

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?

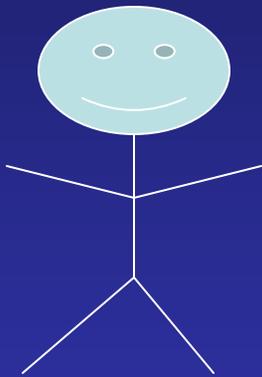
What will management be outside MPAs?

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

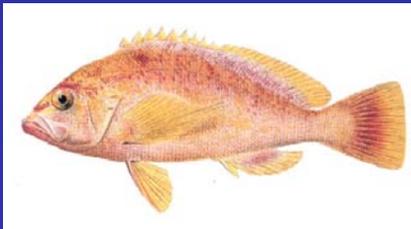
Fraction of Lifetime Egg Production (FLEP)

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, un-fished LEP (i.e., FLEP)

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

35% (Clark 1991)

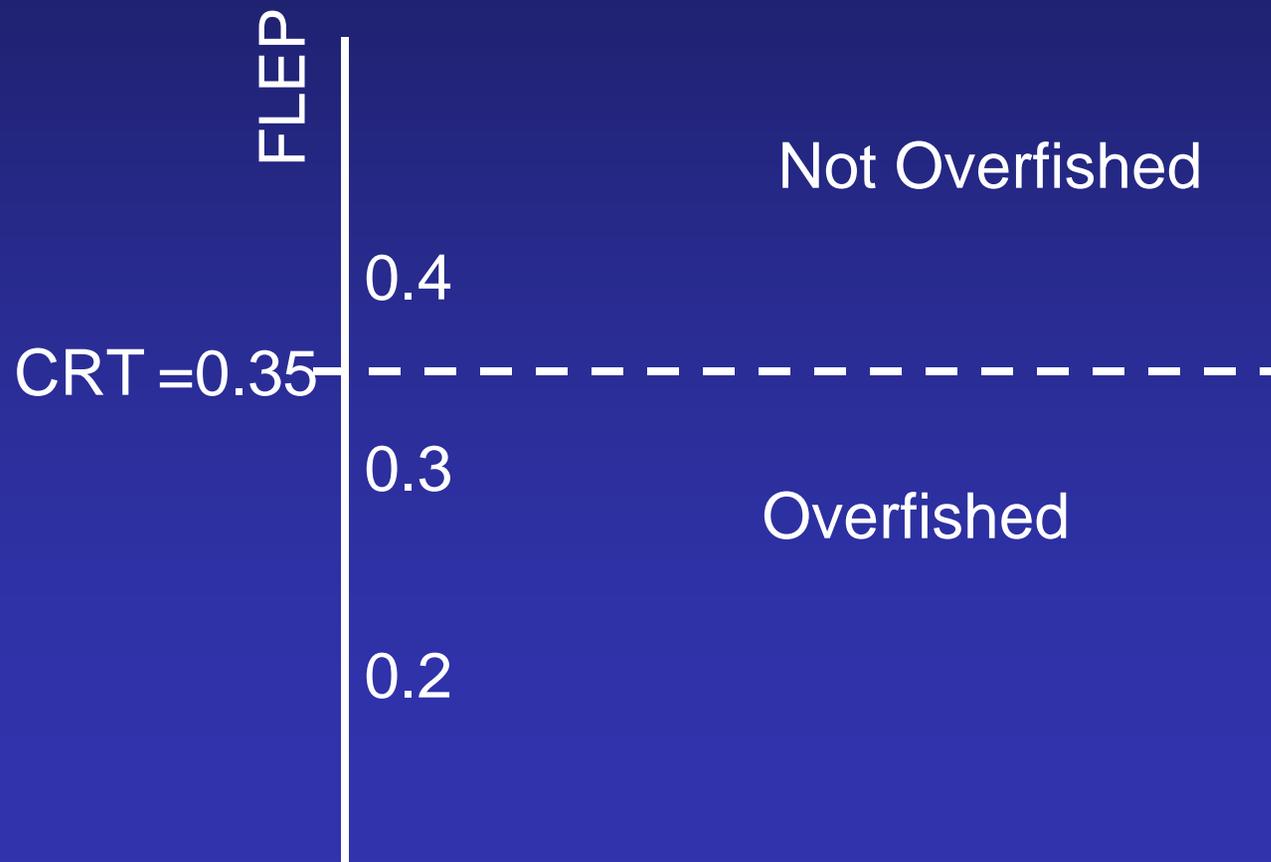


30% (Mace and Sissenwine 1993)

40% (Clark 1993, Mace 1994)

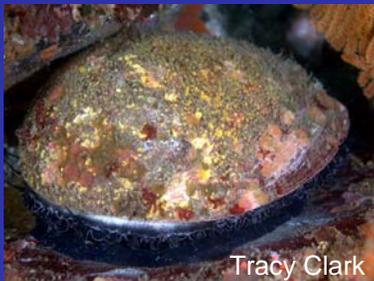
55-60% (Dorn 2002, for rockfishes)

Calculations re: FLEP and CRT

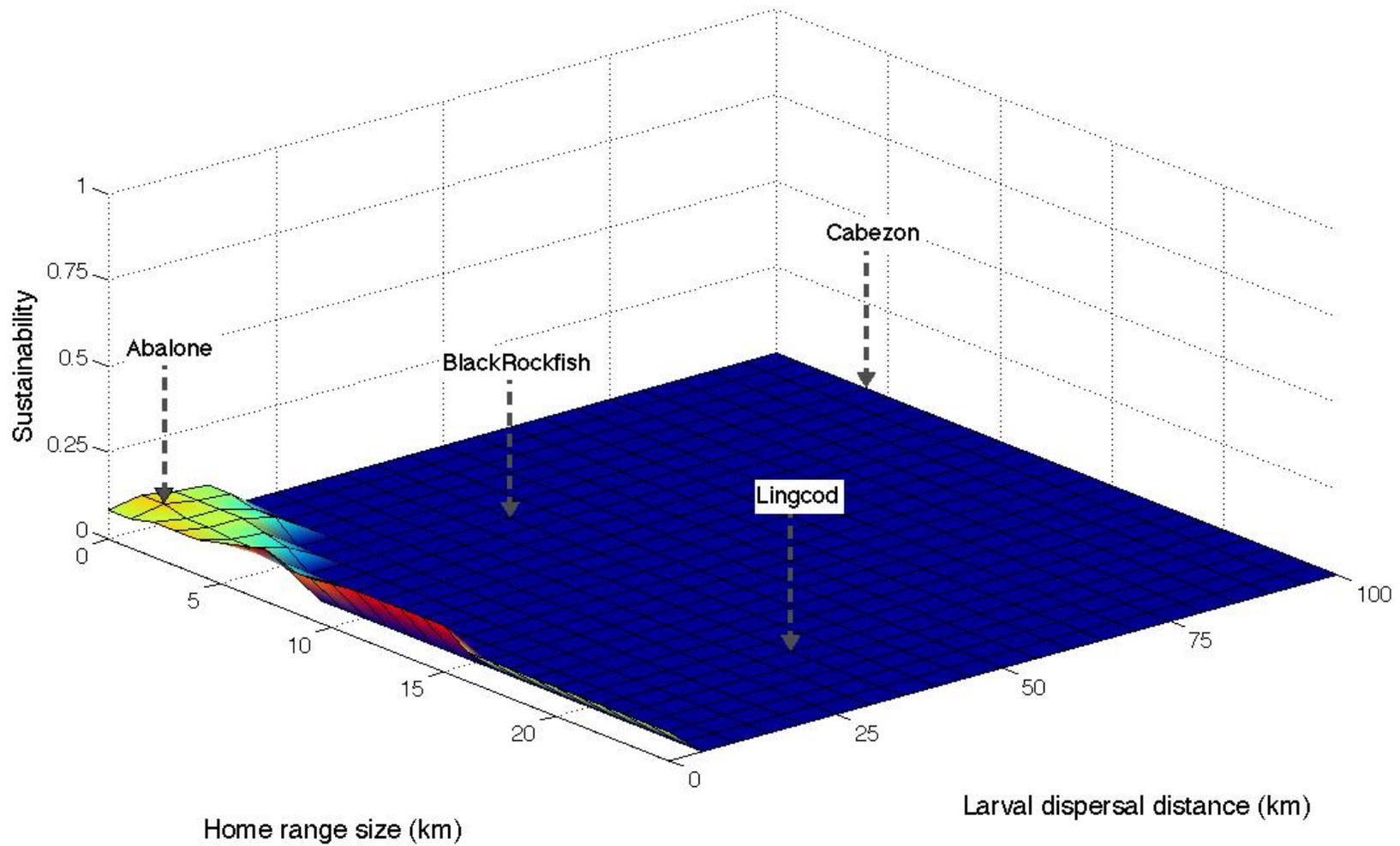


Species Considered

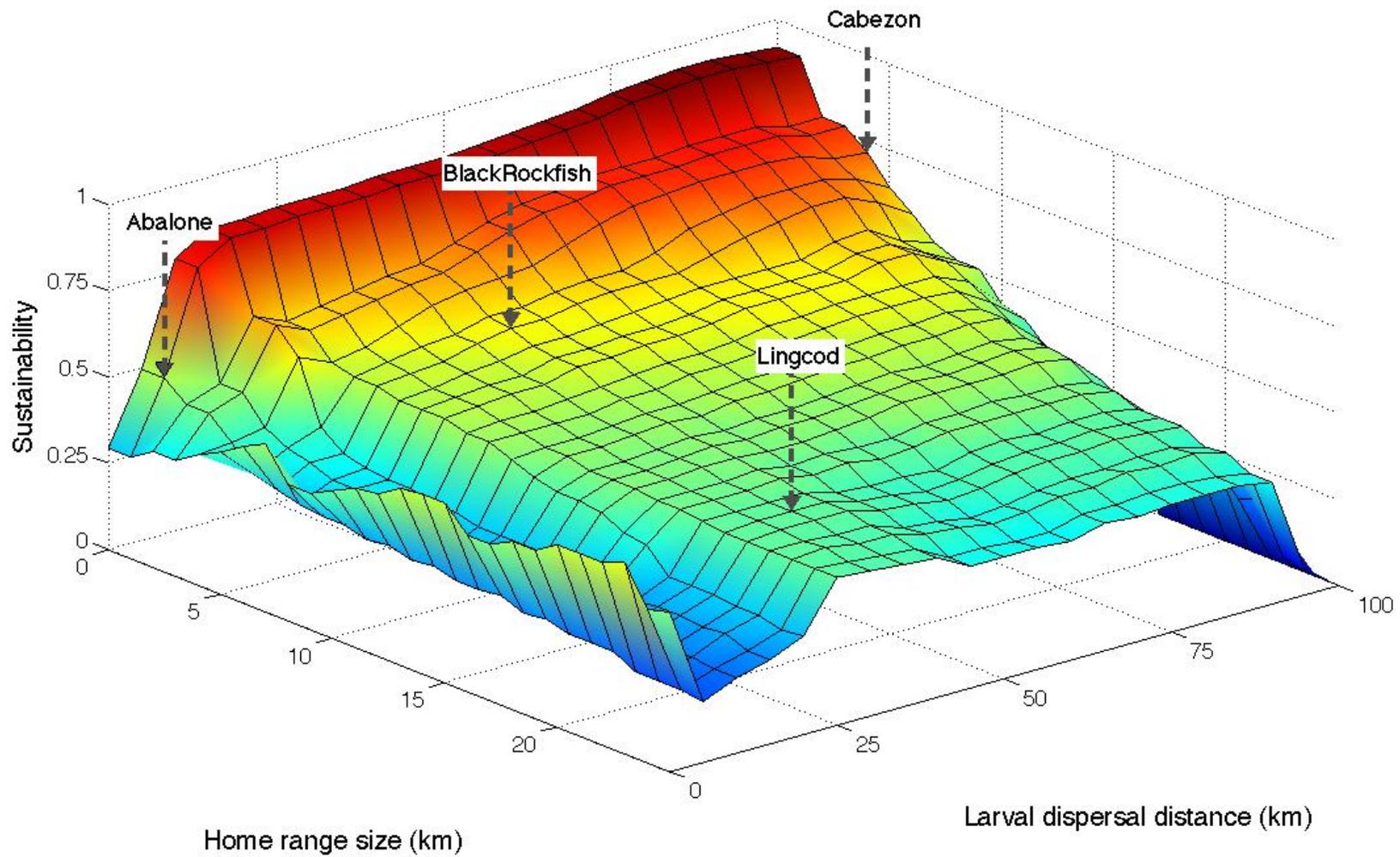
Species	Average larval dispersal distance (km)	Average homerange diameter (km)
Abalone	1	1
Black Rockfish	40	6
Cabezon	100	1
Lingcod	35	15
Canary Rockfish	40	40
California Halibut	45	30
Dungeness Crab	75	14
Red Sea Urchin	50	1



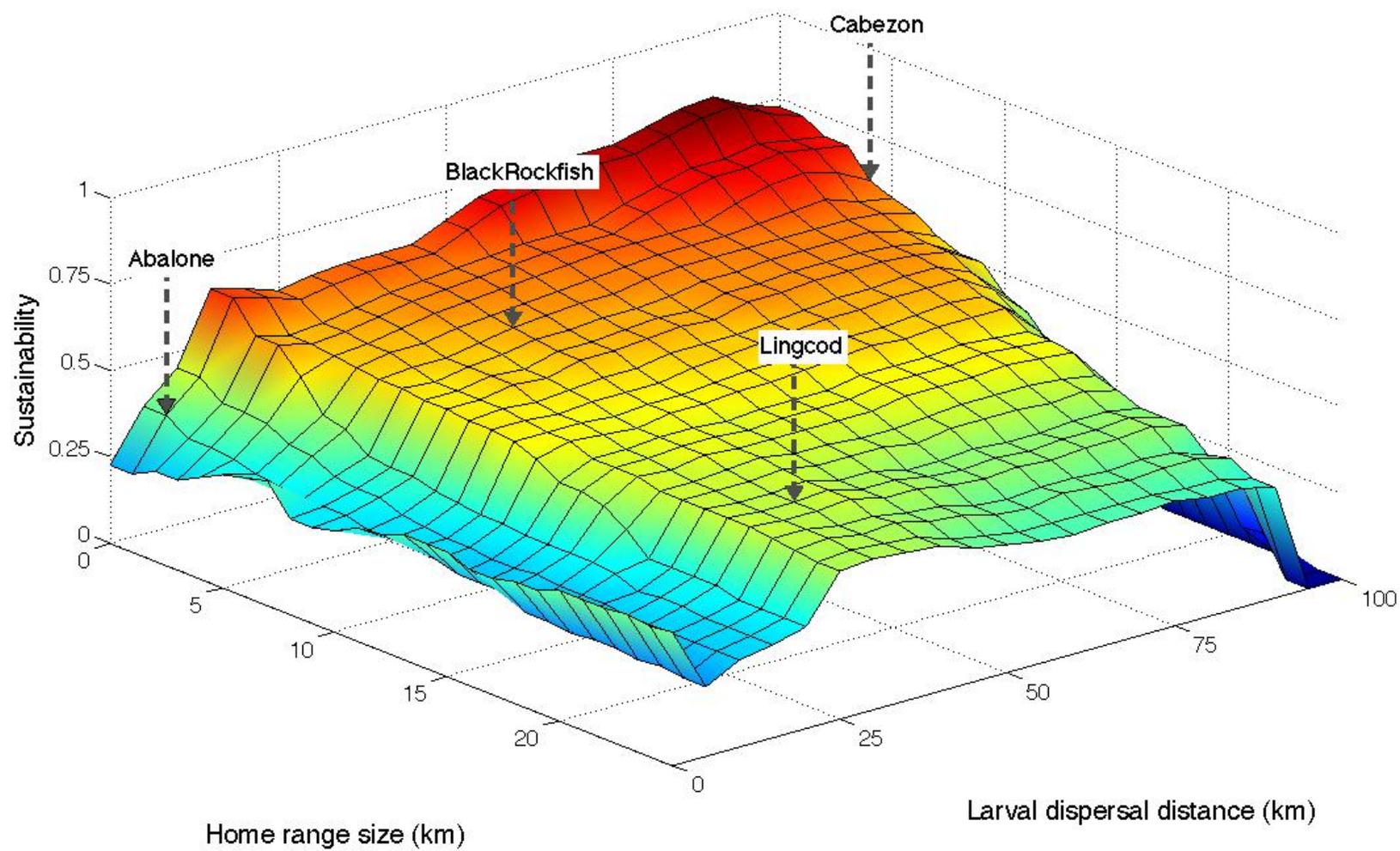
Hard Bottom; Package No Action; Overfished (FLEP = 0.3)



