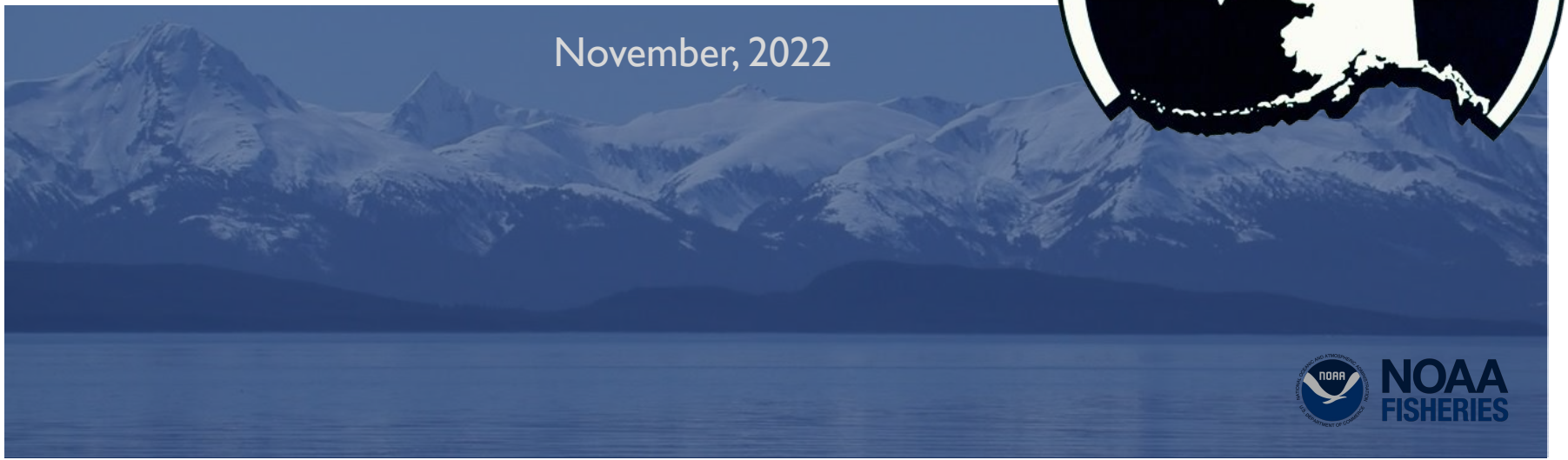
Climate-enhanced multi-species Stock Assessment for walleye pollock, Pacific and arrowtooth flounder in the EBS

Kirstin K. Holsman, Jim Ianelli, Kerim Aydin, Grant Adams, Kelly Kearney, Kalei Shotwell, and Ingrid Spies

November, 2022



Model Summary

CEATTLE 2016 - now annually

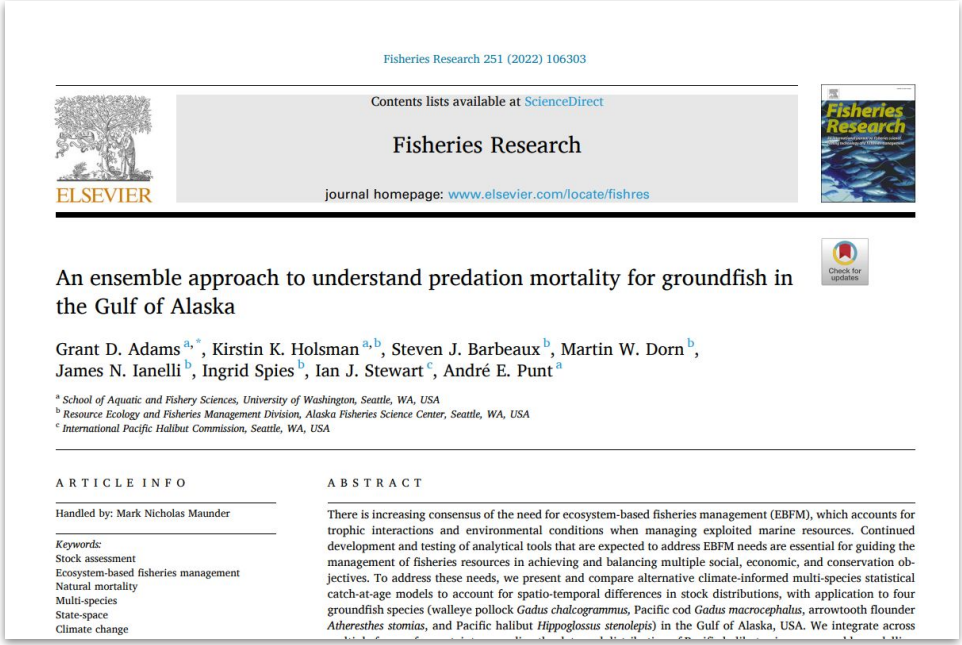
- Age or Length based
- Multi- or single-species
- ADMB
- Climate (energetics) effects on
  - Growth
  - Mortality (if in MSM)
  - Recruitment
- Used to derive climate-inform. ABC
- Pollock, Pcod, ATF

Rceattle (Adams, Holsman, Punt, et al.

