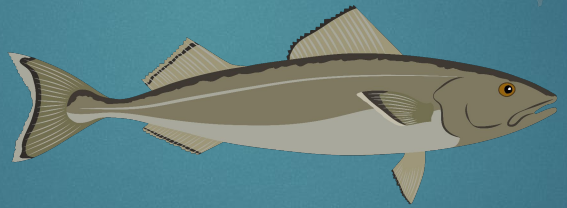
Sablefish Management Strategy Evaluation (MSE) Tool Development and Results of the Spatial Analyses



Joshua A. Zahner, Dan Goethel, Curry Cunningham, Matt Cheng, Ben Williams

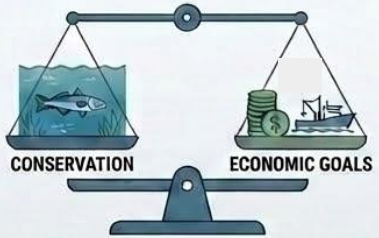
SABLEFISH MSE PROJECT: KEY OBJECTIVES

ADDRESSING ROBUSTNESS

Test NPFMC HCR performance for long-term yield and conservation.

SPATIAL CONSEQUENCES

Evaluate regional impacts of HCRs considering recruitment and movement shifts.

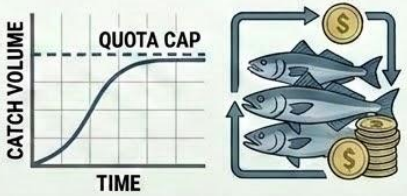


BALANCING OBJECTIVES

Balance conservation priorities with economic goals like yield and stability.

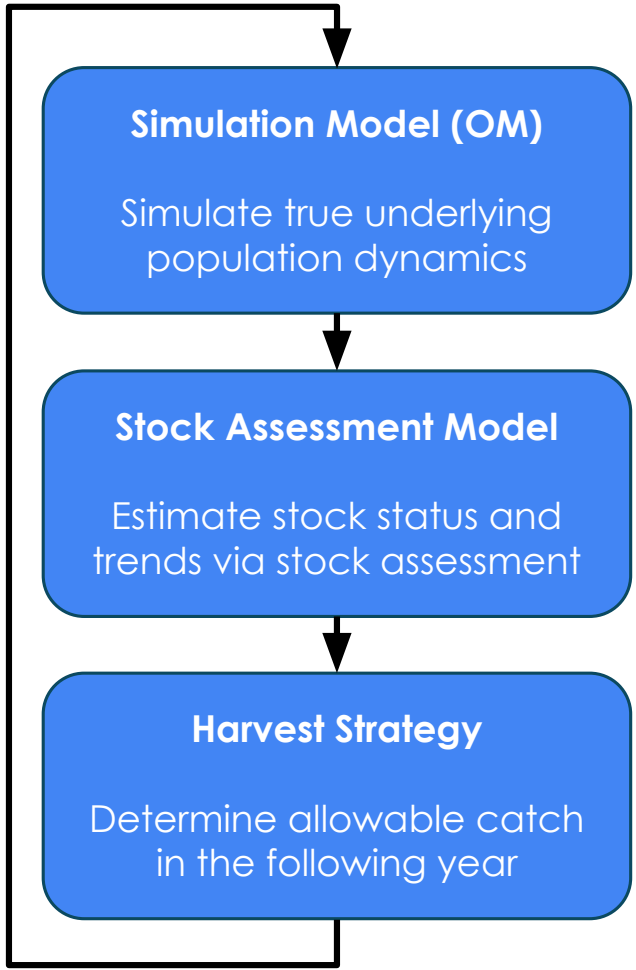
STAKEHOLDER ENGAGEMENT

Collaborate with stakeholders to address NPFMC constituent concerns.



EXPLORE QUOTA CAPS

Test if quota caps can optimize economic value and manage market saturation for long-lived species.



Management Strategy Evaluation

Simulation tool for comparing the performance of different management strategies across a range of demographic, estimation, and implementation uncertainties.

3 stakeholder meetings to elicit feedback on alternative HCRs, relevant performance metrics, and future OM scenarios:

- June 2024, December 2024, April 2025

Feedback spurred development of the spatial OM, refinements to value-based metrics, and alternative HCRs.

NOTE: this work constitutes development of an MSE tool, and does not reflect intention by the authors to pursue modifications to the existing sablefish HCR (which requires a NFPMC process)

Sablefish MSE Tool Building Process

- Develop single-region MSE model
- Hold stakeholder meeting to identify relevant alternative HCRs
- Present initial results to stakeholders for feedback
- Develop additional alternative HCR based on stakeholder feedback
- Present single-region model results to JPT
- Develop multi-region MSE model at stakeholder request
- Present multi-region model results to JPT  we are here
- Hold final stakeholder meeting to present multi-region model results (TBD; 2027)

