

Ecosystem & Socioeconomic Profile (ESP): Gulf of Alaska (GOA) Pacific Cod



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January 2026 Groundfish Plan Team

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Overview

- Appendix 2.1 in SAFE Report
 - Full ESP in 2020-2021
 - Report Cards in 2021-2024
- Update & Report Card in 2026
 - Newly defined categories for informing decisions
 - New templates for communicating to various audience

Appendix 2.1

Appendix 2.1. Ecosystem and Socioeconomic Profile of the Pacific cod stock in the Gulf of Alaska - Update

S. Kalei Shotwell and Russel Dame (Editors)
January 2026



With Contributions from:

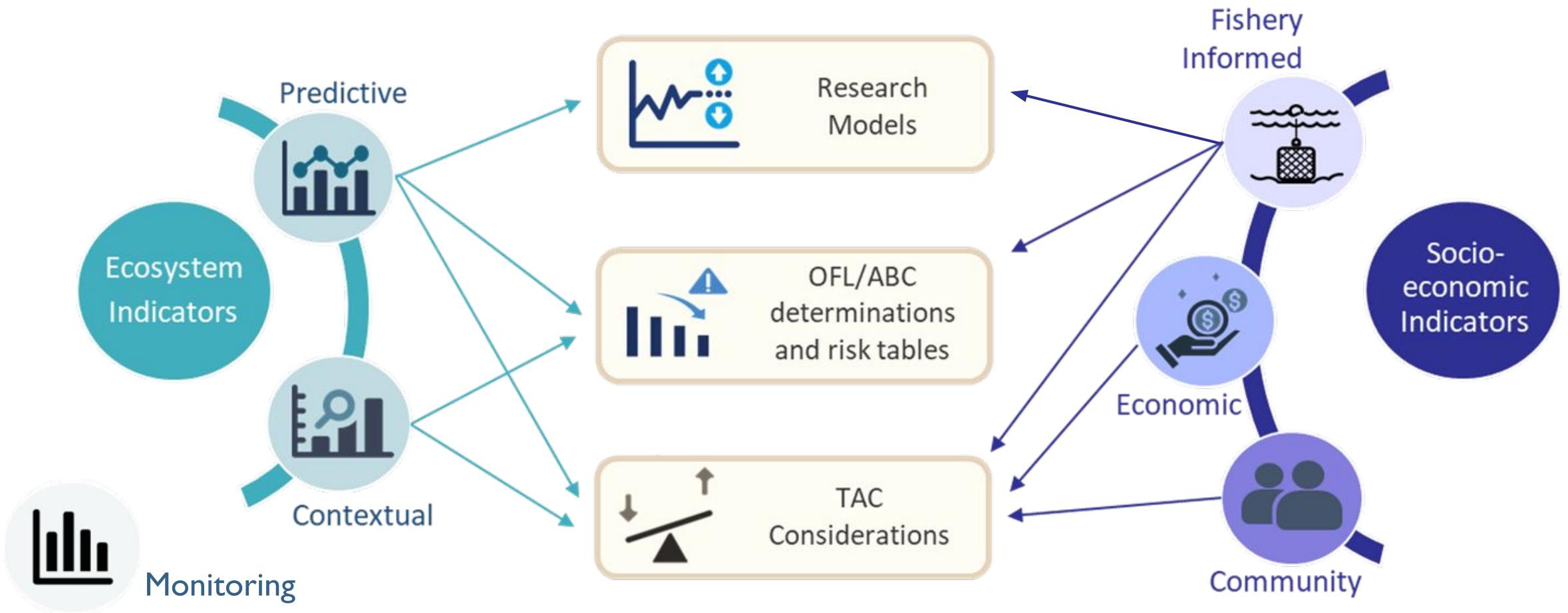
ESP Team: Bridget Ferriss, Peter-John F. Hulson, Ben Laurel, Beth Matta, Krista Oke, Lauren Rogers

ESP Data: Anna Ableman, Alisa Abookire, Grant Adams, Steven Barbeaux, Matt Callahan, Wei Cheng, Ben Laurel, Jean Lee, Krista Oke, Zack Oyafuso, Lauren Rogers, Sean Rohan, Margaret Spile, Katie Sweeney, Muvin Wang, Stephani Zador

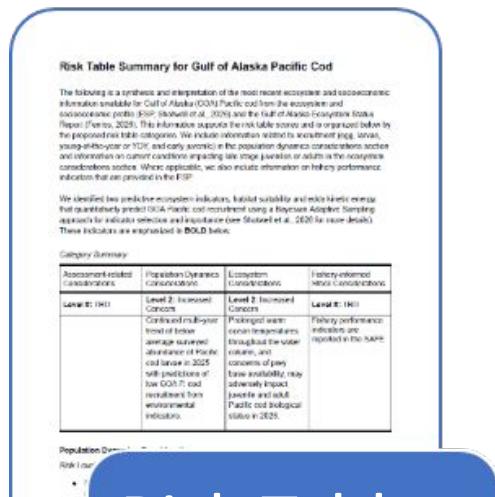
This report may be cited as: Shotwell, S.K., and Dame, R. 2026. Appendix 2.1. Ecosystem and Socioeconomic Profile of the Pacific cod stock in the Gulf of Alaska - Update. In: Hulson, P.J.F., Barbeaux, S.J., Ferriss, B., Echave, K., Nielsen, J., McDermott, S., Laurel, B., Abookire, A., Spies, I., S.K., Shotwell. 2026. Assessment of the Pacific cod stock in the Gulf of Alaska. North Pacific Fishery Management Council, Anchorage, AK. Available from <https://www.npfmc.org/library/safe-reports/>.



