# California Master Plan Science Advisory Team
# Parallel Processes Work Group
# Draft Layperson's Guide to Interpreting EDOM Model
***January 7, 2007***

**Model Name**
EDOM: Equilibrium delay-difference optimization model

**Description**
EDOM attempts to predict equilibrium (long term) spatial distribution patterns of multiple populations subject to multiple fishing gears. Population dynamics relationships (larval dispersal, habitat-linked juvenile recruitment, age and growth, fecundity, harvesting) are similar to the UC Davis model; distributions are calculated or 1 km or 2km spatial cells extending from the coast to the limits of State jurisdiction. Spatial fishing effort is predicted using behavioral ("gravit") and/or optimization models. Key capability is to predict "bionomic equilibrium" abundance and effort patterns absent effective fishery regulation, and tradeoffs-conflicts among gear types (eg recreational vs commercial).

**Specific assumptions of the model**
For each species, larvae are distributed along the coast from each spatial cell using a bell-shaped settlement curve. Recruitment from these larval may be limited by larval settlement or availability of nursery habitat (Beverton-Holt recruitment curve with habitat-dependent maximum recruitment). Growth and survival after recruitment follow Ford-Brody growth curve and age-independent survival rate, and egg production assumed proportional to total weight of recruited (older) fish.

Two types of movement are modeled: irreversible dispersal of fish to seek new home ranges, and movement within home ranges. Irreversible dispersive movements are assumed to be relatively rare (few percent of spawning fish), but home ranges can be quite large (10-20km longshore). Movement within home ranges creates an "exploitable biomass" for each model cell that is a sum of contributions from surrounding nursery or spawning cells, hence representing "spillover" effects near MPA boundaries.

Effort for each gear type is assumed to take all species in each cell, i.e. is not species-selective. When effort distributions are predicted (rather than optimized) using gravity model, effort for each cell is proportional to total vulnerable fish biomass (summed over species and ages) on that cell, weighted also by relative fish prices.

**Specific parameters utilized**
Population dynamics parameters are described in Walters et al. manuscript. Main population dynamics parameters are listed in the following table along with indicator species used for hard-bottom community simulations (these species make up a high proportion of the total inshore harvestable biomass of hard-bottom species).

| | **Lingcod** | **Cabezon** | **Black Rockfish** | **Canary Rockfish** |
|---|---|---|---|---|
| **Annual survival rate (e-M, yr-1))** | 0.84 | 0.78 | 0.79 | 0.94 |
| **Body growth intercept (a, kg)** | 1.17 | 0.42 | 0.19 | 0.25 |
| **Body growth slope ®** | 0.95 | 0.93 | 0.90 | 0.96 |
| **Weight at maturity (wk, kg)** | 2.23 | 0.57 | 0.74 | 0.28 |

| | | | | |
|---|---|---|---|---|
| **Recruitment compensation ratio (K)** | 10.00 | 5.00 | 2.00 | 20.00 |
| **Mean larval dispersal distrance (km)** | 10.00 | 45.00 | 45.00 | 45.00 |
| **Adult emigration rate (e, yr-1)** | 0.01 | 0.01 | 0.01 | 0.02 |
| **Mean adult dispersal distance (km)** | 5.00 | 5.00 | 5.00 | 10.00 |
| **Adult home range radius (km)** | 10.00 | 0.50 | 7.00 | 3.00 |
| **Unfished spawning biomass (tmt)** | 30.00 | 3.50 | 24.00 | 80.00 |
| **Ratio of current to unfished biomass** | 0.20 | 0.30 | 0.30 | 0.10 |

## Model limitations

The model does not predict transient changes toward equilibrium, and does not include all species that may affect fishing effort distributions. It may not completely represent how concentration of fishing effort and spatial targeting may result in even higher rates of fishing mortality in some spatial cells than would be predicted based on spreading of effort within cells.

Biological interactions (competition, predation on young juveniles) are not represented, nor are possible changes in overall productivity associated with marine regime shifts. No linkage is considered between the fish inside California State waters and offshore components of stocks such as Canary rockfish that may be partially protected through Federal RCAs and EFS closures.