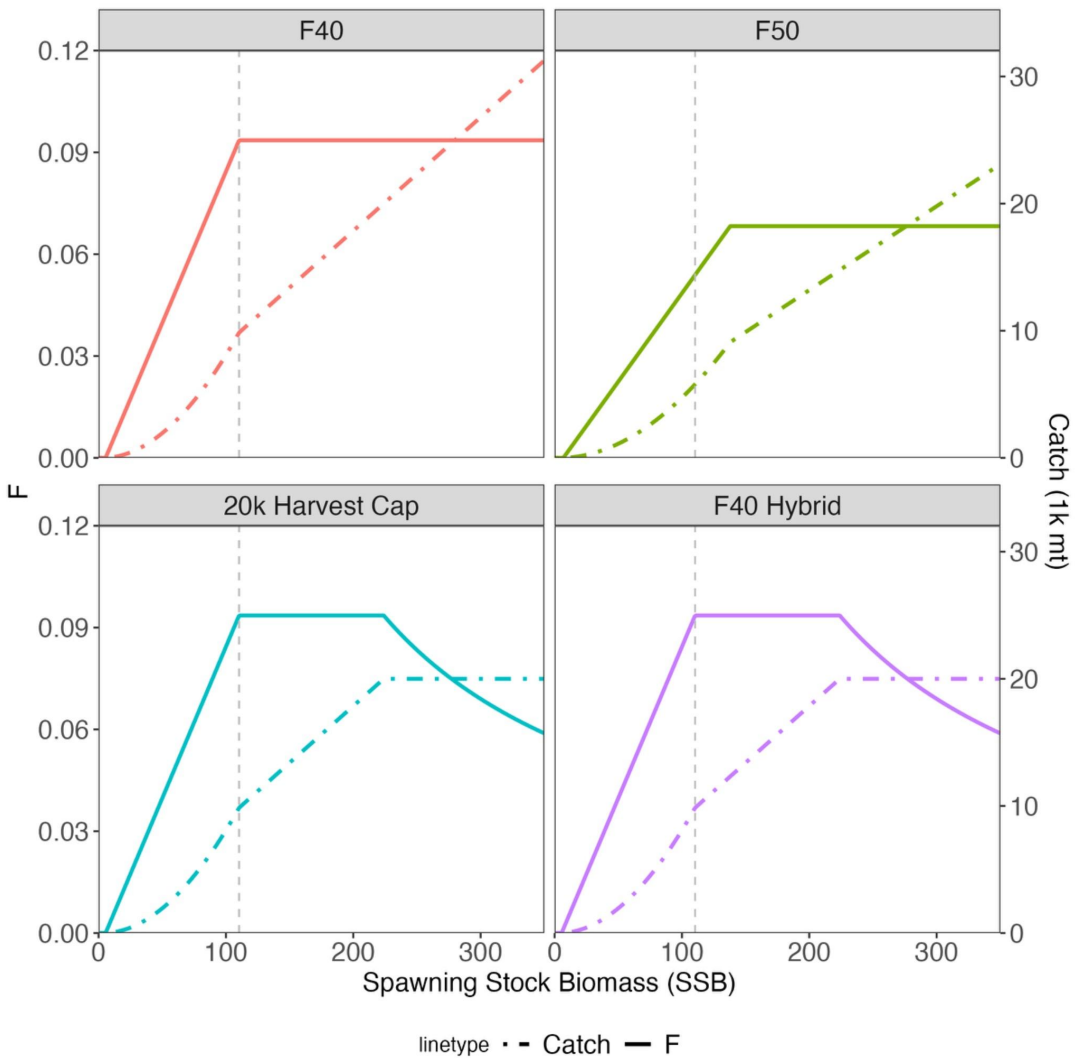
Harvest Control Rules

F40 - $SPR_{40\%}$ RPs (status quo)

F50 - $SPR_{50\%}$ RPs

F40 Hybrid - $SPR_{40\%}$ RPs + 20k harvest cap + 10% up stability constraint (Zahner et al. *(in review)*)

20k Harvest Cap - $SPR_{40\%}$ RPs + 20k harvest cap



Performance Metrics

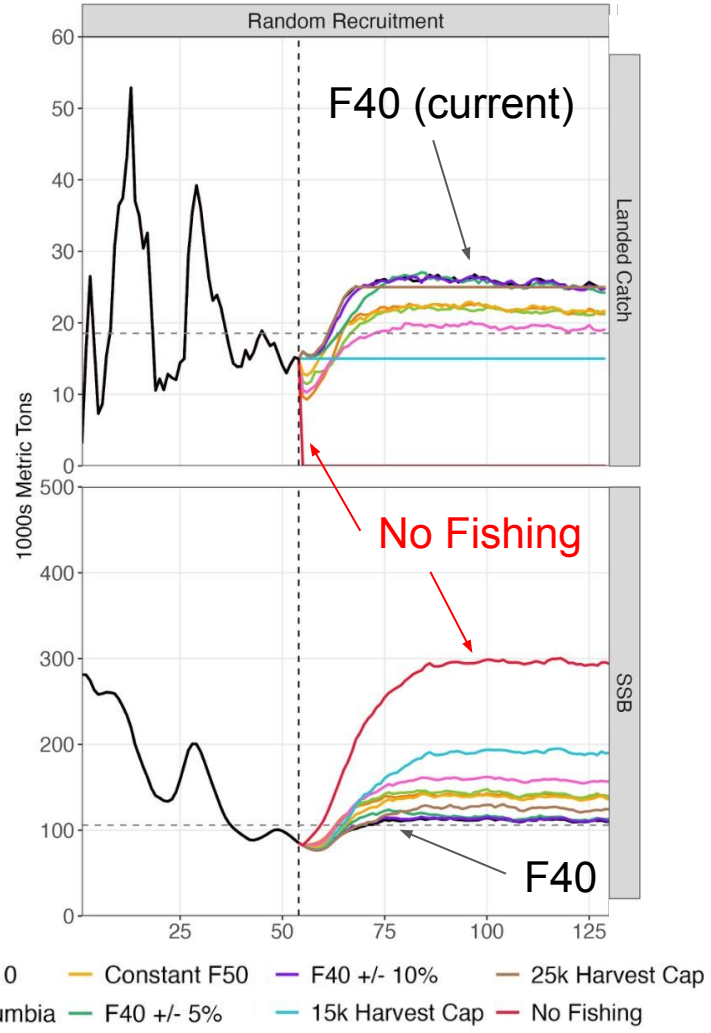
- Average Catch - indicator of total fishery performance
- Catch AAV - indicator of catch stability
- Average SSB - indicator of population size
- Average Age - indicator of population age structure
- Proportion Large Catch - indicator of quality of fishery landings
- Dynamic Economic Value* - indicator of economic performance

** assumes negative relationship between landings and prices; implemented at stakeholder request despite limited economic data to parameterize relationship*

Also: Proportion of Years SSB < B35 and Proportion of Years on HCR Ramp

Summary of MSE Results to Date

- F40 HCR is robust to substantial recruitment variability, including regime changes and sudden crashes



Zahner et al. (2026). Canadian Journal of Fisheries and Aquatic Sciences.

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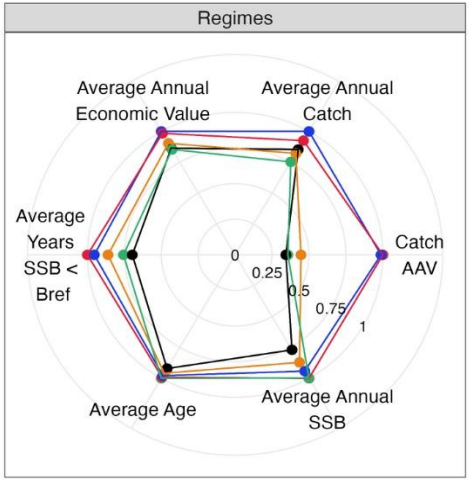

