2026 SEAK Pink Salmon Forecast

Sara Miller

Objective

To forecast the Southeast Alaska (SEAK) pink salmon commercial harvest in 2026. This document is for guidance as to what was done for the current forecast year. It is for internal use only.

Executive Summary

Forecasts were developed using an approach originally described in Wertheimer et al. (2006), and modified in Orsi et al. (2016) and Murphy et al. (2019), but assuming a log-normal error structure (Miller et al. 2022). This approach is based on a multiple linear regression model with either; 1) the raw juvenile pink salmon catch-per-unit-effort (adj_raw_pink; a proxy for abundance) or 2) the vessel-adjusted CPUE (a proxy for abundance) adjusted by the pooled-species vessel calibration coefficient for the Cobb. Additional variables included a vessel factor to account for the survey vessels through time, an odd and even year factor to account for potential odd and even year cycles of abundance, and temperature data from the Southeast Alaska Coastal Monitoring Survey (SECM; Piston et al. 2021; ISTI20_JJ) or from satellite sea surface temperature (SST) data (Huang et al. 2017). The adj_raw_pink variable is defined as the natural logarithm of the maximum untransformed catch, adjusted to a 20 minute haul, from either June or July. The Stellar and Chellissa vessels were only used for one year each, 2008 and 2009, respectively, and so these two years are not used in the assessment (Table 1). The vessel-adjusted CPUE variable is defined as the CPUE, adjusted by the pooled-species vessel calibration coefficient for the Cobb and was then the maximum average from either June or July (whichever was higher). As there was not a SECM survey in May, temperature data from May was unavailable. Therefore, the temperature variable from the SECM survey and used in the model (ISTI20_JJ) was the average from June and July. In prior forecasting years, the ISTI variable was the average from May through July.

There were 36 individual models considered:

- adj_raw_pink model with a vessel interaction, an odd/even year factor, and a vessel factor (m1);
- adj_raw_pink model with a vessel interaction, an odd/even year factor, a vessel factor, and temperature data from the the SECM survey (m2);
- 16 adj_raw_pink models with a vessel interaction, an odd/even year factor, a vessel factor, and satellite SST data (m3-m18);
- vessel-adjusted CPUE, and an odd/even year factor (m1a);
- vessel-adjusted CPUE, an odd/even year factor, and temperature data from the the SECM survey (m2a);
- 16 vessel-adjusted CPUE models with an odd/even year factor, and satellite SST data (m3a-m18a);

The model performance metric one-step ahead mean absolute percent error (MAPE) for the last five years (MAPE5; forecast years 2021 through 2025) was used to evaluate the forecast accuracy of the 36 individual models, the AICc values were calculated for each model to prevent over-parameterization of the model, and the adjusted R-squared values, significant terms, and overall p-value of the model were used to the determine fit. Based upon the performance metric the 5-year MAPE, the AICc values, significant parameters in the models, and the adjusted R-squared values, model xx (a model that included xx; Appendix B) was the best performing model and the 2026-forecast using this model has a point estimate of xx million fish (80% prediction interval: xx to xx million fish).

Analysis

Individual, multiple linear regression models

Biophysical variables based on data from Southeast Alaska were used to forecast the harvest of adult pink salmon in Southeast Alaska, one year in advance, using individual, multiple linear regression models with two main structures (models m1-m18 and models m1a–m18a). The first model structure, model m1, consisted of the predictor variable juvenile adj_raw_pink (CPUE) with a vessel factor interaction, an odd/even year factor, and a vessel factor (model m1),

$$E(Y) = \beta_0 + \beta_1 X_{V1} + \beta_2 X_{V2} + \beta_3 X_O + \beta_4 CPUE + \beta_5 (X_{V1} \times CPUE) + \beta_6 (X_{V2} \times CPUE)) + \epsilon.$$

The reference category is an even year with the survey vessel Cobb. The vessel factor and even/odd year factor adjust the intercept, and the vessel interaction terms adjust the model slope. For example, during even years when the survey vessel is the Cobb, the model simplifies to $E(Y) = \beta_0 + \beta_4 CPUE + \epsilon$. Although the simplest model does not contain a temperature variable, including temperature data with CPUE has been shown to result in a substantial improvement in the accuracy of model predictions (Murphy et al. 2019). The temperature index for models m2-m18 was either the SECM survey Icy Strait temperature Index (ISTI20_JJ; Murphy et al. 2019) or one of the 16 satellite-derived SST data (Huang et al. 2017).

The second model structure, model m1a, consisted of the predictor variable vessel-adjusted CPUE ($CPUE_{adj}$), and an odd/even year factor,

$$E(Y) = \beta_0 + \beta_2 X_O + \beta_3 (CPUE_{adj}) + \epsilon.$$

The reference category (i.e., reference intercept) is an even year. The temperature index for models m2a-m18a was either the SECM survey Icy Strait temperature Index (ISTI20_JJ; Murphy et al. 2019) or one of the 16 satellite-derived SST data (Huang et al. 2017).

The response variable (Y; Southeast Alaska adult pink salmon harvest in millions), the adj_raw_pink, and the vessel-adjusted CPUE were log transformed in the model, but temperature data were not. The forecast ($\hat{Y}_i$), and 80% prediction intervals (based on output from program R; R Core Team 2023) from the 36 regression models were exponentiated and bias-corrected (Miller 1984),

$$\hat{F}_i = \exp(\hat{Y}_i + \frac{{\sigma_i}^2}{2}), \tag{2}$$

where $\hat{F}_i$ is the preseason forecast (for each model i) in millions of fish, and σ_i is the variance (for each model i).

Performance metric: One-step ahead MAPE

The model summary results using the performance metric one-step ahead MAPE are shown in Table 2; the smallest value is the preferred model (Appendix C). The performance metric one-step ahead MAPE was calculated as follows.

1. Estimate the regression parameters at time t-1 from data up to time t-1.
2. Make a prediction of $\hat{Y}_t$ at time t based on the predictor variables at time t and the estimate of the regression parameters at time t-1 (i.e., the fitted regression equation).
3. Calculate the MAPE based on the prediction of $\hat{Y}_t$ at time t and the observed value of Y_t at time t,

$$\text{MAPE} = |\frac{exp(Y_t) - exp(\hat{Y}_t + \frac{{\sigma_t}^2}{2})}{exp(Y_t)}|. \tag{3}$$

4. For each individual model, average the MAPEs calculated from the forecasts,

$$\frac{1}{n}\sum_{t=1}^{n}|\frac{exp(Y_t) - exp(\hat{Y}_t + \frac{{\sigma_t}^2}{2})}{exp(Y_t)}|, \tag{4}$$

where n is the number of forecasts in the average (5 forecasts for the 5-year MAPE and 10 forecasts for the 10-year MAPE). For example, to calculate the five year one-step-ahead MAPE for model m1 for the 2022 forecast, use data up through year 2016 (e.g., data up through year 2016 is t -1 and the forecast is for t, or year 2017). Then, calculate a MAPE based on the 2017 forecast and the observed pink salmon harvest in 2017 using equation 3. Next, use data up through year 2017 (e.g., data up through year 2017 is t -1 and the forecast is for year 2018; t) and calculate a MAPE based on the 2018 forecast and the observed pink salmon harvest in 2018 using equation 3. Repeat this process for each subsequent year through year 2020 to forecast 2021. Finally, average the five MAPEs to calculate a five year one-step-ahead MAPE for model m1. As the results of the 5-year MAPEs with or without the forecast bias adjustment have been similar (i.e., the model performance order did not change whether the five year one-step-ahead MAPE or the bias-corrected five year one-step-ahead MAPE was compared), for simplicity, the bias adjustment for the forecast was not used in the calculation of the five year one-step-ahead MAPE for model comparison.

