West Hawaii Aquarium Project

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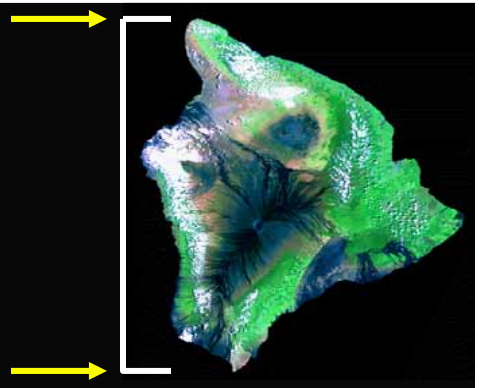
Evaluate the effectiveness of a marine reserve network in Hawai'i

Evaluate impact of reserve network on aquarium fishery

WHAP was developed to meet the mandates of Act 306 (1998)



Created the West Hawai`i Regional Fisheries Management Area.

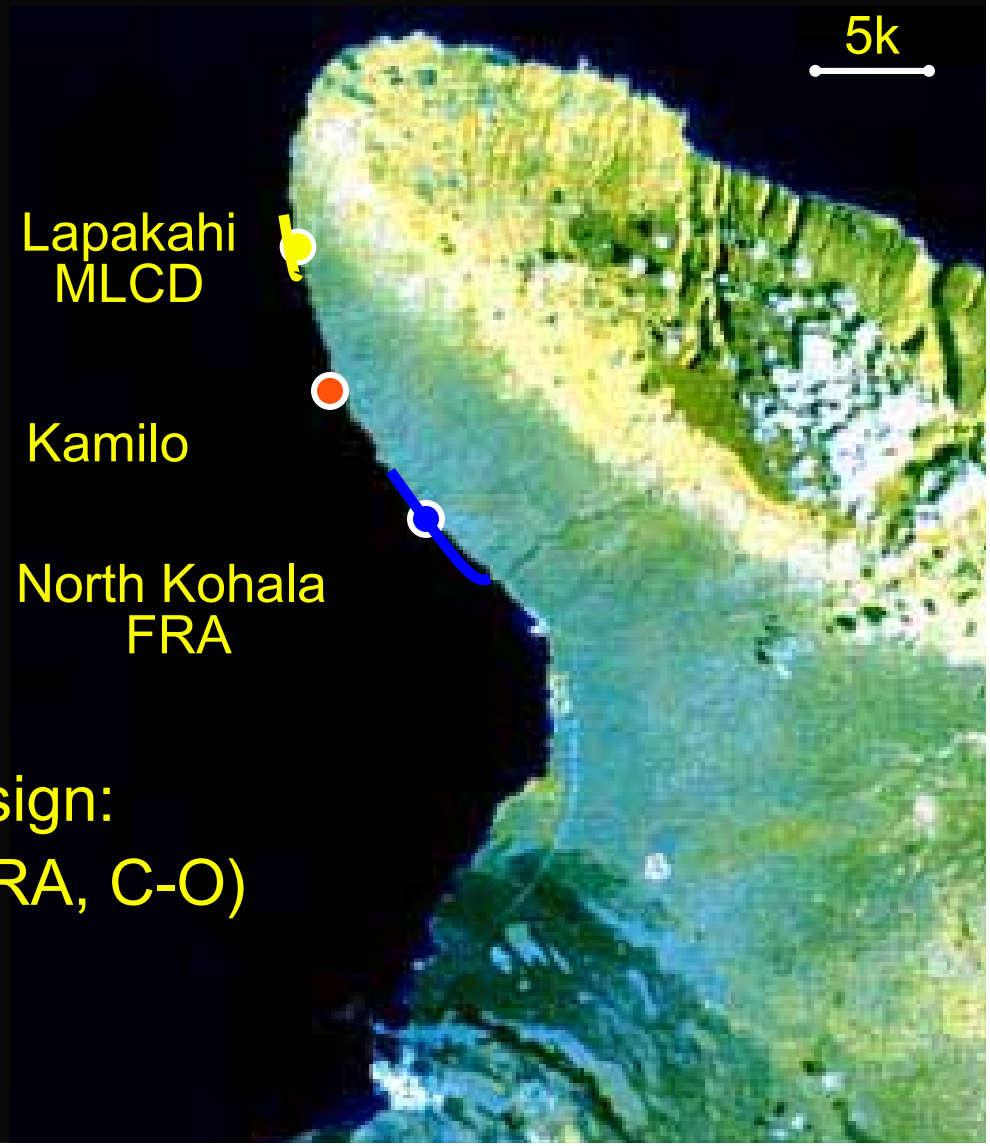
Designated ≥ 30% of coastal waters be established as Fish Replenishment Areas (FRAs) where aquarium fish collecting is prohibited

