California Marine Life Protection Act (MLPA) Initiative
Bioeconomic Model Evaluations of Round 2 MPA Proposals for South Coast Study Region

Report to South Coast Science Advisory Team

Revised *July 23, 2009*

Overview of Modeling Approach

Bioeconomic model analyses of the Round 2 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.

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 (http://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.

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 modeling groups 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 incorporate information from 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 group 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 has produced results from this revised fleet model for travel costs consistent with the EcoTrust data. The UCD modeling group took a more probabilistic approach, and used the EcoTrust data to calculate how distance from port reduces the probability of fishermen visiting a particular location. The UCD group also detected spatial trends unrelated to distance from port, with higher fishing occurring in the southeastern portion of the study area, and the modelers incorporated that trend into their revised fleet model. The

modeling groups are still working to improve these revised fleet models, but the preliminary results do provide an alternative evaluation that indicates 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 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. The only exception was the unsuccessful management scenario in the UCSB model using the revised 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 occurs when the cost of traveling to distant patches is high relative to the value of the fish that can be harvested in those patches.

The overall rankings generally followed these patterns (where > indicates values "greater than", and where brackets group proposals that had similar rankings across the model results):

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

Economic Value (Unsuccessful Management – except UCSB model with the revised fleet model):
[Topaz and Lapis 1] > [Opal, External A, External B and Lapis 2] > Proposal 0

Economic Value (Unsuccessful Management – UCSB model with revised fleet model):
[External A, Lapis 1, Lapis 2 and External B] > [Opal and Topaz] > Proposal 0

Economic Value (MSY-type Management or Conservative Management):
Proposal 0 > [Lapis 2, External A and External B] > [Topaz, Lapis 1, and Opal]

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 the four MPA proposals developed during Round 2 and the two revised external 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 (their location along the line) 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 to fall along one end of the line (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 of the continuum (i.e., with lower fish biomass and greater potential fishery yield).

Comparing the six Round 2 proposals to the nine evaluated in Round 1 reveals that the proposals from both rounds tend to fall on the same straight lines. However, the Round 2 proposals are clustered within a smaller region, falling within the lowest third of the previous round's range in terms of conservation value.

The results of the bioeconomic modeling evaluation of all proposals will not always be constrained to fall along a straight line. For example, in Round 2, Lapis 1 falls above the line defined by the other proposals under MSY-type and conservative management scenarios, indicating that this proposal achieves slightly higher economic value for a given conservation value. 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 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 information about each MPA in each proposal. The information may be used by the RSG 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) can be used to determine sources that probably 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. An MPA's relative contribution to the MPA network is defined as the difference between the expected biomass produced by the network with versus without that individual MPA. 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.

Because the Round 2 MPA proposals are all relatively similar to each other, the differences among proposals in the deletion analysis are rather subtle. Nonetheless, some general results are apparent (although stakeholders are likely to discover additional useful comparisons with a careful examination of the deletion results). First, MPAs near Laguna Beach tend to have high contribution and high efficiency. Additionally, proposals with larger SMRs in that area (e.g., Lapis 1) tend to have higher contribution, suggesting a positive benefit of increasing MPA area there. Second, most proposals placed MPAs either near Point Dume or the Big Sycamore area. Those MPAs tended to have high contribution and high efficiency. Proposal Topaz had MPAs in both areas and lower contributions for both, suggesting some degree of redundancy. In that case, the Deer Creek SMCA near Big Sycamore had higher contribution, suggesting that area may be more favorable for MPA placement than the Point Dume area. Third, MPAs in the Point Conception area tended to have higher contribution when their eastern border extended further east, as in Proposal Opal. Fourth, the many small MPAs surrounding Catalina Island in many proposals tended to have low contributions but high efficiency, reflecting the fact that they are targeted to particular habitat patches and suggesting that they do have some conservation value once their size is considered. Fifth, the pending military closures on San Clemente Island tended to have high contributions but low efficiencies because they encompass so much habitat. Pending San Clemente closure #2 had lower contributions in proposals with greater overall MPA area (e.g., Topaz, Lapis 1) than in proposals with less overall MPA area (e.g., External A and B). This suggests that military closure #2 provides a greater conservation benefit when there is less MPA area on the mainland and nearby on Santa Catalina Island. Finally, MPAs in the San Diego area tended to have lower overall contributions. This may be due to some degree of redundancy among them; because there were typically four to five MPAs close to each other in that region, the deletion of any one of them did not have a great effect on overall network performance. However, MPAs in the Point Loma and Del Mar areas (e.g., Lapis 1) tended to have higher contributions than other MPAs in the San Diego area.

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 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 External A, External B or Lapis 2 had the highest expected economic value unless management is unsuccessful outside of the MPAs, in which case the results depend on the fleet model used. The revised UCSB fleet model predicted that Lapis 1, External A and External B will have slightly higher expected economic values than the other proposals. In the revised UCD fleet model and both original fleet models, Lapis 1 and Topaz have the highest expected economic values, whereas External A, External B 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.