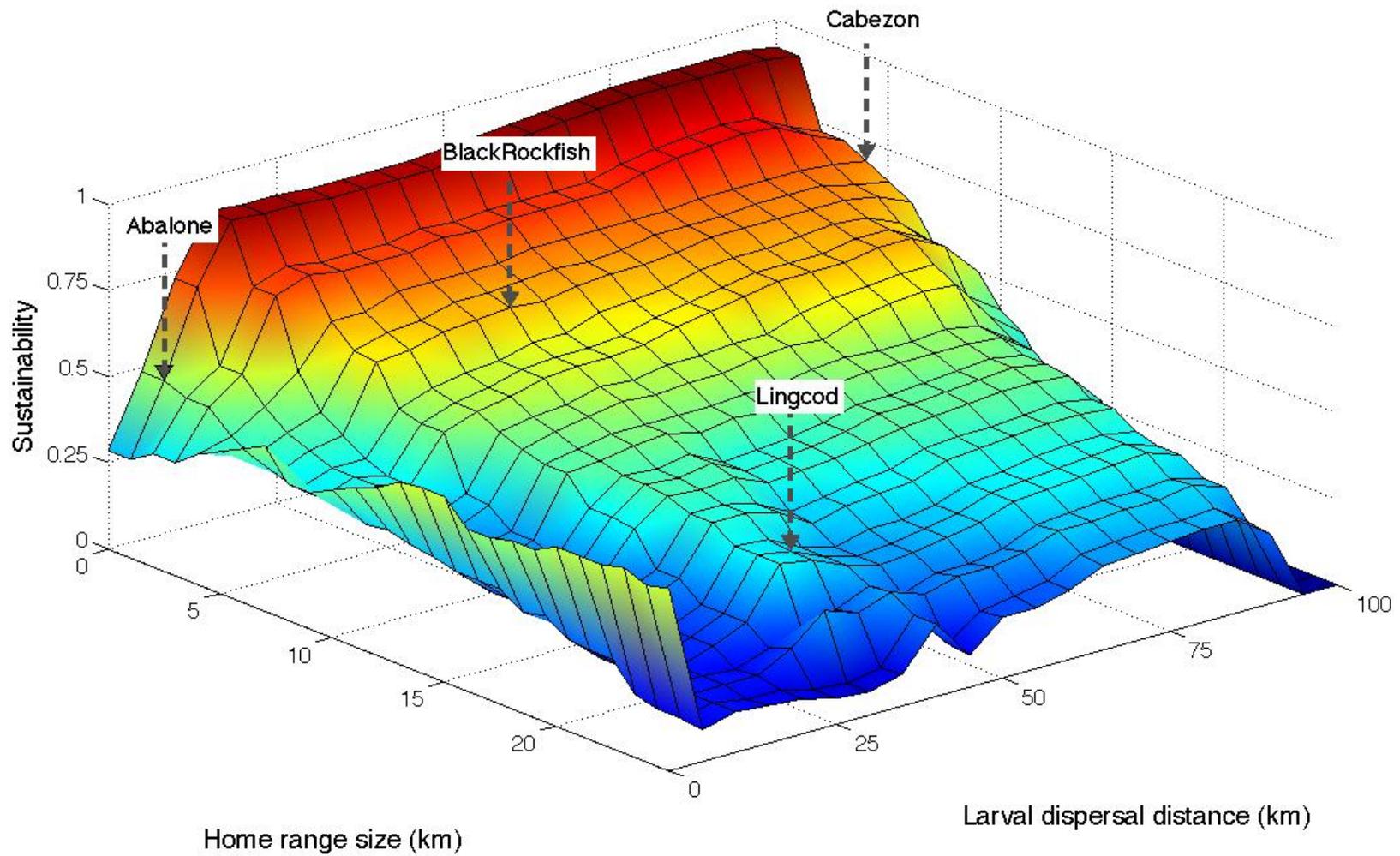
Hard Bottom; Package TC; Overfished (FLEP = 0.3)



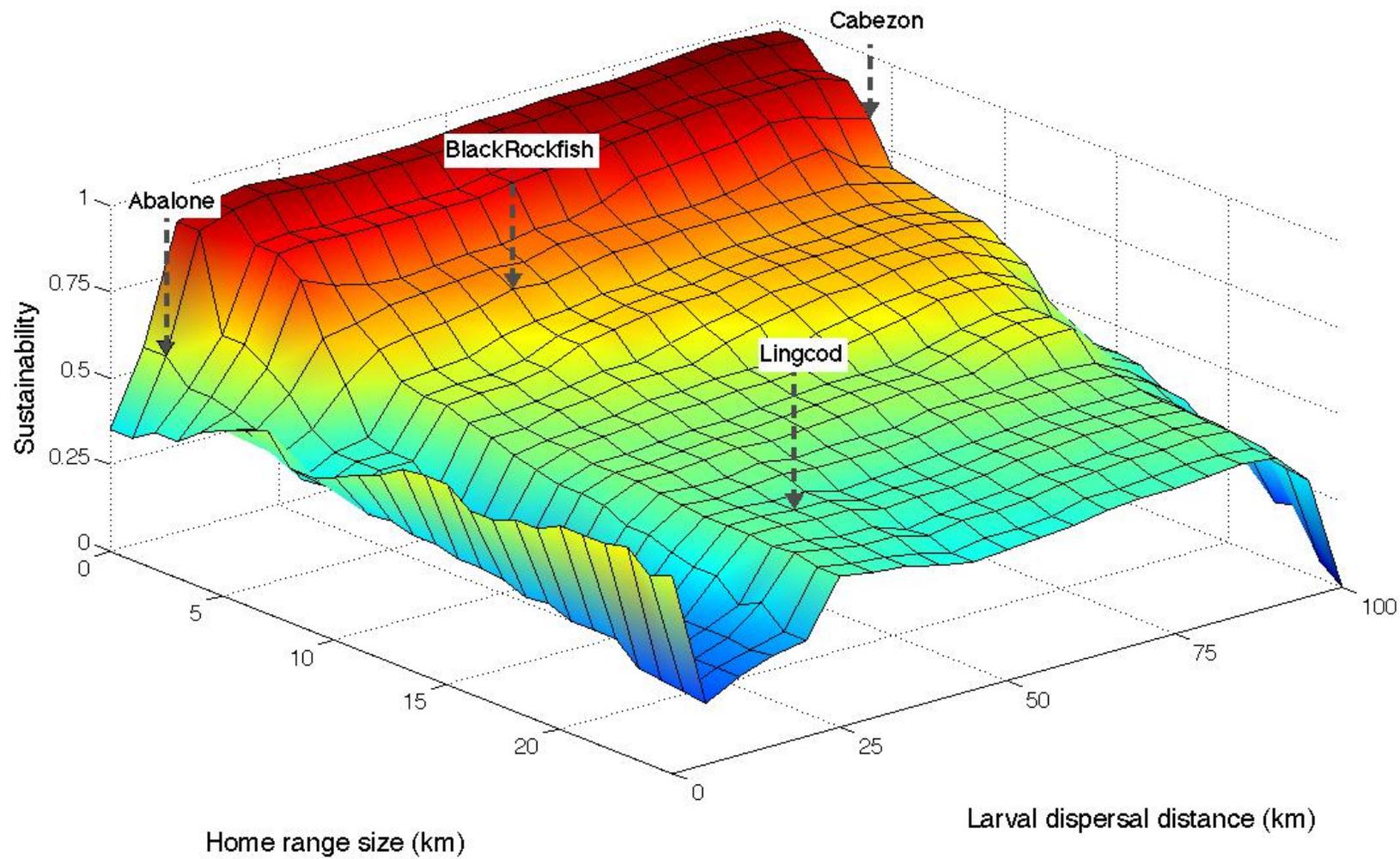
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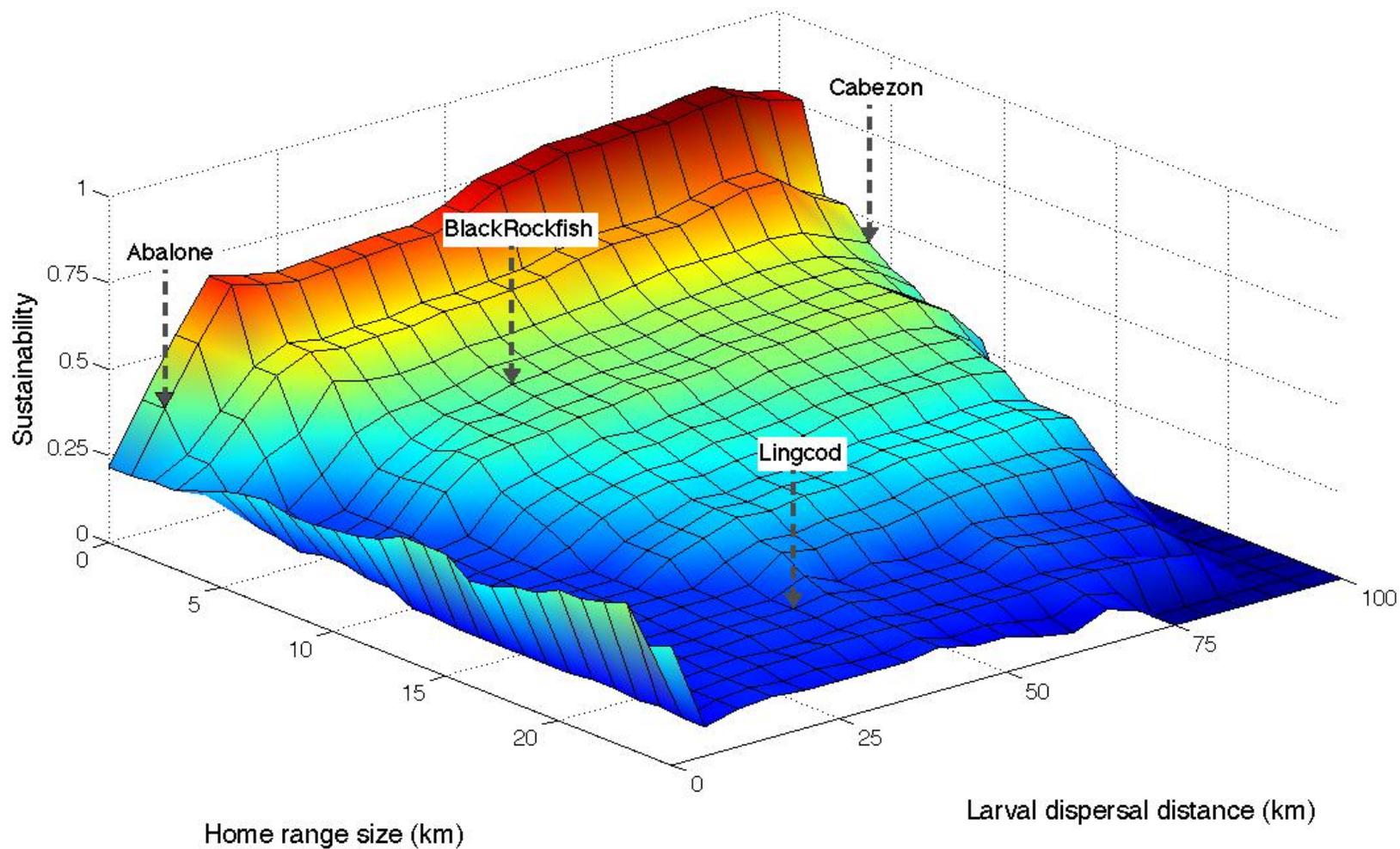
Hard Bottom; Package EC; Overfished (FLEP = 0.3)



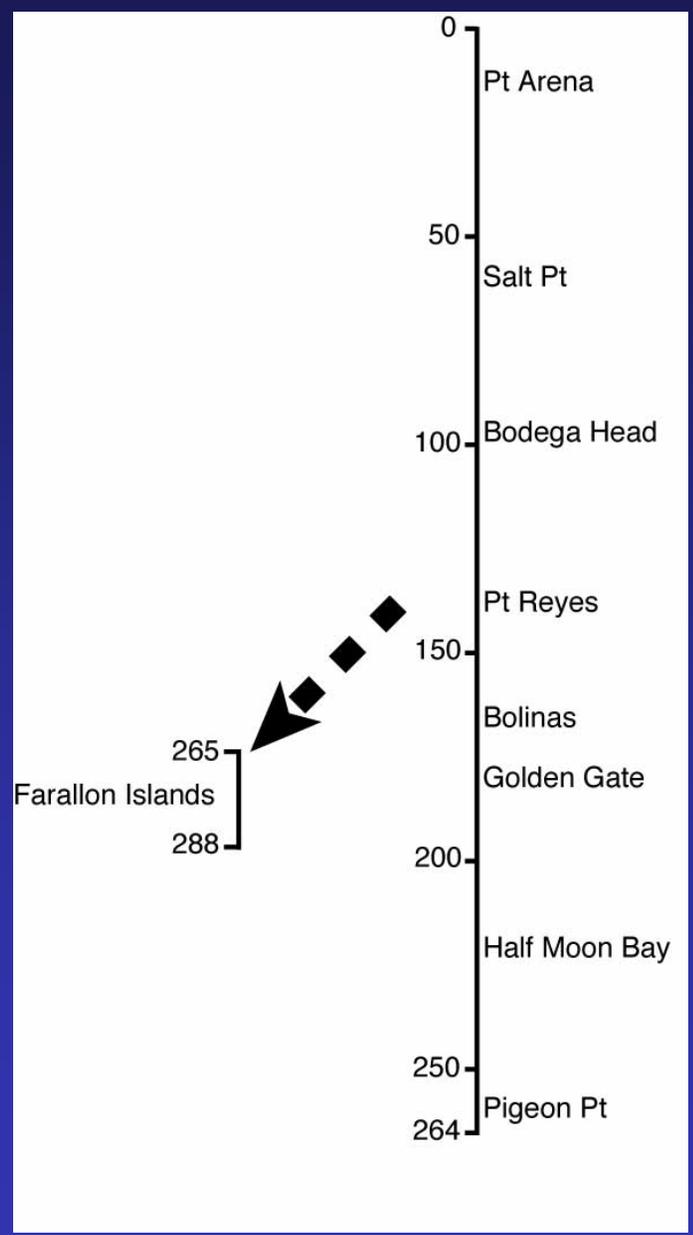
Hard Bottom; Package JC; Overfished (FLEP = 0.3)