The FRAs shall be evaluated for effectiveness after 5 years in cooperation with the University of Hawai`i.

WHAP Monitoring Program

Five complete observational design blocks

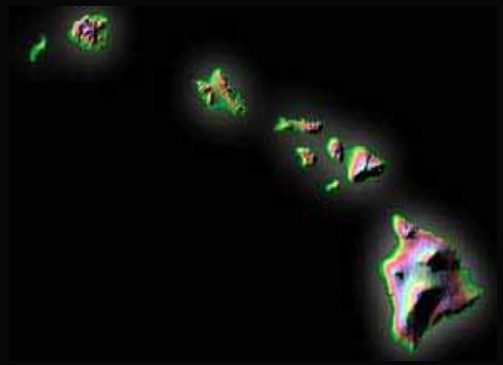
- Control — Lapakahi MLCD
- Open — Kamilo
- FRA — North Kohala FRA



Repeated measure BACI design:

- Among treatments (C-FRA, C-O)
- Before vs. After
- Among locations

Focus of Talk



How to design effective MPAs?

Do MPAs recover stocks?

If so, what factors are important?

- MPA area
- Reef cover
- Critical habitat features
- Population characteristics

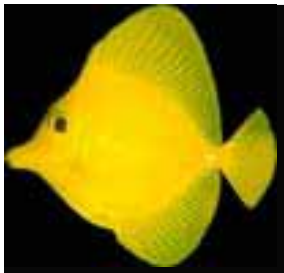
WHAP results to date

5th year of study (one baseline; 4 post-closure)

