

Resilience through an MPA Network: A Hawaii Case Study



Todd Stevenson
Circumpolar Conservation Union

Brian Tissot, Bill Walsh, Jim Beets, Sara Peck, Ivor Williams, Mark Hixon, Leon Hallacher, Steve Cotton, Delisse Ortiz, Emily Munday, Mark Christie



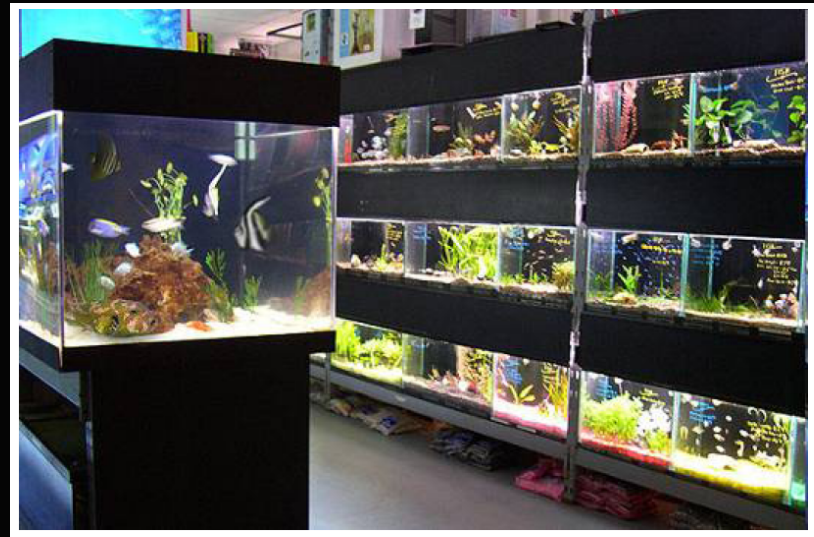
Marine Ornamental Trade

Aquarium, jewelry & curios:

- ~1500 species of reef fish
- ~5000 species invertebrates
- Live coral & live rock

Estimated trade:

- ~ 30 million fish / yr
- ~ 9-10 million invertebrates
- ~ 1.5 million live corals
- ~ 1 million fish parts



Harvesting Effects

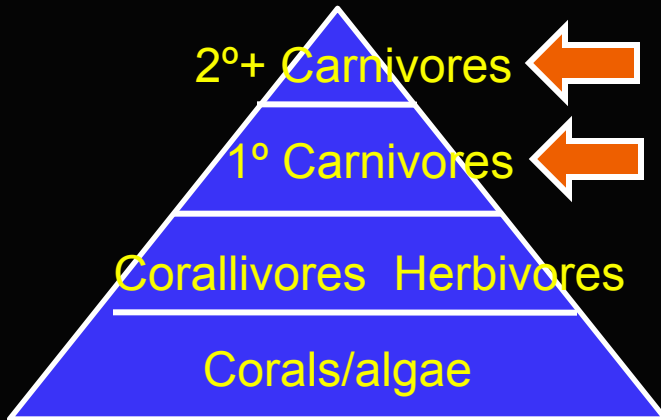
Typical impacts:

- High mortality
- By-catch
- Loss of habitat
- Loss of key species

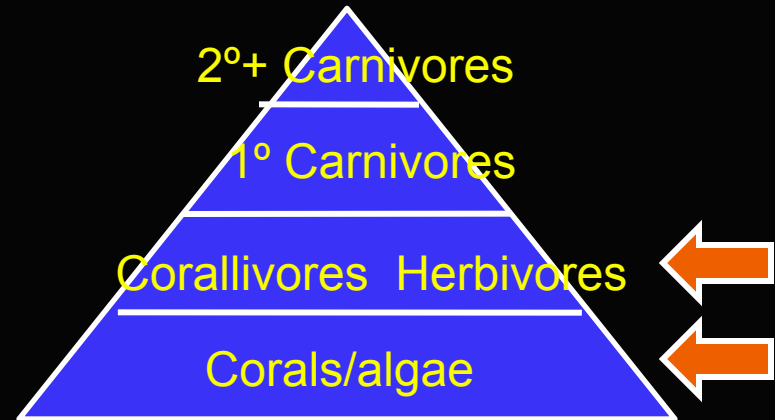


Community Effects

Food
Fisheries



Ornamental
Fisheries



Hobby Demand Shift

Home aquarium hobbyists now prefer live coral tanks

Increased harvest pressure on herbivorous fishes as well as live corals



VS.



Hawaii Aquarium Fish Research



Principal Investigators:

Brian Tissot, **Humboldt State University**

Bill Walsh, **Hawai'i Division of Aquatic Resources**

Ivor Williams, **NOAA Fisheries**

Leon Hallacher, **University of Hawai'i Hilo**



Divers :

Jonathan Hultquist, Mark Albins, Paul Clark, Steve Cotton, Jeff Elba, Karen Geisler, Ranya Henson, Jackie Holbrook, Shaun Norris, Daniel Okumura, Kara Osada, Kim Page, Greg Polloi, Linda Preskitt, Noelani Puniwai, Todd Wass, Lisa Wedding, Darla White, Rachael Younger, Brian Zyglicynski + 50 others