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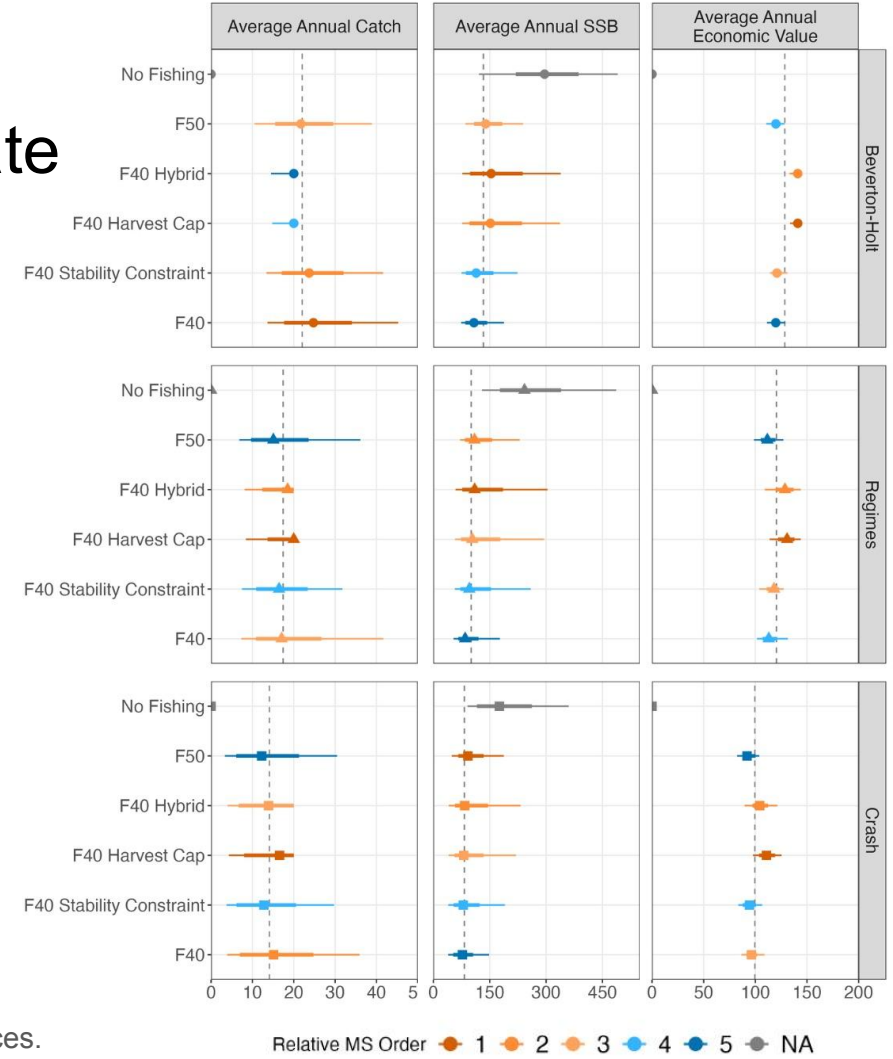
Summary of MSE Results to Date

- F40 HCR is robust to substantial recruitment variability, including regime changes and sudden crashes
- Quota caps can be effective at simultaneously improving conservation and economic outcomes, particularly during periods of sudden productivity shifts
- Relative performance may change with recruitment scenario, however the relative ranking (e.g., the best performing HCR) is largely consistent across scenarios



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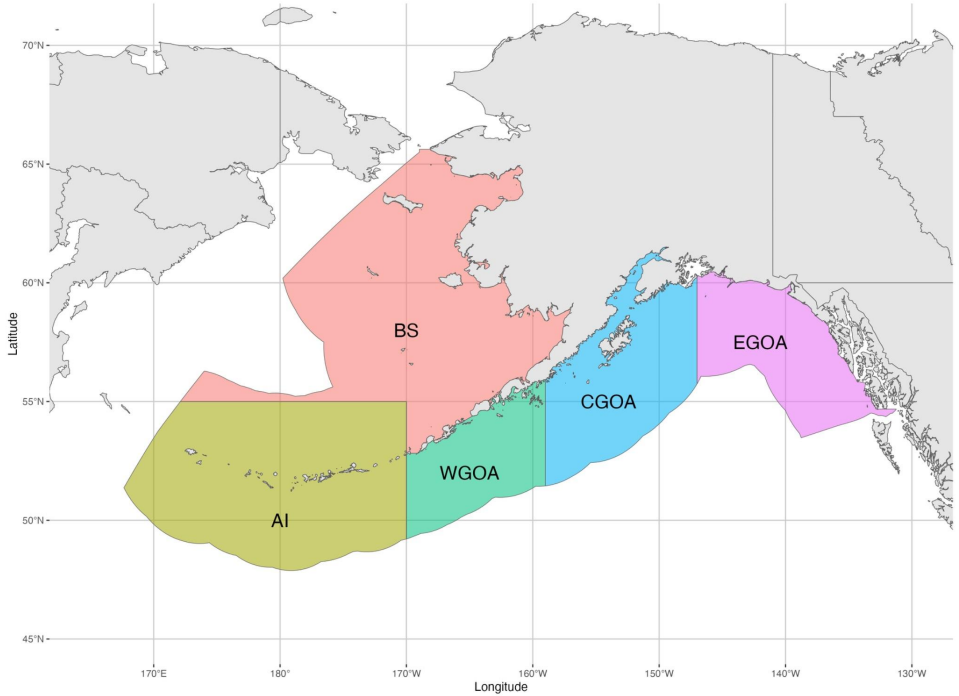
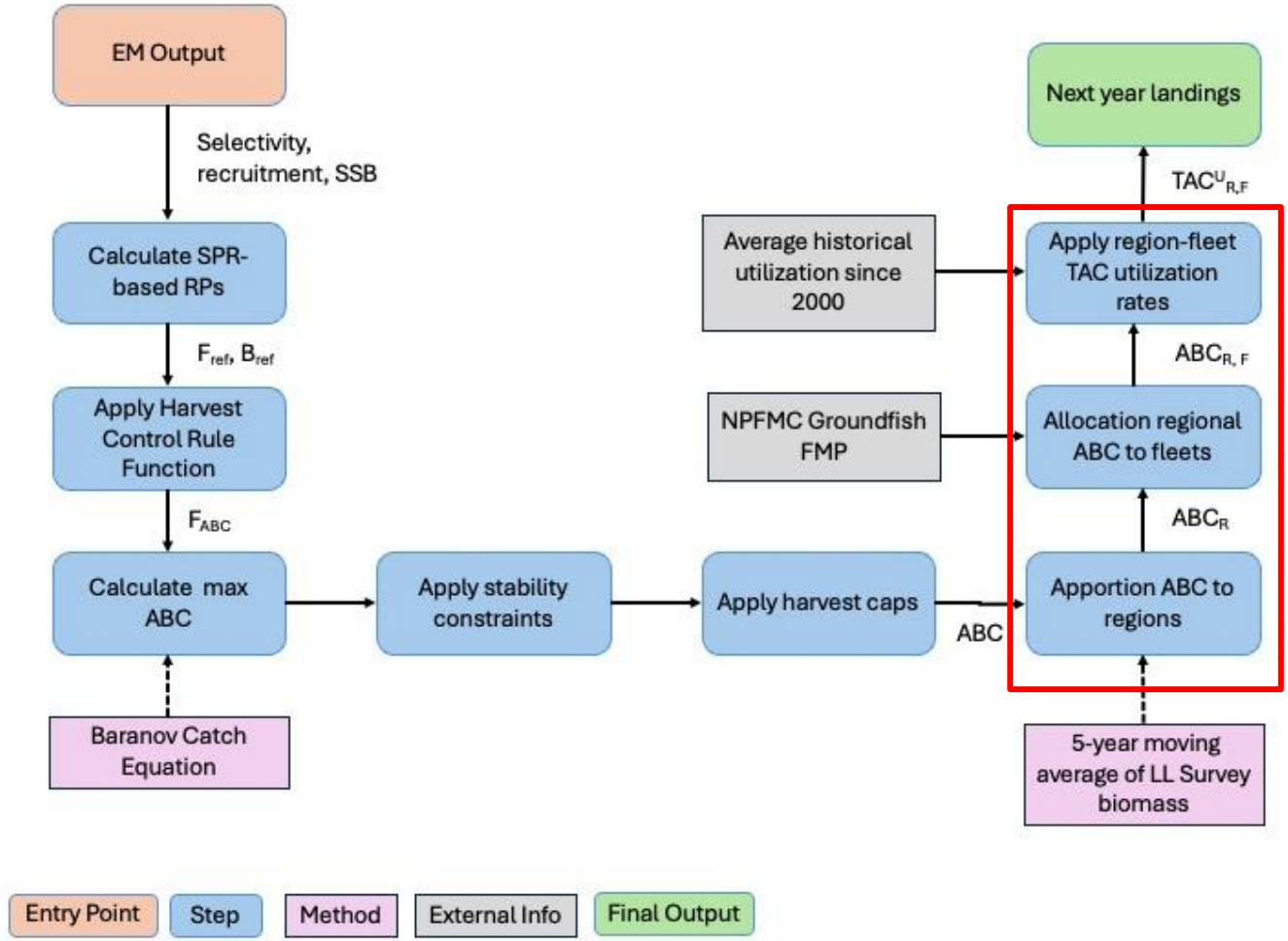
Spatial and non-spatial MSE