Akaike Information Criterion corrected for small sample sizes (AICc)

Hierarchical models were compared with the AICc criterion. The best fit models, according to the AICc criterion, is one that explains the greatest amount of variation with the fewest independent variables (i.e., the most parsimonious; Table 2). The lower AICc values are better, and the AICc criterion penalizes models that use more parameters. Comparing the AICc values of two hierarchical models, a $\Delta_i \leq 2$ suggests that the two models are essentially the same, and the most parsimonious model should be chosen (Burnham and Anderson 2004). If the $\Delta_i > 2$, the model with the lower AICc value should be chosen.

Results

Based upon the 5-year MAPE performance metric, the AICc values, significant parameters in the models, and the adjusted R-squared values, model xx (a model that included CPUE (i.e., adj_raw_pink) and the satellite SST variable from northern SEAK in May; Table 1 and Table 2; Appendix C) was the best performing model and the 2025-forecast using this model has a point estimate of xx million fish (80% prediction interval: xx to xx million fish).

Table 1: Summary of the data used for the 2026-forecast.

JYear	Year	Harvest	odd_even_factor	vessel	adj_raw_pink_log	CPUE
1997	1998	42.4	even	Cobb	5.33	2.48
1998	1999	77.8	odd	Cobb	7.14	5.62
1999	2000	20.2	even	Cobb	5.05	1.60
2000	2001	67.0	odd	Cobb	6.39	3.73
2001	2002	45.3	even	Cobb	5.50	2.87
2002	2003	52.5	odd	Cobb	6.11	2.78
2003	2004	45.3	even	Cobb	5.32	3.08
2004	2005	59.1	odd	Cobb	6.80	3.90
2005	2006	11.6	even	Cobb	5.06	2.04
2006	2007	44.8	odd	Cobb	6.14	2.57
2007	2008	15.9	even	Cobb	3.85	1.17
2008	2009	38.0	odd	NA	NA	2.32
2009	2010	24.1	even	NA	NA	2.33
2010	2011	58.9	odd	NW Explorer	9.43	4.11
2011	2012	21.3	even	NW Explorer	5.71	1.45
2012	2013	94.7	odd	NW Explorer	8.52	3.52
2013	2014	37.2	even	NW Explorer	6.80	2.14
2014	2015	35.1	odd	NW Explorer	7.67	3.82
2015	2016	18.4	even	NW Explorer	6.72	2.45
2016	2017	34.7	odd	NW Explorer	7.94	4.35
2017	2018	8.1	even	NW Explorer	3.56	0.35
2018	2019	21.1	odd	Medeia	3.93	1.17
2019	2020	8.1	even	Medeia	5.32	1.14
2020	2021	48.5	odd	Medeia	4.41	2.15
2021	2022	18.3	even	Medeia	4.46	0.87
2022	2023	47.8	odd	Medeia	4.33	1.45
2023	2024	20.1	even	Medeia	3.40	1.19
2024	2025	20.1	odd	Medeia	3.85	1.66
2025	2026	NA	even	Medeia	5.02	1.29

Table 2: Summary of the performance metrics for the 36 regression models.

Terms	Model	Fit	Fit_LPI	Fit_UPI	AdjR2	AICc	MAPE5
ISTI20_JJ	m2a	22.5	13.6	37.3	0.69	31.1	29.2
Chatham_SST_AMJ	m5a	19.0	12.4	29.0	0.77	22.4	32.1
NSEAK_SST_AMJ	m13a	19.3	12.5	29.7	0.76	23.3	32.5
Icy_Strait_SST_AMJ	m9a	20.0	13.0	30.9	0.76	23.4	33.9
SEAK_SST_AMJ	m17a	18.4	11.8	28.7	0.75	24.8	34.1
NSEAK_SST_May	m11a	18.9	12.4	28.9	0.77	22.2	34.7
Chatham_SST_May	m3a	18.4	12.1	28.0	0.78	21.6	35.1
SEAK_SST_May	m15a	18.8	12.1	29.0	0.76	24.0	36.1
NSEAK_SST_AMJJ	m14a	20.1	12.6	32.0	0.72	27.6	36.1
Icy_Strait_SST_May	m7a	18.5	12.1	28.2	0.77	22.4	36.7
Icy_Strait_SST_AMJJ	m10a	21.5	13.4	34.4	0.72	27.7	36.8
Chatham_SST_AMJJ	m6a	20.0	12.5	31.7	0.73	27.2	36.9
SEAK_SST_AMJJ	m18a	18.9	11.8	30.4	0.71	28.4	37.3
NSEAK_SST_MJJ	m12a	21.1	12.9	34.5	0.69	30.4	40.3
SEAK_SST_MJJ	m16a	20.0	12.2	32.8	0.69	30.8	41.1
Icy_Strait_SST_MJJ	m8a	22.7	13.8	37.5	0.69	30.6	41.9
Chatham_SST_MJJ	m4a	21.1	12.8	34.6	0.69	30.8	42.7
no temperature index included	m1a	19.2	11.1	33.4	0.61	35.1	47.7
Icy_Strait_SST_May	m7	18.0	9.6	33.7	0.66	44.2	56.1
Chatham_SST_May	m3	18.2	9.7	34.0	0.67	43.9	58.9
NSEAK_SST_May	m11	19.2	10.2	36.2	0.67	43.9	59.6
ISTI20_JJ	m2	22.2	11.2	44.3	0.64	45.9	60.8
NSEAK_SST_AMJ	m13	20.7	11.0	39.1	0.68	43.3	60.8
Chatham_SST_AMJ	m5	19.4	10.4	36.1	0.68	43.2	61.2
Icy_Strait_SST_AMJ	m9	20.3	10.7	38.5	0.67	43.9	61.3
SEAK_SST_May	m15	19.1	10.1	36.1	0.66	44.4	62.7
NSEAK_SST_AMJJ	m14	21.8	11.2	42.3	0.66	44.9	62.9
Chatham_SST_AMJJ	m6	20.3	10.6	39.2	0.65	45.0	63.3
SEAK_SST_AMJ	m17	19.9	10.6	37.6	0.67	43.7	63.7
SEAK_SST_AMJJ	m18	20.7	10.8	39.9	0.66	44.8	63.9
no temperature index included	m1	16.0	8.0	31.7	0.59	45.8	64.0
Icy_Strait_SST_AMJJ	m10	21.7	11.1	42.6	0.65	45.4	64.6
SEAK_SST_MJJ	m16	21.0	10.6	41.6	0.64	46.3	67.1
Chatham_SST_MJJ	m4	20.2	10.2	40.3	0.63	46.9	67.2
NSEAK_SST_MJJ	m12	21.9	10.9	44.1	0.63	46.5	67.3
Icy_Strait_SST_MJJ	m8	21.5	10.7	43.5	0.63	46.9	68.3