Delisse Ortiz



Mark Christie

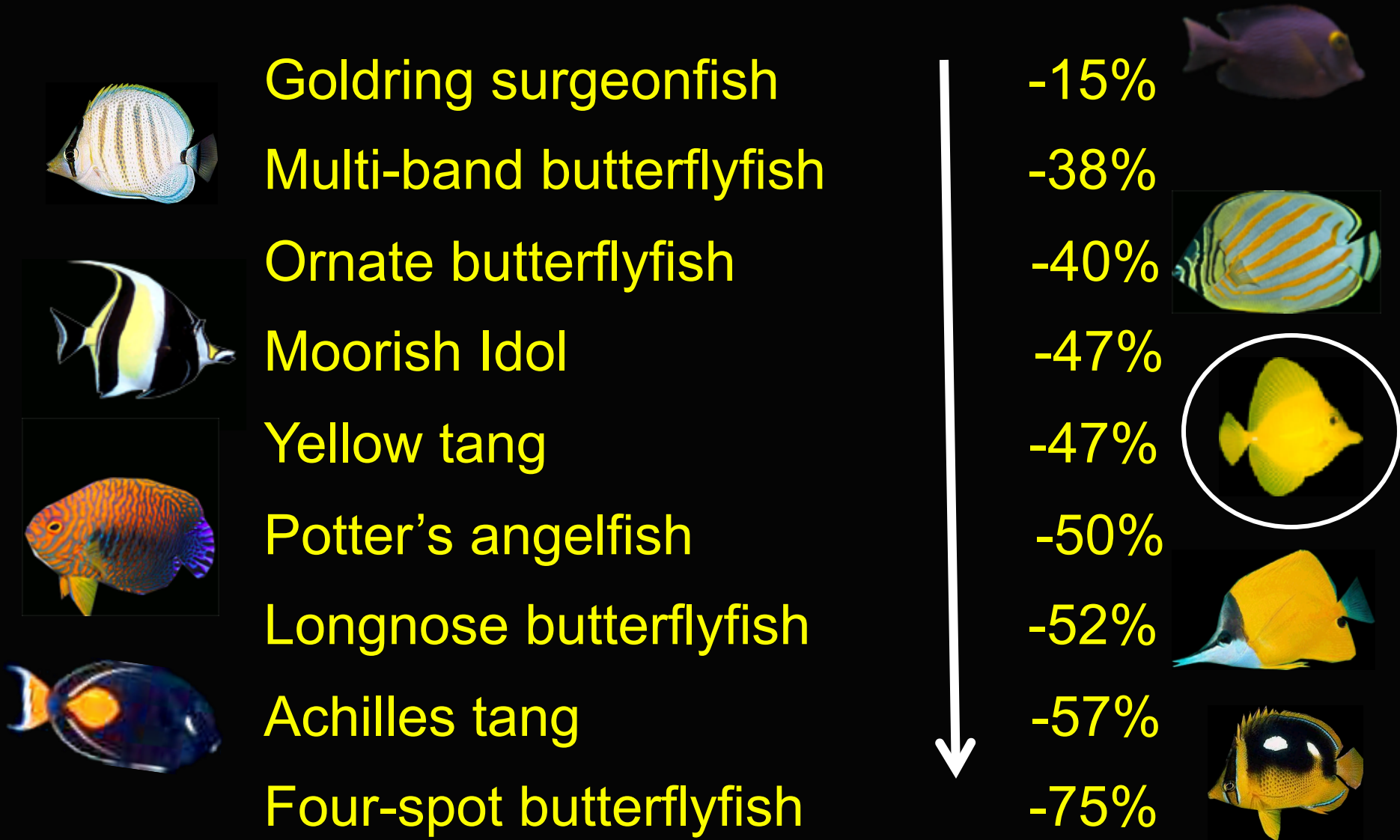


Emily Munday



Todd Stevenson

Fish Collecting Impacts in Kona (1996-97)



All species: $P < 0.05$

WEST HAWAII

TODAY

Tuesday, February 23, 1999 • VOL. XXX, NO. 4 • 32 Pages • 50 Cents

Study finds fewer fish at collection sites

Coral reefs also reported to be stressed by activity

By **BOBBY COMMAND**
West Hawaii Today

A two-year study to assess the impact aquarium fish collecting and commercial dive operators have on offshore reef habitats concludes what most people already believe: Populations of sought-after fish are significantly lower at collection sites, and coral reefs

show signs of stress in places where dive boats conduct their operations.

Findings of the study, commissioned by the Legislature through the state Department of Land and Natural Resources, will support the establishment of the West Hawaii Regional Fisheries Management Act, which would ban aquarium fish collection along a minimum of 30 percent of the West Hawaii shoreline.

The scientists who carried out the research were Leon Halbacher,

professor and chairman of the biology department at the University of Hawaii-Hilo, and Brian Tissot, associate professor of environmental science at Washington State University-Whitman. They were aided by students of the UH-Hilo Marine Options Program.

One study analyzed the effects of aquarium fish collecting at two popular collection sites, the entrance to Honolulu Harbor and Red Hill, mako of Kealahouka.

The other study examined the effects "non-consumptive" dives

were having in Kealahouka.

The aquarium fish study found numbers of the seven most popular species taken by collectors were significantly lower than at nearby control sites at the Old Kona Airport and Kealahouka Bay Marine Life Conservation District (MLCD).

Halbacher said the seven species — Achilles tang, Peter's angelfish, kolo, forcpa butterfly fish, orange spine unicorn fish, Moorish idol and yellow tang — account for 99 percent of all fish

collected for salt water aquariums.

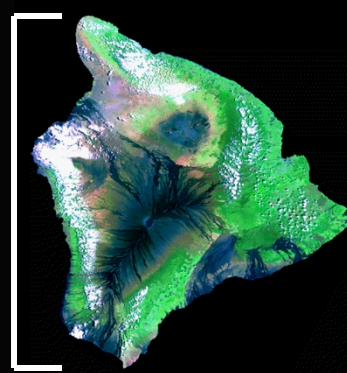
The study also compared the populations of 20 widely dispersed species such as the saddleback wrasse (*Pisces*) and the convict tang (*Muraena*).

Halbacher said they found the numbers of fishes among the seven popular species were significantly lower at the collection sites, while there was no difference between the impact and control areas in the