- Age or Length based
- Multi- or single-species
- TMB
- Random effects
- Data weighting
- Climate (energetics) effects on
  - Growth*
  - Mortality (if in MSM)
  - Recruitment
- Used in EBS, GOA, and Cali Current (hake)
- Pollock, Pcod, ATF, Halibut, and Hake

Rceattle

https://github.com/grantdadams/Rceattle



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An ensemble approach to understand predation mortality for groundfish in the Gulf of Alaska

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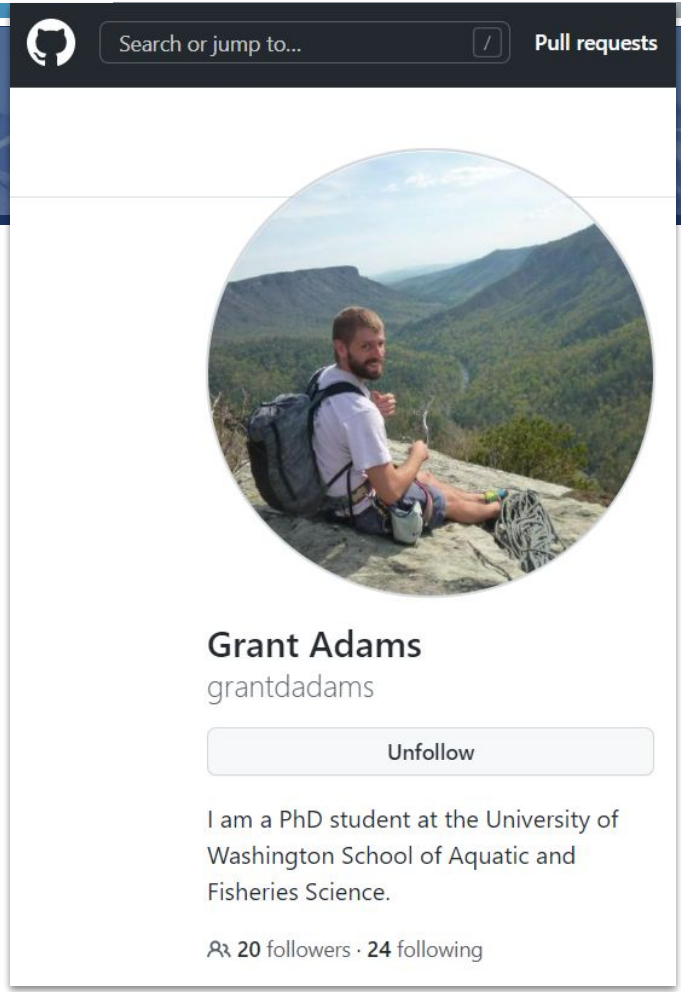
ABSTRACT

There is increasing consensus of the need for ecosystem-based fisheries management (EBFM), which accounts for trophic interactions and environmental conditions when managing exploited marine resources. Continued development and testing of analytical tools that are expected to address EBFM needs are essential for guiding the management of fisheries resources in achieving and balancing multiple social, economic, and conservation objectives. To address these needs, we present and compare alternative climate-informed multi-species statistical catch-at-age models to account for spatio-temporal differences in stock distributions, with application to four groundfish species (walleye pollock *Gadus chalcogrammus*, Pacific cod *Gadus macrocephalus*, arrowtooth flounder *Atheresthes stomias*, and Pacific halibut *Hippoglossus stenolepis*) in the Gulf of Alaska, USA. We integrate across



CEATTLE

2022 Climate-enhanced multi-species Stock Assessment for walleye pollock, Pacific cod, and arrowtooth flounder in the South Eastern Bering Sea

Kirstin K. Holsman, Jim Ianelli, Kerim Aydin, Grant Adams, Kelly Kearney, Kalei Shotwell, Grant Thompson, and Ingrid Spies

