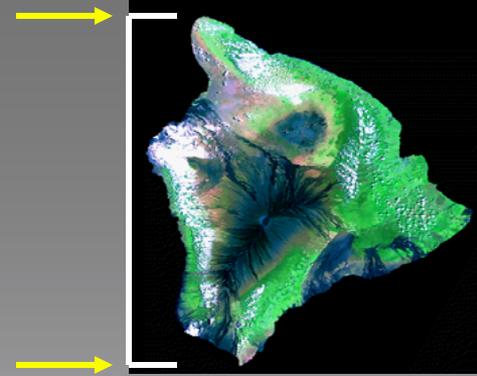


West Hawai'i Aquarium Project: Fishery Management of Marine Protected Areas



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



Which created The West Hawai`i Regional Fisheries Management Area extending from Upolu Pt. to Ka Lae.

And designated that $\geq 30\%$ 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.

Fish Replenishment Areas

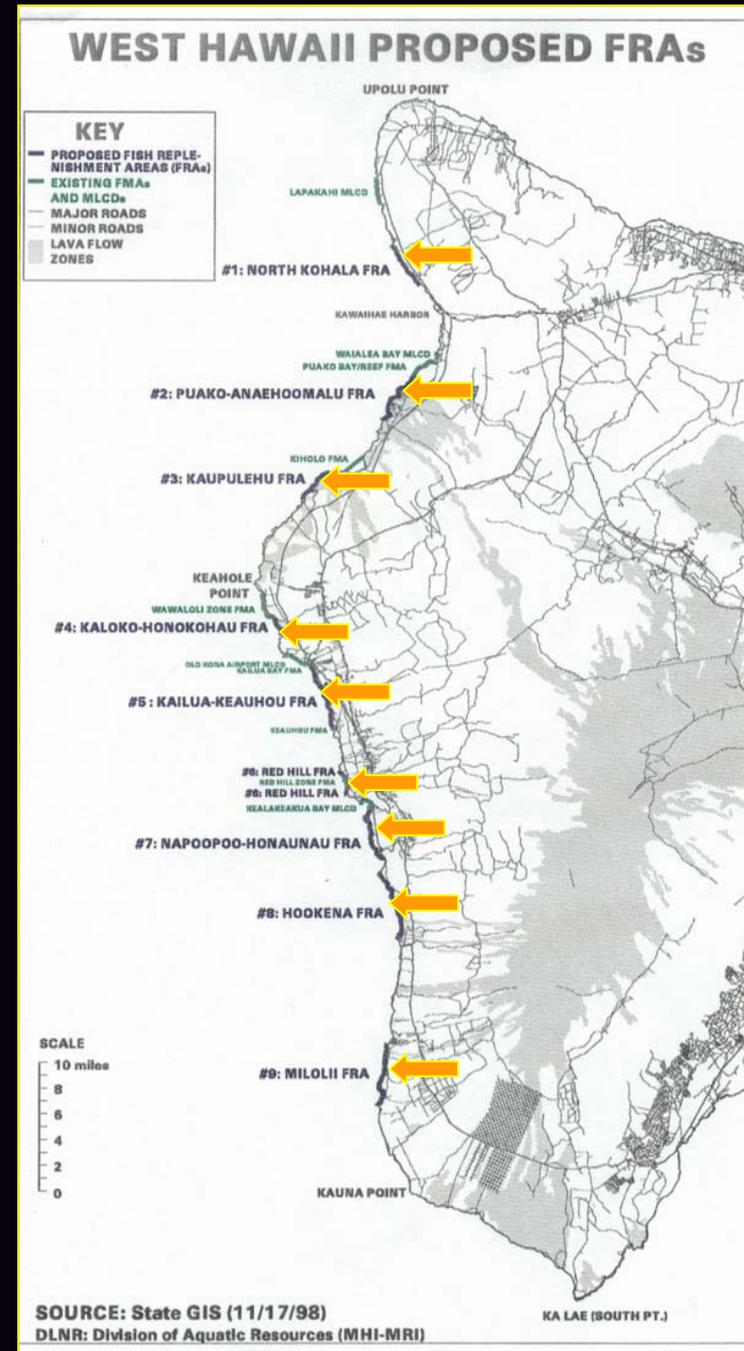
- Established by the legislature in 1998
- Closed Dec. 31, 1999:



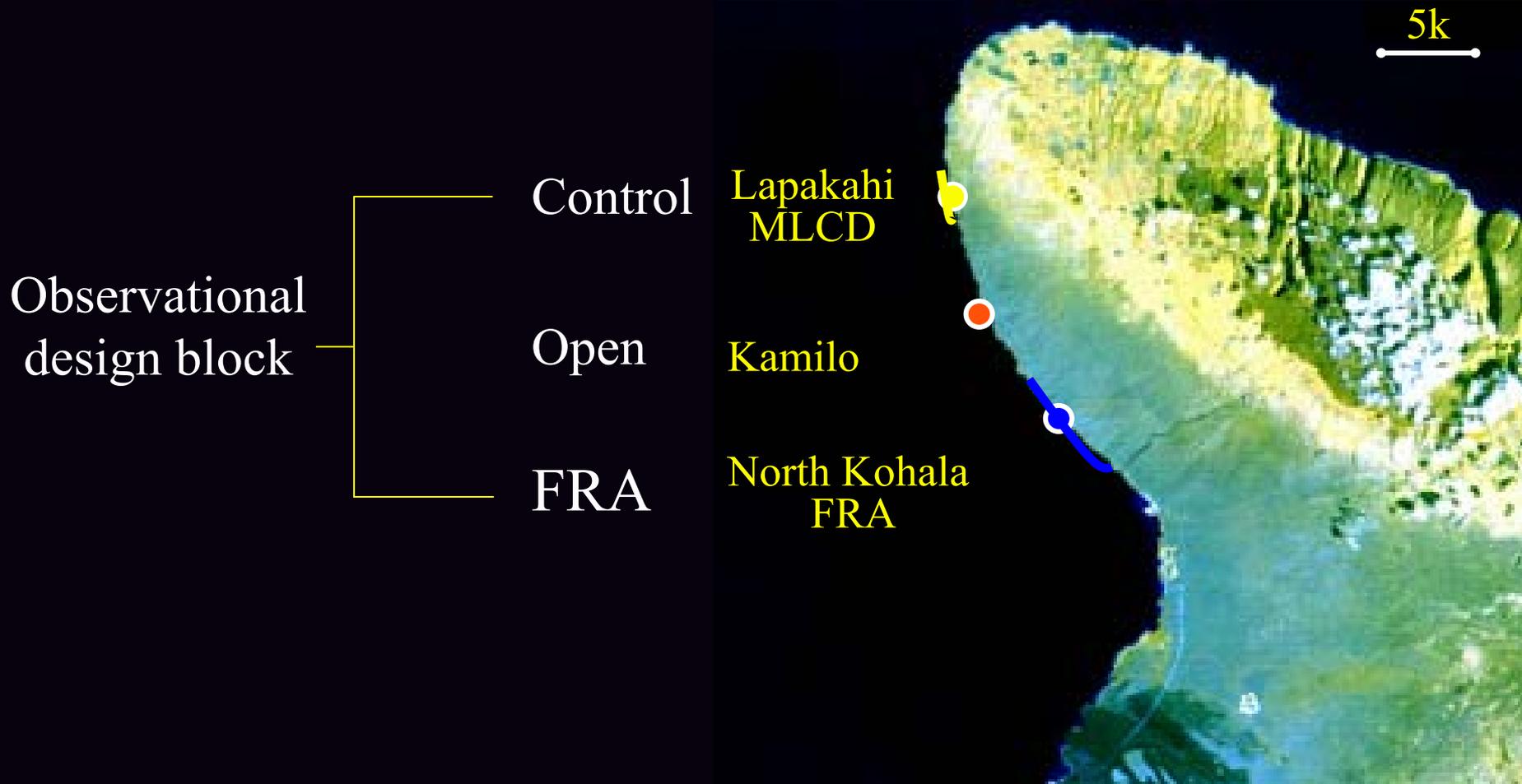
1. North Kohala (4.8 k)
2. Puako (7.0)
3. Ka'upulehu (4.3)
4. Honokahau (3.4)
5. Kailua-Kona (7.8)
6. Red Hill (1.1)
7. Napo'opo'o (6.4)
8. Ho'okena (7.2)
9. Miloli'i (7.2)



