

A Model to Evaluate Sustainability and Yield of Proposed MPA Plans II

UC Davis SAT Tools Contract

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Outline

- FLEP and overfishing review
- Sustainability vs. movement
- Spatial distribution plots & RSG
- Sustainability/Yield plots
- Overfishing status
- Sustainability and Yield vs. OF status

Points

Sustainability/Yield trade-off

Effects of Uncertainty

Use by stake holders

Sustainability

The ability of a population to avoid collapse.

All MLPA goals require Population Sustainability

Yield

Total fishery catch of a species in the NCC Region

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

Important assumption-Overfishing?

What will management be outside MPAs?

Represented as ability of an individuals to replace themselves (i.e. population growing or declining?)

Fraction of Lifetime Egg Production (FLEP)

Lifetime Egg Production (LEP) = a measure of replacement

Sustainability requires that individuals in a population replace themselves in their lifetime.



In humans, a couple replaces themselves with 2 babies



How many eggs does it take to replace one fish?

How much LEP is enough for individuals to replace themselves?

We express this as a Fraction of natural, unfished LEP (i.e., FLEP)

From examples where we have data, we can calculate a Critical Replacement Threshold (CRT):

35% (Clark 1991)

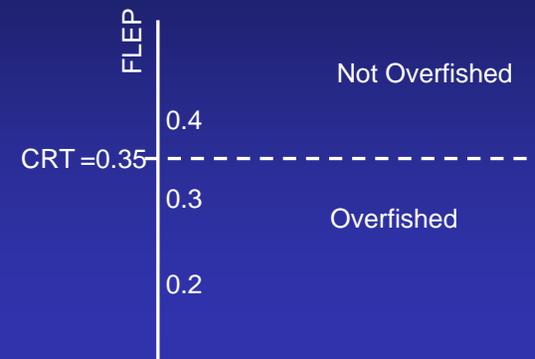


30% (Mace and Sissenwine 1993)

40% (Clark 1993, Mace 1994)

55-60% (Dorn 2002, for rockfishes)

Calculations re: FLEP and CRT



Species Considered

Species	Average larval dispersal distance (km)	Average homerange diameter (km)
Abalone	1	1
Black Rockfish	40	6
Cabezon	100	1
Lingcod	35	15
Canary Rockfish	40	40
California Halibut	45	30
Dungeness Crab	75	14
Red Sea Urchin	50	1



Fish Home Ranges (diameter in km)

1	< 2	< 6	< 10	10 – 20	20 – 40	> 40
kelp greenling	cabezon	black rf	yelloweye rf	lingcod	yellowtail rf	bocaccio rf
rock greenling	wolf eel	china rf		blue rf		canary rf
monkey face eel	brown rf	olive rf				
rock prickleback	copper rf					
black & yellow rf	gopher rf					
kelp rf	grass rf					
black perch	quillback rf					
striped perch	starry rf					
	treefish rf					
	vermillion rf					
	giant seabass					
	pile perch					

To be determined:

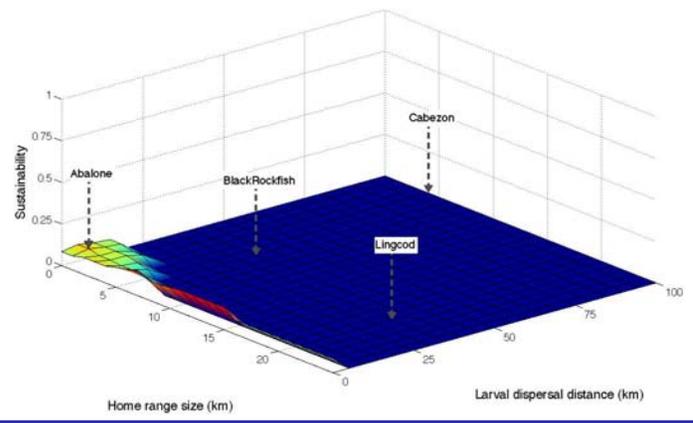
- rock sole
- rainbow perch
- rubberlip perch
- shiner perch

Don't know:

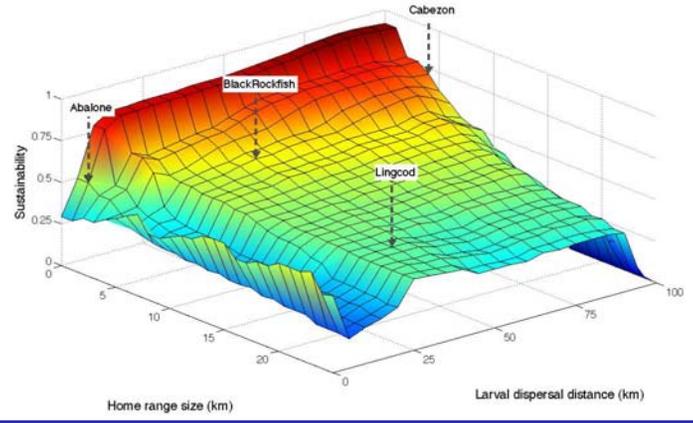
- bank rf
- calico rf
- chillipepper rf
- flag rf
- greenstriped rf
- rosy rf
- speckled rf
- squarespot rf
- widow rf