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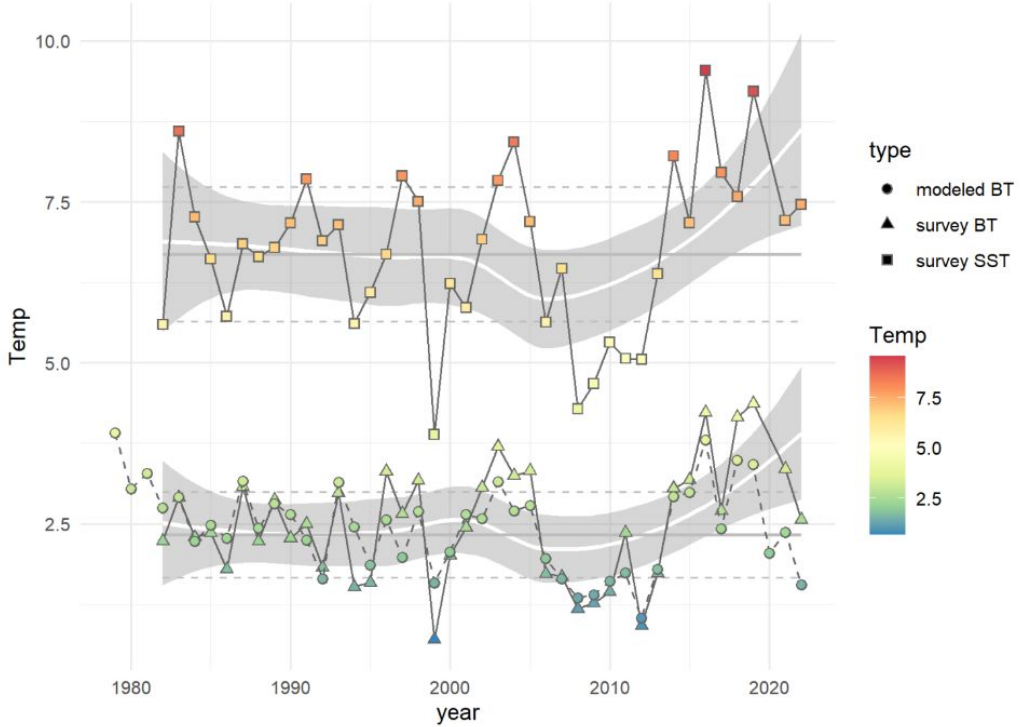
7600 Sand Point Way N.E., Seattle, Washington 98115

