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Area 23 (Barkley Sound, Alberni Inlet) Sockeye Forecast for the 2024 Return
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SUMMARY

1. For 2024 fishery management purposes, the Area 23 Roundtable has agreed to begin fisheries in the “Moderate” zone (500000–700000 adult return) for early season harvest management. Henderson Lake Sockeye remain a constraining stock in the “Low” zone.
2. There is uncertainty among the 2024 forecast models. Predictions (Table 3) vary between 281000 (survival stanza method), 352000 (Coho leading indicator model), 773000 (multivariate model), and 805000 (sibling model). Forecast models for the 2024 aggregate Somass Sockeye return are described in Appendix A.
3. All models, except the Coho leading indicator, predict GCL will comprise the dominant portion of the run. In 2020 and 2021 (broods returning as ages 5 and 4 fish, respectively, in 2024), escapements to both lakes were near or above average (Figure 5). The estimated juvenile Sockeye abundances in Great Central Lake and Sproat Lake in the 2021 and 2022 sea-entry years were low compared to historic levels. However, returns from the 2021 sea-entry year have thus far indicated a very high marine survival rate. The marine survival rate for the 2022 sea-entry year is uncertain as only jacks that went to sea in 2022 have returned. 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 preliminary run size reforecast is expected 20 June 2024.
4. The recommended management outlook for Henderson Sockeye is the “Low” zone for harvest management, corresponding to an expected return of 15000–25000 (Table 4). The key consideration influencing this outlook is a high marine survival rate in 2021, and moderate spawner abundances in the main contributing brood years, 2019–2020.

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 1980–2023, the median adult terminal returns (catch and escapement) of Great Central Lake, Sproat Lake, and Henderson Lake Sockeye are 305000, 241000 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: 46–61% 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, 20 June 2024.

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 management decisions around the amount and timing of fisheries that are likely to intercept Henderson Sockeye.

2024 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 2024 age classes, sea surface temperatures recorded at both Amphitrite Point Lightstation and an offshore buoy anchored south of the Brooks Peninsula, survival rates of Coho from the same brood year but 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 2024 aggregate Somass Sockeye return are described in detail in Appendix A and summarized here:

- The Multivariate forecast (Table 3) predicts a total return to the Somass River of 773000 (75% prediction interval: 240000–2200000) adult Sockeye. The predicted returns to Great Central and Sproat Lakes are 505000 and 223000 adult Sockeye, respectively (71% GCL).
- The Sibling forecast (Table 3) predicts a total return to the Somass River of 805000 adult Sockeye. The predicted returns to Great Central and Sproat Lakes are 616000 and 189000 adult Sockeye, respectively (77% GCL). The model suggests age-4 fish will be the dominant age class in both the Great Central and Sproat returns (Table 3).
- The sea-surface-temperature-based SStM forecast (Table 3) predicts a total return to the Somass River of 281000 adult Sockeye. The predicted returns to Great Central and Sproat Lakes are 195000 and 86000 adult Sockeye, respectively (69% GCL). Spring marine temperatures at Amphitrite Point were below average in 2021 and in 2022, which results in a "high" survival scenario (5%) for returning 4- and 5-year-olds. Indications from the 2020–2021 sea-entry years suggest marine survivals are high for these cohorts (Figure 6), likely much higher than the 5% assumed by the model. However, smolt abundances were low in both Great Central and Sproat Lakes through 2020–2021 (Figure 4).
- The Coho Leading Indicator (CLI) model predicts a total return to the Somass River of 352000 adult Sockeye. The predicted returns to Great Central and Sproat Lakes are 121000 and 232000 adult Sockeye, respectively (34% GCL). The CLI model accounts for spawner abundances in the contributing brood years, as well as the survival rate of Robertson Creek Coho from the contributing sea-entry years. Coho survival rates were slightly above the 6% average in 2021 (7.4%) and in 2022 (6.7%).

2024 SOMASS SOCKEYE MANAGEMENT FORECAST

For fishery management purposes, the Area 23 Roundtable has agreed to manage to a forecast in the "Moderate" zone (see Table 8) corresponding to an expected return of 500000 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 2024 include:

- 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 rates in Area 23 in the second and third weeks 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.

2024 HENDERSON SOCKEYE OUTLOOK

The recommended management outlook for Henderson Sockeye is the “Low” zone for harvest management, corresponding to an expected return of 15000–25000 Sockeye (Table 4). Spawner abundance in the 2019 brood year (13500 Sockeye) was near the historical median of 13000, but in the 2020 brood year, only 4600 spawners were estimated (Table 4). Based on positive ocean indicators and data from incomplete brood years, Sockeye marine survival rates for the 2021 smolt year are high. Therefore, expectations are for a near-average Henderson sockeye return in 2024.

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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 was 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 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 often 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 39% and 62%, respectively (Figure 7). Over the past 5 years, the Sibling and SSM models have performed the best (MAPEs of 41% and 80% respectively), while the SStM and CLI models have performed poorly (MAPEs of 90%, 183%, respectively; Figure 7). The Multivariate model appears to improve on the Sibling model, with a retrospective MAPE of 33%. 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. New for 2024 is the inclusion of average January–February sea surface temperatures from ECCC buoy c46132 “South Brooks,” which appears to more accurately predict survival rates compared to the nearshore temperatures recorded at the Amphitrite Point Lightstation (Figure 6).

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.

2023 forecast performance

The pre-season management forecast was in the “Moderate” zone with a predicted return of approximately 500000 adult Somass Sockeye (Table 2).

The observed return of approximately 543000 adult Somass Sockeye was in the 47th percentile of all runs recorded since 1977 (Table 1, Table 5, Figure 2). Fish from the 2017–2020 brood years returned in 2023, with the majority contributed from 2018 and 2019. The proportion of age 4_2 fish (49%) was well above the sibling model prediction (13%) and well below the SStM prediction (78%) but similar to predictions from the Multivariate and CLI models (54%, and 51% respectively). The 2023 return included an above average jack (ages 3_2 and 4_3) return to Great Central Lake.

The proportion of Great Central Lake in the total adult return (46%) was higher than expected pre-season (37%; average of the 4 forecast models employed). Returns from the 2018 brood year are heavily dominated by Sproat Lake (85%), but a relatively even abundance from the two lakes has been observed returning from the 2019 brood year (50% Great Central) and returns from the 2020 brood year are dominated by Great Central Lake (73%; Table 6).