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

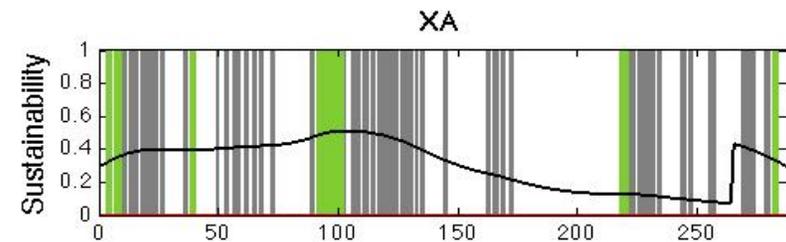
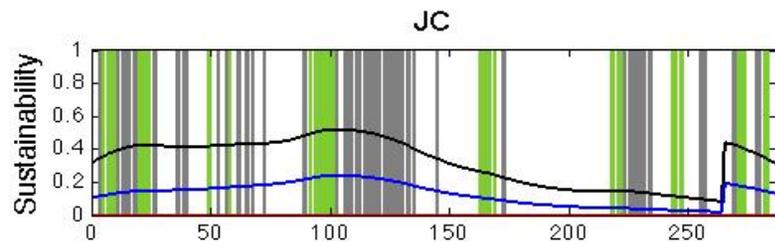
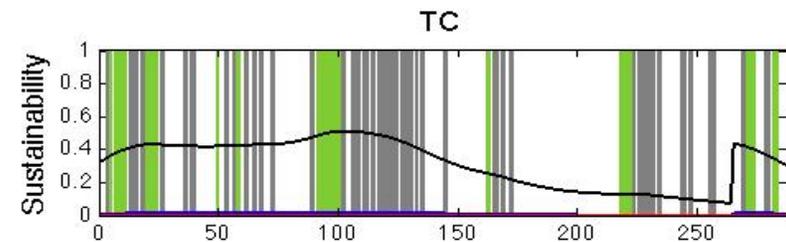
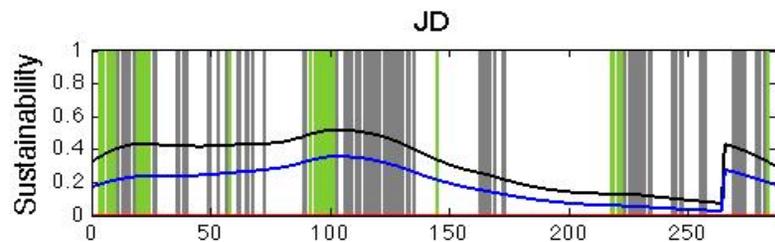
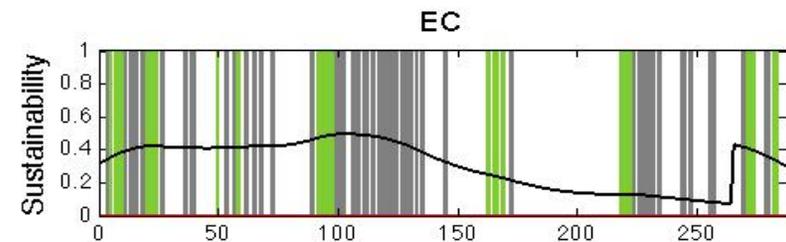
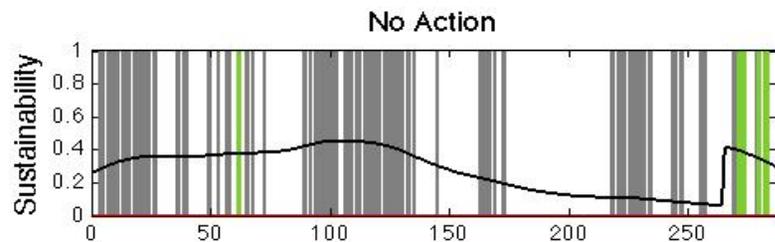
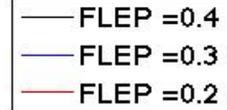


One-dimensional map



Canary Rockfish - Sustainability

CanaryRockfish

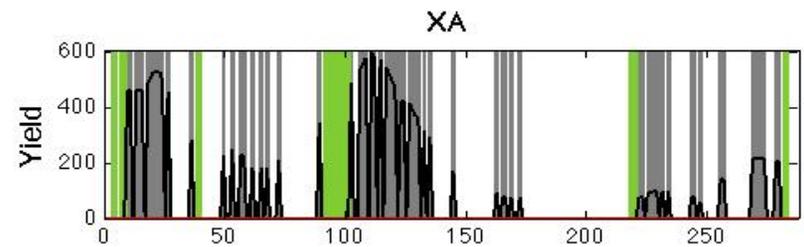
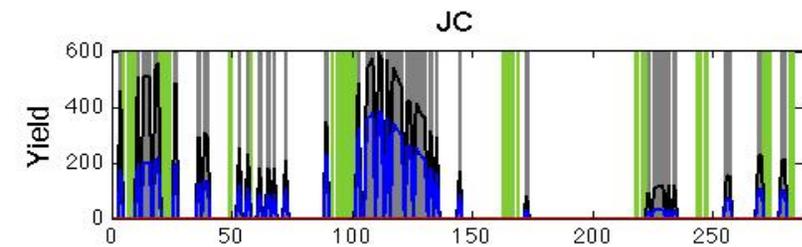
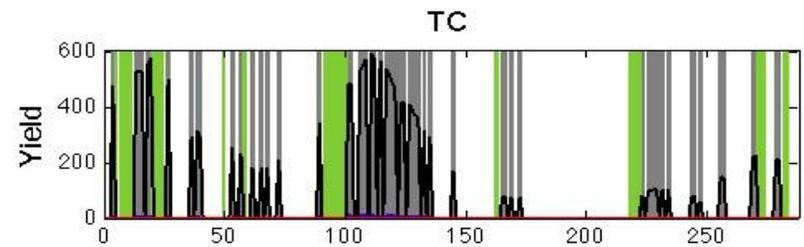
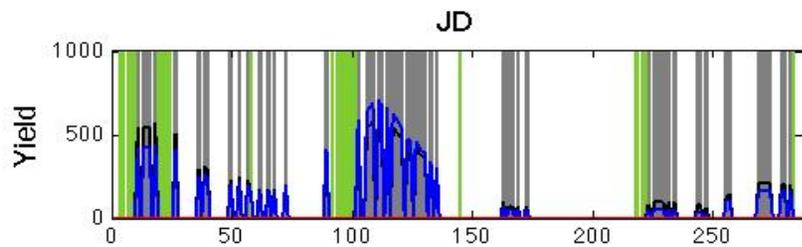
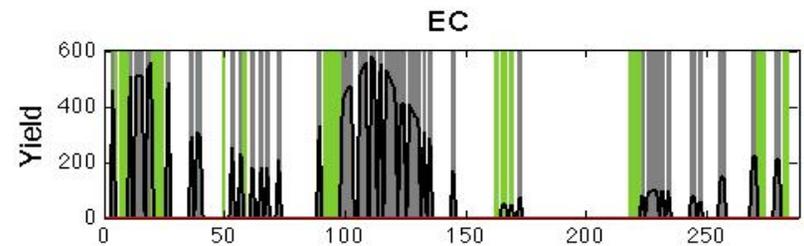
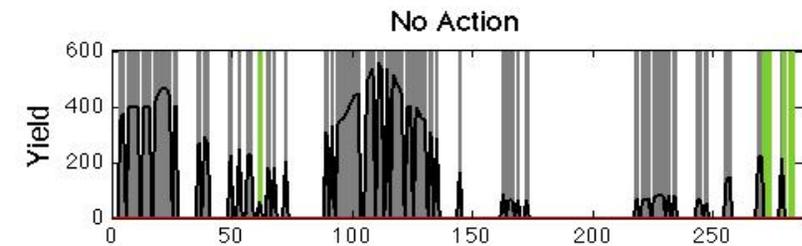
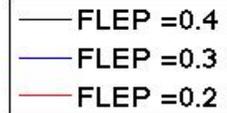


Distance Along Coast (km)

Distance Along Coast (km)

Canary Rockfish - Yield

CanaryRockfish

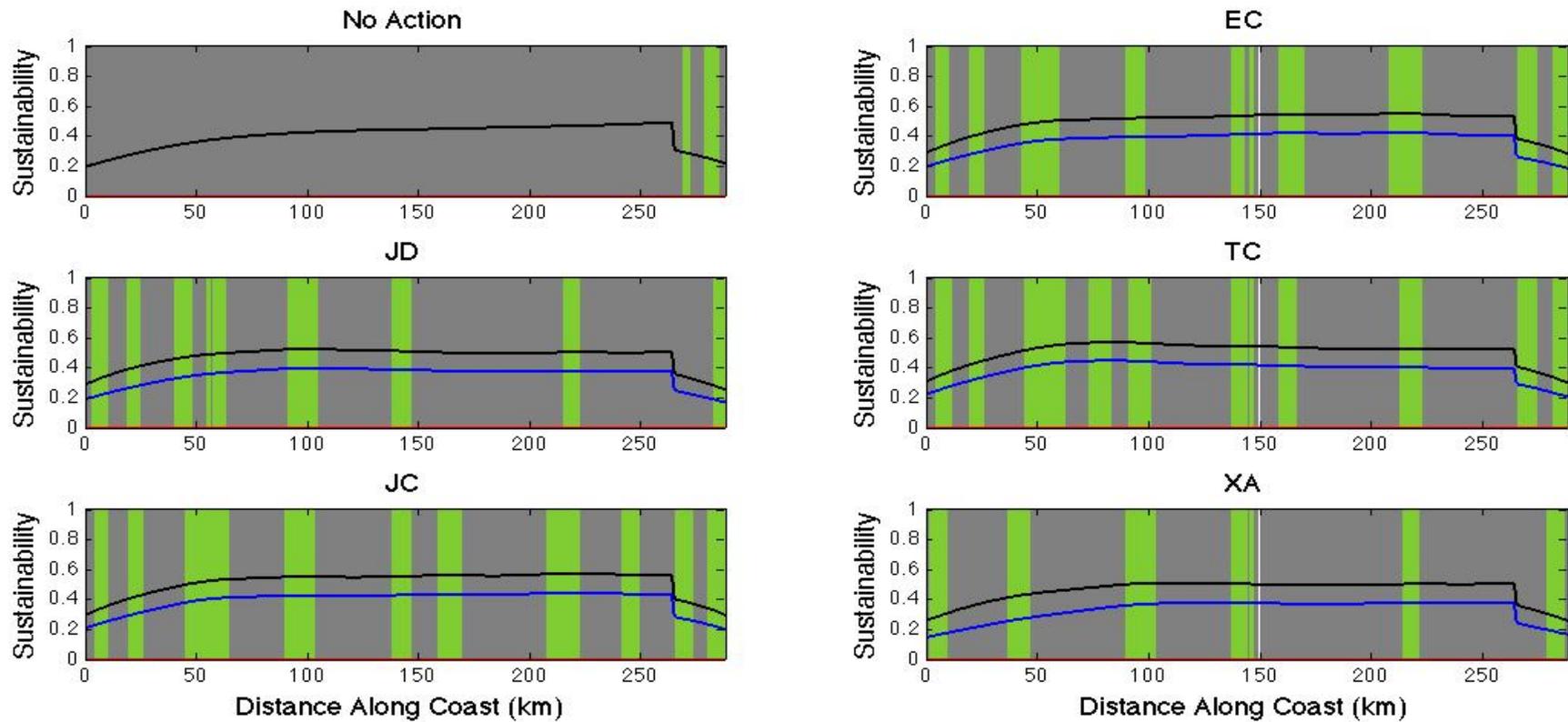
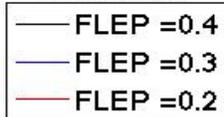