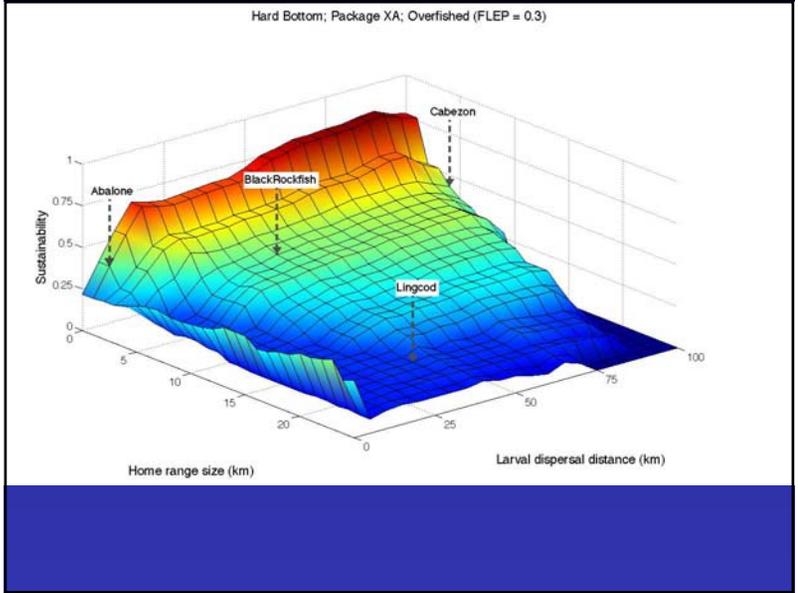
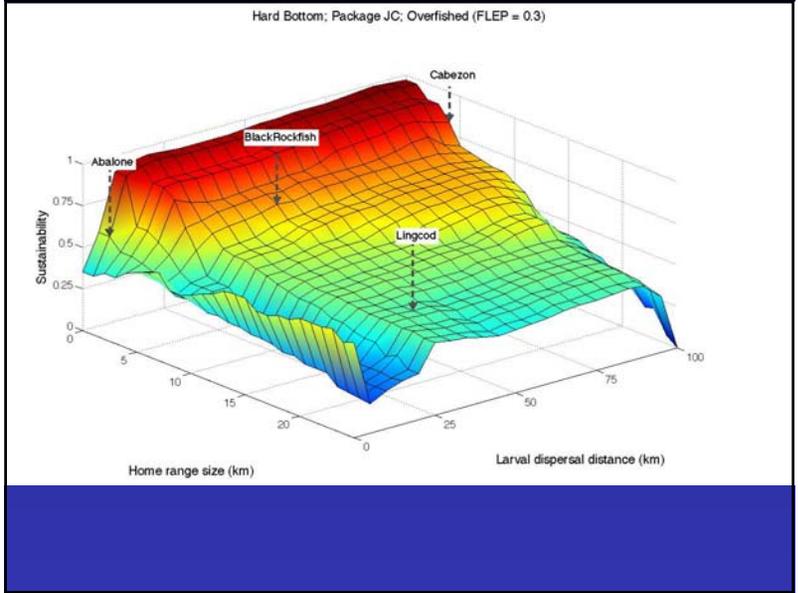
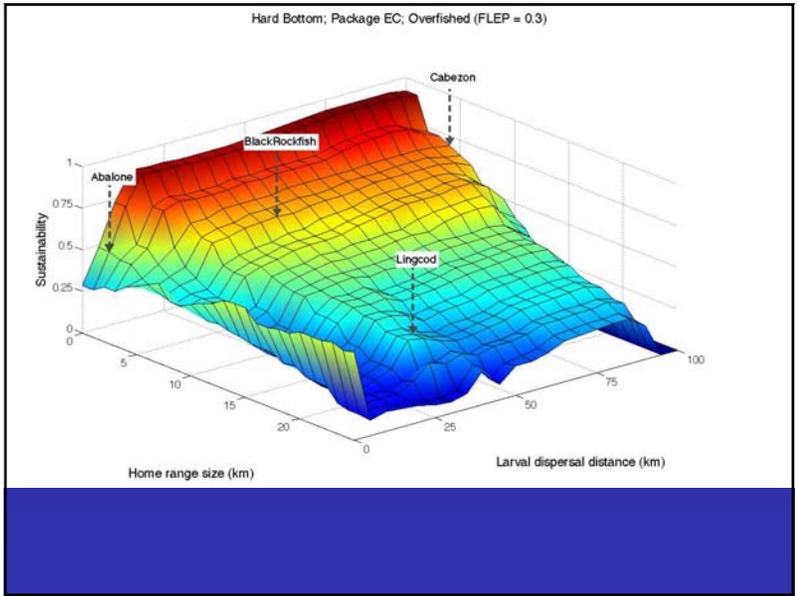
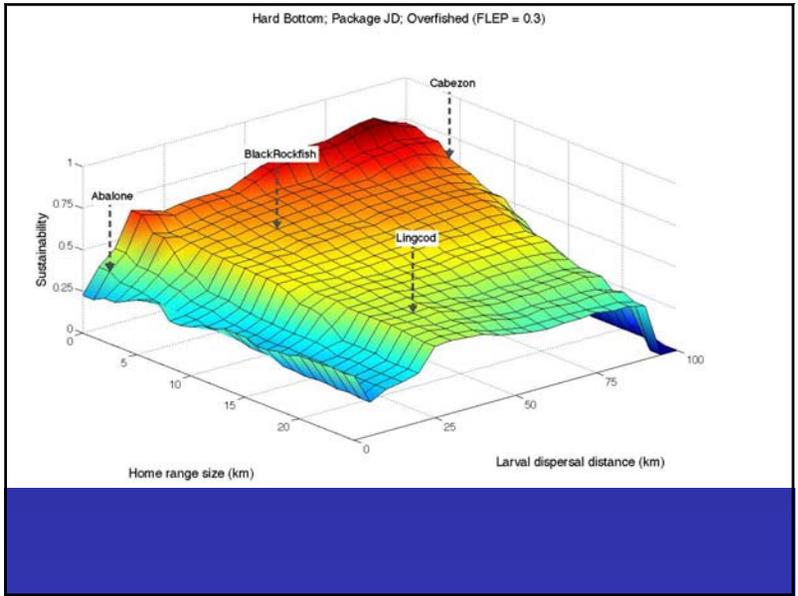
(after Freiwald, unpublished dissertation)