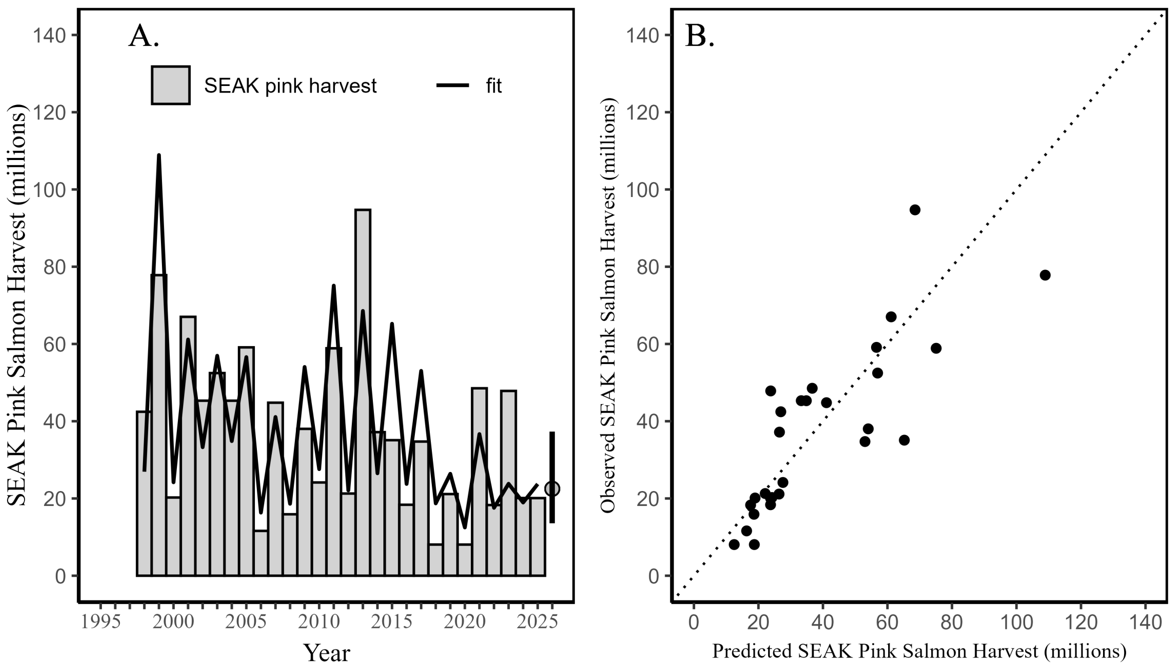

Figure 1: A. SEAK pink salmon harvest (millions) by year with the model fit (line) based upon the best performing model (model m2a). The predicted 2026 forecast (22.5 million fish) is symbolized as a grey circle with an 80% prediction interval (13.6 to 37.3 million fish). B. SEAK pink salmon harvest (millions) against the fitted values from model m2a by year. The dotted line is a one to one reference line.

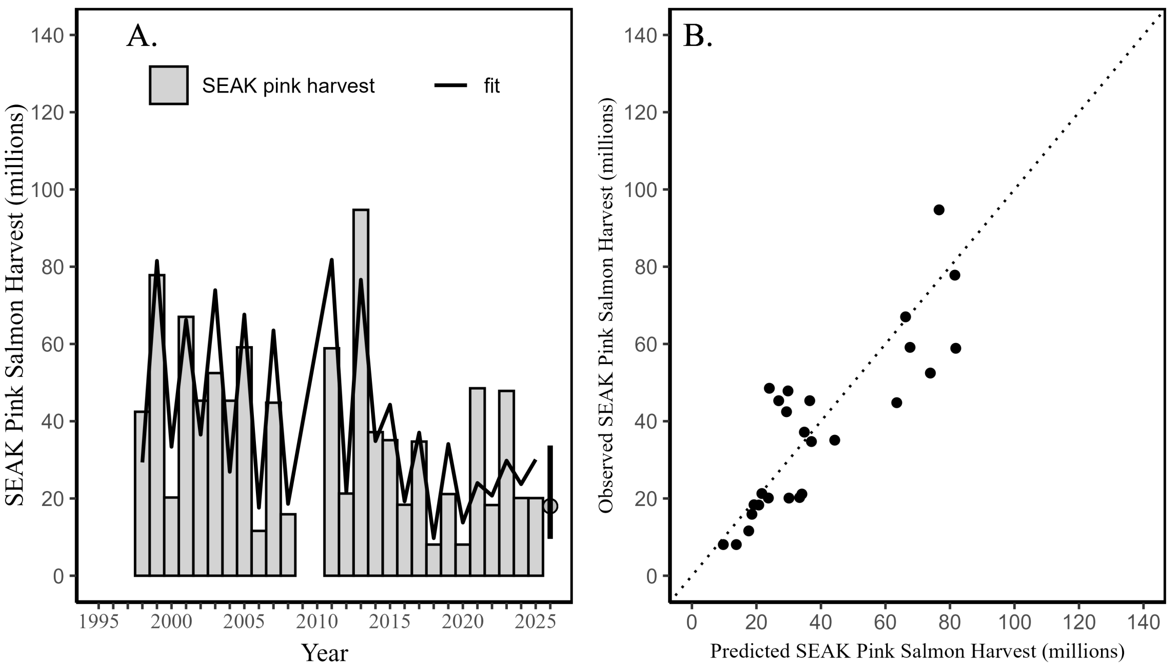

Figure 2: A. SEAK pink salmon harvest (millions) by year with the model fit (line) based upon the best performing model (model m2a). The predicted 2026 forecast (18.0 million fish) is symbolized as a grey circle with an 80% prediction interval (9.6 to 33.7 million fish). B. SEAK pink salmon harvest (millions) against the fitted values from model m7 by year. The dotted line is a one to one reference line.