Created	49.1k	27.8%
Pre-Existing	13.1	7.4%
Total	62.2	35.2%



WHAP Monitoring Program utilizes a powerful Before/After - Control/Impact Design (BACI) which permits multiple comparisons between open and protected areas and tracks areas through time



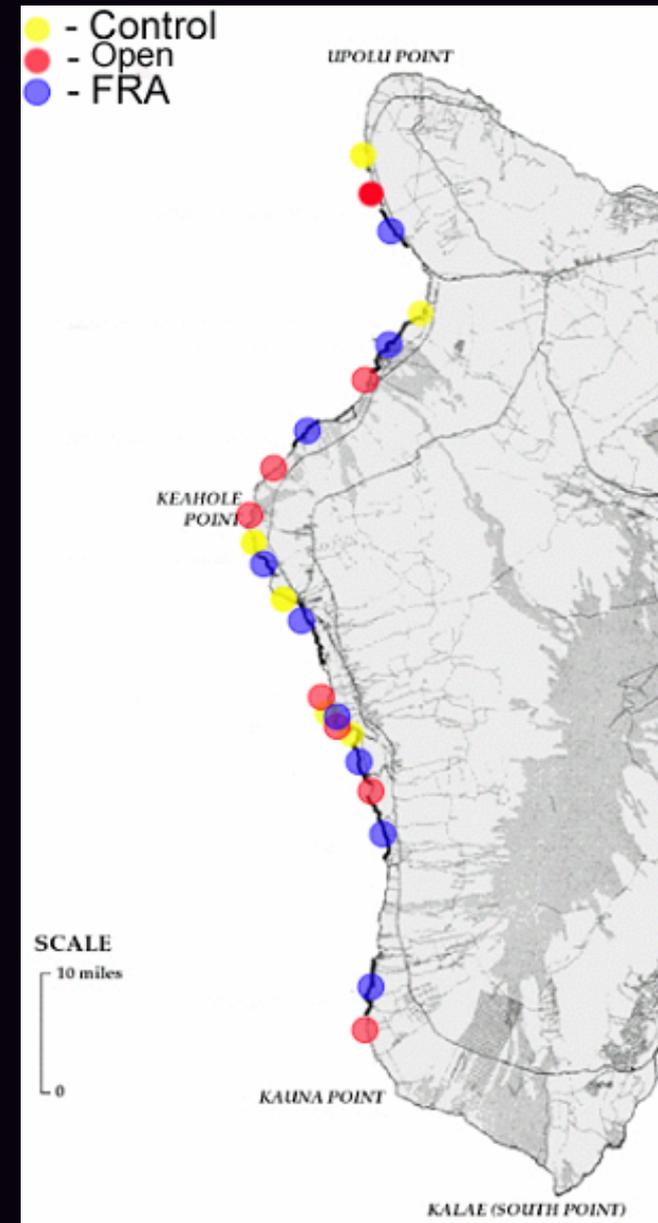
WHAP Monitoring Program

Study sites (23) - established March 1999

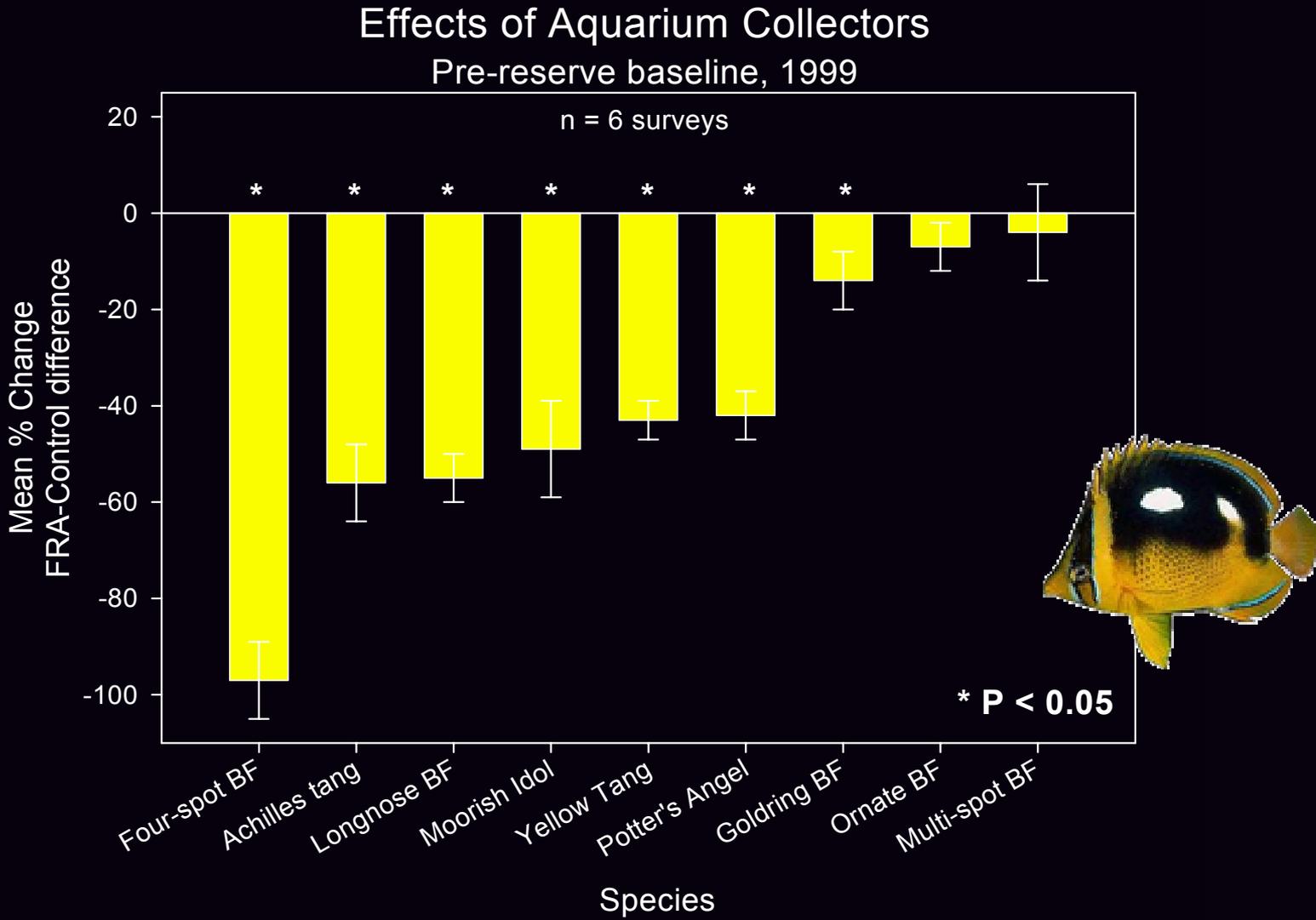
- 16 fish surveys (n= 1,472 transects)
 - **Six baseline** (pre-reserve closure)
 - **Ten post-reserve** closure
- Also survey major macro-invertebrates
- Benthic video analysis