Indicator Pathways to Decisions



Templates for Streamlining Communication



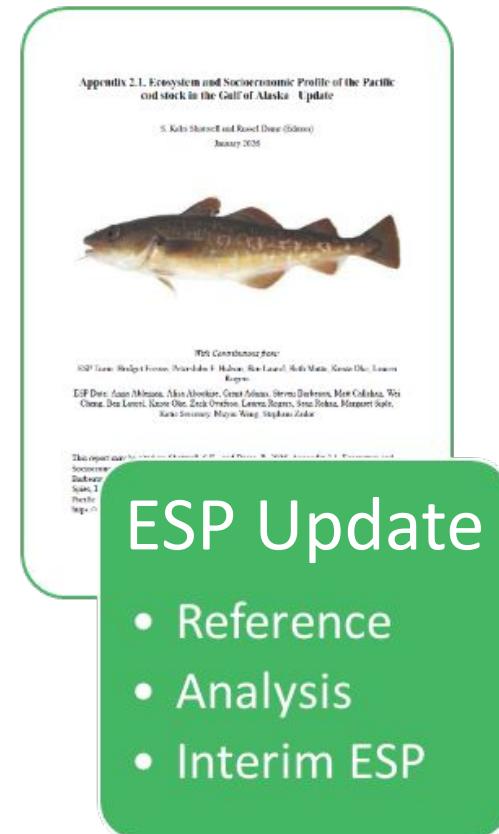
Risk Table

- ESP/ESR Coordination
- Internal Doc



ESP Full

- Synthesis
- Analysis
- First/CIE ESP



ESP Update

- Reference
- Analysis
- Interim ESP



Pacific Cod Conceptual Model

3) Yolk-sac Larva (0-45 m, 5-6°C)

April
Temperature
Advection/retention

2) Egg (20-200 m, 3-6°C)

Adhesive Mar-Apr
Temperature

1) Spawning (20-290 m, 1-7°C)

Batch in Feb-Apr, Peak March
Habitat suitability
Distribution

4) Feeding Larva (0-45 m, 5-6°C)

April-May
Temperature
Currents
Prey

5) Juvenile (10-40 m)

June-October
Currents
Comp/Predation
Temperature

6) Pre-recruit (0-300 m)

1-2 years

Prey
Comp/Predation

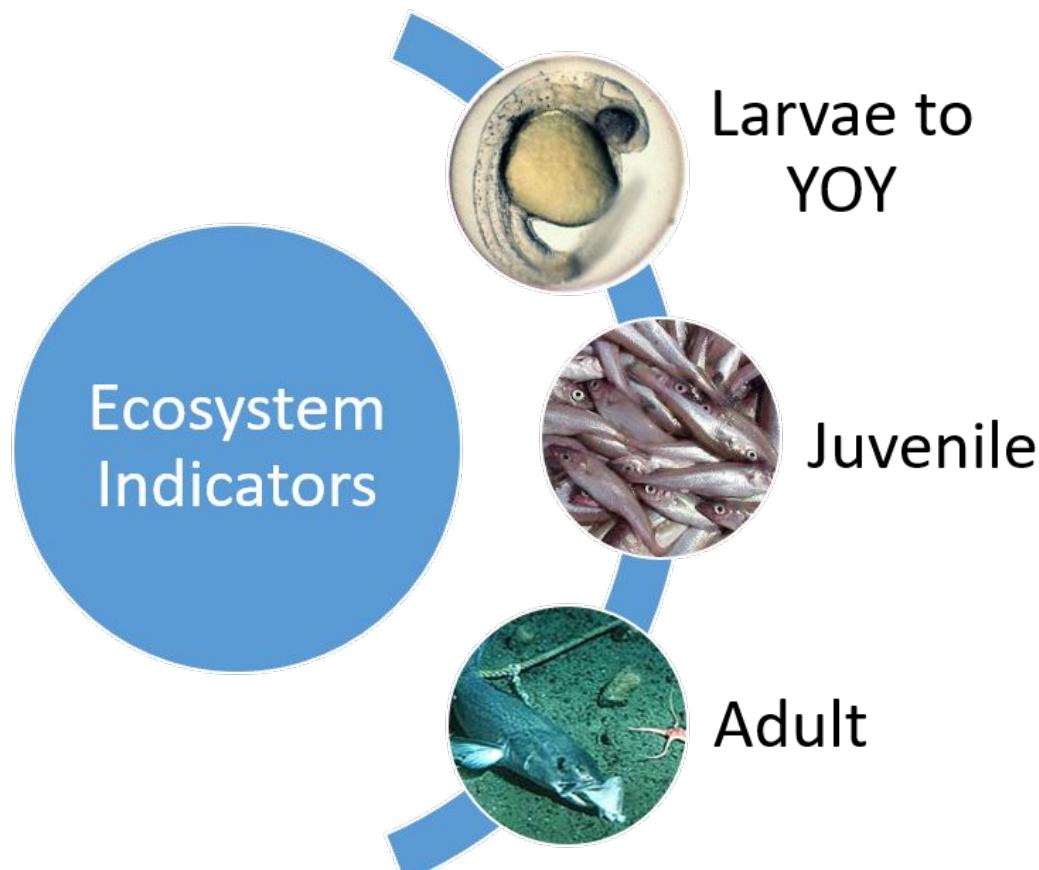
7) Recruit (0-300 m)