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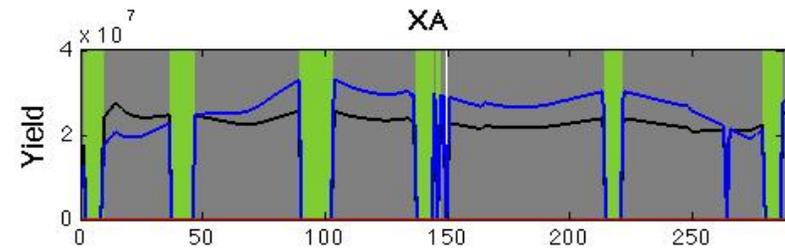
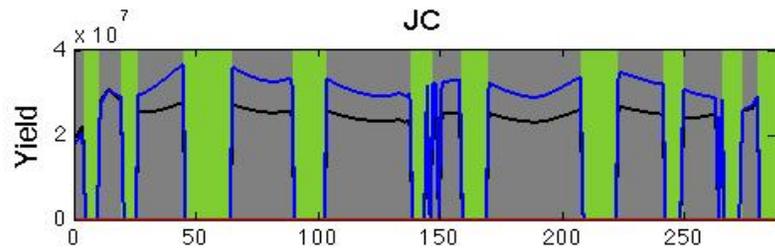
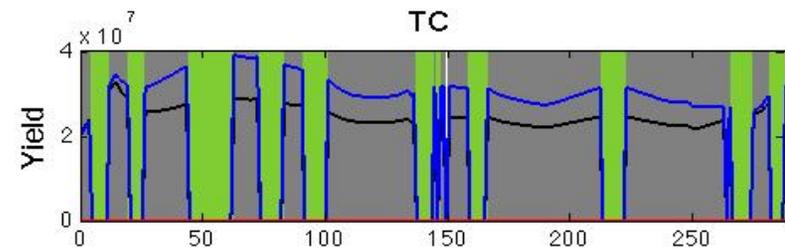
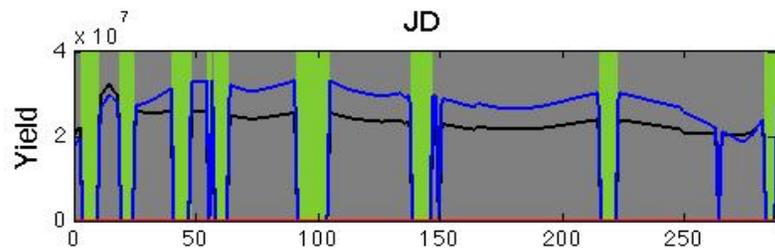
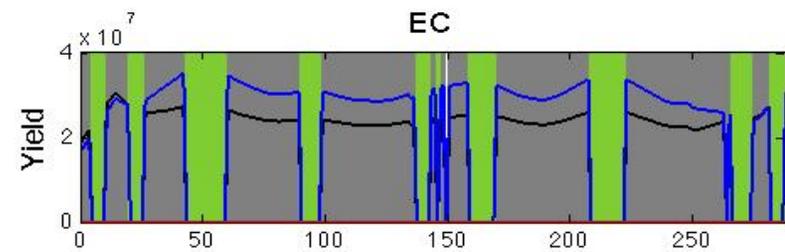
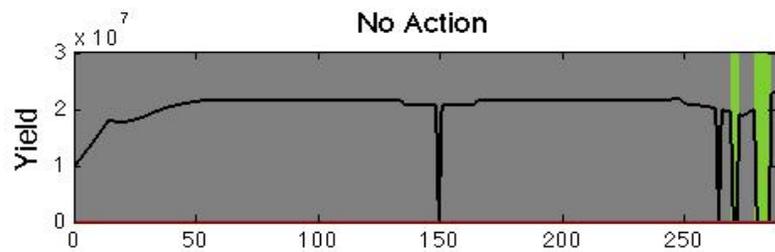
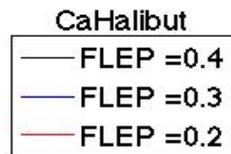
Distance Along Coast (km)

California Halibut - Sustainability

CaHalibut



California Halibut - Yield

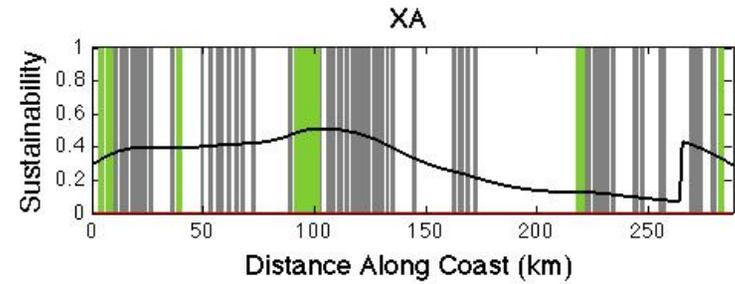
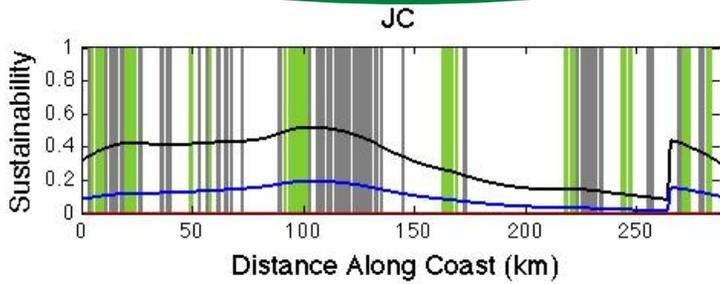
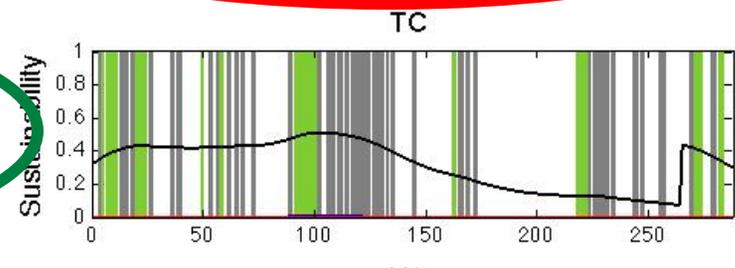
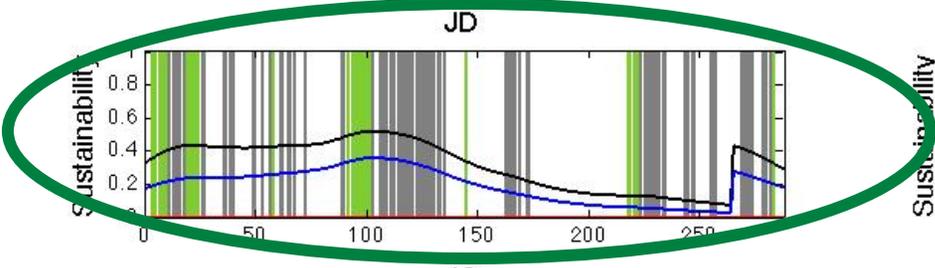
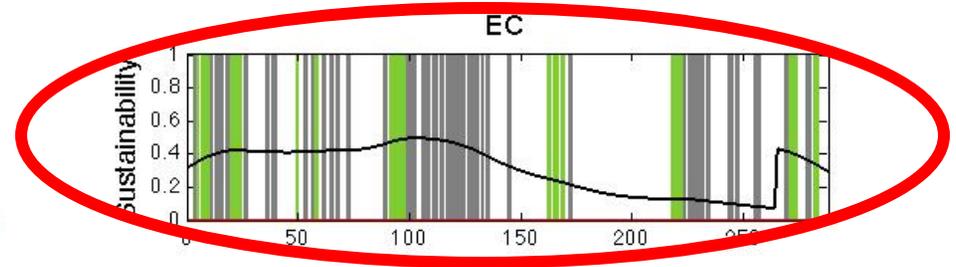
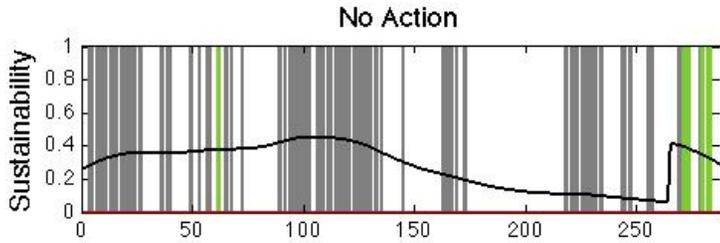


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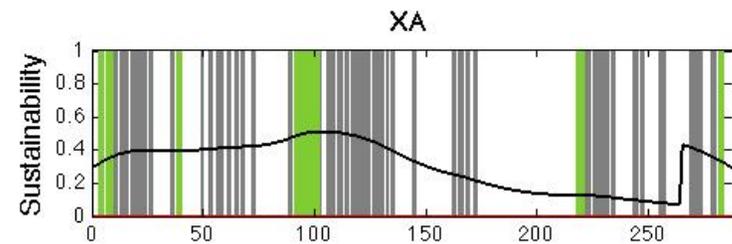
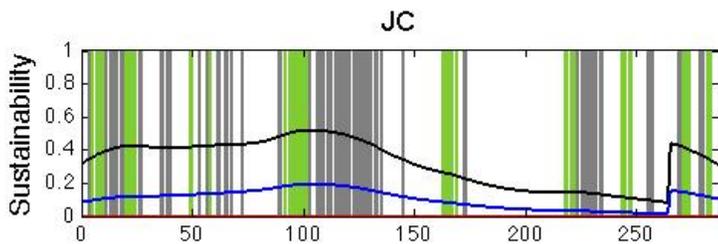
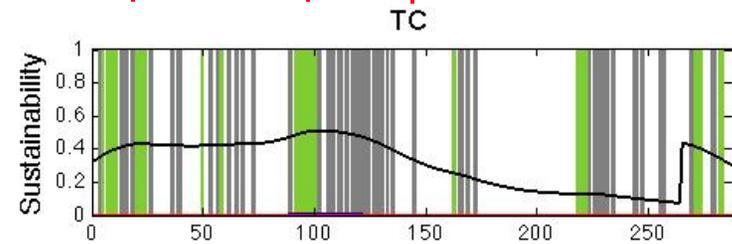
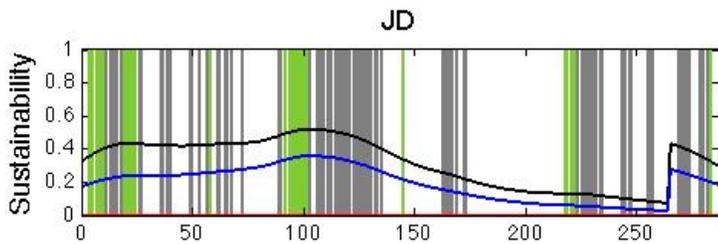
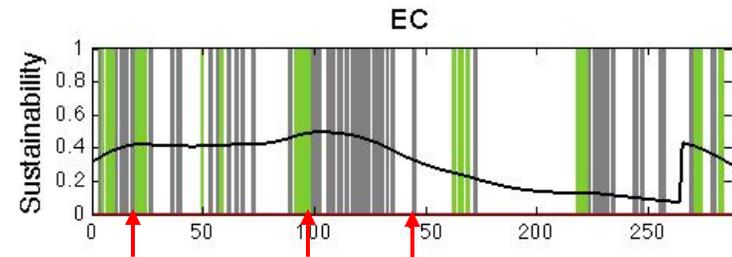
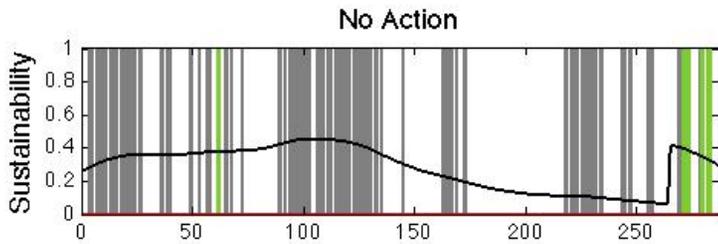
How to improve sustainability?

CanaryRockfish
— FLEP = 0.4
— FLEP = 0.3
— FLEP = 0.2



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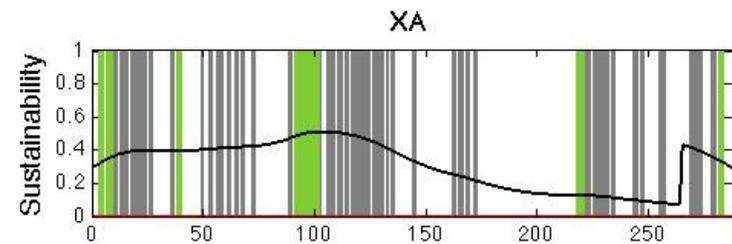
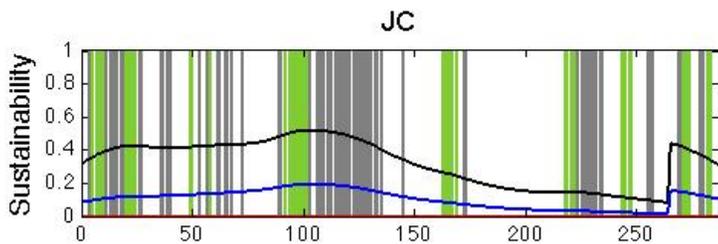
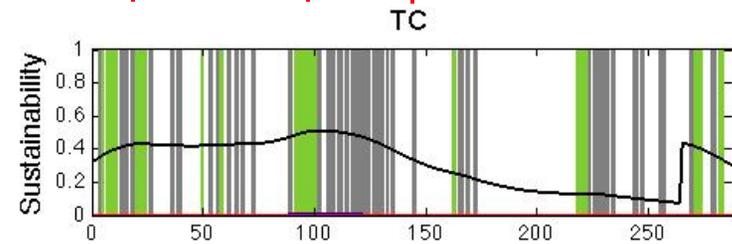
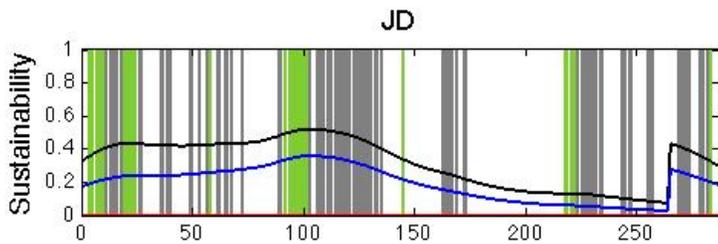
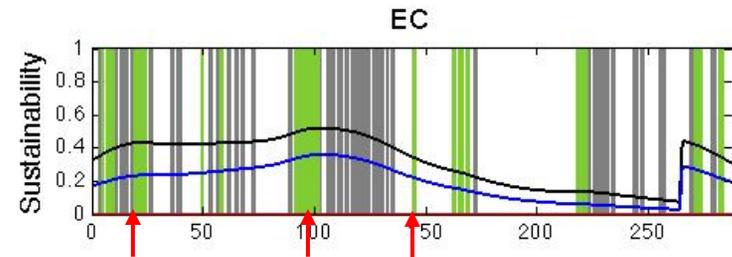
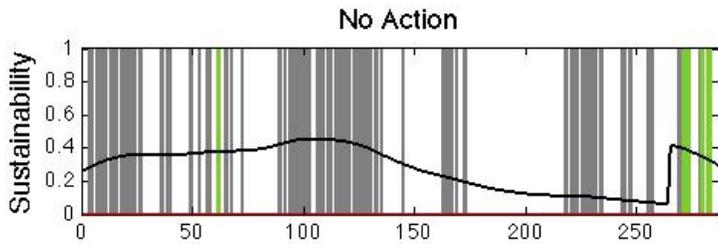
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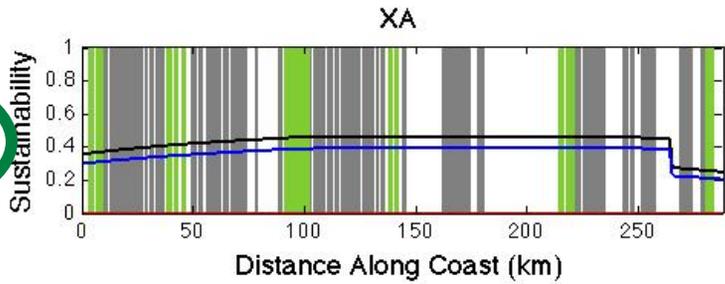
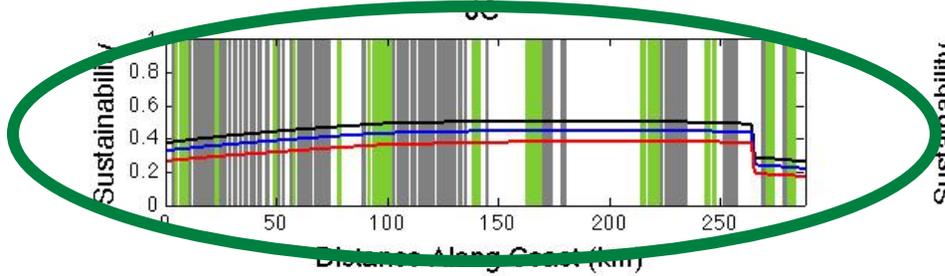
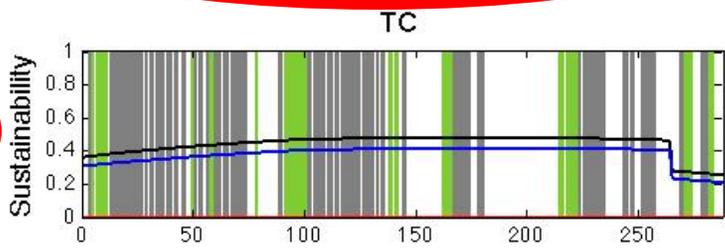
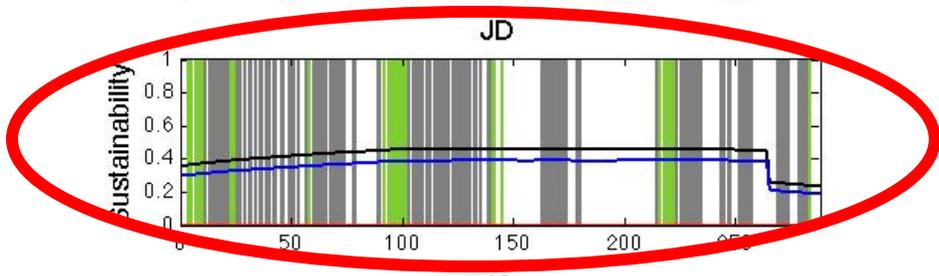
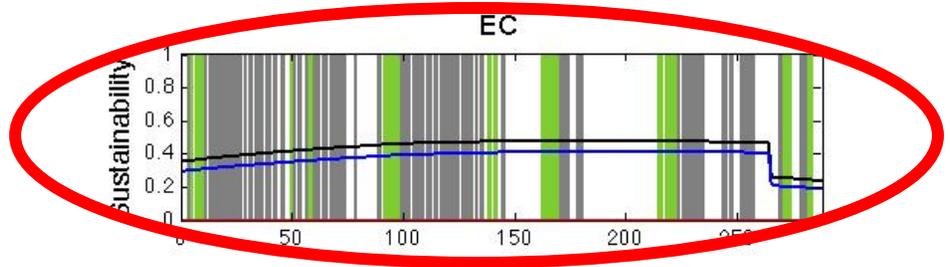
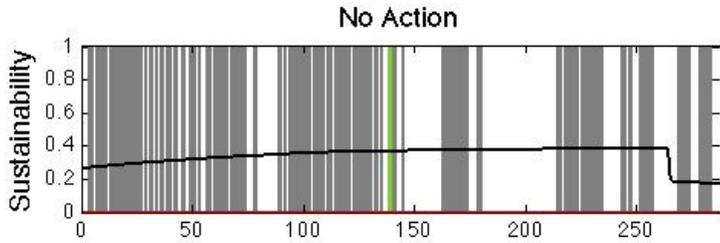
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How to improve sustainability?

