MLPA Master Plan Science Advisory Team
Draft Bioeconomic Model Evaluations of Round 2
MPA Proposals for the MLPA South Coast Study Region

June 18, 2009 Draft

Overview of Modeling Approach

Bioeconomic model analyses of the Round 2 marine protected area (MPA) proposals for the MLPA South Coast Study Region were performed by the UC Davis and UC Santa Barbara 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 the MLPA evaluation methods document for the study region. 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) and each of eight species (Ocean Whitefish, Black Surfperch, Opaleye, Kelp Bass, Kelp Rockfish, Sheephead, Red Sea Urchin, and California Halibut) under three different future fishery management scenarios ('Unsuccessful Management', 'MSY-Type Management', and 'Conservative Management').

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 will be made available online. 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.

Updates to Modeling Approach

One component of both bioeconomic models is a sub-model known as the 'fleet model' which predicts the spatial distribution of fishing effort in each model year. In Round 1, both teams used fleet models in which fishing effort was distributed solely based on the spatial distribution of fish biomass; that is, fishermen fished in locations with the best return per unit effort. Since then, the groups have worked to analyze the Ecotrust dataset on the spatial distribution of fishing for several of the modeled species. These analyses suggest that there may be spatial factors determining the fishing effort in a patch. In particular, patches close to ports are more heavily fished than more distant patches with similar biomass. The UCSB modeling team has incorporated this effect into their fleet model as an increased cost of fishing more distant patches due to travel costs (following Smith and Wilen, 2003 J. Env. Econ. Manag.), and have produced results from this updated fleet model for travel costs consistant with the ecotrust data. The UCD modeling team took a more probabilistic approach, and used the Ecotrust data to calculate how distance from port reduces the probability of fishermen visiting it. The UCD team also detected spatial trends unrelated to distance from port, with higher fishing occurring in the south eastern portion of the study area, and incorporated that trend into their updated fleet model. The modeling groups are still working to improve these updated fleet models, but the preliminary results provide an alternative evaluation that indicate how travel costs might change the rankings of proposals.

Key findings

Results of the Round 2 evaluations followed the same general trends exhibited in the previous round: in the Unsuccessful Management scenario, there is a positive correlation between the conservation and economic value of each proposal. By contrast, in the MSY-Type Management and Conservative Management scenarios, there was a negative correlation between conservation and economic value, so that proposals with high conservation value had lower economic value. These patterns were consistent across both models, using both the original fleet model and the newer fleet model. The only exception was the Unsuccessful Management scenario in the UCSB model with the newer fleet model. In this version, the correlation between conservation and economic value switches from positive to somewhat negative, consistent with correlation seen in the other management scenarios. This result depends on the cost of traveling to a patch relative to the value of the fish that can be harvested in that patch.

The overall rankings generally followed these patterns:

Conservation Value:

[Topaz and Lapis 1] > [External B, External A, and Opal] > Lapis 2 > Proposal 0

Economic Value (Management Fails – except UCSB new fleet model):

[Topaz, Lapis 1, and External B] > Opal > [External A and Lapis 2] > Proposal 0

Economic Value (Management Fails – UCSB new fleet model):

[External A, Lapis 1and Lapis 2] > [External B and Opal] > [Topaz] > Proposal 0

Economic Value (MSY Management or Conservative Management):

Proposal 0 > [Lapis 2 and External A] > External B > [Topaz, Lapis 1, and Opal]

Brackets group proposals that had similar rankings across the model results.

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

It is also important to note that the difference between 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.

Information regarding potential changes to improve proposals

There were tight correlations (both negative and positive) between overall economic and conservation value across all three management scenarios in both models. That is, the results from the seven proposals fall along a relatively straight line within each management scenario. This result seems to reflect 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 (their location along the line) appear to reflect differences in the relative sizes and levels of protection of the MPAs in those locations: a proposal with a large SMR in a given location will tend fall along one end of the line, while a proposal with a smaller SMCA in the same location will tend to fall along the opposite end of the continuum.

This is not to say that the results are constrained to fall along a straight line. For example, Lapis 1 falls somewhat above the line defined by the other proposals under MSY-Type and Conservative management fishing, indicating that it achieves slightly higher economic value for a given level of conservation value and vice versa. By contrast, Opal and Lapis 2 tend to fall below the line, indicating that they are predicted to achieve slightly lower economic value for a given level of conservation value. These differences suggest that there is potential to improve proposal performance above the range defined by the current set of proposals.

Both the UCSB and UCD models produce spatial results (www.dfg.ca.gov/mlpa) which can be used to evaluate whether each MPA within a proposal is attaining a desired level of biomass (or supporting a desired level of fishery yield nearby). The models also produce spatial maps of larval supply to each location, expressed as the increase in larval supply relative to that expected under Proposal 0. Since larval supply eventually translates into both biomass (conservation value) and fishery yield (economic value), these maps can reveal which locations are poorly supplied by a given MPA proposal. Comparing those maps to the larval connectivity diagrams for each species (available online) can be used to determine which MPAs undersupplied locations. Increasing the size of MPAs (or adjusting their boundaries to include more of a particular habitat type) could improve larval supply to the 'downstream' locations, improving proposal performance.

Additionally, both models undertake a deletion analysis, in which each MPA in a proposal is sequentially removed, one-at-a-time, at conservation and economic values are then recalculated. The ratio of proposal performance *with* and *without* a given MPA are an indication of that MPA's relative contribution to the MPA network, and when this ratio is divided by the amount of habitat protected by the MPA, it gives a measure of that MPA's efficiency in achieving MLPA goals. Comparing the deletion statistics from MPAs in similar locations across the proposals should reveal whether changing the size, shape, or level of protection (SMR vs. SMCA) in a given MPA could improve its performance and thus its contribution to the network. MPAs with very small deletion statistics could be discarded or altered to improve performance. This computationally intensive analysis is still underway at the time of writing, so no specific recommendations are available at this time.

Conclusion

There is a clear and consistent ranking in expected conservation value across the six MPA proposals, with Lapis 1 or Topaz giving the highest expected conservation value under all 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 External A and Lapis 2 give the highest economic value unless management is unsuccessful outside of the MPAs, in which case the results depend on the fleet model used. The UCSB updated fleet model predicts that Lapis 1 and External A will have slightly higher expected economic values than the other proposals. In the UCD updated fleet model and both older fleet models, Lapis 1, Topaz and External B have the highest expected economic values, whereas External A and Lapis 2 have the lowest. The remaining proposal (Opal) tends to exhibit intermediate levels of both conservation and economic value, regardless of future management.