

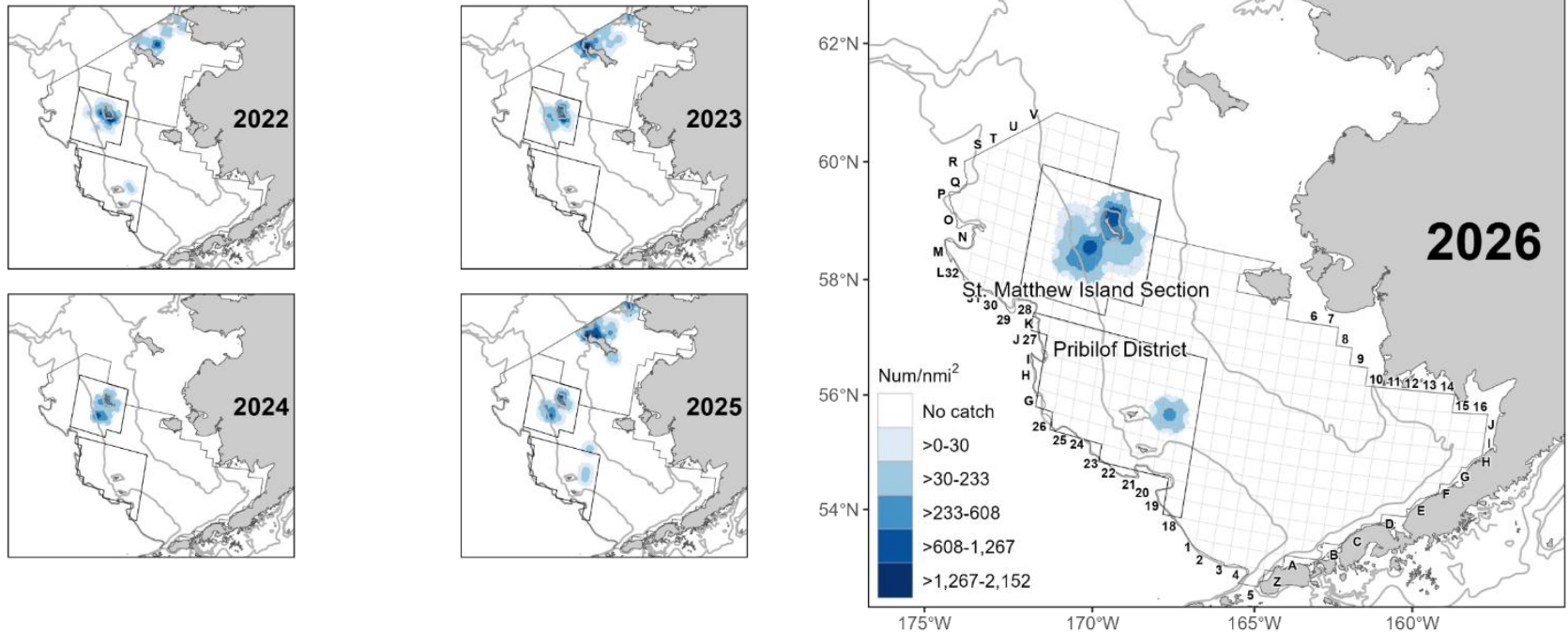
St. Matthew Island blue king crab final models



Caitlin Stern and Katie Palof
Crab Plan Team, September 2026

St. Matthew Island blue king crab stock

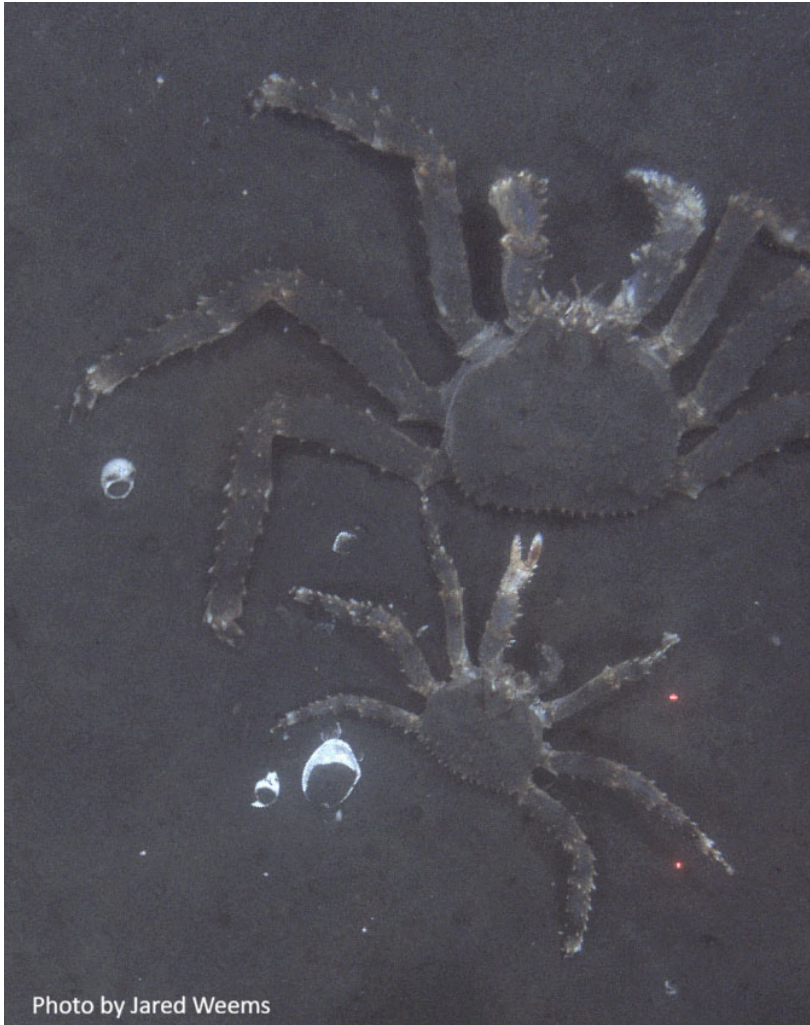
Blue King Crab Mature Male



Zacher et al. (2026) The 2026 Eastern and Northern Bering Sea Continental Shelf Trawl Surveys: Results for Commercial Crab Species.



St. Matthew Island blue king crab stock



Fishery closed since 2016/2017

Declared overfished in fall 2018

Rebuilding plan approved in June 2020

Last full assessment in 2024



Topics

Priorities for the assessment

Bridging: newer GMACS version

Bridging: data updates

Development of a model-based index

Development of model-based size compositions

Proposed models including model-based index and comps



SSC comments from June 2026

The SSC concurs with the CPT and authors' recommended models for setting harvest specifications in October. These include models 26.1, the new base model, and 26.2. The SSC... recommends continued exploration of estimating catchability in future models, at the author's discretion.

We include models 26.1b and 26.2 here, along with a model using model-estimated EBS survey size comps. We plan to continue exploring estimation of catchability.

The SSC also recommends more detailed information on the new model-based index be provided in the main assessment document in October, which will inform model selection for final specifications.

We moved details about the model-based index to the main assessment document.

Regarding previous recommendations to integrate the EBS bottom trawl survey and the ADF&G pot survey, the SSC acknowledges the difficulties in aligning an area-swept survey with a discrete pot survey and recommends exploring alternative methodologies, such as developing separate model-based indices for each survey and using ensemble models or model averaging, to continue progress toward creating a comprehensive index of abundance for this stock.

We plan to explore creating a single index in a future assessment cycle.



CPT comments from May 2026

The author and CPT also discussed estimated trawl survey selectivity values greater than the bounded value of 1 for the middle size class, across all three models. The CPT recommended adding this issue for the January modeling workshop but is likely related to scaling of selectivity over size-classes.

We look forward to addressing this topic at the January 2027 modeling workshop.

The CPT also agreed with the author's proposal to focus on exploration of model-based estimates of survey size-composition data and the development of a single model-based index to incorporate both the trawl and pot surveys as the highest-priority research directions for this assessment.

We look forward to CPT's and SSC's feedback on the model including model-based estimates of survey size-composition data. Development of a single model-based index is planned for a future assessment cycle.

The CPT noted that this stock might be usefully moved to a triennial schedule...

We recommend maintaining a biennial schedule at least through the 2028 assessment cycle in order to complete the transition to using model-based estimates for the survey and size composition data, and allow for progress on development of a single model-based index.



Topics

Priorities for the 2026 assessment cycle

Bridging: newer GMACS version

Bridging: data updates

Development of a model-based index (MBI)

Development of model-based size compositions

Proposed models including model-based index and comps



May 2026 recommended model: 26.1

- males ≥ 90 mm only, 3 size classes
- catch: pot fishery retained, discards from directed pot, groundfish trawl, groundfish fixed gear fisheries
- relative abundance: EBS trawl survey, ADF&G pot survey
- size comps: pot fishery, EBS trawl survey, ADF&G pot survey
- $M = 0.23$, estimated for 1998/1999 event
- survey selectivity: max slx at size forced = 1, estimated for size classes 1 and 2
- survey catchability fixed = 1 for trawl survey, estimated for pot survey
- GMACS 2.20.34a



Model 26.1a: 26.1 in GMACS 2.20.44

Component	26.1	26.1a	Difference
Catch: fishery retained	-69.0	-69.0	0
Catch: fishery discarded	4.4	4.4	0
Catch: trawl bycatch	-9.4	-9.4	0
Catch: fixed gear bycatch	-9.4	-9.4	0
Index: EBS trawl survey	0.3	0.3	0
Index: ADFG pot survey	74.9	74.9	0
Size comp: pot fishery	-105.1	-105.1	0
Size comp: EBS trawl survey	-283.4	-283.4	0
Size comp: ADFG pot survey	-109.1	-109.1	0
Number of parameters	162	162	0
Total	-425.0	-425.0	0



Model 26.1a: 26.1 in GMACS 2.20.44

	26.1	26.1a
MMB	1,496	1,496
B_{MSY}	2,901	2,901
MMB/B_{MSY}	0.52	0.52
F_{OFL}	0.11	0.11
OFL	146	146
ABC	102	102

units: metric tons



Topics

Priorities for the assessment

Bridging: newer GMACS version

Bridging: data updates

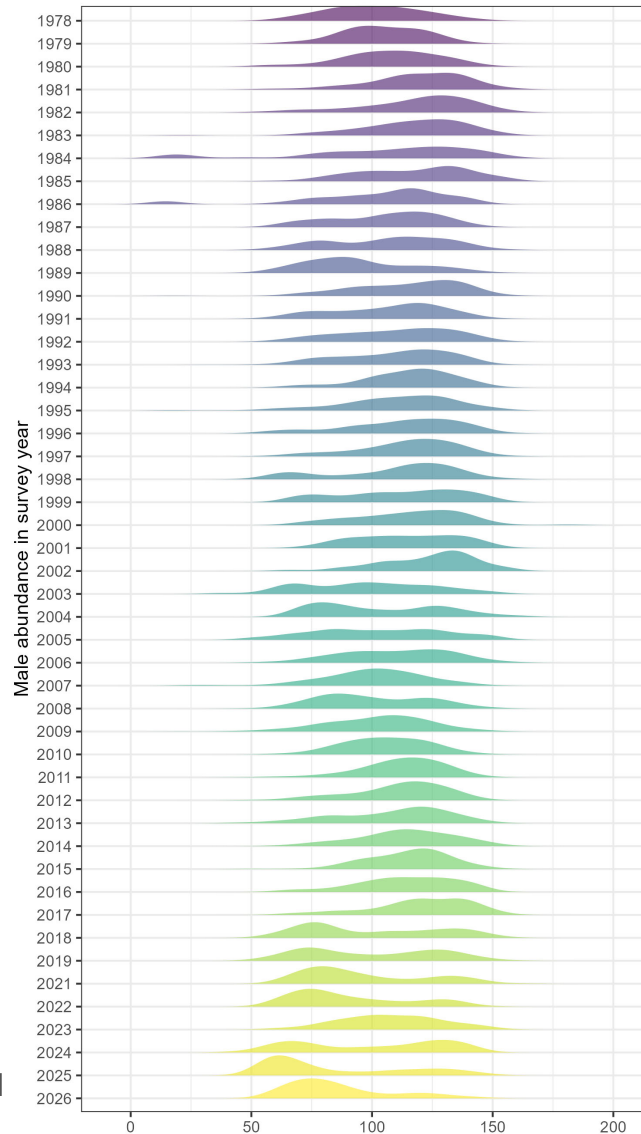
Development of a model-based index (MBI)

Development of model-based size compositions

Proposed models including model-based index and comps

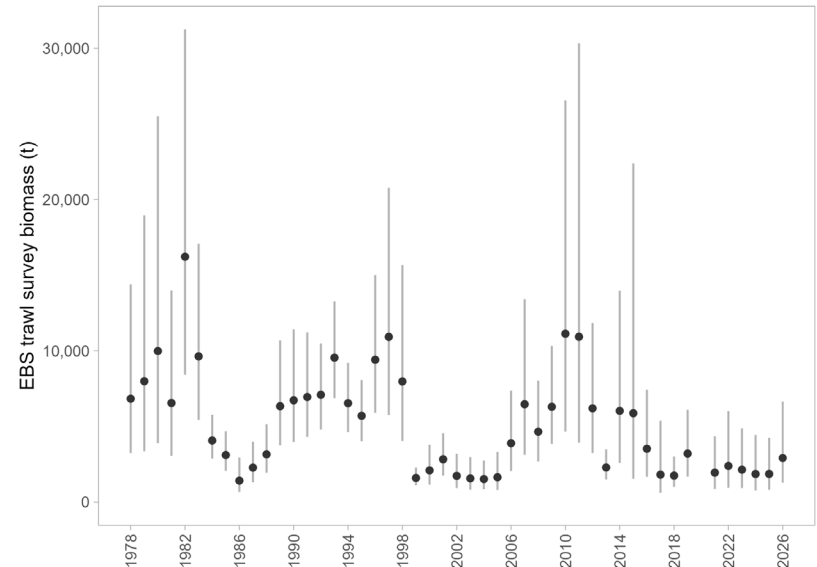


Model 26.1b: 26.1a with data updates



2026 EBS trawl survey: biomass and size comp data

2025/2026 groundfish trawl and fixed gear bycatch



Model 26.1b: 26.1a with data updates

Component	26.1a	26.1b	Difference
Catch: fishery retained	-69.0	-69.0	0.009
Catch: fishery discarded	4.4	4.5	0.053
Catch: trawl bycatch	-9.4	-9.6	-0.275
Catch: fixed gear bycatch	-9.4	-9.6	-0.275
Index: EBS trawl survey	0.3	-0.2	-0.508
Index: ADFG pot survey	74.9	75.1	0.182
Size comp: pot fishery	-105.1	-105.1	-0.001
Size comp: EBS trawl survey	-283.4	-291.2	-7.803
Size comp: ADFG pot survey	-109.1	-108.5	0.605
Number of parameters	162	165	3.000
Total	-425.0	-433.3	-8.341



