

## Marine Life Protection Act Initiative



### Spatial Bioeconomic Models for Evaluating Marine Protected Area Proposals

Dr. Christopher Costello, MLPA Master Plan Science Advisory Team and  
University of California, Santa Barbara  
Dr. Will White, University of California, Davis

Presentation to the MLPA Master Plan Science Advisory Team  
January 27, 2009 • Los Angeles, CA

## Value of Models in MLPA Process



- MPA proposals **must ensure population persistence** to meet MLPA goals
- **Existing guidelines and evaluation tools** attempt to address this requirement (e.g., size and spacing guidelines)
- **Size and spacing guidelines** do not comprehensively assess the combined effects of
  - Conditions outside MPAs (harvest)
  - Spatial population structure, adult movement, and larval connectivity
  - Dynamic responses to protection or harvest outside MPAs



## Value of Models in MLPA Process

- **Spatially explicit bioeconomic models** account for these factors and also include
  - Contributions from MPAs that do not meet size and spacing guidelines
  - Status and management of fished populations outside of MPAs
  - Tradeoffs (cost or benefit) between conservation and economic returns



## Model Inputs

- Geographic
  - Habitat maps
  - Proposed MPA boundaries and regulations
- Species-specific
  - Life history (growth, natural mortality, fecundity)
  - Adult movement (home range diameter)
  - Larval dispersal (pelagic larval duration, spawning season, some behavior)
  - Dispersal patterns from UC Los Angeles / UC Santa Barbara circulation model
  - Egg-recruit or settler-recruit relationship (critical to population persistence)



## Model Inputs

- Other
  - Oceanography: Multiple years of flow data with variable patterns
  - Behavior of fishing fleet in response to fish abundance
  - Fishery management outside of MPAs



## Model Outputs

- **Conservation**
  - Spatial distribution of larval settlement and biomass
  - Total settlement and biomass (summed over study region, weighted sum across species)
- **Economic**
  - Spatial distribution of yield
  - Total yield and profit (summed over study region, weighted sum across species)



## Model Outputs

- **Other Data**
  - Spatial distribution of fishing effort
  - Larval connectivity patterns
- *All outputs are based on long-term equilibria*
- *Each output is calculated for a range of assumptions about future fishery management outside MPAs<sup>1</sup>*

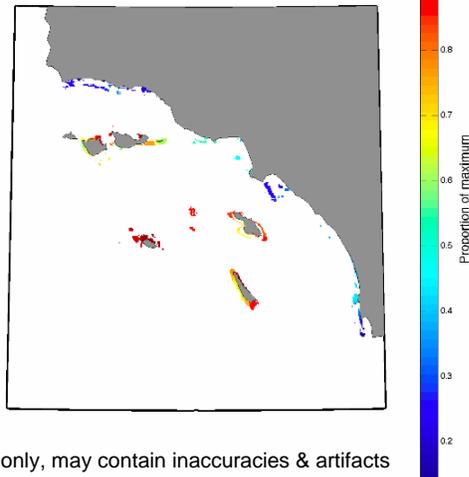
<sup>1</sup>For complete list of assumptions, see evaluation methods document, Chapter 9, Appendix 1.



## Example Results<sup>1</sup>

### Spatial Distribution of Larval Settlement

- **Species:** Kelp Bass
- **Management Assumption:**  
Poor management outside MPAs
- **Larval Dispersal Data:**  
Mean of ROMS model years 1996-2002



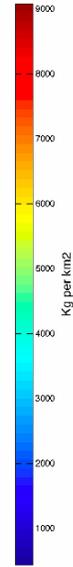
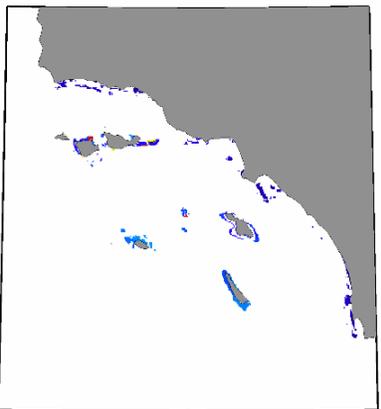
<sup>1</sup>UC Davis Model, preliminary example results only, may contain inaccuracies & artifacts