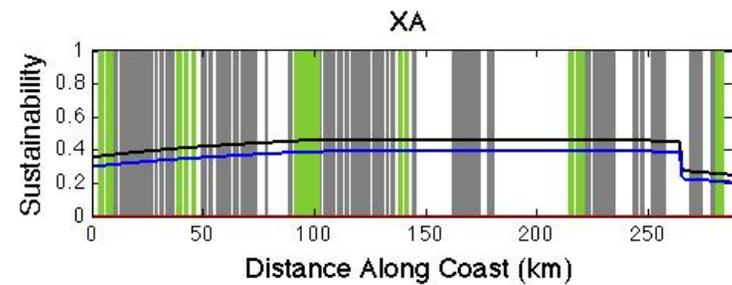
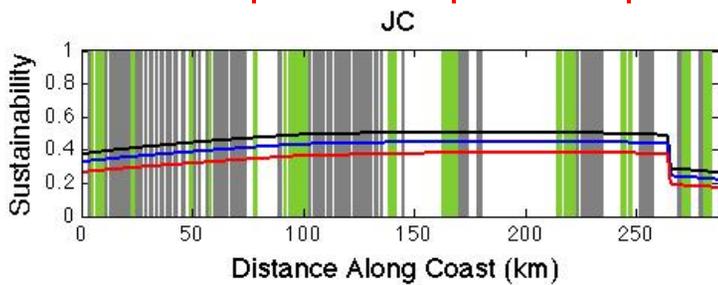
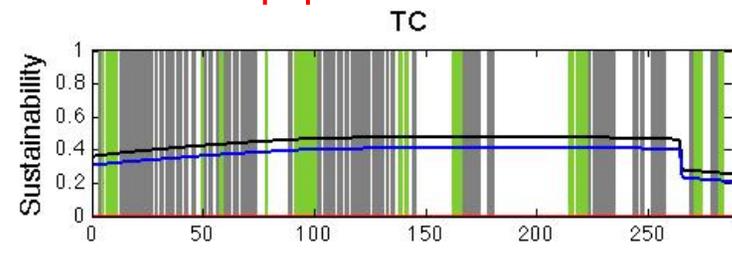
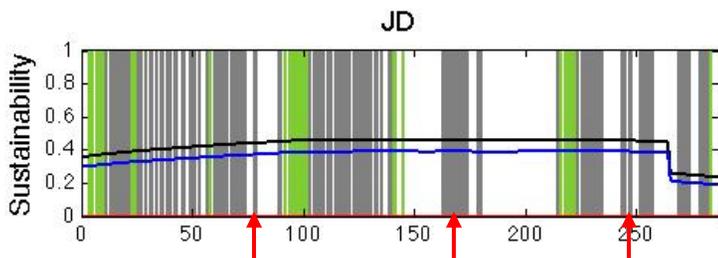
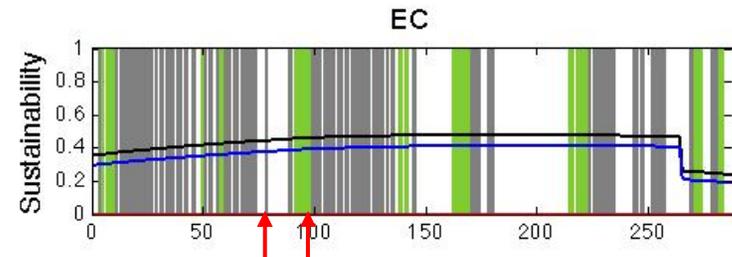
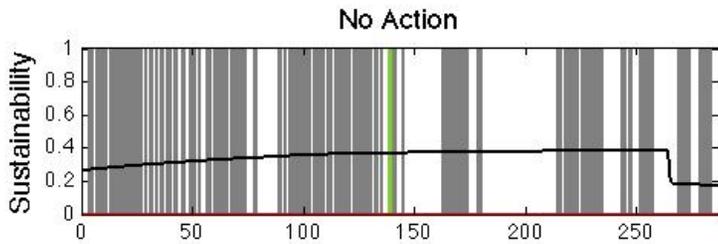
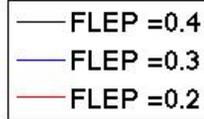
RedSeaUrchin

- FLEP = 0.4
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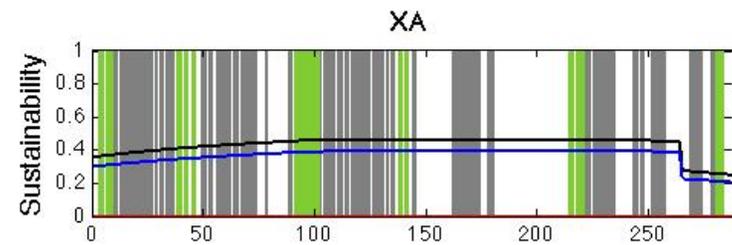
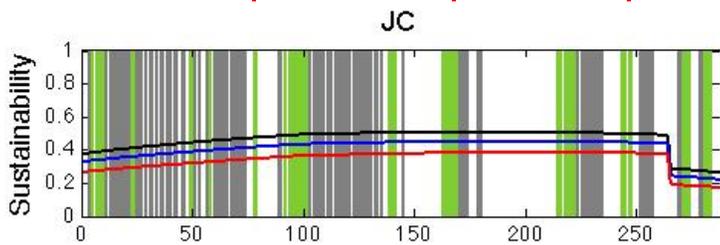
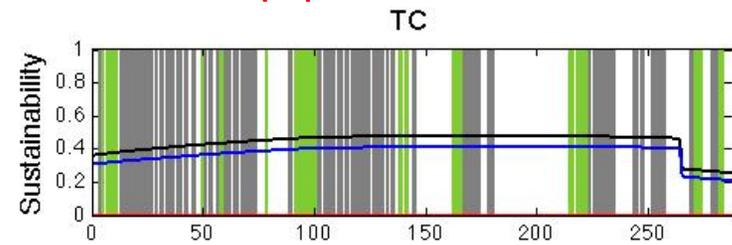
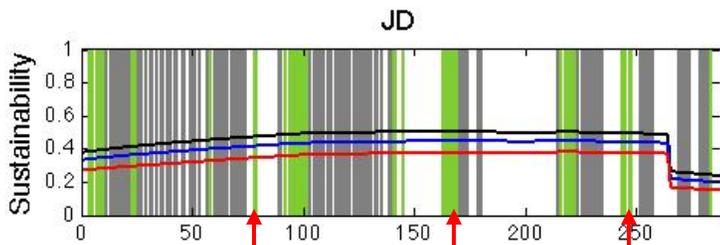
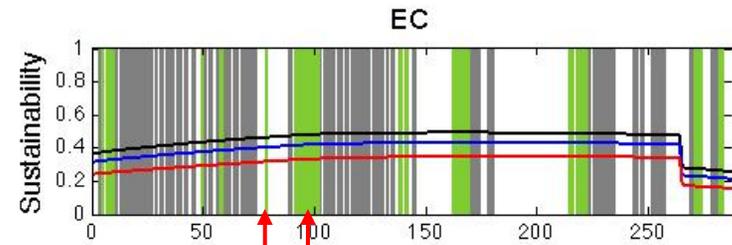
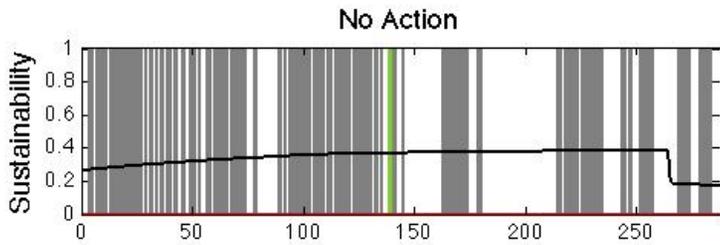
How to improve sustainability?

RedSeaUrchin



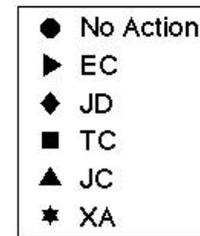
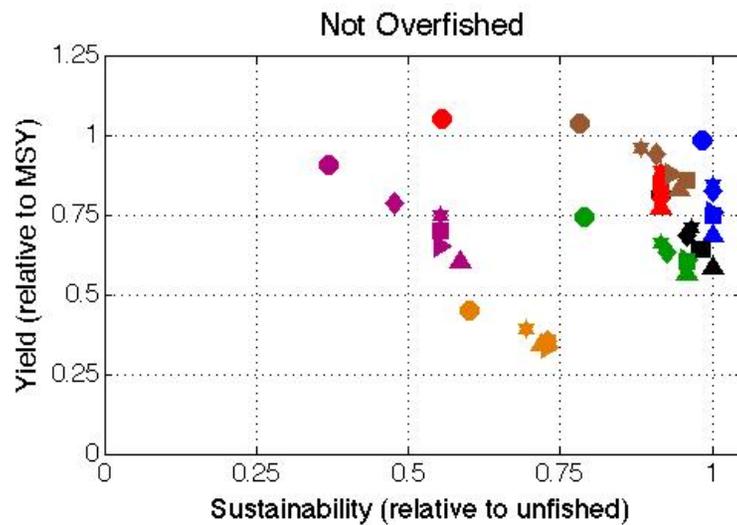
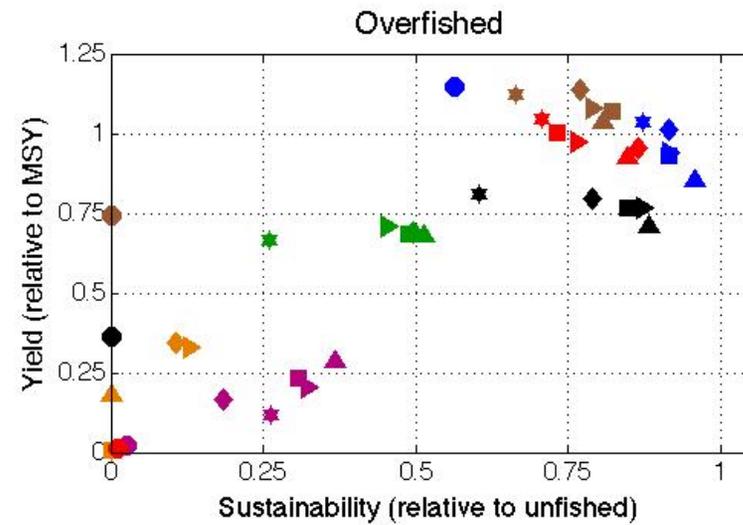
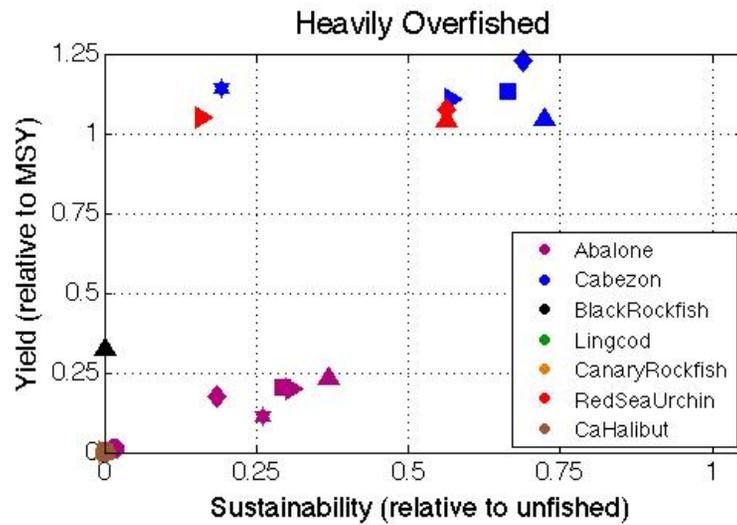
How to improve sustainability?

