MLPA Master Plan Science Advisory Team
Parallel Approaches Work Group – Overview of Modeling Approaches
Revised November 18, 2007

Model Description	Model Parameters and Inputs	Model Outputs	Model Limitations	How Can Results be Used to Inform MLPA Process and Improve MPA Designs?
1. Population Sustainability Model [Botsford et al]: 1-dimensional models (alongshore, with Farallones) sustainability of generic species (short/long dispersers) in context of MPAs, fishing effects expressed as a fraction of lifetime egg production (FLEP)	- Dispersal distributions (long to short dispersers) - Distribution of hard bottom habitat - MPA location (and specifically SMRs) - Fishing mortality rate, or FLEP - Home range	- Alongshore distribution of species - Coastline sustainable vs. coastline protected - Alongshore distribution of yield - Expected results from size/spacing guidelines	- Does not include complete population distribution >3nm (no habitat data, connectivity?). - Equilibrium-based, no transients, present value	- This model assesses the contribution of proposed MPAs to sustainability of larval dispersing species with juvenile/adult movement, for any habitat distribution and level of fishing. - Shows locations where reserves most effective, areas improvable (i.e., in need of greater fraction in MPAs). - General results, in addition to species specific (i.e., for larval distance, adult home range, FLEP level)
2. Hilborn	4x43 km squares in State waters - Each square one of 4 habitats (hard shallow, hard deep, soft shallow,soft deep) - Diffusive larval dispersal - Diffusive adult dispersal - Each square protected or not protected for an individual species - Harvest managed by total catch based on a fraction of biomass,	Alongshore distribution of abundance, yield effort and catch-per-effort	Does not (at present) include non-state waters - Diffusive movement may not be appropriate for species with home ranges - Movement parameters for adults highly uncertain	This model explicitly shows the tradeoff between abundance and yield, and calculates how many areas would have persistent populations - Could easily be used interactively by stakeholders to evaluate alternative MPA plans, a run takes only a minute or two.

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	fishing fleet dynamically moves to areas with highest catch rates			
3. Ecospace Model [Walters, et al]	- Whole ecosystem dynamics based on John Field model; model simulates mixture of aggregate biomass changes for some species, along with detailed population dynamics (size, age, fecundity) for indicator species; population parameters for indicator species estimated from independent stock assessment, fitted in Ecosim - Larval dispersal, diffusive movement of older fish - Indicator species also linked through trophic interactions, dependence on highly mobile prey resources (macrozooplankton, small pelagic fish) - 1x1km grid extending	- Alongshore and offshore spatial distributions of indicator species and 20 biomass groups, over time from 1960 to present and forward 30 yrs under alternative MPA policies - Summaries of biomasses at indicator future times (2035) under MPA options and w/o MPAs - Summaries of future catch (recreational, commercial) at future indicator time(s) (2035) - Can also summarize economic performance (effort, landed values, etc.) for each MPA option (data not entered yet)	- Diffusive movement does not account for fractional vulnerability of animals with home ranges that cross MPA boundaries - Larval transport is purely diffusive (no longshore advection pattern considered yet) - Assumes high mortality rates of post-settlement juveniles that settle in bad habitats, during movement to suitable rearing habitats - Conservation of total fishing effort (effort moves but does not drop out under more restrictive MPA policies) - Poaching not included in fishing rate calculations - Historical and future changes in pelagic	The model should be used interactively with stakeholders to help refine MPA locations, etc. It will also help expose and stimulate debate on the basic tradeoff between harvest and abundance, and where to aim along that tradeoff. It can also help to screen out policy options that are not good in terms of either future catch or future abundance.

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	from shore to 200m depth, with habitat types (species associated with specific types, ontogenetic habitat shifts) - MPA options overlain on habitat map, biomass movement into/out of protected areas - Spatial fishing effort dynamics, effort shifted to remaining open areas when MPAs present; effort concentration near MPA boundaries when spillover - Effort response to combined abundance of indicator species (total hard bottomfish abundance)		fisheries (e.g. sardine) not modeled yet; crab and shrimp fisheries also assumed stable into future	
4. Costello (extended from a National Science Foundation Biocomplexity project based at UC Santa Barbara)	4x43 km squares in state waters - Each square one of four habitats (hard shallow, hard deep, soft shallow,soft deep)	Spatial distribution of yield, biomass by species, catch per unit effort, economic and ecological values of reserves. Benefits and	- dispersal kernels uncertain. - Optimized management limited to case of constant (but optimized)	This model explicitly shows the tradeoff between abundance and yield, and calculates how many areas would have persistent populations - Could easily be used

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	- Diffusive larval dispersal, settlement depends on distance from source and habitat suitability (which depends on species) - Diffusive adult dispersal, adults "choose" habitat in which to settle, but this will also depend on proximity to source - Each square protected or not protected for an individual species - Harvest managed by total catch based on a fraction of biomass, fishing fleet dynamically moves to areas with highest catch rates. - A key contribution of this model is that it allows for optimized management outside reserves.	costs of implementing alternative reserve networks. Value of reserves for different harvest rates outside reserves – allows for determination of re-optimized management outside reserves.	harvest rate outside.	interactively by stakeholders to evaluate alternative MPA plans as a run takes only a minute or two. Runs extremely quickly (a few seconds for any given scenario).
5. Marxan 2.0 – as evaluative tool [Scholz et al] numerical optimization tool to	Habitat targets defined by habitats protected under each RSG package.	Spatially explicit optimum reserves based on "habitat conservation targets"	Evaluates optimum solution based on maximizing habitat protection and	Help show users where they can achieve similar or better habitat types while reducing impact on commercial fisheries. Can be

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design marine reserve networks that represent a portion of habitats across depth zones and have a minimal impact on commercial and recreational fisheries	- Cost data derived from weighted average value across all commercial fisheries (rec. data not yet included)		minimizing costs – does not optimize for population sustainability - Does not consider spacing. - Considers all MPAs as no-take reserves, so overestimates costs.	used to “fine tune” proposals.