## Example Results<sup>1</sup>

### Spatial Distribution of Adult Biomass

- **Species:** Kelp Bass
- **Management Assumption:** Poor management outside MPAs
- **Larval Dispersal Data:** Mean of ROMS model years 1996-2002



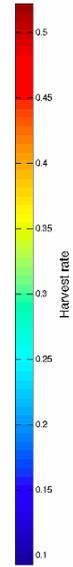
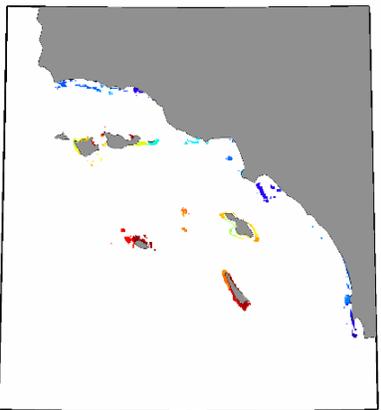
<sup>1</sup>UC Davis Model, preliminary example results only, may contain inaccuracies & artifacts



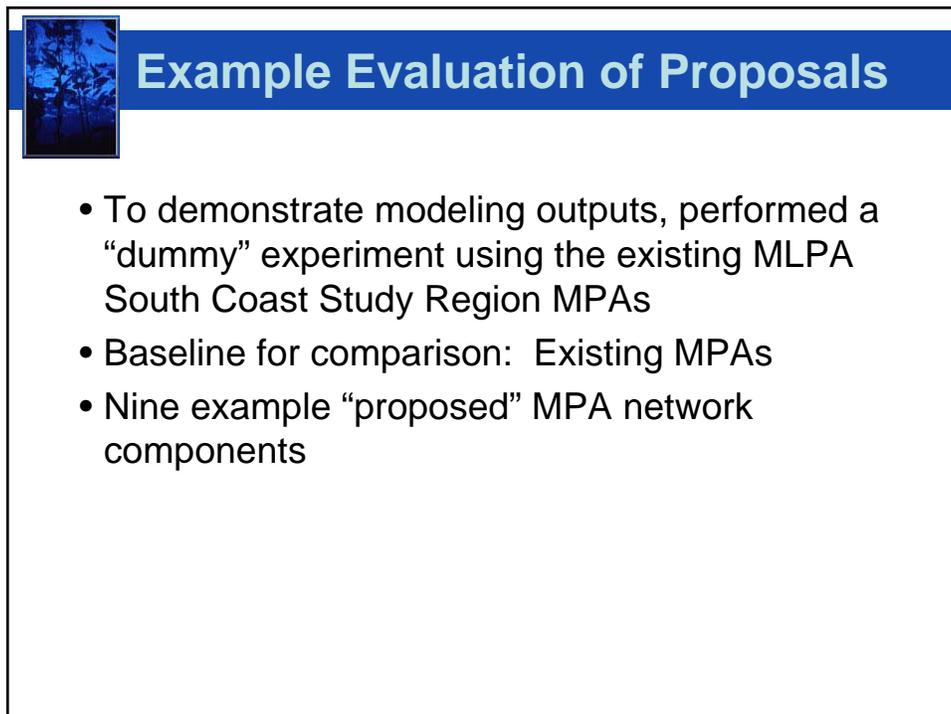
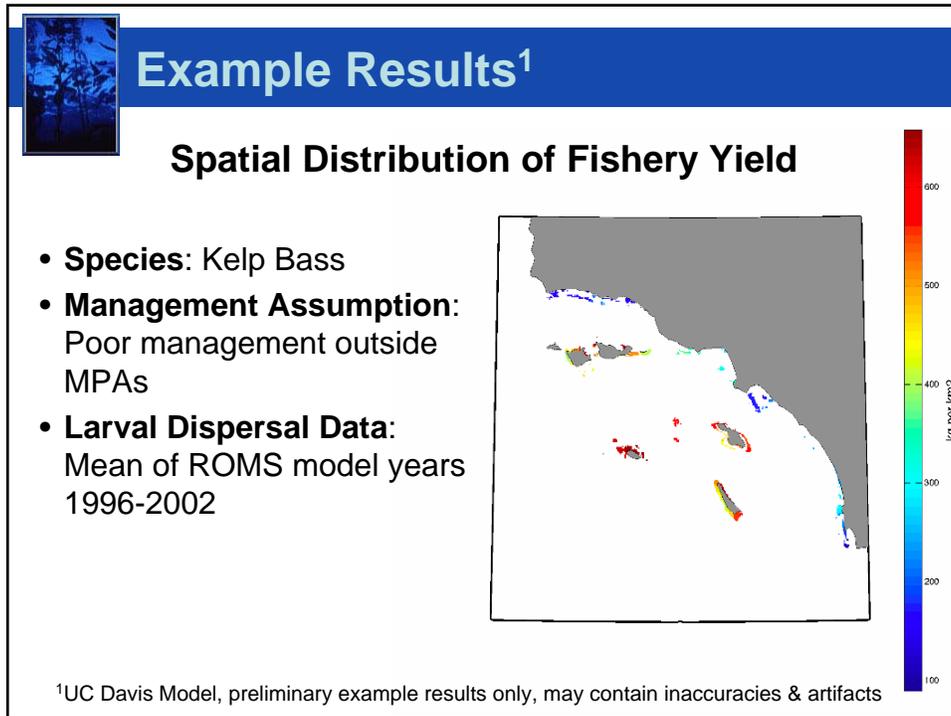
## Example Results