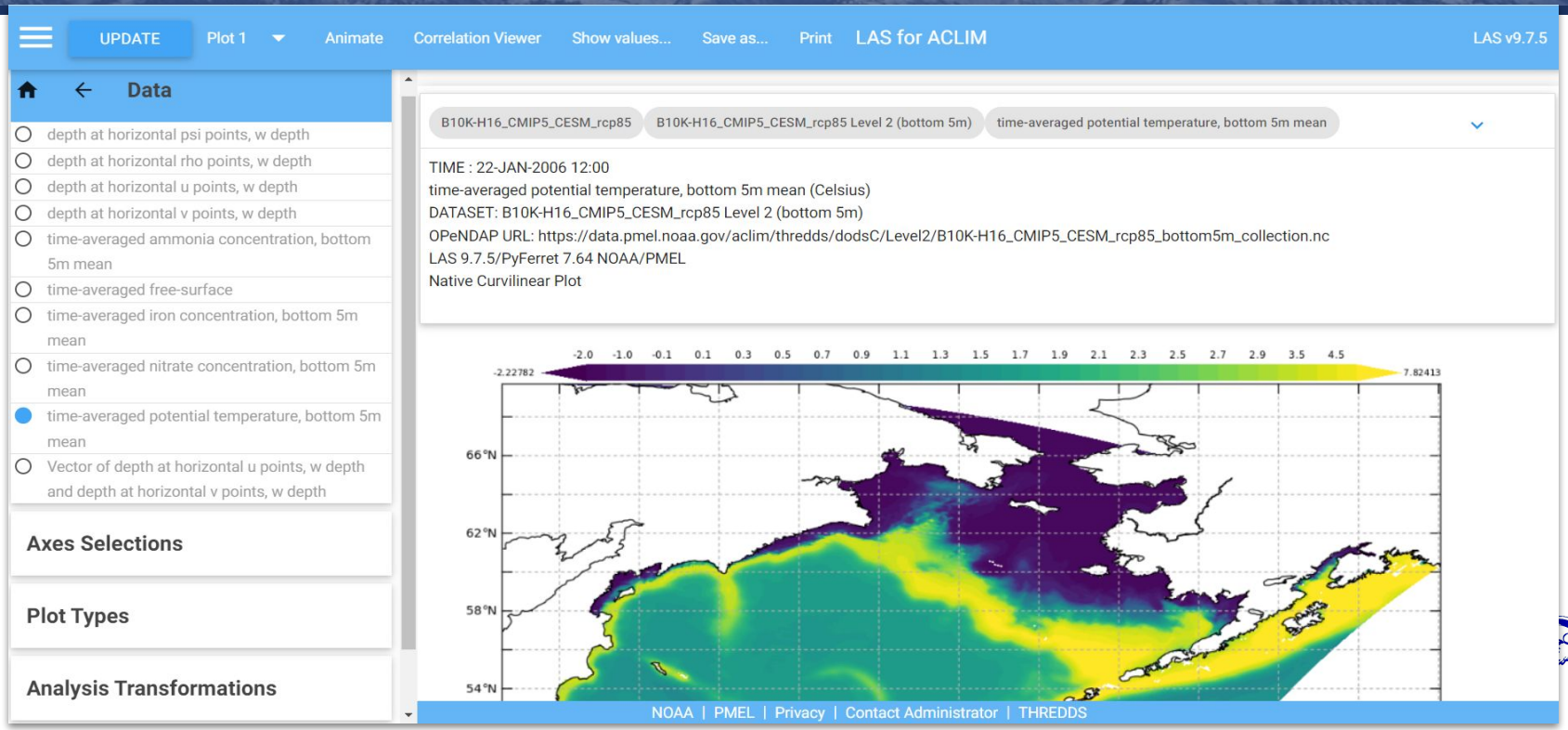
ROMS output

https://data.pmel.noaa.gov/aclim/thredds/catalog/files.html