Hard Bottom; Package No Action; Overfished (FLEP = 0.3)

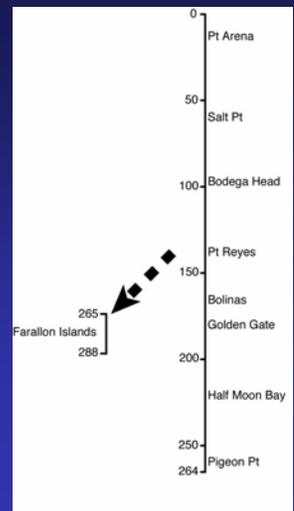


Hard Bottom; Package TC; Overfished (FLEP = 0.3)

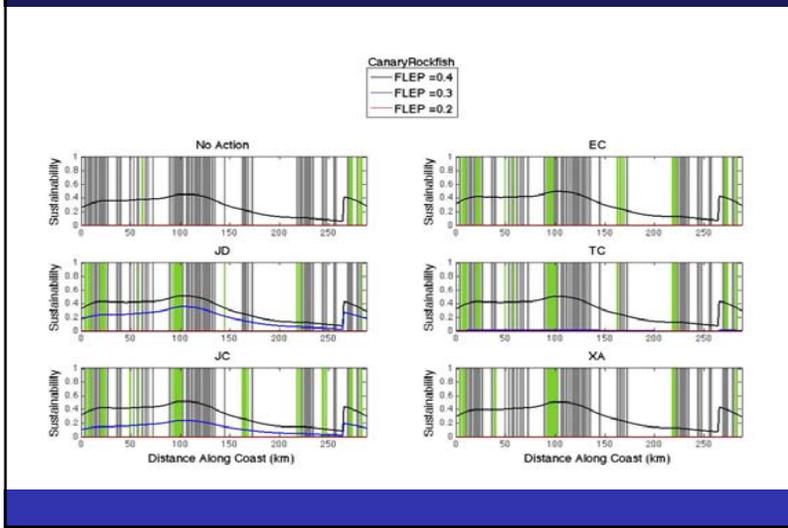




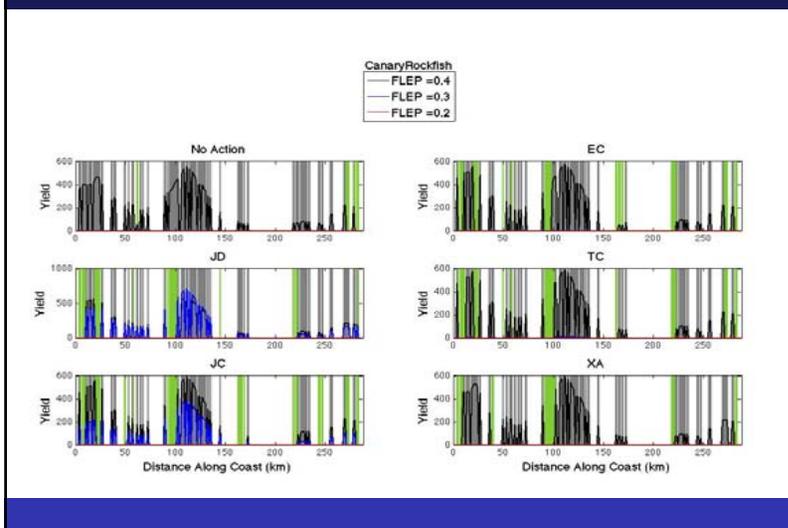
One-dimensional map