Goal: evaluate *effectiveness* of FRAs as a management option

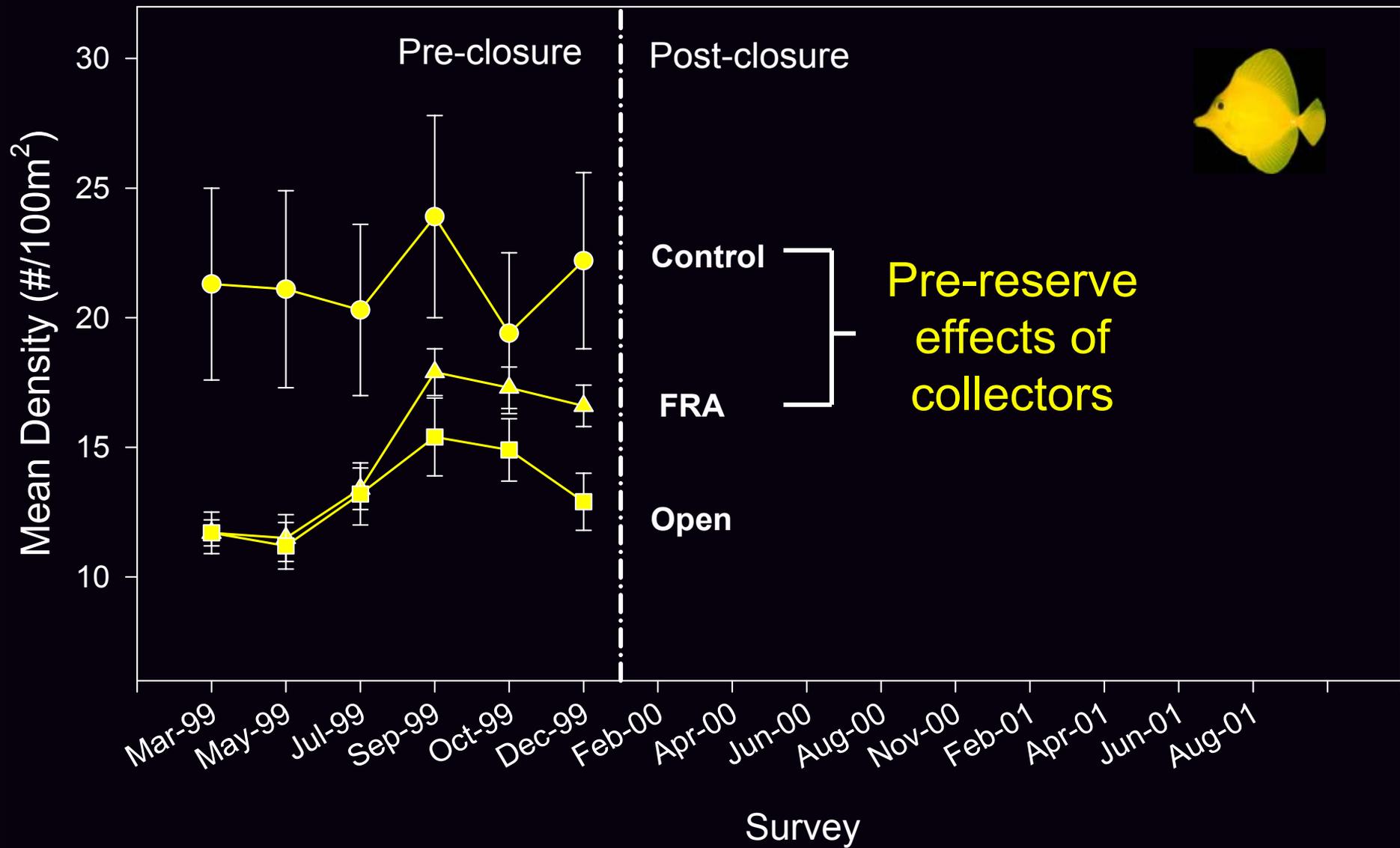
- Do reserves increase fish stocks?
- How do reserves differ?
- What are important processes?
- How does it affect the fishery?



Prior to their establishment, the FRAs were heavily collected and several collected species at these sites were significantly less abundant relative to existing protected areas. This difference provides an estimate of the impact of aquarium collecting.