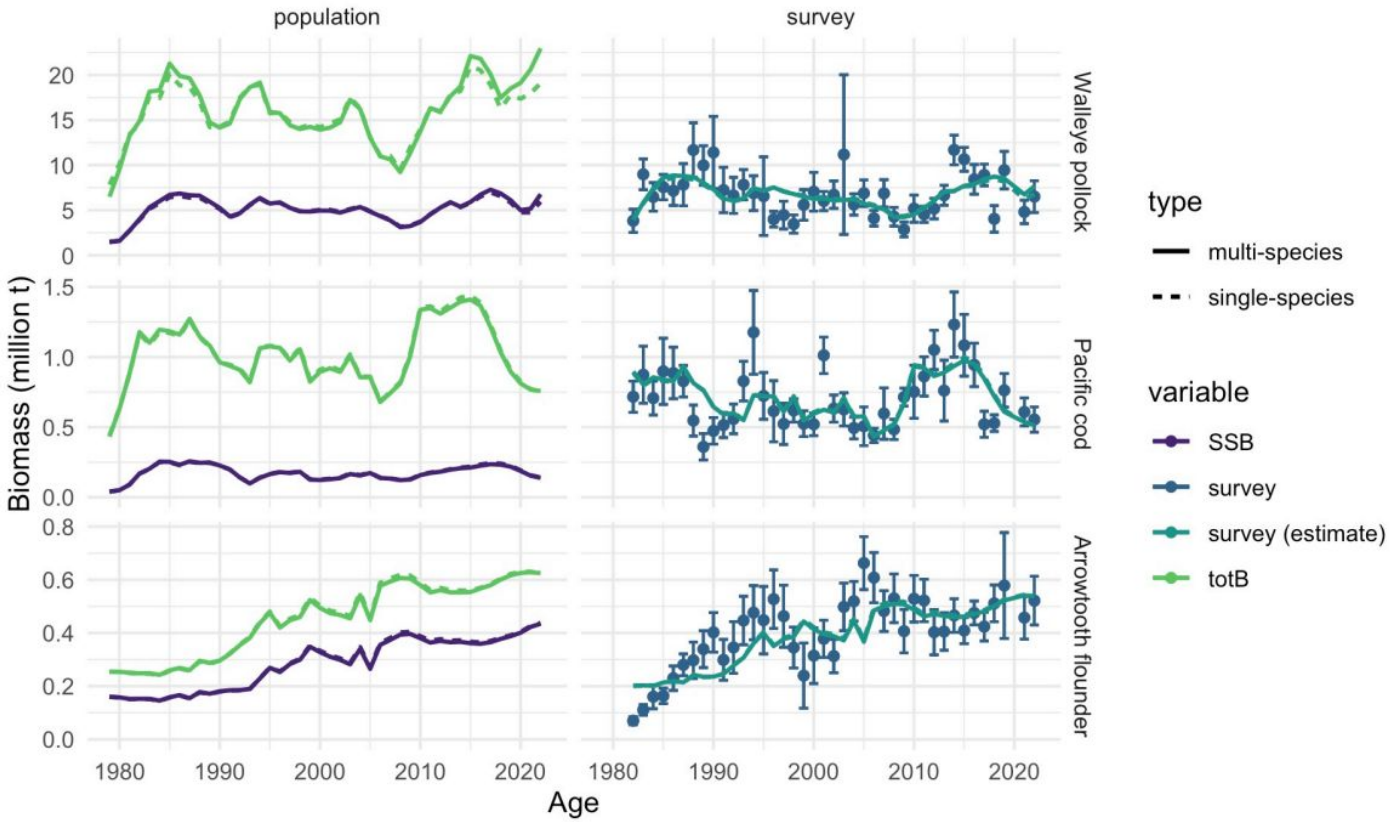


ROMS output

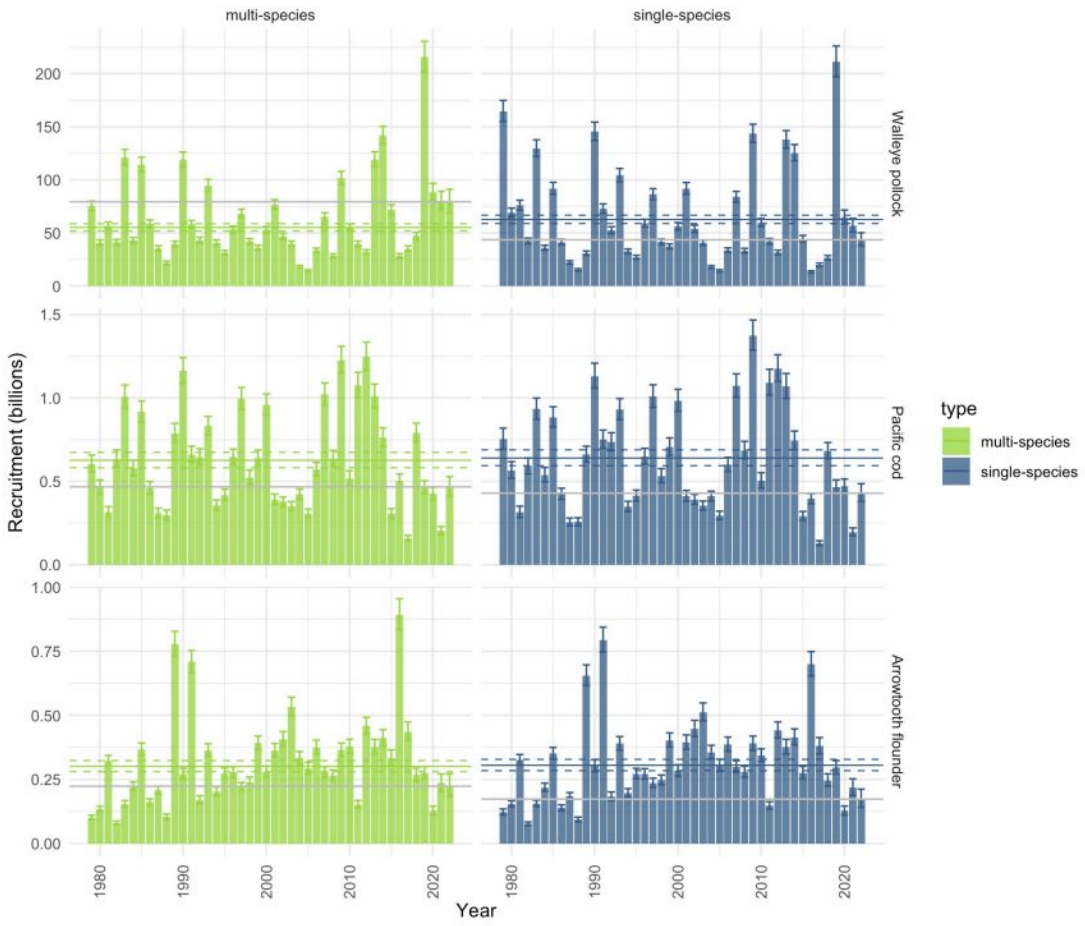
https://data.pmel.noaa.gov/aclim/las/UI.html



