# Marine Life Protection Act Initiative

# An Assessment of MPA Spacing as an Evaluation Tool

**Presentation to the MLPA Master Plan Science Advisory Team**

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# Underlying Logic

- Marine protected areas (MPAs) can’t be too far apart or there won’t be enough larvae coming into them from other MPAs to either maintain populations or to re-establish populations in the case of a catastrophic event
- Distance is a compromise across different life histories

# Primary Criticism

- MPA spacing assumes that most of the larvae (if not all) come from other MPAs
  - There are no other larvae coming from habitat between MPAs

# Calculating Larval Sources

- Larvae from non-reserve sites:  Assume density is 1.0 so larval input from non-reserve sites is 1 minus % area in reserves
- Larvae from reserves:  Is % areas in reserves times ratio of fish inside to outside

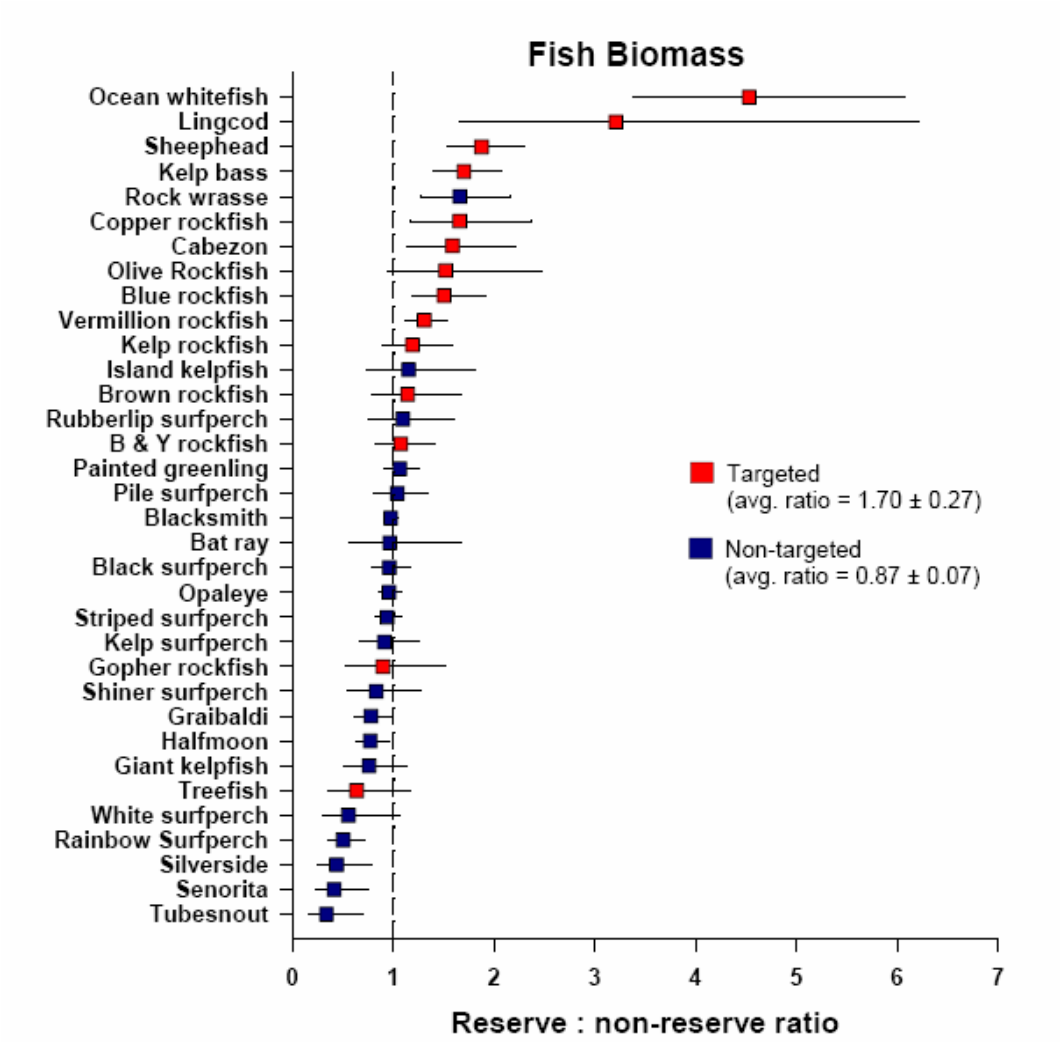
# Percent of Total Larvae from Reserves

Larvae from reserves = % habitat in reserves (x) (fish inside/ fish outside)

Larvae from non-reserve sites = 1 minus % areas in reserves

| Proportion of habitat in reserves | Ratio of abundance inside to outside reserves | | | |
|---|---|---|---|---|
| | 1:1 | 2:1 | 3:1 | 4:1 |
| 0.05 | 5% | 10% | 14% | 17% |
| 0.1 | 10% | 18% | 25% | 31% |
| 0.15 | 15% | 26% | 35% | 41% |
| 0.2 | 20% | 33% | 43% | 50% |
| 0.25 | 25% | 40% | 50% | 57% |
| 0.3 | 30% | 46% | 56% | 63% |
| 0.35 | 35% | 52% | 62% | 68% |
| 0.4 | 40% | 57% | 67% | 73% |