Spatial MSE

- Five region OM
  - Spatially homogeneous demographics/ selectivity
  - Inter-regional movement
- Single region EM** with data aggregated to the AK-wide level
- HCR applied by Alaska-wide biomass
- ABC apportionment by survey biomass
- Regional BRD assigned to fleets based on FMP
- Support for fleet-specific utilization rates

** - different model from single-area MSE EM



Management model now supports Biologically-informed Recommended Distributions (BRDs) for ABC among regions, fleet allocation, and TAC utilization rates.

Operating Model Scenarios

Recruitment Scenarios

BH Recruit - recruitment from a Beverton-Holt SRR (serves as a base equilibrium scenario)

Regime Recruit - recruitment alternates between high/low regime

Crash Recruit - recruitment crashes 15 years into the projection period before recovering

Movement Scenarios

AB Move - movement is age-based as informed by estimated movement rates (Cheng et al. 2025)

Climate Move - movement rates change so as redistribute the population towards western and northern regions of Alaska

Future Climate Scenarios

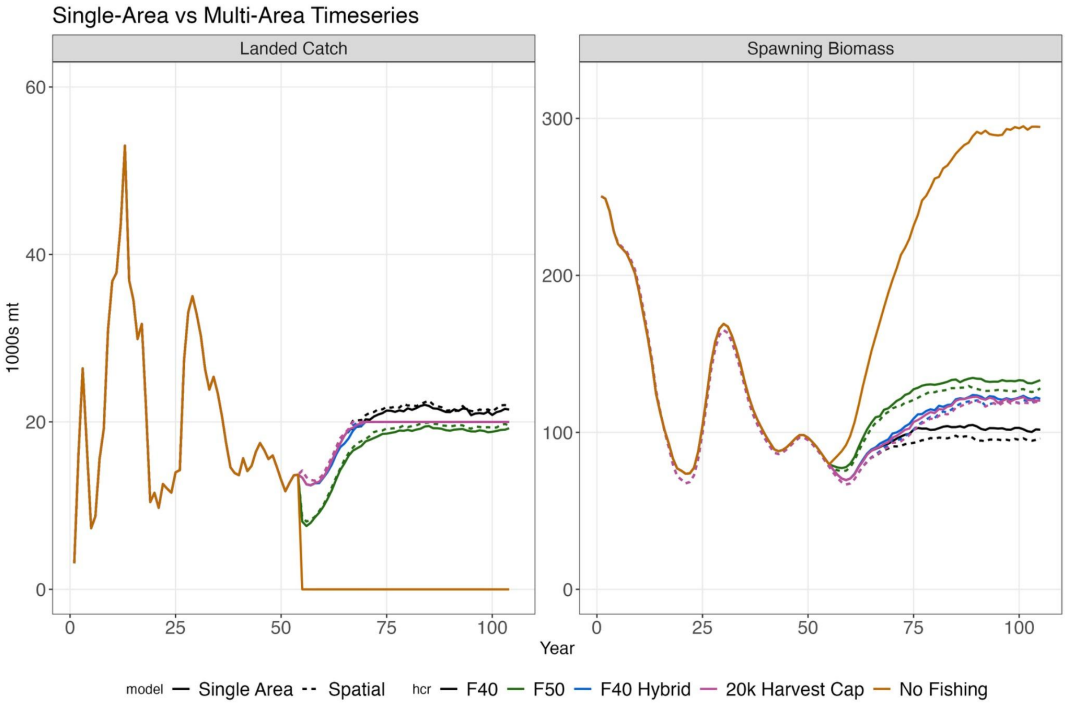
Designed to evaluate performance across a range of plausible futures (Climate Move), and expected (Regime Recruit) or worst case scenarios (Crash Recruit), rather than explicit predictions for the future directly linked to climate projections.

Comparison of Single Area/Spatial MSE

Extending the single-area MSE framework to a five-area spatial model did not substantially change Alaska-wide SSB or landings trajectories, despite including finer-scale recruitment patterns and fishery dynamics.