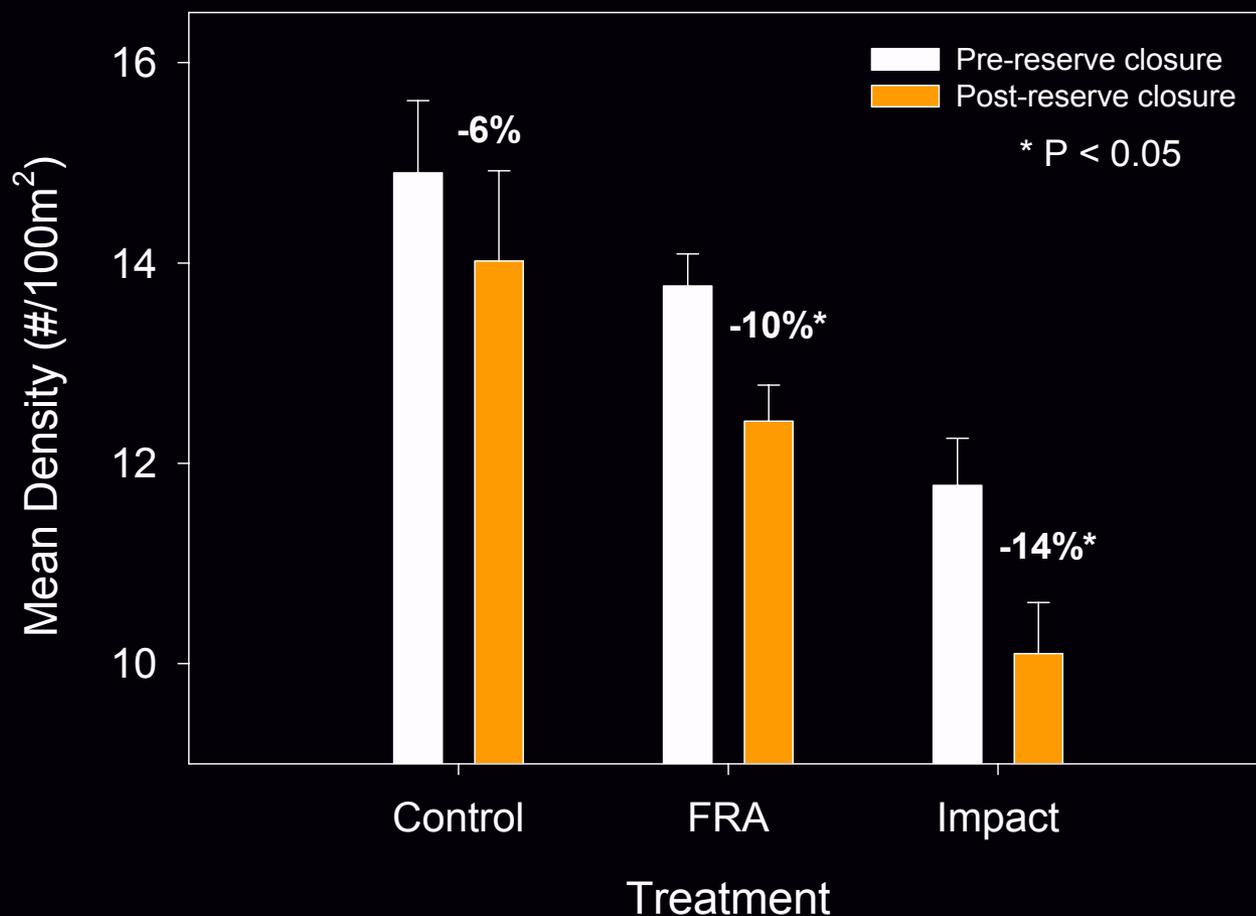


Zebrasoma flavescens



After first year of FRA establishment there was a significant decline in Aquarium fish species within both protected FRAs and open areas.

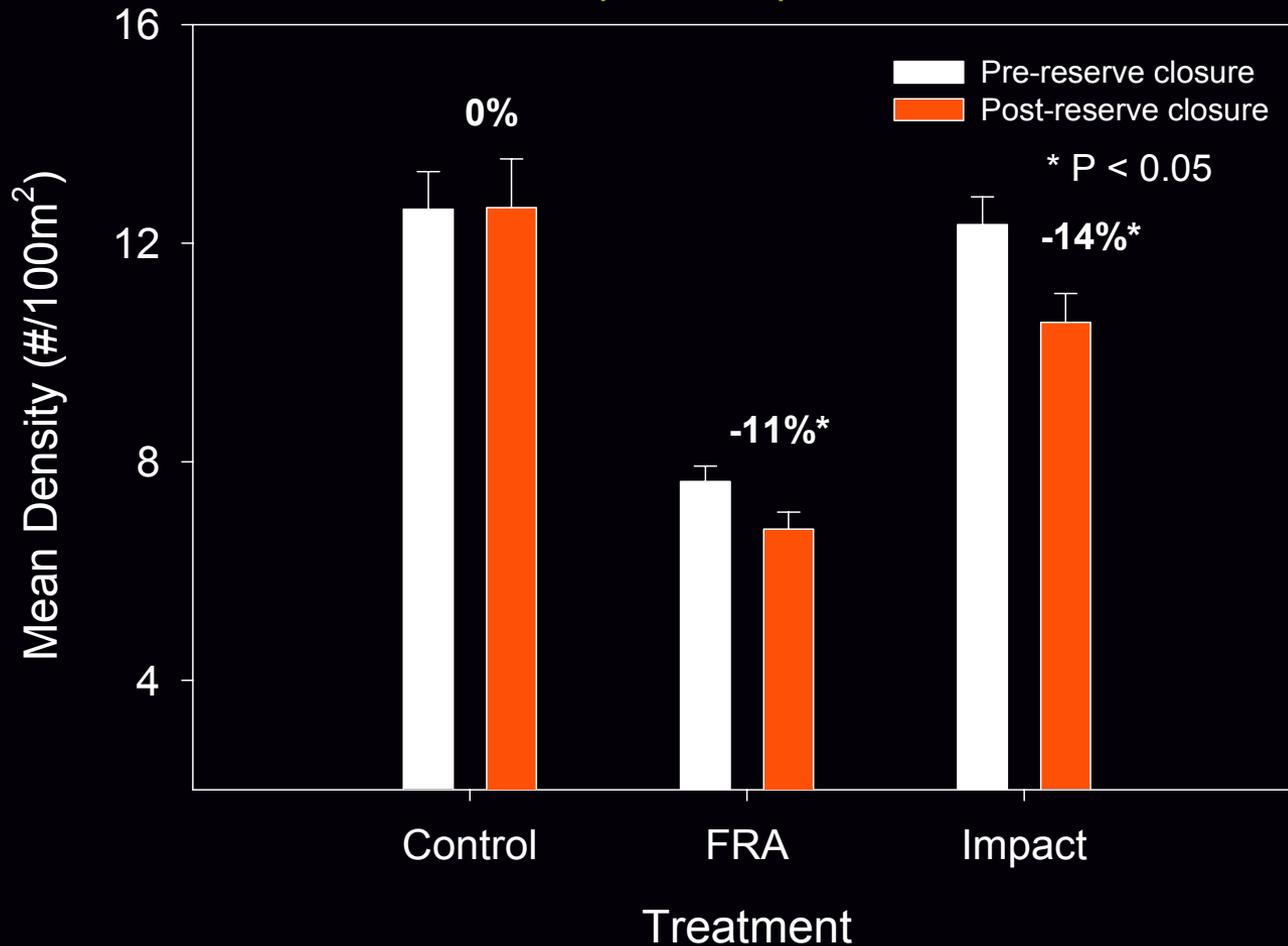
Control-FRA-Impact Comparisons Top 10 Aquarium Species Pooled