3 plus years

Prey
Predation

Depth

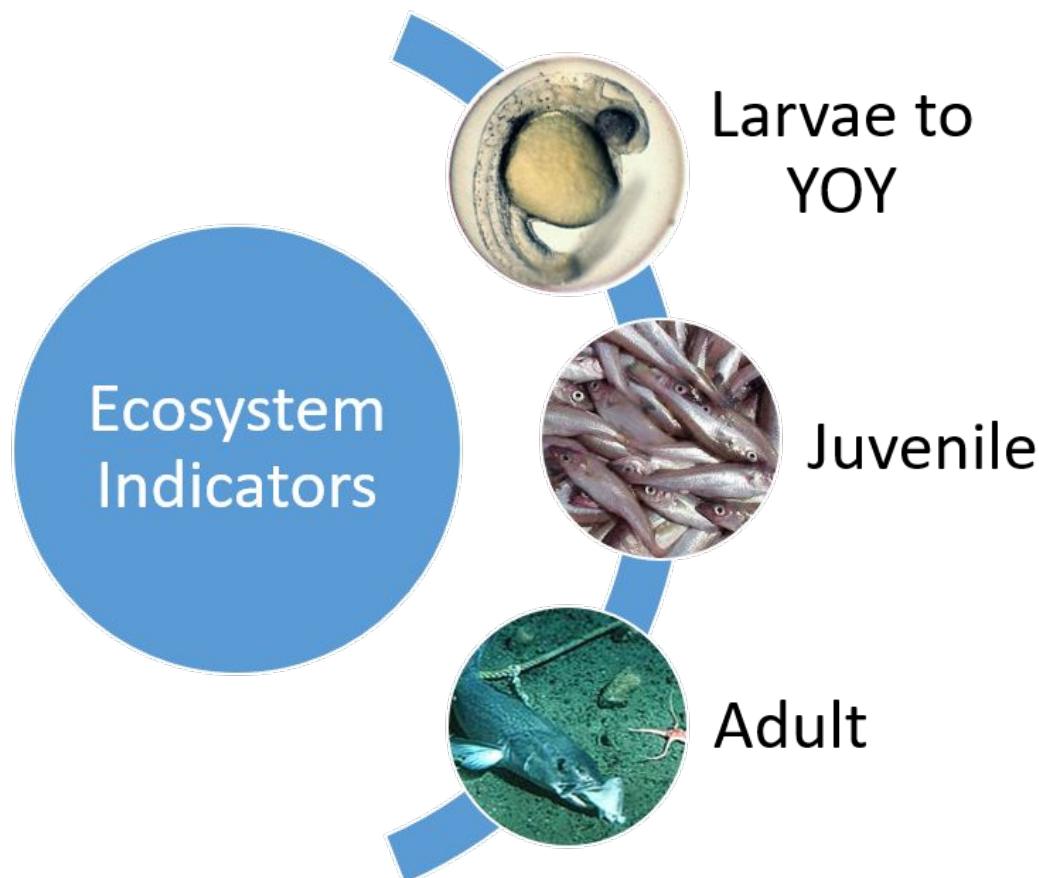
Ecosystem Indicators



- Marine heatwave index spawning (OISST), -
- Spawning habitat suitability (model), +
- Eddy kinetic energy Kodiak (CMEAMS), +
- Peak timing spring bloom WCGOA (OC-CCI), +
- Summer large copepods Shelikof (EcoFOCI), +
- Spring Pacific cod larvae Shelikof (EcoFOCI), +
- Murre reproductive success Chowiet (USFWS), +
- YOY Pacific cod CPUE WCGOA (Beach Seine), +
- Age-1 natural mortality (multispecies model), -
- Bottom temperature shelf (CFSR), -
- Juvenile condition (GAP), +
- Adult condition (GAP), +
- Annual Pacific cod ration (multispecies model), -
- Center of gravity, both North and East (GAP), -
- Area occupied (GAP), +
- Biomass eaten of Pacific cod (multispecies model), -
- Adult Steller sea lion counts (MML), -



