2025 Bristol Bay Sockeye Salmon Forecast

University of Washington
Alaska Salmon Program
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The 2025 UW-FRI Bristol Bay sockeye salmon preseason forecast is 54.1 million. This forecast is 12% **lower** than the recent 10-year average (61.2 million) and 8% **higher** than the recent 20-year average (49.9 million) of observed sockeye runs to Bristol Bay. This estimate is the sum of individual predictions for each of the dominant age classes (1.2, 1.3, 2.2, 2.3) for all nine major river systems – Kvichak, Egegik, Ugashik, Naknek, Alagnak, Wood, Nushagak-Mulchatna, Igushik, and Togiak rivers, and the contribution of the Nushagak 0.3 and 1.4 age classes (Table 1, Figure 1). **The predicted inshore harvest based on this forecast is 37.8 million sockeye salmon with an estimated weight of 209.6 million pounds** (Table 2). The average weights used for the 2025 preseason forecast were 4.6 lbs and 6.1 lbs, for 2-ocean and 3-ocean sockeye salmon respectively. **For the 2025 forecast of 54.1 million, we expect 37% 2-ocean and 63% 3-ocean sockeye salmon.**

To generate the forecast for inshore harvest we subtract two quantities from the overall preseason run size estimate: 1) estimated escapement to each river system; in most cases derived from the relationship between realized escapement and run size in prior years and considering current management and conservation goals, except for the Kvichak and Alagnak rivers where we assume a harvest rate of approximately 50%, and 2) an estimate of the 2025 South Peninsula harvest (1 million) from the predicted total run. We estimate the South Peninsula harvest for the coming season by averaging sockeye salmon harvest from June South Unimak and Shumagin Islands for the most recent 10 years, excluding 2021 and 2022 which both had Bristol Bay run sizes exceeding 70 million sockeye salmon.

Harvest predictions for 2025 are provided in tables 1 and 2 (below). This harvest estimate depends on realized escapement in 2025 equaling the assumed values in Table 1, and industry's ability and opportunity to harvest all surplus fish. To determine the harvest in pounds for each age group we multiply the forecasted catch in numbers by the average weight of 2- or 3-ocean sockeye salmon observed for Bristol Bay sockeye run sizes most similar to our 2025 forecast. Over the recent 20-year period the average range of weight for 2-ocean sockeye salmon is 4.0-5.1 lbs and 5.5-7.1 lbs for 3-ocean sockeye salmon, with average weight-at-age showing a negative relationship with total Bristol Bay run size among years (i.e. lower weight-at-age in years with larger run sizes).

Methods

The 2025 preseason forecast is based on historical catch, escapement, age composition, and genetic composition of catch data collected by the Alaska Department of Fish and Game (ADF&G), and annual stock and age-specific run sizes reconstructed (1963-present) using methods described in Cunningham et al. (2018). The overall UW-FRI Bristol Bay forecast is comprised of 38 individual stock by age class forecasts. The majority of these 2025 stock-age forecasts were generated from models informed by prior returns of "siblings" or younger ocean age-classes from the same stock and brood year, but returning in previous years (e.g. predicting 2025 Nushagak River 1.3's based on the 2024 abundance of Nushagak River 1.2's). The return abundance of younger age classes is informative because individuals from the same cohort experience the same environmental conditions as juveniles in freshwater and at ocean entry as the age class being forecasted, and likely exhibit similar patterns in survival.

Rather than simply choosing the best sibling relationship for each age and river, for all forecasts based on sibling abundance data, we use a technique that weights the forecasts from models with different combinations of predictor sibling age classes according to how well each has performed in the past. While the best sibling relationship carries the most weight in our forecasts for each stock-age group, retrospective analysis indicates that there is useful information conveyed by other models (i.e. sibling models that include alternative age classes and different combinations thereof), and that this information improves forecast accuracy.

In recent years we have increasingly relied on Dynamic Linear Models (DLM) to generate sibling-based forecasts based on their superior performance. DLM sibling models allow both the intercept (average production of the forecasted stock-age group) and coefficients describing the relationship between younger and older sibling age classes, to evolve over time. As such, DLMs are more robust to environmentally-driven variation in average marine survival and changes in the likelihood that salmon return after 1, 2, or 3 years at sea (i.e., the maturation schedule). DLMs were used for 61% of stock-age group forecasts (Kvichak 1.3, 2.2 & 2.3; Alagnak 1.2 & 2.3; Naknek 1.3 & 2.3; Egegik 1.2. 1.3, 2.2 & 2.3; Ugashik 1.2. 1.3, 2.2 & 2.3; Wood 1.2 & 1.3; Nushagak 1.3; Igushik 1.2, 1.3 & 2.2; Togiak 1.3 & 2.3). Additionally, ensemble models that average the range of forecasts generated by all model types under the assumption that multiple models provide predictive information, were explored for each stock-age combination in the 2025 forecast and used in two instances (Nushagak 2.2 & 2.3).