References

Burnham, K. P., and D. R. Anderson (1998) Model Selection and Inference. Springer, New York. 353 pp.

Burnham, K. P., and D. R. Anderson (2004) Multimodel inference: Understanding AIC and BIC in model selection. Sociological Methods & Research, Vol. 33(2): 261-304.

Cook, R. D. (1977) Detection of influential observations in linear regression. Technometrics 19: 15-18.

Fox, J. and S. Weisburg (2019) An R Companion to Applied Regression, Third Edition. Thousand Oaks CA: Sage Publications, Inc.

Heinl, S. C., and A. W. Piston (2009) Standardizing and automating the Southeast Alaska pink salmon escapement index. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 1J09-06, Douglas.

Huang, B., P. W. Thorne, V. F. Banzon, T. Boyer, G. Chepurin, J. H. Lawrimore, M. J. Menne, T. M. Smith, R. S. Vose, and H. M. Zhang (2017) Extended reconstructed sea surface temperature, version 5 (ERSSTv5): upgrades, validations, and intercomparisons. Journal of Climate 30:8179–8205.

Miller, D. M. (1984) Reducing transformation bias in curve fitting. The American Statistician 38: 124-126.

Miller, S. E., J. M. Murphy, S. C. Heinl, A. W. Piston, E. A. Fergusson, R. E. Brenner, W. W. Strasburger, and J. H. Moss (2022) Southeast Alaska pink salmon forecasting models. Alaska Department of Fish and Game, Fishery Manuscript No. 22-03, Anchorage.

Murphy, J. M., E. A. Fergusson, A. Piston, A. Gray, and E. Farley (2019) Southeast Alaska pink salmon growth and harvest forecast models. North Pacific Anadromous Fish Commission Technical Report No. 15: 75-81.

Orsi, J. A., E. A. Fergusson, A. C. Wertheimer, E. V. Farley, and P. R. Mundy (2016) Forecasting pink salmon production in Southeast Alaska using ecosystem indicators in times of climate change. N. Pac. Anadr. Fish Comm. Bull. 6: 483–499. (Available at https://npafc.org)

Piston, A. W., and S. C. Heinl (2020) Pink salmon stock status and escapement goals in Southeast Alaska through 2019. Alaska Department of Fish and Game, Special Publication No. 20-09, Anchorage

Piston, A. W., J. Murphy, J. Moss, W. Strasburger, S. C. Heinl, E. Fergusson, S. Miller, A. Gray, and C. Waters (2021) Operational Plan: Southeast coastal monitoring, 2021. ADF&G, Regional Operational Plan No. ROP.CF.1J.2021.02, Douglas.

R Core Team (2023) R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL: http://www.r-project.org/index.html

Ren, Y. Y., L. C. Zhou, L. Yang, P. Y. Liu, B. W. Zhao and H. X. Liu (2016) Predicting the aquatic toxicity mode of action using logistic regression and linear discriminant analysis, SAR and QSAR in Environmental Research, DOI: 10.1080/1062936X.2016.1229691

Sturdevant, M.V., E.A. Fergusson, J.A. Orsi, and A.C. Wertheimer (2004) Diel feeding and gastric evacuation of juvenile pink and chum salmon in Icy Strait, Southeastern Alaska, May-September 2001. NPAFC Tech. Rep. 5. (Available at http://www.npafc.org).

Trenberth, K. E., and J. W. Hurrell (1994) Decadal atmosphere-ocean variations in the Pacific Climate Dynamics, Berlin 9(6):303-319.

Wertheimer A. C., J. A. Orsi, M. V. Sturdevant, and E. A. Fergusson (2006) Forecasting pink salmon harvest in Southeast Alaska from juvenile salmon abundance and associated environmental parameters. In Proceedings of the 22nd Northeast Pacific Pink and Chum Workshop. Edited by H. Geiger (Rapporteur). Pac. Salmon Comm. Vancouver, British Columbia. pp. 65–72.

Wertheimer, A. C., J. A. Orsi, and E. A. Fergusson (2015) Forecasting pink salmon harvest in southeast Alaska from juvenile salmon abundance and associated biophysical parameters: 2014 returns and 2015 forecast. NPAFC Doc. 1618. 26 pp. National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), Alaska Fisheries Science Center, Auke Bay Laboratories, Ted Stevens Marine Research Institute (Available at http://www.npafc.org).

Wertheimer, A. C., J. A. Orsi, E. A. Fergusson, and J.M. Murphy (2018) Forecasting pink salmon harvest in Southeast Alaska from juvenile salmon abundance and associated biophysical parameters: 2016 returns and 2017 forecast. NPAFC Doc. 1772. 25 pp. National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), Alaska Fisheries Science Center, Auke Bay Laboratories, Ted Stevens Marine Research Institute (Available at http://www.npafc.org).

Zhang, Z. (2016) Residuals and regression diagnostics: focusing on logistic regression. Annals of Translational Medicine 4: 195.

Appendix A

Variable definitions

adj_raw_pink: First, the raw untransformed catch by year, month, haul, and area was adjusted to a 20 minute haul (raw_pink_catch). Then, these values were log-transformed (i.e., ln(raw_pink_catch + 1). Next, the maximum value in either June or July, whichever month had the highest in a given year, was used as the adj_raw_pink value for the year. Note: the adj_raw_pink value data was not adjusted using vessel calibration factors. This value was used as the 'CPUE' value in the 2025 forecast (i.e., adj_raw_pink = maximum(ln(raw_pink_catch + 1)) in either June or July).

CPUE: The average Ln(CPUE+1) for catches in either June or July, whichever month had the highest average in a given year, where effort was a standard trawl haul. The CPUE data was adjusted using vessel calibration factors to account for differences in fishing power among vessels. The last time the CPUE variable was incorporated in the forecasting process was the 2024 forecast.

ISTI20_JJ: The average 20-m integrated water column temperature at the eight stations in Icy Strait (Icy Strait and Upper Chatham transects) sampled during the SECM surveys in June, and July of each year (in degrees Celsius). The last time the ISTI variable was incorporated in the forecasting process was the 2023 forecast. This year there was no survey in May. Therefore, this temperature index no longer includes May in the average.

Satellite SST variables

Icy_Strait_SST_May: The Icy Strait region encompasses waters of Icy Strait from the east end of Lemesurier Island to a line from Point Couverden south to Point Augusta. This variable is the average SST in May. The last time this variable was incorporated in the forecasting process was the 2023 forecast.

Icy_Strait_SST_MJJ: The Icy Strait region encompasses waters of Icy Strait from the east end of Lemesurier Island to a line from Point Couverden south to Point Augusta. This variable is the average SST in May through July. The last time this variable was incorporated in the forecasting process was the 2023 forecast.

Icy_Strait_SST_AMJ: The Icy Strait region encompasses waters of Icy Strait from the east end of Lemesurier Island to a line from Point Couverden south to Point Augusta. This variable is the average SST in April through June. The last time this variable was incorporated in the forecasting process was the 2023 forecast.

