



FUTURE SEAS

Barbara Muhling, Elliott Hazen

Desiree Tommasi, Isaac Kaplan, Felipe Quezada-Escalona,
Pierre-Yves Hervann, Stefan Koenigstein, Robert P.
Wildermuth, Steven Bograd, Jerome Fiechter, Beth Fulton,
Kevin Hill, Michael Jacox, Peter Kuriyama, James Smith,
Stephen Stohs, Brian Wells and Juan Zwolinski



Future Seas is a collaborative, interdisciplinary effort to explore potential impacts of climate change on U.S. west coast fisheries and to evaluate strategies for managing those impacts.

Fisheries

We are focused on fisheries for swordfish, albacore tuna, and coastal pelagic species off the US West Coast

Science

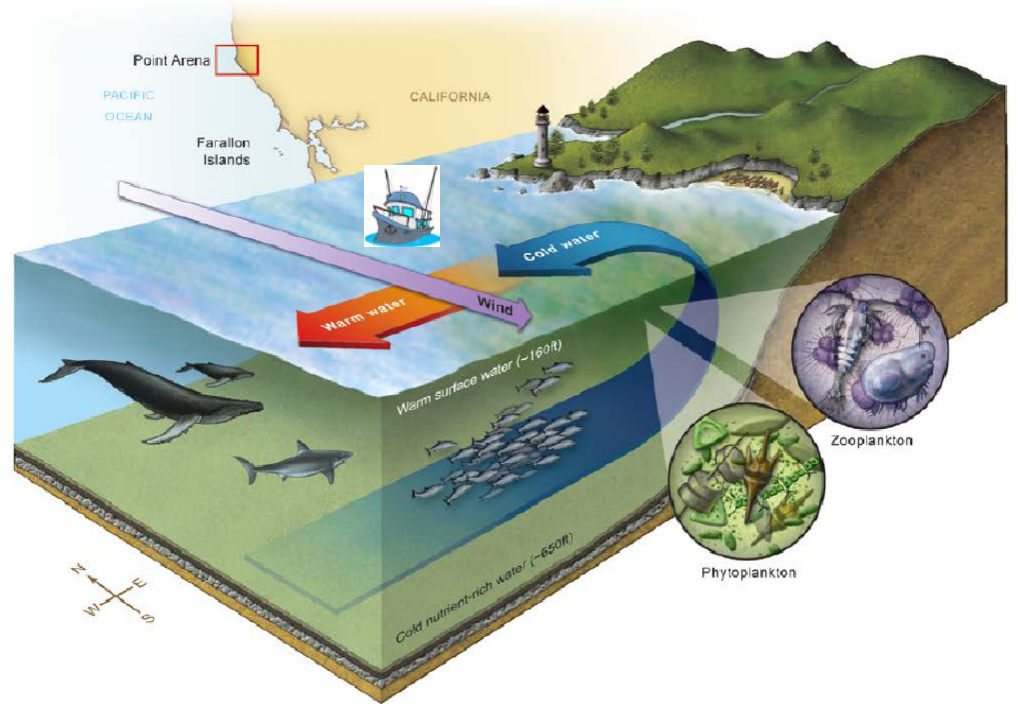
We are combining dynamical, statistical, and conceptual models to project physical, ecological, and socioeconomic change

Team

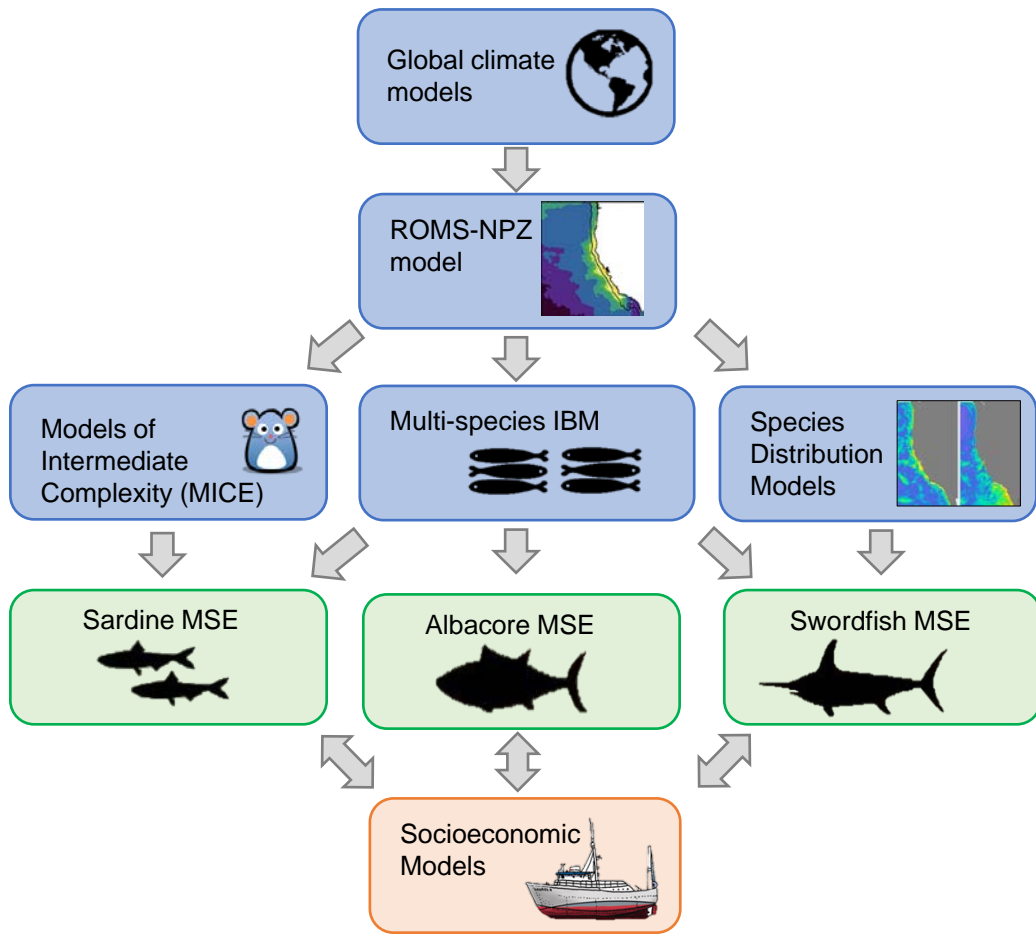
We are climate scientists, oceanographers, ecologists, economists, and social scientists, working closely with fishers and fishery managers