In addition to sibling or cohort regression models based on prior returns within a single river system, forecast models based on several classes of machine learning methods were also used. Retrospective analysis indicates machine learning models informed by Bristol Bay sockeye salmon return numbers across many different age classes and river systems together, combined with information on environmental conditions such as sea-surface temperature and abundance of

other salmon species during a cohort's ocean phase, can improve preseason forecast accuracy at the river system and age-group levels. For the 2025 preseason forecast, 21% of stock-age group forecasts (Alagnak 1.3 & 2.2; Naknek 1.2 & 2.2; Igushik 2.3; Wood 2.2; Nushagak 1.2; Togiak 1.2) were produced using machine learning methods.

Preseason vs Preliminary Forecast

In August of 2023 UW-FRI began the release of a Bristol Bay sockeye forecast, referred to as the "UW-FRI Preliminary Forecast". We continued with the preliminary forecast for 2025 releasing it on August 15, 2024 almost 3 months prior to our formal preseason forecast for Bristol Bay. The preliminary forecast uses catch and escapement numbers from the last ADF&G Bristol Bay 'Daily' release and the last ADF&G inseason age composition report, to generate an aggregate forecast for Bristol Bay sockeye. These two sources of inseason information provided by ADF&G allow us to produce a preliminary forecast several months prior to the formal preseason forecast (described here), which is typically released each year in the first or second week of November. A twenty-year retrospective analysis of the total run forecasts generated from these two methods show a mean absolute percent error of 15.1% for formal preseason forecasts (this document) and 19.3% for preliminary forecasts (released in August). Although the difference in percent error between forecasts methods is reasonably small, the preliminary methodology only allows for an aggregate (i.e. total run) forecast for Bristol Bay as a whole to be generated.

For 2025, our preliminary (August) forecast was 49.6 million sockeye salmon for Bristol Bay, while our formal preseason forecast sums to 54.1 million across stock-age groups. Most of the 8% difference between these two forecasts is in the 3-ocean age classes.

References

Cunningham, C. J., T. A. Branch, T. H. Dann, M. Smith, J. E. Seeb, L. W. Seeb, and R. Hilborn. 2018. A general model for salmon run reconstruction that accounts for interception and differences in availability to harvest. Canadian Journal of Fisheries and Aquatic Sciences **75**:439-451.

Table 1. 2025 pre-season forecast of the number of sockeye salmon in millions returning to Bristol Bay, Alaska by river system and age class.

		AGES						Estimated	Inshore	
DISTRICT	RIVER	**1.2**	**1.3**	**2.2**	**2.3**	TOTAL	ESCAPEMENT	S. PEN CATCH	HARVEST	
Naknek\Kvichak		**4.56**	**11.00**	**1.03**	**0.84**	**17.43**	**7.91**	**0.32**	**9.22**	
	Kvichak	1.89	6.44	0.46	0.23	9.02	4.40	0.17	4.46	
	Naknek	1.03	1.80	0.33	0.35	3.51	1.10	0.06	2.35	
	Alagnak[a]	1.64	2.76	0.24	0.26	4.90	2.41	0.09	2.41	
Egegik		**1.06**	**2.65**	**1.41**	**0.63**	**5.75**	**1.10**	**0.11**	**4.54**	**millions of fish**
Ugashik		**1.68**	**4.56**	**0.48**	**0.57**	**7.29**	**1.18**	**0.13**	**5.97**	
Nushagak		**9.01**	**12.93**	**0.35**	**0.09**	**22.43**	**4.84**	**0.41**	**17.18**	
	Wood	5.45	3.06	0.27	0.05	8.84	2.50	0.16	6.18	
	Nushagak[b]	2.63	8.02	0.07	0.03	10.78	2.00	0.20	8.58	
	Igushik	0.93	1.85	0.01	0.01	2.81	0.34	0.05	2.42	
Togiak		**0.26**	**0.89**	**0.01**	**0.01**	**1.17**	**0.23**	**0.03**	**0.90**	
Totals[c]		**16.57**	**32.03**	**3.28**	**2.14**	**54.07**	**15.26**	**1.00**	**37.81**	

[a]The spawning goal for the Alagnak River was set by ADFG as the estimated escapement based on exploiting the return of sockeye to the Alagnak at the same rate as the return to the Kvichak

[b]The Nushagak River total forecast includes 39,708 age 0.3 and age 1.4 sockeye

[c]The 'Totals' catergory cannot be summed horizontally because the Nushagak 1.4's and 0.3's are not included in the 'Ages' part of the table.