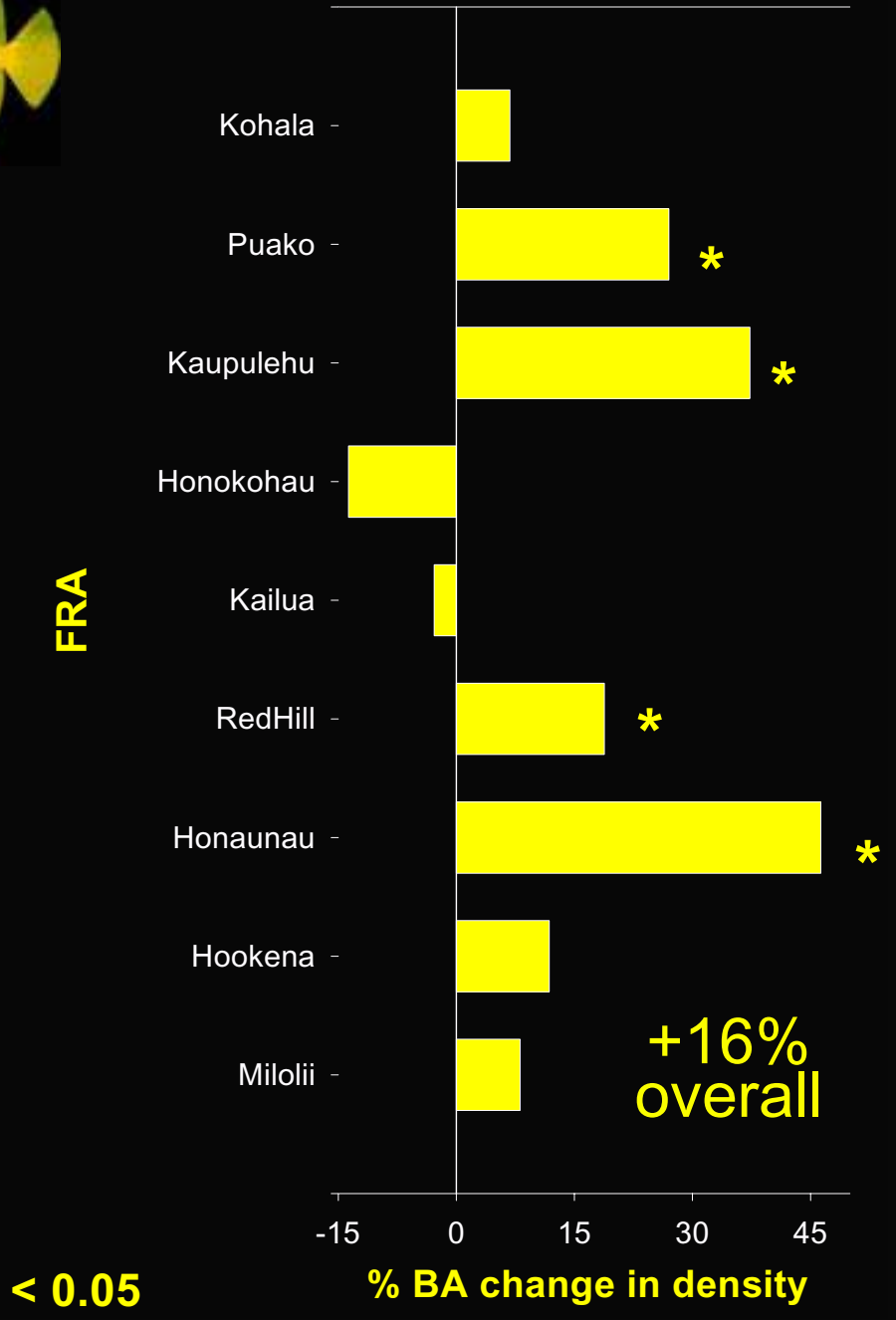
- Completed 28 surveys of 23 sites
- Analyze data using BACI design