Icy_Strait_SST_AMJJ: The Icy Strait region encompasses waters of Icy Strait from the east end of Lemesurier Island to a line from Point Couverden south to Point Augusta. This variable is the average SST in April through July. The last time this variable was incorporated in the forecasting process was the 2023 forecast.

Chatham_SST_May: The Chatham and Icy Straits region encompasses waters of Chatham and Icy Straits east of Lemesurier Island to Point Couverden, and south to the approximate latitude of 56.025 degrees north (roughly Cape Decision off Kuiu Island). This variable is the average SST in May. The last time this variable was incorporated in the forecasting process was the 2023 forecast.

Chatham_SST_MJJ: The Chatham and Icy Straits region encompasses waters of Chatham and Icy Straits east of Lemesurier Island to Point Couverden, south to the approximate latitude of 56.025 degrees north (roughly Cape Decision off Kuiu Island). This variable is the average SST in May through July. The last time this variable was incorporated in the forecasting process was the 2023 forecast.

Chatham_SST_AMJ: The Chatham and Icy Straits region encompasses waters of Chatham and Icy Straits east of Lemesurier Island to Point Couverden, south to the approximate latitude of 56.025 degrees north (roughly Cape Decision off Kuiu Island). This variable is the average SST in April through June. The last time this variable was incorporated in the forecasting process was the 2023 forecast.

Chatham_SST_AMJJ: The Chatham and Icy Straits region encompasses waters of Chatham and Icy Straits east of Lemesurier Island to Point Couverden, south to the approximate latitude of 56.025 degrees north (roughly Cape Decision off Kuiu Island). This variable is the average SST in April through July. The last time this variable was incorporated in the forecasting process was the 2023 forecast.

NSEAK_SST_May: The NSEAK region encompasses northern Southeast Alaska from 59.475 to 56.075 degrees north latitude (approximately Districts 9 through 15, and District 13 inside area only; northern Southeast Inside subregion for Southeast Alaska (NSEI)). This variable is the average SST in May. The last time this variable was incorporated in the forecasting process was the 2023 forecast.

NSEAK_SST_MJJ: The NSEAK region encompasses northern Southeast Alaska from 59.475 to 56.075 degrees north latitude (approximately Districts 9 through 15, and District 13 inside area only; northern Southeast Inside subregion for Southeast Alaska (NSEI)). This variable is the average SST in May through July. The last time this variable was incorporated in the forecasting process was the 2023 forecast.

NSEAK_SST_AMJ: The NSEAK region encompasses northern Southeast Alaska from 59.475 to 56.075 degrees north latitude (approximately Districts 9 through 15, and District 13 inside area only; northern Southeast Inside subregion for Southeast Alaska (NSEI)). This variable is the average SST in April through June. The last time this variable was incorporated in the forecasting process was the 2023 forecast.

NSEAK_SST_AMJJ: The NSEAK region encompasses northern Southeast Alaska from 59.475 to 56.075 degrees north latitude (approximately Districts 9 through 15, and District

13 inside area only; northern Southeast Inside subregion for Southeast Alaska (NSEI)). This variable is the average SST in April through July. The last time this variable was incorporated in the forecasting process was the 2023 forecast.

SEAK_SST_May: The SEAK region encompasses Southeast Alaska from 59.475 to 54.725 degrees north latitude. This variable is the average SST in May. The last time this variable was incorporated in the forecasting process was the 2023 forecast.

SEAK_SST_MJJ: The SEAK region encompasses northern Southeast Alaska from 59.475 to 54.725 degrees north latitude. This variable is the average SST in May through July. The last time this variable was incorporated in the forecasting process was the 2023 forecast.

SEAK_SST_AMJ: The SEAK region encompasses Southeast Alaska from 59.475 to 54.725 degrees north latitude. This variable is the average SST in April through June. The last time this variable was incorporated in the forecasting process was the 2023 forecast.

SEAK_SST_AMJJ: The SEAK region encompasses Southeast Alaska from 59.475 to 54.725 degrees north latitude. This variable is the average SST in April through July. The last time this variable was incorporated in the forecasting process was the 2023 forecast.

Appendix B

Table 3: Parameter estimates for the 18 individual models for Models m1-m18.

Model	Term	Estimate	Standard Error	Statistic	p value
m1	(Intercept)	1.354	0.989	1.369	0.187
m1	as.factor(odd_even_factor)odd	0.372	0.239	1.556	0.136
m1	as.factor(vessel)Medeia	2.764	1.727	1.600	0.126
m1	as.factor(vessel)NW Explorer	-0.142	1.084	-0.131	0.897
m1	adj_raw_pink_log	0.371	0.183	2.025	0.057
m1	as.factor(vessel)Medeia:adj_raw_pink_log	-0.657	0.360	-1.825	0.084
m1	as.factor(vessel)NW Explorer:adj_raw_pink_log	-0.083	0.179	-0.464	0.648
m2	(Intercept)	4.360	1.843	2.365	0.029
m2	as.factor(odd_even_factor)odd	0.208	0.241	0.864	0.399
m2	as.factor(vessel)Medeia	2.626	1.623	1.619	0.123
m2	as.factor(vessel)NW Explorer	-0.353	1.024	-0.344	0.735
m2	ISTI20_JJ	-0.332	0.176	-1.888	0.075
m2	adj_raw_pink_log	0.443	0.176	2.518	0.022
m2	as.factor(vessel)Medeia:adj_raw_pink_log	-0.605	0.339	-1.782	0.092
m2	as.factor(vessel)NW Explorer:adj_raw_pink_log	-0.074	0.168	-0.439	0.666
m3	(Intercept)	3.388	1.257	2.694	0.015
m3	as.factor(odd_even_factor)odd	0.370	0.216	1.713	0.104
m3	as.factor(vessel)Medeia	2.624	1.561	1.681	0.110
m3	as.factor(vessel)NW Explorer	0.044	0.983	0.045	0.964
m3	Chatham_SST_May	-0.303	0.132	-2.299	0.034
m3	adj_raw_pink_log	0.405	0.166	2.440	0.025
m3	as.factor(vessel)Medeia:adj_raw_pink_log	-0.590	0.327	-1.805	0.088
m3	as.factor(vessel)NW Explorer:adj_raw_pink_log	-0.095	0.162	-0.591	0.562
m4	(Intercept)	3.858	1.785	2.161	0.044
m4	as.factor(odd_even_factor)odd	0.338	0.230	1.471	0.159
m4	as.factor(vessel)Medeia	2.666	1.654	1.612	0.124
m4	as.factor(vessel)NW Explorer	0.072	1.046	0.069	0.946
m4	Chatham_SST_MJJ	-0.282	0.170	-1.655	0.115
m4	adj_raw_pink_log	0.415	0.177	2.342	0.031
m4	as.factor(vessel)Medeia:adj_raw_pink_log	-0.599	0.347	-1.728	0.101
m4	as.factor(vessel)NW Explorer:adj_raw_pink_log	-0.114	0.172	-0.661	0.517
m5	(Intercept)	4.042	1.411	2.864	0.010
m5	as.factor(odd_even_factor)odd	0.349	0.213	1.634	0.120
m5	as.factor(vessel)Medeia	2.456	1.543	1.592	0.129
m5	as.factor(vessel)NW Explorer	0.113	0.971	0.116	0.909
m5	Chatham_SST_AMJ	-0.389	0.159	-2.439	0.025