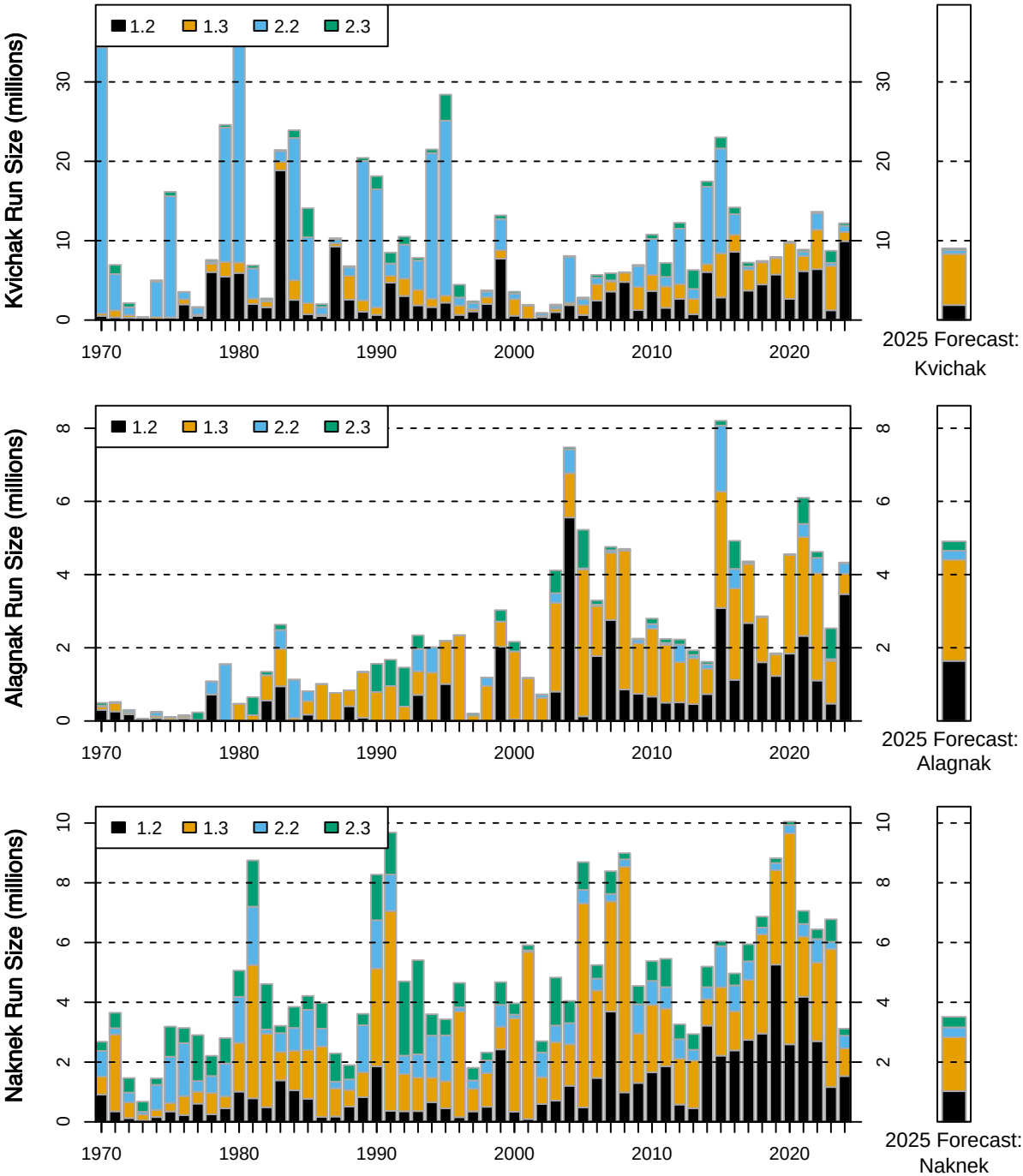
Table 2. 2025 pre-season Bristol Bay sockeye harvest forecast in millions of pounds by fishing district and age class.

