California MLPA Master Plan Science Advisory Team
Draft Bioeconomic Model Evaluations of Round 3 SCRSG Marine Protected Area Proposals for the MLPA South Coast Study Region

October 5, 2009 Draft

Overview of Modeling Approach

Bioeconomic model analyses of the Round 3 marine protected area (MPA) proposals for the South Coast Study Region were performed by the UC Davis (UCD) and UC Santa Barbara (UCSB) modeling research groups. A description of each of the models, the inputs, outputs, and assumptions, and the differences between the two models can be found in “Draft Methods Used to Evaluate Marine Protected Area Proposals in the MLPA South Coast Study Region” [Chapter 8 and Appendix B]. Briefly, each group simulated population dynamics and calculated long-term equilibrium estimates of conservation value (i.e., biomass) and economic value (i.e., fishery yield and/or profit) for each MPA proposal (including Proposal 0, the existing MPAs) and each of eight species (ocean whitefish, black surfperch, opaleye, kelp bass, kelp rockfish, California sheephead, California halibut, and red sea urchin) under three different future fishery management scenarios (unsuccessful management, Maximum Sustainable Yield (MSY)-type management and conservative management. As in Round 2, both modeling research groups conducted evaluations using both the original fishing fleet model and a revised fleet model. Primary evaluation results are reported only for the original model to maintain consistency with previous evaluations, but key differences observed in the results obtained from the revised fleet model also are noted when applicable.

Detailed, spatially explicit model outputs, including maps for each response variable and sub-regional summaries of key statistics for each species, proposal, and management scenario are available online (www.dfg.ca.gov/mlpa). Here, we report overall results only, focusing on the mean (averaged across all species) conservation value and economic value for each proposal under each management scenario.

Key Findings

Results of the Round 3 evaluations followed the same general trends exhibited in the previous round: In the “unsuccessful management” scenario, there is a positive correlation between the conservation value (biomass) and economic value (fishery yield) of each MPA proposal. By contrast, in the “MSY-type management” and “conservative management” scenarios, there were negative correlations between conservation value and economic value, so proposals with high conservation value had lower economic value. These patterns were consistent across both models, using both the original fleet model and the revised fleet model. In Round 2, the UCSB revised fleet model results had exhibited a slightly different pattern for the unsuccessful management scenario, in which the correlation between conservation and economic value switched from positive to somewhat negative. This pattern also was somewhat evident in the Round 3 results but it did not affect proposal rankings as dramatically as in Round 2.

The overall rankings generally followed these patterns (where > indicates values “greater than”, and the names of each Round 3 MPA Proposal developed by the South Coast Regional Stakeholder Group are abbreviated as "P1", "P2", and "P3"; the no action alternative is "P0"):

Conservation Value:

P3 > P1 > P2 > P0

Economic Value (Unsuccessful Management – except UCSB model with the revised fleet model):

P3 > P1 > P2 > P0

Economic Value (Unsuccessful Management – UCSB model with revised fleet model):

P3 > P0 > P2 > P1

Economic Value (MSY-type Management or Conservative Management):

P0 > P2 > P1 > P3

These overall rankings reflect the general trend that proposals with greater total area in MPAs had higher conservation value in all scenarios and greater economic value with unsuccessful fishery management, but lower economic value in other scenarios. Thus, in the two more conservative management scenarios (MSY-type management and conservative management), there is a tradeoff between improving conservation value and maintaining fishery yield. This arises because in those scenarios, yield typically would be highest if there were no MPAs at all. By contrast, if fishery management is unsuccessful, overall yield is predicted to be quite low, even with the existing MPAs in Proposal 0, and there is no tradeoff between economic and conservation value in that scenario.

It also is important to note that the difference between MPA proposals in either economic or conservation value within a given management scenario is dwarfed by the differences among the future fishery management scenarios. Thus future management success will have a strong bearing on the performance of any MPA network.

How can proposals be improved to increase conservation value and fishery yield?

There were tight correlations (both negative and positive) between overall economic value and conservation value across all three management scenarios in both models. In other words, the results from the bioeconomic modeling evaluation of SCRSG proposals fall along a relatively straight line for each management scenario, indicating that there is a direct relationship between economic and conservation value.