Topics

Priorities for the assessment

Bridging: newer GMACS version

Bridging: data updates

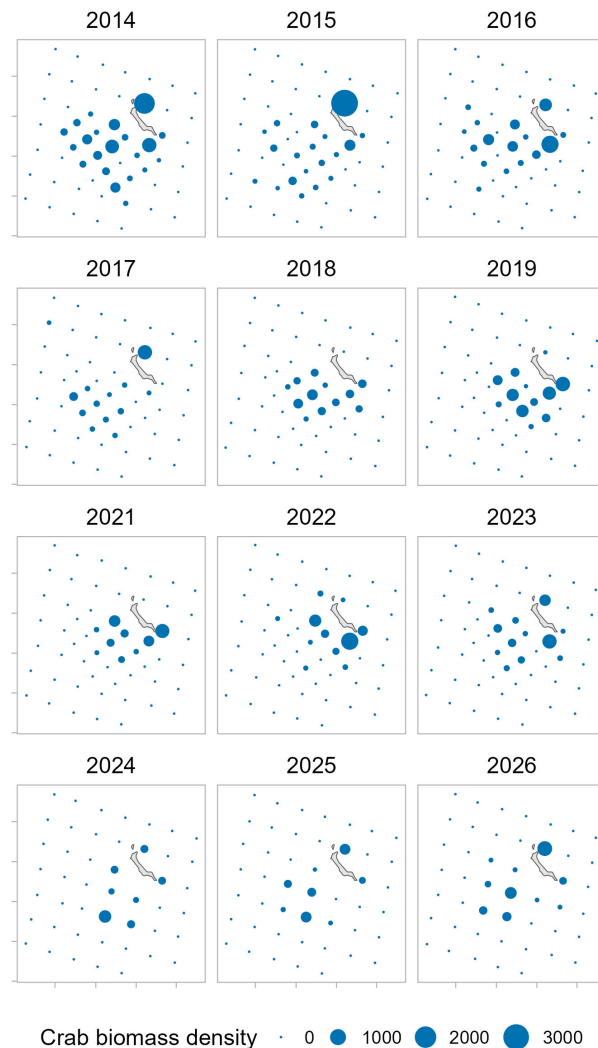
Development of a model-based index (MBI)

Development of model-based size compositions

Proposed models including model-based index and comps



Model-based index development



Corner station sampling ended in 2023

EBS survey time series biomass estimates
no longer directly comparable

Spatiotemporal model-based index
standardization accounts for differences in
survey station sampling among years

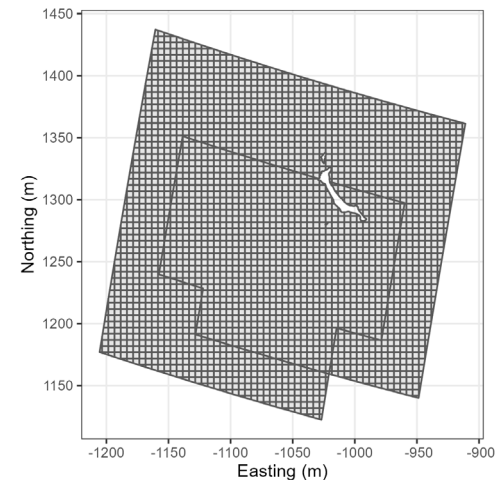
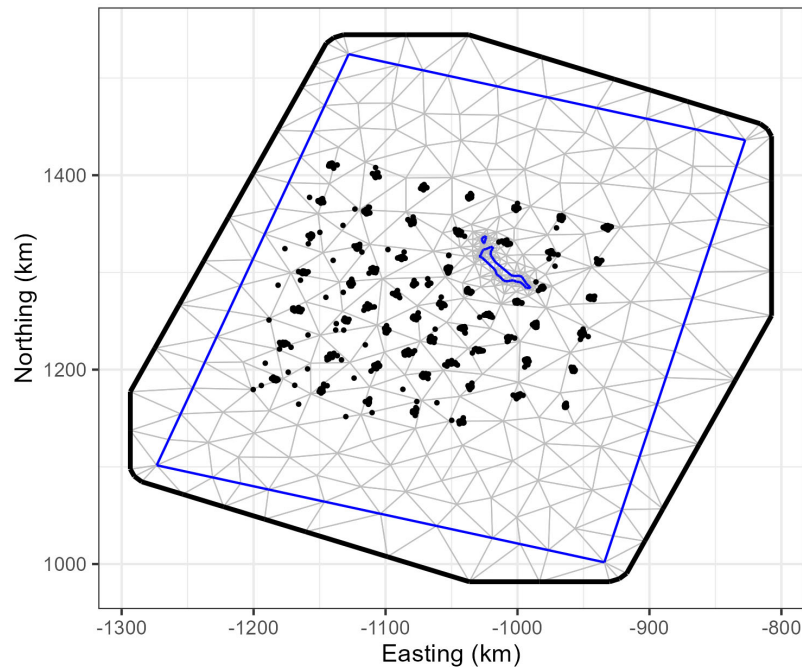


Spatiotemporal models

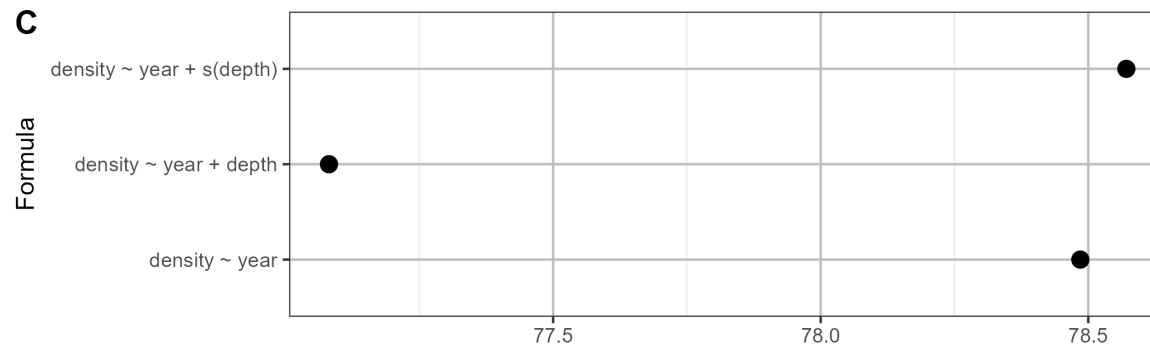
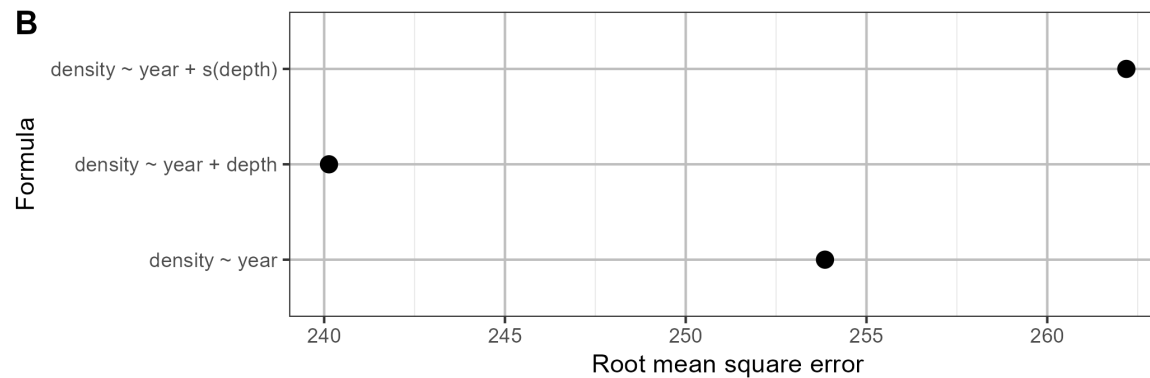
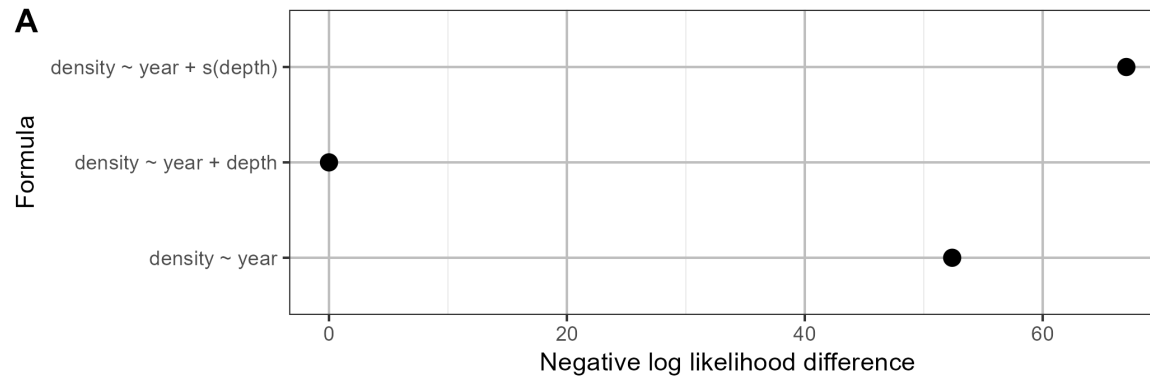
Fit geostatistical GLMMs with spatiotemporally correlated random effects to survey data using sdmTMB

Fixed effects: year, depth. Distribution families: Tweedie, delta gamma, delta lognormal

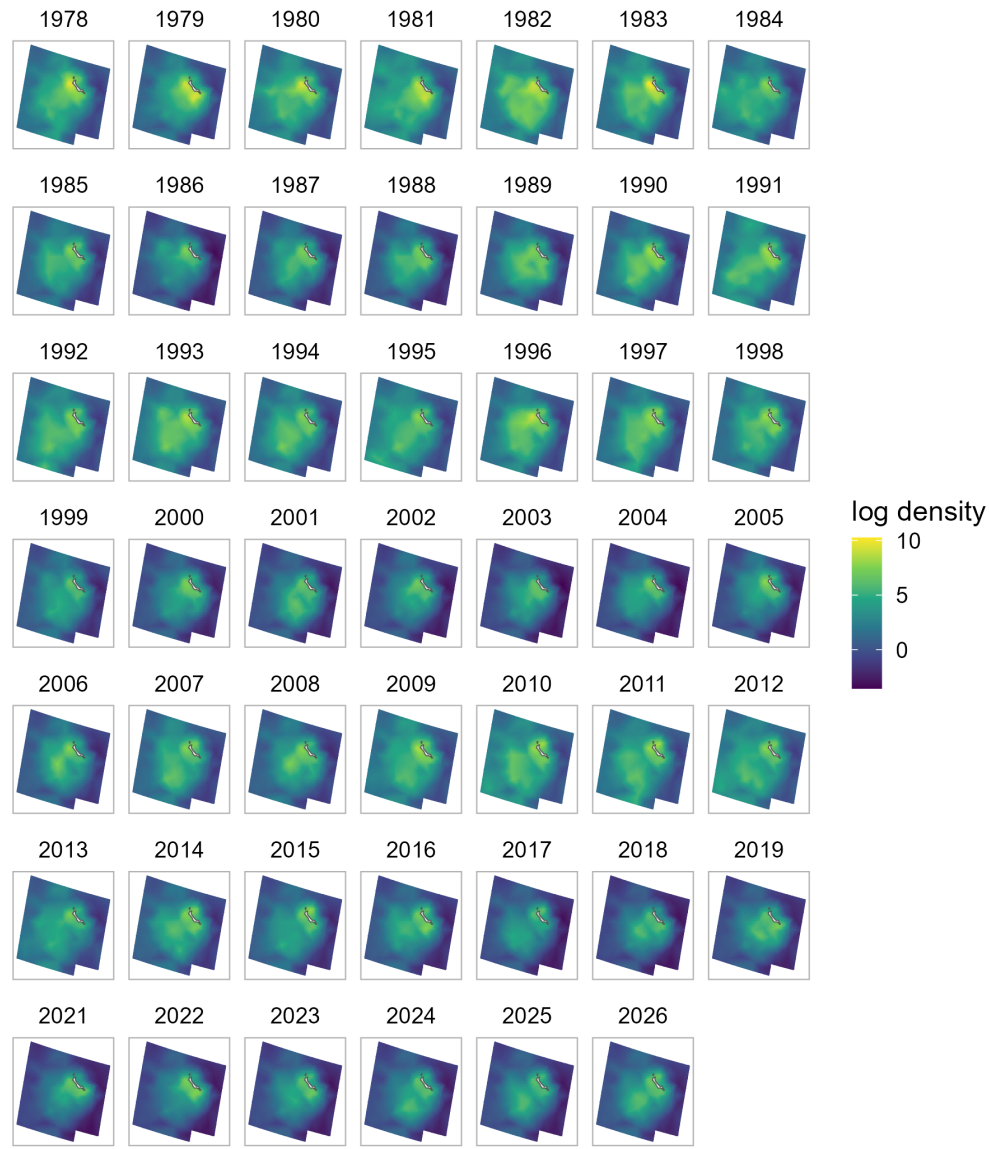
Only Tweedie models converged, passed sanity checks, and successfully completed cross validation