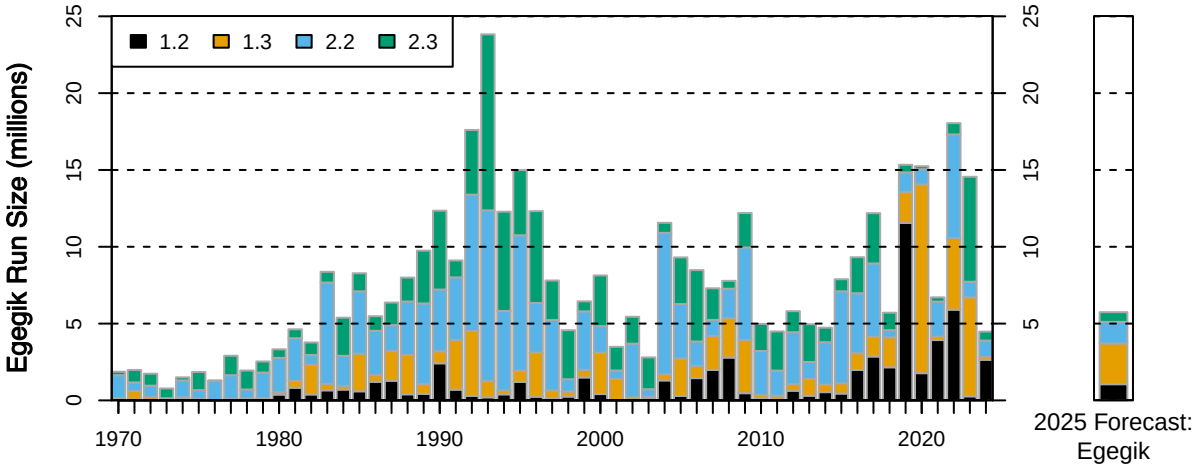
					Inshore Harvest	
DISTRICT	1.2	1.3	2.2	2.3	lbs (millions)	no. of fish (millions)
Naknek\Kvichak	11.17	35.03	2.64	2.90	**51.74**	9.22
Egegik	3.84	12.77	5.11	3.03	**24.75**	4.54
Ugashik	6.32	22.78	1.79	2.87	**33.76**	5.97
Nushagak	30.83	61.72	1.17	0.40	**94.12**	17.18
Togiak	0.94	4.25	0.01	0.04	**5.24**	0.90
Totals	**53.10**	**136.55**	**10.72**	**9.24**	**209.61**	**37.81**

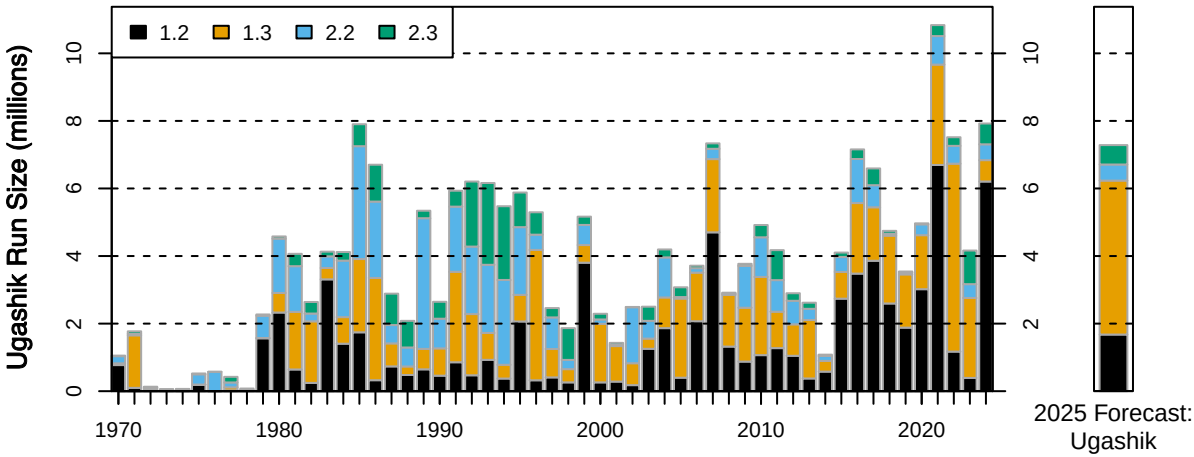
Table 3. 2025 and 2024 preseason forecast of the number of sockeye salmon in millions returning to Bristol Bay, Alaska by river system, and actual returns of sockeye salmon in millions by river system 2014-2024.

