A Model to Evaluate Sustainability and Yield of Proposed MPA Plans

UC Davis SAT Tools Contract
Loo Botsford
Will White
Liz Moffitt
Doug Fischer

What is Sustainability?

The ability of a population to avoid collapse.

The same as:
• Persistence
• Resilience
• Biomass
• Fraction of coastline persistent
• Total larval supply
Why model Sustainability?

All MLPA goals require Population Sustainability

Our models will show the BRTF the effect of proposed MPAs on population sustainability

What is yield?

Total fishery catch of a species in the NCC Region
Why model Yield?

So the BRTF can account for the economic impact of proposed MPAs on fisheries.

What does this model do?

BRTF needs to know difference between 'no action' and the effects of MPA packages.

Our model summarizes long-term benefits and costs of each package, in terms of:

- Sustainability
- Yield

(For five representative species)
What assumptions does it make?

- Larval dispersal patterns, by species
- Adults move within a home range
- When larvae settle, only a certain maximum number can recruit at each location in each year
- Status of species (fishing/overfishing, e.g. BRF)
  - not overfished
  - overfished
  - heavily overfished

Constant effort (others can be used)

What data does it use?

- Fishing mortality rate
- Natural mortality rate
- Growth rate
- Fecundity (number of offspring produced)
- Distribution of hard bottom habitat
- Location & regulations of proposed MPAs
## Species Considered

<table>
<thead>
<tr>
<th>Species</th>
<th>Average larval dispersal distance (km)</th>
<th>Average home range size (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abalone</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Black Rockfish</td>
<td>40</td>
<td>9</td>
</tr>
<tr>
<td>Cabezon</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>Lingcod</td>
<td>35</td>
<td>9</td>
</tr>
<tr>
<td>Canary Rockfish</td>
<td>40</td>
<td>14</td>
</tr>
</tbody>
</table>

### Use one-dimensional strip along coastline

[Map showing coastal MPA and bottom types]
One-dimensional map

Long-term sustainability and yield for overfished case

Package ‘EC’, Overfished

Cabazon (larval dispersal = 100 km)

Abalone (larval dispersal = 1 km)

- Hard-bottom habitat (no MPA)
- Hard-bottom habitat + MPA
Example: summarizing results across NCC region

Effects of uncertainty in stock status

MLPA SAT January 8, 2008 meeting
Quantify differences between Proposals and “No Action”

Effects on each species: heavily overfished
Summary: range of uncertainty in stock status

Moving beyond 5 focal species

No Action; Overfished
Moving beyond 5 focal species

Package EC; Overfished

Further work needed

What is overfishing status of each of these species?
Effects of effort shift
Two-dimensional model.
Continue working on combination with MARXAN
Fast version with graphical user interface???
Present results with fishery management changed to optimize catch???
Conclusions

• MLPA goals require population sustainability

• Our model shows BRTF effects of MPAs on
  • Sustainability
  • Yield

• Results for 5 species + other ‘generic’ species

• MPA impacts depend on current population status
  • Considerable uncertainty about current status

Black Rockfish Landings

from Sampson (2007) Black Rockfish Stock Assessment
Black Rockfish Catch Per Unit Effort (CPUE)

from Sampson (2007) Black Rockfish Stock Assessment

Recent decline in predicted Black Rockfish spawning output

from Sampson (2007) Black Rockfish Stock Assessment