*** Implies single-area model is sufficient for testing of alternative HCRs. ***

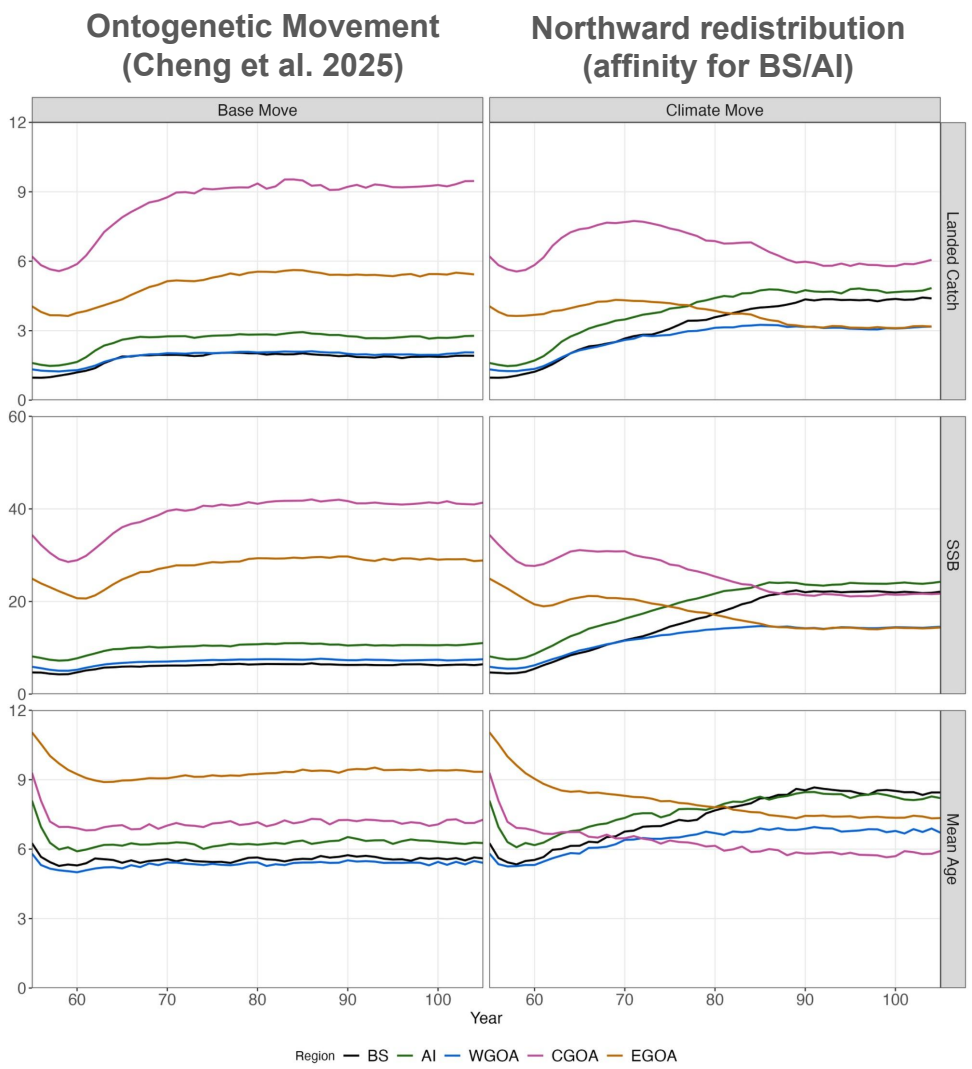
…..BUT, the spatial model better emulates the management framework and regional impacts, and is likely a better tool for future HCR analyses.



Regional Outcomes under Spatial MSE

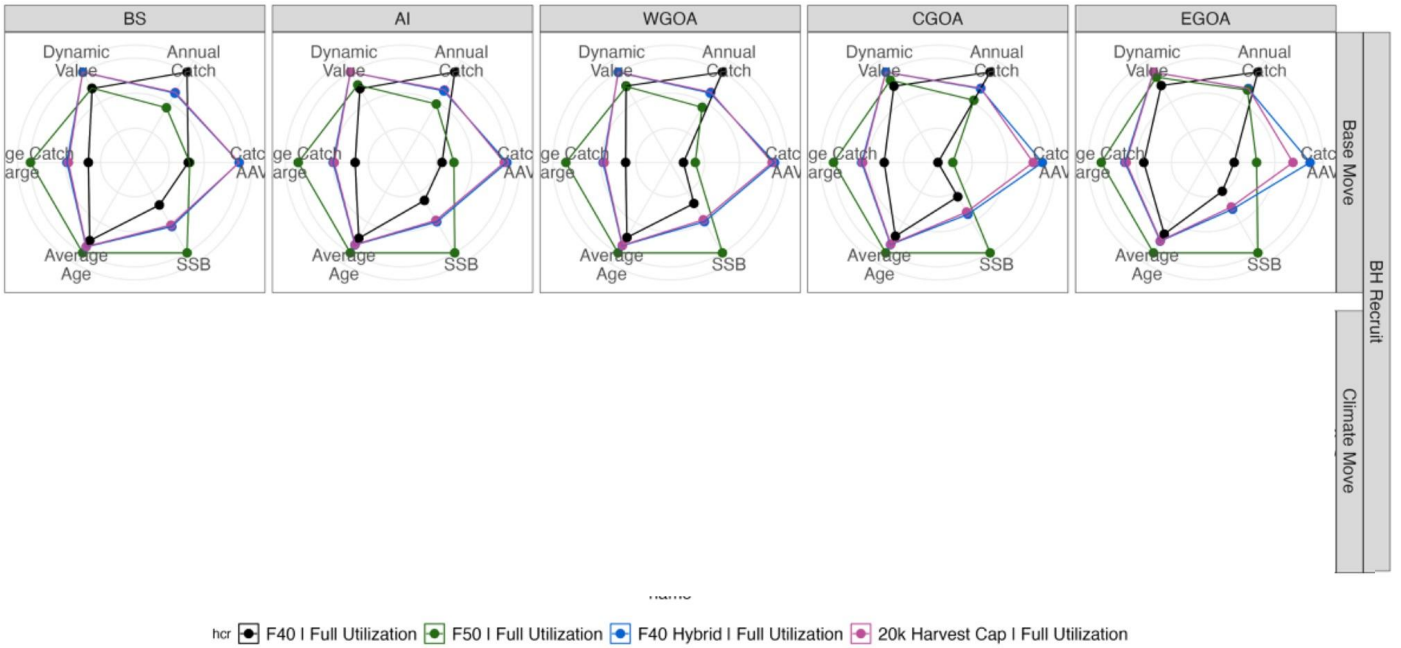
Alternative movement scenario leads to large increases in catch/SSB in western regions at the expense of eastern regions.

CGOA still produces the most catch, while AI and BS have the most biomass and oldest fish.