### Spatial Distribution of Fishing Effort

- **Species:** Kelp Bass
- **Management Assumption:** Poor management outside MPAs
- **Larval Dispersal Data:** Mean of ROMS model years 1996-2002



<sup>1</sup>UC Davis Model, preliminary example results only, may contain inaccuracies & artifacts





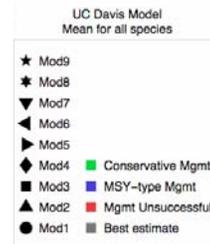
## Example Evaluation of Proposals

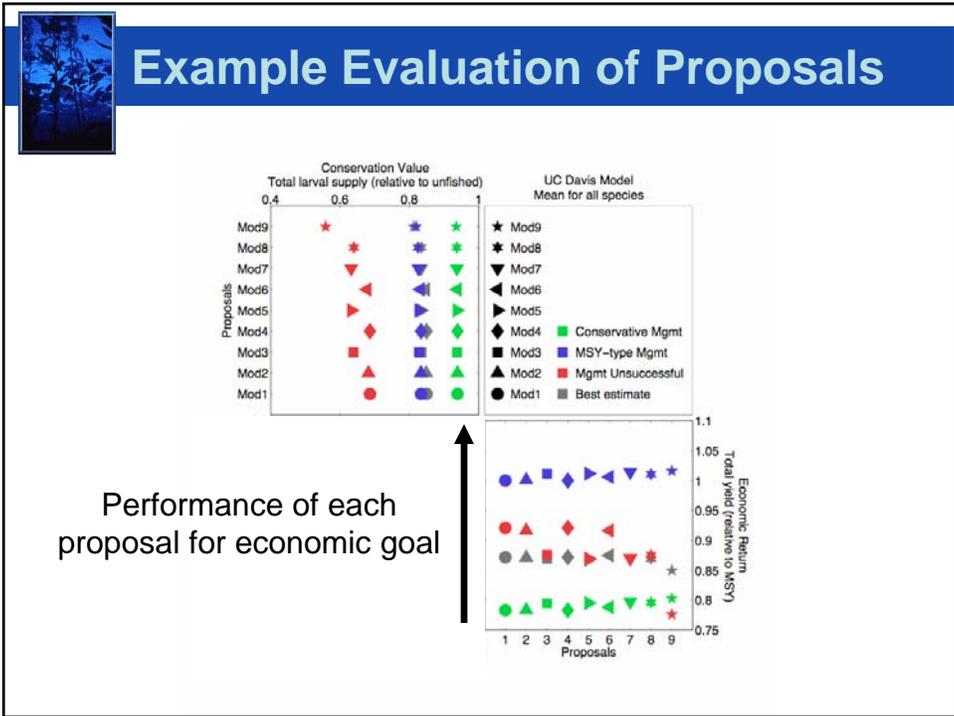
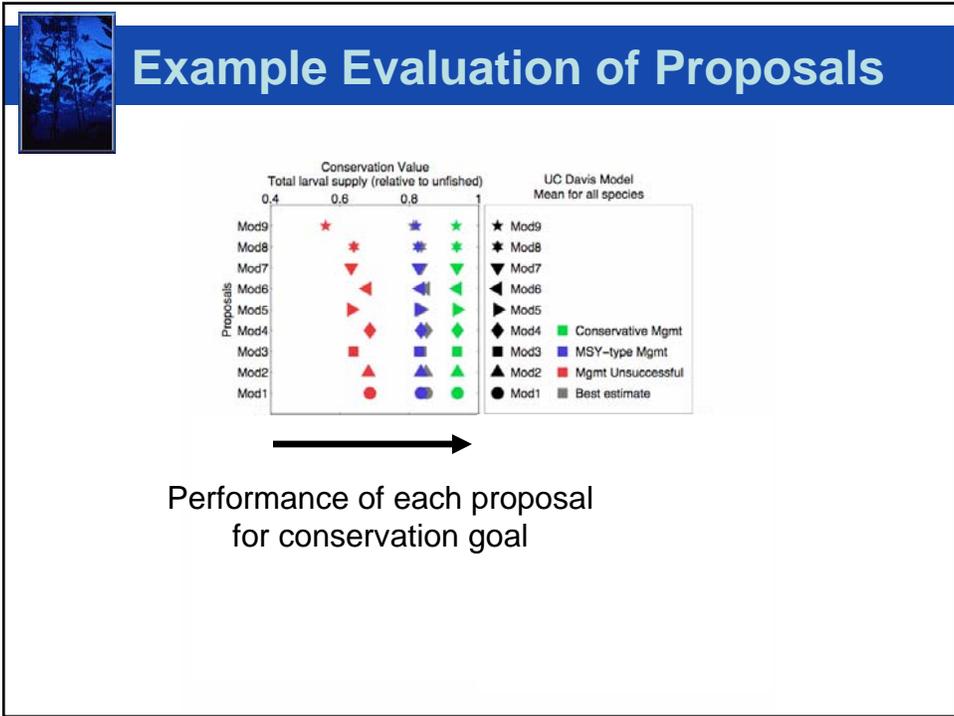
- Each “**proposal**” generated by removing 1, 3 or 5 MPAs from the Channel Islands area
- **9 arbitrary “proposals”** generated to show range of values for conservation and economic returns
- **Examples illustrate outputs** prior to submission of actual MPA proposals
- **Results are highly sensitive** to assumptions about fishery management outside of MPAs
- **For actual evaluation**, must include various future fishery management scenarios