The California Current Ecosystem

- Productive upwelling ecosystem
- Provides many ecosystem services
- Forage species transfer energy from plankton to upper trophic levels, including protected species, commercial fisheries and recreational fisheries



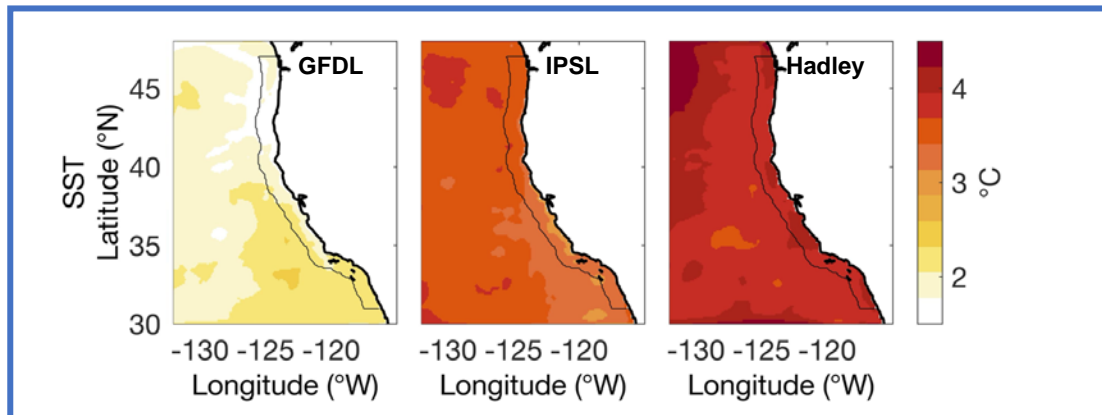
Phase I: 2017 - 2021



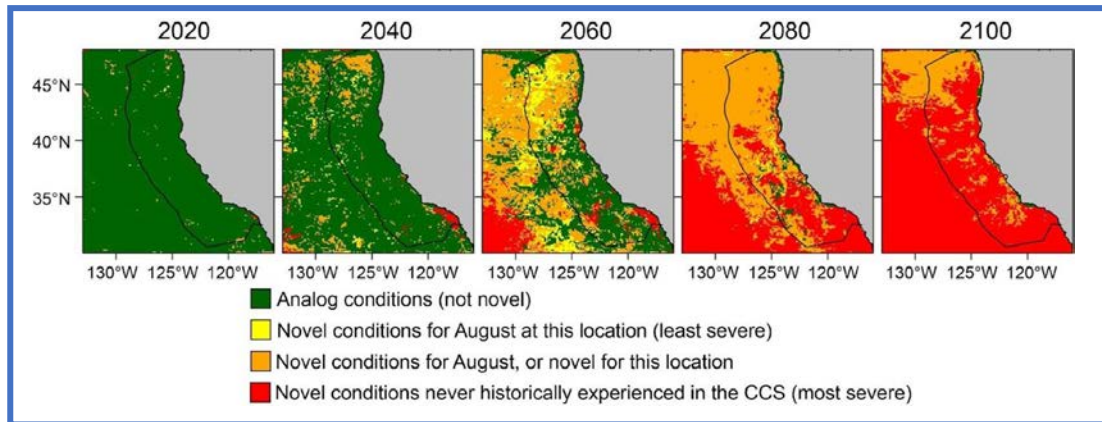
Phase I: 2017 - 2021

Major outputs

Warming and
changing oceans
(Pozo Buil et al. 2021)