Model	Term	Estimate	Standard Error	Statistic	p value
m5	adj__raw__pink__log	0.416	0.164	2.533	0.021
m5	as.factor(vessel)Medeia:adj__raw__pink__log	-0.548	0.324	-1.690	0.108
m5	as.factor(vessel)NW Explorer:adj__raw__pink__log	-0.108	0.160	-0.674	0.509
m6	(Intercept)	4.197	1.640	2.558	0.020
m6	as.factor(odd__even__factor)odd	0.333	0.221	1.502	0.151
m6	as.factor(vessel)Medeia	2.578	1.595	1.616	0.123
m6	as.factor(vessel)NW Explorer	0.143	1.009	0.141	0.889
m6	Chatham__SST__AMJJ	-0.364	0.175	-2.085	0.052
m6	adj__raw__pink__log	0.428	0.171	2.500	0.022
m6	as.factor(vessel)Medeia:adj__raw__pink__log	-0.572	0.335	-1.707	0.105
m6	as.factor(vessel)NW Explorer:adj__raw__pink__log	-0.123	0.166	-0.743	0.467
m7	(Intercept)	3.210	1.224	2.622	0.017
m7	as.factor(odd__even__factor)odd	0.402	0.218	1.845	0.082
m7	as.factor(vessel)Medeia	2.563	1.572	1.630	0.121
m7	as.factor(vessel)NW Explorer	-0.060	0.986	-0.061	0.952
m7	Icy__Strait__SST__May	-0.288	0.129	-2.234	0.038
m7	adj__raw__pink__log	0.396	0.167	2.376	0.029
m7	as.factor(vessel)Medeia:adj__raw__pink__log	-0.581	0.329	-1.764	0.095
m7	as.factor(vessel)NW Explorer:adj__raw__pink__log	-0.078	0.163	-0.482	0.636
m8	(Intercept)	3.638	1.676	2.171	0.044
m8	as.factor(odd__even__factor)odd	0.365	0.229	1.593	0.129
m8	as.factor(vessel)Medeia	2.439	1.665	1.465	0.160
m8	as.factor(vessel)NW Explorer	0.047	1.044	0.045	0.964
m8	Icy__Strait__SST__MJJ	-0.250	0.152	-1.653	0.116
m8	adj__raw__pink__log	0.409	0.177	2.314	0.033
m8	as.factor(vessel)Medeia:adj__raw__pink__log	-0.556	0.350	-1.585	0.130
m8	as.factor(vessel)NW Explorer:adj__raw__pink__log	-0.111	0.172	-0.644	0.528
m9	(Intercept)	3.843	1.402	2.740	0.013
m9	as.factor(odd__even__factor)odd	0.398	0.216	1.838	0.083
m9	as.factor(vessel)Medeia	2.328	1.571	1.482	0.156
m9	as.factor(vessel)NW Explorer	0.026	0.982	0.026	0.979
m9	Icy__Strait__SST__AMJ	-0.369	0.160	-2.302	0.033
m9	adj__raw__pink__log	0.406	0.166	2.446	0.025
m9	as.factor(vessel)Medeia:adj__raw__pink__log	-0.521	0.331	-1.576	0.132
m9	as.factor(vessel)NW Explorer:adj__raw__pink__log	-0.094	0.162	-0.580	0.569
m10	(Intercept)	3.867	1.559	2.480	0.023
m10	as.factor(odd__even__factor)odd	0.364	0.222	1.637	0.119
m10	as.factor(vessel)Medeia	2.422	1.615	1.500	0.151
m10	as.factor(vessel)NW Explorer	0.131	1.017	0.129	0.899
m10	Icy__Strait__SST__AMJJ	-0.325	0.163	-1.995	0.061
m10	adj__raw__pink__log	0.426	0.172	2.470	0.024

Model	Term	Estimate	Standard Error	Statistic	p value
m10	as.factor(vessel)Medeia:adj__raw__pink__log	-0.541	0.340	-1.592	0.129
m10	as.factor(vessel)NW Explorer:adj__raw__pink__log	-0.124	0.168	-0.738	0.470
m11	(Intercept)	3.303	1.234	2.678	0.015
m11	as.factor(odd__even__factor)odd	0.389	0.216	1.798	0.089
m11	as.factor(vessel)Medeia	2.535	1.564	1.621	0.122
m11	as.factor(vessel)NW Explorer	0.130	0.987	0.132	0.896
m11	NSEAK__SST__May	-0.291	0.127	-2.294	0.034
m11	adj__raw__pink__log	0.397	0.166	2.396	0.028
m11	as.factor(vessel)Medeia:adj__raw__pink__log	-0.558	0.328	-1.700	0.106
m11	as.factor(vessel)NW Explorer:adj__raw__pink__log	-0.105	0.162	-0.646	0.526
m12	(Intercept)	3.915	1.736	2.255	0.037
m12	as.factor(odd__even__factor)odd	0.343	0.228	1.505	0.150
m12	as.factor(vessel)Medeia	2.637	1.641	1.607	0.126
m12	as.factor(vessel)NW Explorer	0.199	1.047	0.190	0.852
m12	NSEAK__SST__MJJ	-0.292	0.166	-1.754	0.096
m12	adj__raw__pink__log	0.421	0.176	2.391	0.028
m12	as.factor(vessel)Medeia:adj__raw__pink__log	-0.571	0.346	-1.653	0.116
m12	as.factor(vessel)NW Explorer:adj__raw__pink__log	-0.129	0.172	-0.752	0.462
m13	(Intercept)	3.961	1.394	2.841	0.011
m13	as.factor(odd__even__factor)odd	0.364	0.214	1.705	0.105
m13	as.factor(vessel)Medeia	2.451	1.547	1.584	0.131
m13	as.factor(vessel)NW Explorer	0.247	0.981	0.252	0.804
m13	NSEAK__SST__AMJ	-0.389	0.161	-2.416	0.027
m13	adj__raw__pink__log	0.417	0.165	2.535	0.021
m13	as.factor(vessel)Medeia:adj__raw__pink__log	-0.527	0.326	-1.616	0.123
m13	as.factor(vessel)NW Explorer:adj__raw__pink__log	-0.124	0.161	-0.770	0.451
m14	(Intercept)	4.162	1.617	2.575	0.019
m14	as.factor(odd__even__factor)odd	0.345	0.221	1.563	0.135
m14	as.factor(vessel)Medeia	2.579	1.592	1.620	0.123
m14	as.factor(vessel)NW Explorer	0.271	1.017	0.266	0.793
m14	NSEAK__SST__AMJJ	-0.367	0.175	-2.103	0.050
m14	adj__raw__pink__log	0.432	0.171	2.524	0.021
m14	as.factor(vessel)Medeia:adj__raw__pink__log	-0.552	0.335	-1.646	0.117
m14	as.factor(vessel)NW Explorer:adj__raw__pink__log	-0.140	0.167	-0.838	0.413
m15	(Intercept)	3.270	1.256	2.604	0.018
m15	as.factor(odd__even__factor)odd	0.369	0.218	1.688	0.109
m15	as.factor(vessel)Medeia	2.750	1.576	1.745	0.098
m15	as.factor(vessel)NW Explorer	0.186	1.001	0.186	0.855
m15	SEAK__SST__May	-0.276	0.126	-2.194	0.042
m15	adj__raw__pink__log	0.414	0.168	2.458	0.024
m15	as.factor(vessel)Medeia:adj__raw__pink__log	-0.600	0.330	-1.820	0.085