Significant increases in aquarium fishes

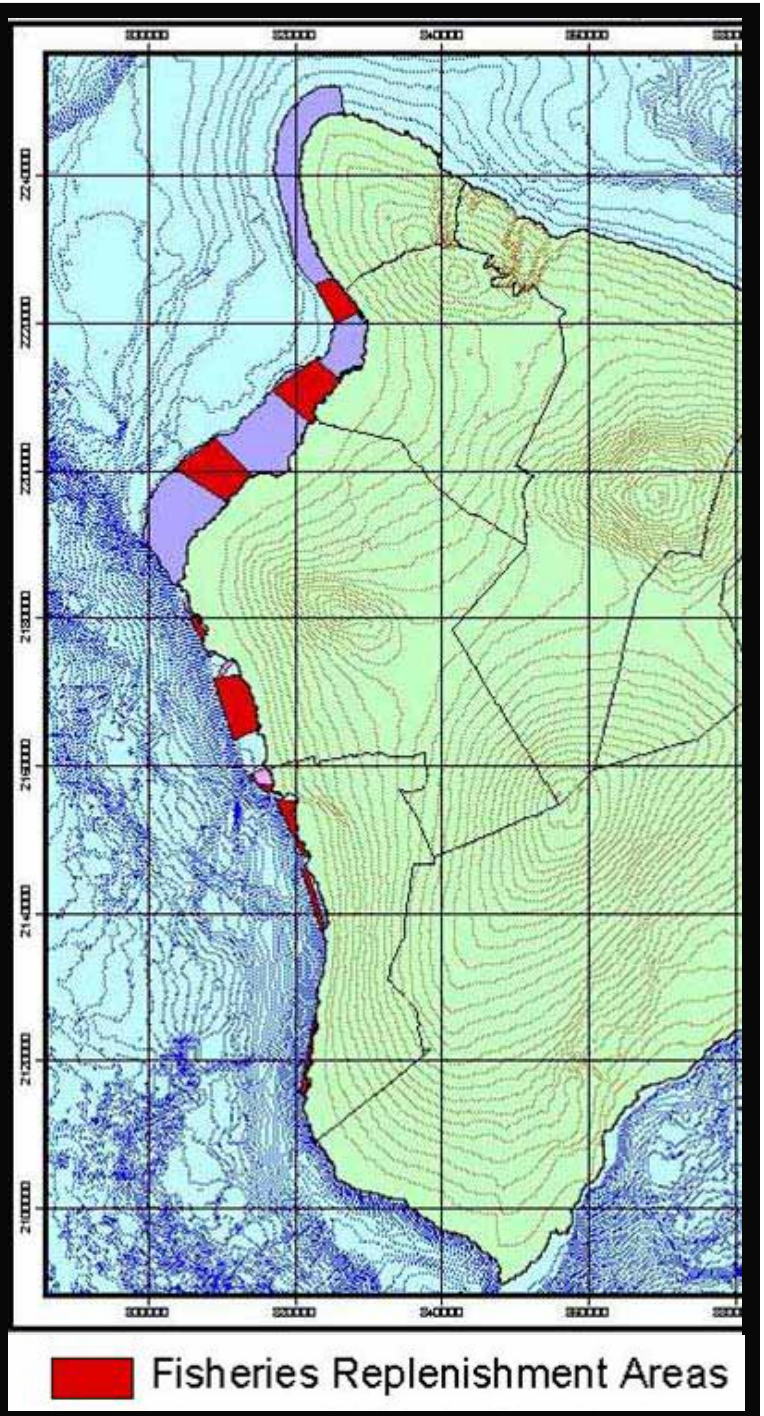
- 16% increase in yellow tangs
- 4 of 9 FRAs show significant increases
- Effectiveness varies among FRAs



Reserve Effectiveness



* P < 0.05



Canonical* Correlation Analysis

FRA characteristics:

1. Rugosity
2. Depth
3. % cover finger coral (*Porites compressa*)
4. % cover lobe coral (*P. lobata*)
5. % cover basalt boulders
6. % cover coral rubble
7. Total MPA area
8. MPA reef width
9. MPA reef area

A Canonical* Correlation Analysis extends a correlation analysis to two sets of data (i.e., FRA traits and Yellow Tang responses) in order to answer the question: Are Yellow Tang responses after FRA closure related to any specific characteristics of the FRAs?