All models, except the sibling forecast, under-predicted the 2023 return (Table 2). The prediction from the multivariate model was closest to the observed return (absolute percentage error: 26%). The sibling

model and the SStM came closest to predicting the final proportion of GCL Sockeye in the final 2023 return (42% and 47% predicted GCL, respectively). In the 2020 sea-entry year (age 5_2 and 6_3 Sockeye returning in 2023), the smolt abundance in GCL was very low, and in 2021, GCL smolt abundance was also low; these abundances nevertheless translated to a strong adult return to GCL in 2023. These low smolt abundances in GCL led the smolt-based forecast model (SStM) to greatly under-predict the return. Preliminary data from the 2020 and 2021 sea-entry years suggest high survival rates on the orders of 12–15+% (Figure 6), well above the 7.2% and 5.0% applied in the CLI and SStM, respectively.

The return of approximately 21000 Henderson Lake Sockeye in 2023 exceeded the 10-year median of *c.* 16000 (Table 1, Table 5, Figure 3) and aligned with the pre-season outlook for a return in the "low" management zone (15000–25000 Sockeye). Pre-season expectations were based on near-average spawner abundances in the 2018 and 2019 brood year, and an expectation for high marine survival rates to be experienced by the 2020 and 2021 sea-entry years.

Sources of uncertainty

The mean absolute percentage errors (MAPEs) for five forecast models that have been used to predict Somass Sockeye returns range from about 38–196%. Retrospective analysis suggests the Multivariate model is the best performing forecast. On average, the observed return is about 40% 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 in the source data (*e.g.* smolt abundances, age compositions in historical returns). Smolt estimates for the 2018–2022 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.

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 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 relationships between available ocean indicators and survival rates in Area 23 Sockeye are uncertain. While there are weak correlations between spring sea surface temperatures and salinities measured at Amphitrite Point and Somass Sockeye survival (R^2 0.03–0.17), some years with seemingly excellent ocean conditions (*e.g.* 2002) have not yielded high survivorship. The inclusion of winter sea surface temperature data from a buoy further offshore of the WCVI (see above) seems to yield improved predictions of Sockeye survivals ($R^2 \approx 0.24$; Figure 6).

APPENDIX B. FUTURE DIRECTIONS FOR STATISTICAL FORECASTING

Biological oceanographic covariates

The early marine period is understood to be a critical phase in Sockeye survival that can potentially explain a significant portion of return variability (Tanasichuk & Routledge, 2011). Measurements from physical oceanographic parameters, such as temperature and salinity, have been considered in the Area 23 Sockeye forecast since the late 1980s (Hyatt et al., 2003) as indicators of marine conditions affecting Sockeye survival. However, physical oceanographic characteristics are considered proxies for biological factors, namely predator and prey abundances, that are assumed to affect survival more directly (Koslow et al., 2002; Meuter, Peterman & Pyper, 2002). Tanasichuk & Routledge (2011) showed that for Somass Sockeye, a significant portion of return variability could be explained by euphausiid (krill) abundances in Barkley Sound during the juvenile marine migration period. Further work has also elucidated effects of continental shelf piscivorous hake biomass and Gulf of Alaska Pink salmon abundances on Somass Sockeye returns (R. Tanasichuk, pers. comm.). DFO plankton surveys in Barkley Sound operated from 1991–2014, and were resumed in 2022. Piscivorous hake biomass estimates are generated each year for the entire North American continental shelf, but further analysis is required to estimate the portion of the total estimate that is close to the WCVI (to account for interannual variability in hake latitudinal distribution). A fruitful avenue for future forecasting efforts would be to assimilate pertinent euphausiid and hake data, and to incorporate these as predictors in a forecast model.

Heritability in age-at-return

Sockeye from Great Central and Sproat Lakes exhibit diverse life histories with respect to freshwater and marine ages. Emerging research suggests age-at-maturity and perhaps life history type (*i.e.* freshwater and marine ages) could be heritable in Sockeye salmon (Walters et al, 2021; R. Tanasichuk, pers. comm.). If this is the case, a more accurate forecast could be developed that considers both stock- and life-history-specific predictors. For example, life-history- and stock- specific datasets appear to better describe stock-recruit relationships in Somass Sockeye (Figure 8). Future forecasts could explore relationships with age-matched brood year spawners, and perhaps investigate whether any of the candidate physical or biological oceanographic variables described above can be used to predict residuals from the stock-recruit relationships (Figure 9).

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APPENDIX C. TABLES AND FIGURES

Table 1. Total return of Sockeye to Barkley Sound in 2023.

Conservation Unit	Age at Return						Total	Adults
	3_2	4_2	4_3	5_2	5_3	6's		
Great Central Lake	90779	169485	8830	32609	29952	18654	350309	250700
Sproat Lake	34453	164034	3956	107511	17022	6108	333083	294674
Henderson Lake		4263		16740	149	157	21309	21309
Total	**125232**	**337781**	**12786**	**156861**	**47123**	**24919**	**704702**	**566684**

Table 2. Forecast performance of Somass Sockeye models for 2023. Absolute Percentage Error (APE) is the absolute value of (Forecast return – Observed return) × (Observed return)$^{-1}$.

2023 Management forecast: Moderate zone (*c.* 500000 adults)				
543414 observed	**Forecast 2023**			
	SStM	**CLI**	**Sibling**	**Multivariate**
Expected	145108	275610	723094	464524
Obs. − Exp.	398306	267804	−179680	78890
APE	129%	87%	58%	26%

Table 3. Predictions by age and lake for 2024 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	483,764	106,108	26,042	**615,914**	77%
	SPL	102,358	74,503	12,310	**189,171**	23%
	Total	586,122	180,611	38,352	**805,085**	
	% at age	73%	22%	5%		
		4s	**5s**		**Total**	
SStM	GCL	155,814	39,025		**194,839**	69%
	SPL	69,546	16,300		**85,846**	31%
	Total	225,360	55,325		**280,685**	
	% at age	80%	20%			
		4_2	**5_2**	**5_3**	**6_3**	**Total**	
CLI	GCL	92,433	19,749	5,804	2,620	**120,606**	34%
	SPL	164,864	53,318	9,620	3,905	**231,707**	66%
	Total	257,297	73,067	15,424	6,525	**352,313**	
	% at age	73%	21%	4%	2%		
		4_2	**5_2**	**5_3**	**6_3**	**Total**	
Multivariate	GCL	359,708	146,530	29,616	14,022	**549,876**	71%
	SPL	111,013	91,537	16,431	4,059	**223,040**	29%
	Total	470,721	238,067	46,047	18,081	**772,916**	
	% at age	61%	31%	6%	2%		

Table 4. Factors considered in the 2024 outlook for the Henderson Sockeye return.