# From Jenn Caselle*, Scott Hamilton*, Dan Malone†, David Kushner‡, Mark Carr†



# Thus

- Given the data seen in the Channel Islands we can expect that abundance will be 2 or 3 times higher inside reserves than outside
- Assuming 20% of areas in MPAs, 33-43% of larvae will come from reserves
- Thus 67-57% of larvae will come from non-MPA areas
- Almost all larvae arriving in a MPA will either come from that MPA, or the non-MPA areas adjacent to it
- Input of larvae from other MPAs will be almost insignificant

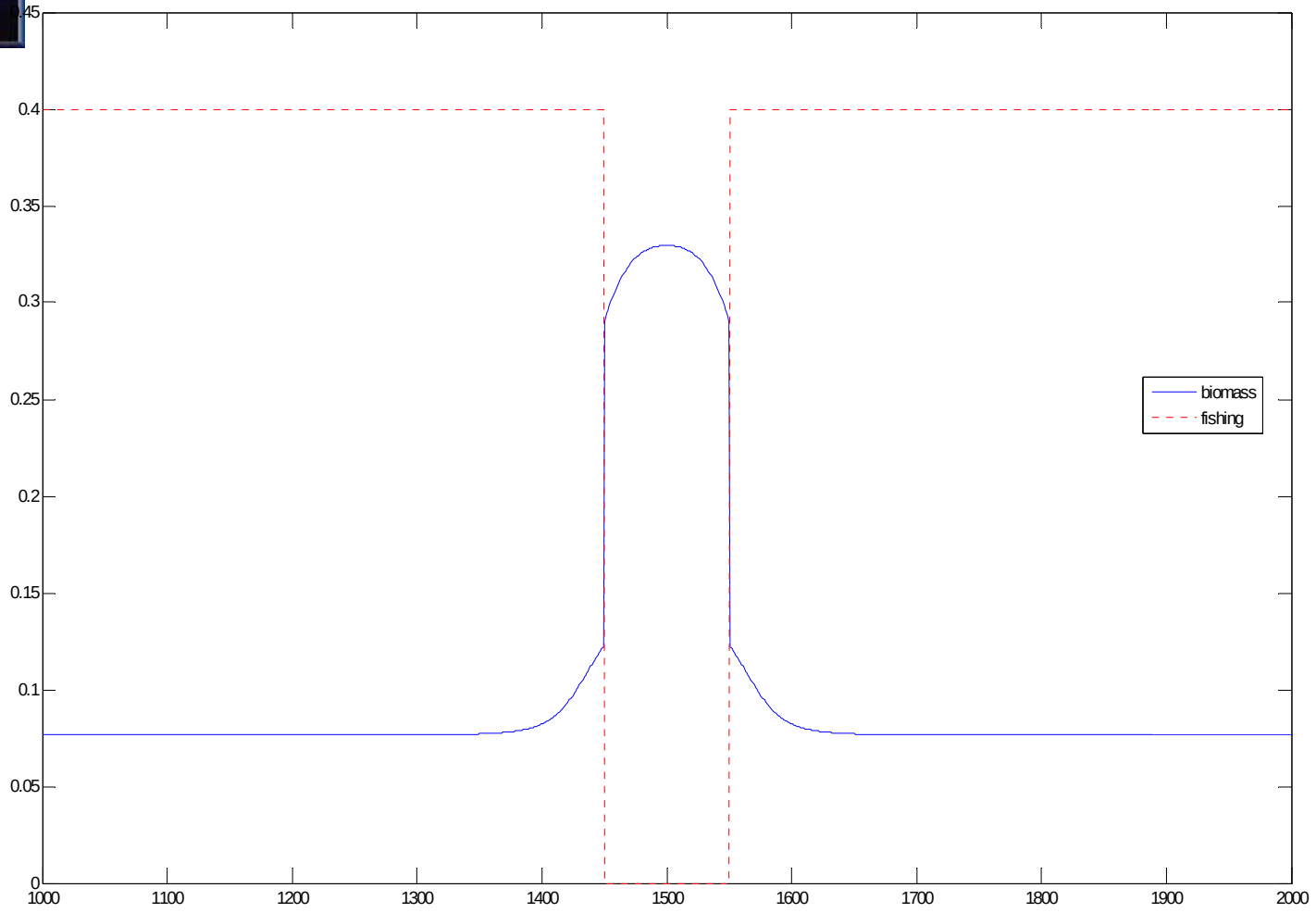
## Numerical Experiments: Thanks to Andrew Rassweiler and Chris Costello

- Set up 20 kilometer reserves in the middle of a long linear coastline
- Explore abundance relative to un-fished abundance for different spacings, different life history, and different larval dispersal distance