Model selection



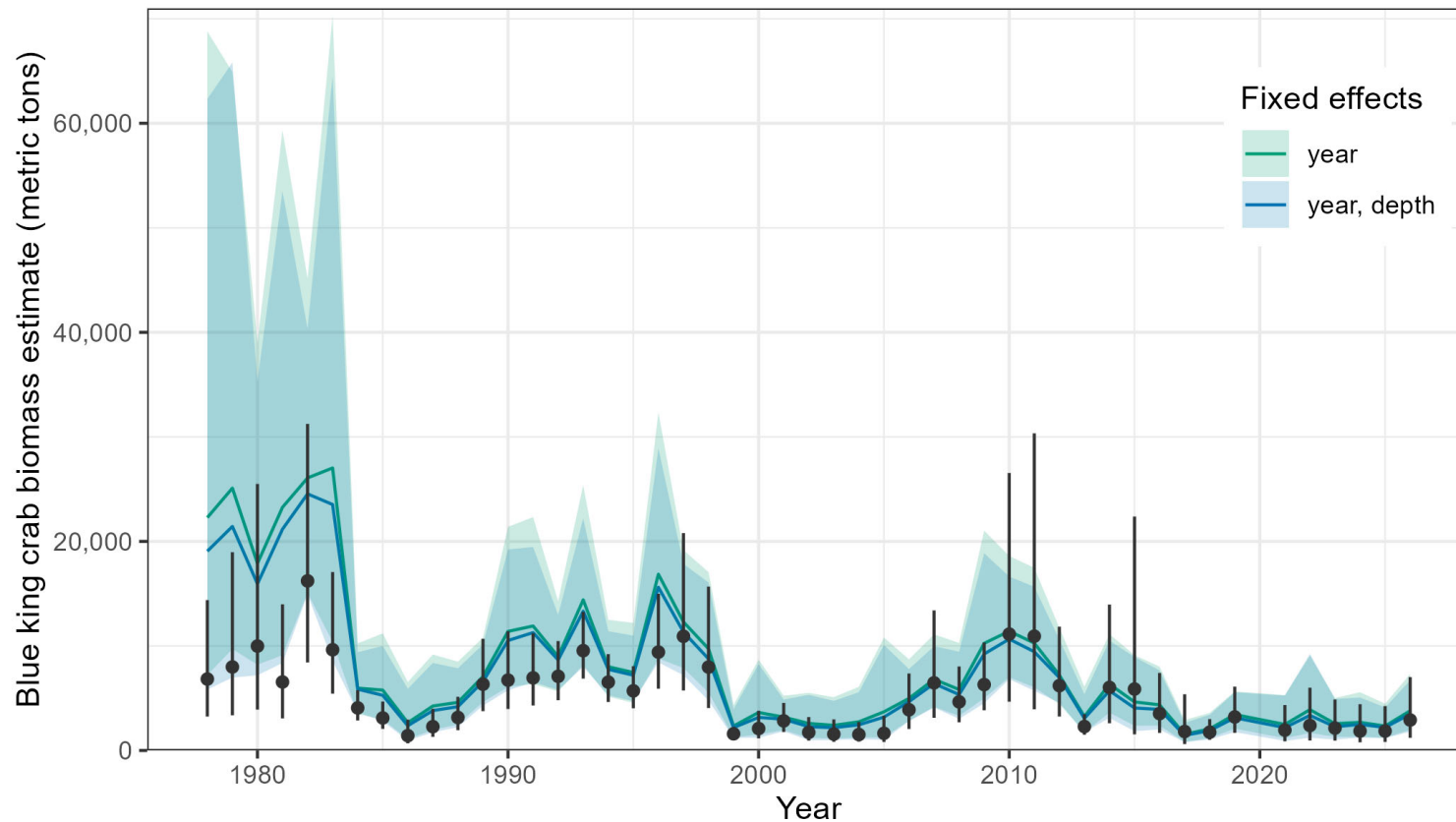
Spatial predictions



Model-based vs. design-based indices

Spatiotemporal model-based biomass index accounts for changes in survey station sampling over time

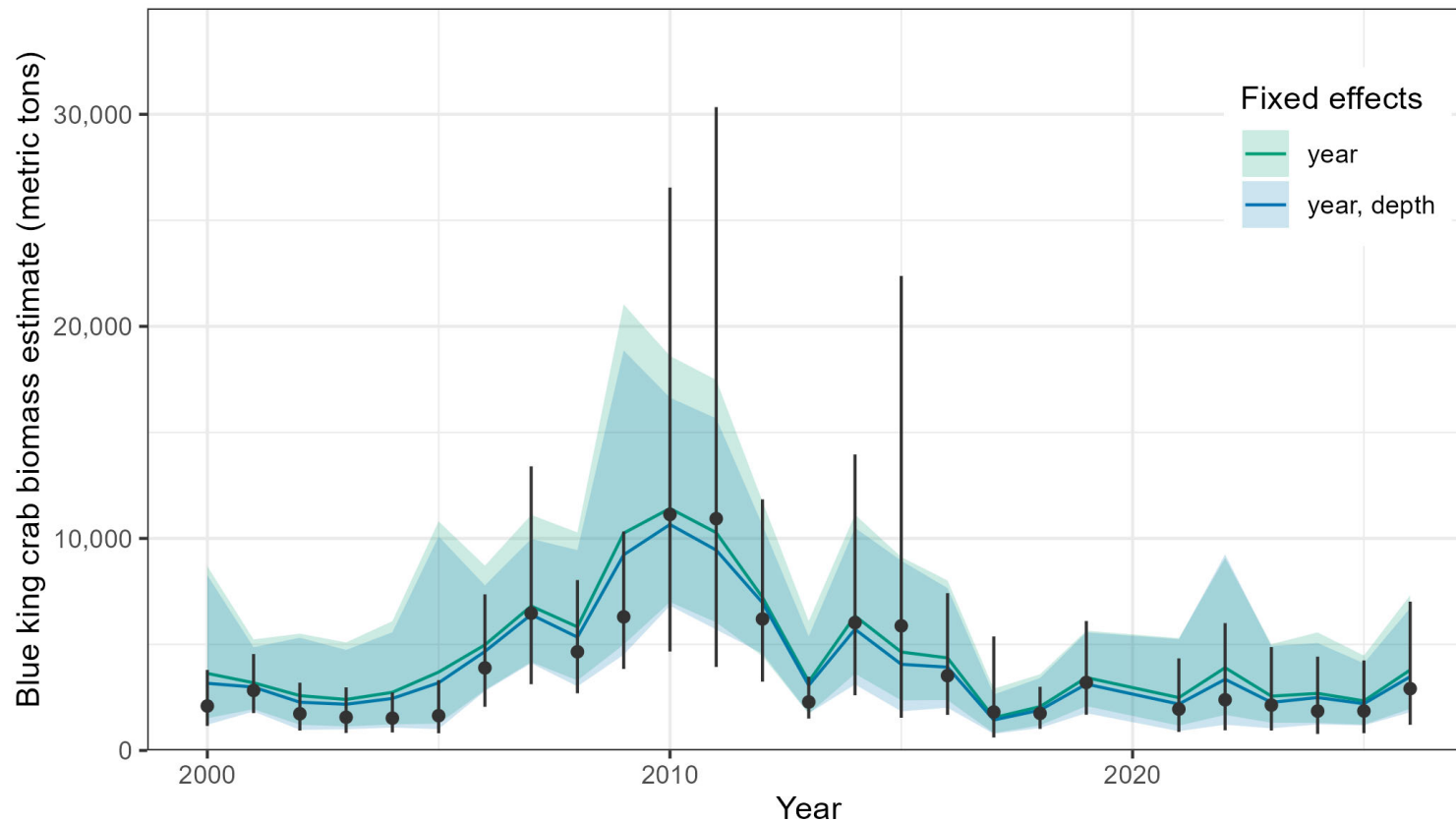
Produces consistent time series of biomass estimates



Model-based vs. design-based indices

Spatiotemporal model-based biomass index accounts for changes in survey station sampling over time

Produces consistent time series of biomass estimates



Topics

Priorities for the assessment

Bridging: newer GMACS version

Bridging: data updates

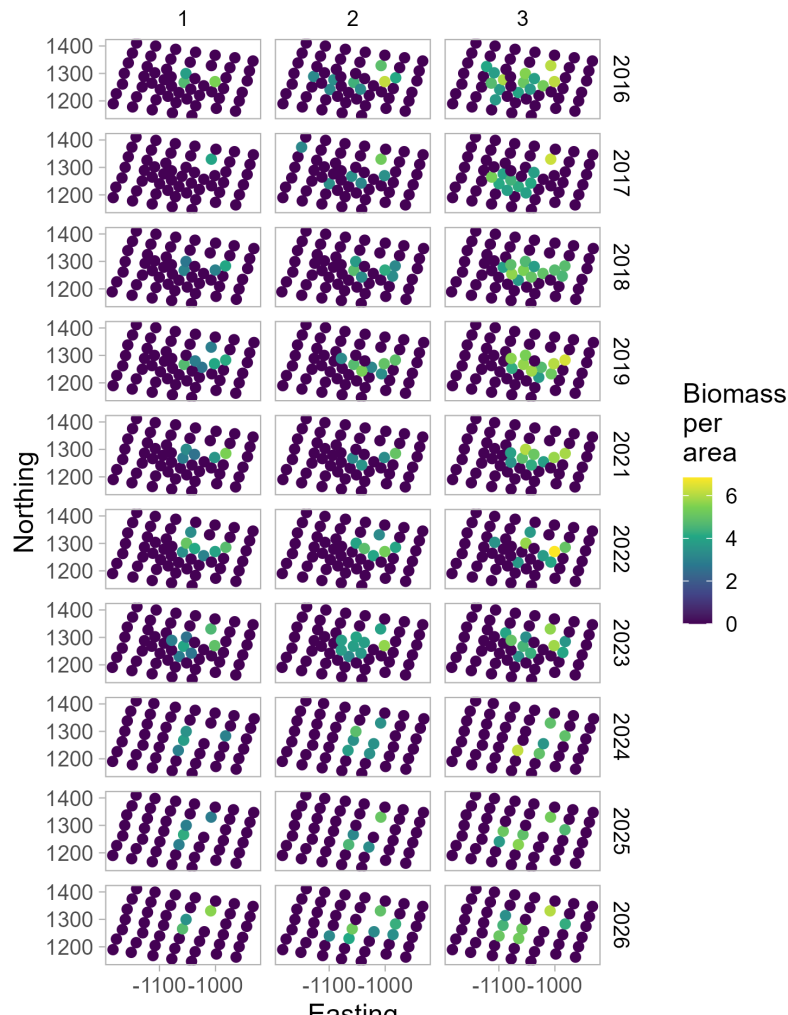
Development of a model-based index (MBI)

Development of model-based size compositions

Proposed models including model-based index and comps



Spatiotemporal model-based size composition standardization



Fit geostatistical GLMMs with spatiotemporally correlated random effects to survey data using sdmTMB

Mirrored model configuration for index standardization

Specified spatial and spatiotemporal fields with shared SDs across sizes

No *a priori* hypotheses about how magnitude of spatial or spatiotemporal variation might differ among sizes