Return Year	Age at Return	Brood year	Spawner abundance	Smolt Year	Smolt Abundance	Marine Survival
2023	4	2020	4.5k (low)	2022	*Pending*	uncertain
	5	2019	13.5k (avg.)	2021	*Pending*	high

Table 5. Terminal adult return of Area 23 Sockeye; 1980–2023. “Total A23 Catch” includes Henderson Sockeye.

RETURN YEAR	TEST FISHERY	FIRST NATIONS CATCH				COMMERCIAL CATCH					RECREATIONAL	TOTAL A23 CATCH	HED 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		SOM return	HED return
1980	-	15,791	-		15,791	292,339	374,760	-	-	667,099	-	682,890		246,041	124,943	21,000	391,984	**1,074,874**	**1,053,874**	**21,000**
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**	**1,340,258**	**40,000**
1982	-	23,500	-		23,500	229,271	246,673	-	-	475,944	-	499,444		155,579	213,477	56,000	425,057	**924,501**	**868,501**	**56,000**
1983	-	30,000	-		30,000	315,478	603,827	-	-	919,305	-	949,305		339,204	239,763	45,000	623,967	**1,573,272**	**1,528,272**	**45,000**
1984	-	21,000	-		21,000	454,813	463,971	-	-	918,784	-	939,784		131,000	76,373	61,000	268,374	**1,208,158**	**1,147,158**	**61,000**
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**	**683,597**	**16,000**
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**	**350,653**	**3,000**
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**	**637,402**	**26,000**
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**	**720,479**	**35,000**
1989	648	23,395	-		23,395	4,145		-	-	4,145	139	27,679		171,652	133,349	36,000	341,000	**368,679**	**332,679**	**36,000**
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**	**293,541**	**32,000**
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**	**1,703,640**	**37,000**
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**	**913,437**	**35,000**
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**	**1,196,183**	**150,000**
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**	**434,655**	**18,000**
1995	146	23,782	-		23,782	-	-	-	-	-	6,519	30,447		40,940	43,254	4,000	88,195	**118,642**	**114,642**	**4,000**
1996	4,513	28,139	-		28,139	-	-	-	-	-	28,033	60,685		157,087	207,716	56,000	420,804	**481,489**	**425,489**	**56,000**
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**	**443,408**	**49,000**
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**	**534,831**	**82,000**
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**	**482,499**	**12,000**
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**	**266,475**	**23,000**
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**	**686,130**	**11,000**
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**	**1,044,123**	**18,000**
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**	**909,421**	**3,000**
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**	**661,629**	**3,000**
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**	**409,700**	**2,000**
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**	**285,391**	**3,000**
2007	885	8,706	-		8,706	-	-	-	-	-	-	9,591		67,717	52,837	12,000	132,554	**142,145**	**130,145**	**12,000**
2008	-	-	-		-	-	-	-	-	-	-	-		59,589	65,333	11,000	135,921	**135,921**	**124,921**	**11,000**
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**	**481,547**	**30,000**
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**	**1,471,934**	**30,000**
2011	-	109,369		17,081	126,450	231,442	192,333	-	-	423,775	42,799	593,024	6,965	431,213	381,980	20,423	833,616	**1,426,640**	**1,399,252**	**27,388**
2012		154,951		18,047	172,998	116,106	79,550	-	-	195,656	16,940	385,593	5,942	147,440	192,226	17,133	356,800	**742,393**	**719,318**	**23,075**
2013	5,313	31,208		11,851	43,059	11,390	9,128	-	-	20,518	13,274	82,164	1,125	66,688	119,849	12,500	199,037	**281,201**	**267,576**	**13,625**
2014	9,636	164,319		19,659	183,978	169,685	243,937	-	5,190	418,812	16,313	628,739	21,656	66,298	159,751	11,837	237,885	**866,624**	**833,131**	**33,493**
2015	11,298	319,351		25,267	344,618	329,505	521,003	-	15,000	865,508	88,232	1,309,656	5,192	417,774	312,265	6,400	736,440	**2,046,096**	**2,034,504**	**11,592**
2016	8,887	170,326		26,765	197,091	161,607	228,329	-	13,124	403,060	51,680	660,719	23,111	220,952	211,926	10,700	443,578	**1,104,297**	**1,070,486**	**33,811**
2017	3,328	36,305		14,672	50,977	9,879	16,461	-	-	26,340	12,420	93,065	3,217	125,846	142,684	22,704	291,234	**384,299**	**358,378**	**25,921**
2018	4,837	35,886		18,278	54,164	10,785	6,075	-	-	16,860	5,566	81,427	626	36,418	146,312	12,203	194,933	**276,360**	**263,531**	**12,829**
2019	3,409	27,770		12,792	40,562	6,482	-	-	-	6,482	2,193	52,646	154	35,982	91,245	13,549	140,776	**193,422**	**179,719**	**13,703**
2020	6,314	35,890		7,876	43,766	6,961	-	-	-	6,961	6,575	63,616	443	109,174	131,529	4,589	245,292	**308,908**	**303,876**	**5,032**
2021	7,272	51,306		20,795	72,101	35,777	35,110	-	-	70,887	36,410	186,670	4,359	220,319	105,441	14,520	340,280	**526,950**	**508,071**	**18,879**
2022	7,872	98,114		22,698	120,812	99,292	108,395			207,687	9,531	345,902	7,731	194,241	366,294	18,646	579,181	**925,083**	**898,706**	**26,377**
2023	9,281	87,295		24,045	111,340	71,280	93,572			164,852	23,067	308,540	8196	120,979	122,622	13,113	256,714	**565,254**	**543945**	**21309**
MEDIAN	4,837	36,305	-	18,163	43,766 #	52,241	41,576	-	-	74,981	16,940	220,100	4,776	172,962	142,162	18,000	353,834	663,402	482,499	23,038
10 YR MED	6,793	43,806	#N/A	18,969	63,133 #	23,584	25,786	-	-	48,613 #	12,847	139,868		117,510	144,498	12,352	268,263	455,624	433,224	16,291
5 YR MED	6,314	35,890	#N/A	18,278	54,164 #	10,785	6,075	-	-	16,860 #	6,575	81,427		109,174	131,529	13,549	245,292	308,908	303,876	13,703

Table 6. Escapement, catch, and total return-at-age to date from brood years contributing to the 2024 Somass Sockeye return. *Note*.—data from each brood year span multiple return years; *e.g.* fish from the 2018 brood year returned as age 3s in 2021, 4s in 2022, 5s in 2023, and will return as age 6s in 2024.