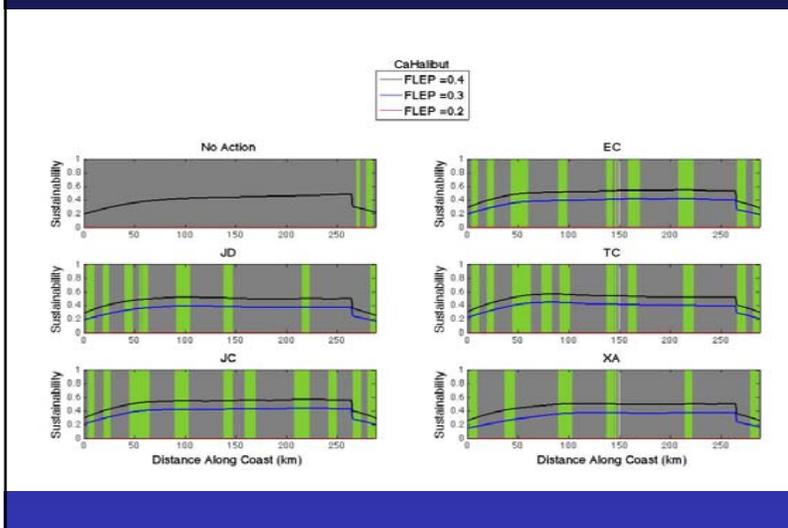
Canary Rockfish - Sustainability

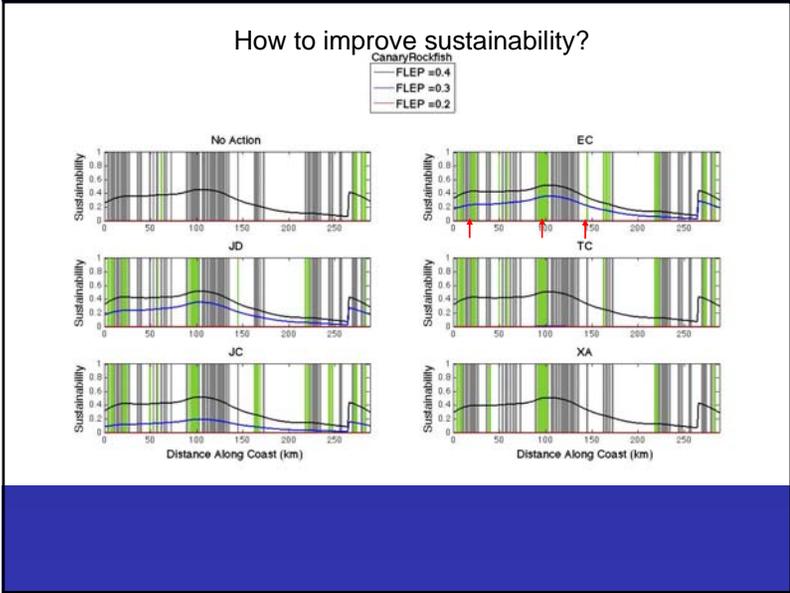
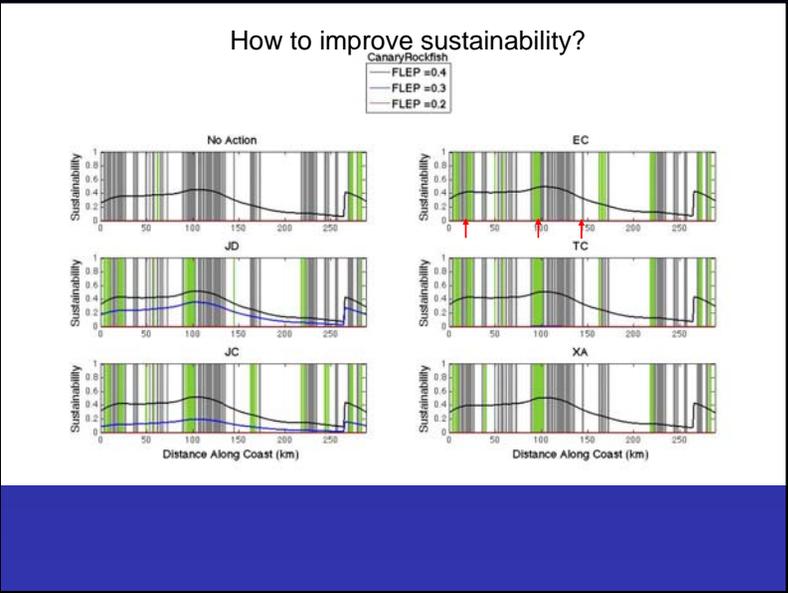
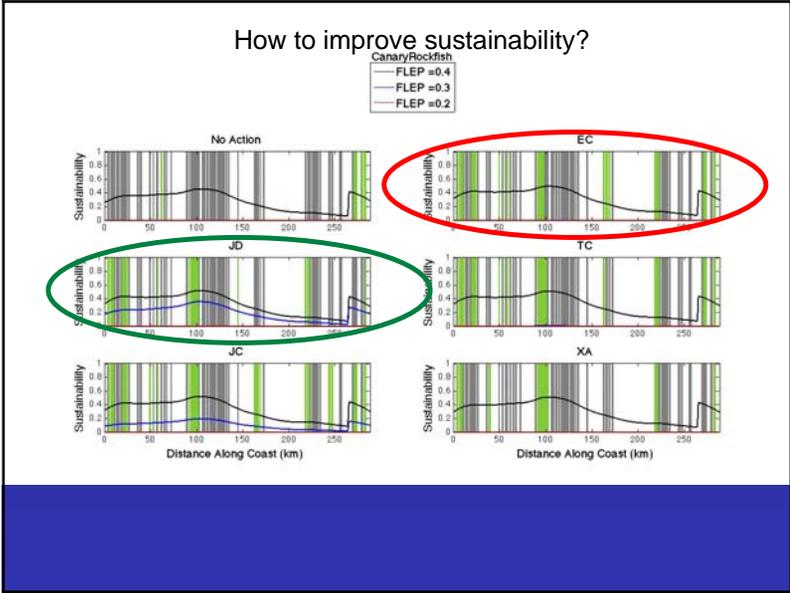
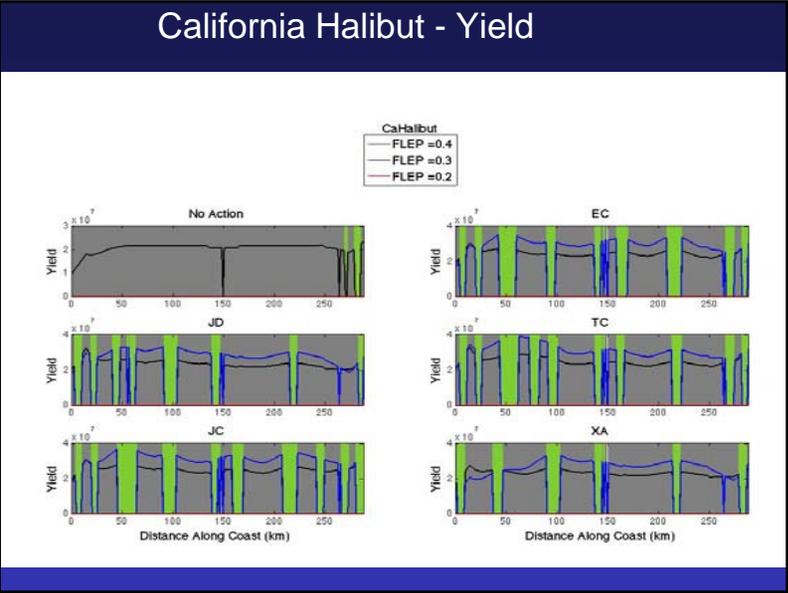