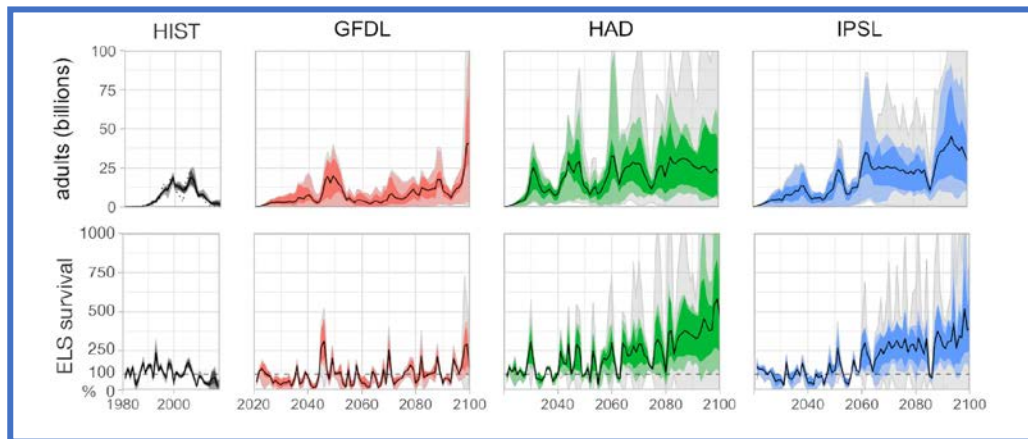
Increasingly novel
ocean conditions
(Smith et al. 2022)



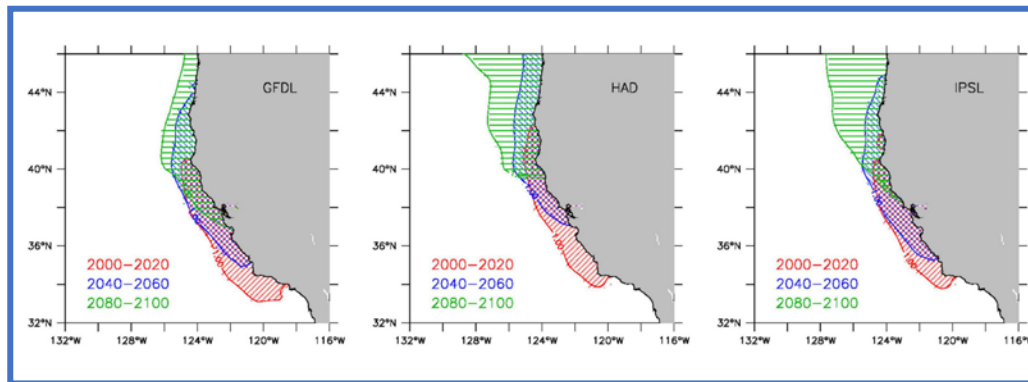
Phase I: 2017 - 2021

Major outputs

Increasing sardine abundance
(Koenigstein et al. 2022)



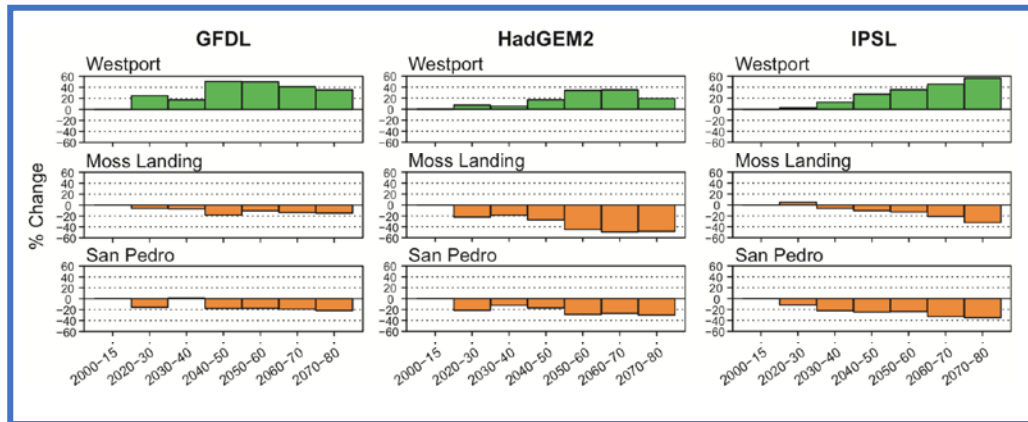
Changing sardine abundance and northward distribution shift
(Fiechter et al. 2021)