		2018 brood year			2019 brood year			2020 brood year		
	Age	GCL	SPL	TOTAL	GCL	SPL	TOTAL	GCL	SPL	TOTAL
Escapement	3_2	2,958	74,697	77,655	39,648	44,028	83,676	80,457	29,049	109,506
	4_2	34,553	349,607	384,160	81,222	64,745	145,967			
	4_3	1,328	3,057	4,385	8,208	3,347	11,555			
	5_2	13,635	48,053	61,688						
	5_3	16,336	7,196	23,531						
	TOTAL	*68,810*	*482,610*	*551,419*	*129,078*	*112,120*	*241,198*	*80,457*	*29,049*	*109,506*
Catch	3_2	1,637	1,034	2,671	7,122	14,120	21,242	10,264	5,157	15,421
	4_2	31,342	196,028	227,370	87,946	98,500	186,445			
	4_3	293	956	1,249						
	5_2	18,911	58,872	77,783						
	5_3	13,571	9,737	23,308						
	TOTAL	*65,754*	*266,627*	*332,381*	*95,690*	*113,196*	*208,887*	*10,264*	*5,157*	*15,421*
Total Return	3_2	4,595	75,731	80,326	46,770	58,148	104,918	90,720	34,206	124,926
	4_2	65,895	545,635	611,530	169,168	163,245	332,412			
	4_3	1,621	4,013	5,634	8,830	3,924	12,754			
	5_2	32,546	106,925	139,471						
	5_3	29,907	16,933	46,840						
	TOTAL	**134,564**	**749,237**	**883,800**	**224,768**	**225,317**	**450,084**	**90,720**	**34,206**	**124,926**
% of Somass return		15%	85%		50%	50%		73%	27%	

Table 7. 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)

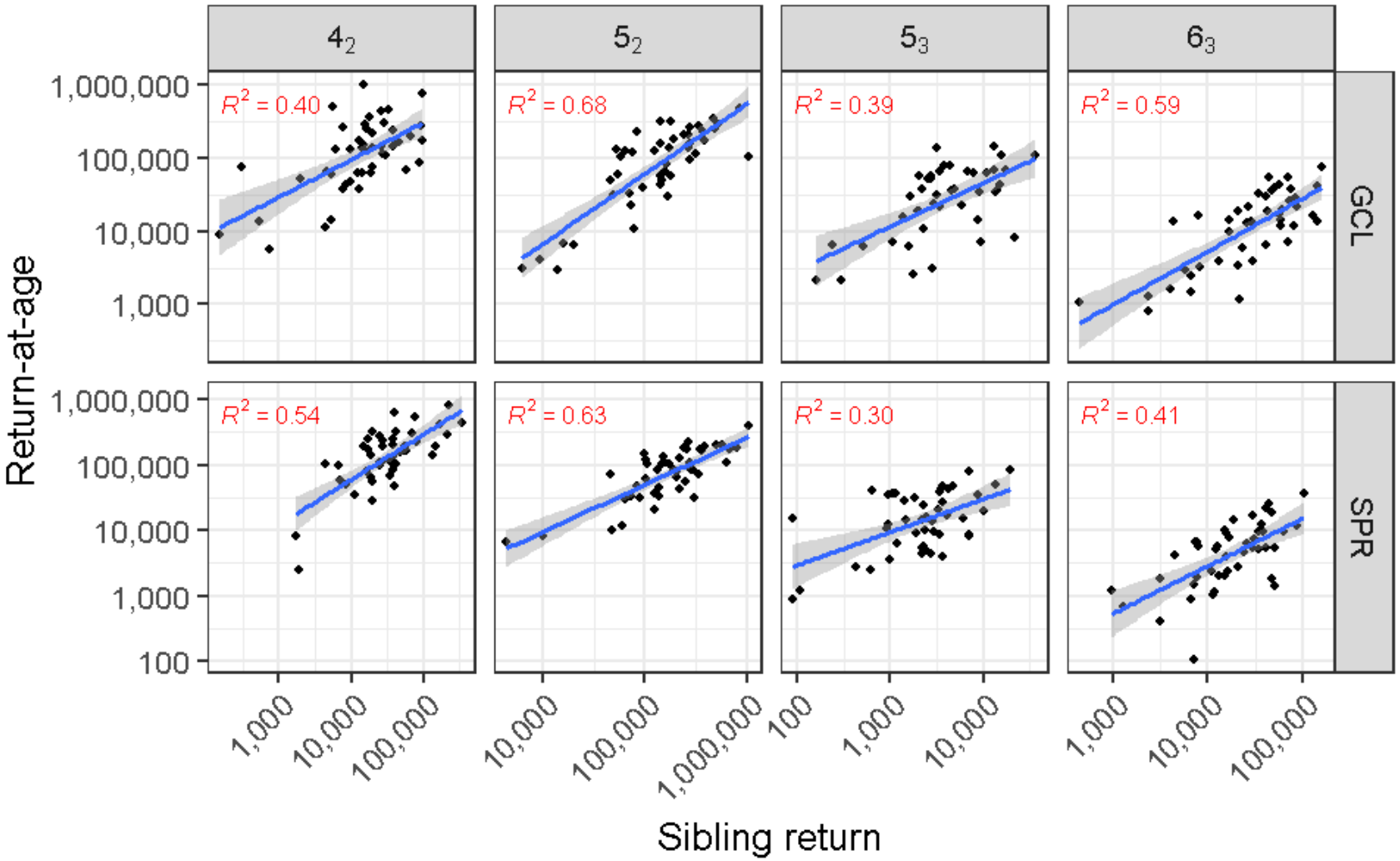

Figure 1. Sibling regression fits by Gilbert-Rich age (columns) and lake (rows; GCL = Great Central Lake, SPR = Sproat Lake). Blue lines and the shaded areas around them show the model predictions and 95% confidence intervals, respectively. Both x and y axes are plotted on a log-scale.