Ecosystem Indicator Analysis



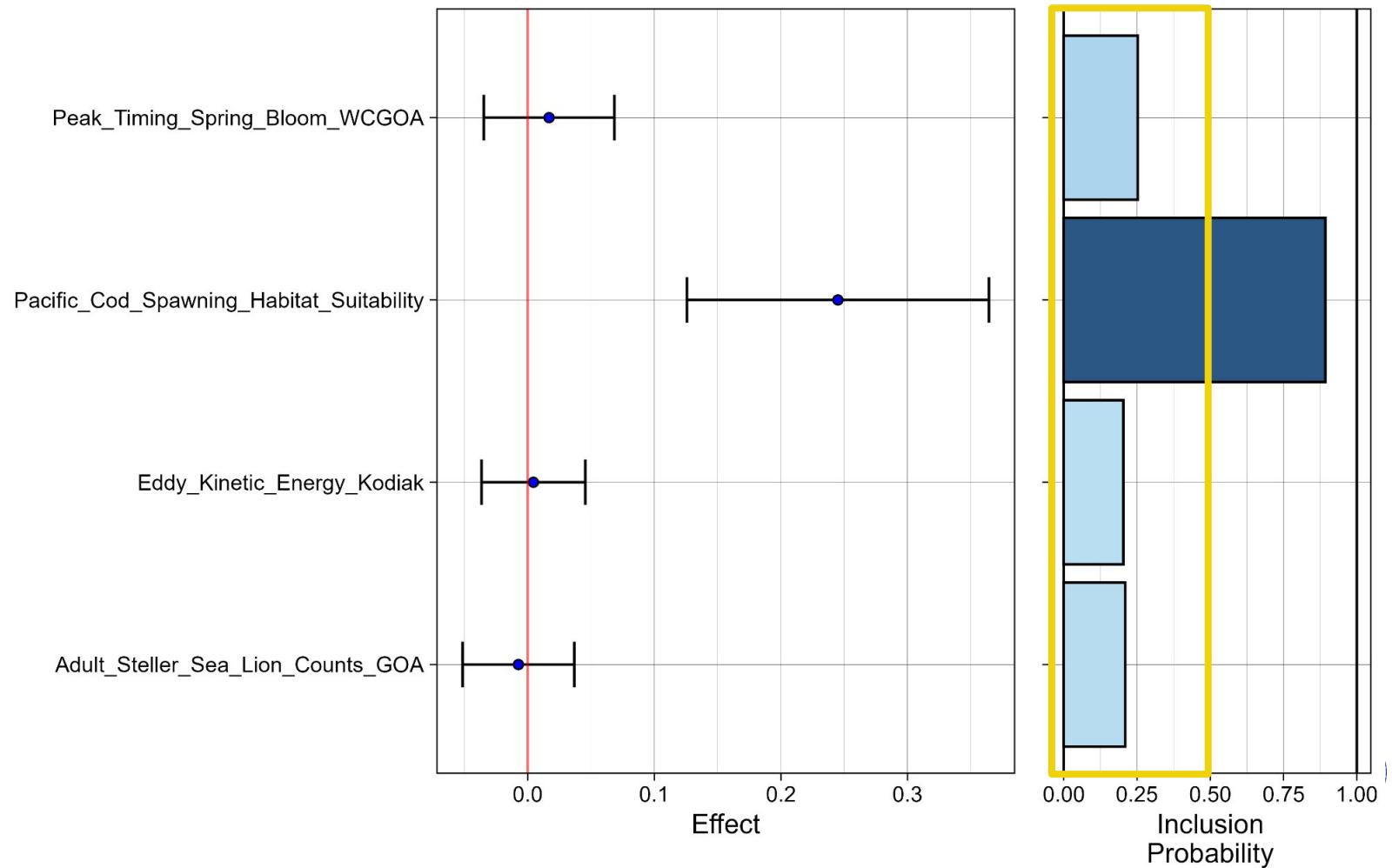
- Marine heatwave index spawning (OISST), -
- **Spawning habitat suitability (model)**, +
- Eddy kinetic energy Kodiak (CMEMS), +
- Peak timing spring bloom WCGOA (OC-CCI), +
- Summer large copepods Shelikof (EcoFOCI), +
- Spring Pacific cod larvae Shelikof (EcoFOCI), +
- Murre reproductive success Chowiet (USFWS), +
- YOY Pacific cod CPUE WCGOA (Beach Seine), +
- Age-1 natural mortality (multispecies model), -
- Bottom temperature shelf (CFSR), -
- Juvenile condition (GAP), +
- Adult condition (GAP), +
- Annual Pacific cod ration (multispecies model), -
- Center of gravity, North and East (GAP), -
- Area occupied (GAP), +
- Biomass eaten of Pacific cod (multispecies model), -
- **Adult Steller sea lion counts (MML)**, -



Indicator Analysis - Importance Testing

One indicator with importance > 0.5 :

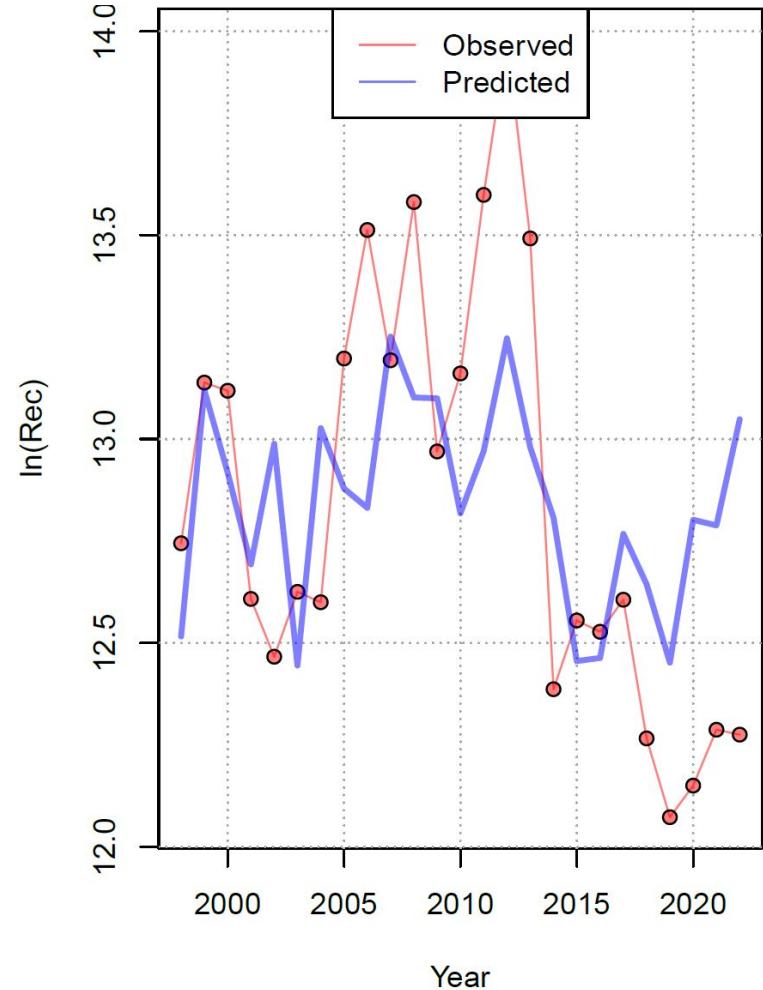
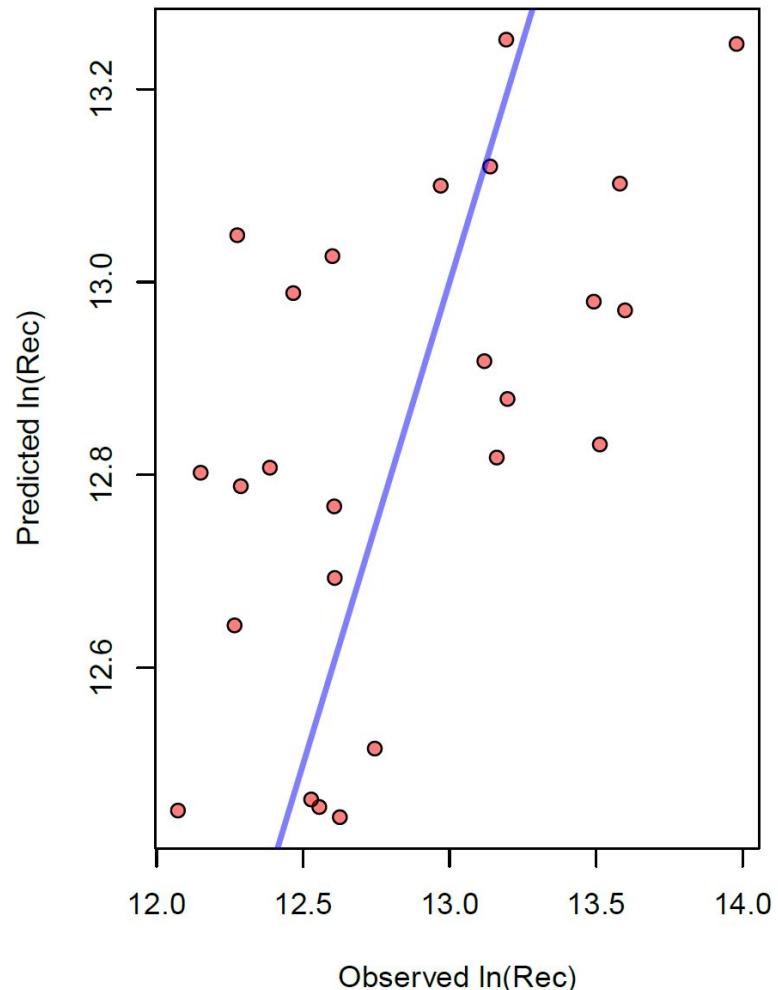
- Pacific Cod Spawning Habitat Suitability (0.89 probability)
- Positive effect, matches conceptual model
- Large CI on effect