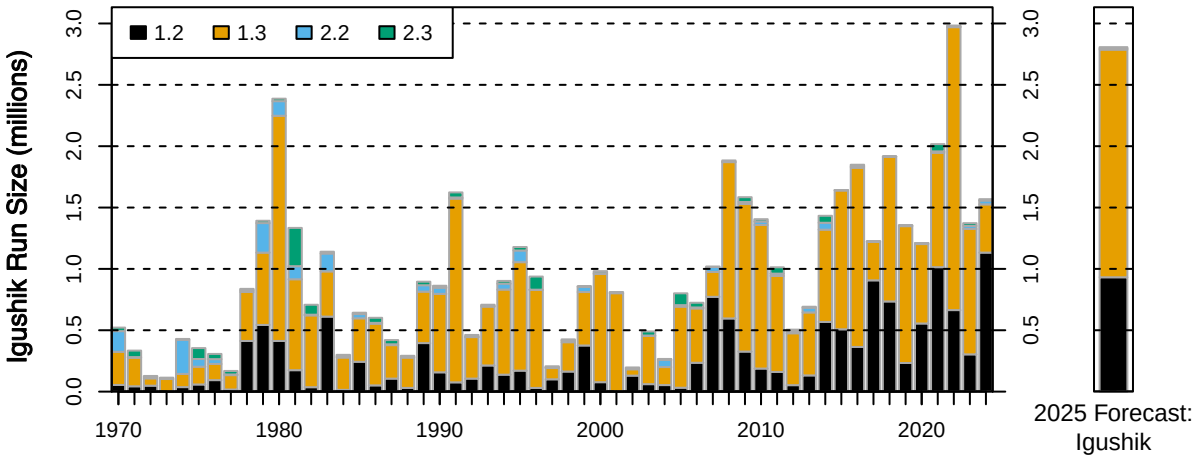
			ACTUAL RETURNS										
RIVER	2025 Forecast	2024 Forecast (last year's)	2024	2023	2022	2021	2020	2019	2018	2017	2016	2015	2014
Kvichak	**9.02**	**8.19**	**12.21**	8.76	13.69	8.89	9.87	7.94	7.47	7.25	14.20	23.10	17.6
Naknek	**3.51**	**6.22**	**3.16**	6.90	6.48	7.10	10.10	8.82	6.93	5.98	5.04	6.09	5.32
Alagnak	**4.9**	**2.31**	**4.33**	2.54	4.66	6.07	4.56	1.86	2.87	4.43	4.94	8.24	1.62
Egegik	**5.75**	**5.52**	**4.63**	14.81	18.22	7.73	15.60	15.43	6.10	12.44	9.89	8.51	5.08
Ugashik	**7.29**	**8.23**	**7.96**	4.38	7.56	10.66	5.08	3.6	4.77	6.67	7.19	4.25	1.15
Wood	**8.84**	**9.11**	**12.27**	10.42	12.45	12.67	8.00	12.34	22.68	11.29	6.38	5.02	7.17
Nushagak	**10.78**	**3.03**	**5.63**	5.45	16.39	15.07	3.63	4.31	9.60	8.20	2.58	2.48	1.51
Igushik	**2.81**	**1.20**	**1.57**	1.38	3.00	2.02	1.21	1.36	1.92	1.23	1.85	1.64	1.44
Togiak	**1.17**	**1.04**	**0.92**	0.72	0.83	0.96	0.62	1.29	1.36	0.67	0.74	0.53	0.53
TOTALS	**54.07**	**44.85**	**52.68**	**55.36**	**83.28**	**71.17**	**58.67**	**56.95**	**63.70**	**58.16**	**52.81**	**59.86**	**41.42**