Canonical Correlation Analysis

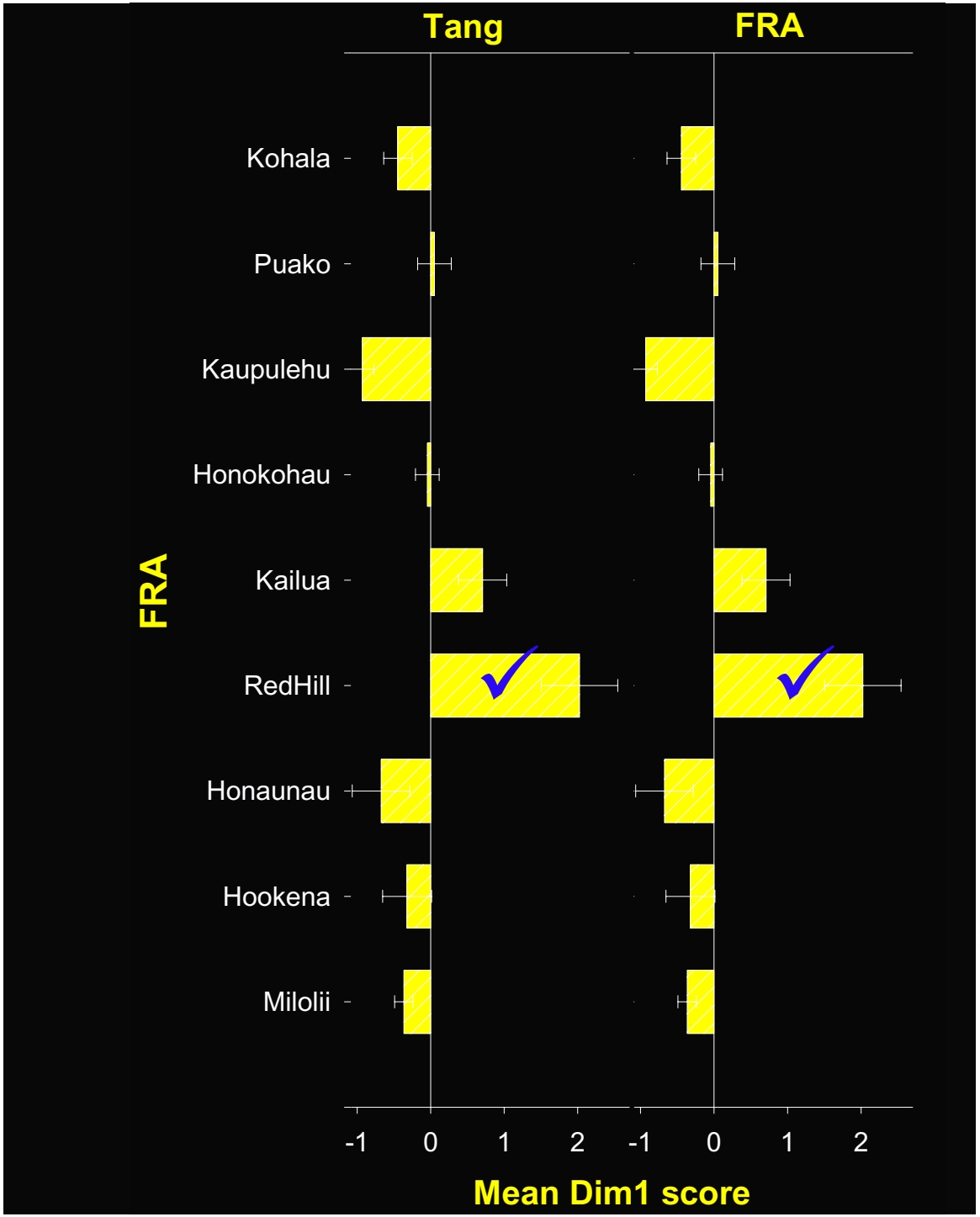
Yellow tang characteristics:

1. Total number of post-closure adults
2. Total number of post-closure juveniles
3. Total number of post-closure recruits
4. Before-After change in density

