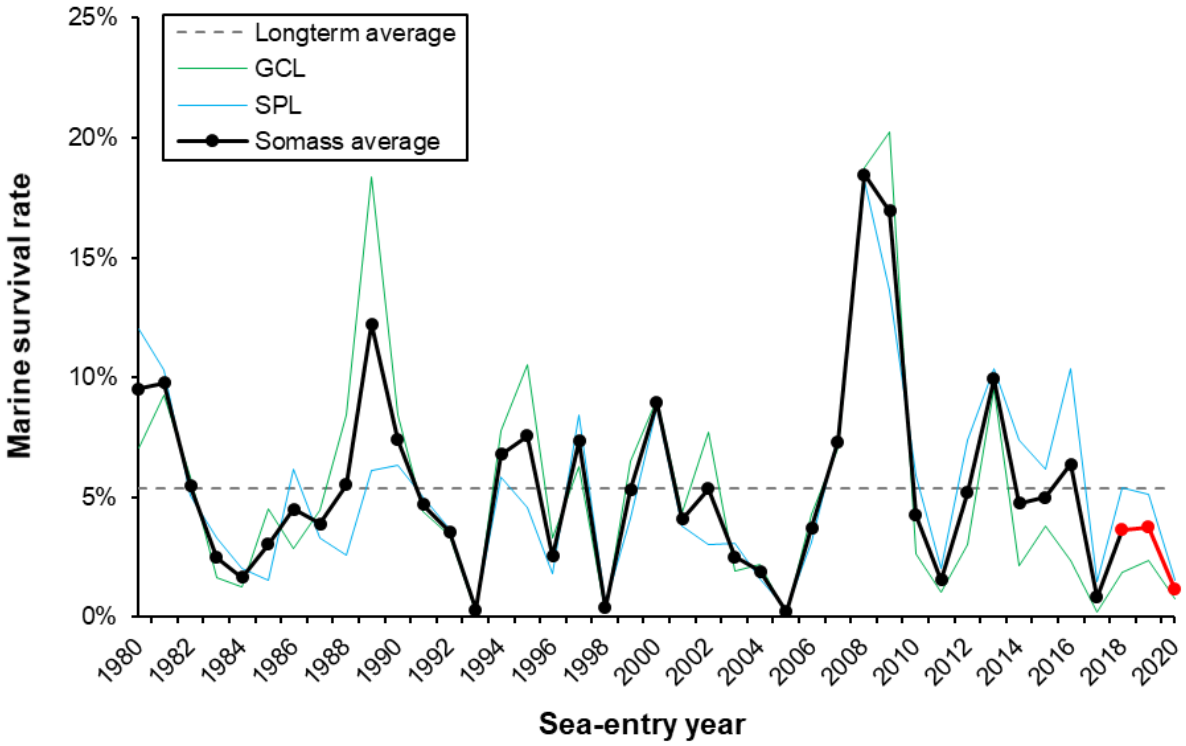

Figure 6. Time series of the marine survival rate index for Somass Sockeye stocks. Red dots and lines indicate the sea-entry years associated with the 2022 return; most adult Sockeye returning in 2022 went to sea in 2019 (5_2 and 6_3 Sockeye) and 2020 (4_2 and 5_3 Sockeye). Although the survival rate index for those years is incomplete (not all fish that went to sea in those years have returned as adults), observed survivorships for the past 4 sea-entry years appear below average.

