

# Fleet Models for the Marine Life Protection Act

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## Why do we need a fleet model?

- Biomass dynamic models seek to predict ecological effects of regional marine protected area (MPA) proposals
  - Space is broken into 1 km<sup>2</sup> discrete “patches”
- Ecological effects depend on spatial fishing effort outside MPAs
  - How is effort currently distributed?
  - Where will effort go after MPAs implemented?

## How do fleets behave?

- "Effort" = time fishing to achieve given fishing mortality
- Spatial fishing effort responds to:
  - Fish densities (adult biomass)
  - Distance from port
  - Fishing conditions/weather
  - Others' fishing effort in the patch
- Effect of each variable may differ across:
  - Fleets (commercial, recreational)
  - Species

## "Value" of fishing a patch

$$\pi_i = \alpha_1 f(E_i, B_{i0}) - [\alpha_2 D_i + \alpha_3 W_i + \alpha_4] E_i$$

- Where
  - $i$  indexes a patch
  - $B$  is current adult biomass
  - $E$  is effort
  - $f(B, E)$  is harvest
  - $D$  is distance
  - $W$  is weather
  - $\alpha_1, \dots, \alpha_4$  are parameters

## How is effort distributed?

- We assume fishermen choose to fish the patches that will return highest value

- Marginal value is:

$$\frac{\partial \pi_i}{\partial E_i} = \alpha_1 f'(E_i, B_{i0}) - \alpha_2 D_i - \alpha_3 W_i - \alpha_4$$

- All fished patches have equimarginal value

## Fitting model parameters

- How do we know the value of the parameters  $\alpha_1, \dots, \alpha_4$ ?
  1. Assume values for  $\alpha_1, \dots, \alpha_4$
  2. Find patch-specific effort that satisfies equimarginal value
  3. Find associate value for each patch
  4. Compare prediction with data
  5. Repeat to choose  $\alpha_1, \dots, \alpha_4$  to optimize fit to data.

## Objective Function

$$\sum_{i=1}^N \left( \frac{\pi_i(\alpha_1, \dots, \alpha_4)}{\sum \pi_i(\alpha_1, \dots, \alpha_4)} - \frac{\psi_i}{\sum \psi_i} \right)^2$$

Sum Over all Patches

Modeled Value from patch i  
(as share of total value)

Observed Value from patch i  
(as share of total value) from EcoTrust

Sum Squared Deviations

## Summary

- To predict ecological effects of MPAs, we need a fleet model
- We'd like fleet model to: (1) accord with basic principles, (2) match effort distribution data under current conditions, (3) provide means of predicting fleet movement under any regional MPA proposal
- Our procedure generates a fleet model that is consistent with principles, existing data
  - But can also be used to forecast fleet changes under MPAs