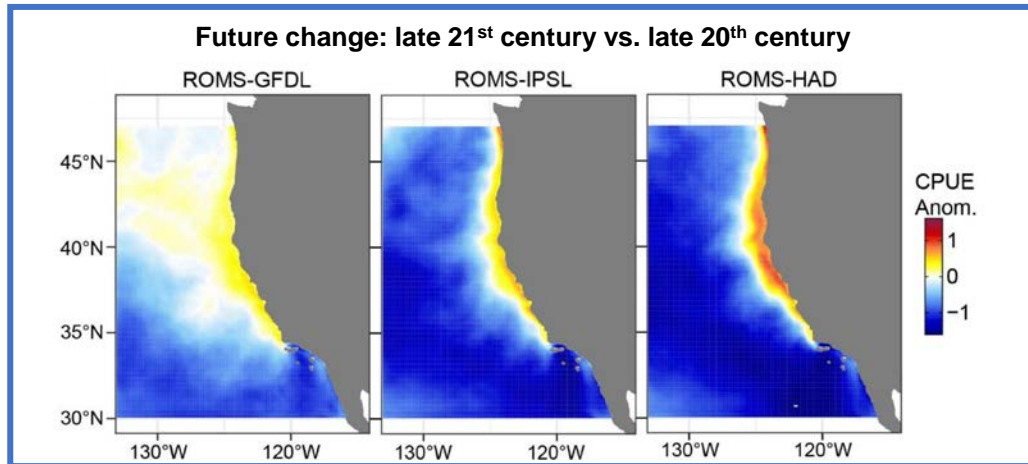
Phase I: 2017 - 2021

Northward shift in
sardine distribution and
landings
(Smith et al. 2021)

Major outputs

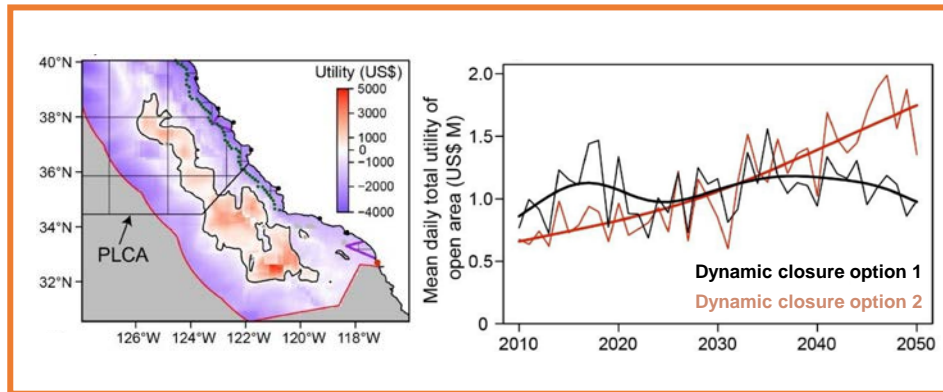


Shoreward contraction of
albacore fishing grounds
(Smith et al. 2023)



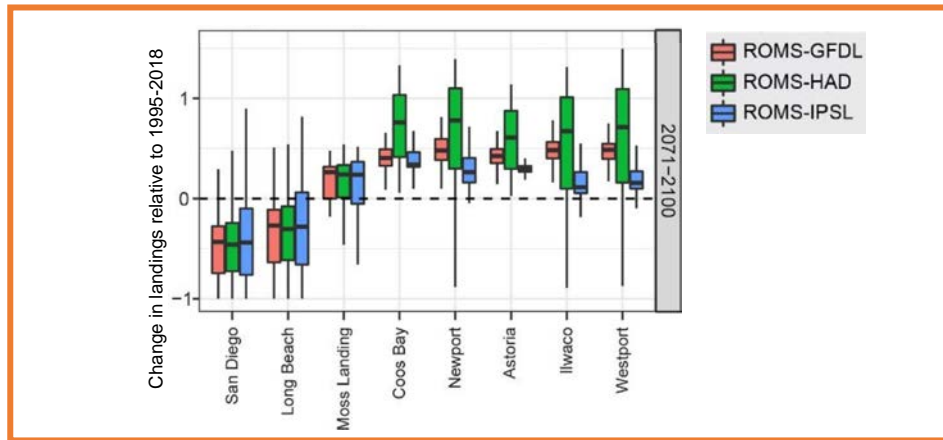
Phase I: 2017 - 2021

Changing opportunities for swordfish fishermen
(Smith et al. 2023)