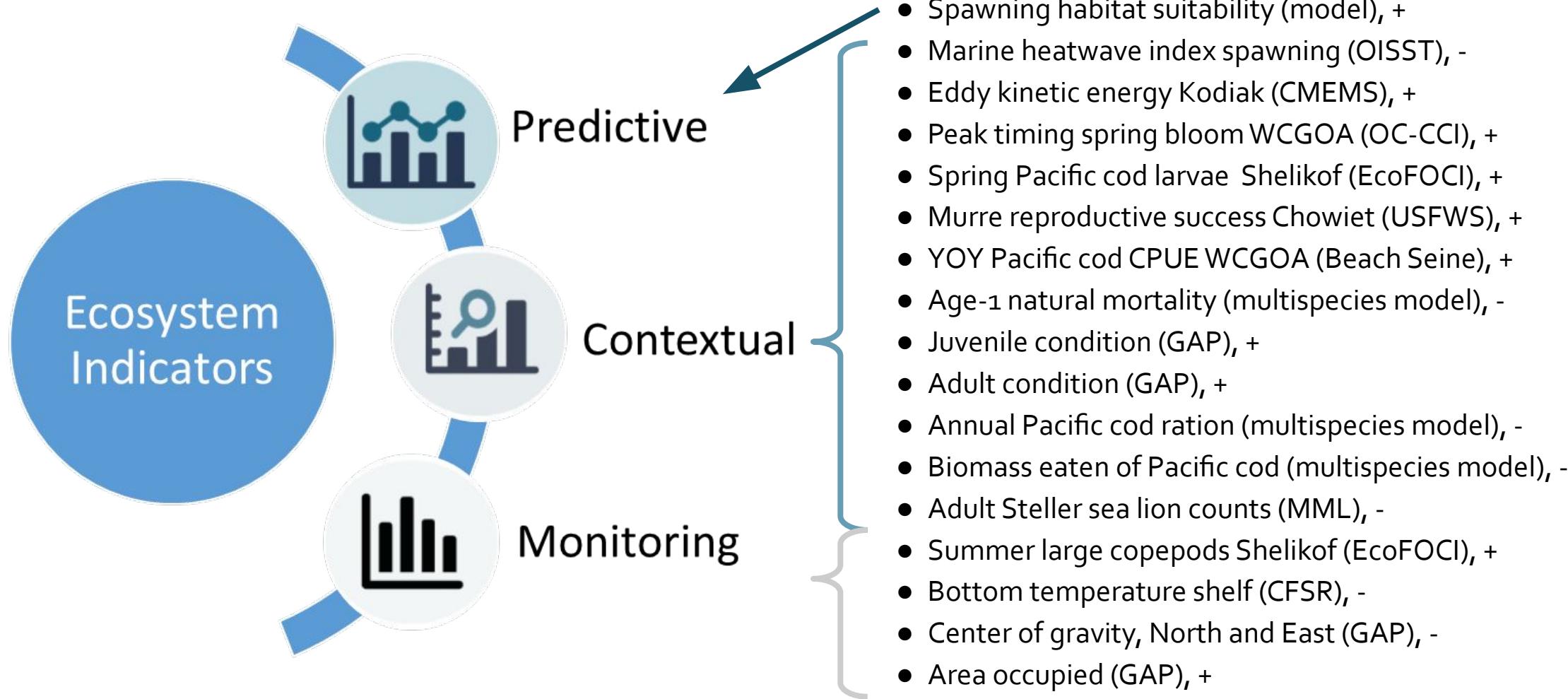
Indicator Analysis - Model

Final model explains moderate amount of variation in recruitment:

- $R^2 = 0.32$
- 1998-2022 year class
- Captures general pattern but not magnitude of variation



Ecosystem Indicator Categorization



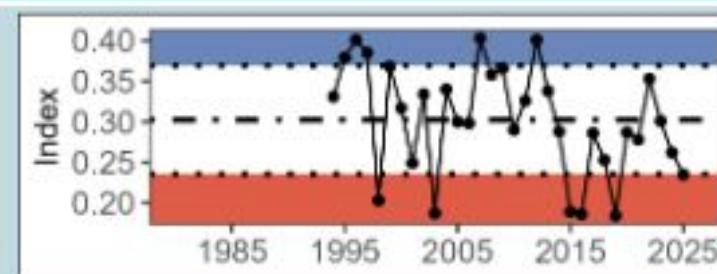
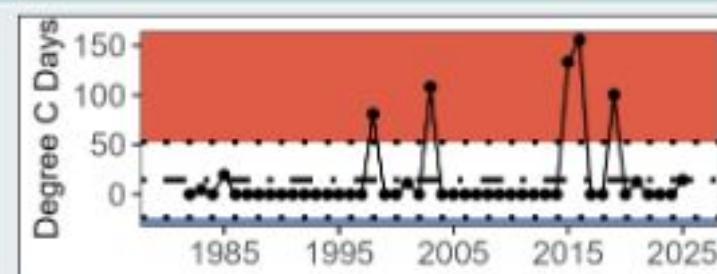
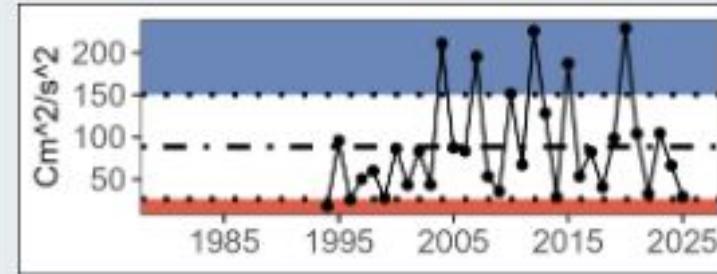
GOA Pacific Cod Report Card



Predictive



Contextual

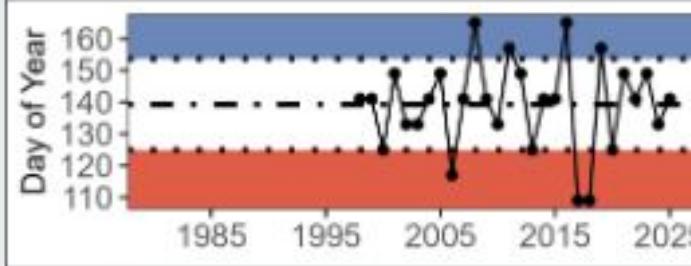
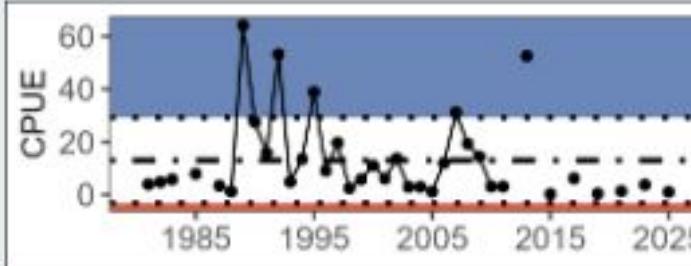
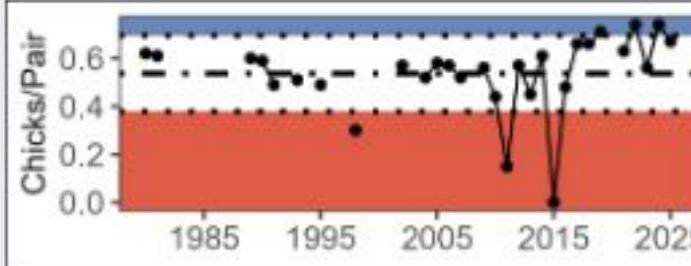
Indicator	Status	Trend
Pacific Cod Spawning Habitat Suitability	Below long-term mean 	
Heatwave During Spawning in GOA	Near long-term mean 	
Eddy Kinetic Energy in Kodiak	Near long-term mean 	



GOA Pacific Cod Report Card



Contextual

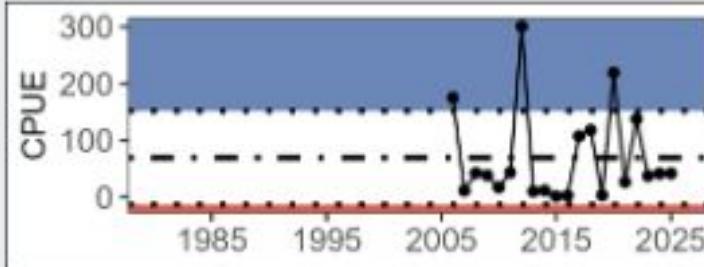
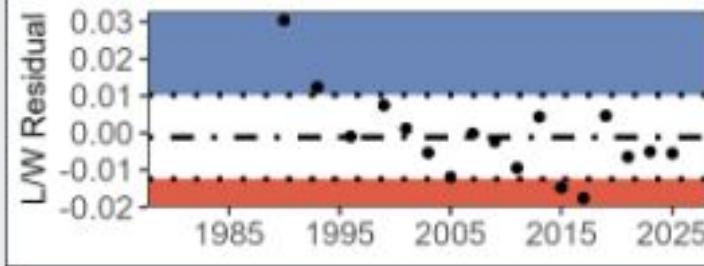
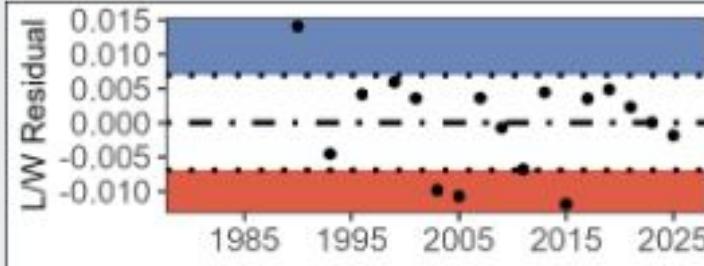
Indicator	Status	Trend
Peak Timing of Spring Bloom in WCGOA	Near long-term mean	
Spring Pacific Cod Larvae CPUE in Shelikof	Near long-term mean	
Murre Reproductive Success on Chowiet	Near long-term mean	