RedSeaUrchin



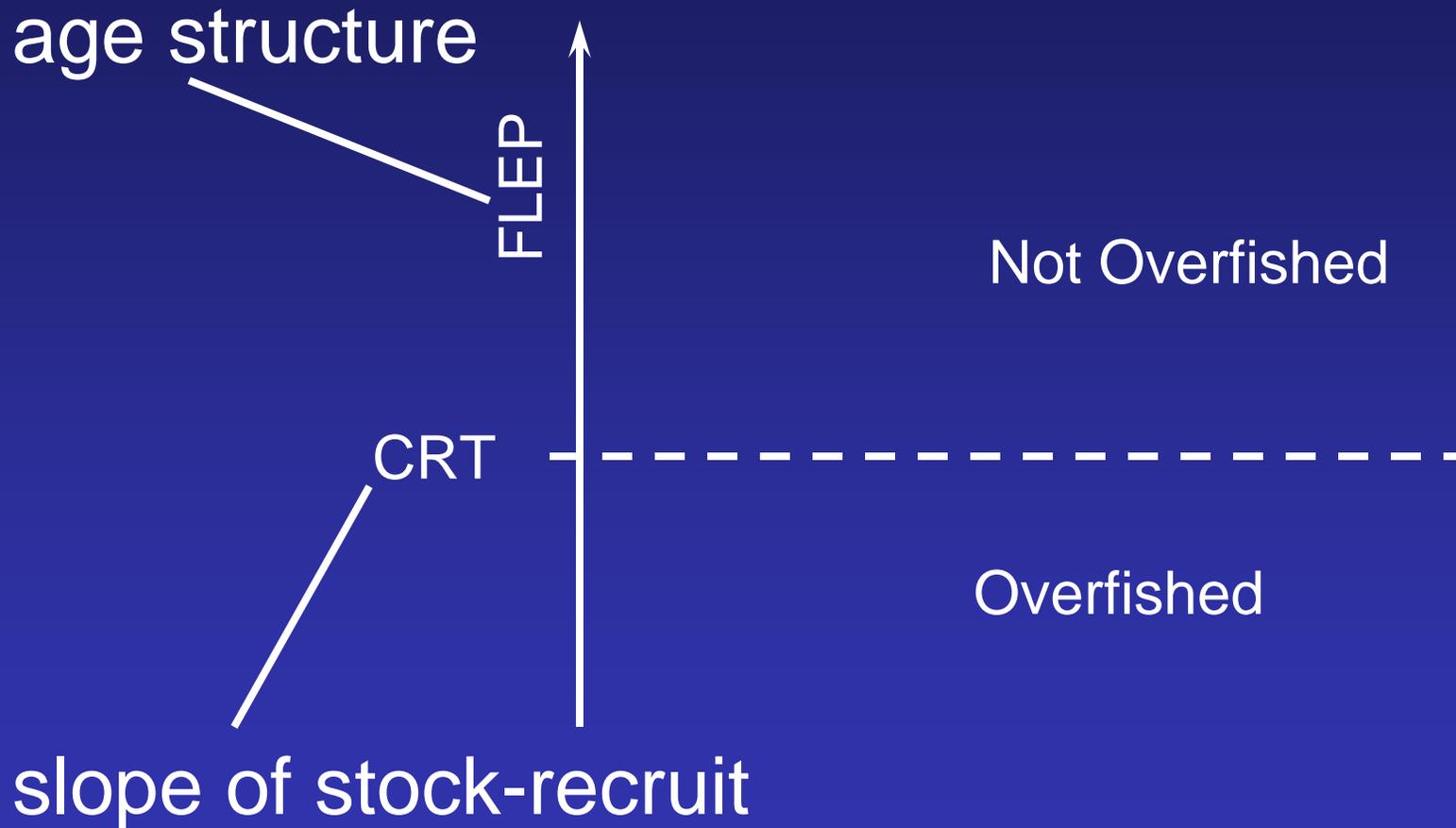
Distance Along Coast (km)

Distance Along Coast (km)



Sustainability and Yield Plots

To calculate improvement, we need to know FLEP and CRT by species



Both are uncertain, but we do know something²⁹

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

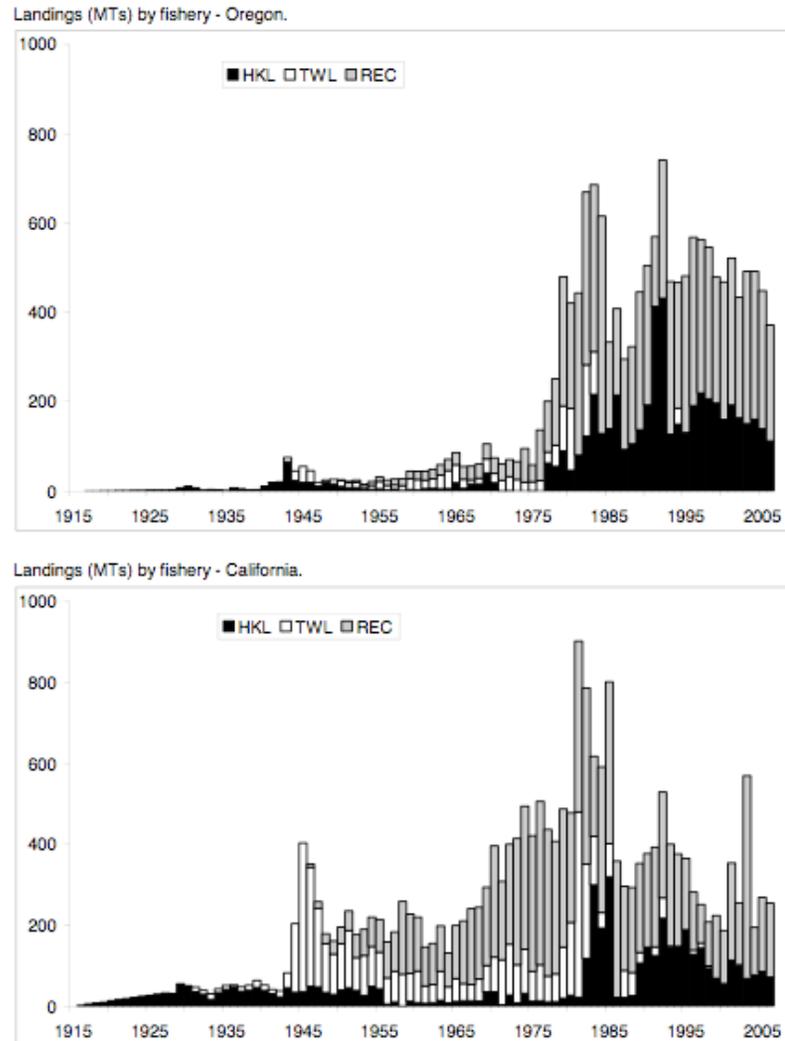
Catch declining (see Stock Assessment)

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

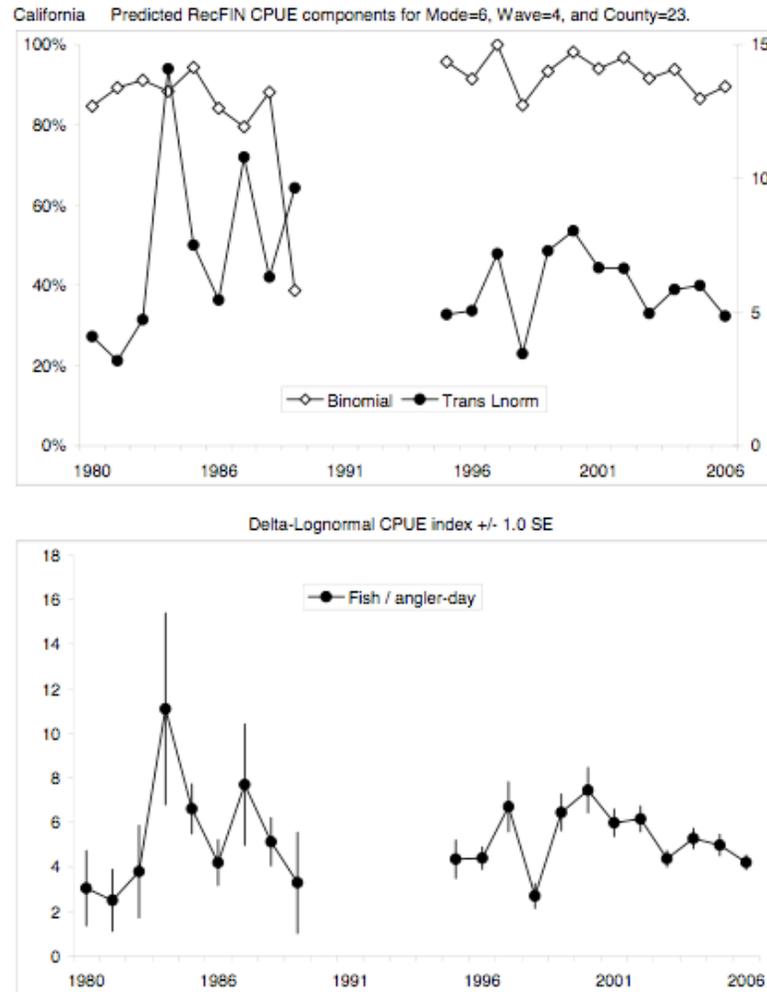
Black Rockfish Landings

Figure 2. Base landings history for black rockfish off Oregon and California.



Black Rockfish Catch Per Unit Effort (CPUE)

Figure 14. RecFIN CPUE abundance indices (continued).