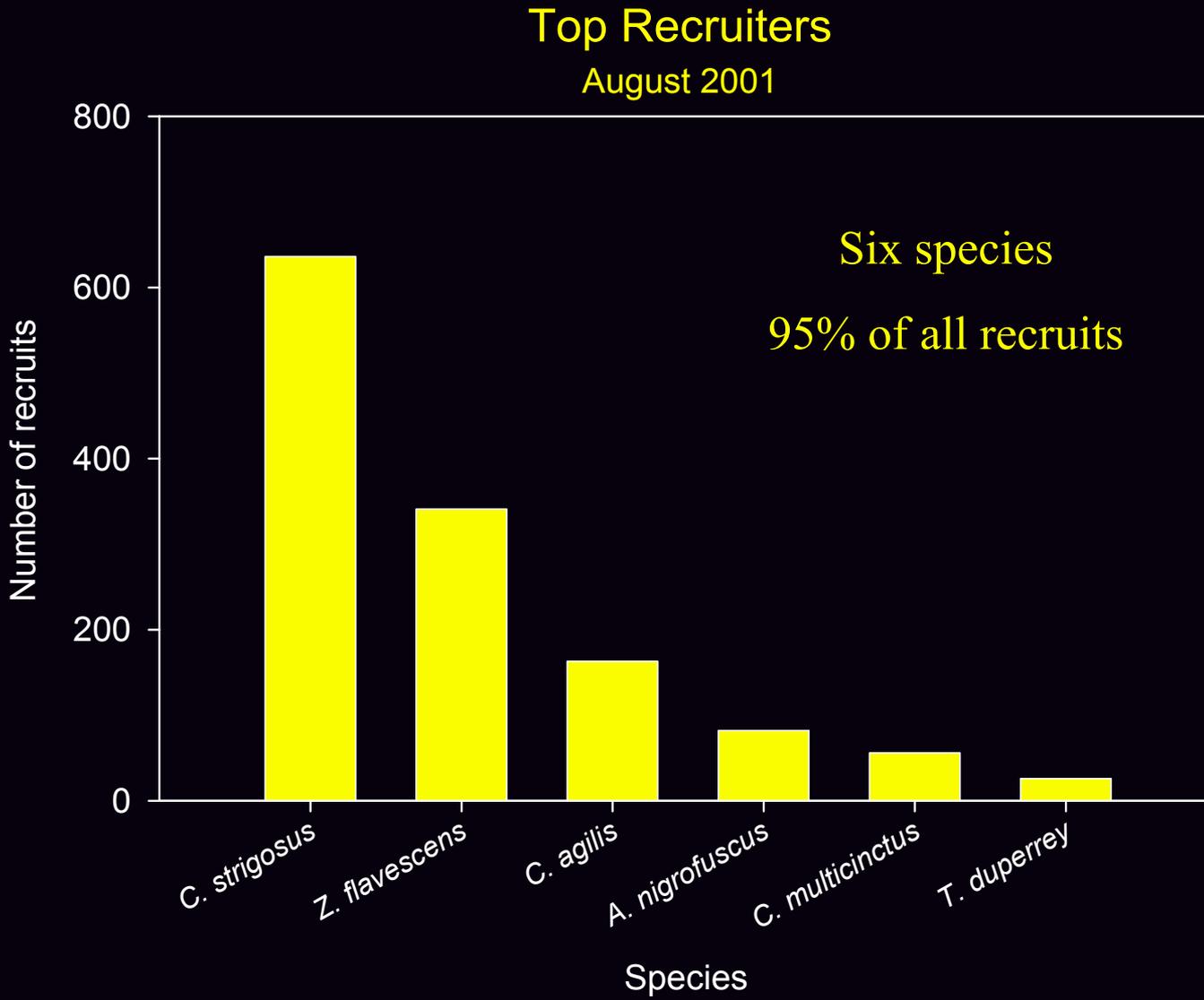
Similar pattern in Non-Aquarium species

Control-FRA-Impact Comparisons

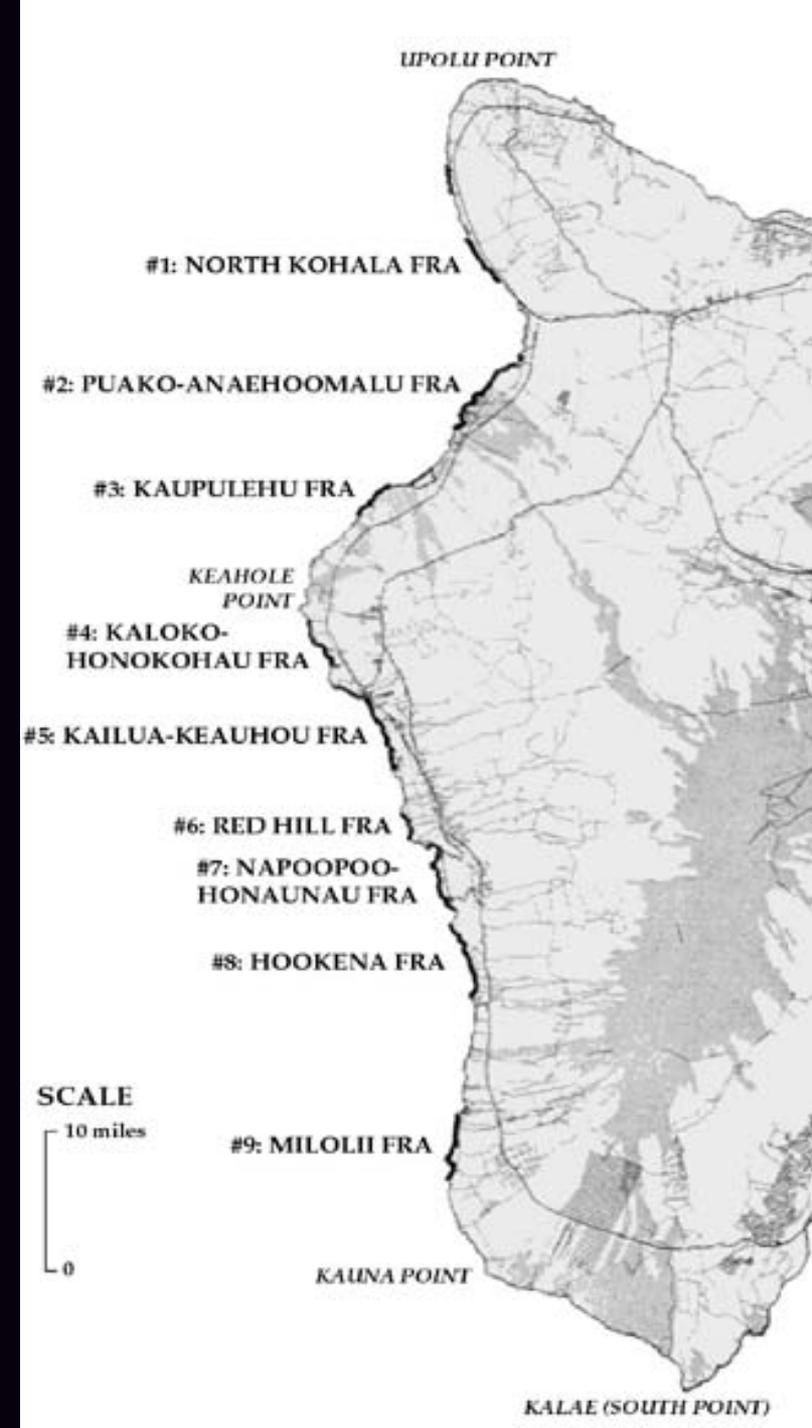
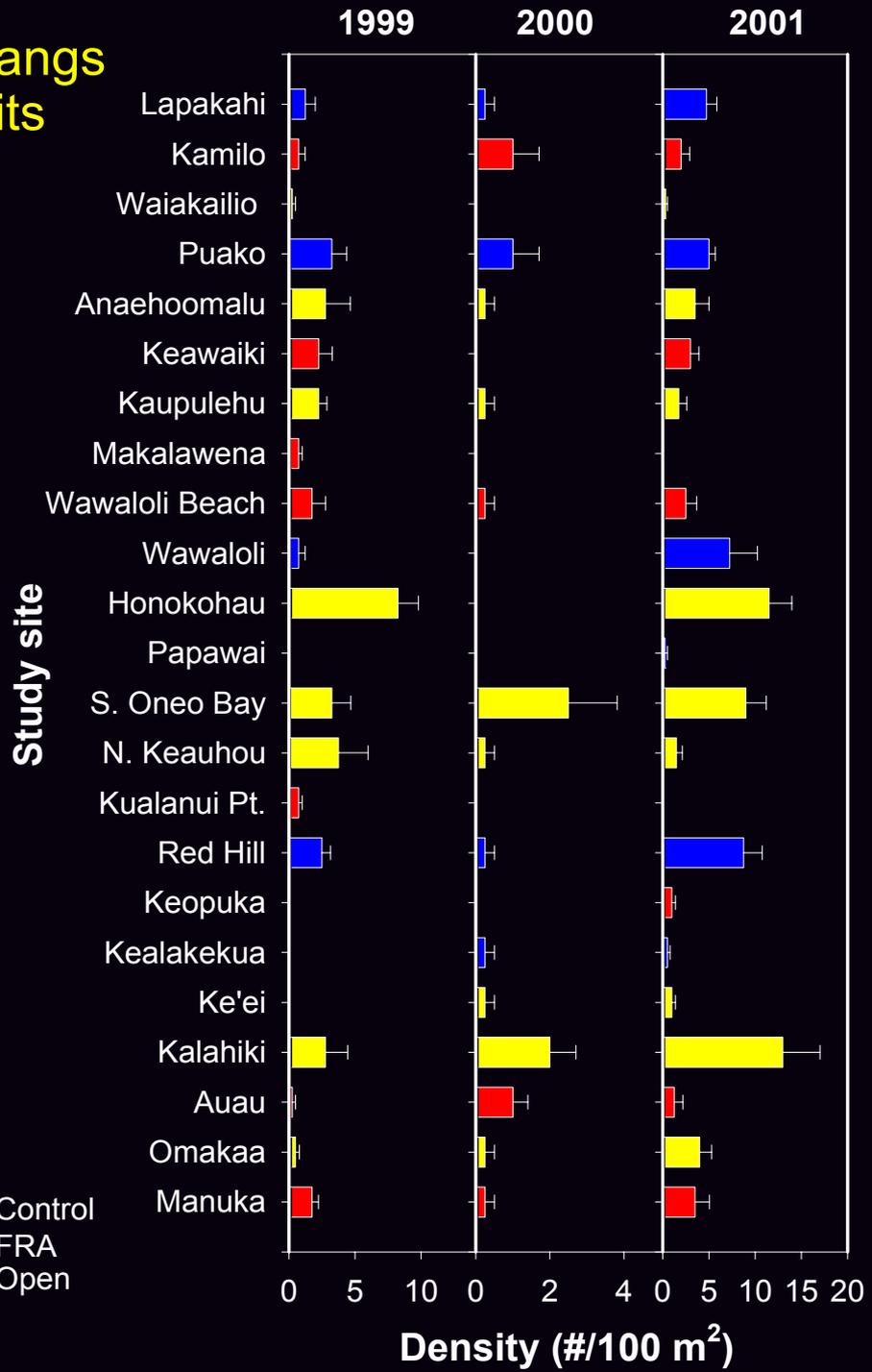
Non-Aquarium Species Pooled