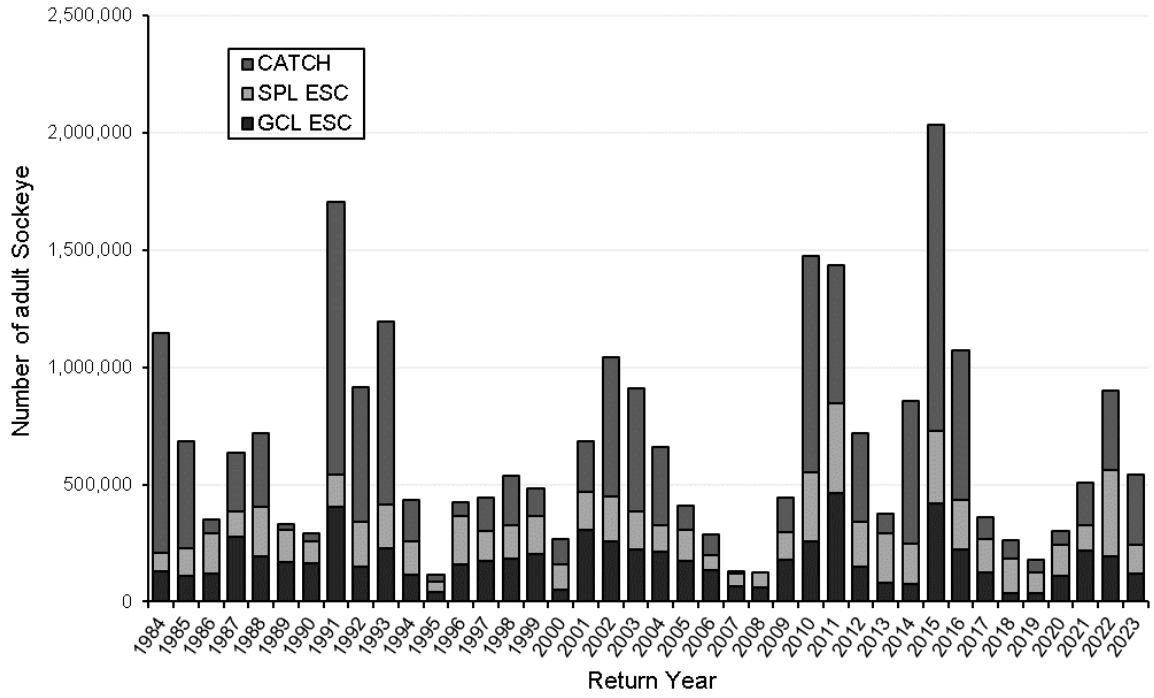

Figure 2. Estimated adult returns of Somass (Great Central and Sproat Lake) Sockeye, 1984–2023.

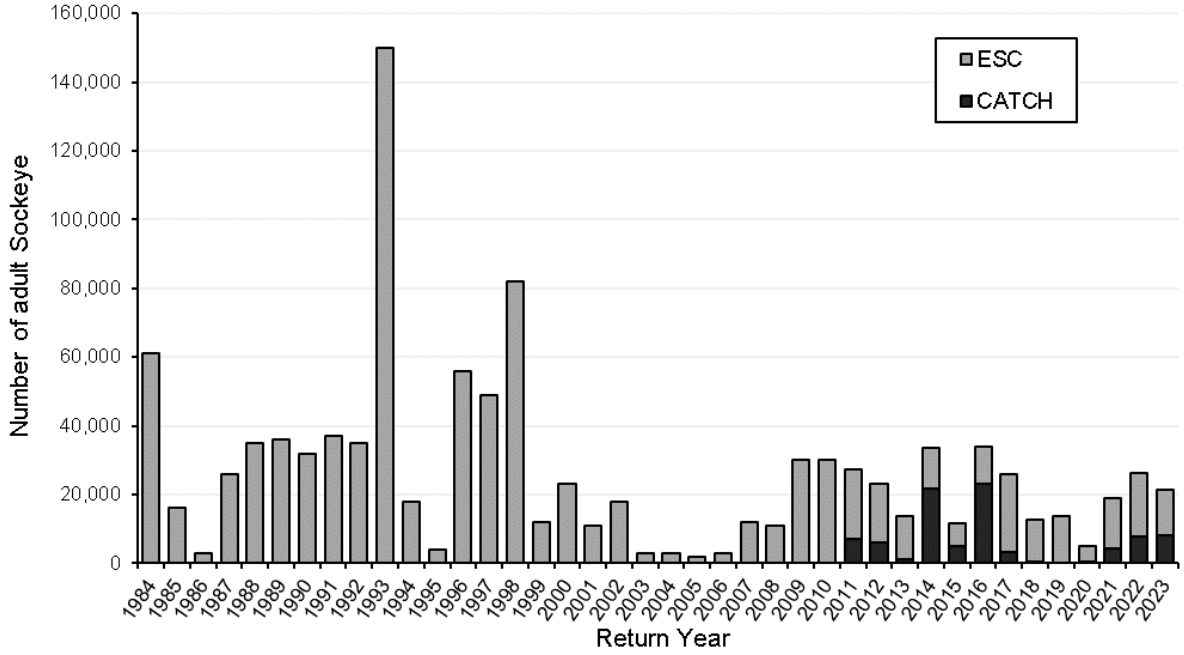

Figure 3. Estimated adult returns of Henderson Lake Sockeye, 1984–2023. Catch estimates begin in 2011 when genetic sampling was instituted.