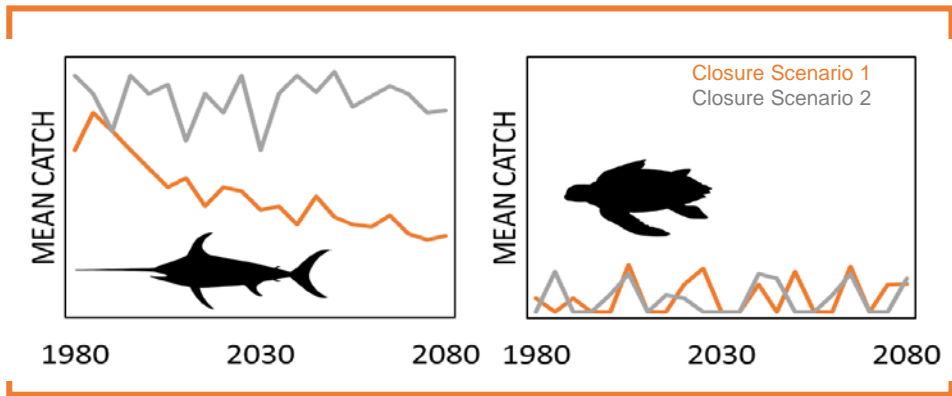
Major outputs

Northward shift in albacore landings across ports
(Smith et al. 2023)

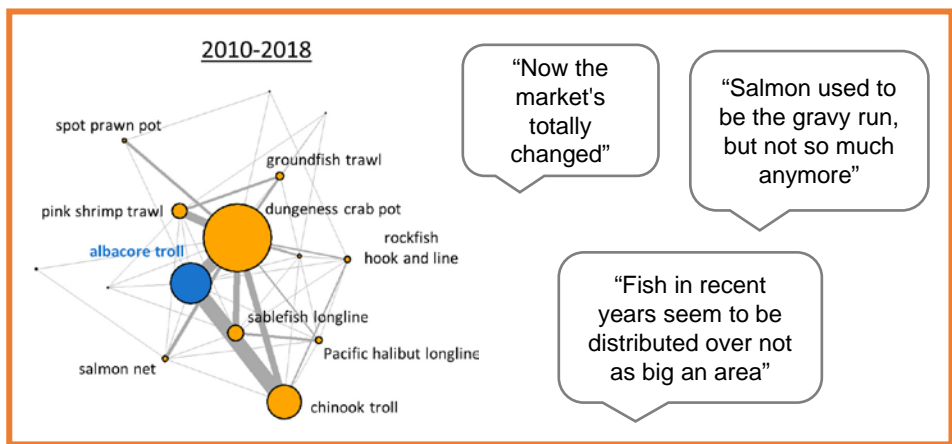


Phase I: 2017 - 2021

Changing catch and bycatch rates in closed areas
(Smith et al. 2021)



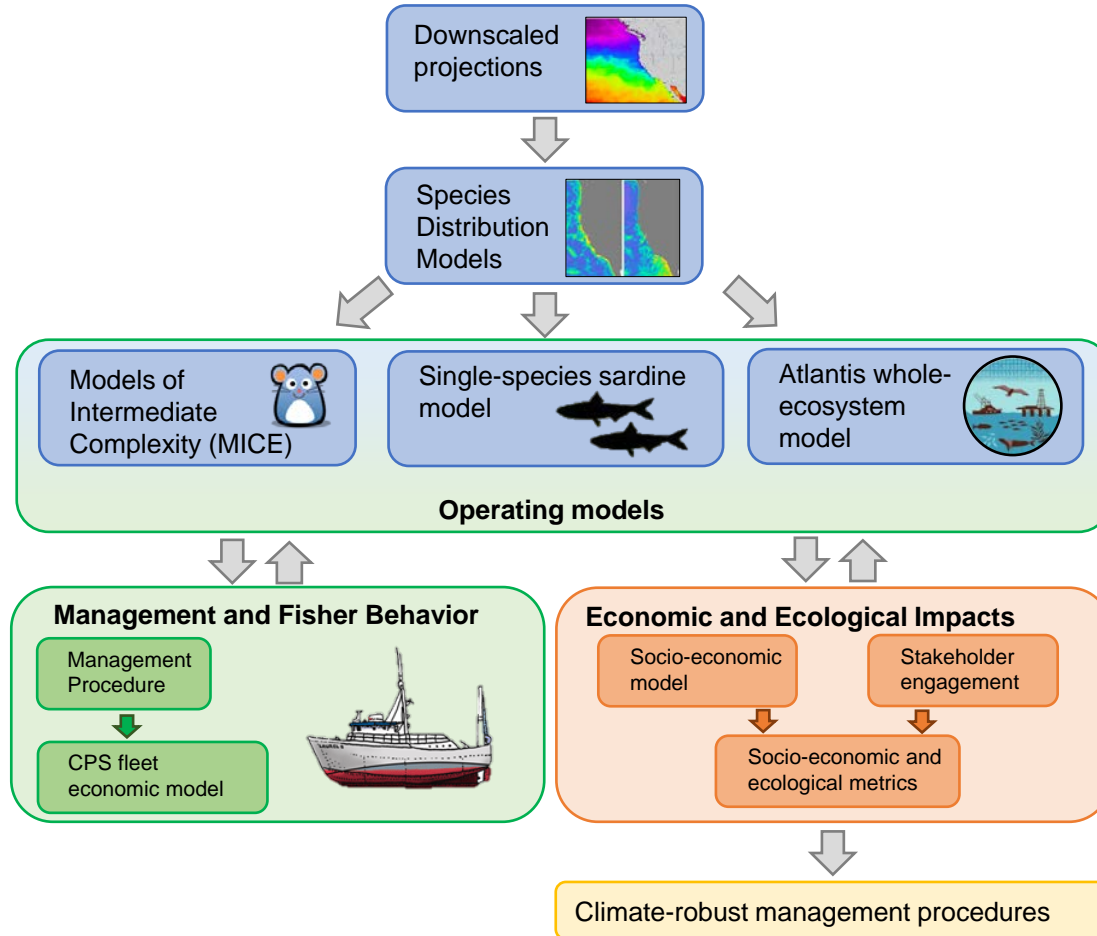
Changing historical social-ecological connections
(Frawley et al. 2021)



