California Master Plan Science Advisory Team
Parallel Processes Work Group
Layperson's Guide to Interpreting UC Davis Model
December 31, 2007

Model Name
Population Sustainability and Yield Model (Note: population sustainability is the ability of a population to remain present, i.e., not collapse. Population persistence and resilience mean roughly the same as sustainability. An example is biomass; a population with higher biomass is more sustainable, more persistent and more resilient. Here yield and catch mean the same thing.)

Description of the Model
This model will tell the user how much a population and fishery yield along the coast increase, decrease or remain the same with the implementation of different marine protected area (MPA) packages. The model uses real data about growth, reproduction, survival, home ranges (area in which adult fish remain) and larval dispersal from abalone, cabezon, black rockfish, ling cod, and canary rockfish. We can also use similar data on other species.

Specific Assumptions of the Model

- Larvae disperse over a range of distances, but settlement declines with distance from origin
- Adults move within home ranges (area within which adult fish remain)
- As the number of larvae settling in an area increases, the fraction of larvae able to survive past the larval stage decreases so that the number of successful recruits is limited to a maximum number.

Specific Parameters Utilized

- Distributions of larval dispersal distances
- Home range sizes
- Fishing mortality rate, growth rate, fecundity (number of offspring produced), natural mortality rate
- Parameters determining sustainability under current management (e.g., steepness, lifetime egg production; these numbers determine how hard a population can be fished without collapsing)
- Distribution of hard bottom habitat (or other habitat type if available)
- MPA locations and type

Model Limitations

- Does not include population distribution beyond state waters (because there is no habitat data available and connectivity is uncertain).
- The model is equilibrium-based, i.e., it calculates the long-term results, not what happens from year to year.

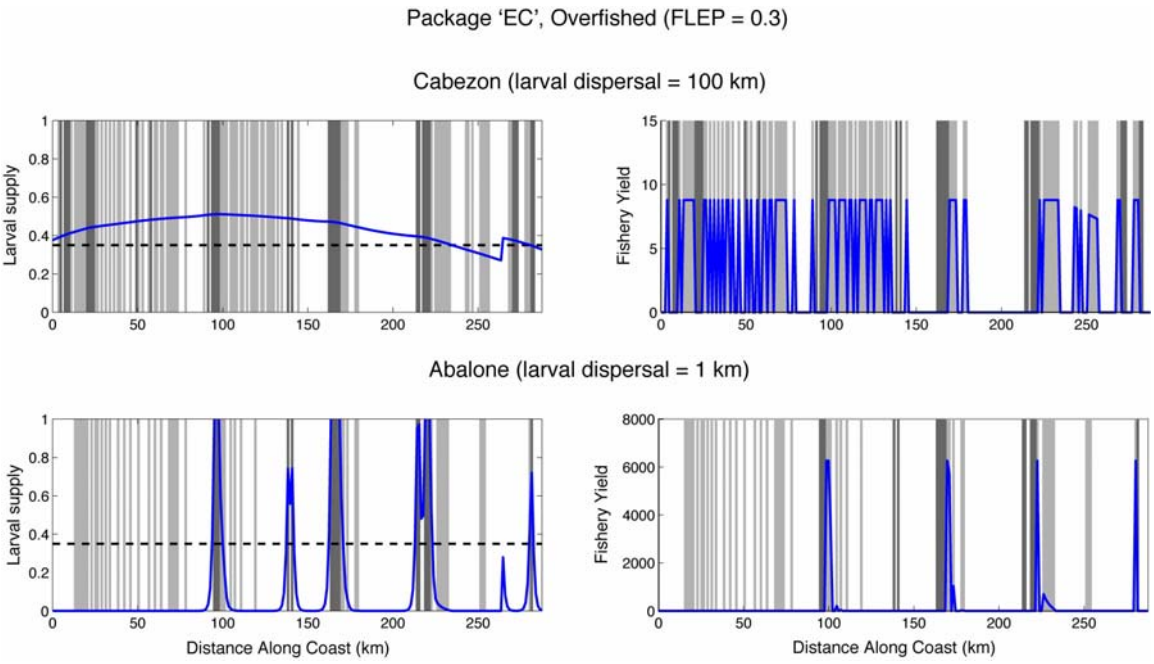
Types of Output

- Alongshore distribution of population resilience (e.g., biomass) for each species

- Alongshore distribution of catch for each species
- Plots of the amount of coastline with sustainable populations (a benefit) vs. coastline protected (a cost)
- Plots of the combinations of population resilience (biomass, fraction of coastline sustainable, or total larval delivery) and yield that result from each proposed MPA package
- Decision tables comparing changes in sustainability and fishery yield for each of the five species with each proposed package of MPAs, under various assumptions regarding sustainability under current management.