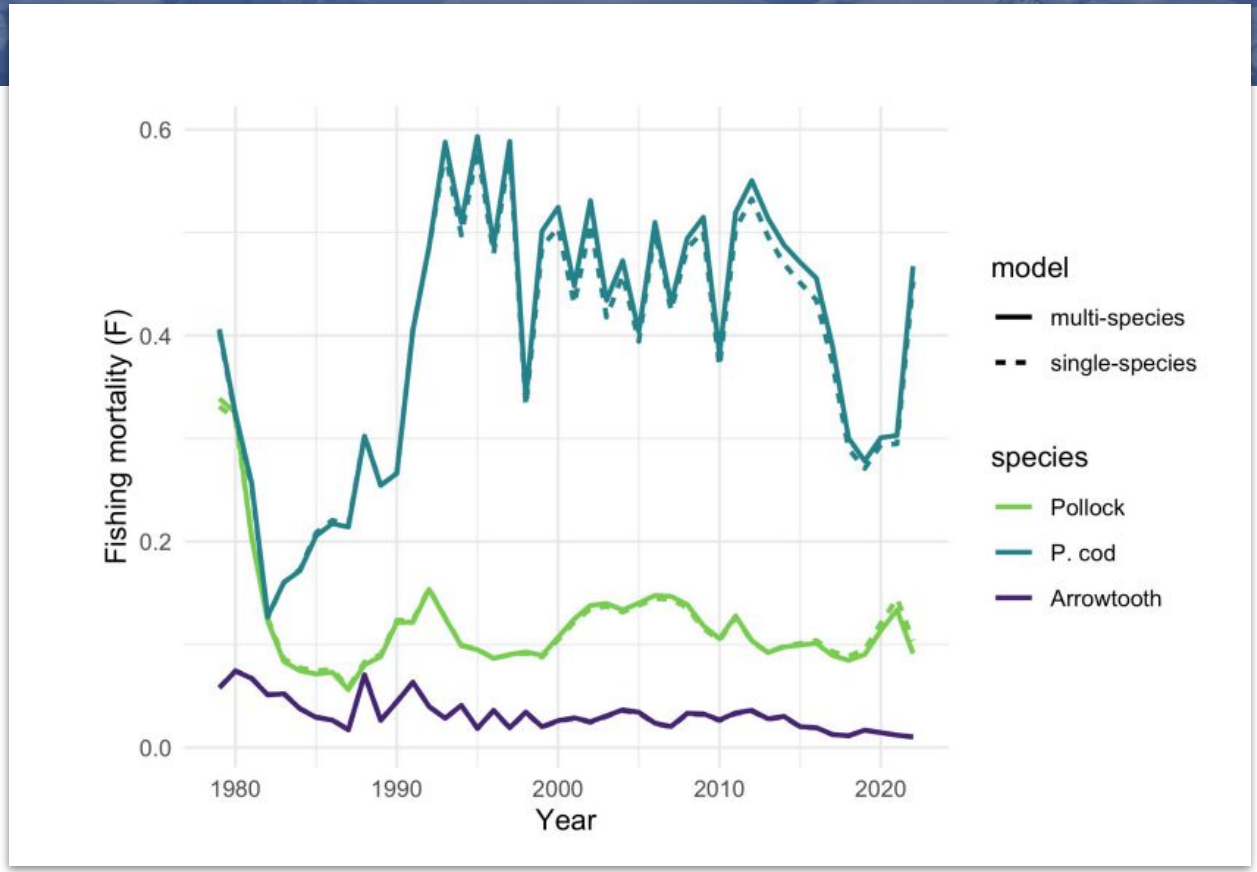
Biomass


population
survey
Walleye pollock
Pacific cod
Arrowtooth flounder
Biomass (million t)
Age
type
multi-species
single-species
variable
SSB
survey
survey (estimate)
totB

Age 1 rec

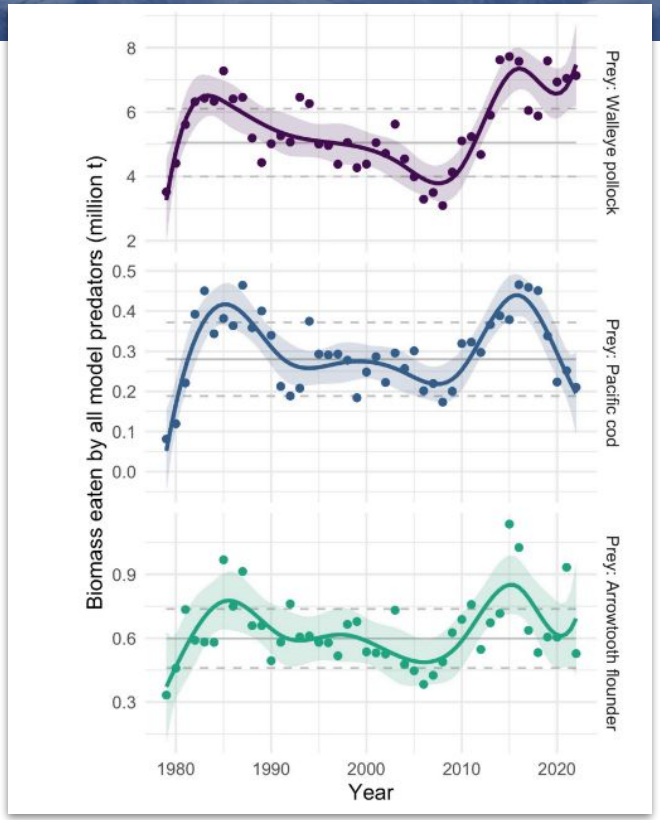

multi-species
single-species
Walleye pollock
Pacific cod
Arrowtooth flounder
Recruitment (billions)
Year
type
multi-species
single-species