See **SCIENTIST:**
Page 4A

Legislative Action

Act 306: *West Hawai'i Regional Fisheries Management Area*



1. Designate $\geq 30\%$ of coast as *Marine Protected Areas*
2. Involvement of community
3. Evaluate effectiveness

West Hawai'i Fisheries Council

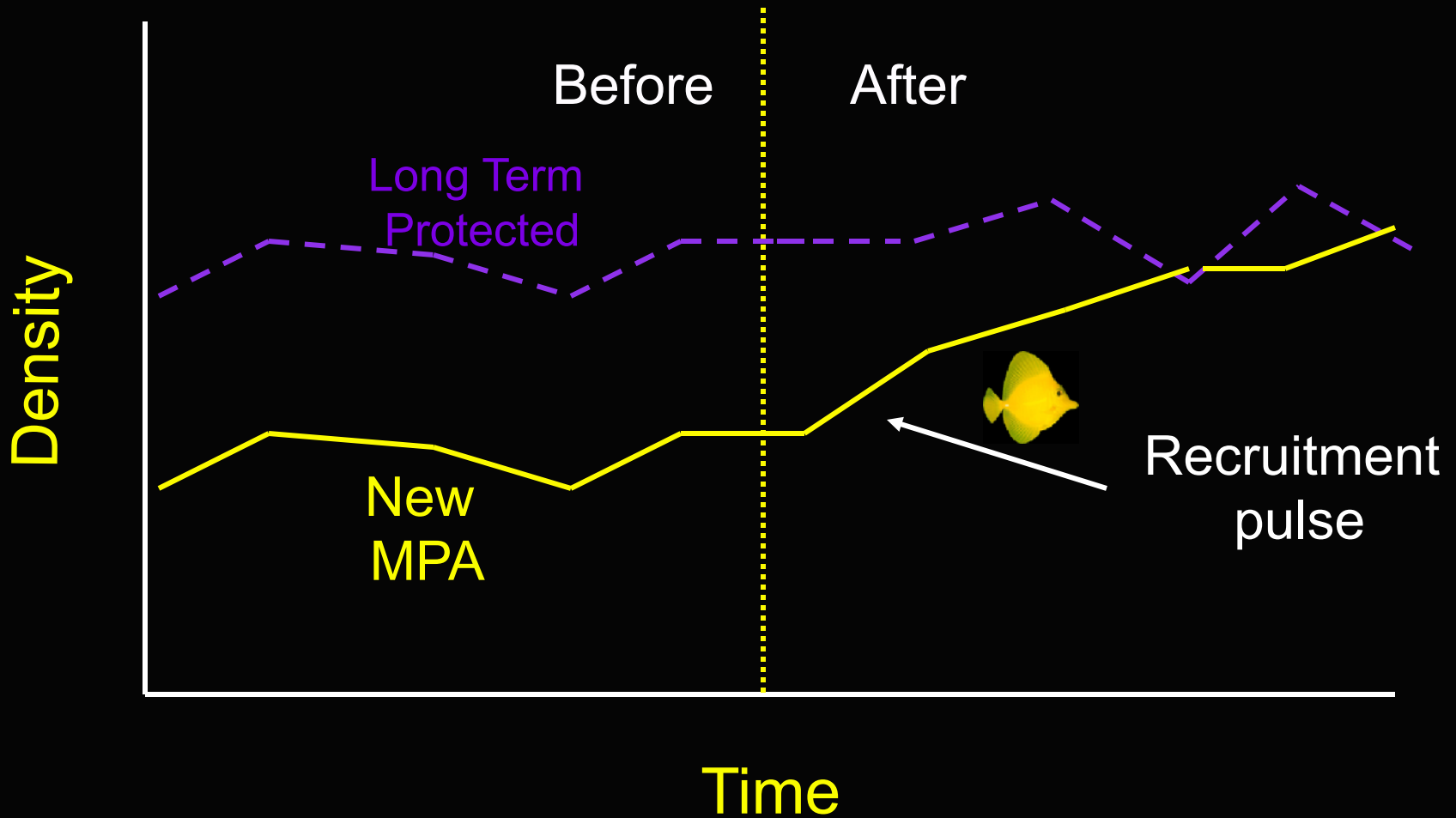


West Hawai'i Aquarium Project



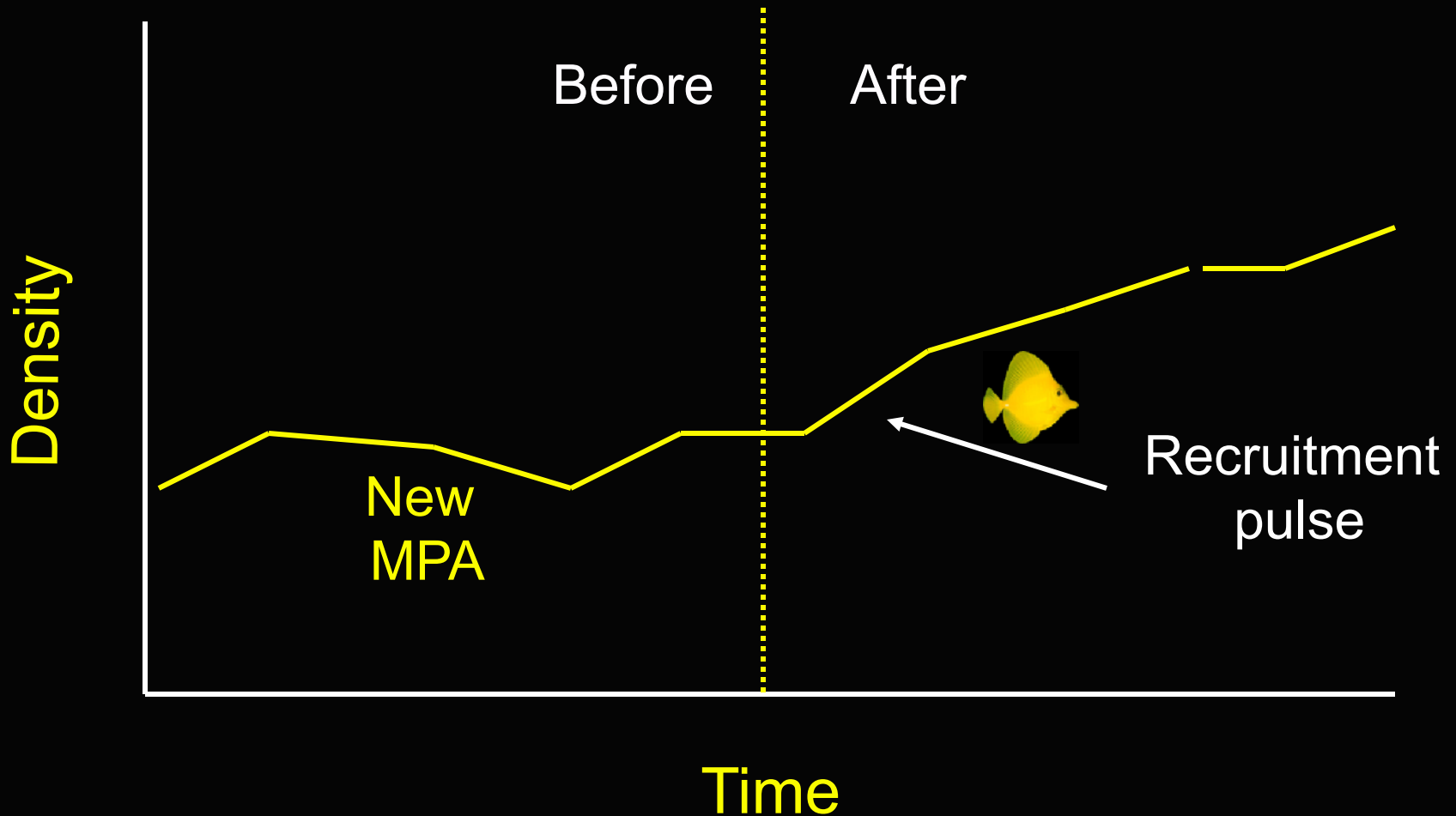
MPA Long-Term Monitoring

BACI: Predicted Response



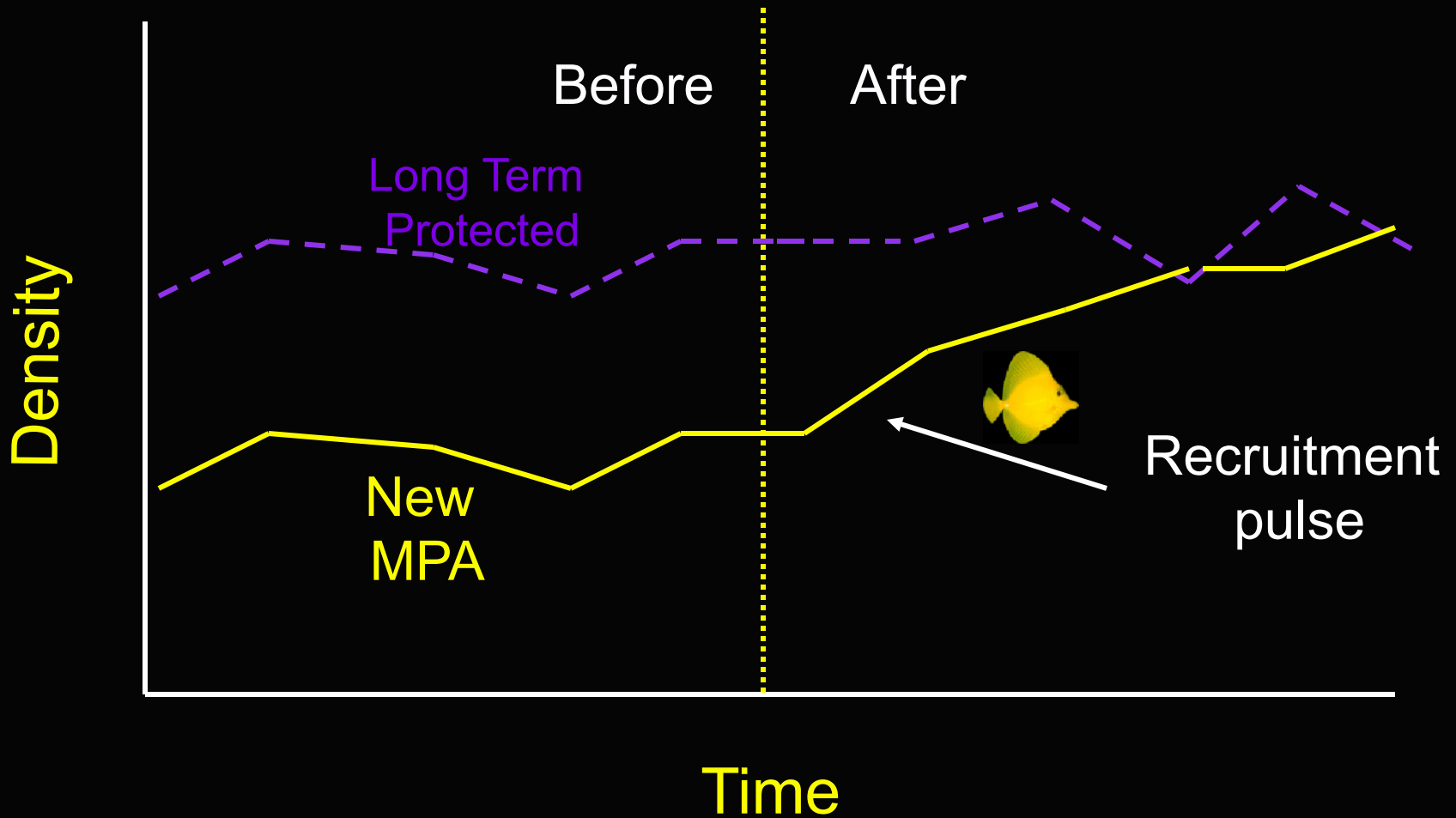