Examples and General Interpretations of the Model Output

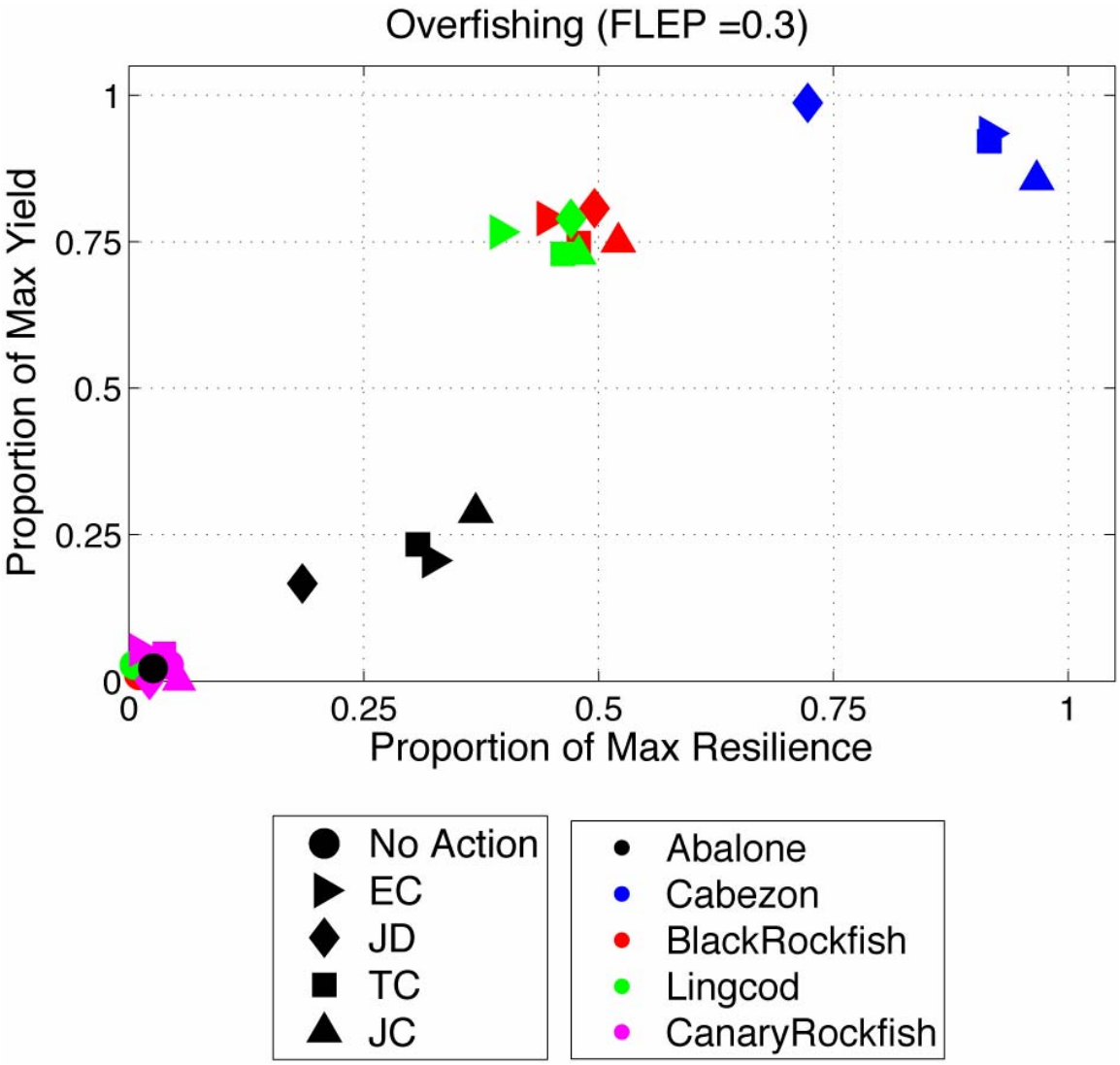
Output Example 1. Distribution of sustainability and yield vs. distance alongshore from the north end of the Marine Life Protection Act (MLPA) North Central Coast Study Region. This kind of plot can be used by the MLPA North Central Coast Regional Stakeholder Group (NCCRSG), Master Plan Science Advisory Team (SAT), Blue Ribbon Task Force (BRTF) and the California Fish and Game Commission to examine the local population effects of changes in the proposed MPAs.