A small number of species account for the majority of recruits.
Such recruitment provides the basis for increased populations within FRAs.

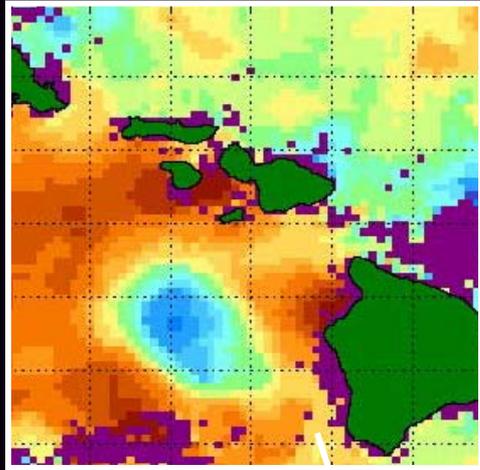


Yellow Tangs Recruits

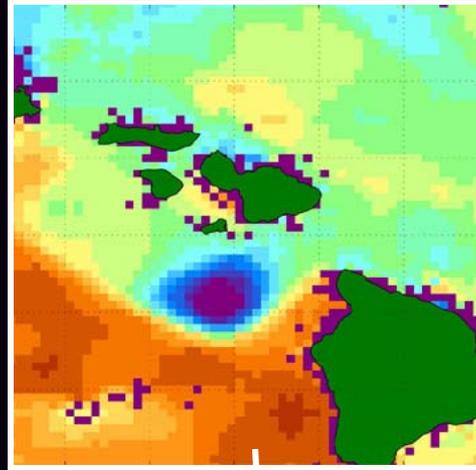


Variation in eddy system may influence recruitment

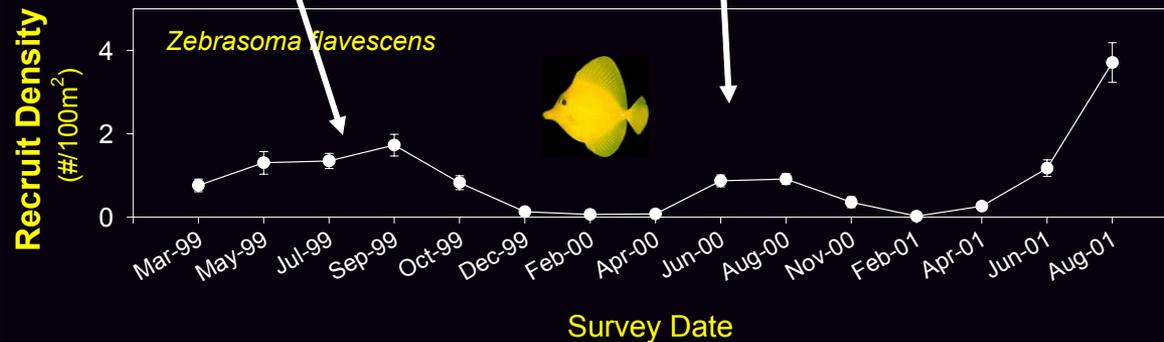
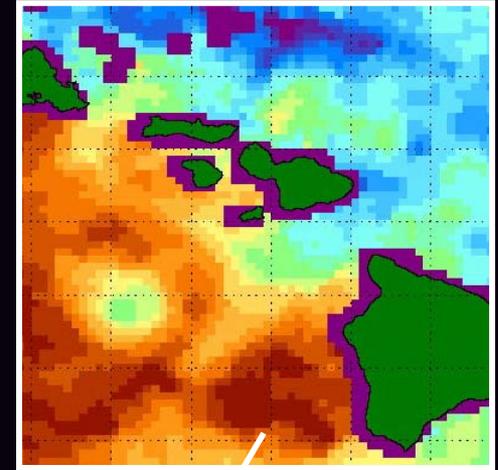
Summer 1999
"Loretta"



Summer 2000
"Ehu Kai"