MPA Long-Term Monitoring

BACI: Predicted Response

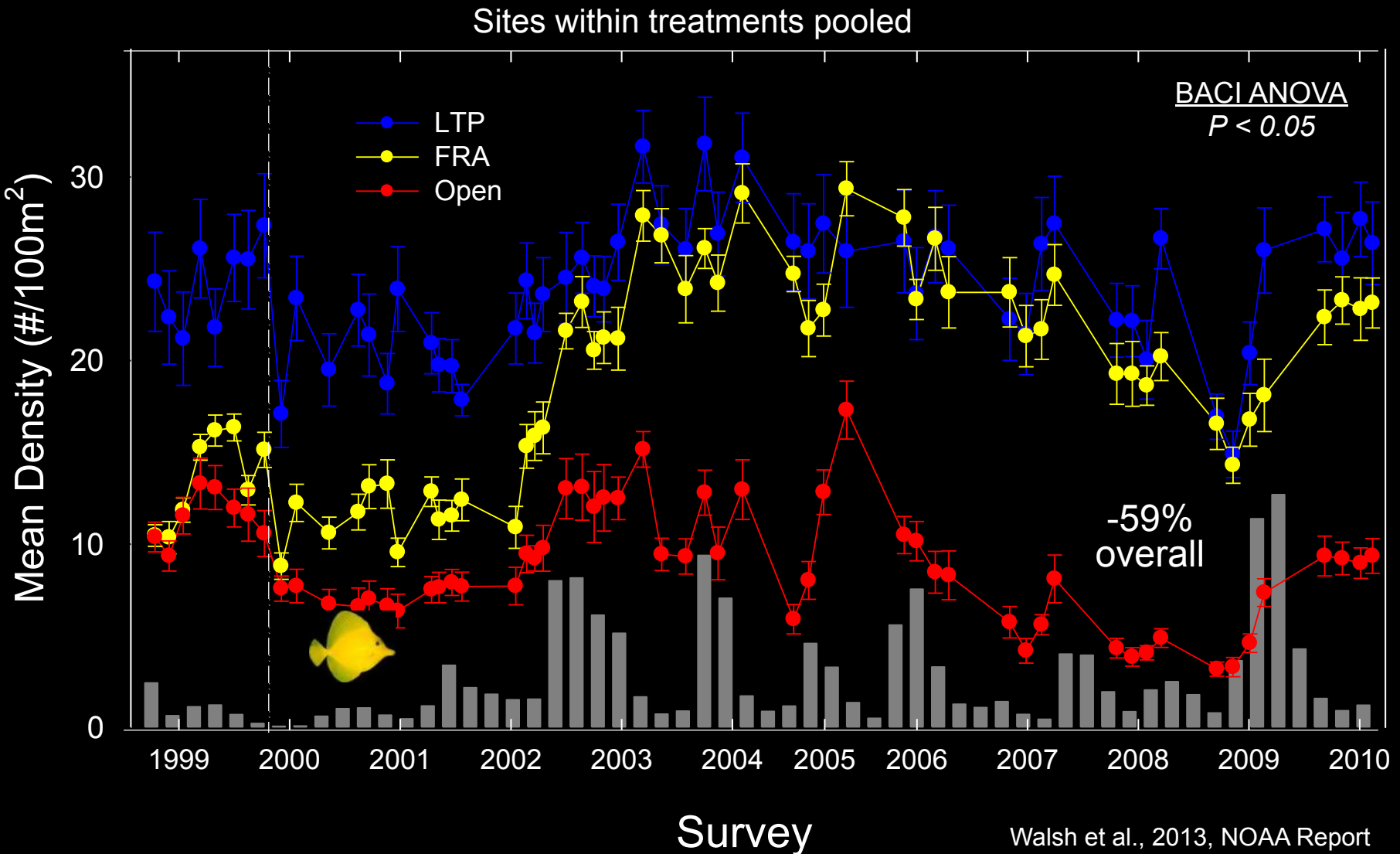


MPA Long-Term Monitoring

BACI: Predicted Response



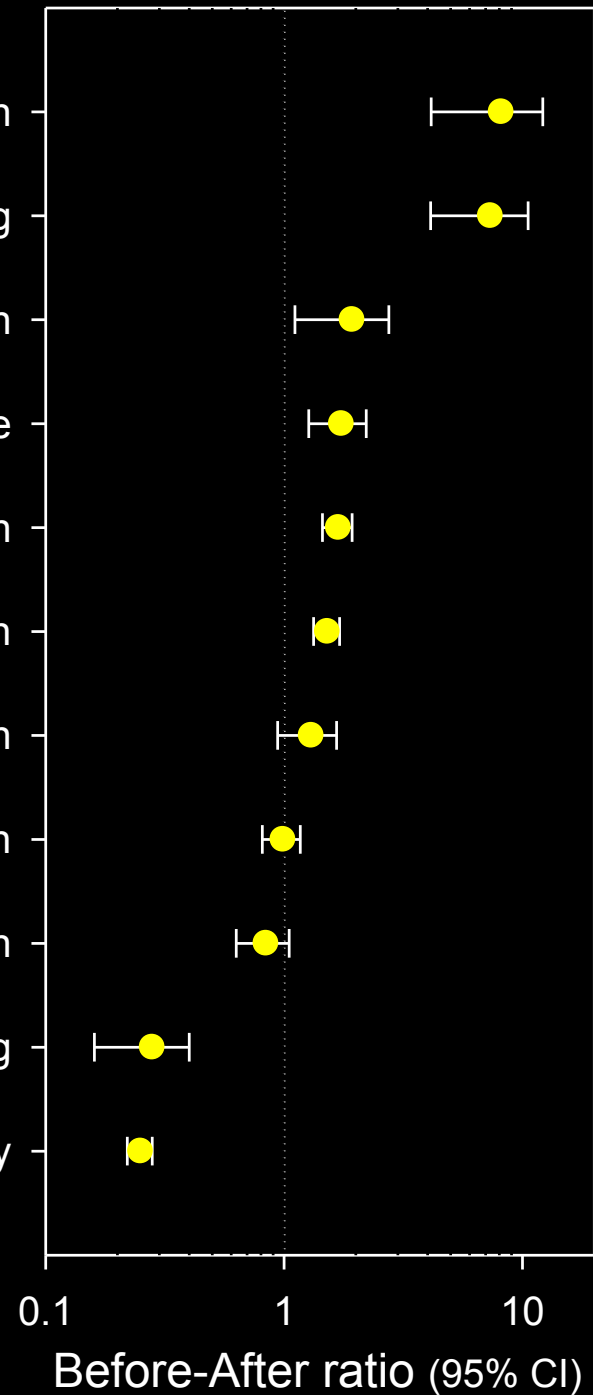
MPA long-term monitoring



Species Effects



Goldring surgeonfish
Yellow tang
Brown surgeonfish
Ornate wrasse
Forcepsfish
Longnose butterflyfish
Multi-band butterflyfish
Orangespine unicornfish
Black surgeonfish
Achilles tang
White-spotted toby



Do MPAs Replenish Aquarium Fish?