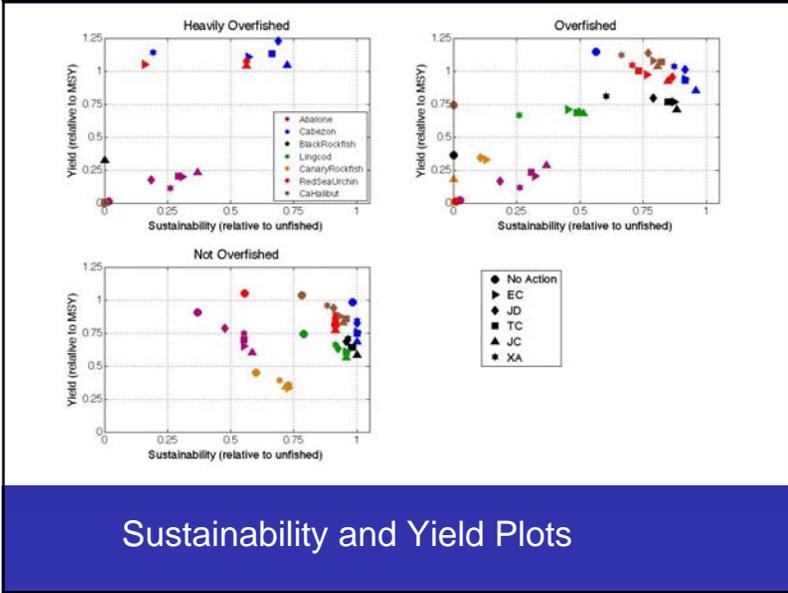
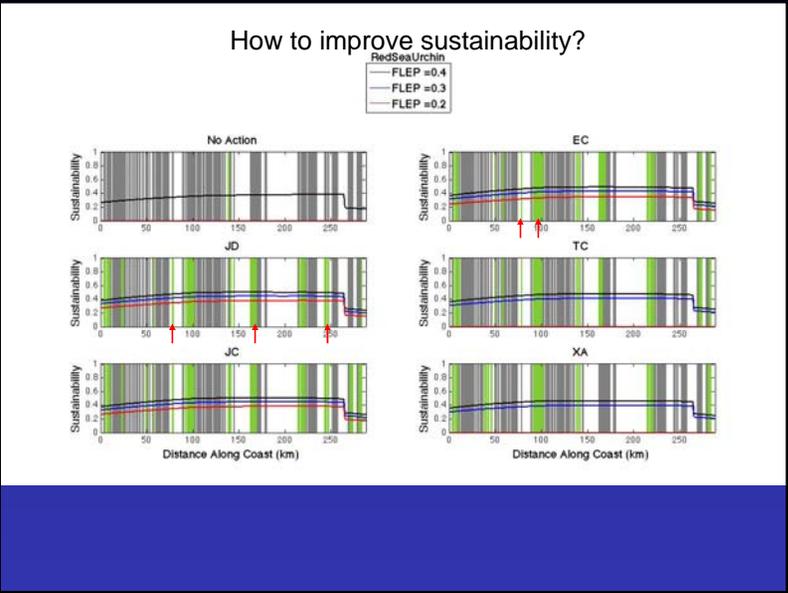
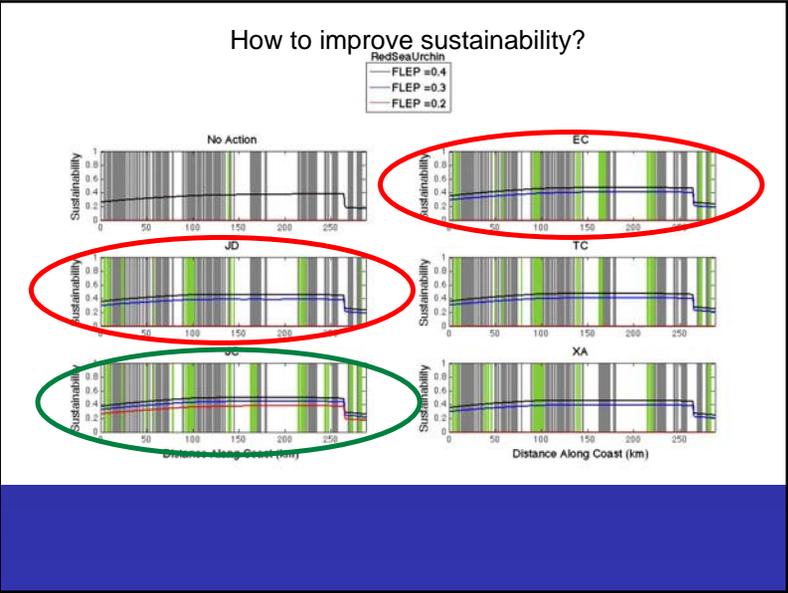
Canary Rockfish - Yield