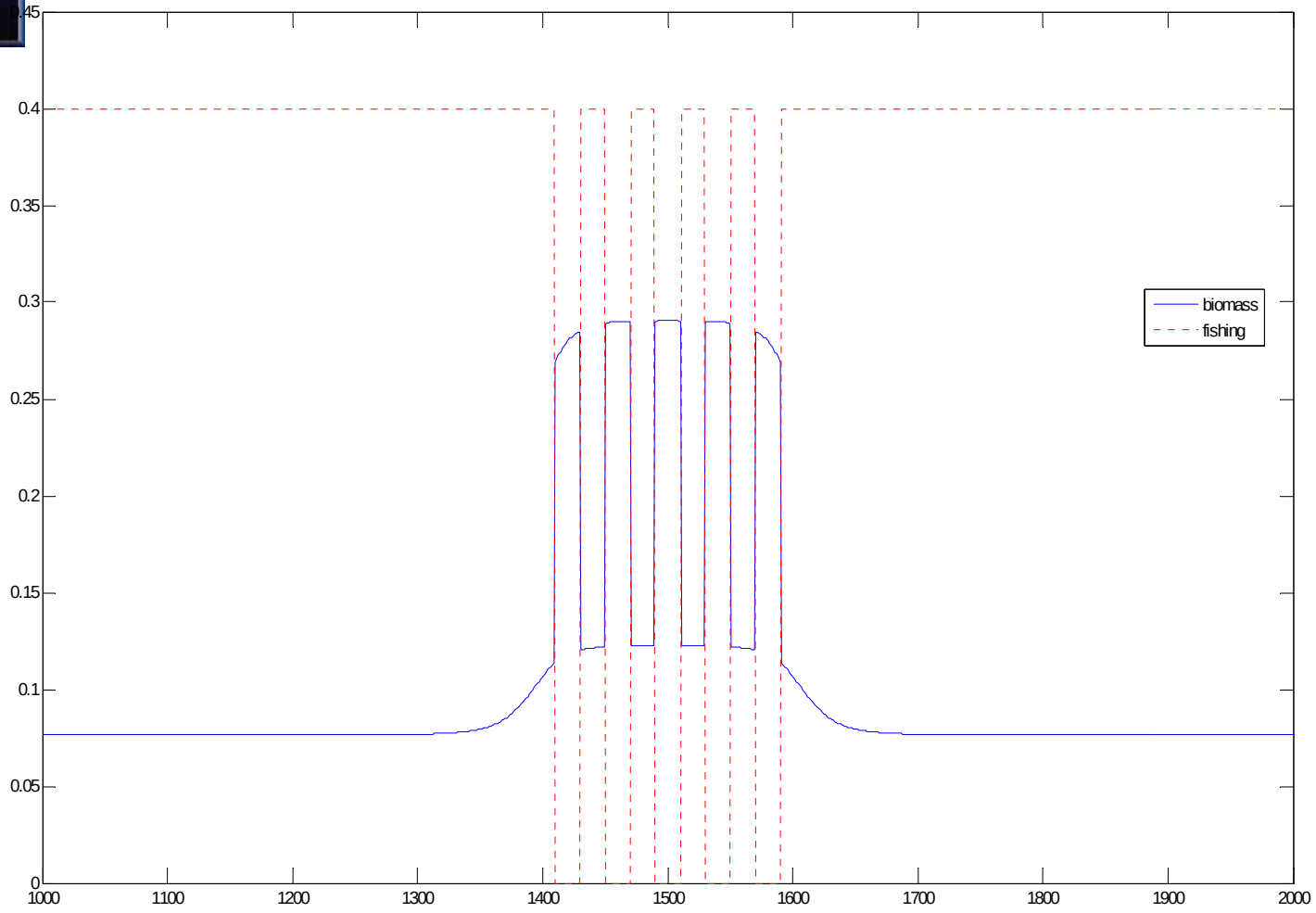
<u>Two species</u>

- Kelp Bass
- Kelp Rockfish

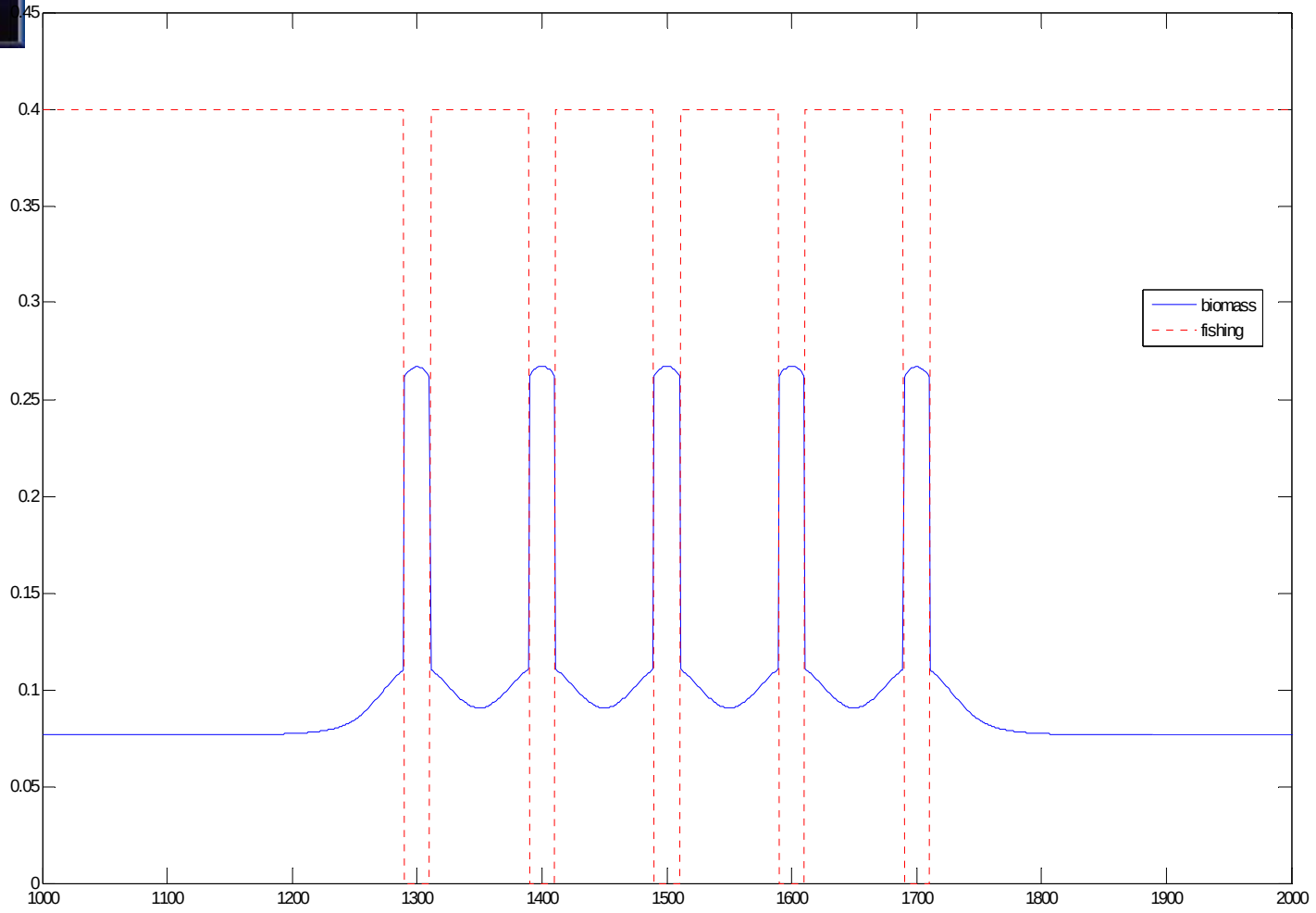
# Kelp bass, sigma = 20, fishing = .4, spacing = 0