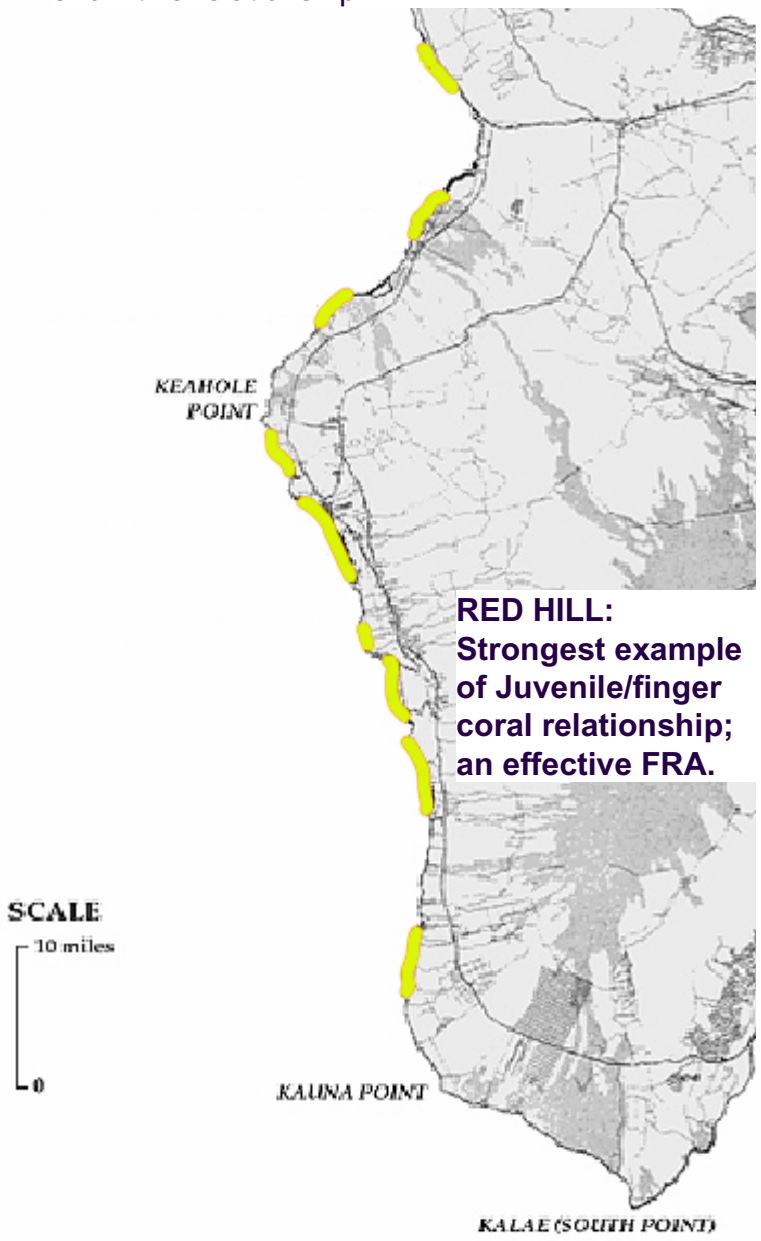
Canonical Correlation Analysis

	Juvenile Tang/ Finger Coral
Canonical R	**0.89**
P(Wilks' λ)	**<0.01**
Rugosity	-0.01
Depth	-0.10
Finger coral	**0.61**
Lobe coral	-0.43
Boulders	-0.31
Rubble	0.02
Total area	-0.12
Reef width	0.09
Reef area	0.08
Adults	-0.39
Juveniles	**0.66**
Recruits	0.05
Before-After	-0.04

The underlined values have the highest absolute score. Therefore, they are likely to be important. Since both values are high positive, they increase together.



The bar graphs show the CCA scores on the juvenile-finger coral relationship. Positive values indicate the degree to which each FRA show this relationship.