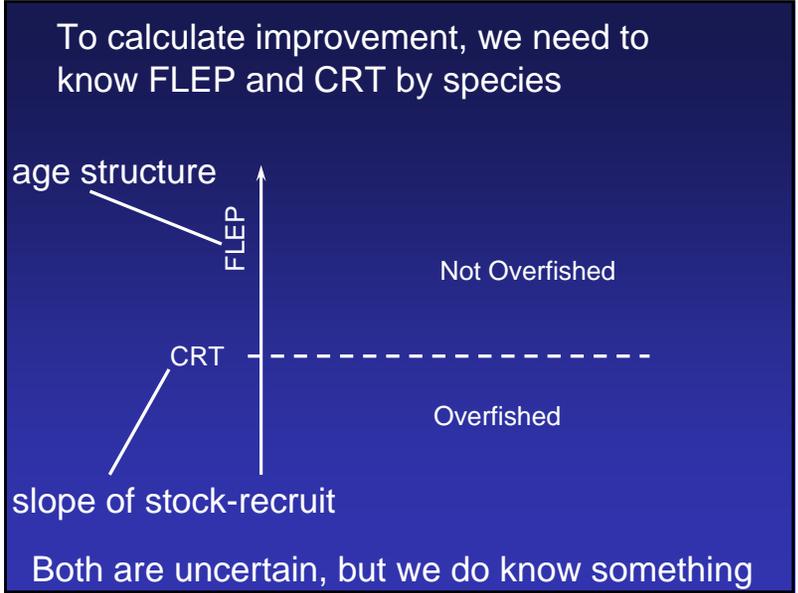


California Halibut - Sustainability









Species values of FLEP and assumed CRT

Species	CRT-UCD Model	CRT-EDOM	CRT-NMFS	FLEP UCD Est.
Abalone	.35			
Black Rockfish	.35	0.5	0.17	0.13 (UCD)
Cabazon	.35	0.2	0.1	
Lingcod	.35	0.1	0.03	
Canary Rockfish	.35	0.05	0.25, 0.5	
California Halibut	.35			
Dungeness Crab	.35			1.0
Red Sea Urchin	.35			0.17 (UCD)

Few estimates of FLEP, therefore we take a decision analysis approach

Based on available information, estimate probability that FLEP has certain values.

FLEP - Red Abalone

Last abalone stock not overfished in CA serial depletion
 MPAs mentioned in recovery
 No stock assessment

	How likely
Not overfishing (FLEP=0.4)	0.5
Overfishing (FLEP=0.3)	0.25
Heavy Overfishing (FLEP=0.2)	0.25

FLEP-Black Rockfish

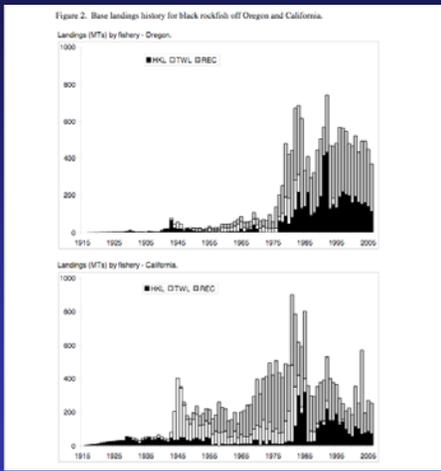
FLEP=0.13, estimated from local size distributions

Catch declining (see Stock Assessment)

CPUE declining (see Stock Assessment)

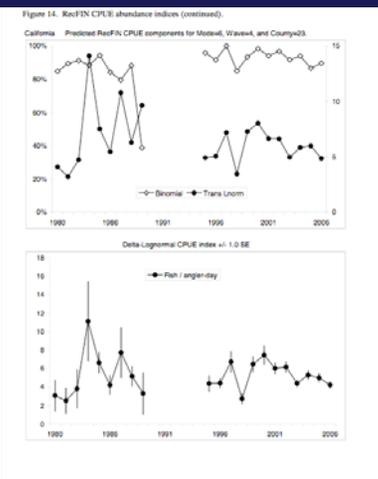
	How likely
Not overfishing (FLEP=0.4)	0.2
Overfishing (FLEP=0.3)	0.3
Heavy Overfishing (FLEP=0.2)	0.5

Black Rockfish Landings



from Sampson (2007) Black Rockfish Stock Assessment

Black Rockfish Catch Per Unit Effort (CPUE)



from Sampson (2007) Black Rockfish Stock Assessment

FLEP - Cabezon

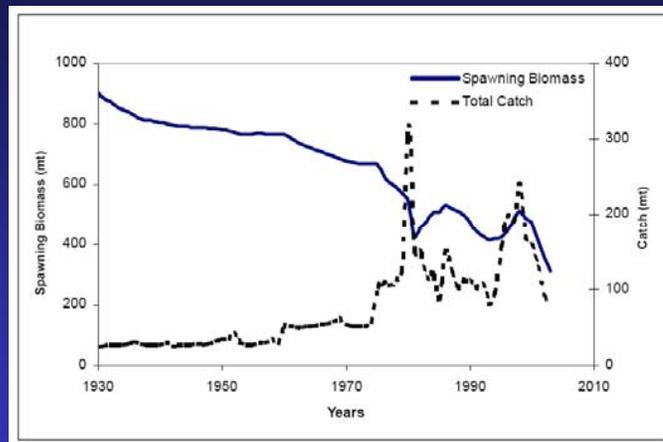
Biomass in long-term decline

Biomass currently at 34.7% B_0 $0.25B_0 < B < 0.4B_0$

Mode of 20 year projection = No Change

	How likely
Not overfishing (FLEP=0.4)	0.2
Overfishing (FLEP=0.3)	0.4
Heavy Overfishing (FLEP=0.2)	0.4