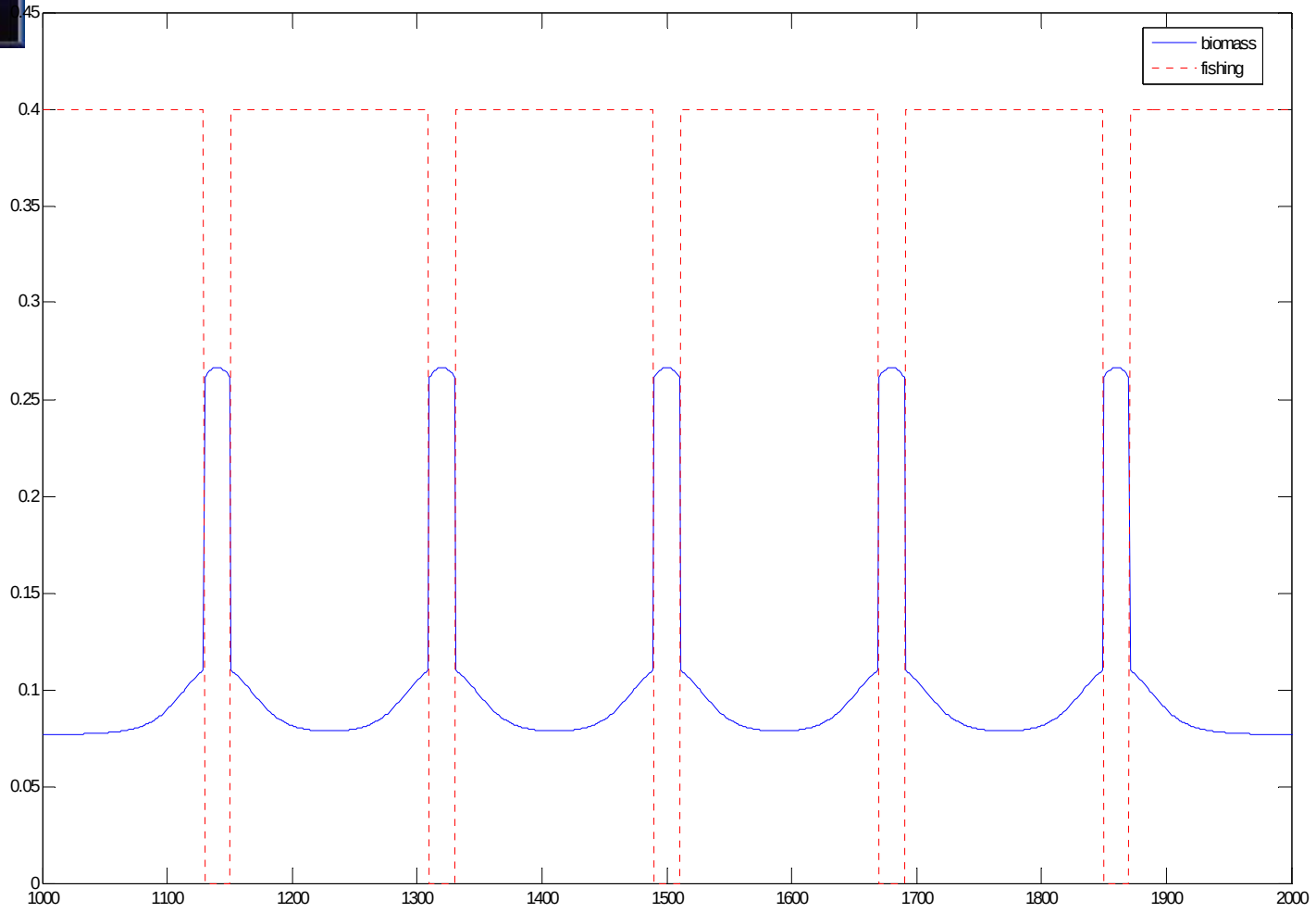
# Kelp bass, sigma = 20, fishing = .4, spacing = 20