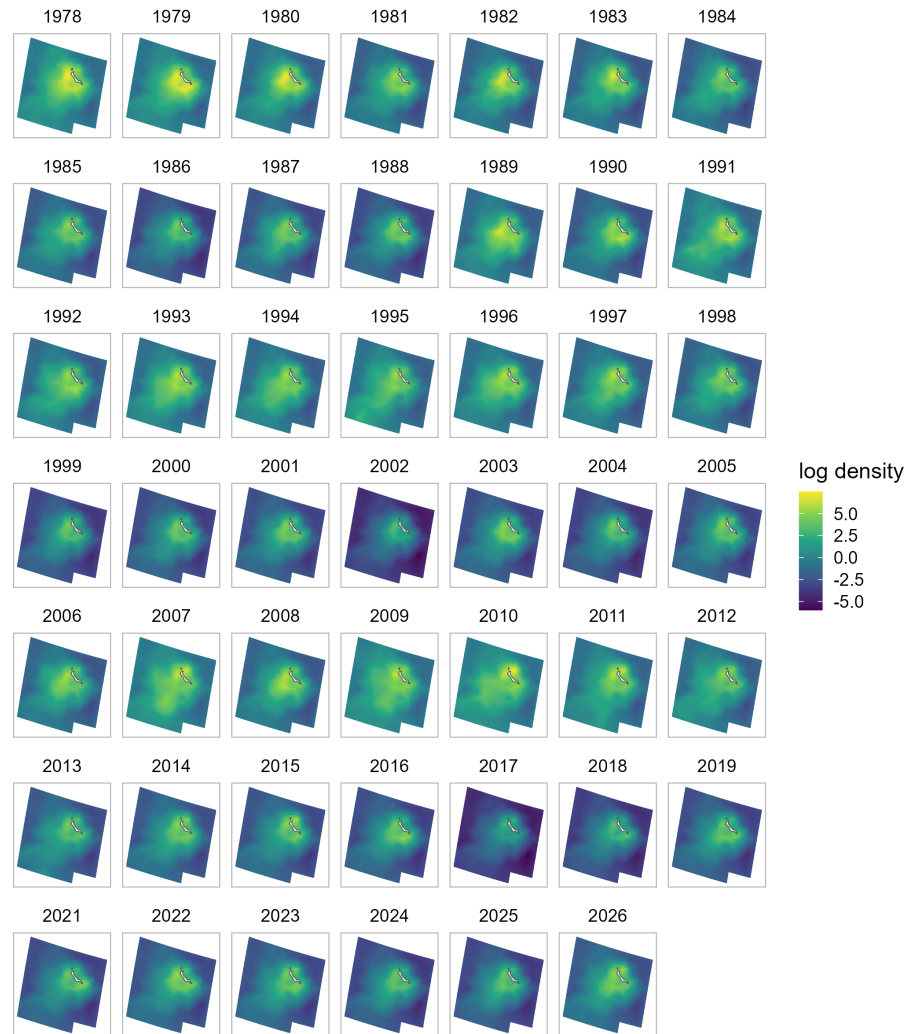
Calculated biomass index for each size

Converted to proportion at size



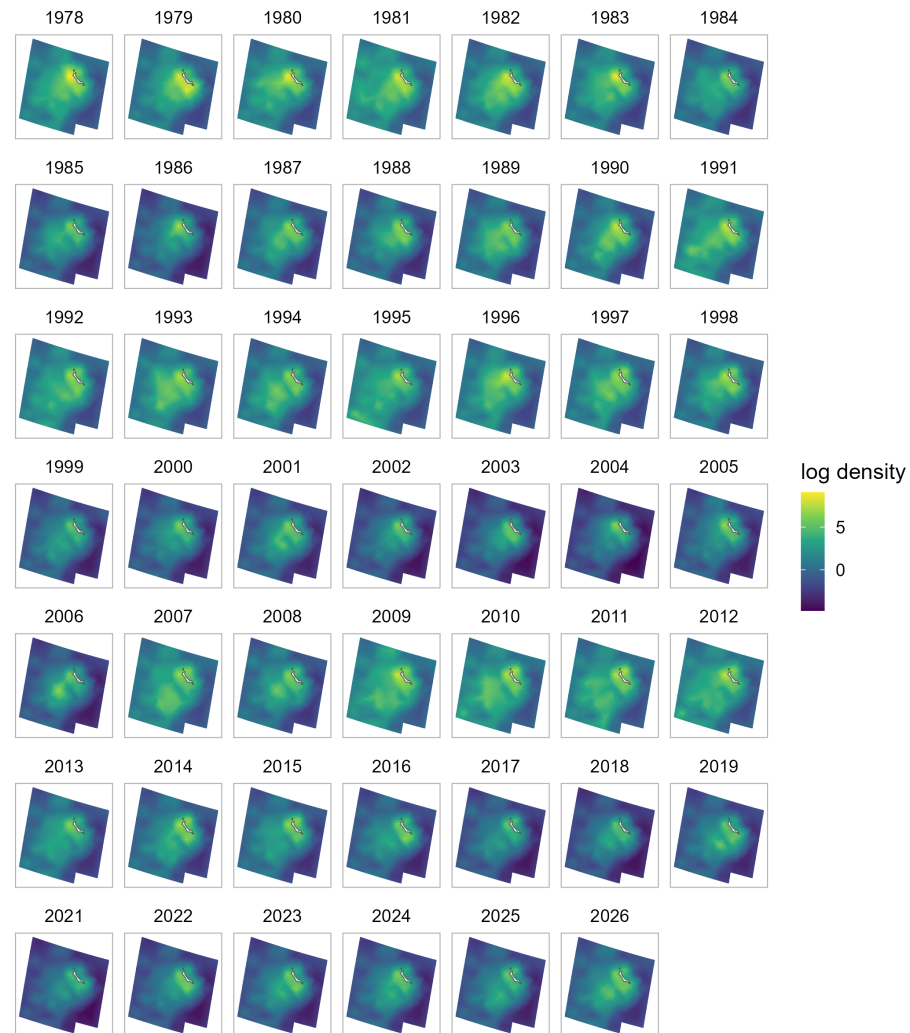
Spatial predictions for size class 1

Size 1



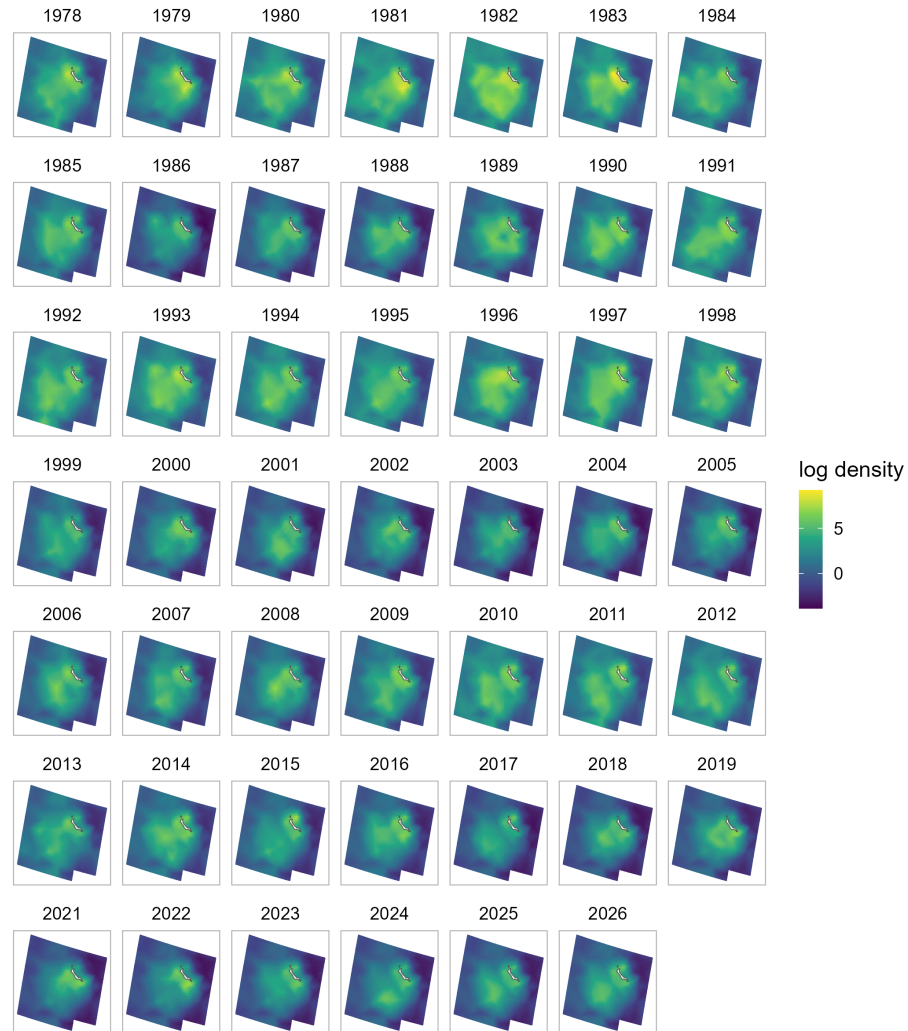
Spatial predictions for size class 2

Size 2



Spatial predictions for size class 3

Size 3

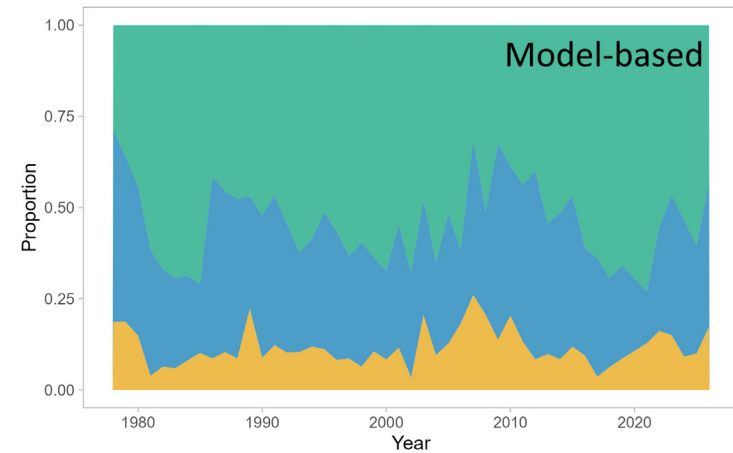
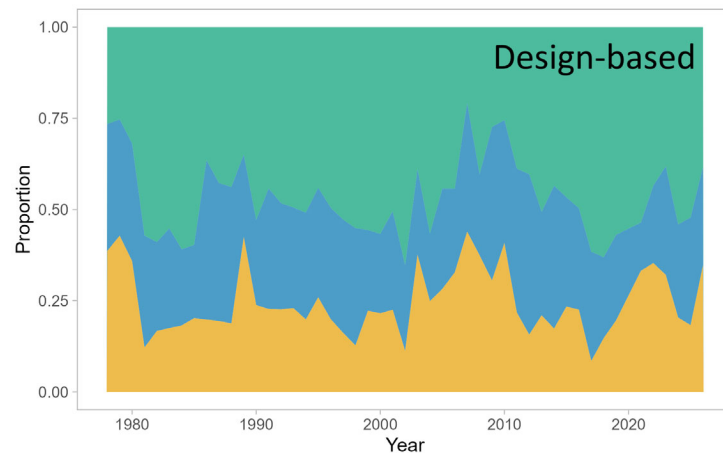


Model- vs. design-based size comps

Spatiotemporal model-based size composition standardization takes into account potential spatial imbalances in sampling data when producing proportion-at-size estimates

Proportion of size 1 males consistently lower in model-based estimates

Size 1 males recorded at fewer stations than size 2 or 3 males in 36 / 48 years

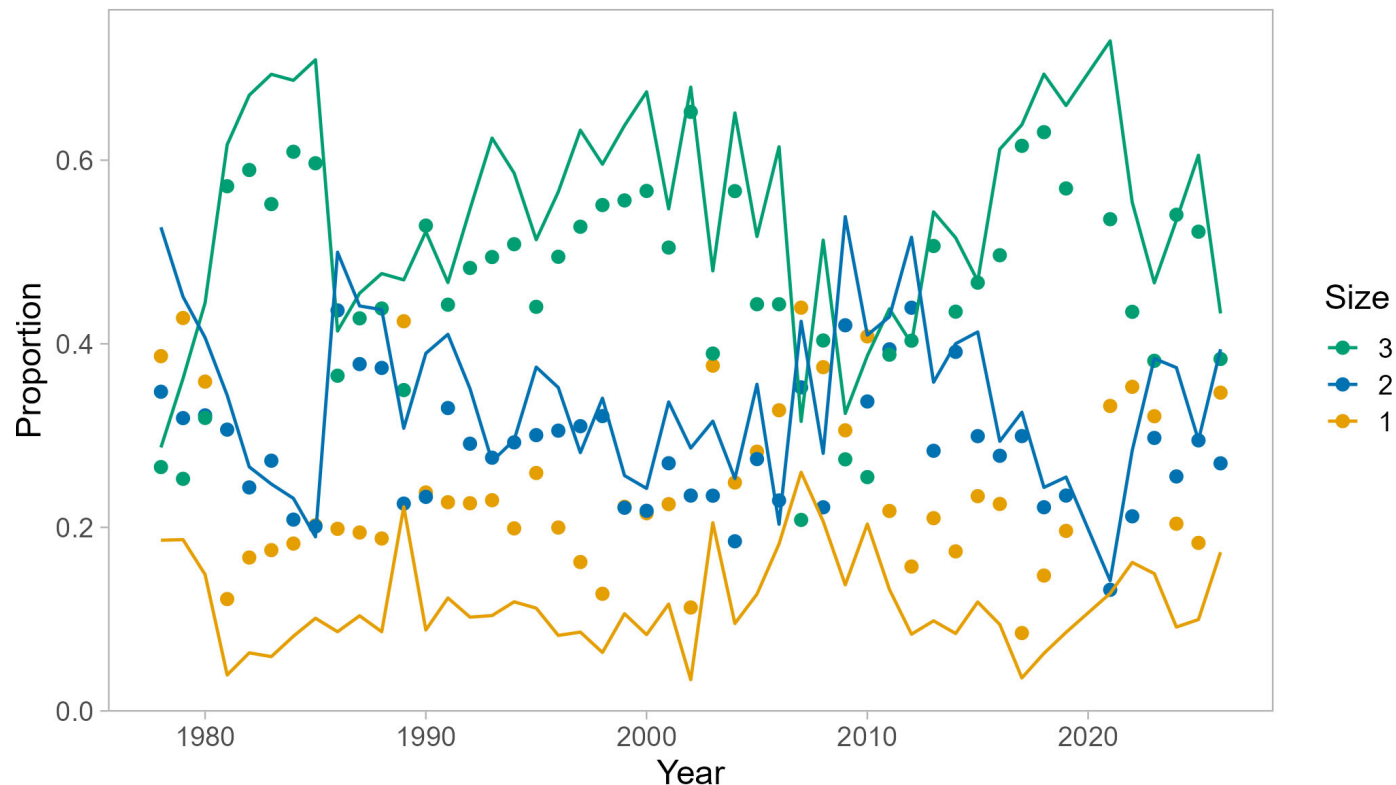


Model- vs. design-based size comps

Spatiotemporal model-based size composition standardization can produce more accurate proportion-at-size estimates when sampling data are spatially unbalanced

Proportion of size 1 males consistently lower in model-based estimates

Size 1 males recorded at fewer stations than size 2 or 3 males in 36 / 48 years



Topics

Priorities for the assessment

Bridging: newer GMACS version

Bridging: data updates

Development of a model-based index (MBI)

Development of model-based size compositions

Proposed models including model-based index and comps



Proposed models for 2026

26.1b: base model with updated GMACS version and data

26.2: 26.1b with model-based index for EBS trawl survey

26.2a: 26.2 with model-based size comps for EBS trawl survey

Model	No. converged jitter runs	No. runs with min. OF value	Max. gradient at MLE
26.1b	100	90	0.000000
26.2	100	81	-0.000001
26.2a	100	84	0.000003