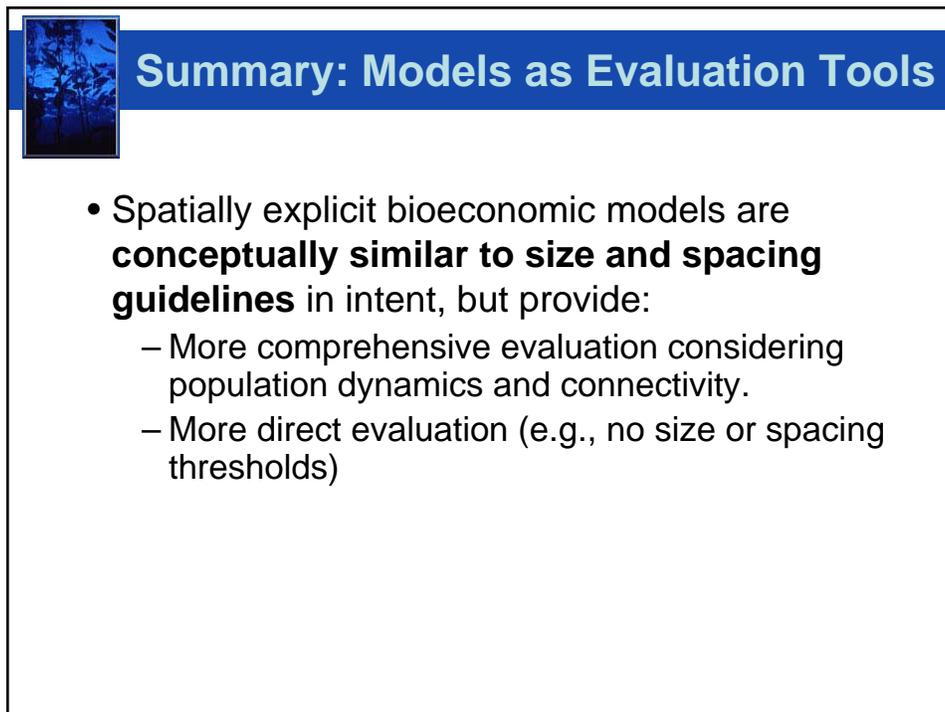
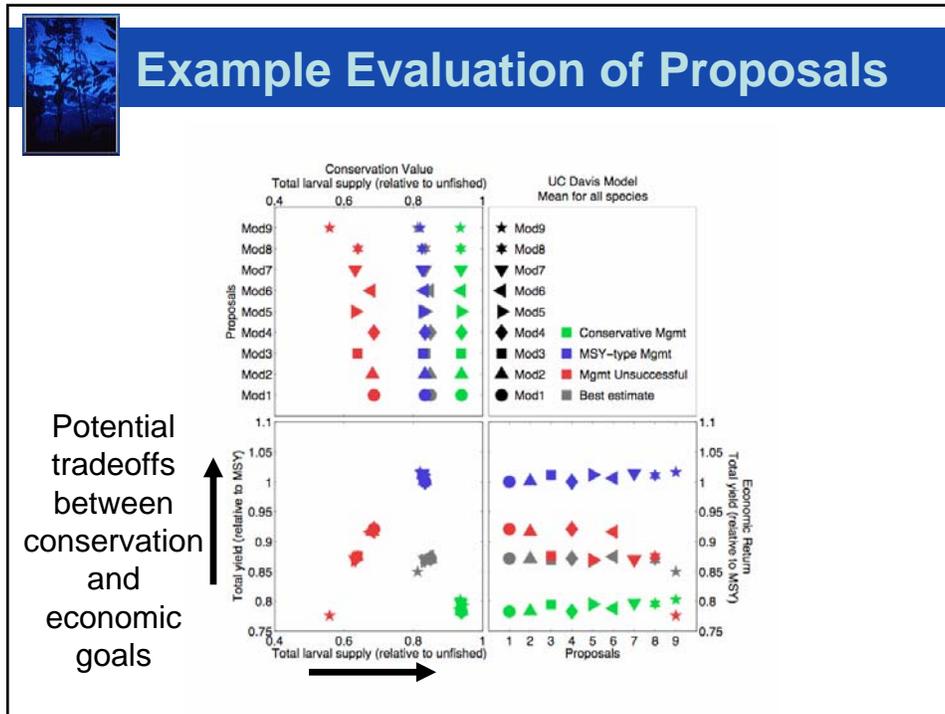


## Example Evaluation of Proposals

- 9 proposals (“Mod1” – “Mod9”)
- 3 future management scenarios
- +1 best estimate of future scenario









## Summary: Models as Evaluation Tools

- **Models provide a framework for:**
  - Evaluating MPA proposals
  - Providing feedback to stakeholders for alteration/improvement of MPA proposals
- **SAT Modeling Work Group recommends:**
  - Size and spacing guidelines be used as a **starting point** for MPA design
  - Modeling provides a more **integrated** and **comprehensive** approach for subsequent evaluations and future MPA design efforts