GOA Pacific Cod Report Card



Contextual

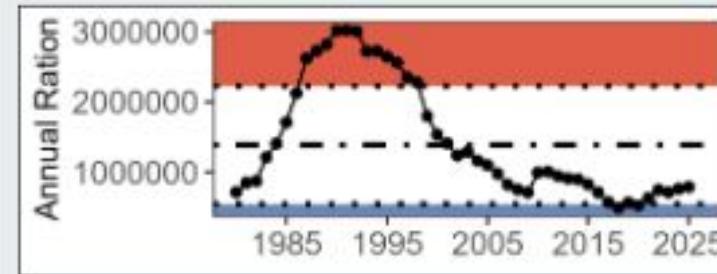
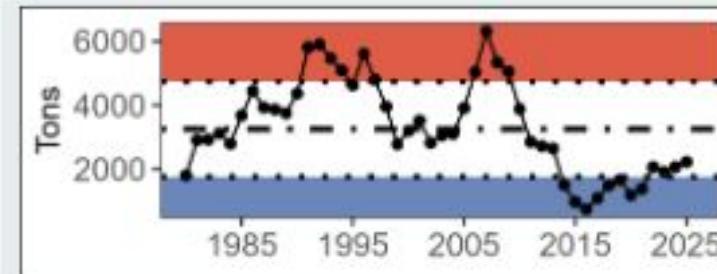
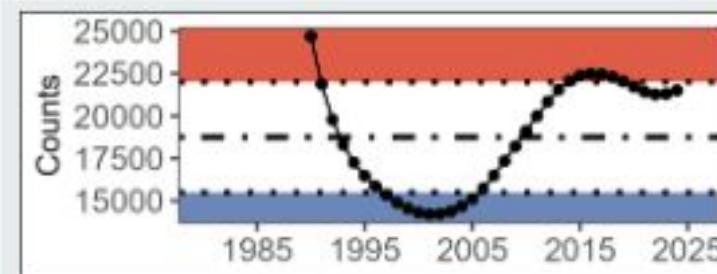
Indicator	Status	Trend
Summer Pacific Cod YOY CPUE in WCGOA	Near long-term mean 	
Juvenile Pacific Cod Condition in GOA	Near long-term mean 	
Adult Pacific Cod Condition in GOA	Near long-term mean 	



GOA Pacific Cod Report Card



Contextual

Indicator	Status	Trend
Pacific Cod Ration in GOA	Near long-term mean 	
Biomass Eaten of Pacific Cod	Near long-term mean 	
Adult Steller Sea Lion Counts in GOA	Near long-term mean 	



REPORT CARD SUMMARY

PREDICTIVE

Spawning Habitat Suitability: DECREASED TO LOW

- 🌡 Warmest temperature at depth since 2019, negative effect on egg survival, potentially poor 2025 year class

CONTEXTUAL

RECRUITMENT

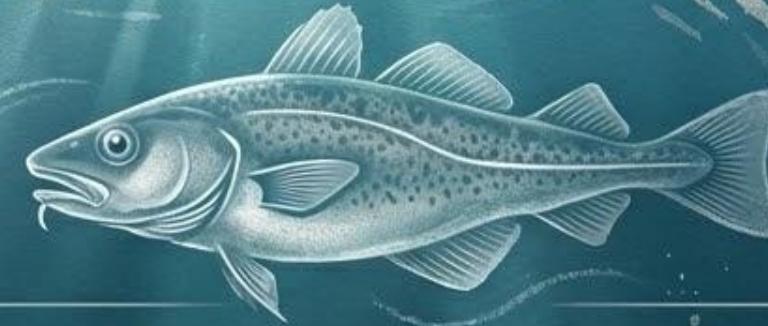
- Spring larvae & summer YOY CPUE **below average**; potentially poor 2025 year class

ECOSYSTEM

- Overall average status; **mixed** directional trends from 2024 to 2025 conditions

ENVIRONMENTAL

- Increase to **average heatwave** events (below 2015/16/19 levels); **decrease** to below **average** eddy kinetic energy (reduced larval retention/transport).