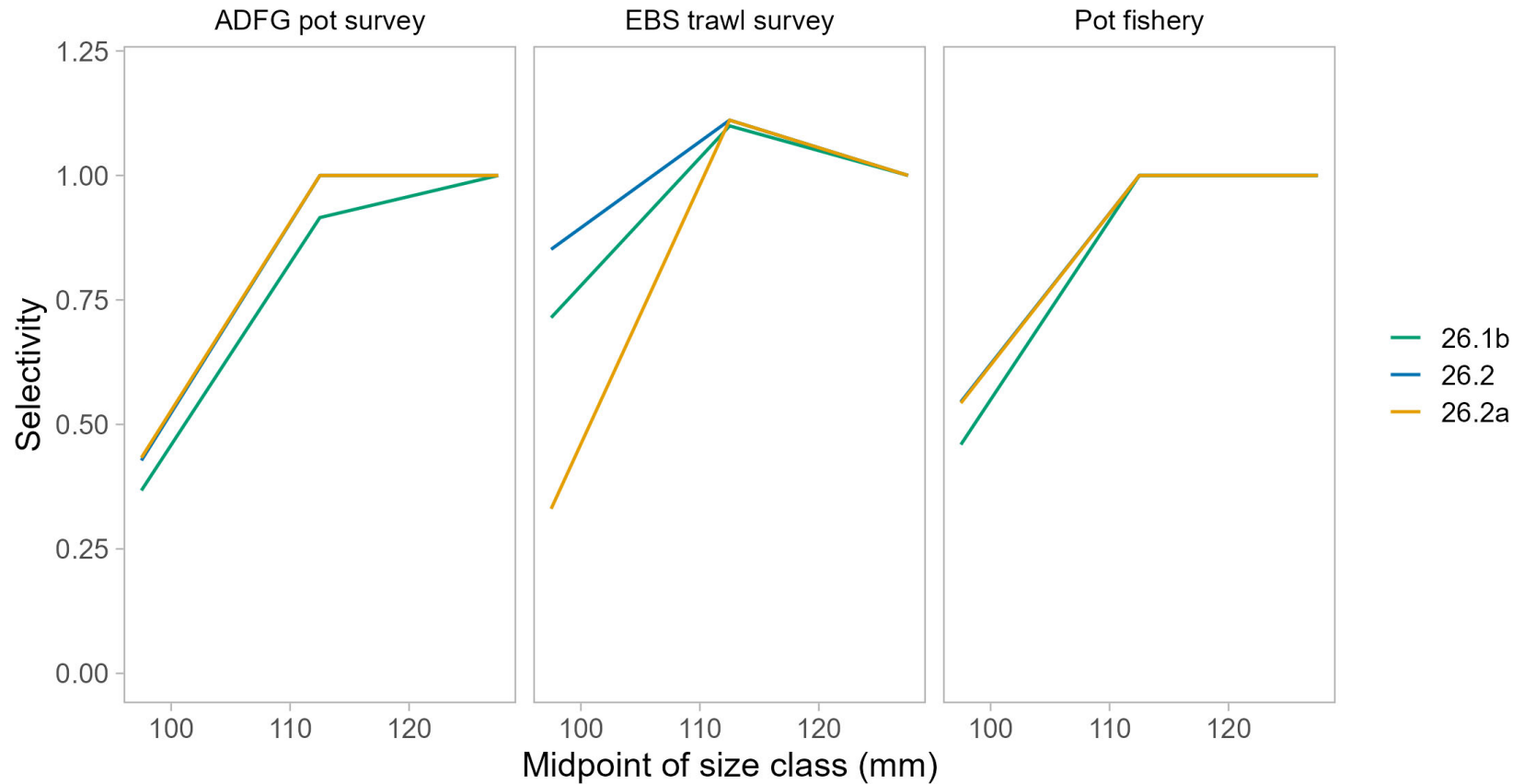


Model results

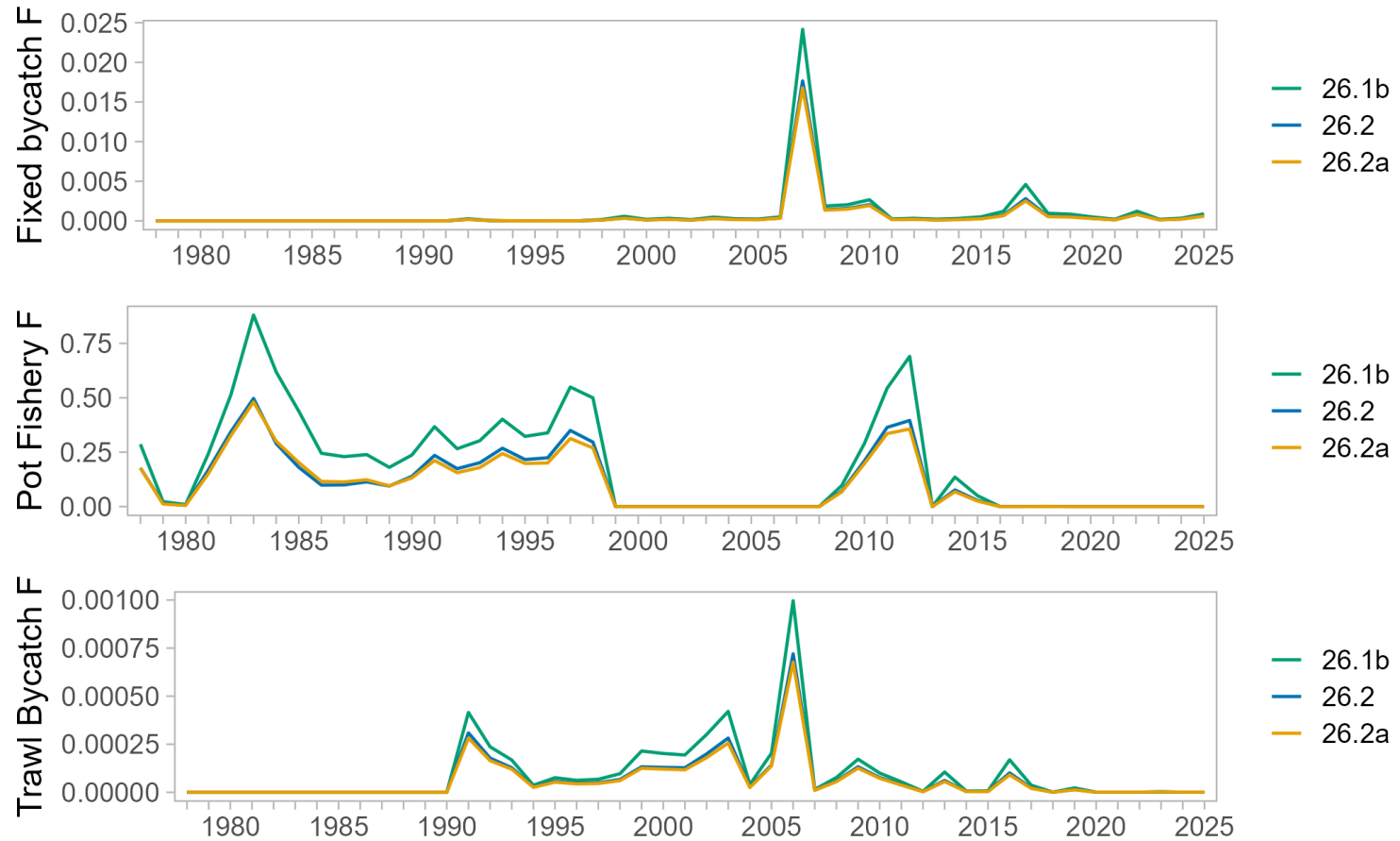
- Selectivity, fishing mortality, natural mortality
- Fits to time series: catch, indices, size comps
- Recruitment, MMB
- Retrospectives
- Reference points



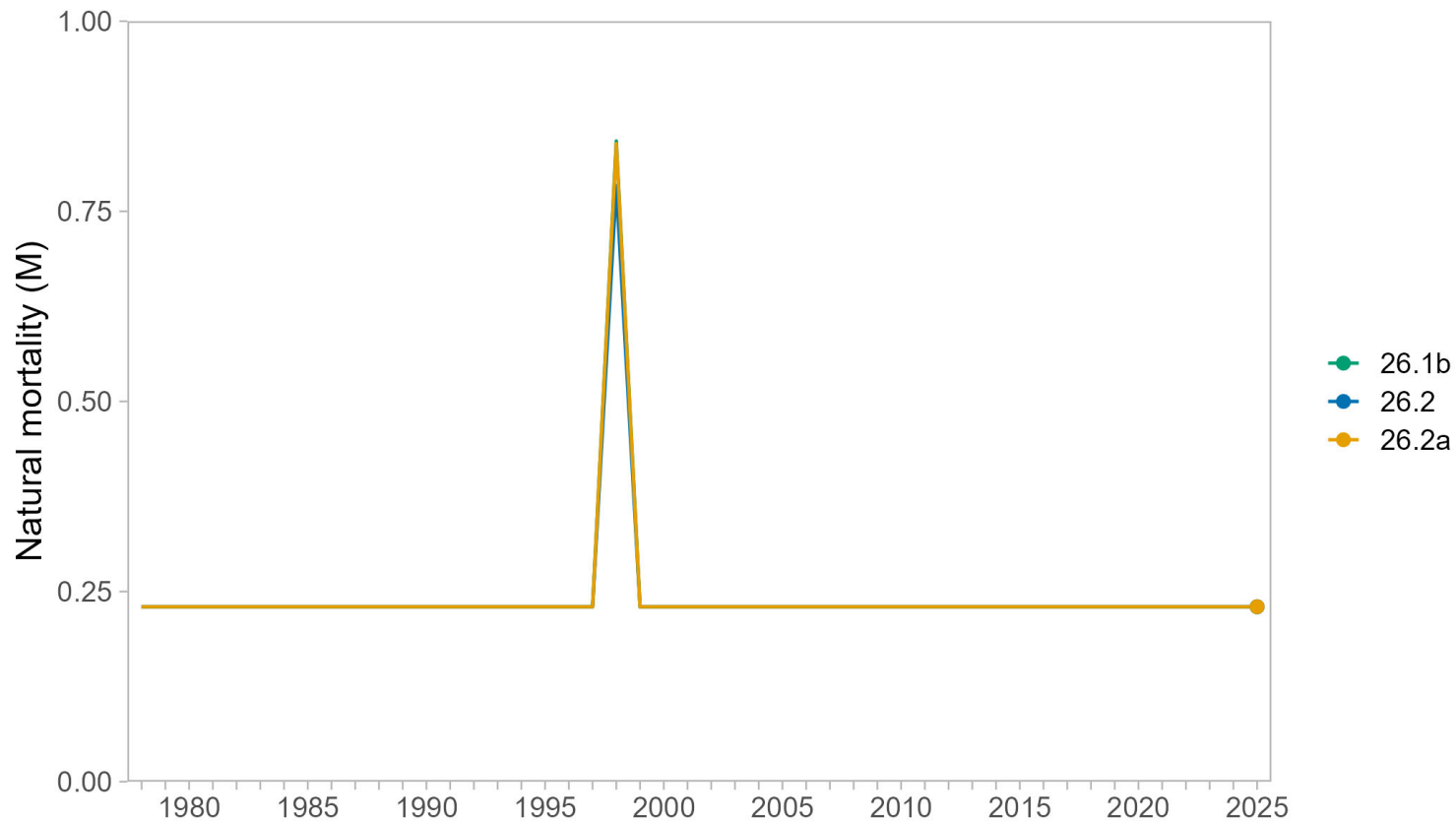
Selectivity



Fishing mortality



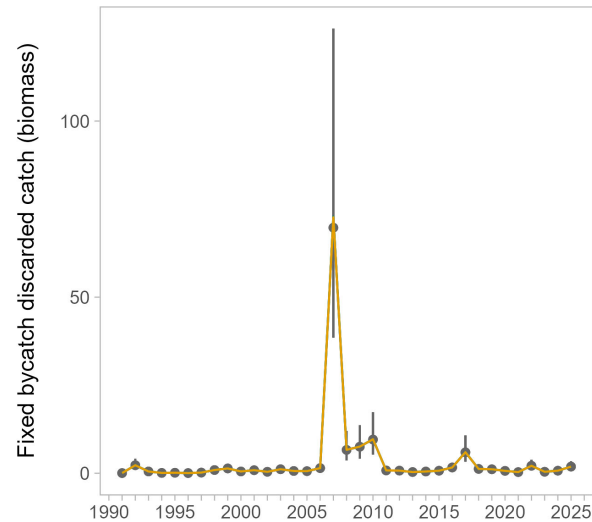
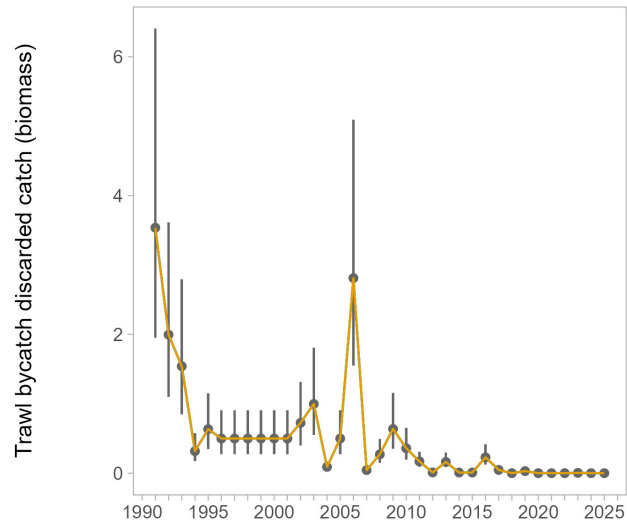
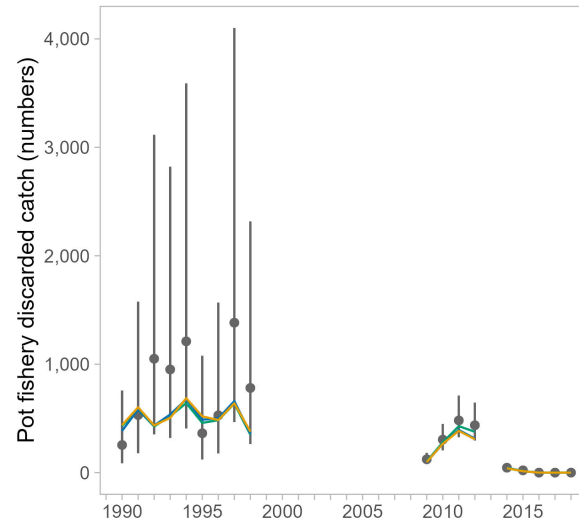
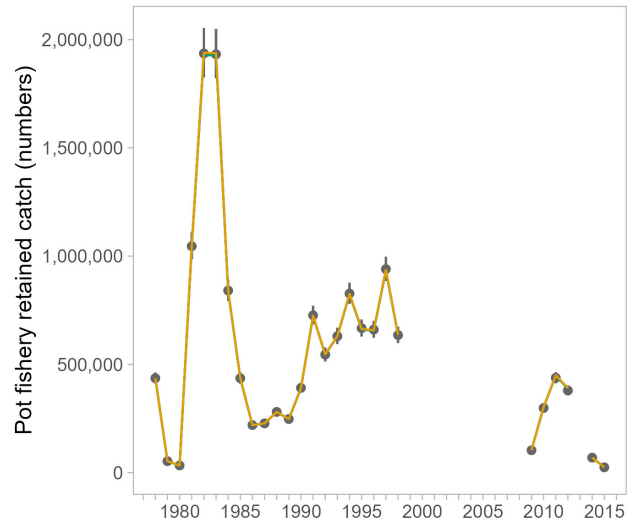
Natural mortality