FUTURE SEAS II

Impact of climate and ecosystem change on the California Current forage complex and the fishing communities and predators it sustains

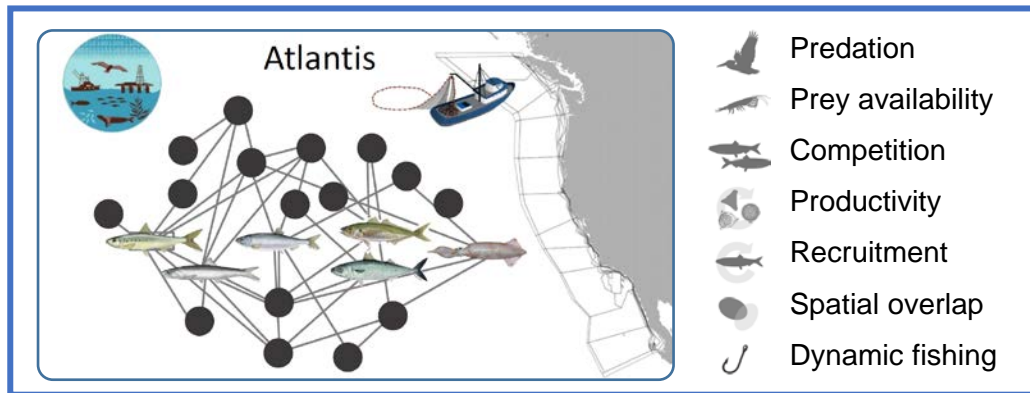
Phase II: 2020 - 2024



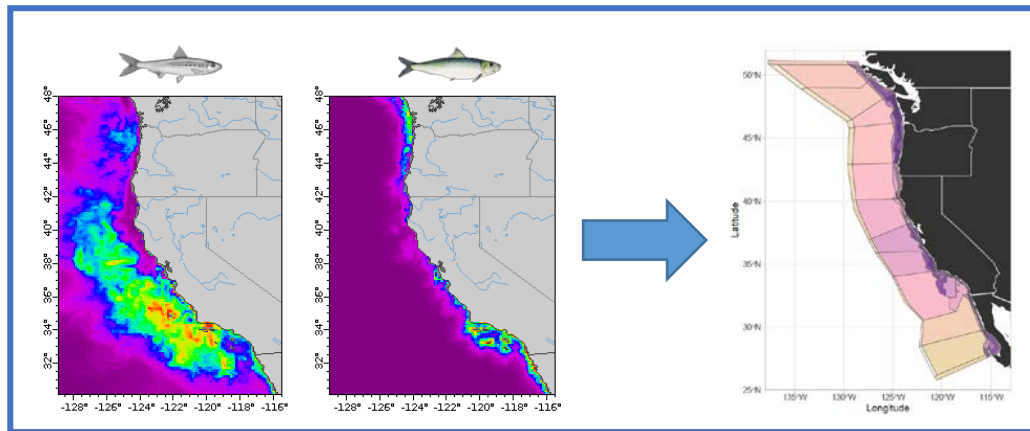
Phase II: 2020 - 2024

Rebuilt West Coast
Atlantis model
(Hervann et al. in prep)

Major outputs



Incorporate SDMs into
Atlantis
(Kaplan et al. in prep)