Cabezon Biomass and Catch



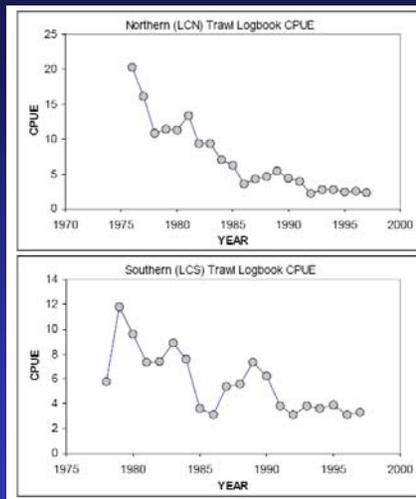
FLEP - Lingcod

Southern stock (CA) biomass below overfished level
 ($0.24 B_0 < 0.25 B_0$)

Southern stock (CA) CPUE declining.

	How likely
Not overfishing (FLEP=0.4)	0.2
Overfishing (FLEP=0.3)	0.4
Heavy Overfishing (FLEP=0.2)	0.4

Lingcod CPUE



Southern stock (CA)

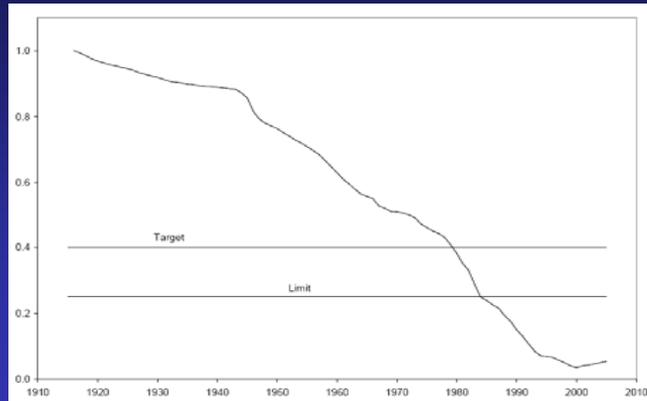
FLEP - Canary Rockfish

Remains overfished, $B \sim 0.1 B_0$

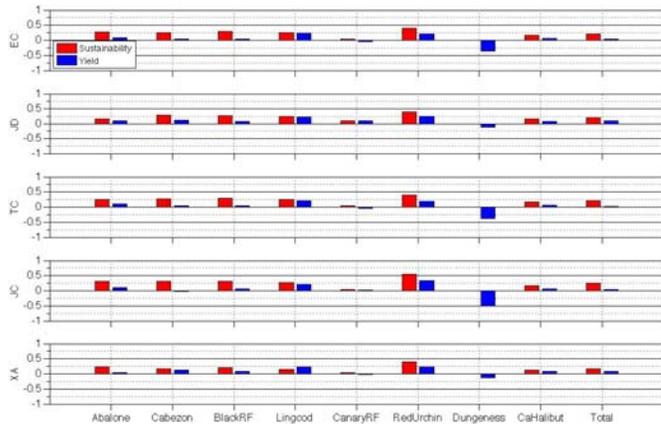
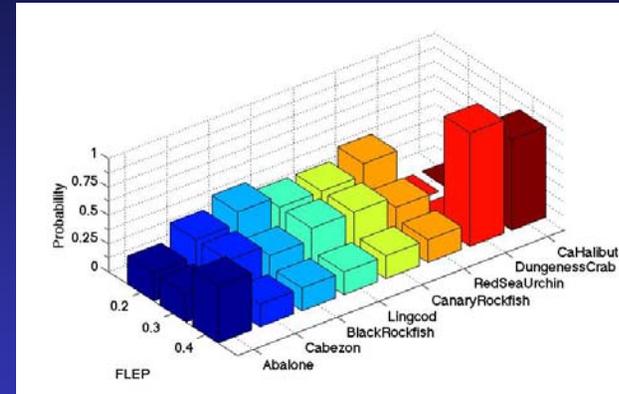
Recreational catch now 60% (up from 6%)

	How likely
Not overfishing (FLEP=0.4)	0.2
Overfishing (FLEP=0.3)	0.4
Heavy Overfishing (FLEP=0.2)	0.4