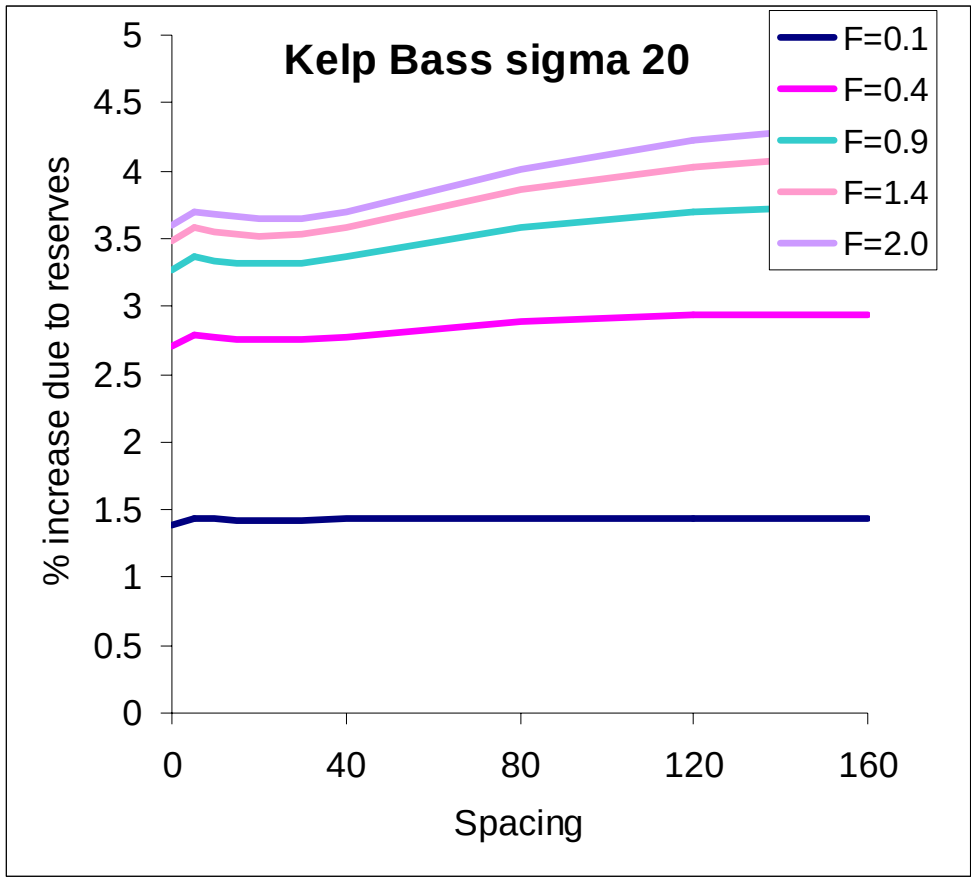
# Kelp bass, sigma = 20, fishing = .4, spacing = 80



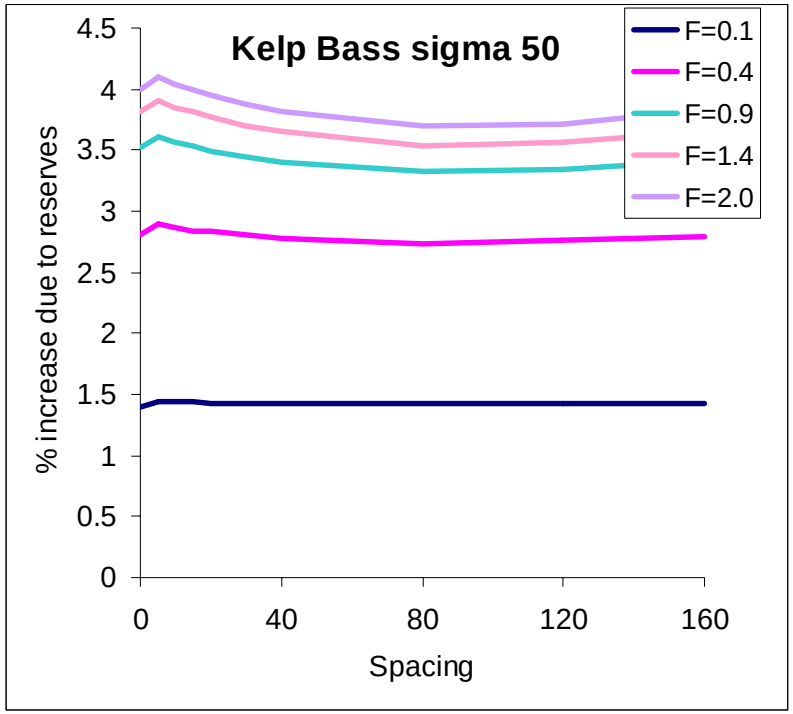
# Kelp bass, sigma = 20, fishing = .4, spacing = 160