Fishing Mortality

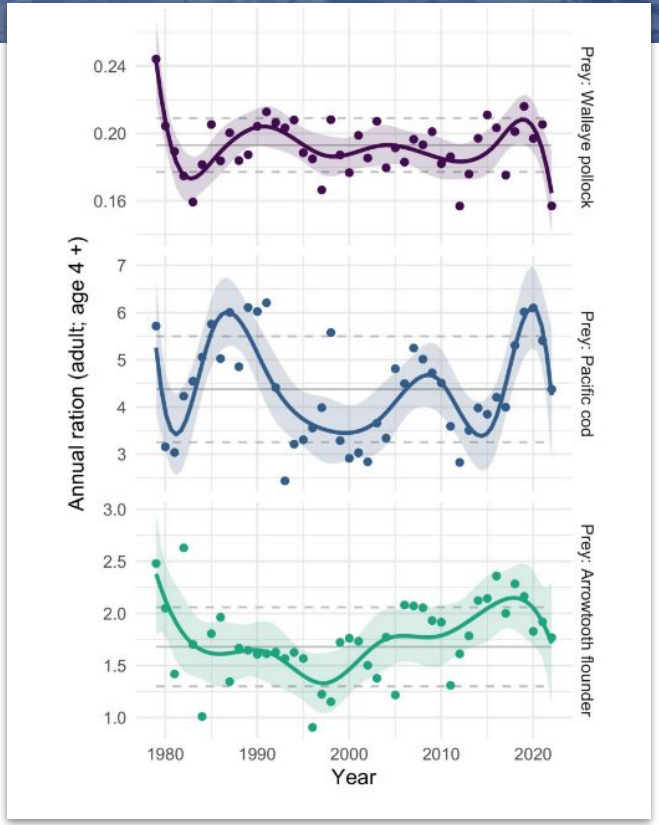


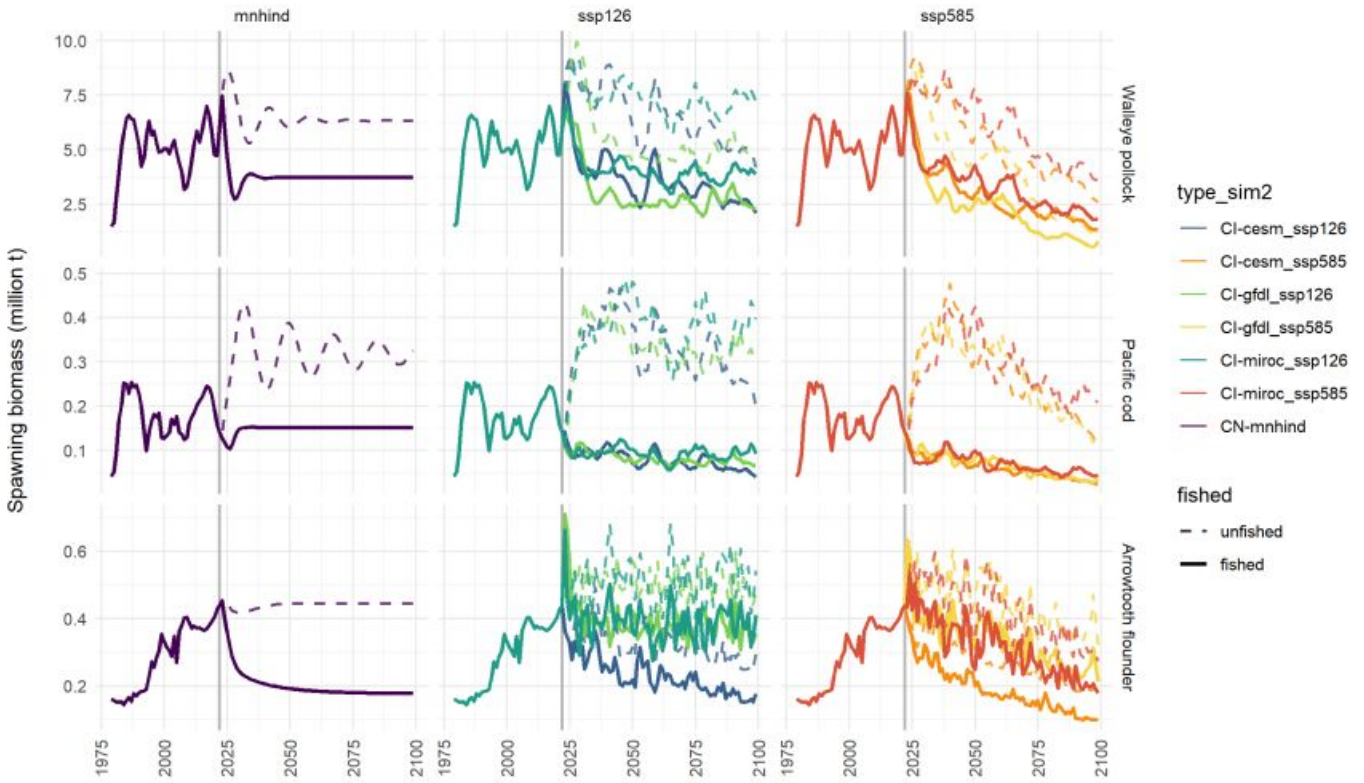
Indices

Use this if need index of M for plk, pcod, or atf



Use this if need index plk, pcod, atf eating other prey (eg snow crab)




mnhind
ssp126
ssp585
Spawning biomass (million t)
Walleye pollock
Pacific cod
Arrowtooth flounder
type_sim2
CI-cesm_ssp126
CI-cesm_ssp585
CI-gfdl_ssp126
CI-gfdl_ssp585
CI-miroc_ssp126
CI-miroc_ssp585
CN-mnhind
fished
unfished
fished

Discussion : Climate informed BRPs

1. Methods to explore for setting climate-informed ABCs
2. Feedback on how long-term outlooks are communicated
3. Push to align with other stocks?

Discussion : Climate informed BRPs

Probability of near-term (+ 1-2 yr) biomass decline or increase:

- Relative to 2022 levels, the model projects SSB of pollock will increase in 2023 (projected based on 2022 catch) followed by an increase in SSB in 2024 (projected with F_{ABC}). For Pacific cod the model projects a decline in SSB in both 2023 and 2024.
- Ensemble projections using climate-enhanced recruitment models and projected future warming scenarios (including high carbon mitigation (ssp126), low carbon mitigation (ssp585), as well as persistence scenarios and assuming 2022 catch for 2023 and F_{ABC} for 2024) estimate a 95% chance that pollock SSB will remain between 125-138% of 2022 SSB in 2023 and will be between 123-134% of 2022 SSB levels in 2024.
- Ensemble projections using climate-enhanced recruitment models based on long-term projections estimate a 95% chance that Pacific cod SSB will continue to decline to between 86-99% of 2022 SSB in 2023 and between 73-83% of 2022 SSB levels in 2024.