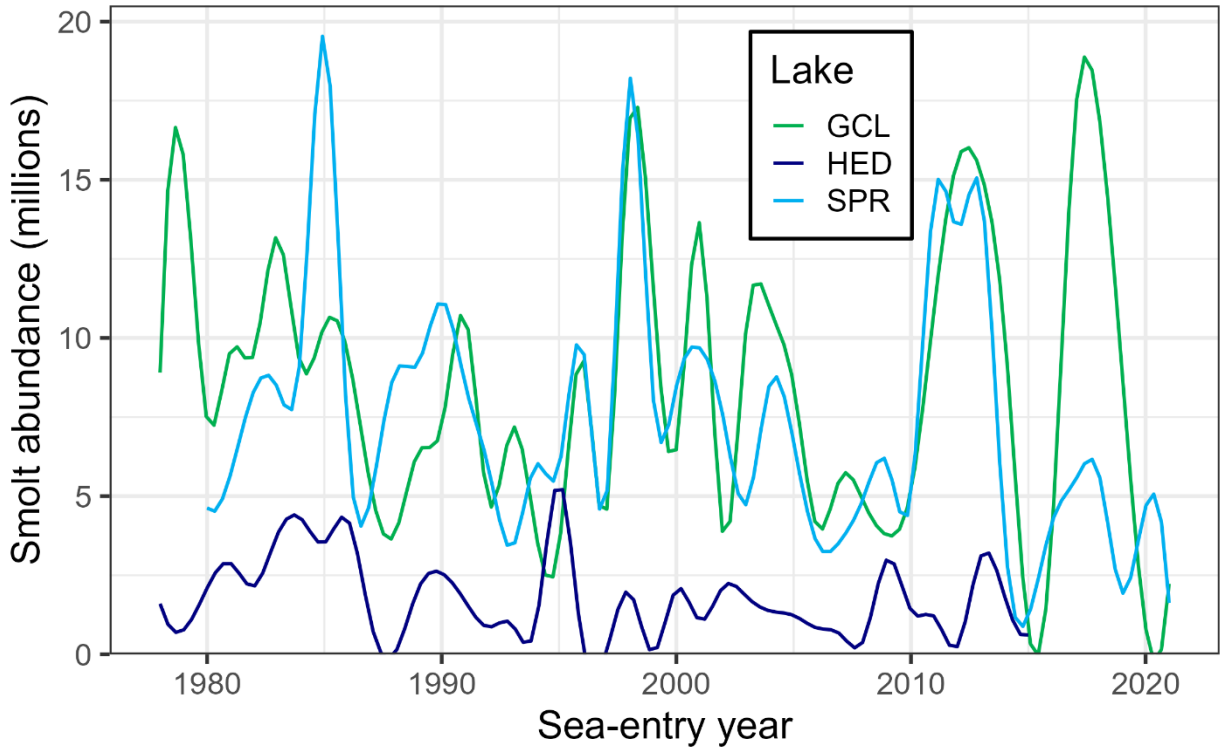

Figure 4. Estimated Sockeye "pre-smolt" juvenile abundances for Great Central, Sproat, and Henderson Lakes by sea-entry year. Most adult Sockeye returning in 2024 are associated with the production from the 2020 and 2021 sea-entry years.

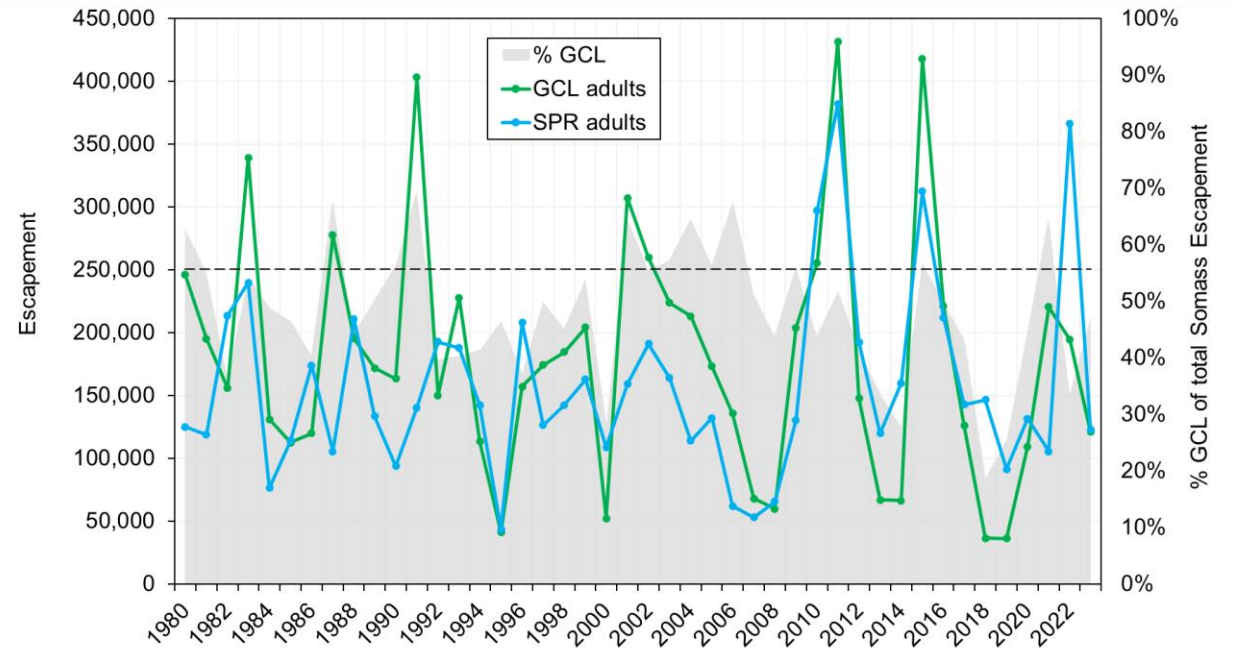

Figure 5. Time series of adult escapements to the Somass River. The black dashed line shows the historical median % GCL in the total return (56%).