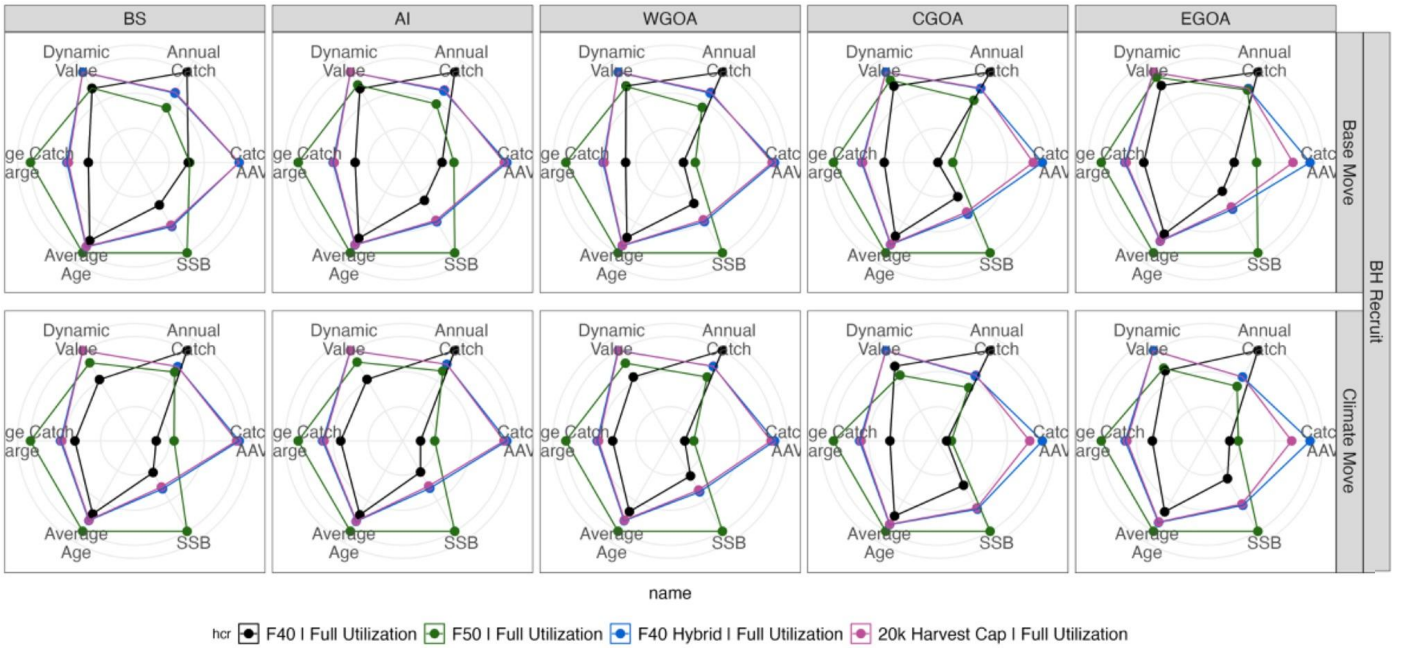
Relative Performance Robust to Change in Movement

HCRs have similar relative effects in each region, implying that the choice of HCR has minimal region-specific impacts, and instead acts as an Alaska-wide scalar on most metrics.



Relative Performance Robust to Space and Change in Movement

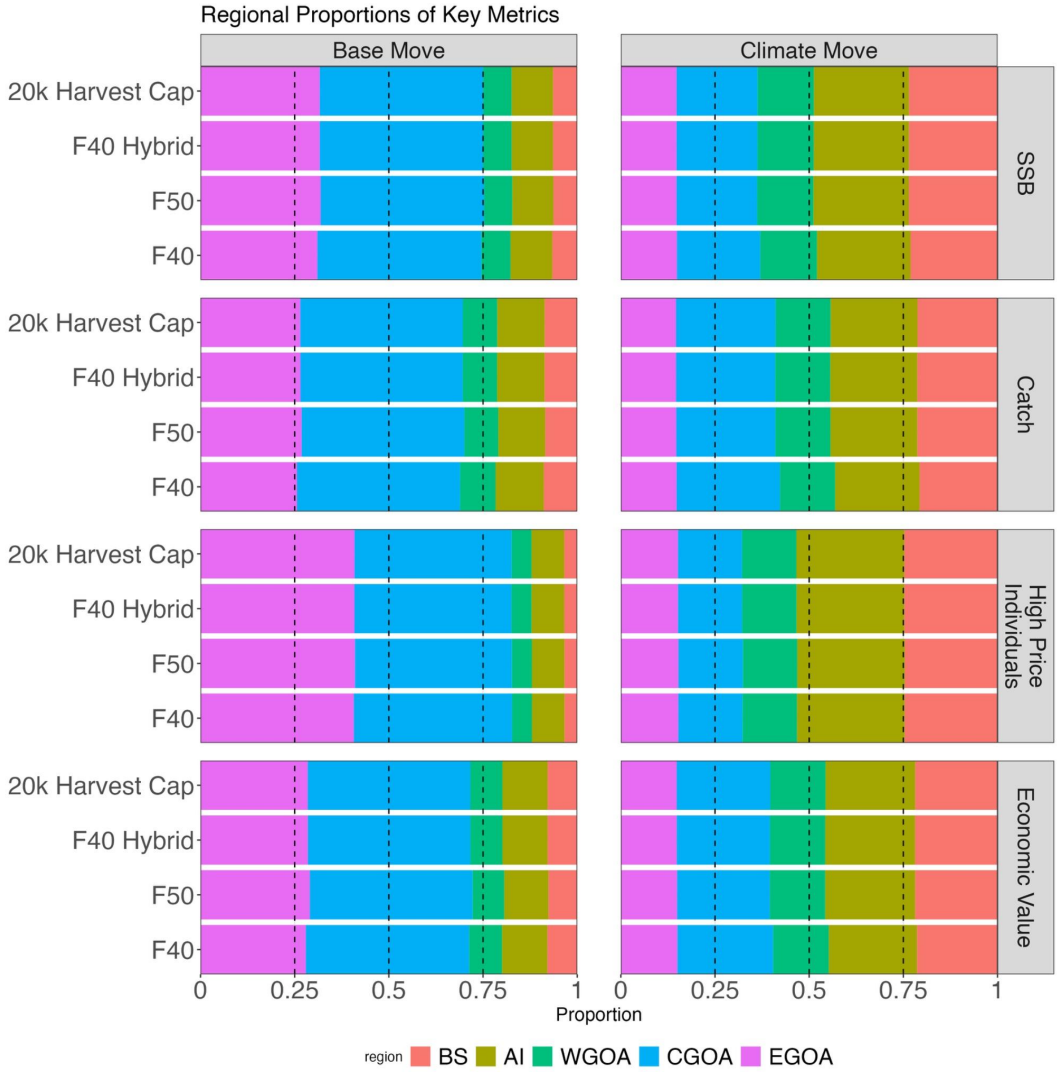
Relative ranking of HCRs remains consistent across regions and scenarios, though the relative benefit (e.g., how much better one HCR is) may vary across scenarios or regions.