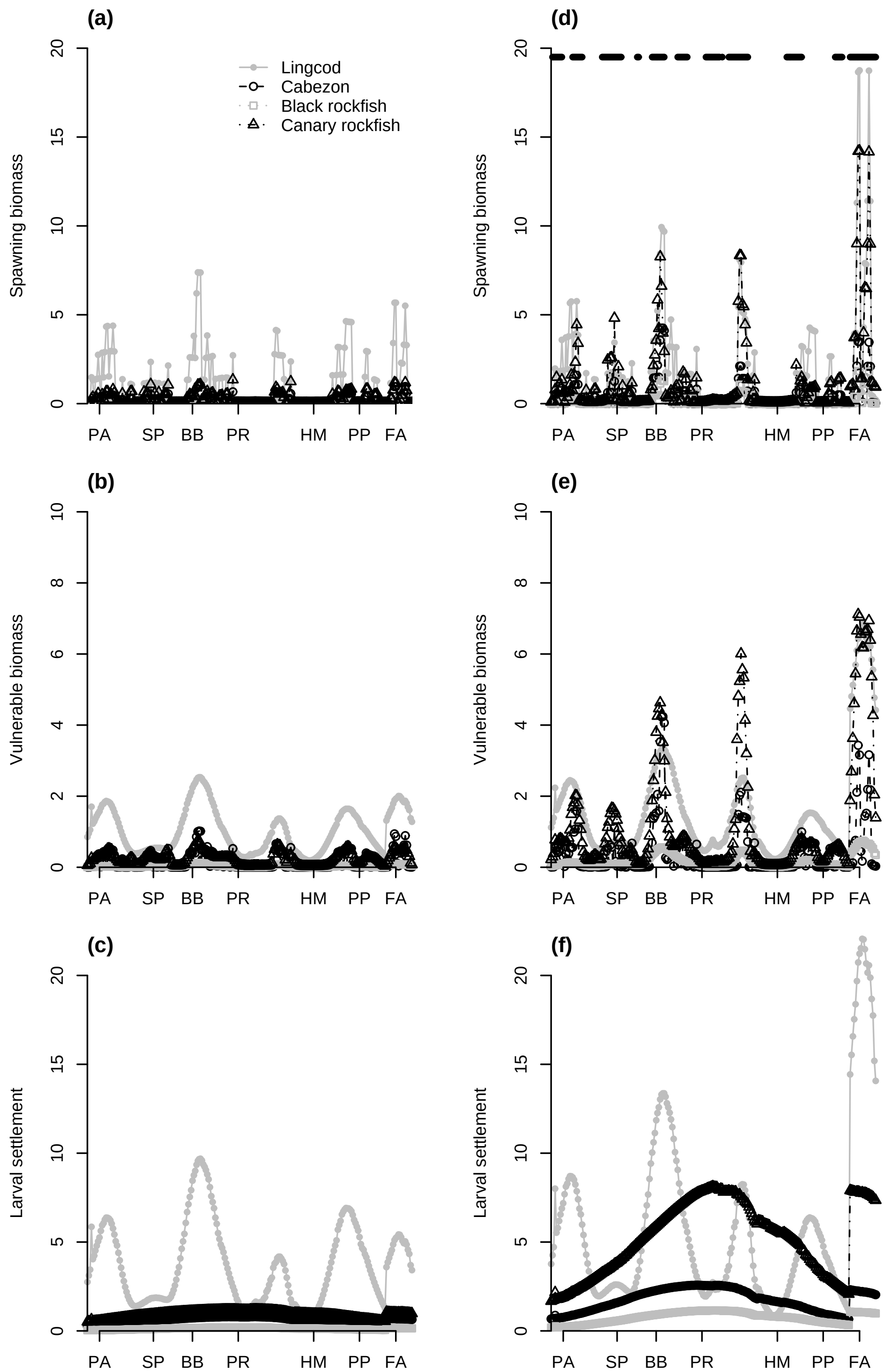
## Types of output

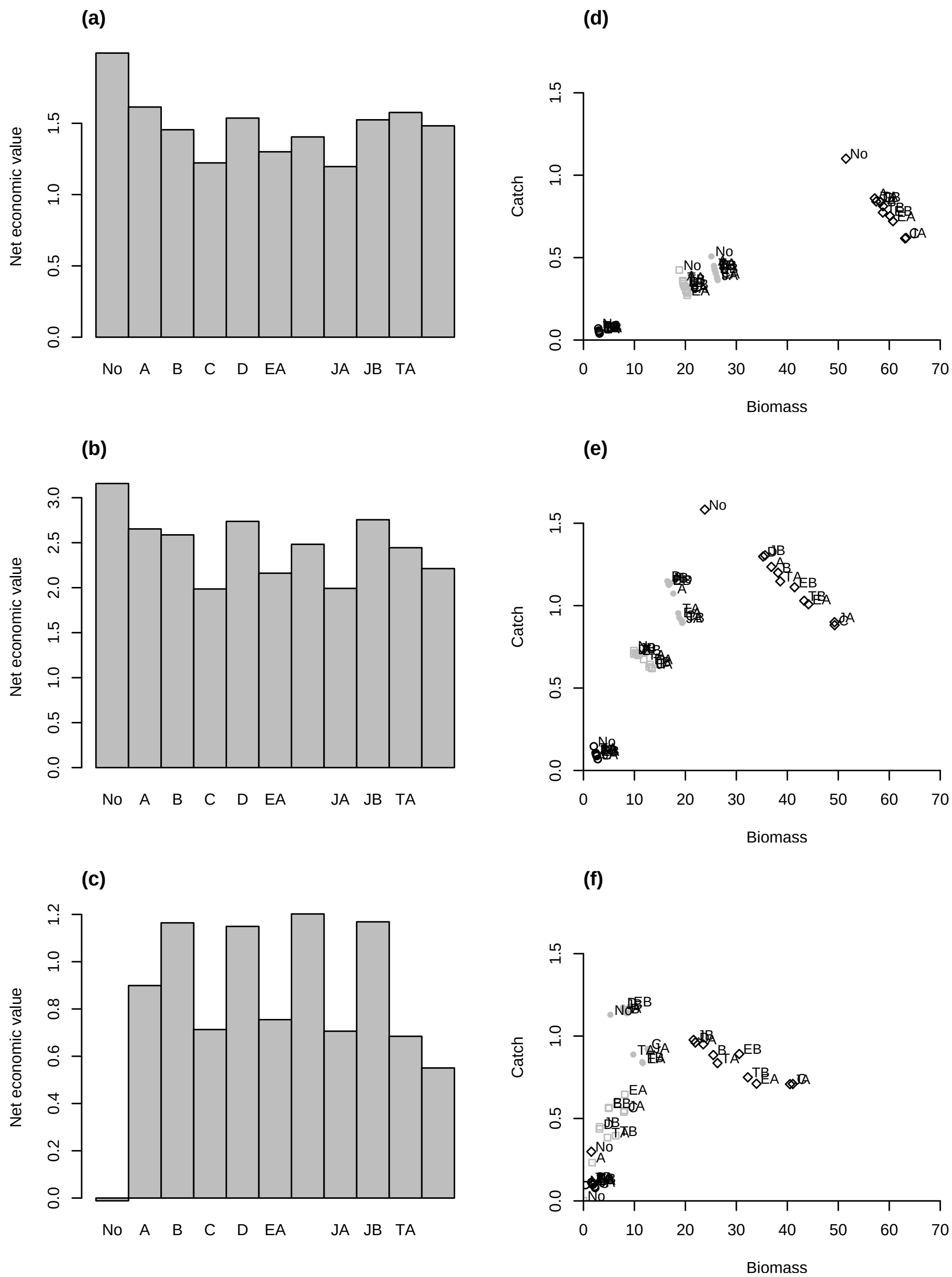
EDOM has a highly interactive user interface allowing changes in habitat use patterns, population parameters, and economic assumptions (cost of fishing, total fishing effort). Marine protected area (MPA) policy options can be quickly selected and compared using indices ranging from total fishing effort at bionomic equilibrium to catches and coastwide abundances.

## Examples and interpretation of model results

Below we show two graphs, one of spatial distributions of population indicators, and one comparing policy options in terms of net economic value and catch-biomass tradeoffs.

Spatial distribution of spawning abundances, harvestable abundances, and larval settlement:






## How can specific outputs from this model inform the MLPA planning and decisionmaking process?

The main aim of EDOM is to evaluate impacts of MPAs on recreational and commercial fishing, in terms of economic and fishing effort indicators. It allows ranking of MPA plan alternatives in terms of such performance measures and also in terms of expected long term abundances of key indicator fish species.

**How does this model address the guidelines with respect to evaluation of MPA proposals?**

Like the other quantitative models, EDOM is intended to provide an alternative to simple guidelines for MPA design. It can output indicators of adherence to guidelines (area protected, reserve spacing, etc.) but is intended to provide a more comprehensive suite of indicators for evaluation of performance.

**How and what MLPA question or goal does the model address?**
1. To protect the natural diversity and abundance of marine life, and the structure, function, and integrity of marine ecosystems.

Like the UC Davis model, EDOM outputs show where populations will be sustainable with each proposed package of MPAs.

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

EDOM emphasizes prediction of long term abundances, distributions, and economic utilization of valued fish species, and can help provide rebuilding targets for depleted species. It estimates conservation value (total abundance and spatial distribution) for each MPA alternative for every indicator species included in each model run.

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.

No specific contribution to education, except to provide a tool that just about anyone can use to rapidly visualize population responses to changes in MPAs and assumed future fishing patterns. Would be very useful as a "gaming" tool for classroom and stakeholder planning use.

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

Particular spatial cells/regions can be designated as needful of protection by setting high fishing costs on them for EDOM spatial optimization runs aimed at maximzing net economic value.

5. To ensure that California's MPAs have clearly defined objectives, effective management

A central aim of EDOM is to provide a set of clearly defined performance measures related to fisheries management and possible change in spatial distribution of stocks.

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

EDOM is mainly useful to compare network options in terms of impacts on larval connectivity, adult fish movement and exposure to fishing. Alternative network proposals can be quickly compared.