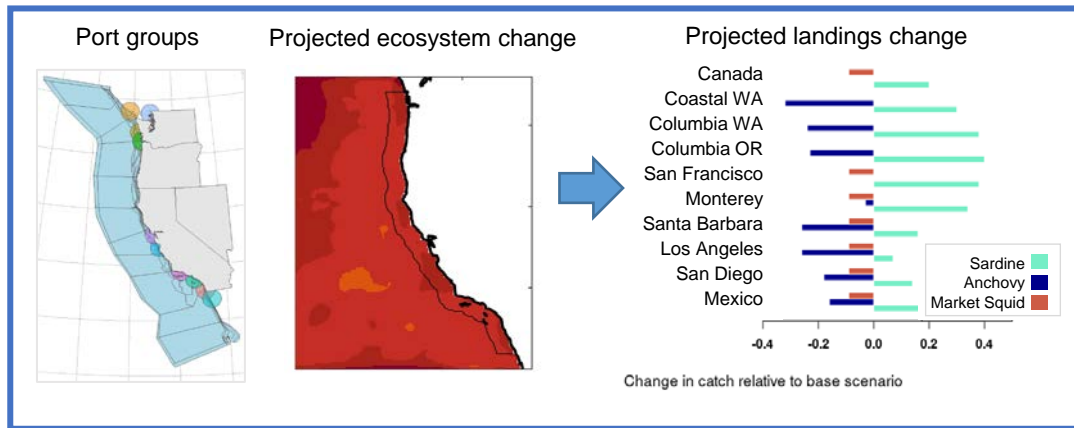
FUTURE SEAS II

Impact of climate and ecosystem change on the California Current forage complex and the fishing communities and predators it sustains

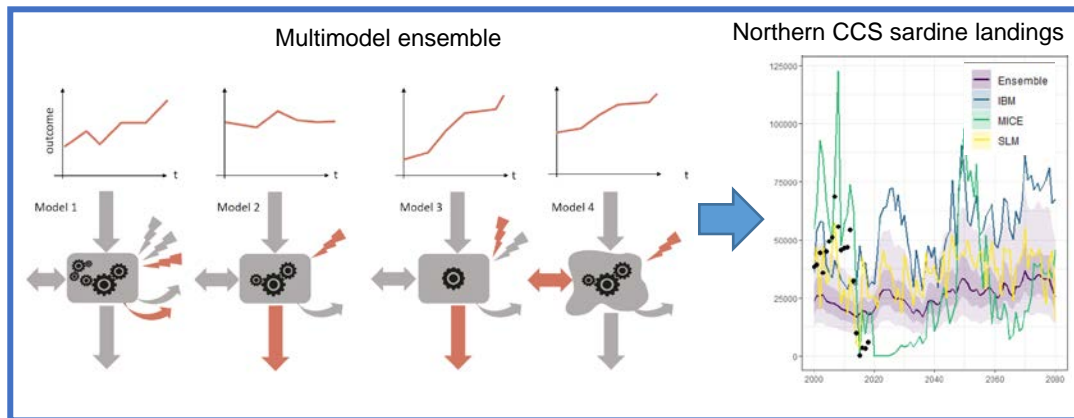
Phase II: 2020 - 2024

Major outputs

Project future landings by species using fleet footprints
(Liu et al. in prep)



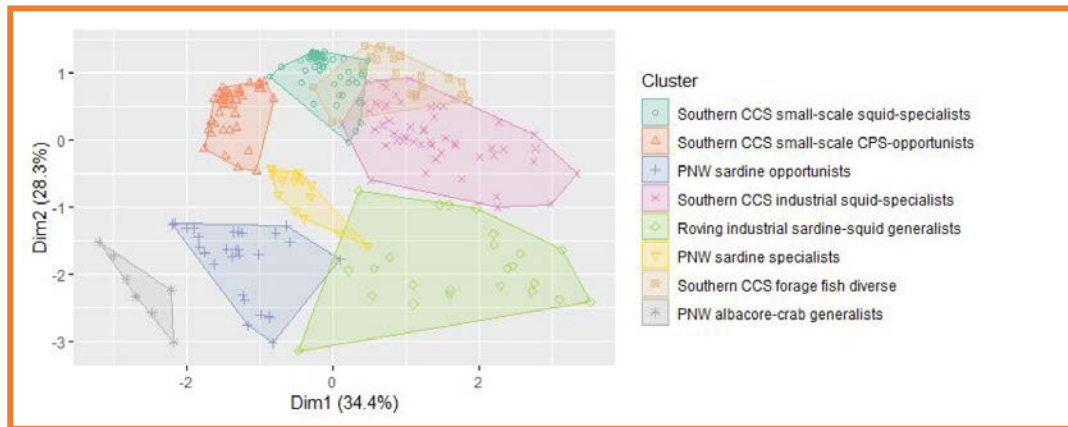
Examine ecosystem model ensembles
(Hervann et al. in prep)



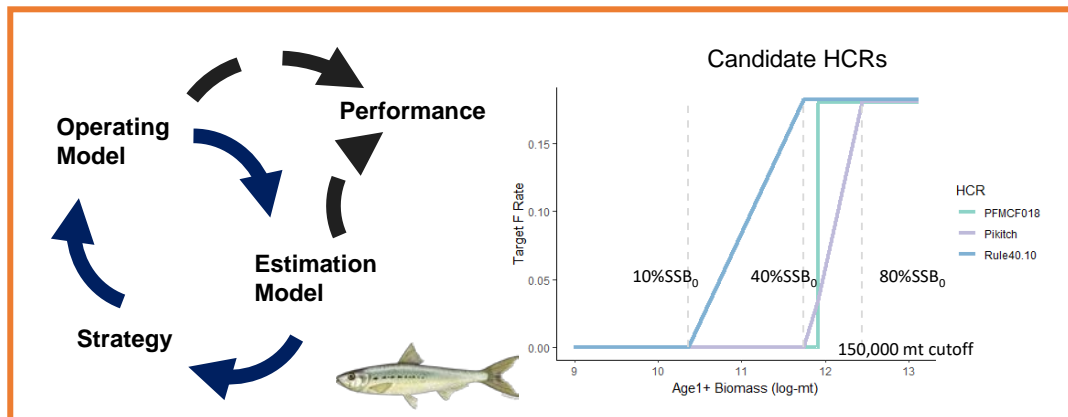
Phase II: 2020 - 2024

Major outputs

Determine fleet segments for vessels targeting CPS
(Quezada et al. submitted)