Regional Attribution of Key Metrics

Changes in movement patterns, and consequent stock redistribution, redistributes fishing opportunities and population biomass.

Alaska-wide HCRs have little influence on regional performance outcomes, as do recruitment scenarios.



Conclusions and Next Steps

- HCR performance robust to spatial structure and match results from single region OM
- Relative ranking of HCRs consistent across regions and scenarios, but relative benefit may change
- Regional differences in performance metrics result from regional recruitment patterns, ontogenetic movement, and spatial management (apportionment, fleet catch assignment)
- Spatial OM important for exploring impact of future spatial management options or FMP changes
    - Better reflects biological/fishery dynamics and reflects likely regional management impacts due to differential availability of size/age classes by region

Acknowledgements

Collaborators

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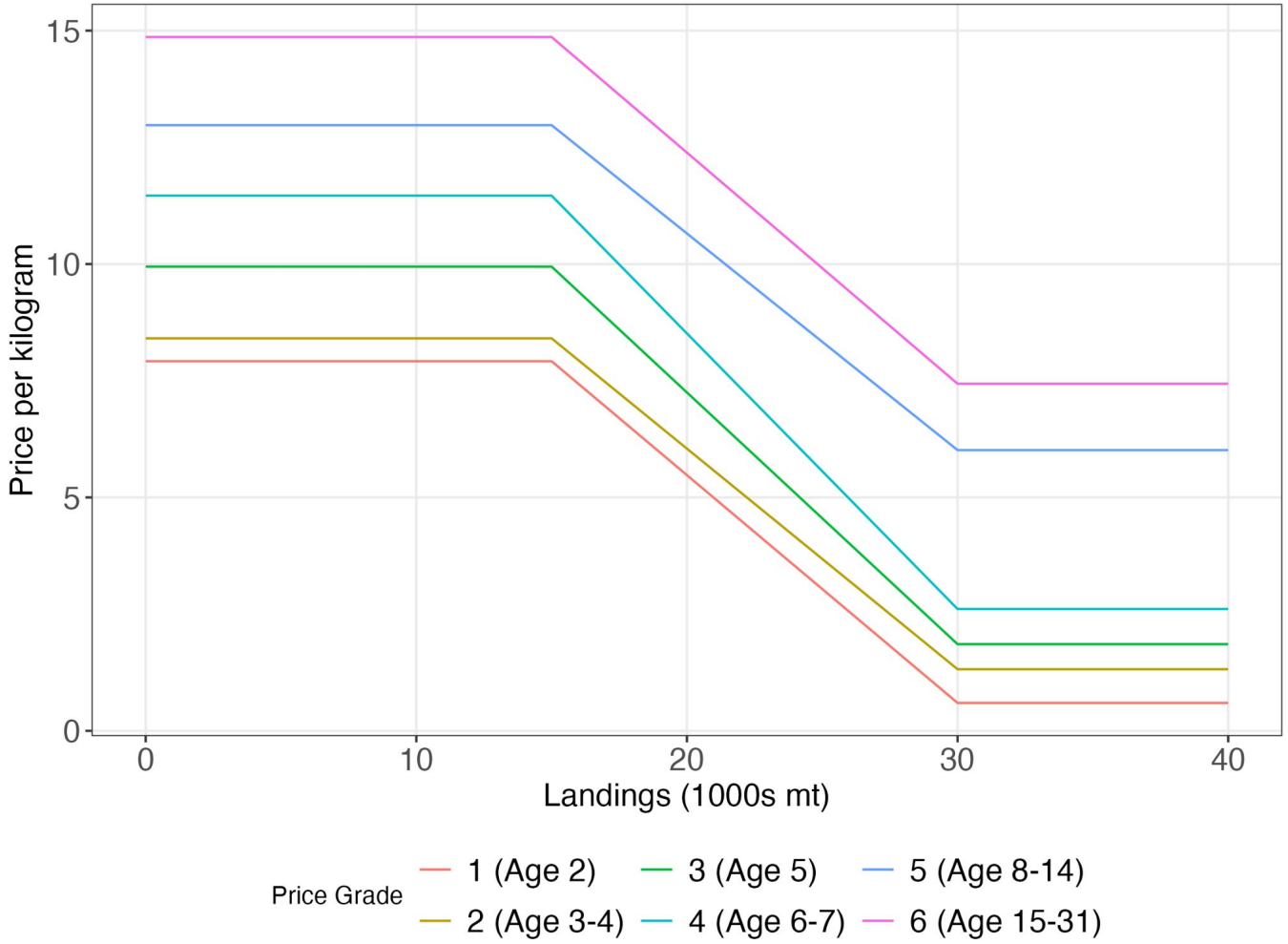
CICOES