FLEP - Cabezon

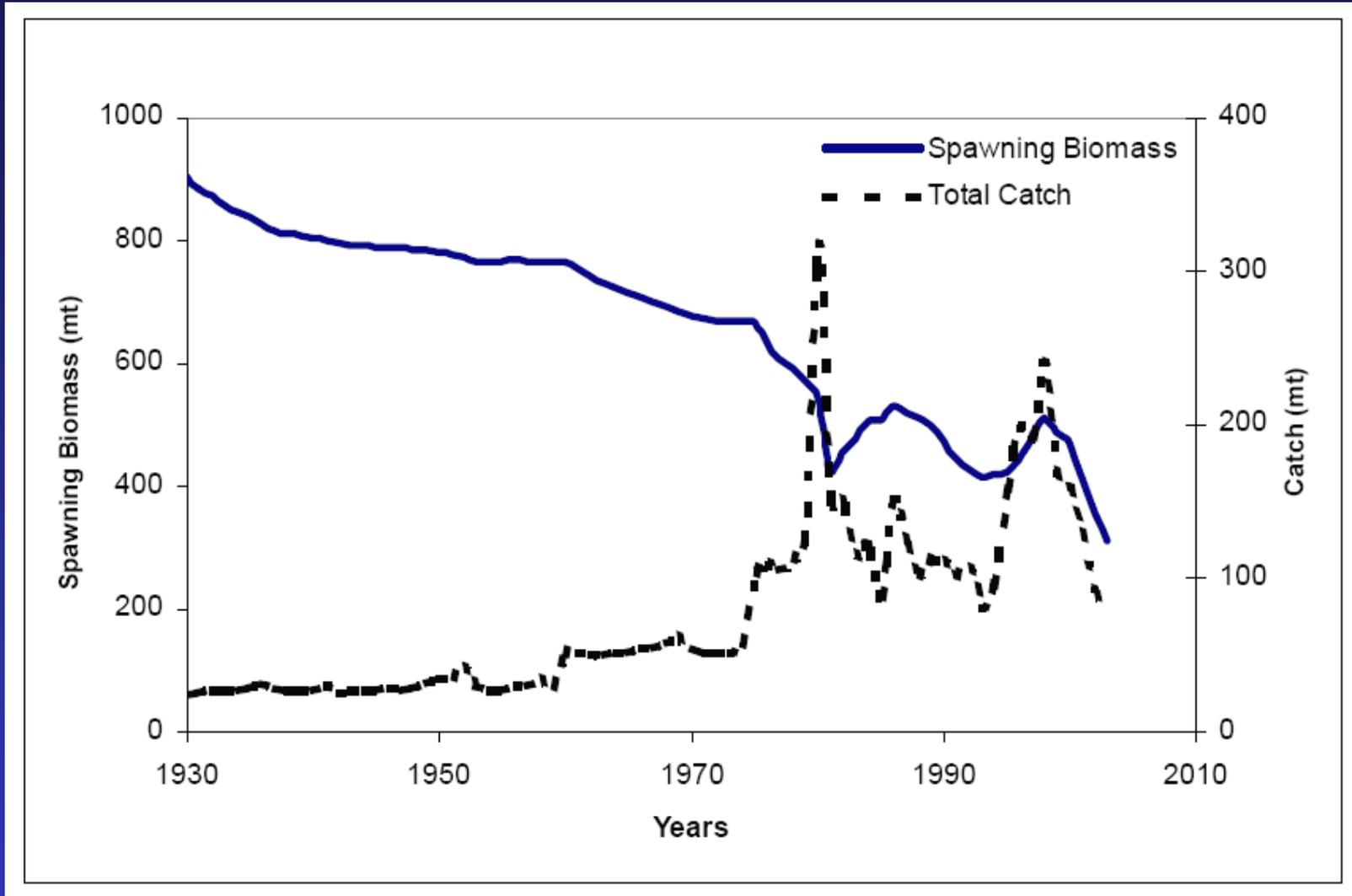
Biomass in long-term decline

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

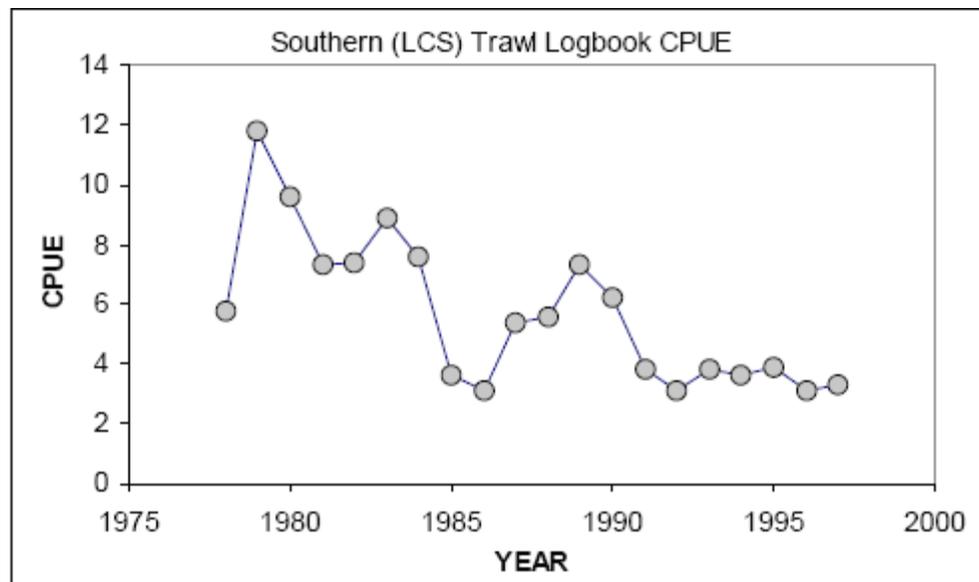
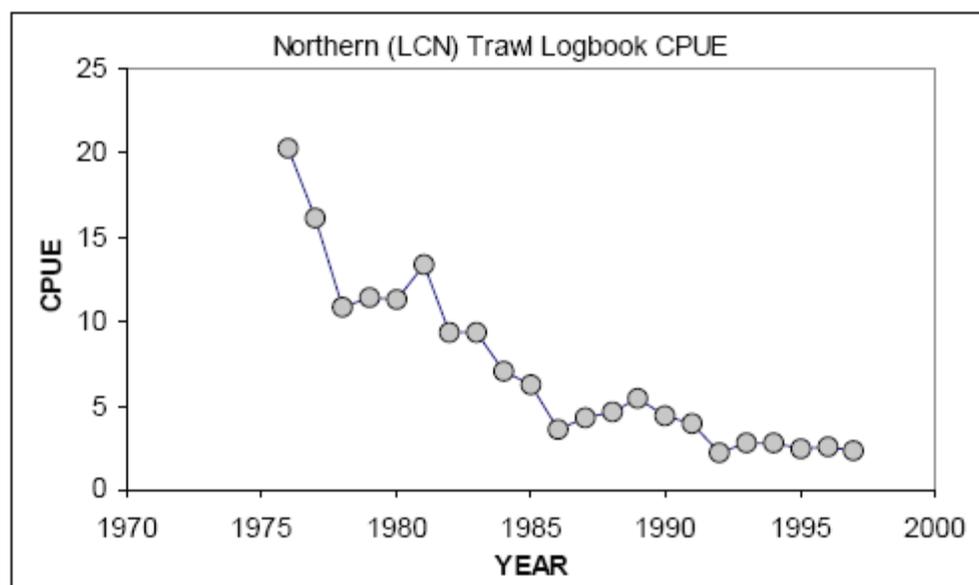
$$(0.24 B_0 < 0.25 B_0)$$

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)



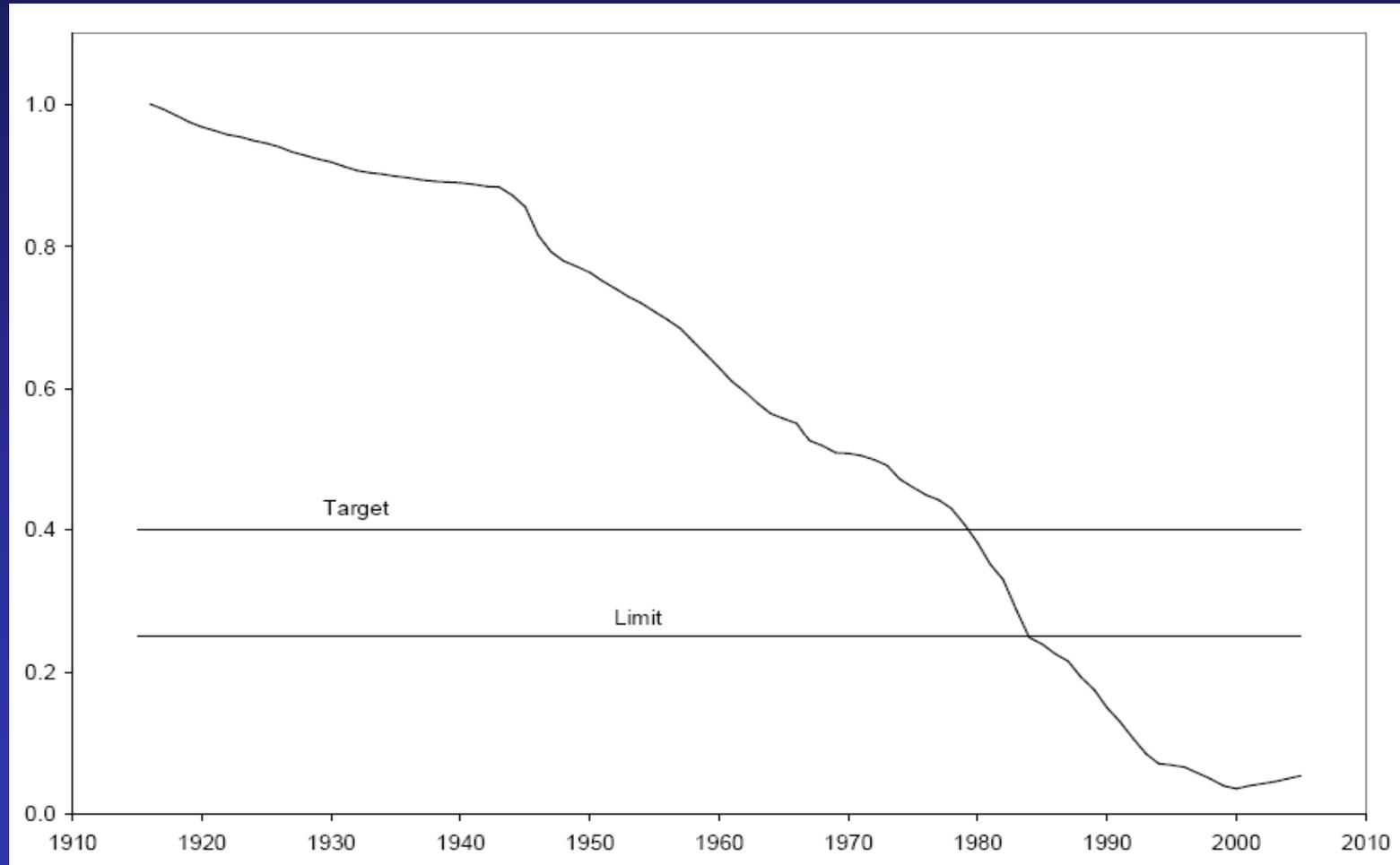
FLEP - Canary Rockfish

Remains overfished, $B \sim 0.1B_0$

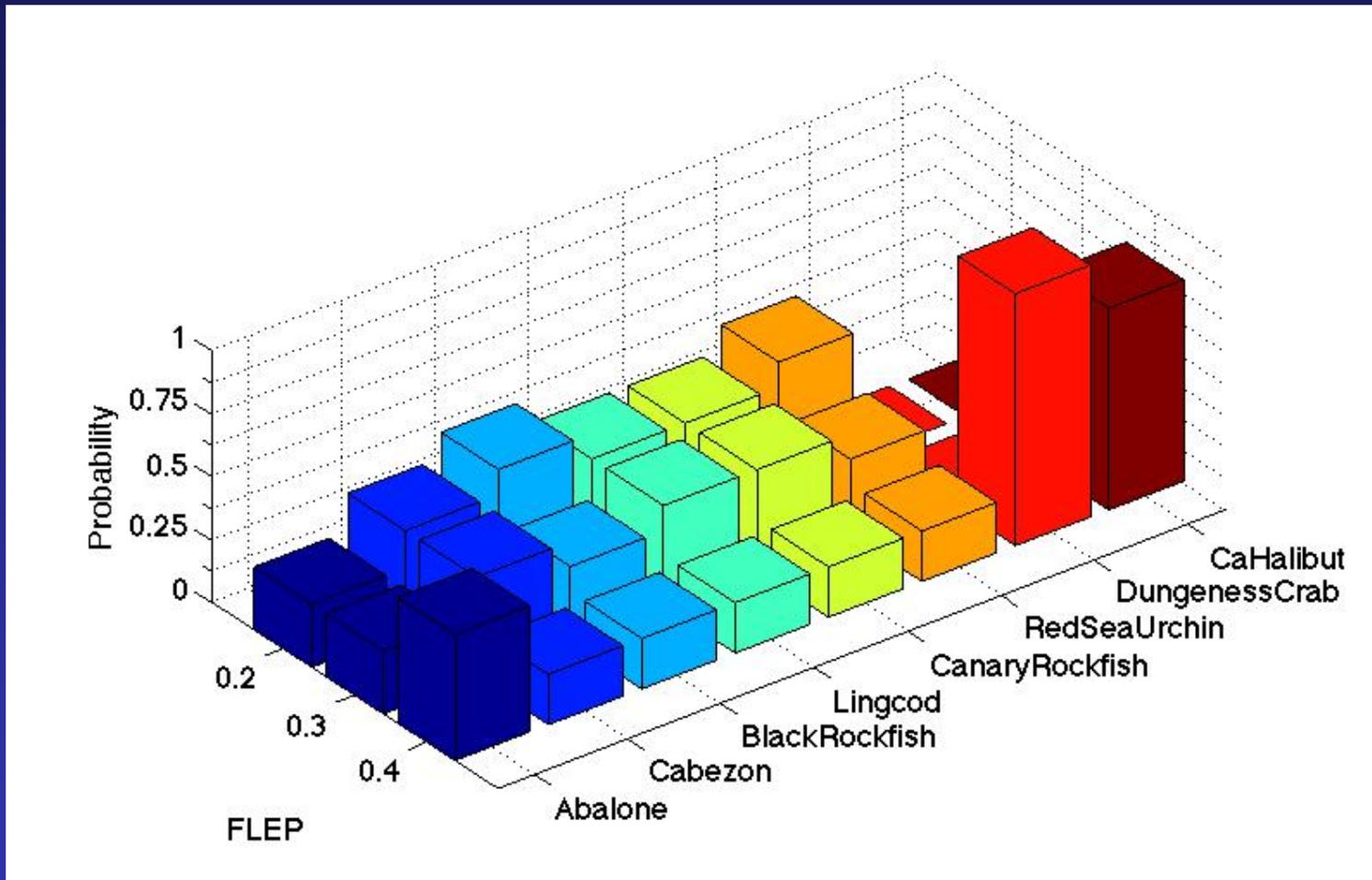
Recreational catch now 60%(up from 6%)

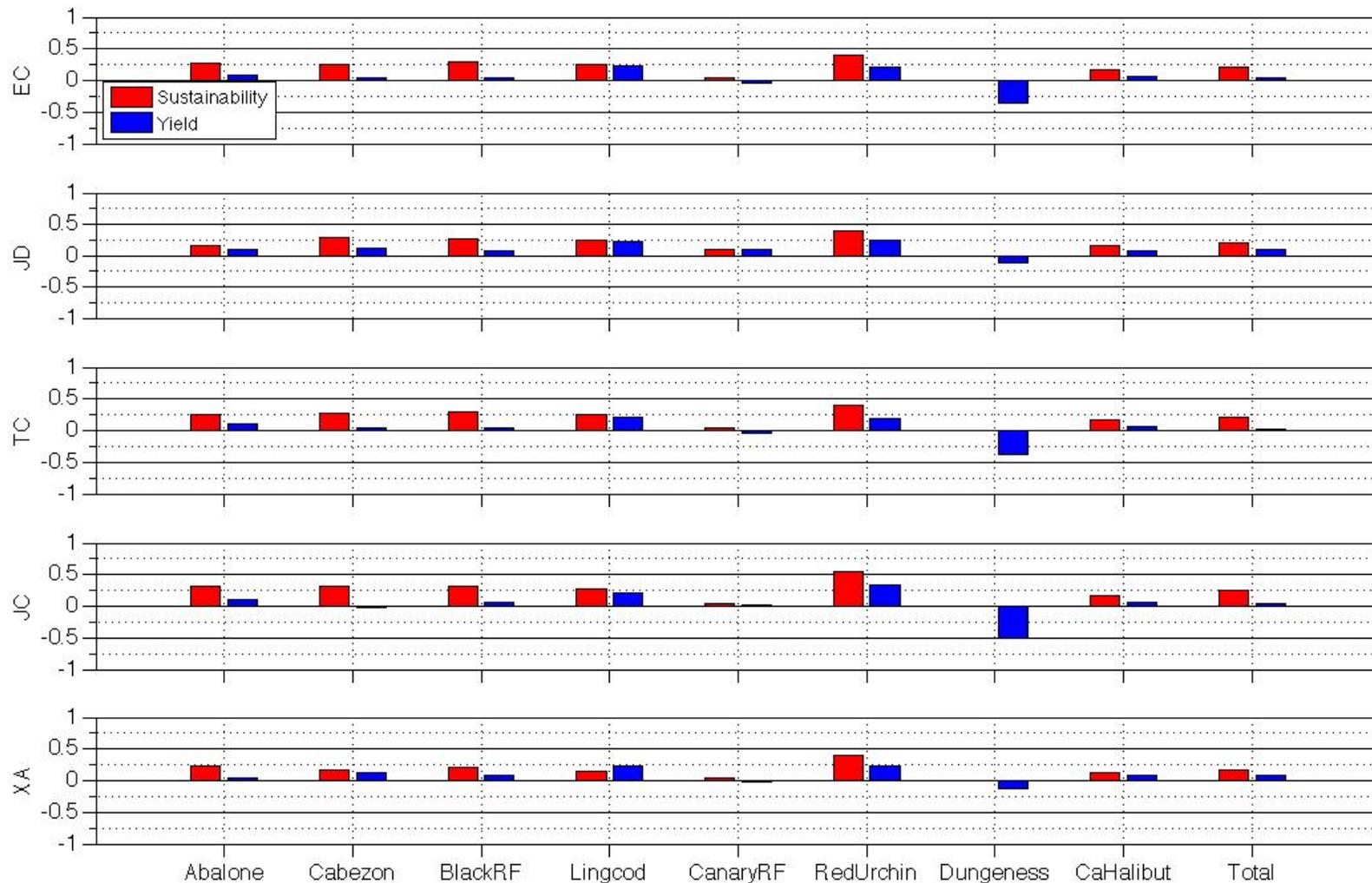
	How likely
Not overfishing (FLEP=0.4)	0.2
Overfishing (FLEP=0.3)	0.4
Heavy Overfishing (FLEP=0.2)	0.4