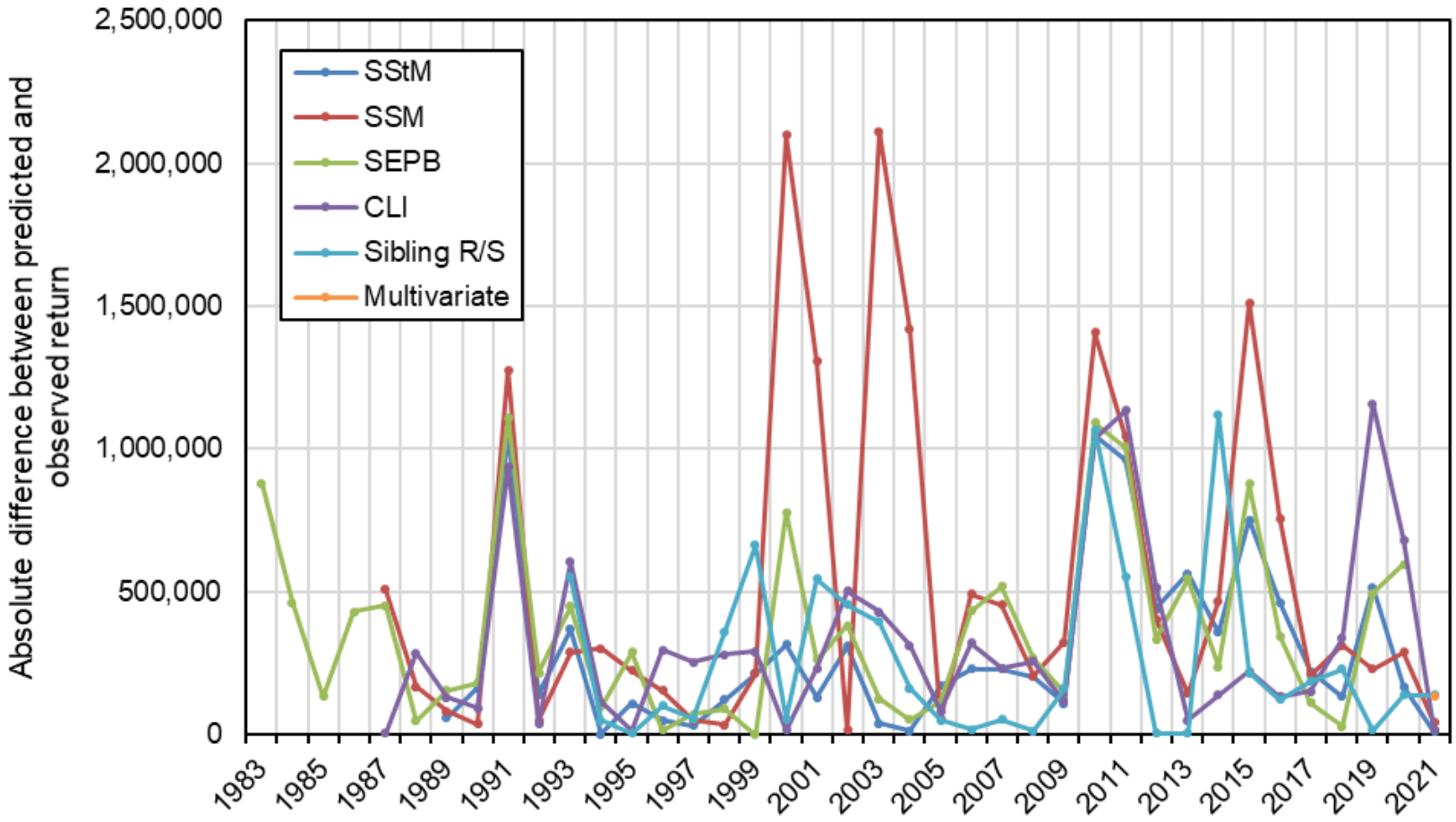

Figure 7. Time series of differences between predictions from the various forecast models and the observed Somass Sockeye returns.

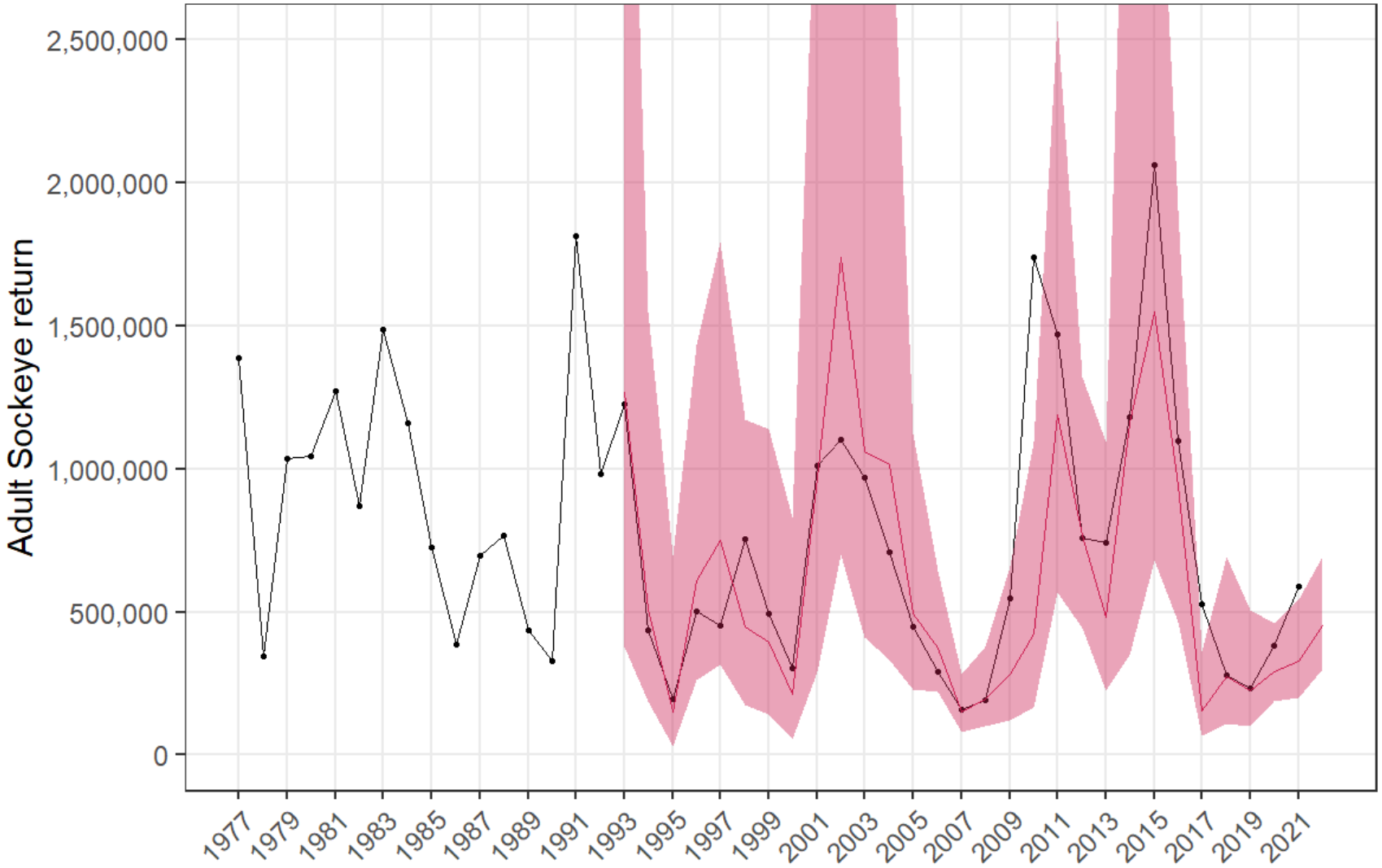

Figure 8. Retrospective analysis of multivariate forecast performance. The observed returns of Somass Sockeye adults are plotted as black dots connected by the black line. The red line shows the multivariate forecast model predictions for each year, and the red shaded area shows its 75% prediction interval.