- Ensemble projections using climate-enhanced recruitment models based on long-term projections estimate a 95% chance that arrowtooth SSB will be between 92 and 130% of 2022 SSB in 2023 and will be between 87 and 117% of 2022 SSB levels in 2024.

Discussion : Climate informed BRPs

Probability of long-term (2032, 2050, 2080) biomass decline or increase under high mitigation (low warming) scenarios:

Note that projections assume no adaptation by the species, fishery, or fishery management.

- Ensemble projections using climate-enhanced recruitment models and projected future warming scenarios and assuming F_{ABC} for 2024 - 2100) estimate a 95% chance that pollock SSB will be between 69-76% of 2022 SSB in 2032, between 73-78% of 2022 SSB levels in 2050, and between 71-75% of 2022 SSB levels in 2080.
- Ensemble projections using climate-enhanced recruitment models based on long-term projections estimate a 95% chance that Pacific cod SSB will be between 69-78% of 2022 SSB in 2032, between 69-74% of 2022 SSB levels in 2050, and between 58-64% of 2022 SSB levels in 2080.
- Ensemble projections using climate-enhanced recruitment models based on long-term projections estimate a 95% chance that arrowtooth SSB will be between 76-100% of 2022 SSB in 2032, between 81-92% of 2022 SSB levels in 2050, and between 76-90% of 2022 SSB levels in 2080.

Probability of long-term (2032, 2050, 2080) biomass decline or increase under low carbon mitigation scenarios (high warming):

Discussion : Climate informed BRPs

Set B0 and B40 target using climate informed models

NO!

Discussion : Climate informed BRPs