Canary rockfish spawning biomass/ B_0

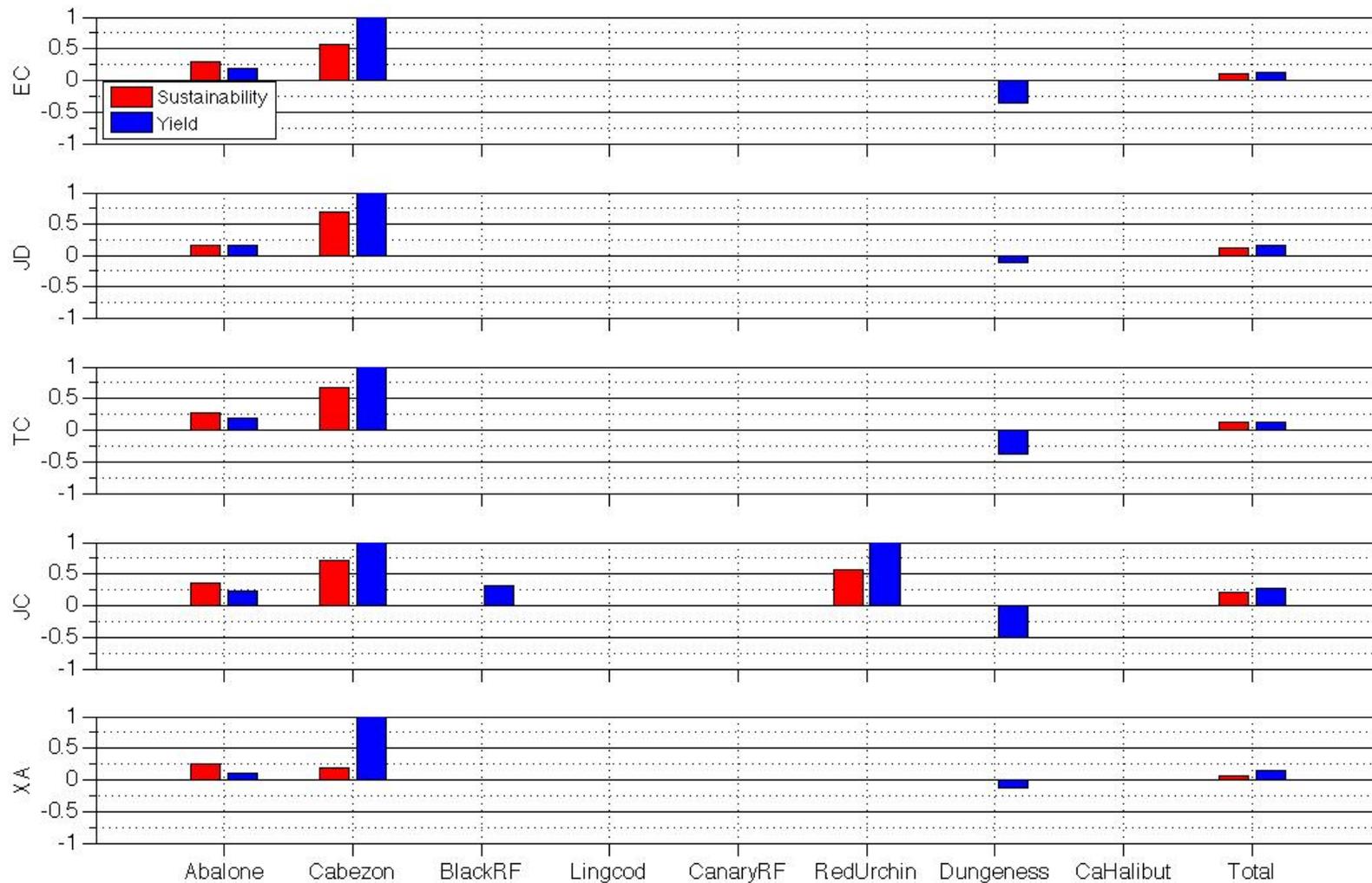


Weightings for each FLEP level informed by stock status

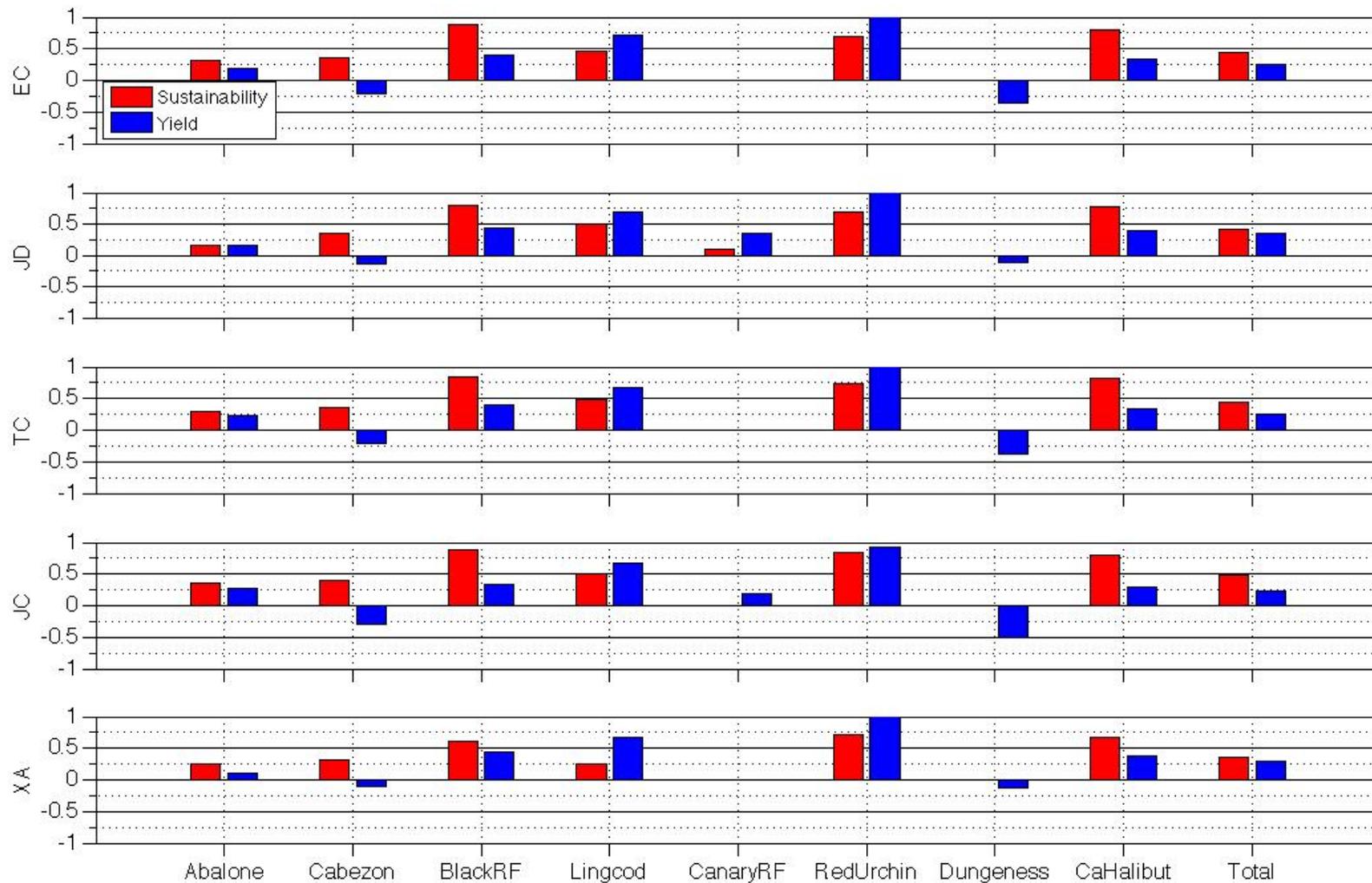




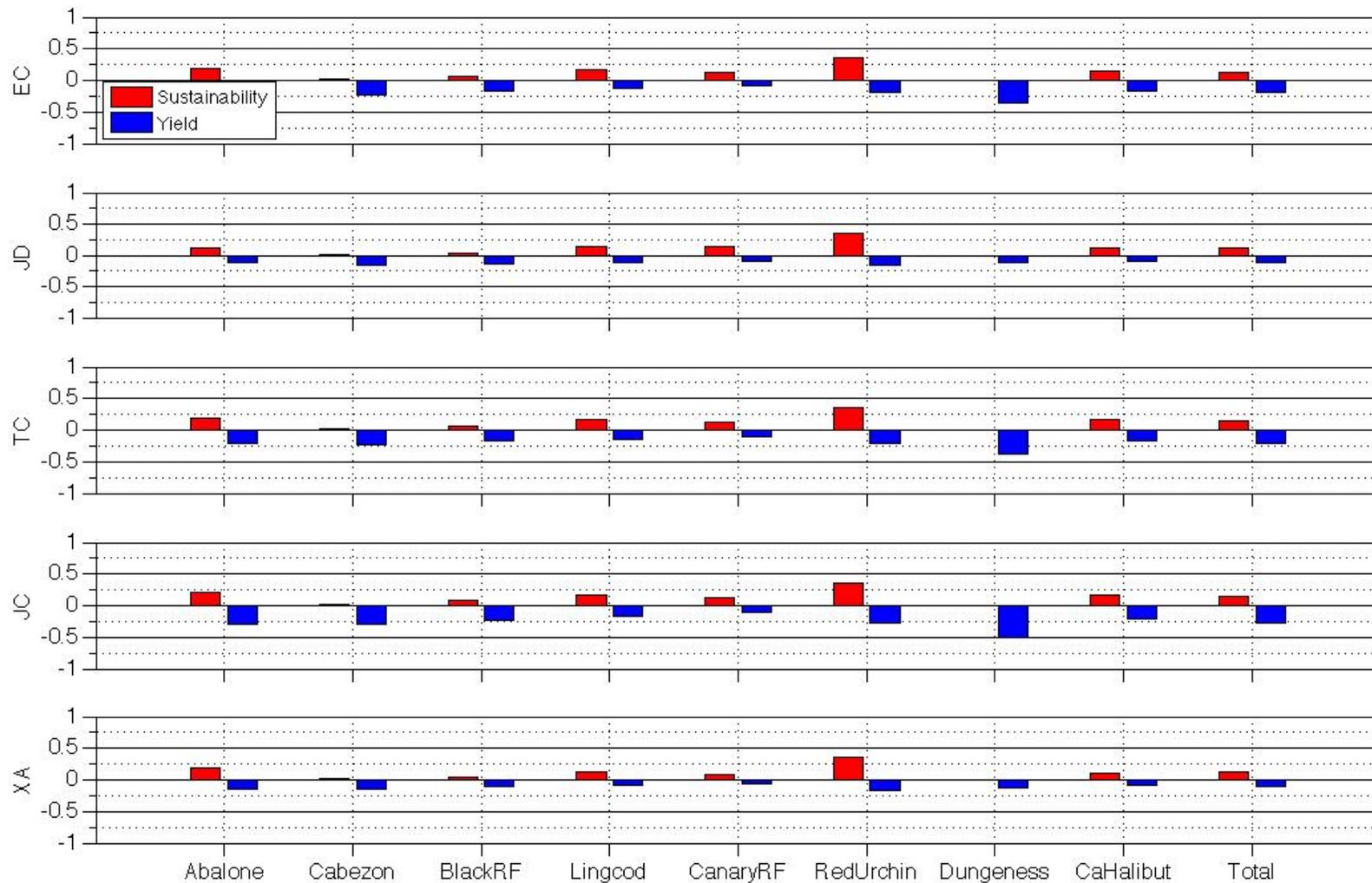
Overfishing weighting for each species from stock status
(other weightings possible)



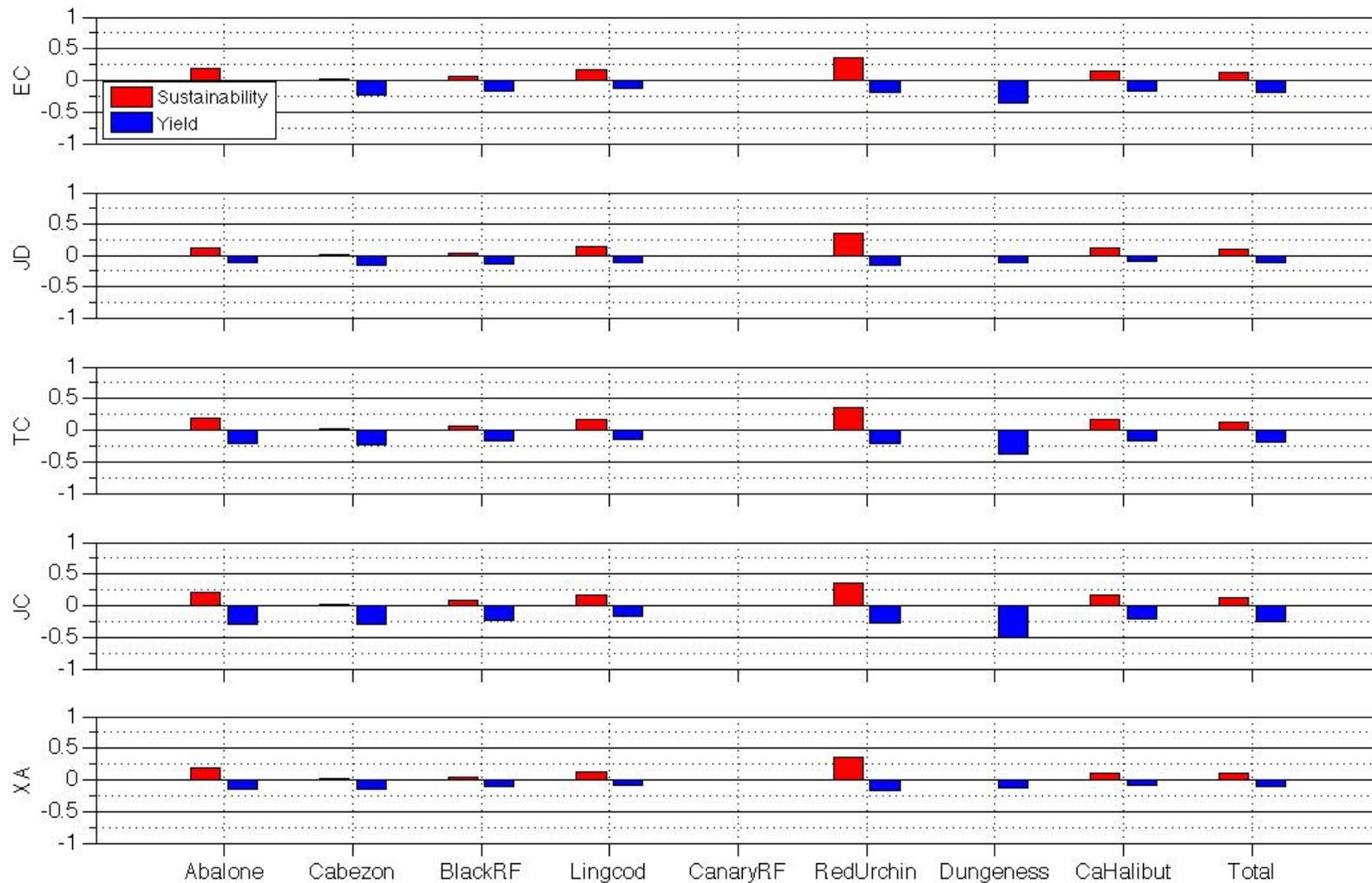
All species heavily overfished (FLEP = 0.2)



All species overfished (FLEP = 0.3)



No species overfished (FLEP = 0.4)



Weightings follow NFMS/DFG overfishing status

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