Model	Term	Estimate	Standard Error	Statistic	p value
m15	as.factor(vessel)NW Explorer:adj__raw__pink__log	-0.116	0.164	-0.706	0.489
m16	(Intercept)	3.913	1.700	2.302	0.033
m16	as.factor(odd__even__factor)odd	0.326	0.228	1.432	0.169
m16	as.factor(vessel)Medeia	2.814	1.633	1.723	0.102
m16	as.factor(vessel)NW Explorer	0.220	1.045	0.211	0.836
m16	SEAK__SST__MJJ	-0.282	0.156	-1.803	0.088
m16	adj__raw__pink__log	0.427	0.176	2.428	0.026
m16	as.factor(vessel)Medeia:adj__raw__pink__log	-0.602	0.342	-1.760	0.095
m16	as.factor(vessel)NW Explorer:adj__raw__pink__log	-0.130	0.171	-0.759	0.458
m17	(Intercept)	3.911	1.409	2.777	0.012
m17	as.factor(odd__even__factor)odd	0.349	0.215	1.618	0.123
m17	as.factor(vessel)Medeia	2.629	1.554	1.691	0.108
m17	as.factor(vessel)NW Explorer	0.306	0.994	0.308	0.762
m17	SEAK__SST__AMJ	-0.365	0.156	-2.342	0.031
m17	adj__raw__pink__log	0.432	0.167	2.593	0.018
m17	as.factor(vessel)Medeia:adj__raw__pink__log	-0.560	0.327	-1.715	0.103
m17	as.factor(vessel)NW Explorer:adj__raw__pink__log	-0.136	0.162	-0.836	0.414
m18	(Intercept)	4.167	1.610	2.589	0.019
m18	as.factor(odd__even__factor)odd	0.333	0.221	1.507	0.149
m18	as.factor(vessel)Medeia	2.748	1.587	1.731	0.101
m18	as.factor(vessel)NW Explorer	0.303	1.018	0.298	0.769
m18	SEAK__SST__AMJJ	-0.351	0.166	-2.118	0.048
m18	adj__raw__pink__log	0.438	0.171	2.557	0.020
m18	as.factor(vessel)Medeia:adj__raw__pink__log	-0.581	0.333	-1.744	0.098
m18	as.factor(vessel)NW Explorer:adj__raw__pink__log	-0.142	0.167	-0.852	0.405

Table 4: Parameter estimates for the 18 individual models for Models m1a-m18a.

Model	Term	Estimate	Standard Error	Statistic	p value
m1a	(Intercept)	2.476	0.171	14.456	0.000
m1a	CPUE	0.310	0.074	4.176	0.000
m1a	as.factor(odd_even_factor)odd	0.397	0.180	2.209	0.037
m2a	(Intercept)	6.125	1.406	4.357	0.000
m2a	CPUE	0.401	0.075	5.319	0.000
m2a	as.factor(odd_even_factor)odd	0.178	0.182	0.980	0.337
m2a	ISTI20_JJ	-0.378	0.145	-2.611	0.015
m3a	(Intercept)	5.527	0.706	7.825	0.000
m3a	CPUE	0.369	0.058	6.372	0.000
m3a	as.factor(odd_even_factor)odd	0.353	0.137	2.583	0.016
m3a	Chatham_SST_May	-0.420	0.096	-4.395	0.000
m4a	(Intercept)	5.823	1.262	4.613	0.000
m4a	CPUE	0.338	0.067	5.027	0.000
m4a	as.factor(odd_even_factor)odd	0.338	0.162	2.079	0.048
m4a	Chatham_SST_MJJ	-0.345	0.129	-2.671	0.013
m5a	(Intercept)	6.130	0.869	7.050	0.000
m5a	CPUE	0.365	0.059	6.233	0.000
m5a	as.factor(odd_even_factor)odd	0.327	0.139	2.349	0.027
m5a	Chatham_SST_AMJ	-0.489	0.115	-4.252	0.000
m6a	(Intercept)	6.215	1.117	5.566	0.000
m6a	CPUE	0.350	0.063	5.520	0.000
m6a	as.factor(odd_even_factor)odd	0.328	0.152	2.154	0.041
m6a	Chatham_SST_AMJJ	-0.436	0.129	-3.377	0.002
m7a	(Intercept)	5.217	0.660	7.906	0.000
m7a	CPUE	0.376	0.059	6.339	0.000
m7a	as.factor(odd_even_factor)odd	0.381	0.139	2.745	0.011
m7a	Icy_Strait_SST_May	-0.402	0.095	-4.240	0.000
m8a	(Intercept)	5.586	1.157	4.827	0.000
m8a	CPUE	0.345	0.067	5.109	0.000
m8a	as.factor(odd_even_factor)odd	0.350	0.161	2.171	0.040
m8a	Icy_Strait_SST_MJJ	-0.316	0.117	-2.711	0.012
m9a	(Intercept)	5.870	0.844	6.955	0.000
m9a	CPUE	0.366	0.060	6.115	0.000
m9a	as.factor(odd_even_factor)odd	0.381	0.141	2.704	0.012
m9a	Icy_Strait_SST_AMJ	-0.472	0.116	-4.073	0.000
m10a	(Intercept)	5.884	1.047	5.617	0.000
m10a	CPUE	0.354	0.064	5.507	0.000
m10a	as.factor(odd_even_factor)odd	0.355	0.153	2.323	0.029
m10a	Icy_Strait_SST_AMJJ	-0.399	0.122	-3.285	0.003