Potential MPA Benefits: *Spillover*



Fisher

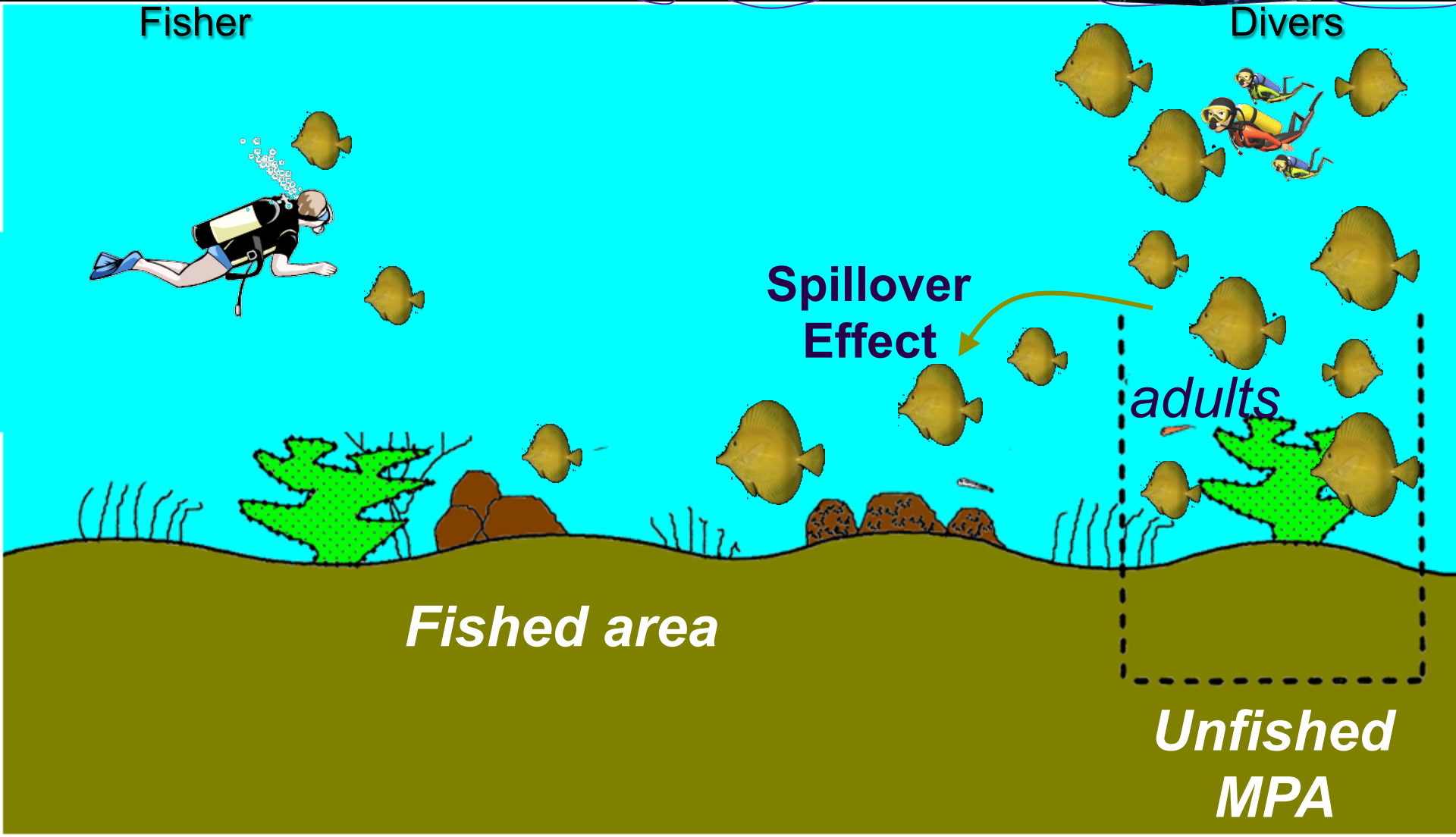
Divers

Spillover
Effect

adults

Fished area

*Unfished
MPA*



Potential MPA Benefits: *Seeding*



Fisher

Divers

Seeding Effect

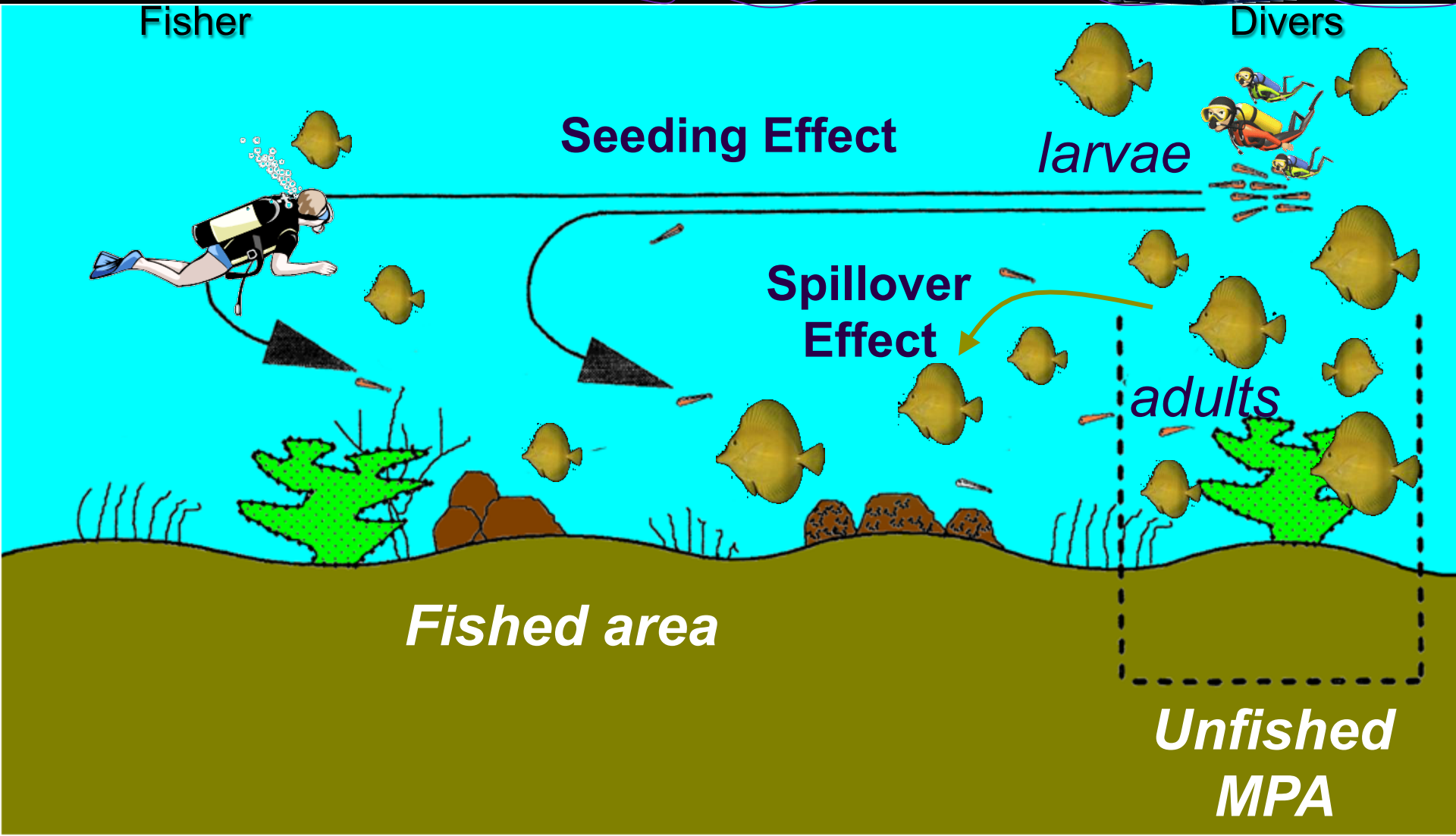
larvae

Spillover Effect

adults

Fished area

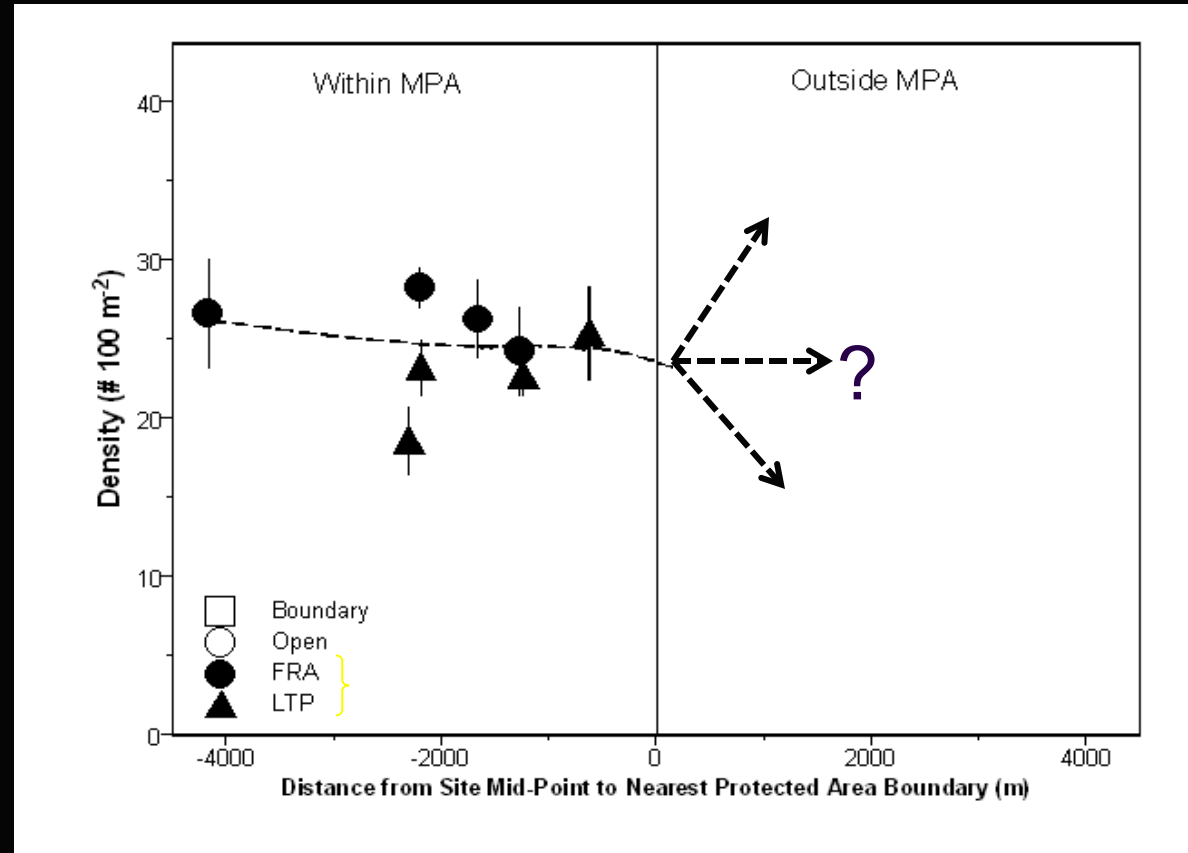
Unfished
MPA



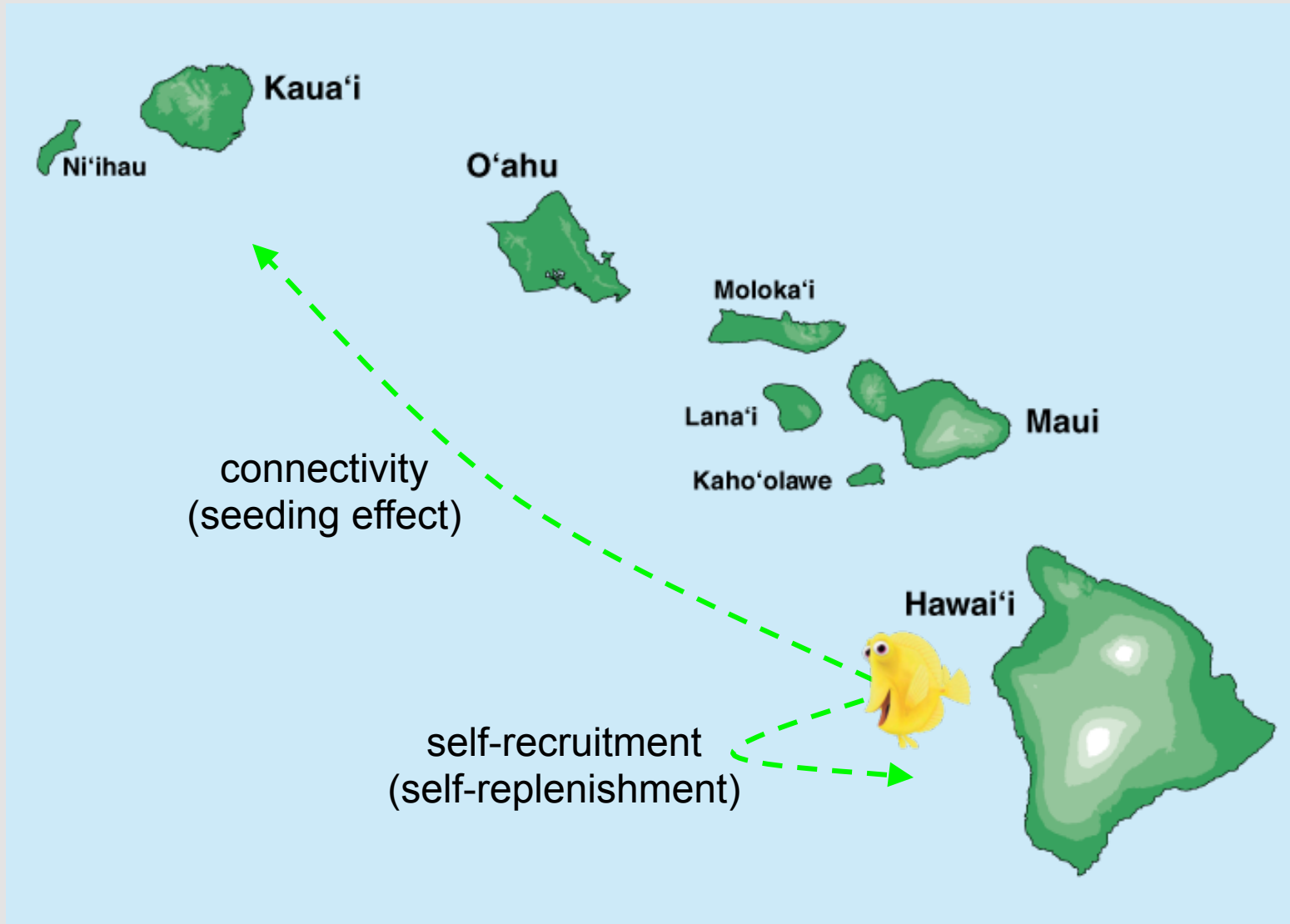
Spillover Effect Study



Jet Boot SCUBA Surveys



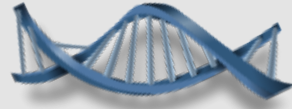
Are populations connected by larval dispersal?



Genetic parentage approach



Mark Christie



- Sampled >1000 new recruits & adults at 10 reefs around Island of Hawaii
- Genotyped all individuals at 15 *microsatellite* loci
- Genotyped putative parent-offspring pairs at 5 additional loci (20 loci total)
- Extracted, genotyped, scored and identified parent-offspring pairs twice