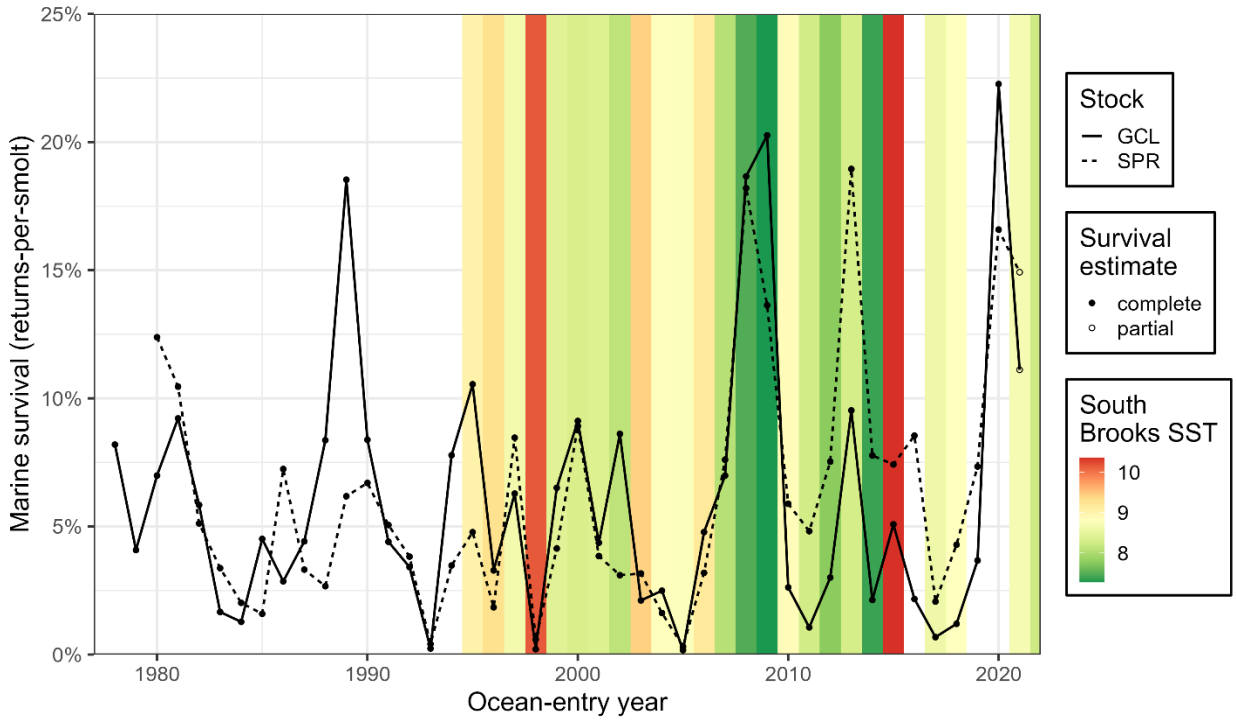

Figure 6. Time series of the marine survival rate index for Somass Sockeye stocks, with coloured tiles showing average January–February sea surface temperatures (SST; °C) measured at Environment and Climate Change Canada's monitoring buoy "South Brooks" (station 46132). Unfilled dots show years where the survival rate index is based on incomplete broods (not all fish that went to sea in those years have returned as adults). The majority of Sockeye returning in 2024 went to sea in 2021 (ages 5_2 and 6_3) and 2022 (ages 4_2 and 5_3).

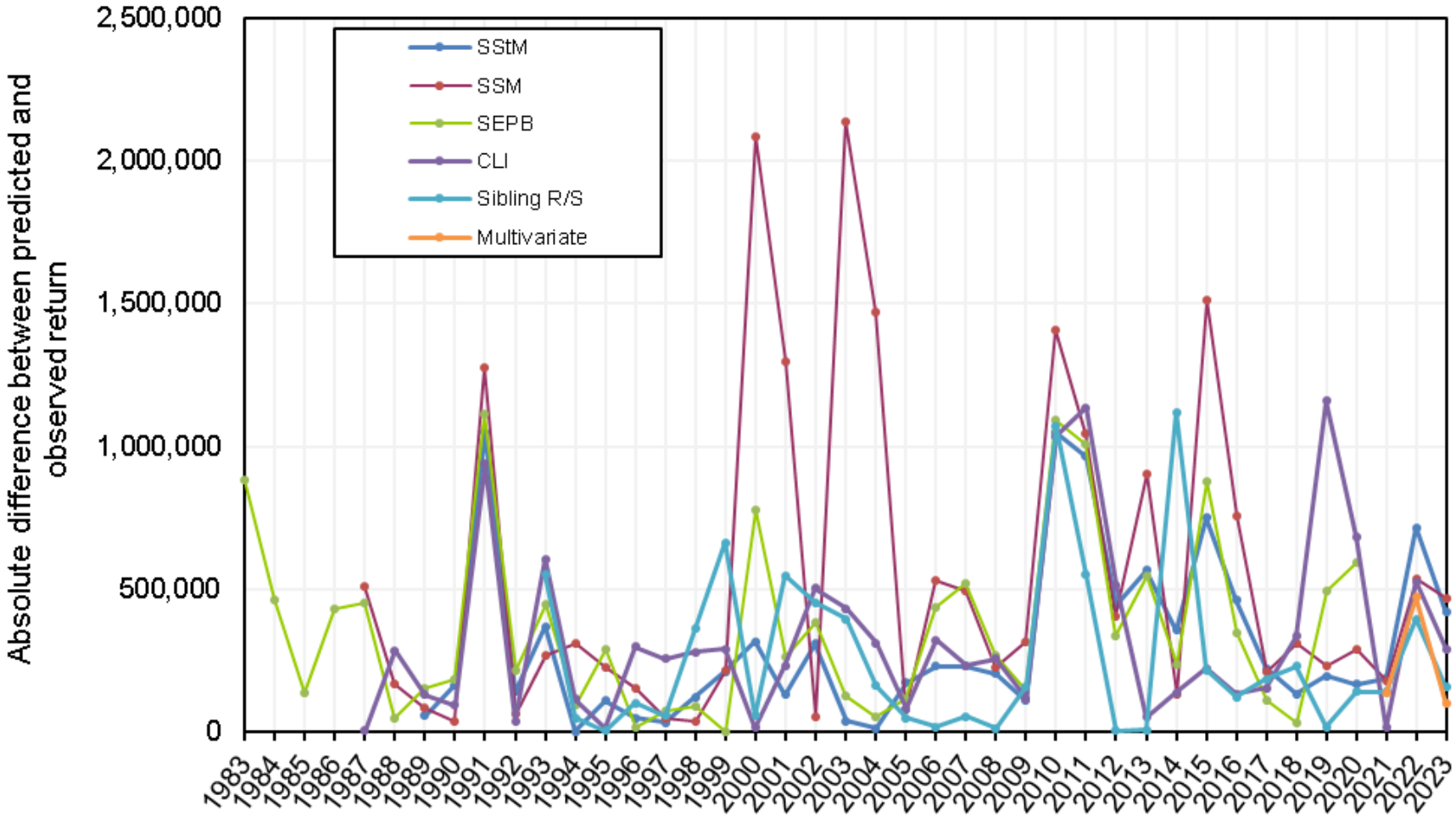

Figure 7. Time series of differences between predictions from the various forecast models and the observed Somass Sockeye returns.