Model	Term	Estimate	Standard Error	Statistic	p value
m11a	(Intercept)	5.259	0.662	7.942	0.000
m11a	CPUE	0.339	0.057	5.919	0.000
m11a	as.factor(odd_even_factor)odd	0.389	0.138	2.818	0.010
m11a	NSEAK_SST_May	-0.379	0.088	-4.288	0.000
m12a	(Intercept)	5.625	1.156	4.868	0.000
m12a	CPUE	0.315	0.066	4.768	0.000
m12a	as.factor(odd_even_factor)odd	0.373	0.160	2.333	0.028
m12a	NSEAK_SST_MJJ	-0.318	0.116	-2.749	0.011
m13a	(Intercept)	5.859	0.837	7.003	0.000
m13a	CPUE	0.333	0.058	5.713	0.000
m13a	as.factor(odd_even_factor)odd	0.379	0.141	2.693	0.013
m13a	NSEAK_SST_AMJ	-0.453	0.111	-4.097	0.000
m14a	(Intercept)	5.923	1.056	5.609	0.000
m14a	CPUE	0.323	0.063	5.136	0.000
m14a	as.factor(odd_even_factor)odd	0.373	0.152	2.453	0.022
m14a	NSEAK_SST_AMJJ	-0.398	0.121	-3.296	0.003
m15a	(Intercept)	5.262	0.715	7.354	0.000
m15a	CPUE	0.335	0.059	5.668	0.000
m15a	as.factor(odd_even_factor)odd	0.394	0.142	2.764	0.011
m15a	SEAK_SST_May	-0.351	0.088	-3.966	0.001
m16a	(Intercept)	5.509	1.146	4.805	0.000
m16a	CPUE	0.305	0.066	4.592	0.000
m16a	as.factor(odd_even_factor)odd	0.386	0.161	2.396	0.025
m16a	SEAK_SST_MJJ	-0.290	0.109	-2.669	0.013
m17a	(Intercept)	5.796	0.881	6.580	0.000
m17a	CPUE	0.328	0.060	5.478	0.000
m17a	as.factor(odd_even_factor)odd	0.386	0.145	2.672	0.013
m17a	SEAK_SST_AMJ	-0.412	0.108	-3.816	0.001
m18a	(Intercept)	5.802	1.065	5.446	0.000
m18a	CPUE	0.313	0.064	4.915	0.000
m18a	as.factor(odd_even_factor)odd	0.390	0.154	2.527	0.019
m18a	SEAK_SST_AMJJ	-0.360	0.114	-3.152	0.004

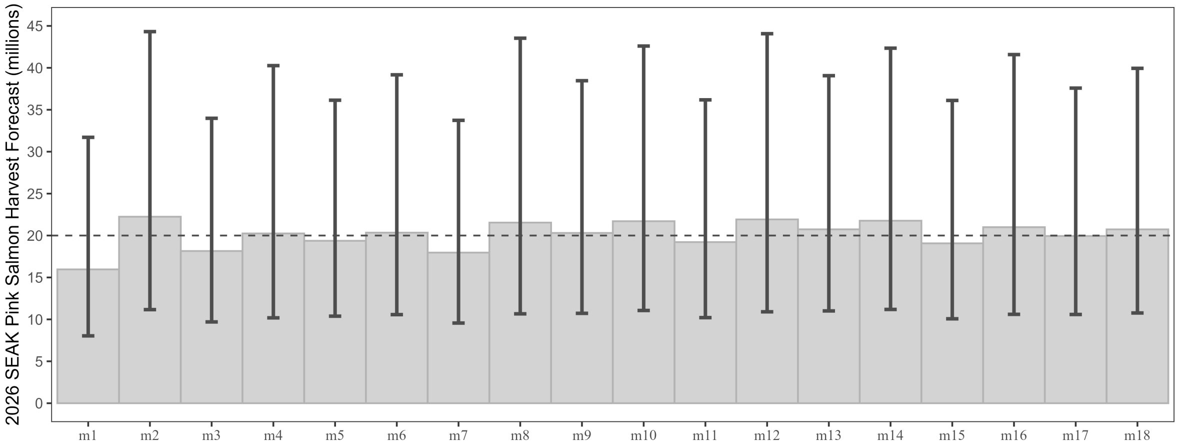

Figure B1: Bias-corrected forecasts (grey bars) for the 18 regression models (Models m1-m18) with 80% prediction intervals (vertical grey lines). A horizontal dotted line at 20 million fish is placed on the figure for reference only. The 2026-forecast using the model mxx has a point estimate of xx million fish (80% prediction interval: xx to xx million fish).

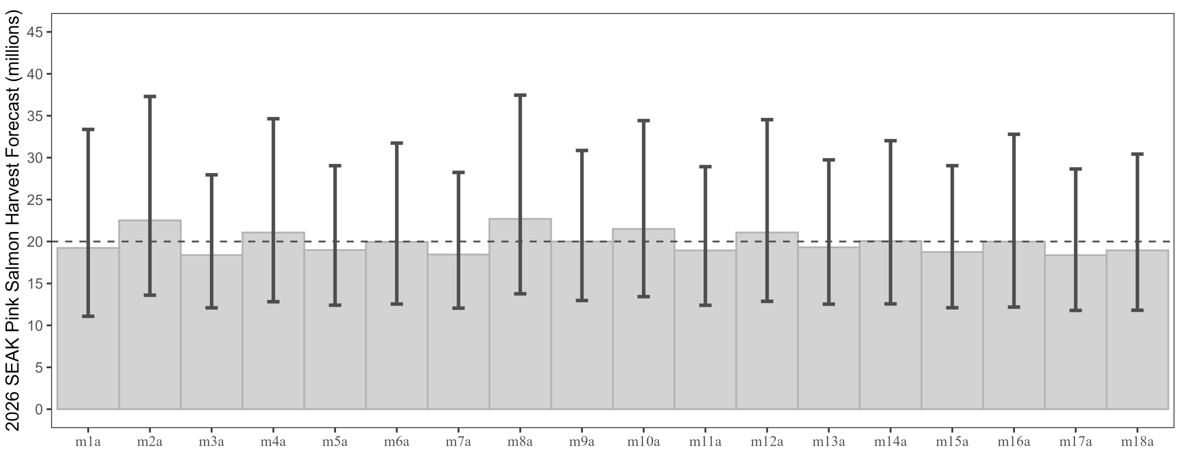

Figure B2: Bias-corrected forecasts (grey bars) for the 18 regression models (Models m1a-m18a) with 80% prediction intervals (vertical grey lines). A horizontal dotted line at 20 million fish is placed on the figure for reference only. The 2026-forecast using the model mxx has a point estimate of xx million fish (80% prediction interval: xx to xx million fish).