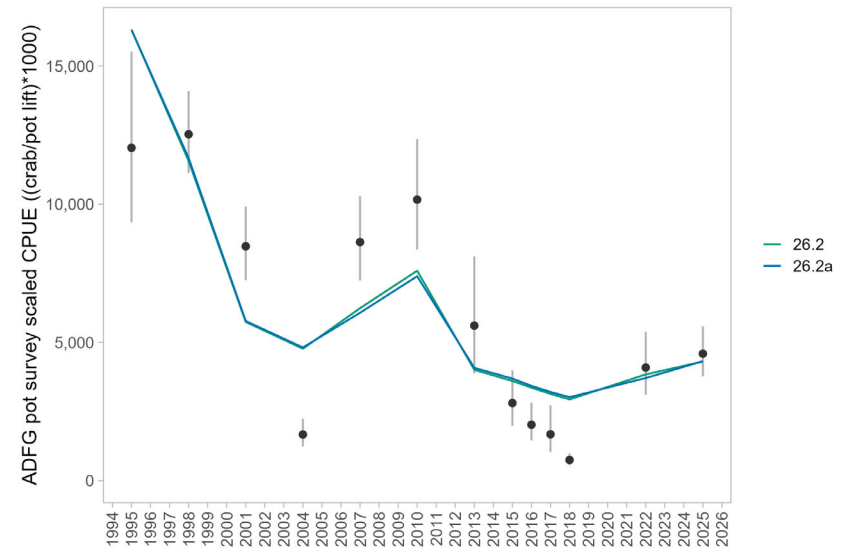
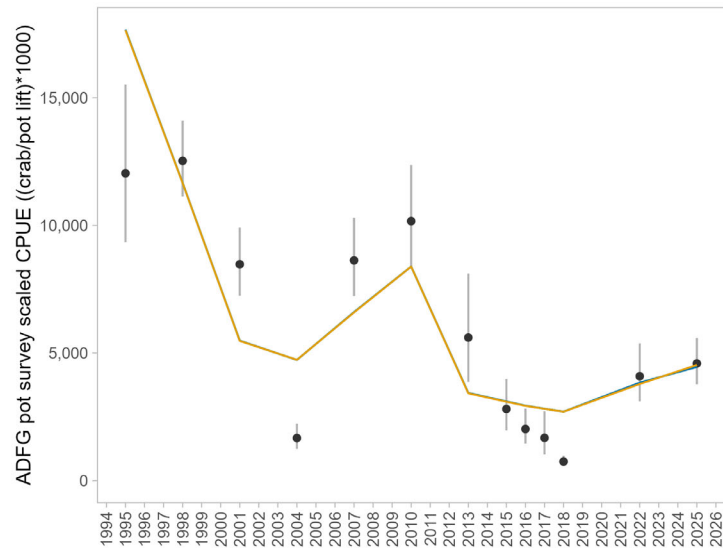
$M = 0.23$ except for estimated 1998/1999 event



Fits to fishery catch data



Fits to ADF&G pot survey index

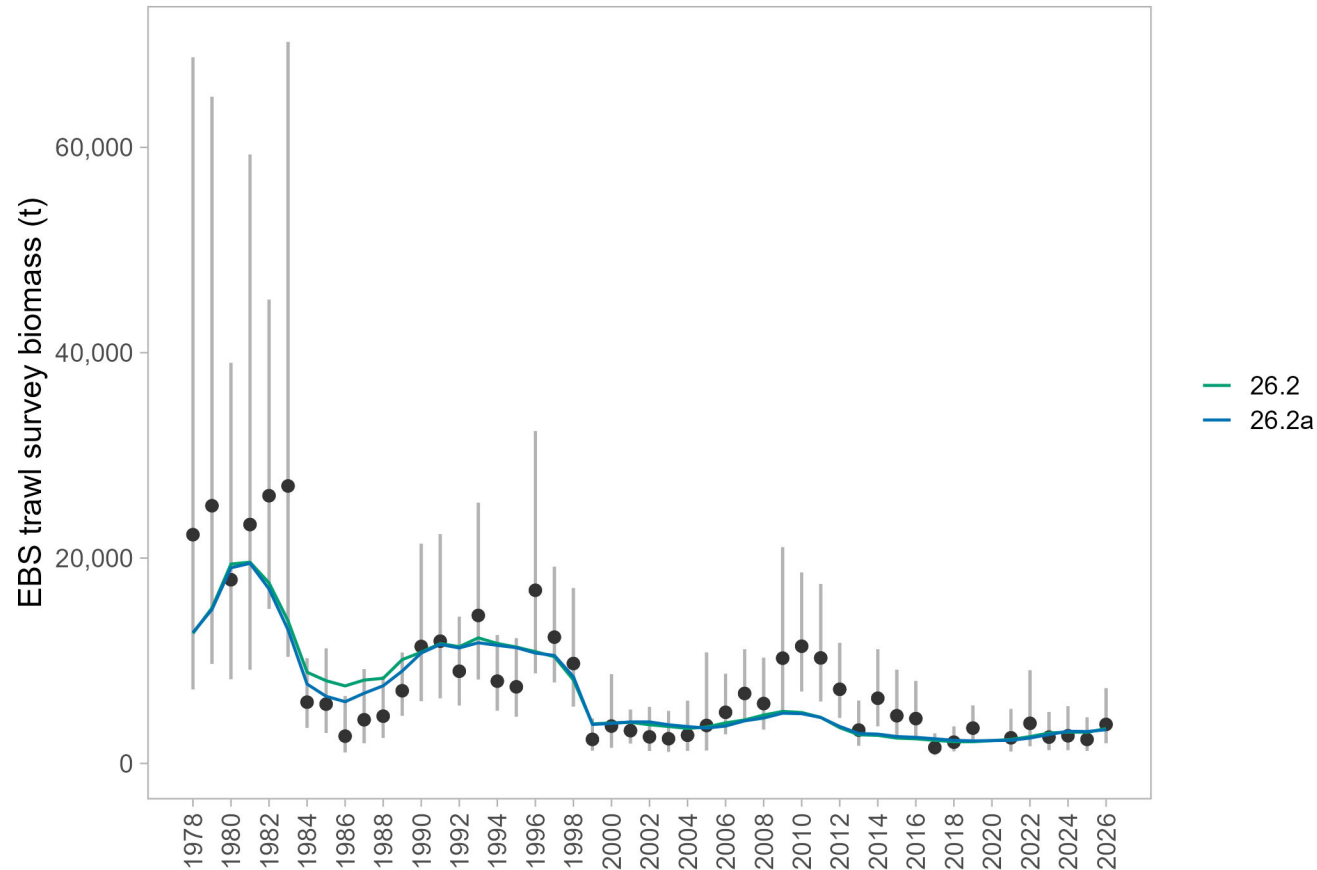


Ranking of fits, best to worst:

26.1b > 26.2 > 26.2a



Fits to model-based EBS survey index

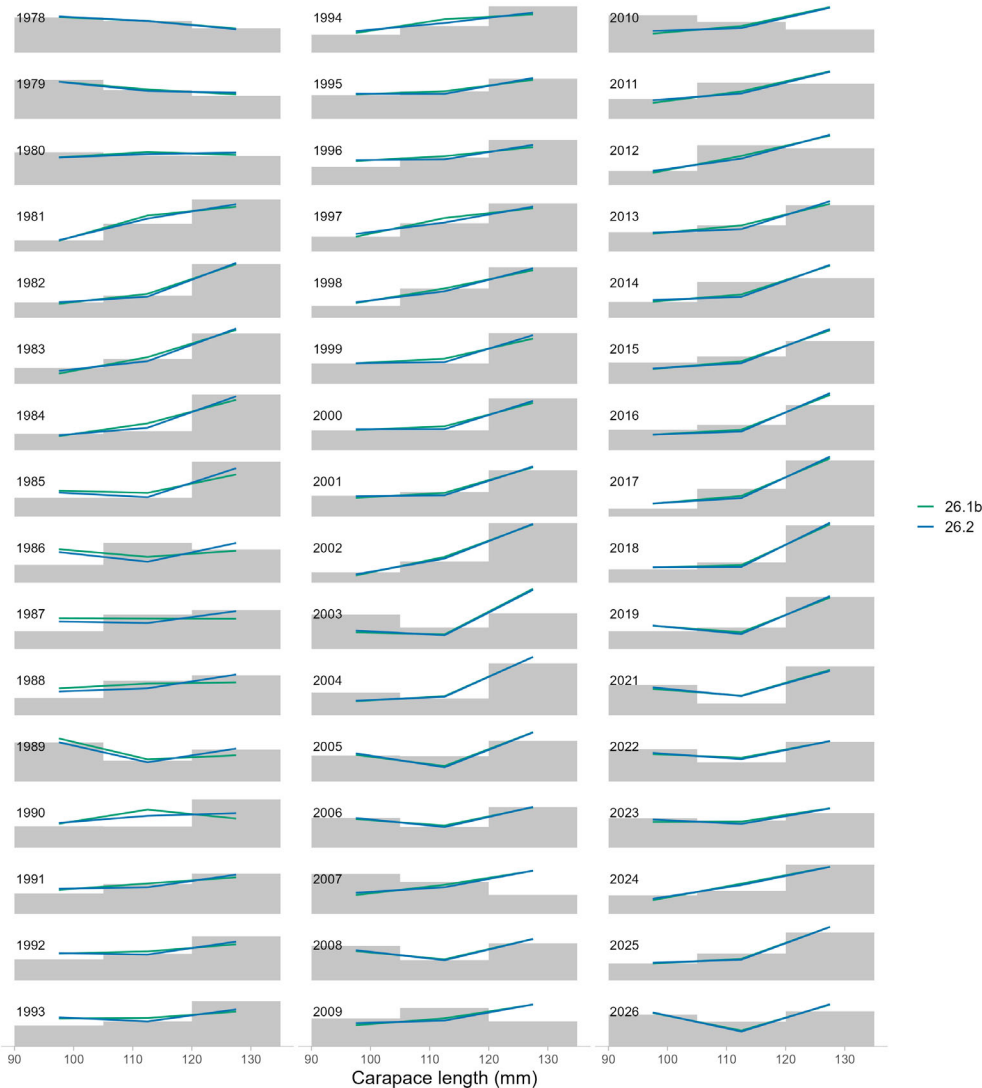


Ranking of fits, best to worst:

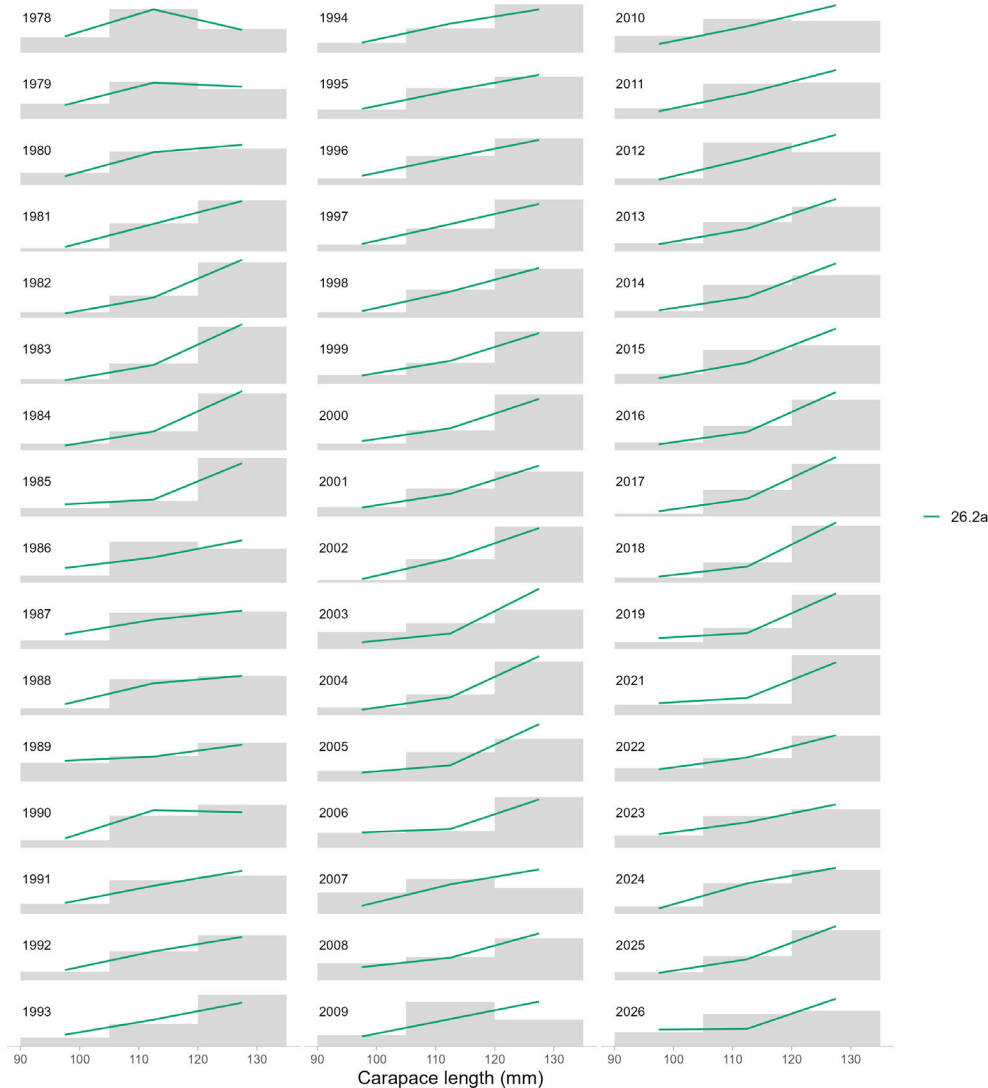
36/51 26.2a > 26.2



Fits to design-based size comps



Fits to model-based size comps

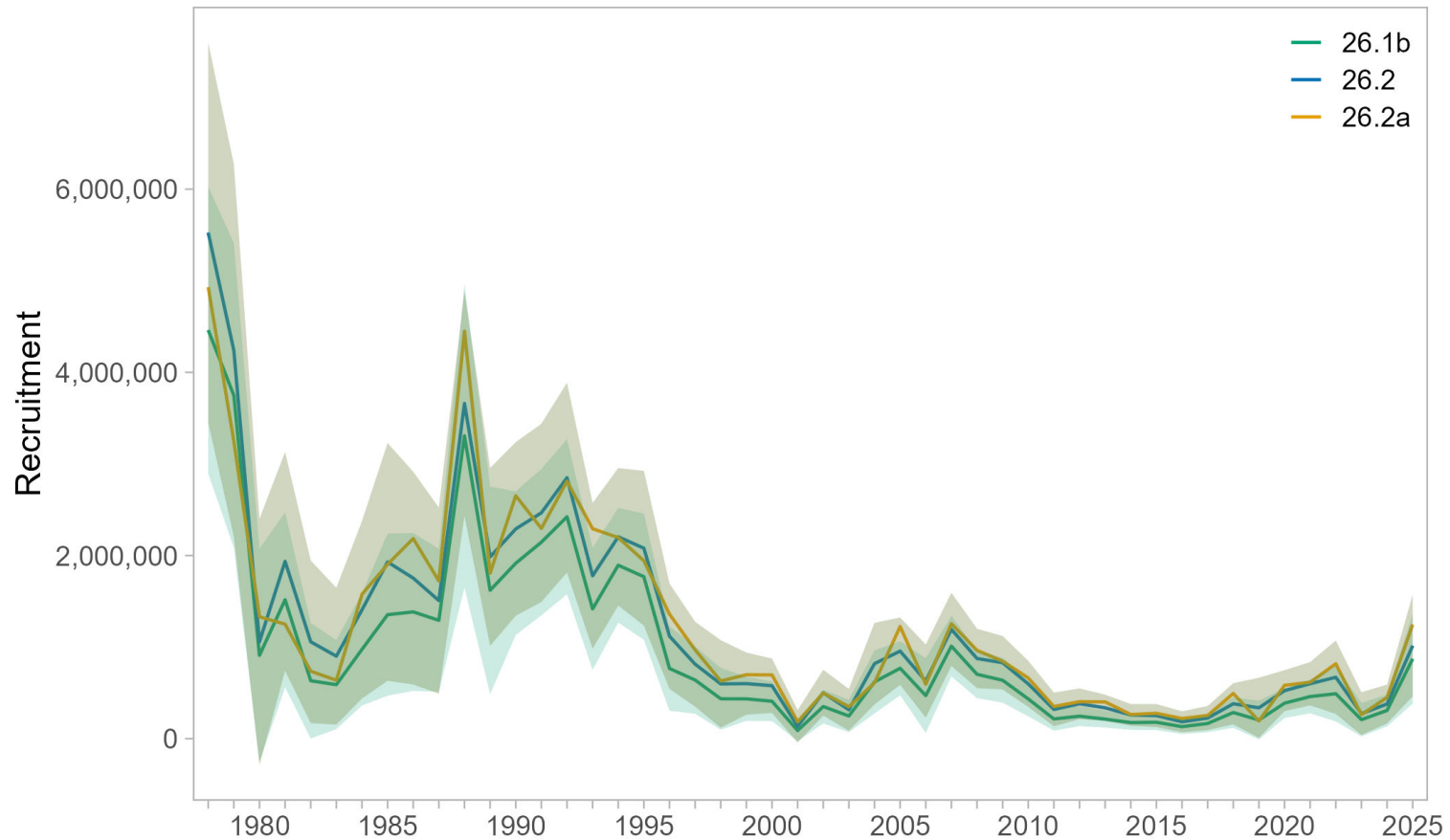


Fits to size comps

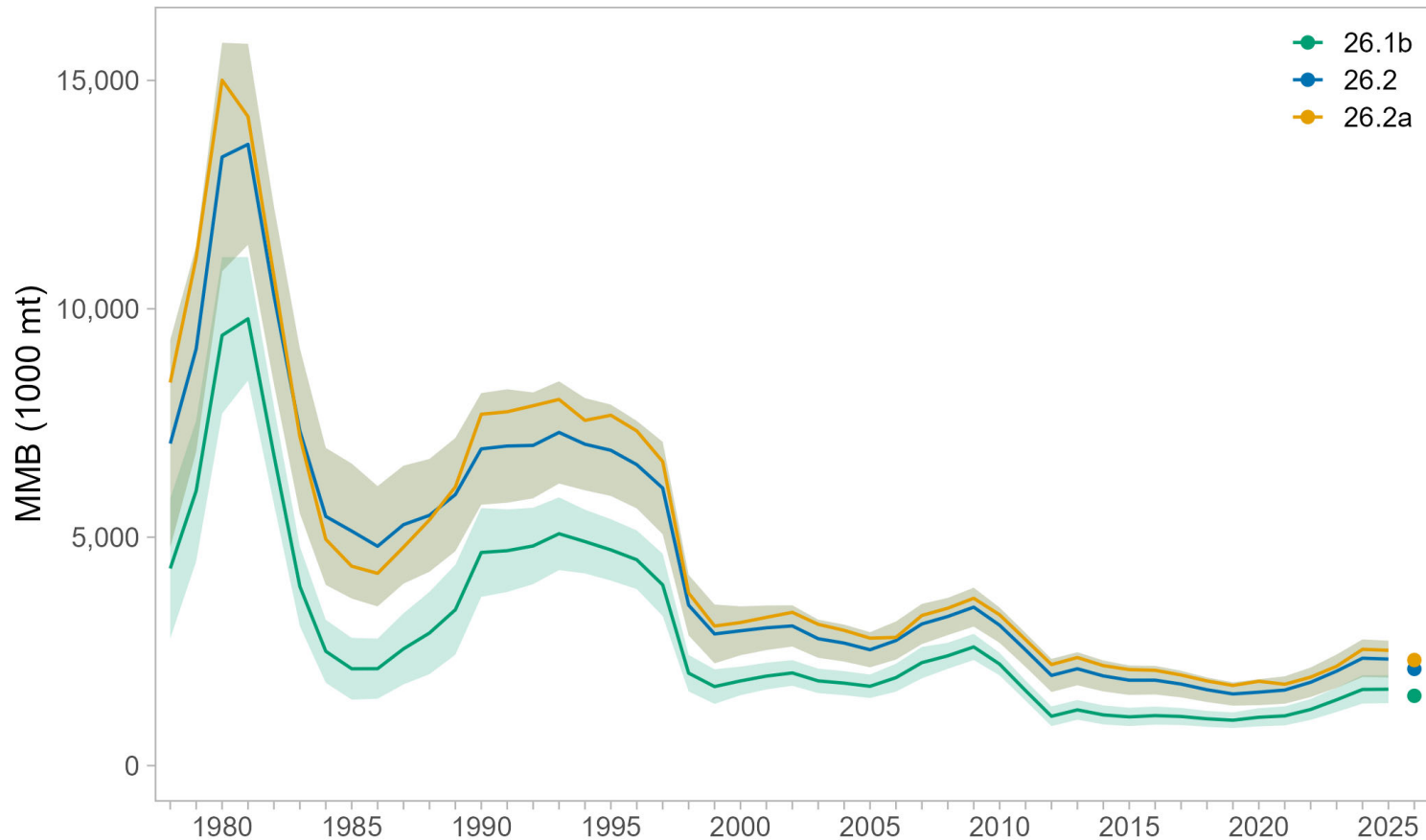
Component	26.1b	26.2	26.2a
Pot fishery	-105.1	-105.2	-105.8
EBS trawl survey	-291.2	-298.3	-306.6
ADFG pot survey	-108.5	-108.5	-107.7