Assess robustness of sardine Harvest Control Rules using MSE
(Wildermuth et al. in prep)



Phase II: 2020 - 2024

Other products in progress

Ecosystem impacts

- Anchovy biomass projections from MICE
- Marine heatwave impacts from ecosystem models
- Sardine and anchovy recruitment indicator development
- Atlantis future projections under status-quo management

Socio-economics

- Fisher participation choice models
- Projections of future fisher participation and landings
- Fisher and community level socio-economic indicators
- Predator and fleet sensitivity to CPS distribution shifts

Management Strategy Evaluation

- Use Atlantis to simulate performance of alternative management rules

Emerging Management Needs

Shifting habitats will impact:

- Survey planning
- Stock structure
- Transboundary management
- Bycatch
- Changing prey interactions
- Changing social vulnerability
- Emerging fisheries



Emerging Management Needs

Changing stock productivity will impact:

- Stock assessment parameters and stock forecast performance
- Less effective management strategies?
- Ecosystem impacts
- Socio-economic impacts



Lessons Learned

- Tailor modeling framework to specific context
- Calibrate ecological/economic models to ensure they can capture past dynamics
- Capture and communicate uncertainty
- Engage stakeholders often
- Multidisciplinary teams are necessary!

WORKSHOP REPORT

**Management Strategy Evaluation (MSE) Workshop for the NOAA OAR/NMFS Project
“Future Climate Change and the California Current (Future Seas) - A Physics to Fisheries
Management Strategy Evaluation”**

March 28, 2018
Scripps Seaside Forum
University of California San Diego, La Jolla, CA



FUTURE SEAS

A Physics-to-Fisheries Management Strategy
Evaluation for the California Current System



All publications
mentioned are
available here

→ future-seas.com

Thank you!

barbara.muhring@noaa.gov



Stefan Koenigstein
Project Scientist
UC Santa Cruz / NOAA
SWFSC



Peter Kuriyama
Statistician
NOAA SWFSC



Gwendal Le Fol
Consultant Researcher
Ocean Environment
Consulting and Translation



Barbara Muhring
Project Scientist
UC Santa Cruz / NOAA
SWFSC



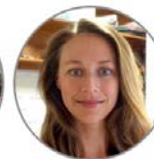
Mercedes Pozo Bull
Project Scientist
UC Santa Cruz / NOAA
SWFSC



Michael Alexander
Meteorologist
NOAA ESRL



Steven Bograd
Oceanographer
NOAA SWFSC



Stephanie Brodie
Ecologist
UC Santa Cruz / NOAA
SWFSC



Enrique Curchitser
Associate Professor
Rutgers University



Christopher Edwards
Professor
UC Santa Cruz



Felipe Quezada
Postdoctoral Scholar
UC Santa Cruz/NOAA
SWFSC



Ryan Rykaczewski
Project Scientist
NOAA PIFSC



James Smith
Project Scientist
UC Santa Cruz / NOAA
SWFSC



Stephen Stohs
Economist
NOAA SWFSC



Jonathan Sweeney
Economist
Private Sector



Jerome Fiechter
Assistant Professor
UC Santa Cruz



Timothy Frawley
Postdoctoral Scholar
UC Santa Cruz/NOAA
SWFSC



Elliott Hazen
Ecologist
NOAA SWFSC



Amber Himes-Cornell
Fishery Officer
FAO Fisheries and
Aquaculture



Michael Jacox
Oceanographer
NOAA SWFSC / NOAA ESRL



Andrew Thompson
Fisheries Biologist
NOAA SWFSC



Desirée Tommasi
Project Scientist
UC Santa Cruz / NOAA
SWFSC



Heather Welch
Project Specialist
UC Santa Cruz / NOAA
SWFSC



Robert Wildermuth
Postdoctoral Scholar
UC Santa Cruz / NOAA
SWFSC



Isaac Kaplan
Ecosystem Modeler
NOAA NWFSC



Pierre-Yves Hervann
Ecosystem Modeler
UC Santa Cruz, NOAA
NWFS



Larry Crowder
Professor
Stanford University



Stephanie Green
Assistant Professor
University of Alberta



Natasha Hardy
Postdoctoral Scholar
University of Alberta