

BECI Workshop 2 Ocean Biology and Fish Production Desiree Tommasi, University of California Santa Cruz and NOAA SWFSC

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Fisheries decisions across time scales are impacted by climate effects



Aquaculture

- Extreme weather responses
- Stocking/harvest time

Fishing Industry

- Labor and gear needs
- Where/when/what to fish for

Coastal Management

• Beach closures (e.g. HAB's, jellies)

Fisheries Management

- Fisheries closures to reduce unwanted and incidental capture
- Provision of catch advice

Tommasi et al., 2017; Progress in Oceanography

Need for climate-ready fisheries management to ensure effective adaptation strategies



Early warning systems

Fisheries relevant indicators to improve forecasting and risk assessment

Tommasi et al., 2021; Frontiers in Marine Science

Management Strategy Evaluation – Drift Gillnet Fishery Dynamic closures using Ecocast (Hazen et al. 2018) can reduce the economic burden of spatial closures, but require a flexible fishery



Smith et al. 2021; Frontiers in Marine Science

Seasonal SST forecasts improve catch advice for Pacific sardine



- Skillful SST forecast maintained higher biomass without foregoing yield (assumes robust SSTrecruitment relationship)
- Lower risk of collapse if combined with existing harvest cutoff
- Combining forecast-informed harvest controls with additional harvest restrictions modulates the risk of an erroneous forecast
- Results are lead-time dependent. Forecast accuracy too low to be useful at leads of 5 months or greater.

Tommasi et al., 2017; Ecological Applications

Impact of changing albacore distribution on landings



Latitude of projected albacore center of gravity

Change in mean albacore habitat suitability (2080-2100-1990-2020)

Smith et al. in prep, Tommasi et al. in prep

Impact of changing albacore distribution on landings



Smith et al. in prep, Tommasi et al. in prep

Impact of changing sardine distribution on landings

Mean change in projected sardine habitat suitability (2040-2055 - 2000-2015)



Percent change in mean landings due to sardine distribution change relative to 2000-2015 average



Smith et al. 2021; Fisheries Oceanography

Impacts on relative share of landings between Pacific Northwest and California consistent across ecological models



Large uncertainty on future biomass dynamics, but distribution change robust across different ecological models

Smith et al. in prep, Fiechter et al. 2021, Koenigstein et al. submitted Fish and Fisheries

Mechanistic age-structured sardine population dynamics model

- Process-based population model
 - early life stage temperature-, food- and transport-dependence
 - adult food availability and egg production
- Ensemble model to estimate ecological uncertainty
- Quantified uncertainty related to early life stage thermal window, under novel temperatures (esp. HAD and IPSL)



Stock assessment estimate
ensemble mean
7 of 9 ensemble members

9 ensemble members

Recent sardine collapse driven by food availability rather than SST



Koenigstein et al. submitted Fish and Fisheries

Projections of indicators of sardine dynamics



Koenigstein et al. submitted Fish and Fisheries

Gaps in understanding

- Limited availability of time series, particularly for zooplankton, for fisheries model development and verification. Example: hindcast with BGC for CCS only until 2010
- Improve uncertainty quantification of interannual variability in zooplankton biomass from BGC models
- Uncertainty in projected changes in basin scale circulation (e.g. poleward displacement of North Pacific Current bifurcation) and impacts on tuna migration and sardine habitat in the CCS



Fiechter et al. 2021

Gaps in understanding

• Uncertainty in early life stage thermal limits



Potential thermal response curves of sardine early life stage. All ensemble members perform equally well in reproducing historical sardine dynamics

Koenigstein et al. submitted, Fish and Fisheries

Recommendations

- Clear assessment of stakeholders needs. Focus not on what is feasible but what is useful (Payne et al. 2017, Frontiers in Marine Science)
- Develop and verify high resolution hindcasts/reanalyses with BGC
- Targeted physiological and process studies to reduce uncertainty in ecological projections (e.g. sardine ELS thermal response)
- Assessment of climate and biological/fisheries model uncertainty using ensembles
- Empirical environment-fisheries relationship need to be regularly tested with new data
- For recommendations regarding development of fisheries forecast systems see Tommasi et al. 2017, Progress in Oceanography



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Stakeholders who participated in Future Seas MSE workshop

NOAA Climate Program Office