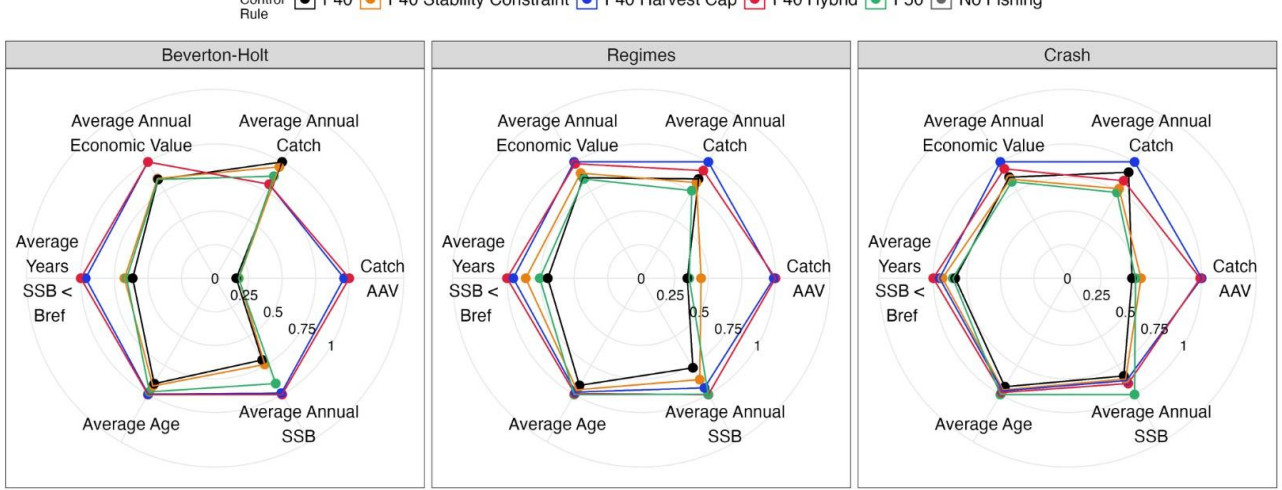
afscOM: Fisheries OM Github

Sablefish MSE Github

Sablefish MSE Publication

Extra Slides

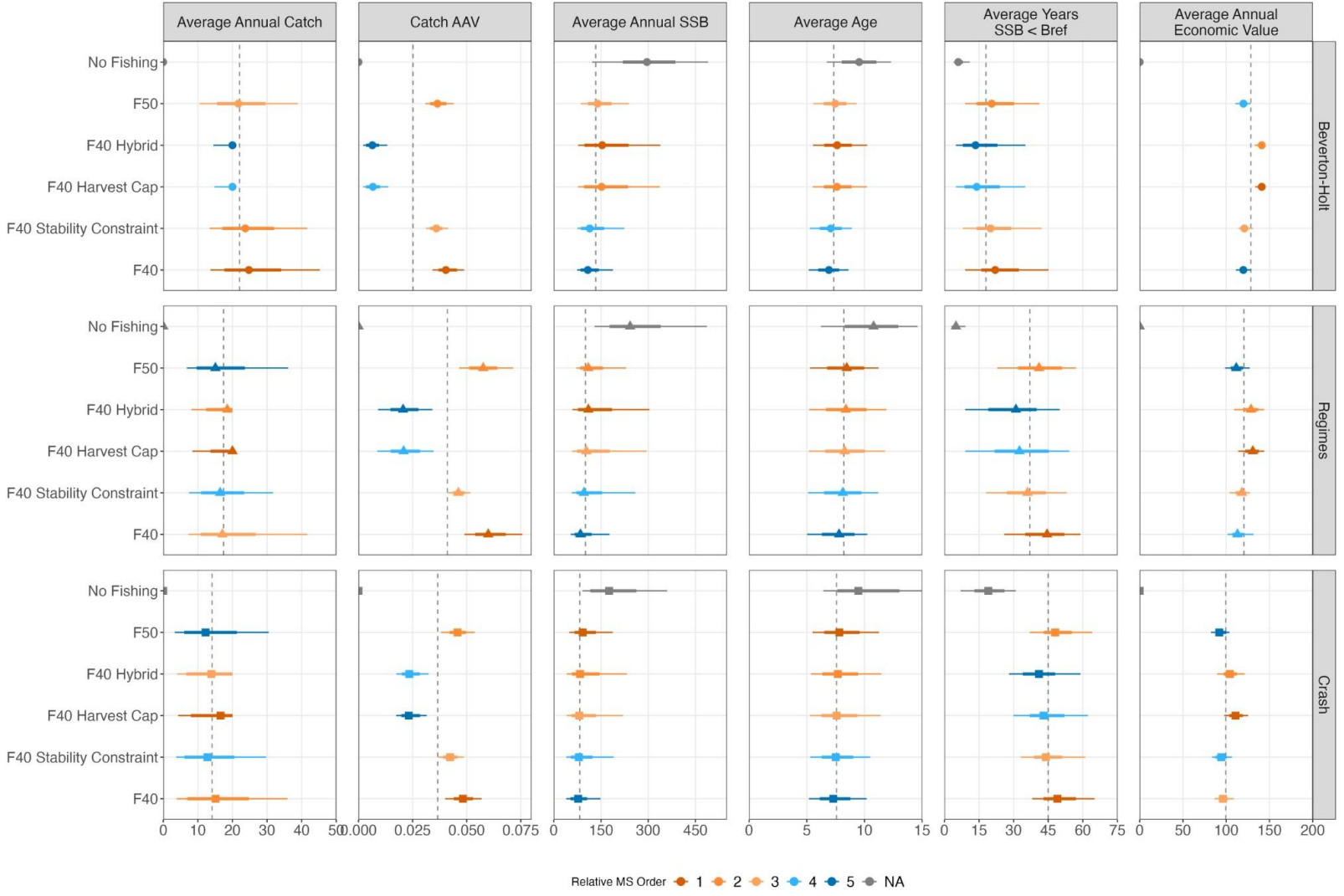

15
10
5
0
Price per kilogram
0
10
20
30
40
Landings (1000s mt)
Price Grade
1 (Age 2)
2 (Age 3-4)
3 (Age 5)
4 (Age 6-7)
5 (Age 8-14)
6 (Age 15-31)



F40	F40 Stability Constraint	F40 Harvest Cap	F40 Hybrid	F50	No Fishing	
119.78	120.93	141.05	141.03	119.87	0	Average Annual Economic Value
22	20	14	13.5	20.5	6	Average Years SSB < Bref
6.92	7.07	7.6	7.63	7.46	9.54	Average Age
107.94	113.86	151.75	153.66	139.04	295.9	Average Annual SSB
0.04	0.04	0.01	0.01	0.04	0	Catch AAV
24.76	23.71	20	20	21.72	0	Average Annual Catch

F40	F40 Stability Constraint	F40 Harvest Cap	F40 Hybrid	F50	No Fishing	
113.02	118.11	130.71	128.68	111.62	0	Average Annual Economic Value
44.5	36	32.5	31	41	5	Average Years SSB < Bref
7.8	8.12	8.28	8.39	8.47	10.79	Average Age
84.56	95.7	103.48	109.82	109.48	242.48	Average Annual SSB
0.06	0.05	0.02	0.02	0.06	0	Catch AAV
17.07	16.44	20	18.51	15.07	0	Average Annual Catch

F40	F40 Stability Constraint	F40 Harvest Cap	F40 Hybrid	F50	No Fishing	
96.17	94.29	110.72	104.21	91.88	0	Average Annual Economic Value
49	44	43	41	48	19	Average Years SSB < Bref
7.3	7.51	7.58	7.69	7.82	9.48	Average Age
77.16	79.61	80.85	83.14	91.89	175.57	Average Annual SSB
0.05	0.04	0.02	0.02	0.05	0	Catch AAV
15.1	12.75	16.57	13.89	12.22	0	Average Annual Catch


Average Annual Catch
Catch AAV
Average Annual SSB
Average Age
Average Years SSB < Bref
Average Annual Economic Value
No Fishing
F50
F40 Hybrid
F40 Harvest Cap
F40 Stability Constraint
F40
Beverton-Holt
Regimes
Crash
0 10 20 30 40 50
0.000 0.025 0.050 0.075
0 150 300 450
0 5 10 15
0 15 30 45 60 75
0 50 100 150 200
Relative MS Order 1 2 3 4 5 NA