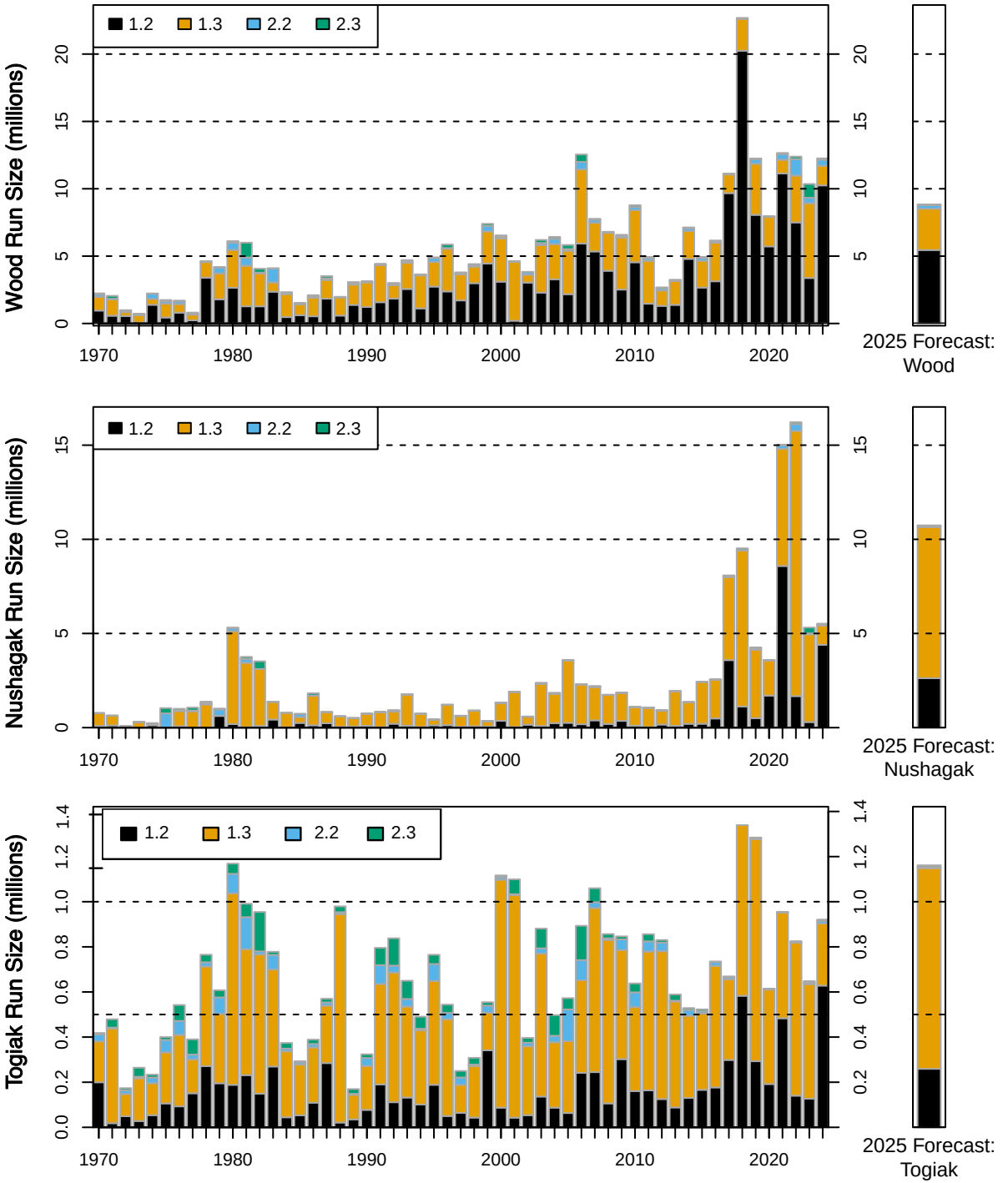
Figure 1. Stock-specific comparison of the 2025 preseason forecast by age class (right panel) with observed run size by age class 1970 - 2024 (left panel).




1.2
1.3
2.2
2.3
Egegik Run Size (millions)
0
5
10
15
20
25
1970
1980
1990
2000
2010
2020
2025 Forecast:
Egegik


1.2
1.3
2.2
2.3
Ugashik Run Size (millions)
0
2
4
6
8
10
1970
1980
1990
2000
2010
2020
2025 Forecast:
Ugashik


1.2
1.3
2.2
2.3
Igushik Run Size (millions)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
1970
1980
1990
2000
2010
2020
2025 Forecast:
Igushik
Return Year


Wood Run Size (millions)
1.2
1.3
2.2
2.3
0
5
10
15
20
1970
1980
1990
2000
2010
2020
2025 Forecast:
Wood
Nushagak Run Size (millions)
1.2
1.3
2.2
2.3
0
5
10
15
1970
1980
1990
2000
2010
2020
2025 Forecast:
Nushagak
Togiak Run Size (millions)
1.2
1.3
2.2
2.3
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1970
1980
1990
2000
2010
2020
2025 Forecast:
Togiak
Return Year