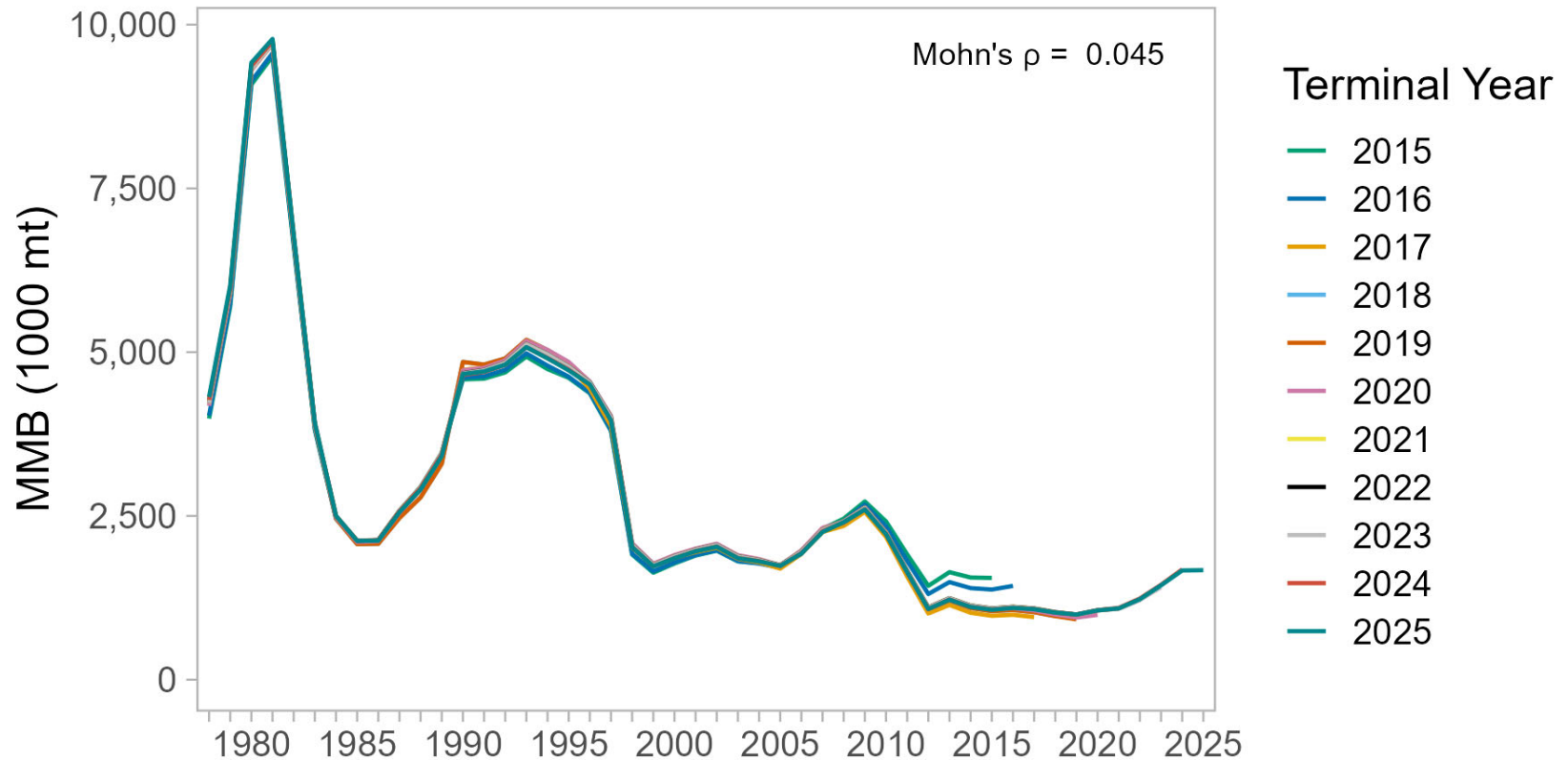
Recruitment



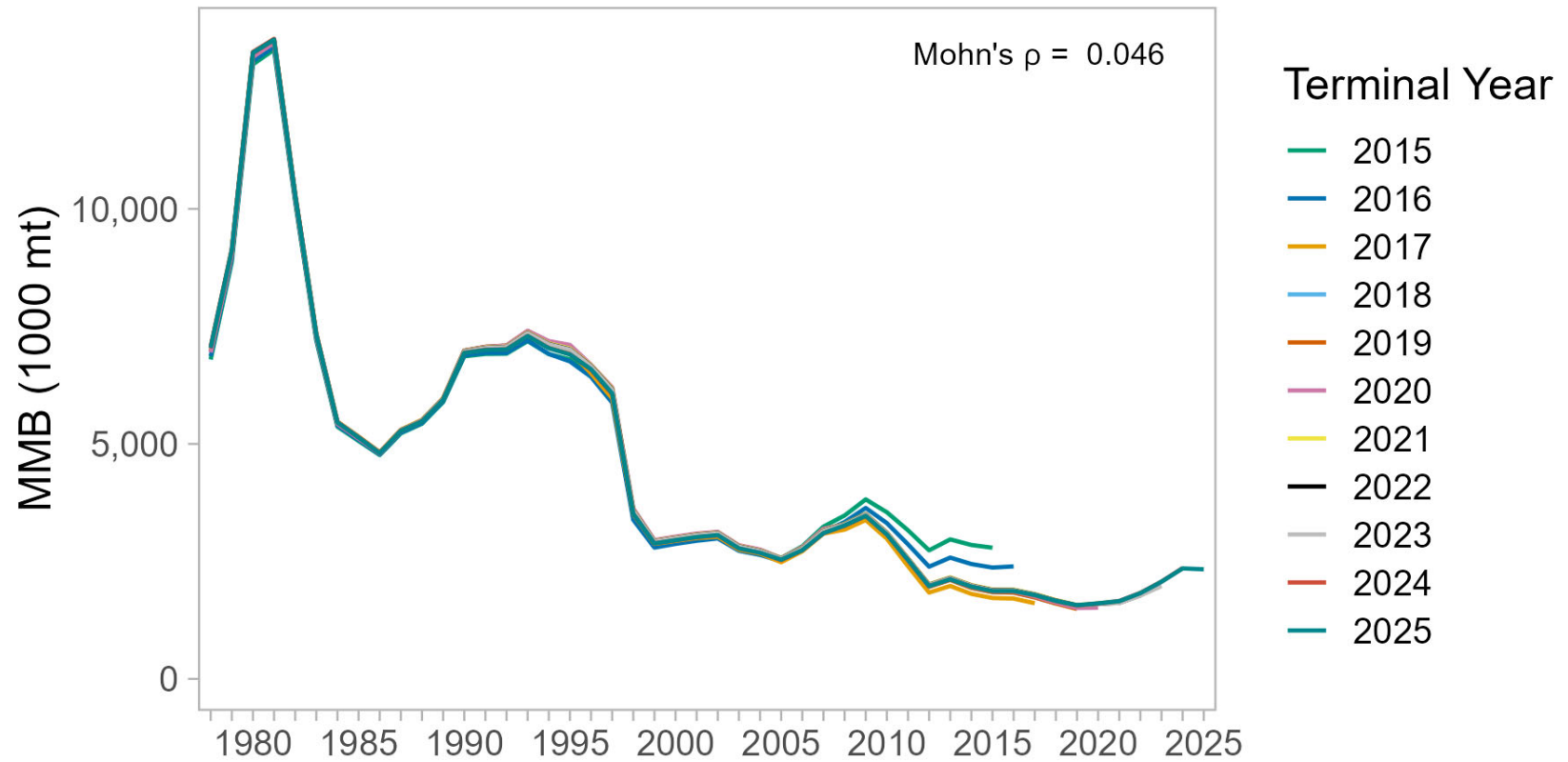
Mature male biomass



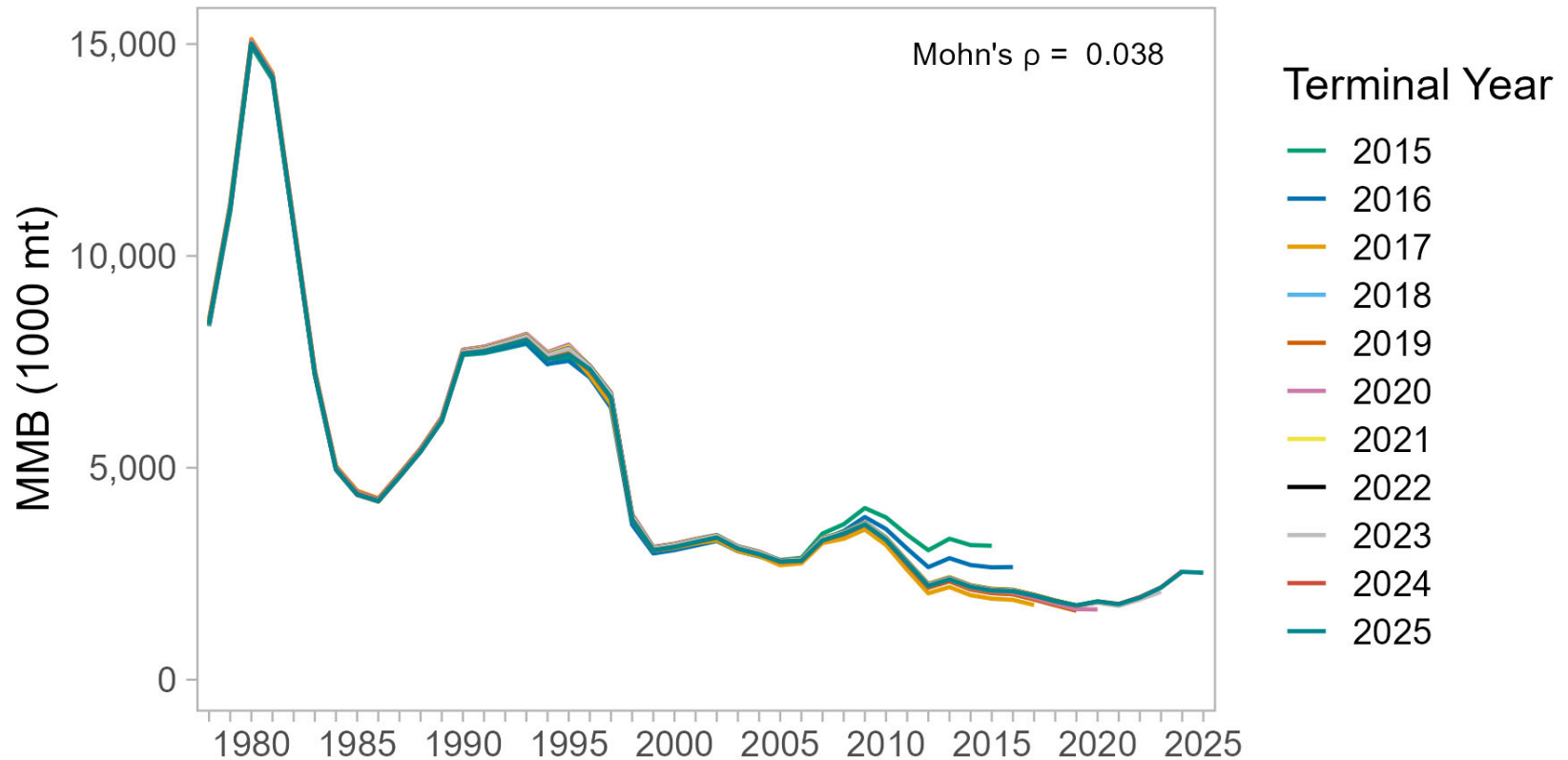
Retrospective analysis - 26.1b



Retrospective analysis - 26.2



Retrospective analysis - 26.2a



Reference points

	26.1b	26.2	26.2a
MMB_{2026}	1,528	2,116	2,311
B_{MSY}	2,876	4,497	4,812
MMB/B_{MSY}	0.53	0.47	0.48
F_{OFL}	0.11	0.1	0.1
OFL_{2026}	151	182	202
ABC_{2026}	106	127	142

units: metric tons



Comparison of model scenarios

Model-based index (MBI) of abundance

- accounts for changes in survey station sampling over time
- produces consistent time series of biomass estimates

Models 26.2 and 26.2a include MBI

Model 26.2a includes model-estimated size compositions

- 26.1b and 26.2 have similar retrospective patterns
- 26.2a shows an improved retrospective pattern



Author-recommended model: 26.2

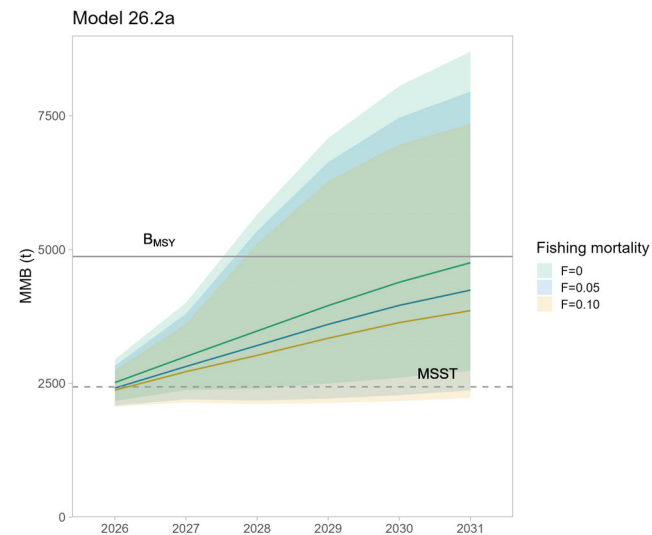
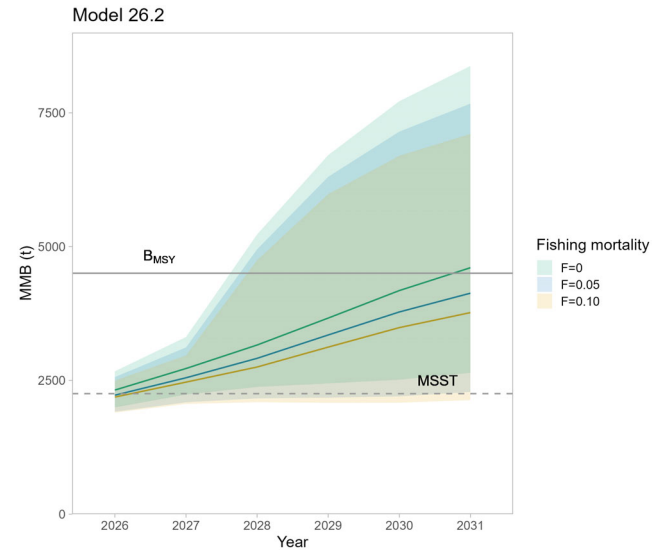
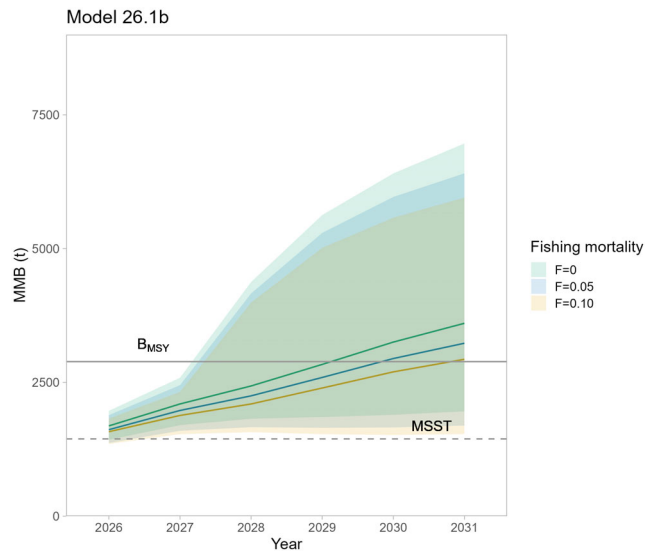
	26.1b	26.2	26.2a
MMB_{2026}	1,528	2,116	2,311
B_{MSY}	2,876	4,497	4,812
MMB/B_{MSY}	0.53	0.47	0.48
F_{OFL}	0.11	0.1	0.1
OFL_{2026}	151	182	202
ABC_{2026}	106	127	142

Authors recommend moving to a unified approach to standardizing EBS trawl survey data (biomass and size compositions) in future.



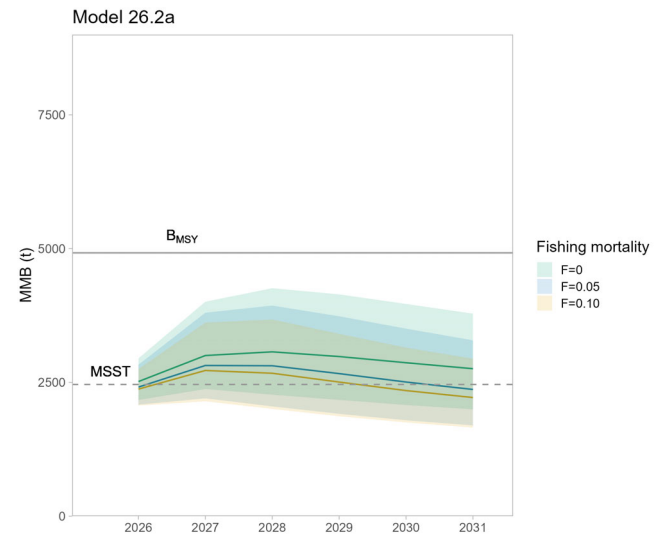
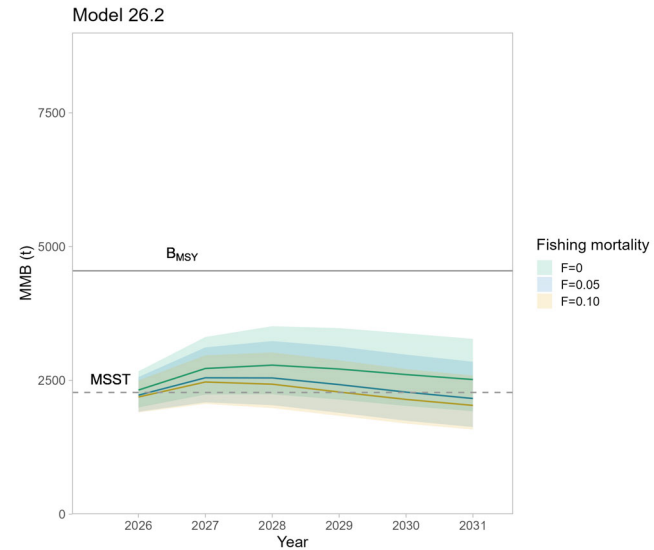
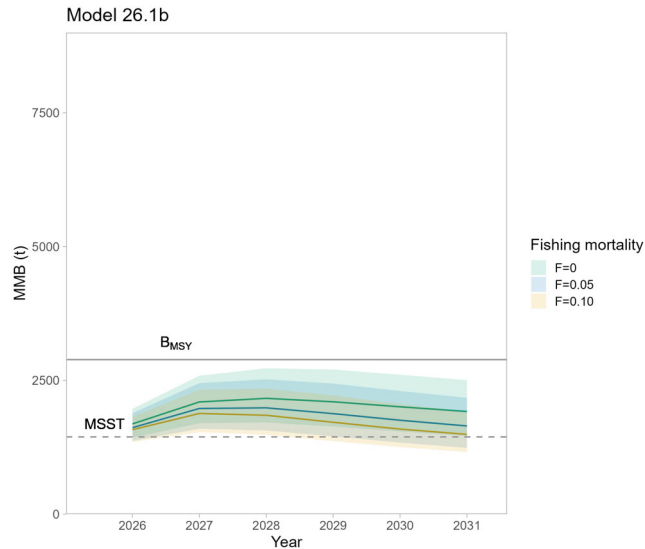
Projections - time series recruitment

B_{MSY} for this Tier 4 stock is average estimated MMB from 1978 to the most recent completed crab year



Projections - recent recruitment

B_{MSY} for this Tier 4 stock is average estimated MMB from 1978 to the most recent completed crab year



Future work



- include model-based size compositions for EBS trawl survey
- create single model-based index including both EBS trawl and ADF&G pot survey data
- explore estimation of catchability for the biomass index



Thanks!

Helpful reviews: Chris Siddon, Tyler Jackson, Aaron Lambert

GMACS development: Buck Stockhausen, André Punt, Tyler Jackson

Model-based index development: Lewis Barnett, Sean Hardison, Emily Ryznar

R packages: Tyler Jackson (gmacsr), Shannon Hennessey (crabpack)



Jared Weems