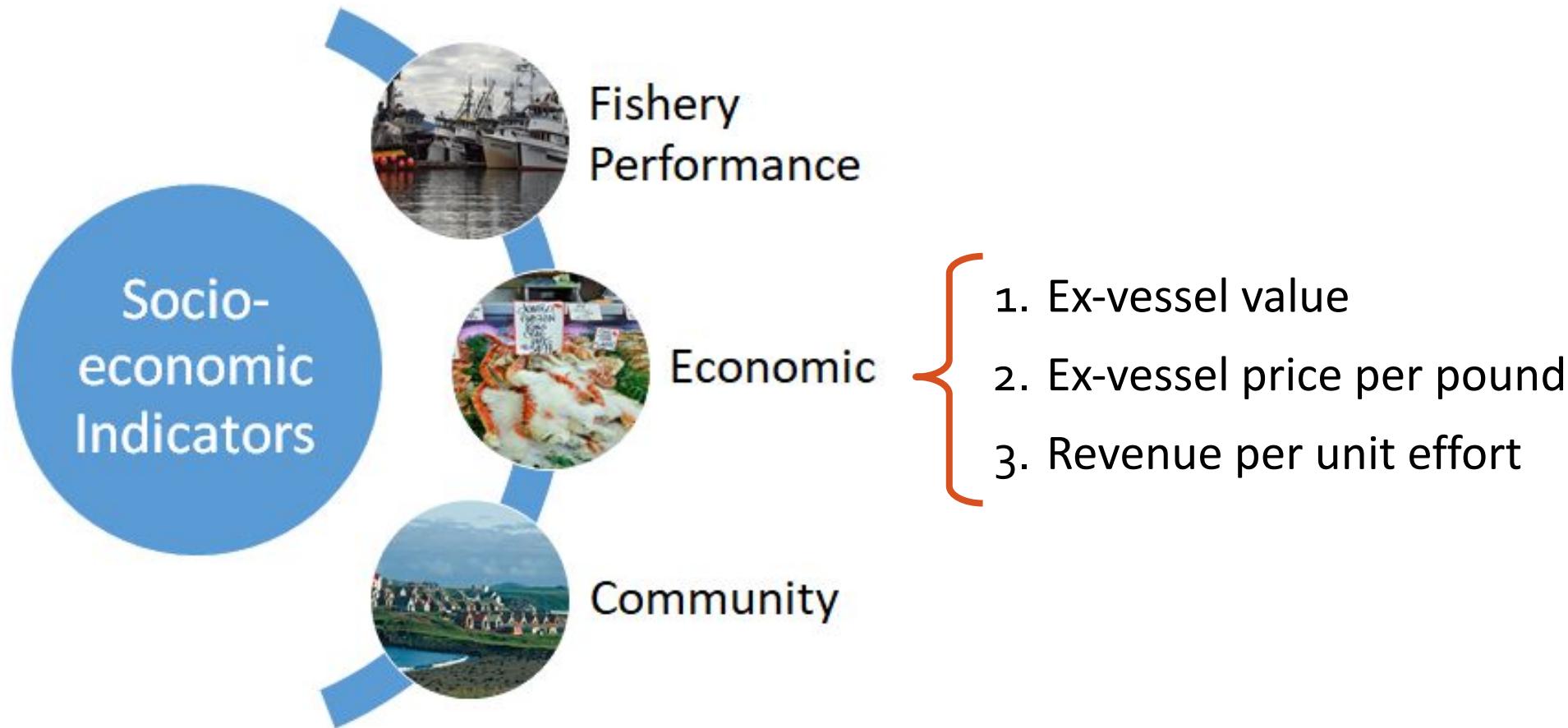
PREY

- Average spring bloom, sufficient forage for seabirds; decrease to below average Pacific cod **body condition**, slightly increased metabolic demand

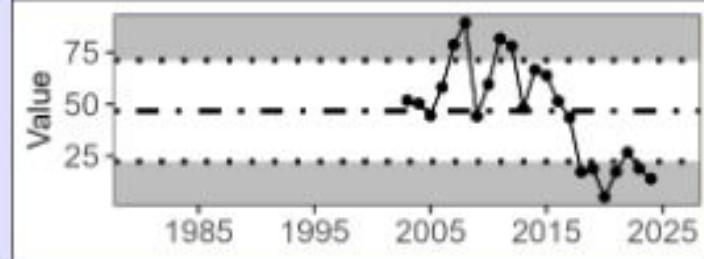
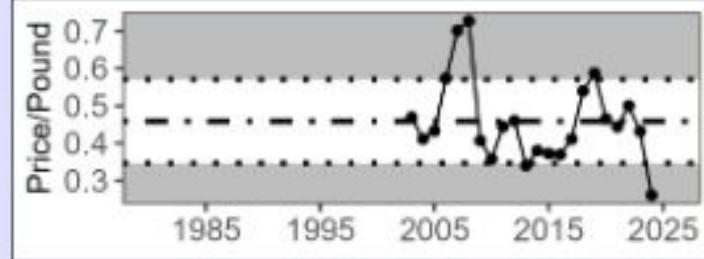
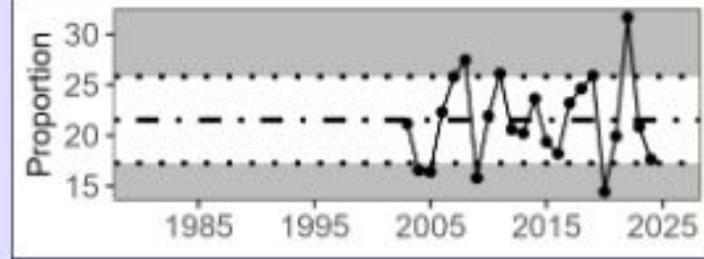
PREDATOR

- Below average biomass consumed of Pacific cod (arrowtooth, cod, pollock multispecies model); steadily increasing Steller sea lion population in GOA

Socioeconomic Indicators



Economic Indicators

Indicator	2025 Status	Trend
Pacific Cod Real Ex-vessel Value in GOA	Below long-term mean 	
Pacific Cod Real Ex-vessel Price in GOA	Below long-term mean 	
Pacific Cod Real Revenue per Unit Effort in GOA	Near long-term mean 	



Planned ESP Developments

- 1) Request for information in 2026, use ESP data gaps and research priorities list, potentially contact leads of current research projects for input on updating indicators
- 2) Improvements to indicator monitoring analysis based on recent work with sablefish (Oke et al.) and GOA pollock (Champagnat et al.)
- 3) National ESP workshops and training to identify support systems that will work toward improving and operationalizing ESPs

Questions?



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