END-TO-END MODELING TO PREDICT GLOBAL CHANGE EFFECTS IN THE CALIFORNIA CURRENT ECOSYSTEM

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End-to-end models of marine ecosystems couple climate, oceanography, food webs, and fisheries (Travers et al. 2007). These kinds of large-scale approaches are necessary to understand the cumulative and synergistic impacts of global change and the implications of marine management. End-to-end models of the California Current, such as Atlantis (Kaplan et al. 2013) and the NEMURO plankton-sardine model (Fiechter et al. 2014) simulate mechanisms of ecological interactions and are mainly of use for decadal time scales, and in these ways differ from some other marine forecasting techniques presented in this CalCOFI symposium and elsewhere. The oceanographic features of end-to-end models are often directly driven by simulations of ocean physics (Curchitser et al. 2005) and increasingly by projections of the ocean and atmosphere under climate change (Dunne et al. 2012).

End-to-end models can play a predictive role, ranking management options and investigating scenarios and hypotheses regarding how global change will unfold. Approximately five years ago, Rose and colleagues (2010) urged "restraint in using end-to-end models in a true forecasting mode." Five years later, end-to-end models have advanced substantially, as evidenced by both basic research and fisheries management applications. End-to-end models can now meet higher standards for model review, fitting, and consideration of uncertainty. One example was a recent multiday review of the California Current Atlantis model, conducted by external reviewers and members of the Pacific Fishery Management Council's Scientific and Statistical Committee[1]. The review included consideration of model calibration, fits to history, uncertainty, and parameter sensitivity.

End-to-end models have already provided some simple predictions of climate change impacts in the California Current (Kaplan et al. 2010; Ainsworth et al. 2011). Additionally, they have been used to predict food web impacts of fisheries, fishery management actions, and harvest of forage stocks (Kaplan et al. 2012, 2013). These efforts using the California Current Atlantis model are now being refined to provide improved spatial and taxonomic resolution of the biology, and more detailed projections of oceanography under climate change. Finally, California Current Atlantis model results have been applied to strategic management questions in the context of an Environmental Impact Statement for groundfish fisheries (Pacific Fishery Management Council and National Marine Fisheries Service 2014).

In conclusion, end-to-end models such as the California Current Atlantis model can be used to predict food web impacts of fisheries; these efforts depend on collaboration with field-based programs such as CalCOFI. Predictions of global change are possible and are improving and depend on collaboration with oceanographic research groups. End-to-end models are not tactical tools, and are not intended for short-term predictions (e.g., annual decision cycles). However, strategic management advice from end-to-end models is appropriate for a variety of ecosystem-based management needs, for instance within fishery management plans, fishery ecosystem plans, and cumulative impacts assessments.

[1]http://www.nwfsc.noaa.gov/research/divisions/cb/ecosystem/marineecology/aem.cfm

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