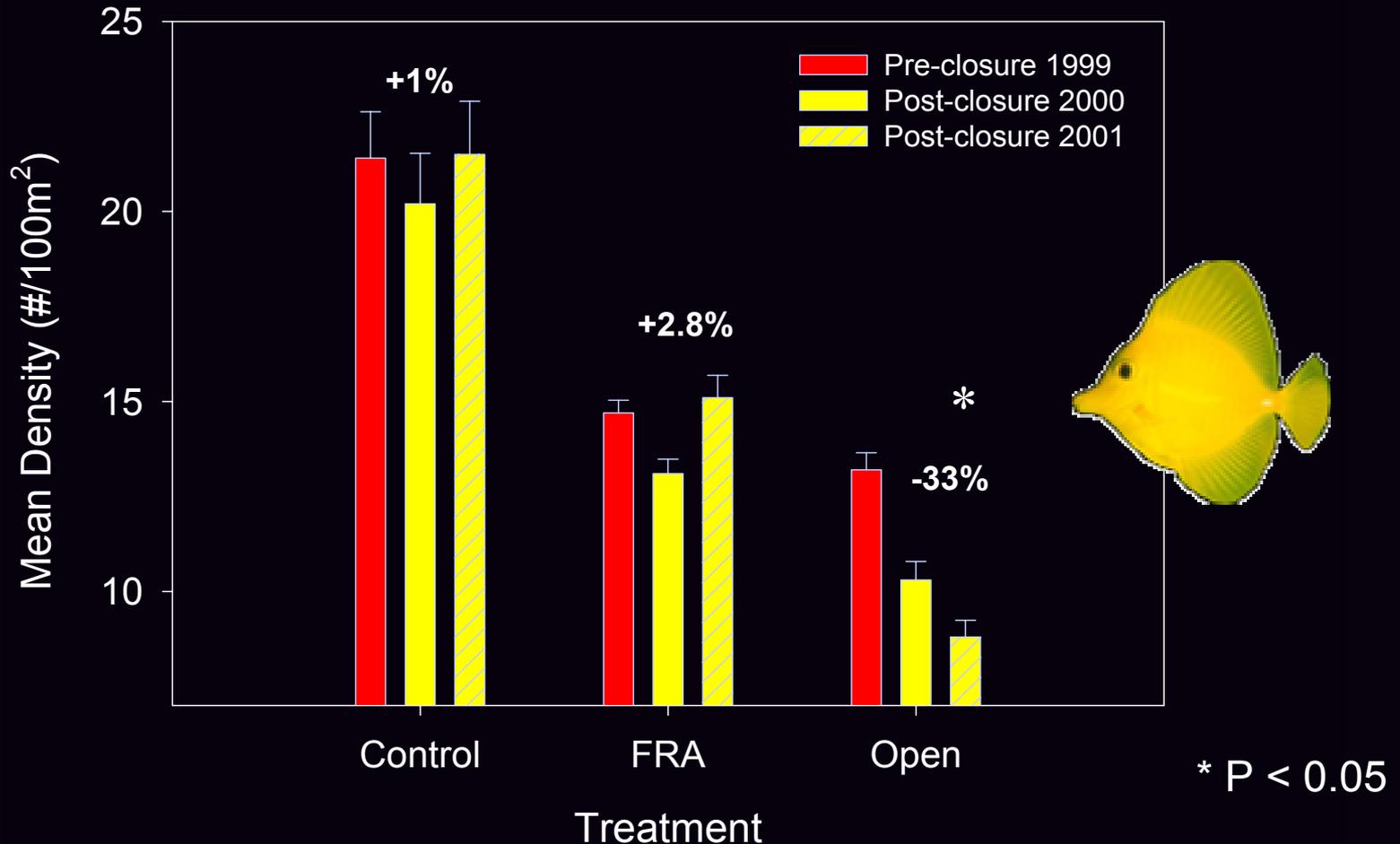
Summer 2001



In year two, FRAs have ceased their decline and now are beginning to show stable populations especially of intensively collected species such as yellow tangs. Open areas continue to decrease in numbers.

