Bioeconomic model evaluations of draft MPA arrays and draft external proposals for the MLPA South Coast Study Region (Round 1): Guide to interpreting model outputs

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The figures and tables accompanying this document present the output of two bioeconomic models used to evaluate draft marine protected area (MPA) arrays and draft external proposals for the Marine Life Protection Act (MLPA) South Coast Study Region (SCSR). The output includes maps that show the spatial distribution of several ecological and economic variables described below. Results are given for a long-term equilibrium, not the initial response to MPA implementation. With few exceptions, results are presented for both the UC Davis and UC Santa Barbara models. While these models are similar in most structural aspects, they represent the movement of adult fish in different ways, among other small differences. A complete description of the modeling evaluation is included in Chapter 8 of the "Draft Methods Used to Evaluate MPA Proposals in the MLPA South Coast Study Region."

The total biomass of these fish species within Southern California is highly uncertain, and the models make no attempt to predict the absolute number of fish (in kilograms per square or kg/km^2) in each location. Rather, the models describe the relative spatial pattern in which biomass and other response variables are distributed. As such, each response variable is scaled to a constant value, such as the maximum biomass observed when the model is run without fishing.

Results are presented in four formats:

1. Values of biomass, yield, fishing effort, and larval recruitment are shown in maps of the study region.
2. Biomass and yield also are summarized into regions for an intermediate-scale comparison. These regions are SM (southern mainland, Mexico to Long Beach), NM (northern mainland, Long Beach to Point Conception), NCI (northern Channel Islands: San Miguel, Santa Rosa, Santa Cruz, Anacapa), and SCI (southern Channel Islands: Santa Barbara, Santa Catalina, San Clemente, San Nicolas).
3. Biomass, self-recruitment, and self-persistence are tabulated for each individual MPA in each MPA array or proposal.
4. Finally, study region-wide totals of biomass and yield in each MPA array or proposal are presented for each species in graphs that show biomass on the x-axis and fishery yield on the y-axis.

Types of inputs:

Habitat

Benthic habitat is classified as hard or soft, and by depth, either 0-30 meters (m) or 30-100 m depth. Each of eight representative species is classified as utilizing one or more of these habitat types. The maximum density of individuals in a particular square kilometer depends on the fraction of suitable habitat in that square kilometer. The habitat maps show the classifications of habitat types.

MPA boundaries
A model cell (each square kilometer of the SCSR) is considered to be in an MPA if at least 25% of its area lies within an MPA boundary. For each MPA array or proposal, maps were generated to show which model cells are considered MPAs for each representative species. The maps do not show an MPA if that MPA has no protection for that species. In the models, the actual regulations specified for each MPA are used (i.e., although all MPAs are shown as the same color in these maps, they may actually differ in the protection afforded to a particular species).

Types of outputs:

Biomass
This is the total biomass of the model species, at equilibrium, for each square kilometer of the study region. Values are scaled to the maximum biomass observed in any one square kilometer in the unfished scenario.

Fishing effort
This is the total fishing effort in each square kilometer. Values are scaled to the maximum effort in any square kilometer observed in the maximum sustained yield (MSY)-type management scenario with the existing MPAs. Both models assume that fishing effort is distributed according to a fleet model, in which fishermen choose to fish in a particular place based on fish biomass in that place.

Fishery yield
Fishery yield is the total harvest of each species in each square kilometer. Values are scaled to the maximum yield obtained in one square kilometer when the model is run with existing MPAs and MSY-type management. Note that the models differ somewhat in their predictions of fishery yield for halibut. This difference arises from the different approaches to modeling fish movement and the fleet model used to describe fishing patterns in these initial model runs. Essentially, the two models predict similar total harvests (and similar biomass) but in the UC Davis model, fishing effort is concentrated into very few square kilometers, which are traversed by the greatest number of fish. The modeling team will consider options for improving the accuracy of the fishery yield in future model runs.

Recruitment
Recruitment is the replenishment of adult populations in each square kilometer by arriving planktonic larvae. Settling larvae are assumed to experience density-dependent mortality before recruiting to the adult population, so there is a maximum density of young per square kilometer. Recruitment patterns indicate the degree to which the adult population in a particular area is being fully replaced each generation. Replacement occurs when recruitment exceeds 25% of the maximum density of young that could settle per square kilometer. Recruitment is only calculated by the UC Davis model.

Self-recruitment
Self-recruitment is the proportion of settling larvae in an MPA that were produced within that MPA. This metric provides information on the relative isolation of the MPA from other larval sources. This value is calculated on an MPA-by-MPA basis in each model. Note that the UC Davis model applied a slightly more restrictive limit on the minimum MPA area needed to be included in the model, so there are no UC Davis model outputs for several of the smaller MPAs.

Self-persistence

Self-persistence is the degree to which an MPA is self-sustaining. It is calculated based on larval production and the proportion of larvae produced within an MPA that return to that MPA (Note that self-recruitment is the proportion of settling larvae that were locally produced). Values of self-persistence that are greater than 1 indicate that the MPA is completely self-sustaining. Values less than 1 indicate that the persistence of the adult population within the MPA depends on larval production from outside sources.