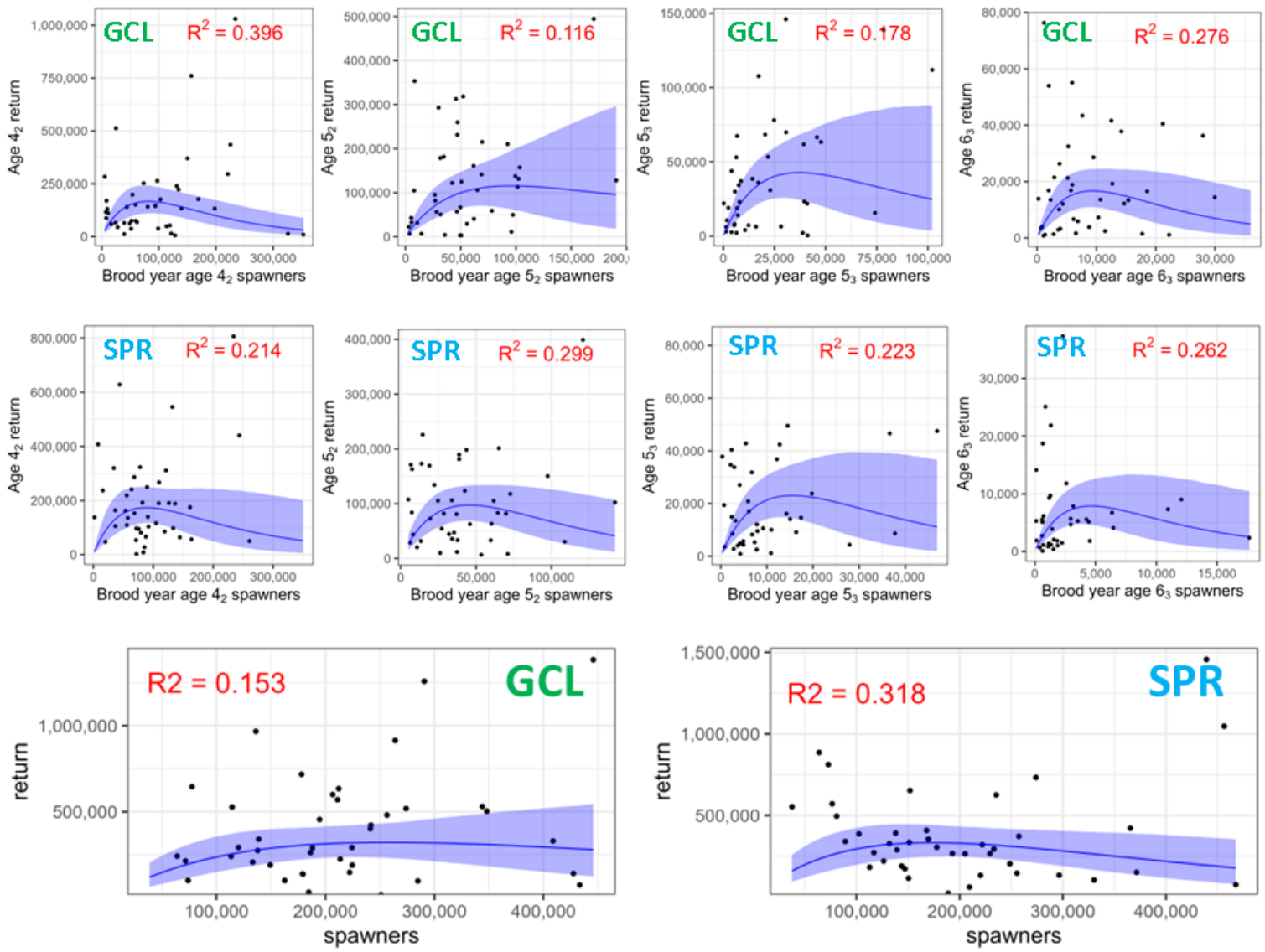

Figure 8. Ricker stock-recruit relationships for Great Central Lake (GCL) and Sproat Lake (SPR). Smaller top panels show life-history-specific relationships, where returns of each age are plotted against same-age spawners by brood year. The larger bottom panels show stock-recruit relationships for entire lake populations, where returns of all ages are plotted against spawners of all ages from the contributing brood year.

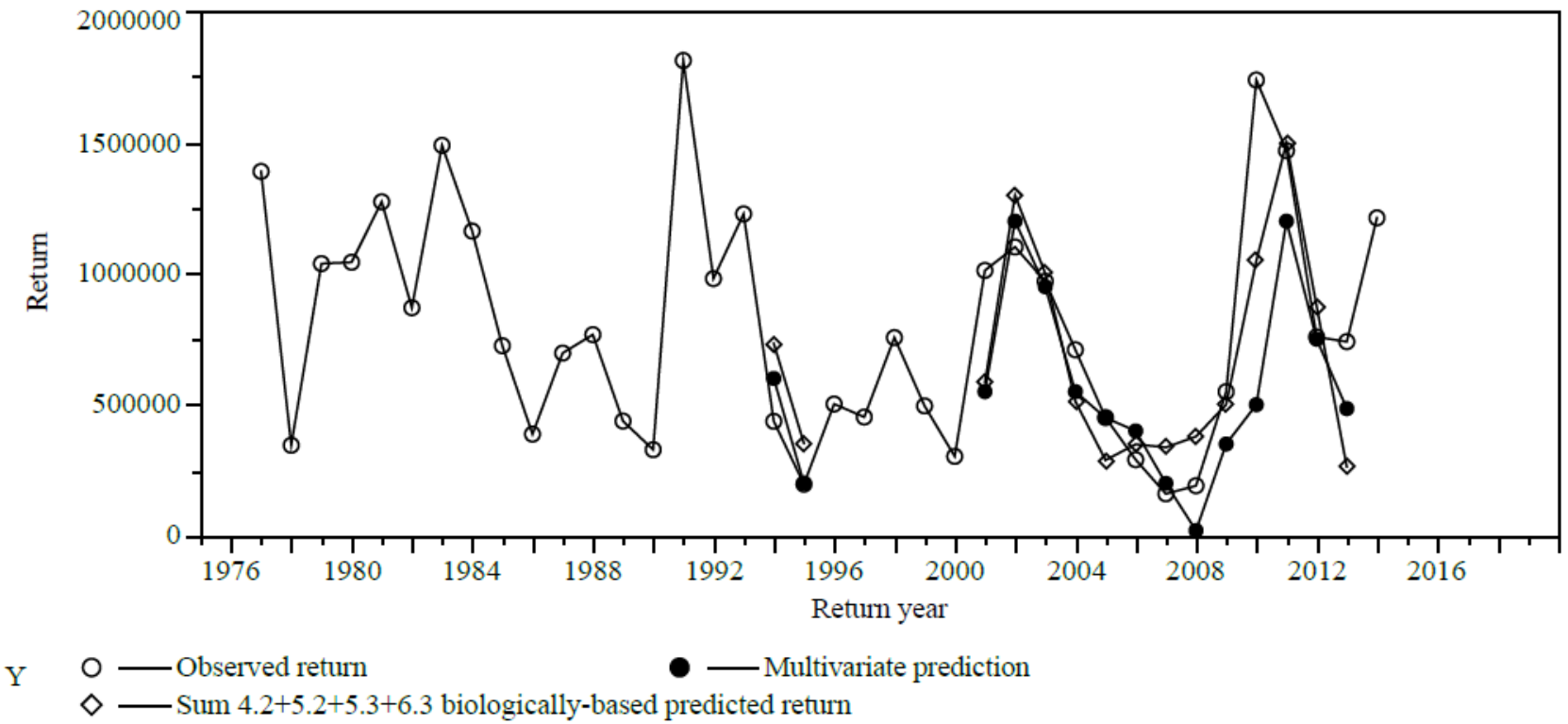

Figure 9. Comparison of multivariate retrospective forecasts and biologically-based return estimates for Somass River sockeye versus observed returns (credit: R. Tanasichuk).