This figure indicates how population sustainability and fishery yield will vary along the coast with a proposed package of MPAs for two example species, cabezon and abalone. The measure of sustainability plotted here is the number of larvae that arrive and try to settle at each point along the coast. It is similar to biomass, but represents sustainability better. The x-axis is distance from the north end of the MLPA North Central Coast Study Region, except that the Farallon Islands are plotted from kilometer 265 to kilometer 288. The light gray background represents hard bottom habitat (0-30m depth for abalone and 0-100m depth for cabezon), and the dark gray background represents locations of MPAs. This model run

assumes that conventional management has failed to maintain a sustainable population, i.e., a level of fishing such that individual replacement is 30 percent of its natural value, where the value required for a population to persist is 35 percent. Note that because abalone disperse short distances, they persist in the MPAs and only a short distance outside of them. On the other hand, since cabezon is a long distance disperser, the population persists everywhere along the coast because the MPAs work together as a network.

Output Example 2. The levels of fishery yield and sustainability produced by the various proposed MPA packages – This type of plot can be used by the SAT, BRTF and the Calirnia Fish and Game Commission to evaluate the benefits (increases in sustainability and yield) and costs (decreases in yield) of each proposed plan for a number of example species.



This plot summarizes the results of many plots like Example Output I by plotting the total yield and total larval supply in the MLPA North Central Coast Study Region for all five example species the modeling groups are using and the all of the proposed MPA packages (including no action). Since this model run assumes that current conventional management has allowed

the species to become overfished, none of the species persist for the no action case (i.e., they are at zero resilience and zero yield). For abalone, both catch and resilience (total larval supply) increase (from the no action case) with all packages because it is a short distance disperser. For cabezon, sustainability increases, but catch decreases with all packages. In this model run, canary rockfish do not persist with any of the proposed packages. The other two species do not persist with some of the proposed packages, but do persist for others.

How can specific outputs from this model inform the MLPA planning and decision-making process? How does this model address the guidelines with respect to evaluation of MPA proposals?

- All guidelines depend on achieving sustainability, and changes in yield are a potential benefit or cost in doing so.
- Stakeholder groups can use maps of sustainability and yield (see Output Example 1) to see locations where MPAs are most effective, and areas where effectiveness could be improved
- BRTF and SAT can use plots of how resilience and catch change for each proposed package of MPAs (see Output Example 2) to judge relative effectiveness in meeting goals (see below)
- BRTF and SAT can use the resilience/catch plots for different assumed sustainability (i.e., different levels of individual replacement) under current management to see how the usefulness of MPAs would change if current status was better or worse than assumed.
- BRTF and SAT can use decision tables to see how various packages compare quantitatively in terms of sustainability and yield under different assumed levels of sustainability under current management

How and what MLPA question or goal does the model address? *Specific goals of the MLPA are listed below.*

1. To protect the natural diversity and abundance of marine life, and the structure, function, and integrity of marine ecosystems.

   Model outputs show where populations will be sustainable with each proposed package of MPAs. If populations are not sustainable there will be no abundance, no ecosystem and no diversity.

2. To help sustain, conserve, and protect marine life populations, including those of economic value, and rebuild those that are depleted.

   Model outputs tell whether proposed MPA packages will actually help sustain, conserve, and protect marine life populations, and the levels to which they would be rebuilt. Most of the species we model are of economic value.

3. To improve recreational, educational, and study opportunities provided by marine ecosystems that are subject to minimal human disturbance, and to manage these uses in a manner consistent with protecting biodiversity.

Recreational, educational and study opportunities will be better if there are as many naturally occurring populations as possible. Our models of generic species indicate what range of species (beyond the 5 focal species) would be protected by MPAs.

4. To protect marine natural heritage, including protection of representative and unique marine life habitats in California waters for their intrinsic value.

The preservation of many marine habitats (e.g., kelp beds) depends on the presence of the natural complement of animal species. This model indicates which MPAs will support sustainable animal populations and thus protect the associated unique marine habitats.

5. To ensure that California's MPAs have clearly defined objectives, effective management measures, and adequate enforcement, and are based on sound scientific guidelines.

This model directly calculates the effectiveness of the management measures. The science underlying this model has been vetted repeatedly in the peer-review process (earlier versions of this model and approaches appear in 3 publications).

6. To ensure that the state's MPAs are designed and managed, to the extent possible, as a network.

A spatially structured population model such as this one is required to calculate how well proposed MPAs will work together as a network.