Parentage analysis

dispersal distance

184 km

$P = 0.0109$

49 km

$P = 0.0013$

140 km

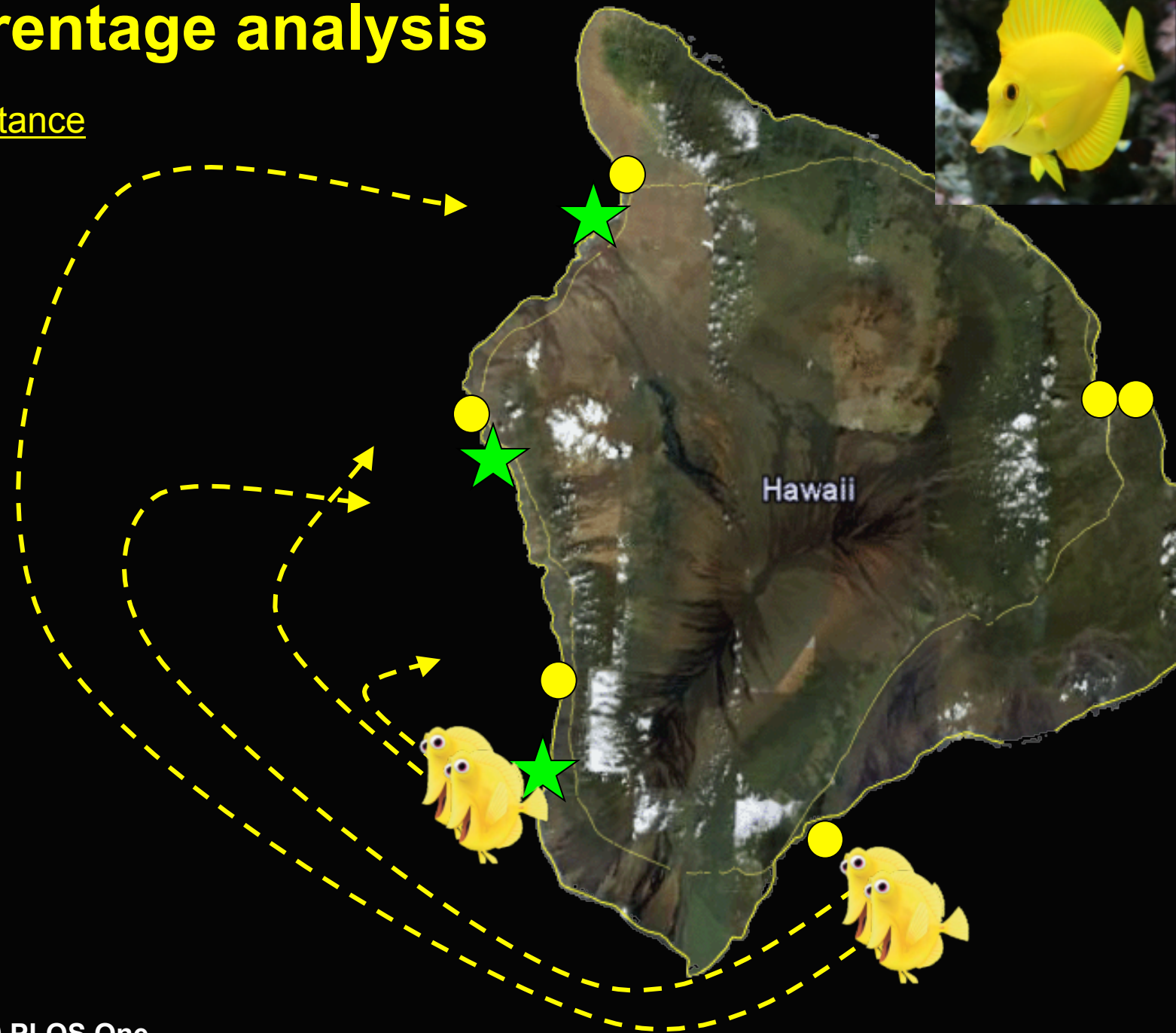
$P = 0.0272$

15 km

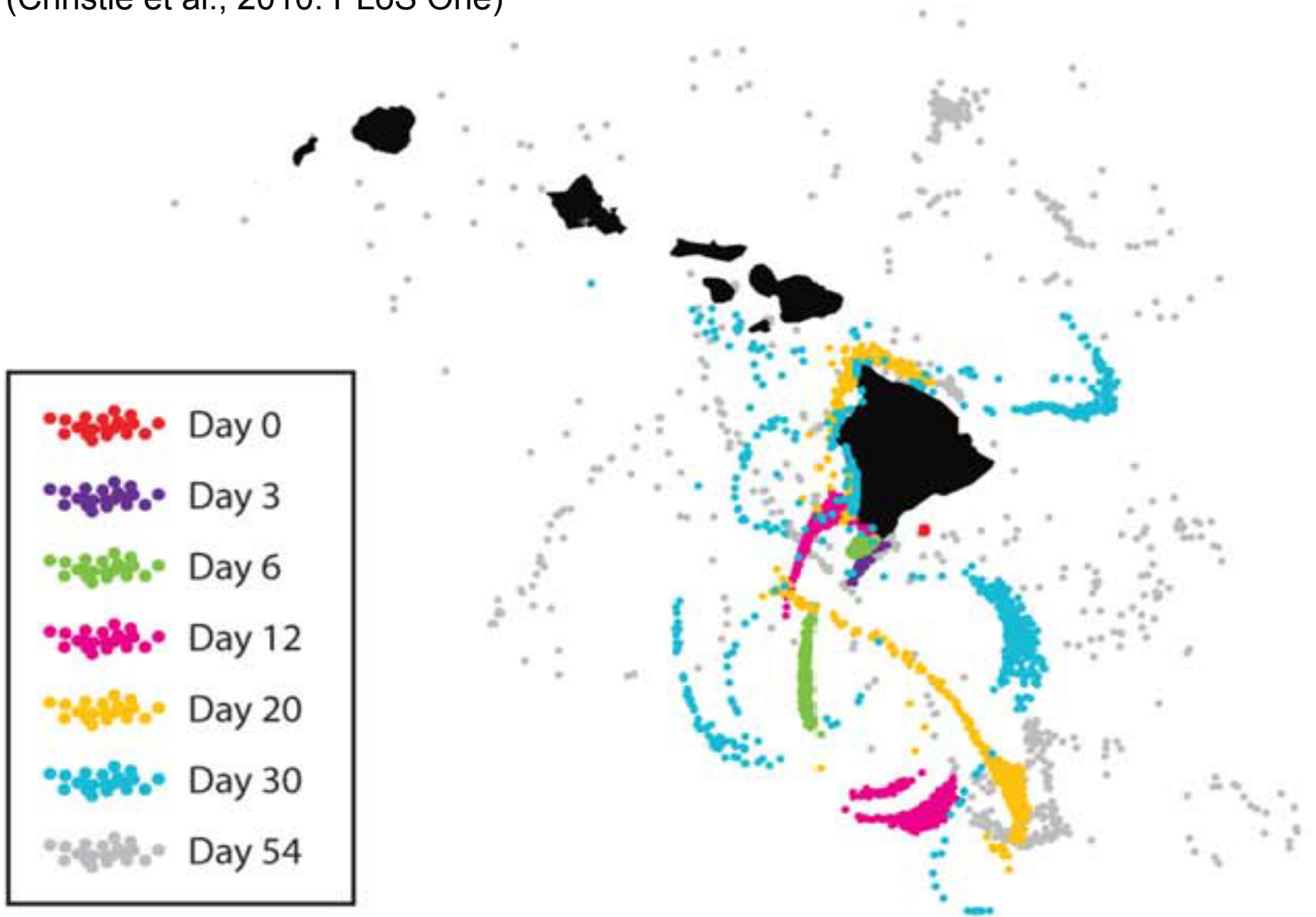
$P = 0.0004$

★ = MPA

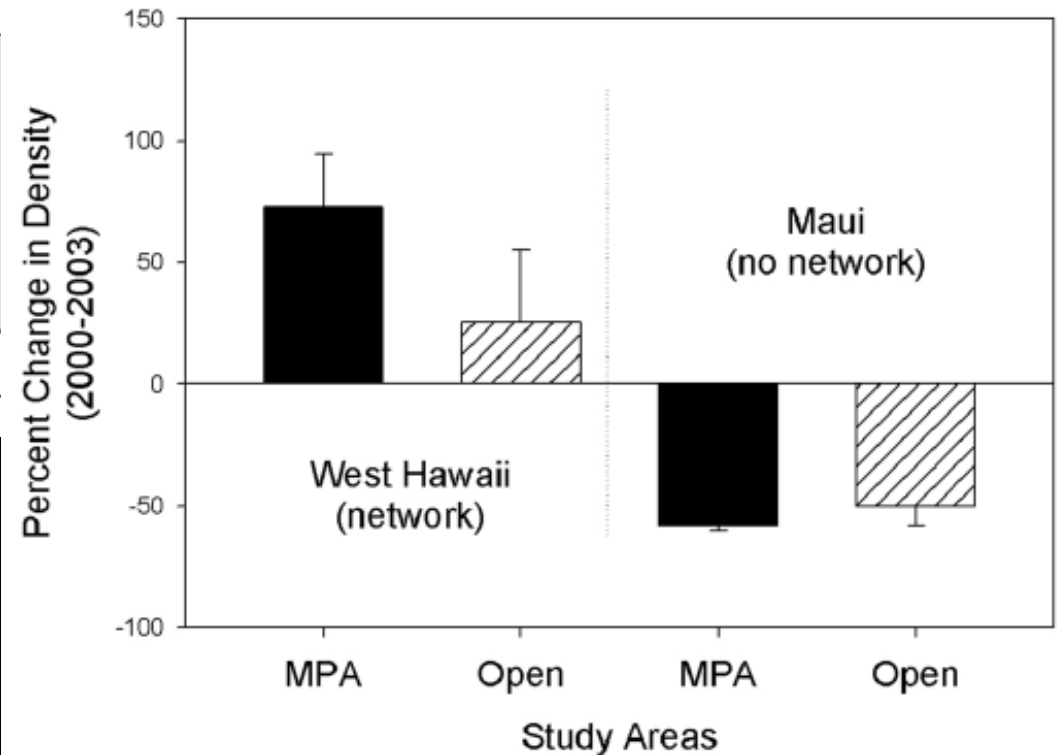
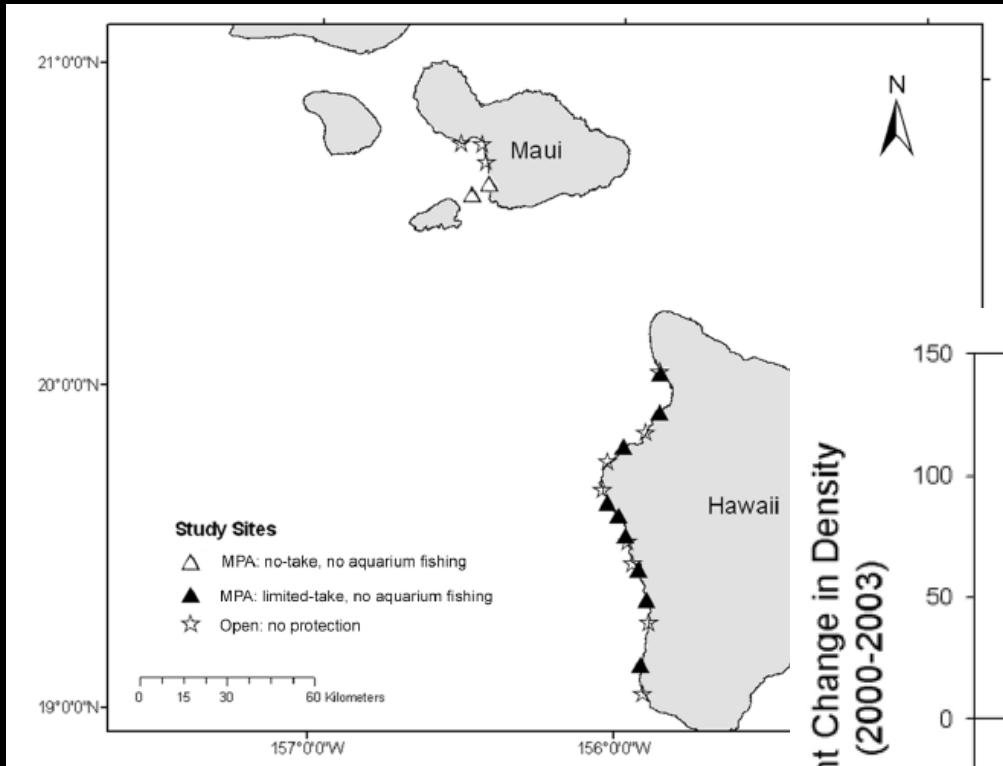
● = Open



Ocean Circulation Model + Virtual Drifter
(Christie et al., 2010. PLoS One)



Is the Whole (Network) Greater than the Sum of Its Parts?



Conclusions

- MPA network significantly increased herbivorous fish abundance
- Robust monitoring framework remains vital for adaptive management
- Important to know life history of target species – don't assume

Thank you

Todd Stevenson

tstevenson@oceanconservancy.org