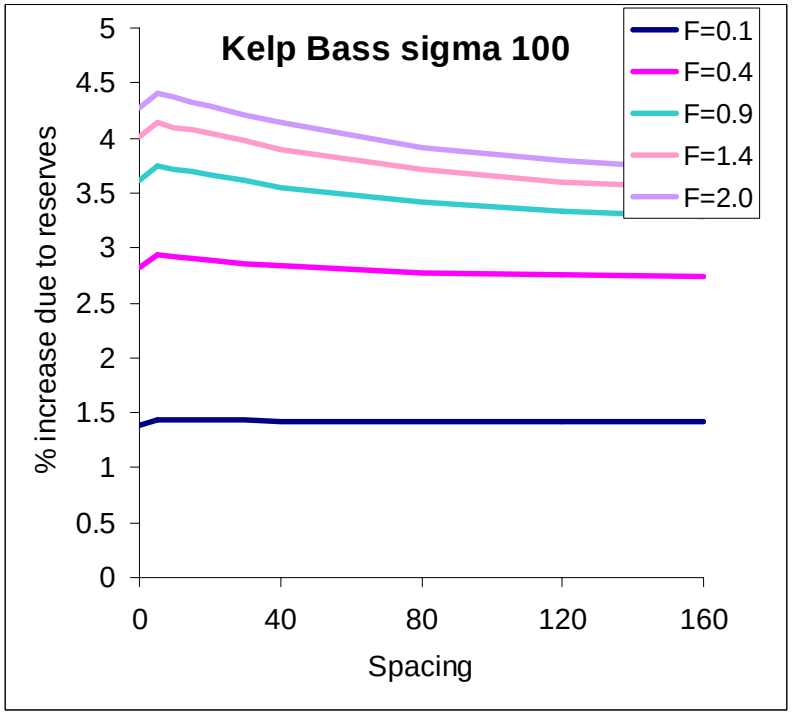


# Kelp Bass Low Dispersal

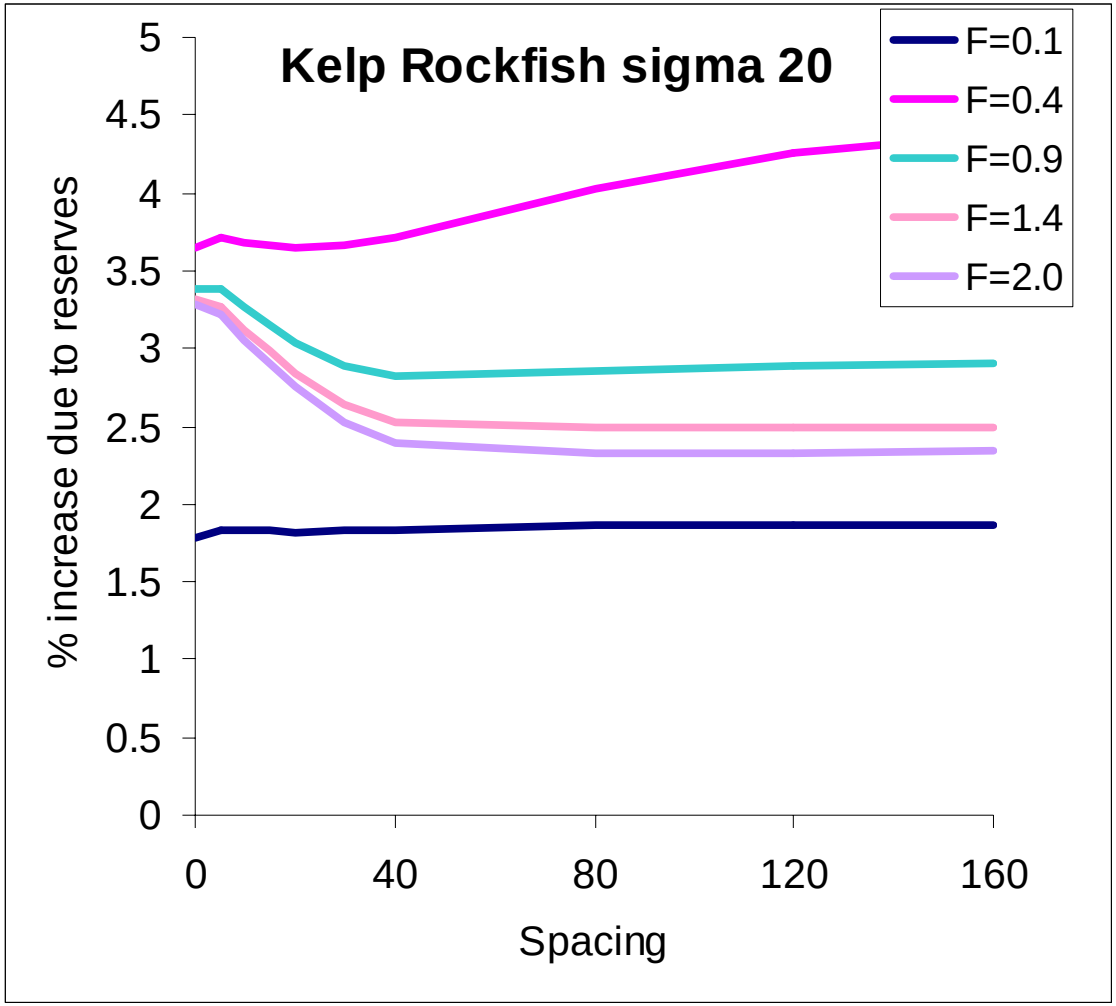


# Longer Dispersal Distance

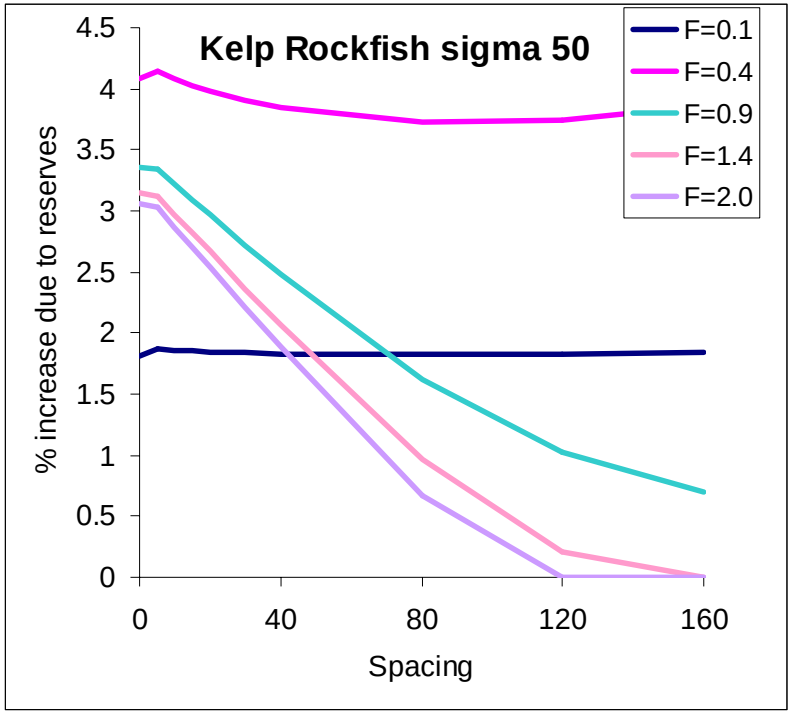


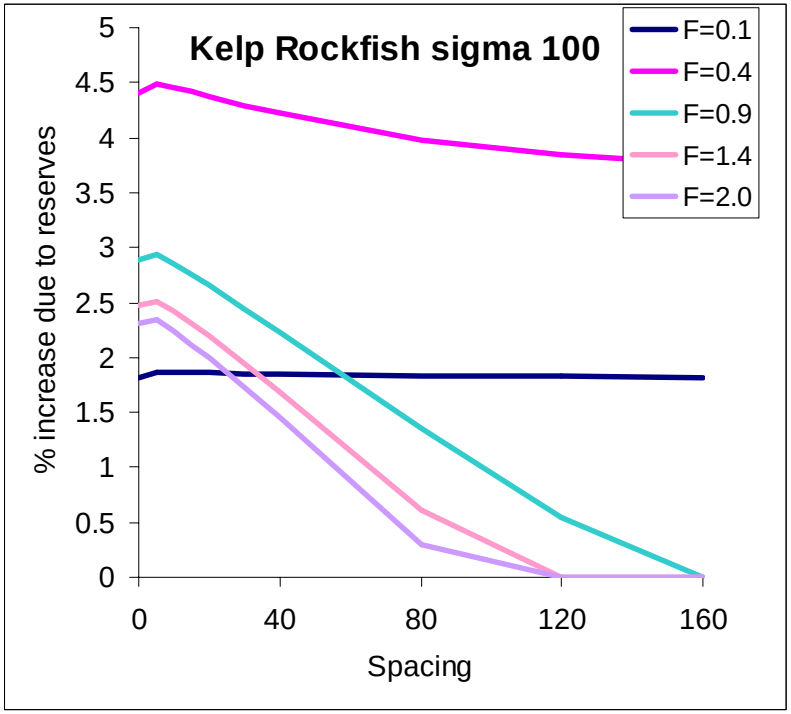



# Kelp Rockfish



# Kelp Rockfish: Longer Dispersal



# Reminder Spacing=0

- When spacing is 0 you have only 1 reserve
  - Can also be interpreted as infinite spacing
- When fishing is very high and you have long distance dispersal, then size is particularly important