This result reflects the fundamental similarity across the proposals in terms of MPA placement (i.e., most proposals have MPAs in similar locations). The differences in proposal performance (relative to economic and conservation values) appear to reflect differences in the relative sizes and levels of protection of the MPAs in those locations. For example, under MSY-type management, a proposal which protects large amounts of habitat will tend fall along one end of the continuum (i.e., with higher fish biomass and lower fishery yield), while a proposal with less habitat protected will tend to fall along the opposite end (i.e., with lower fish biomass and greater potential fishery yield).

Results for proposals from Round 3 and the two previous rounds all fall along the same relatively straight lines of correlation between economic and conservation values for each management scenario. The rounds differ, however, in the spread of proposals along this line. In Round 1, proposals covered a wide spread of conservation values. In Round 2, they converged within approximately 30% of the previous spread, concentrating on greater economic value and lower conservation value, relative to Round 1. In Round 3, the proposals diverged again, and now cover approximately half of the range of conservation values represented in Round 1.

While the results of the bioeconomic modeling evaluations tend to fall more or less along a straight line, they are not constrained to lie *exactly* on the line, and it is possible to identify proposals that fall either above (i.e., better performance) or below (i.e., worse performance) the line defined by the full suite of proposals from all rounds. For example the Round 3 proposals P1 and P2 fall slightly below the line defined by the other proposals, indicating that they afford slightly lower economic value for a given level of conservation value. This result is most noticeable in the UCD results for MSY-type management and the UCSB results for unsuccessful management. By contrast, Proposal 3 tends to fall directly on the line, indicating that it is no better or worse than other proposals providing a similar level of either conservation or economic return.

Both the UCSB and UCD models produce information about each MPA in each proposal. The information may be used to evaluate whether a particular MPA is attaining a desired level of biomass (or supporting a desired level of fishery yield nearby). The models also produce two sets of maps showing predicted changes in larval supply under each proposal. The first type of map shows the change in larval supply to each location (as a percentage of larval supply predicted for Proposal 0). The second type of map shows the change in larval production at each location; that is, which locations produce higher numbers of larvae that successfully settle to downstream locations (again, expressed as a percentage of larval production under Proposal 0). Together, these maps can reveal which MPAs are particularly successful in improving connectivity with the MPA network, and which locations are predicted to benefit most from increased larval production inside MPAs. Diagrams of larval connectivity for each species (available online at www.dfg.ca.gov/mlpa) can be used to determine sources that likely supply locations that appear to be undersupplied on the maps of larval supply. Increasing the size of MPAs in source areas (or adjusting their boundaries to include more of the suitable habitat type) could improve larval supply to the 'downstream' locations, improving the performance of MPA proposals.

Additionally, both modeling groups undertake a deletion analysis, in which each MPA in a proposal is sequentially removed, one at a time, and conservation value is recalculated. We call the difference between the biomass *with* and *without* a given MPA is an indication of that MPA's relative ***contribution*** to the MPA network. When this difference is divided by the amount of habitat protected by the MPA, it gives a measure of that MPA's ***efficiency*** in achieving conservation goals. Comparing these "deletion" statistics from MPAs in similar locations across the proposals should reveal whether changing the size, shape, or level of protection in a given MPA could improve its performance and thus its contribution to the

network. In particular, high efficiencies indicate areas where protecting an additional unit of habitat is likely to cause relatively large increases in biomass.

Conclusion

There is a clear and consistent ranking in expected conservation value across the three Round 3 MPA proposals developed by the SCRSG, with Proposal 3 giving the highest expected conservation value under all management scenarios for both models. The ranking for expected economic value is not as consistent; it depends on the success of future conventional management efforts and on the future cost of travel to distant fishing grounds. However, the general result is that Proposal 2 had the highest expected economic value unless management is unsuccessful outside of the MPAs, in which case Proposal 3 had the highest expected economic value. Proposal 1 tended to exhibit intermediate levels of both conservation and economic value, regardless of future management.