Reserve Comparisons

Zebrasoma flavescens

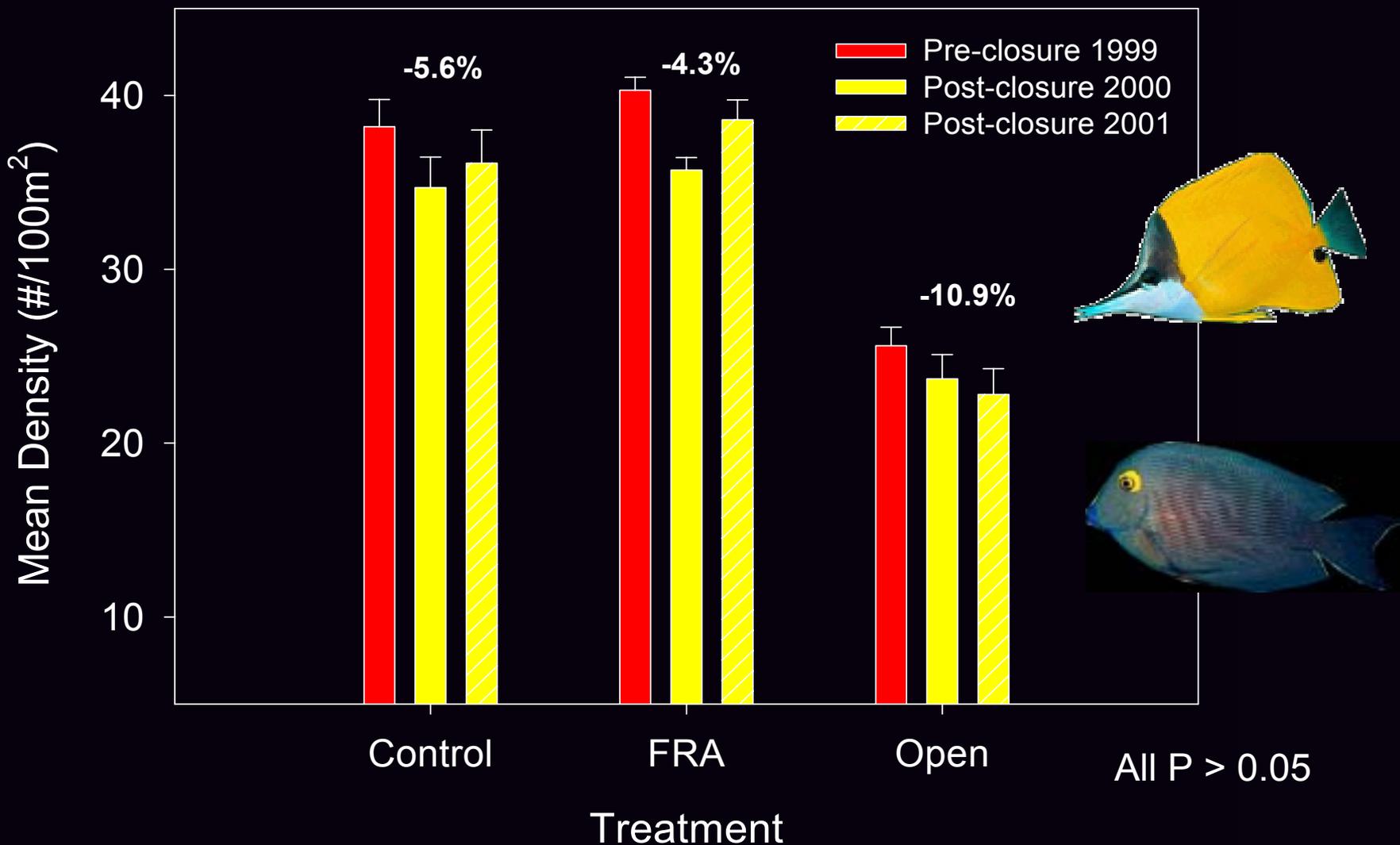


%s are 1999-2001 differences

Other Aquarium species show a similar pattern

Reserve Comparisons

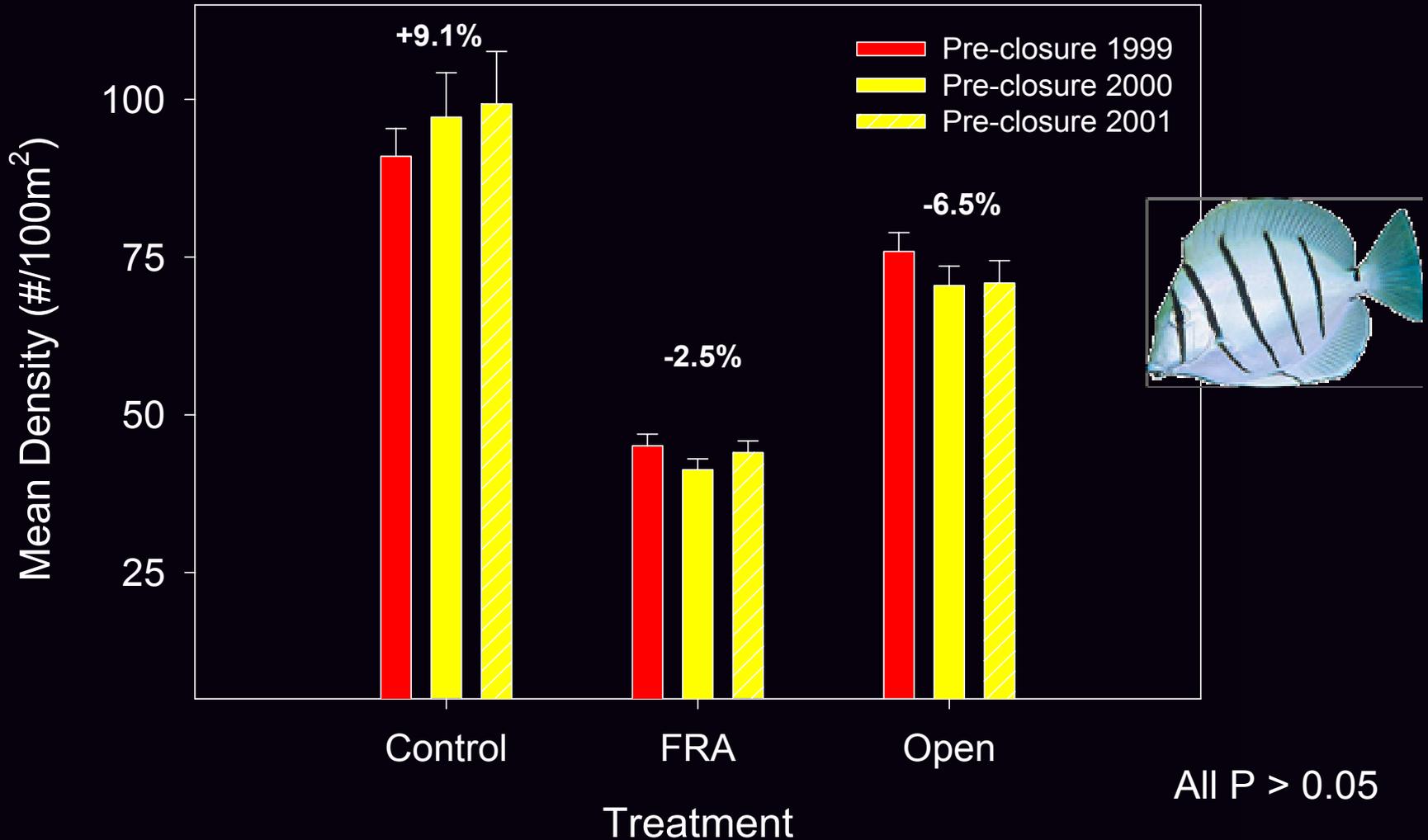
Aquarium fishes (-*Zebrasoma*)



Non-aquarium fishes are also similar

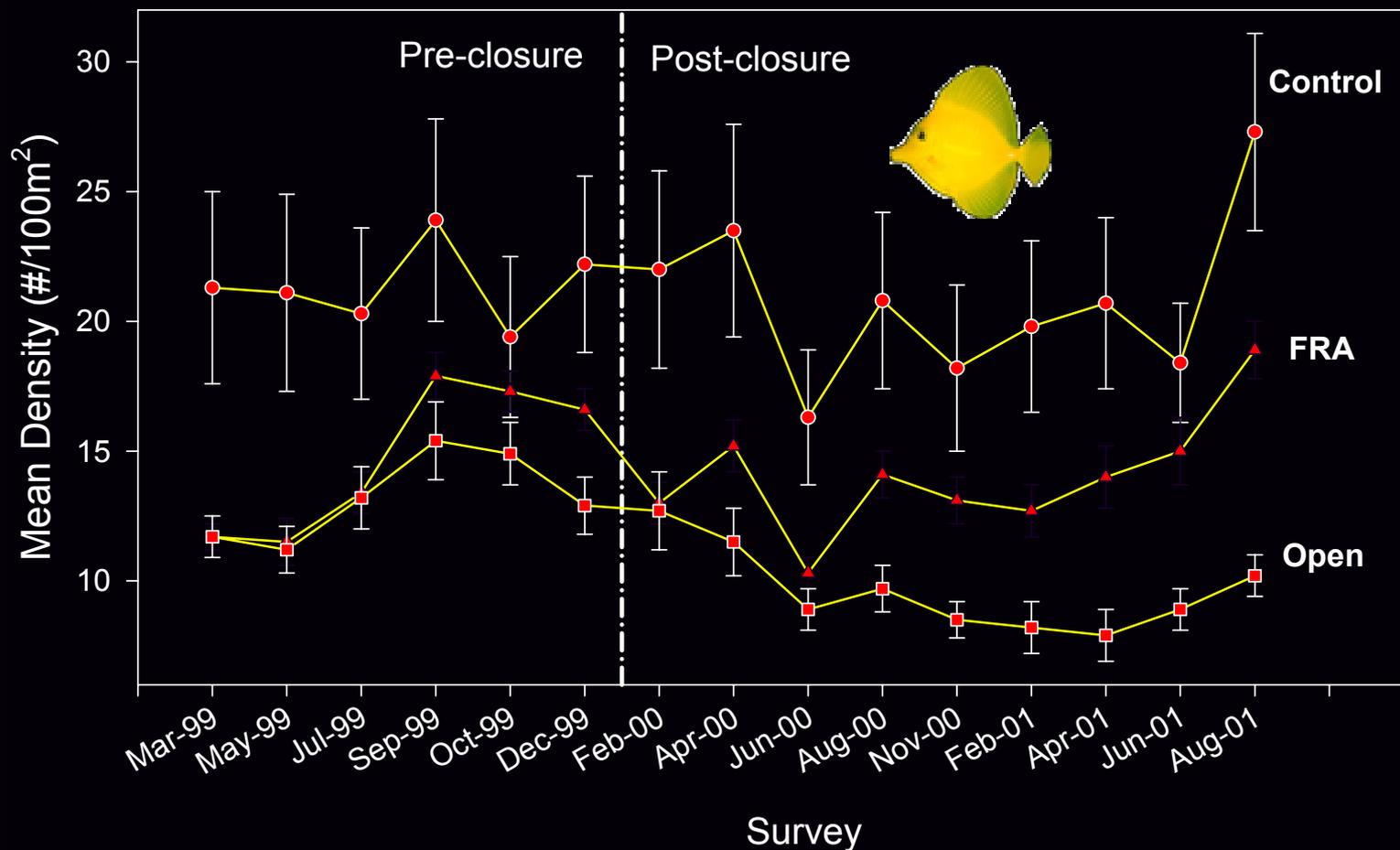
Reserve Comparisons

Non-aquarium fishes



Results so far point out the success of existing protected areas (controls) in increasing fish populations. Newly established areas (FRAs) will take time to achieve the same results. Recruitment of new fishes is an essential element in the workings of protected areas.

Zebrasoma flavescens



Conclusions & Recommendations

- Reserves protect and help recover fish stocks although they may be slow in developing.
- Recruitment is variable in time and space and often very localized.
- We need to better understand the dynamics of recruitment: Near-shore oceanographic research and state-wide monitoring is necessary.
- Habitat is important: monitoring and protection of coral reefs is essential.
- Increasing the number of marine reserves should be encouraged as a precautionary measure.