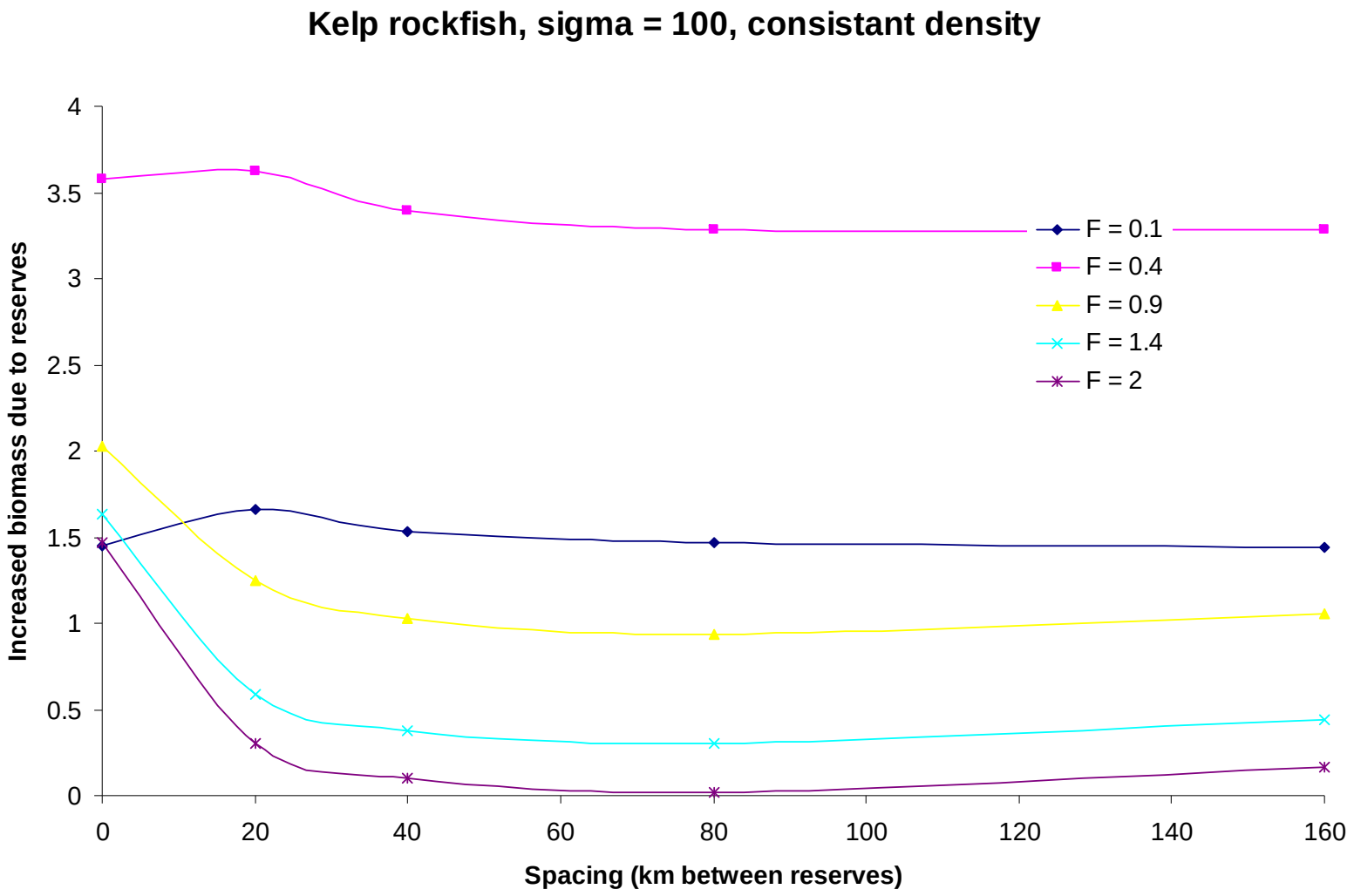
# For Kelp Rockfish with Long Dispersal

- If fishing mortality rates are **very very** high
- And you end up with no fish outside reserves
- THEN
- MPAs lose their effect when they are too far apart or too small
- Because the “density” of protected areas is too low
- Need to run the model with a constant density of MPAs, to correct for MPA density effects vs MPA spacing

# With Constant Density of Reserves

- 20% of area in reserves
- As we increase spacing, the size increases
- Look at “worst” case F=2 sigma=100

# Kelp Rockfish sigma=100 constant density of reserves



# When F=high and sigma=large

- One large reserve is best
- Size matters more than spacing!

**Super high F's are unrealistic**

- They imply the ratio of abundance inside to outside reserves would be very high – there would be nothing outside reserves except right on the edge due to spillover

# Current Exploitation Rates on Groundfish

## from NOAA assessments

| Common Name | F current |
|---|---|
| Arrowtooth flounder | 4.4% |
| Black rockfish | 4.3% |
| Black rockfish | 1.7% |
| Blue rockfish | 6.3% |
| Bocaccio | 0.6% |
| Chilipepper | 0.4% |
| Cowcod | 0.2% |
| Canary rockfish | 0.2% |
| Darkblotched rockfish | 1.4% |
| English sole | 1.7% |
| Longnose skate | 1.3% |
| Pacific ocean perch | 0.3% |
| Sablefish | 2.3% |
| Widow rockfish | 0.7% |
| Yelloweye rockfish | 1.3% |

# Conclusions

- Under F=0.4 or lower, spacing has no impact across cases examined
- Under high F's
  - size is much more important than spacing
  - We see a "reverse spacing effect" it is better to clump reserves together than to space them apart at 50-100 km
  - These high F's are not realistic
    1. Available assessments suggest low Fs
    2. There clearly are significant numbers of fish outside of reserves

# Final Message

- Size, spacing, adult movement and larval dispersal all interact to produce final results of MPAs – SPACING HAS NO SIGNIFICANT IMPACT
- If we want to evaluate the “network” effect, models can and do exactly what we want
- We have the models which are the way that the impacts of size and spacing on abundance should be evaluated

# Ray's Recommendation

- That the regional stakeholder group members be told to not worry about spacing
- That the MLPA Master Plan Science Advisory Team no longer provide an evaluation of how proposals meet spacing guidelines
- That the MLPA Blue Ribbon Task Force be told that our analysis suggests that spacing has no measurable impact on outcome
- That the California Fish and Game Commission be asked to delete spacing from the master plan for MPAs