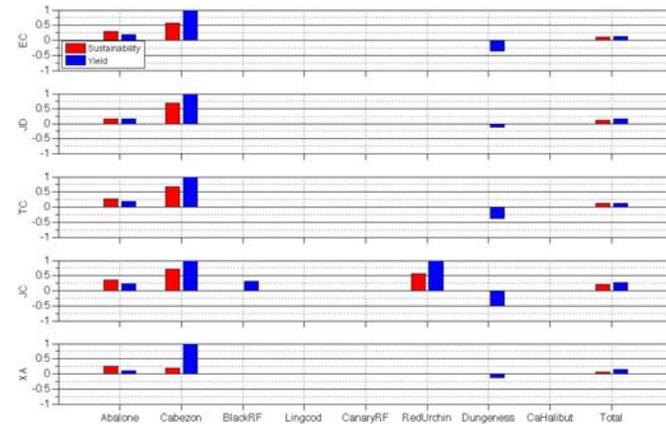
Canary rockfish spawning biomass/ B_0



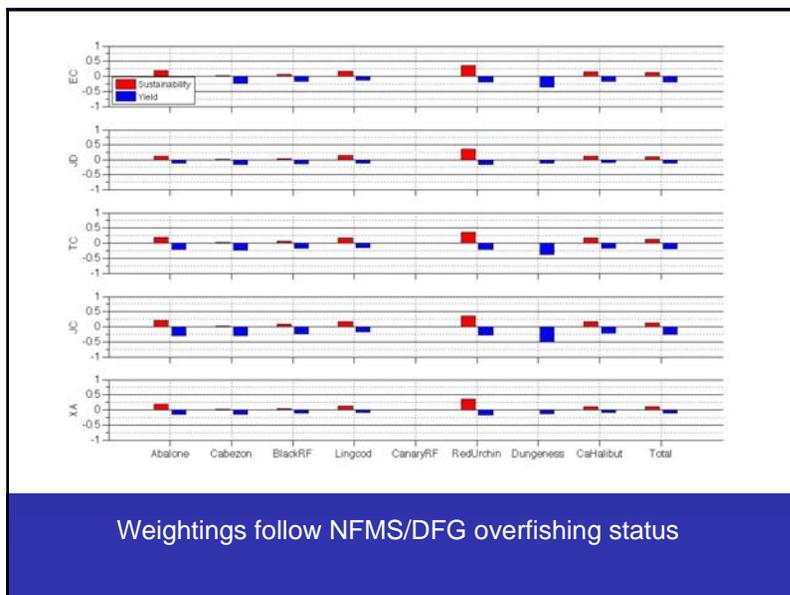
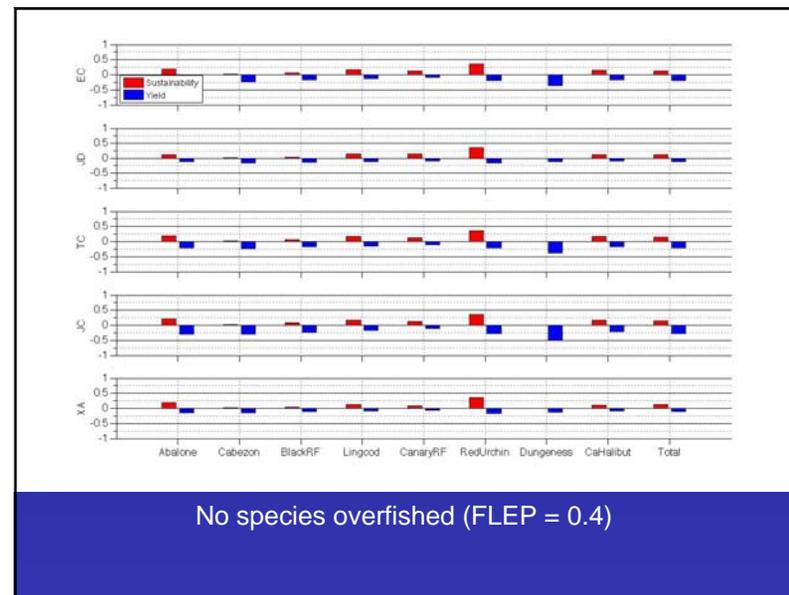
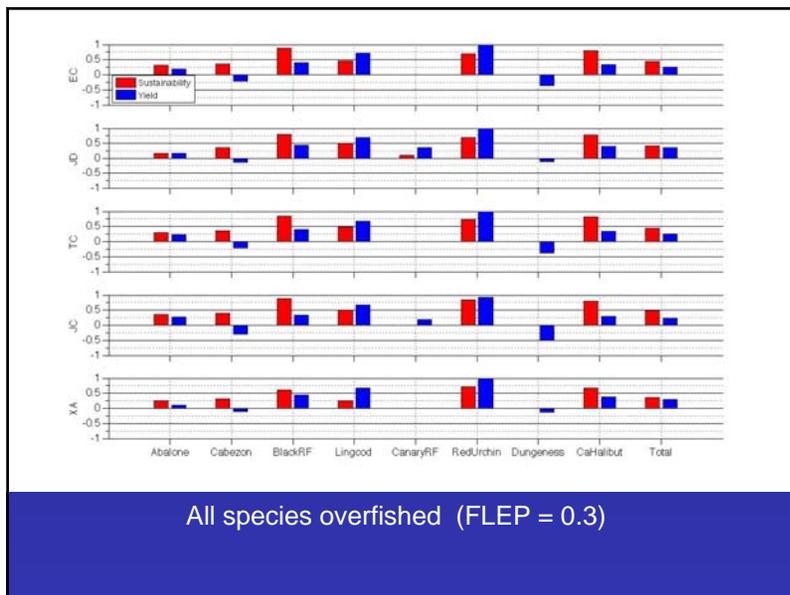
Weightings for each FLEP level informed by stock status



Overfishing weighting for each species from stock status
(other weightings possible)



All species heavily overfished (FLEP = 0.2)



Conclusions

In MPA improvements there is a complex tradeoff between Sustainability and Yield

The uncertainty in overfishing status needs to be accounted for, SAT can decide on weightings

Spatial distribution plots can guide RSG in adding or removing MPAs