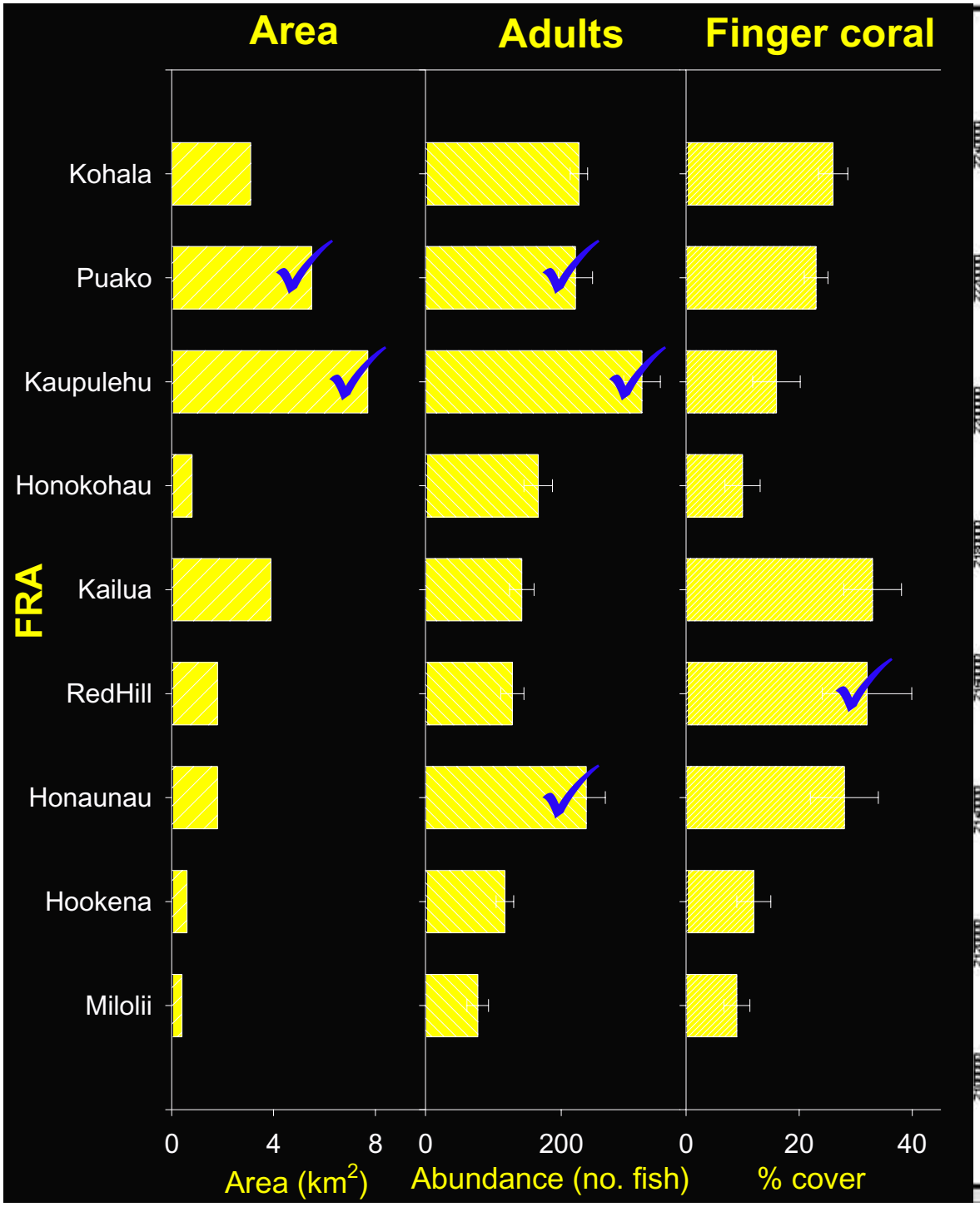


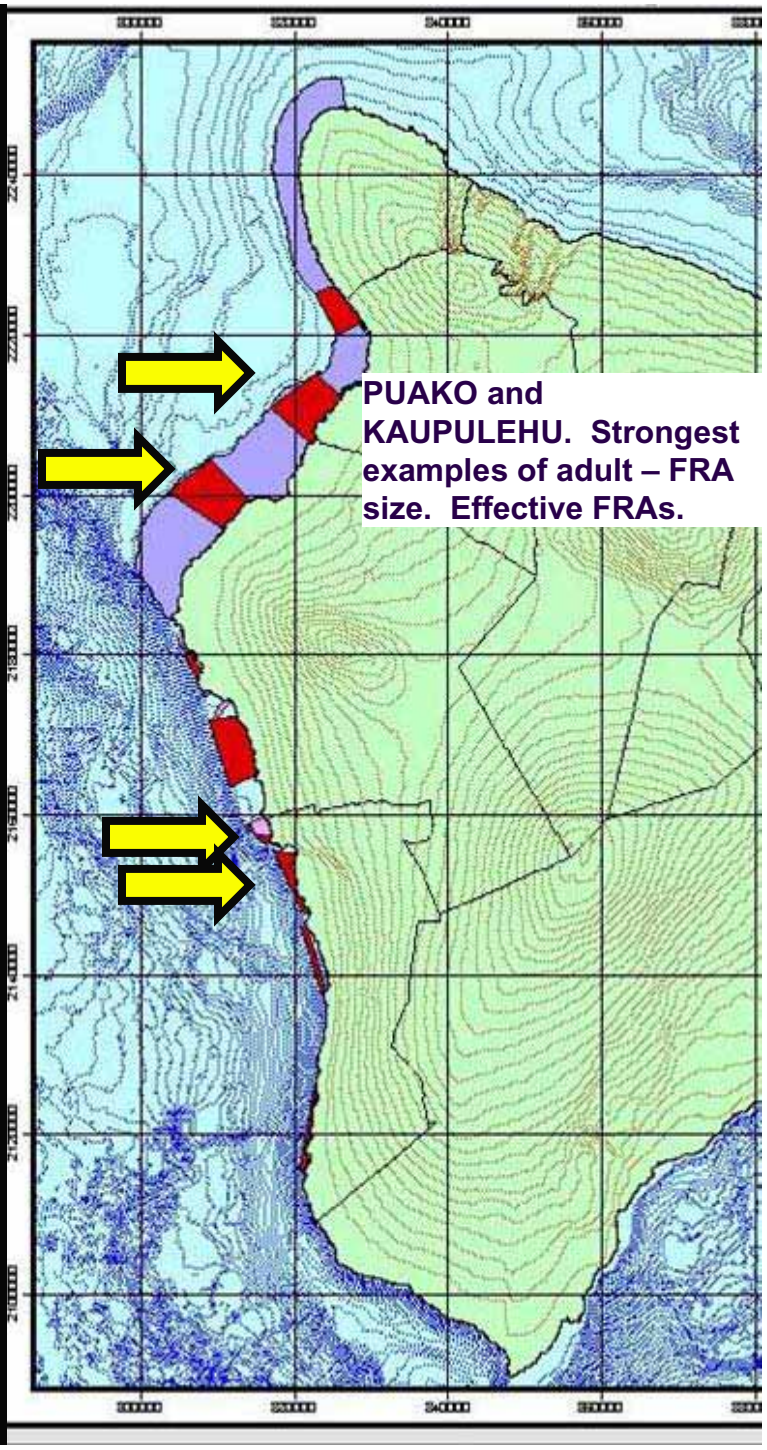
RED HILL: Strongest example of Juvenile/finger coral relationship; an effective FRA.

Canonical Correlation Analysis

	Dim2
Canonical R	**0.86**
P(Wilks' λ)	**<0.01**
Rugosity	0.09
Depth	0.06
Finger coral	**0.45**
Lobe coral	-0.11
Boulders	0.25
Rubble	-0.23
Total area	**0.41**
Reef width	0.31
Reef area	0.11
Adults	**0.85**
Juveniles	-0.22
Recruits	-0.59
Before-After	**0.58**

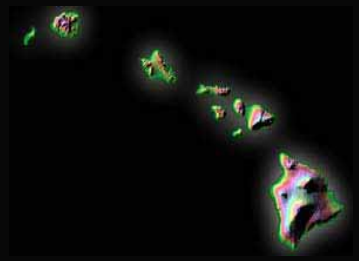
The underlined values have the highest absolute score. Therefore, they are likely to be important. Values that are positive increase together (e.g., as area increases, density of adult tangs increase).





PUAKO and KAUPULEHU. Strongest examples of adult – FRA size. Effective FRAs.

Conclusions



1. **FRA habitat should have a high cover of finger coral for juvenile yellow tangs.**

2. **FRA size should be as large as possible** (*e.g.,* Puako is about 5000 hectares).

3. **FRAs should have a high adult biomass** (*i.e.,* greater than 15 tangs per 100 square meters)

4. **Further analysis of other species may produce different results**