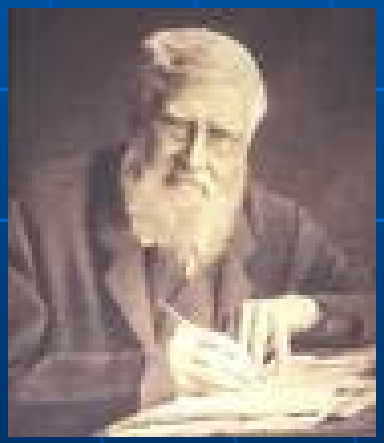
Science for coral reef management

'to understand and protect the marine environment through long-term scientific monitoring'

Dr. Peter Houk

History of Scientific Investigation

- Began with diary type entries about explorations



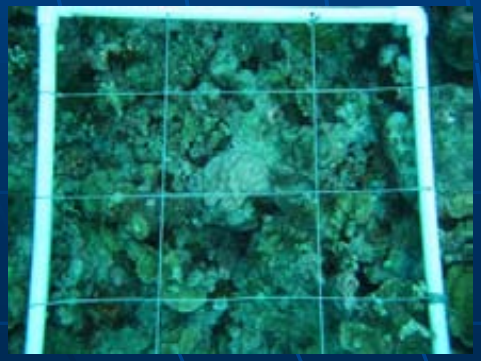
- Methods –
  - "I collected steadily for two months in this jungle, situated in the small island of Wamma, at one end of which is the Bugis settlement of Dobbo, where I resided"
- Results –
  - "With all my exertions I could only muster 90 species of butterflies and 235 Coleoptera at the end of one month, which had increased to 108 and 340 in two months, with 150 Hymenoptera, 120 Diptera, and other orders scanty, making a total of 850 species of insects"

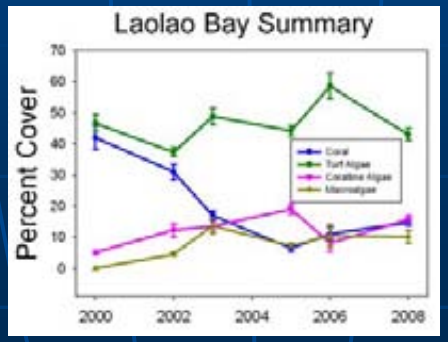
Alfred Russel Wallace, 1858 – Entomology of Aru Islands

Contemporary Science

- Monitoring programs have evolved
- Key elements

1) Question Driven
2) Repeatable
3) Quantifiable
4) Statistically powerful





Many existing programs

- Rarely define questions
- Consider in-water monitoring methods first..
- Federal and local level both

- *Watershed pollution?*
- *MPA effectiveness?*
- *Recovery from climate induced disturbances?*
- *Management effectiveness?*

Question Driven Science

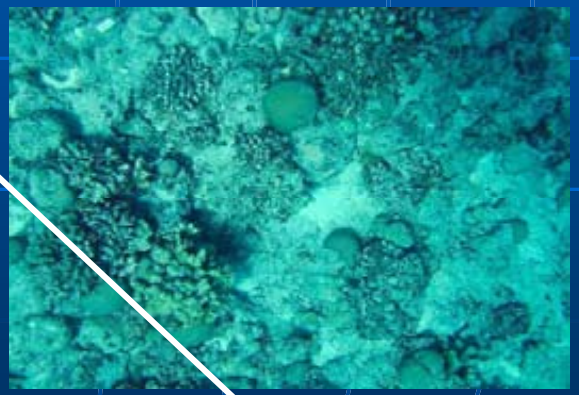
- CNMI long-term monitoring program
- American Samoa land-based pollution monitoring

Questions

- What are the natural controls of coral-reef assemblages and reef growth?
  - Wave exposure
  - Geology
  - Salinity

Questions

- What are the impacts of natural and human disturbances, and what are expected recovery rates and trends?



?

Questions

- How effective are management actions?

Similarities among questions….

- Look at variation within one or more islands at differing sites in most instances
- Look for comparative responses
  - Regression
  - ANOVA

CNMI monitoring program - base

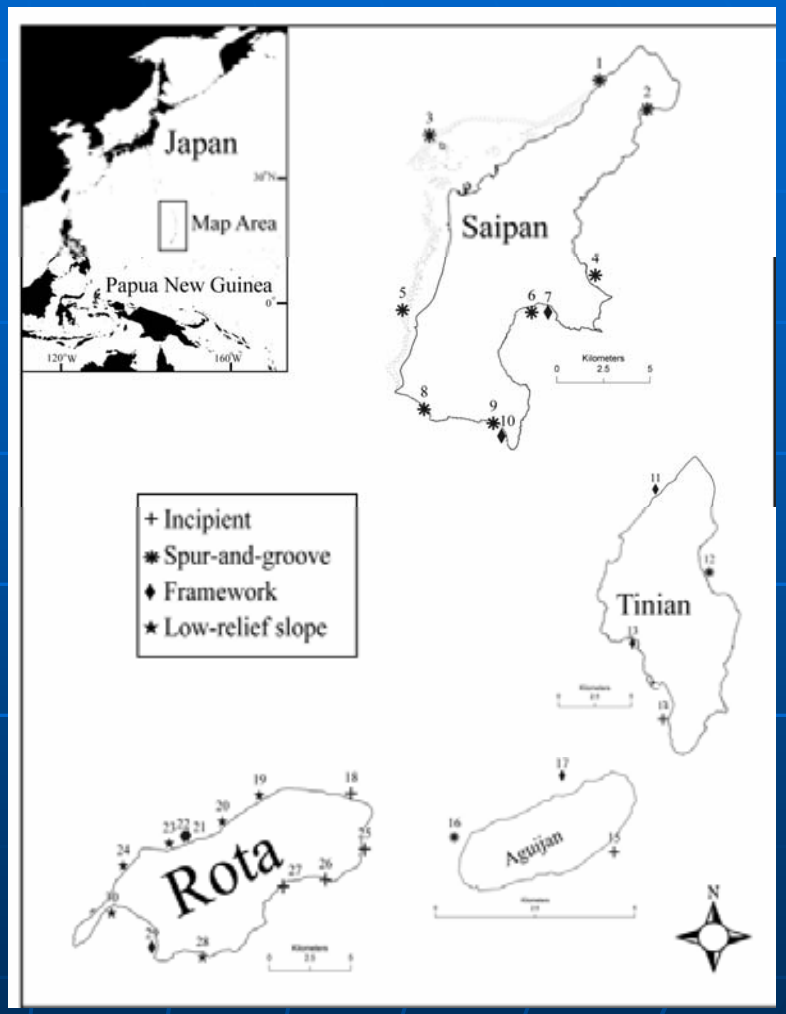
Spur-groove

Incipient reefs

Framework reefs

Failed growth

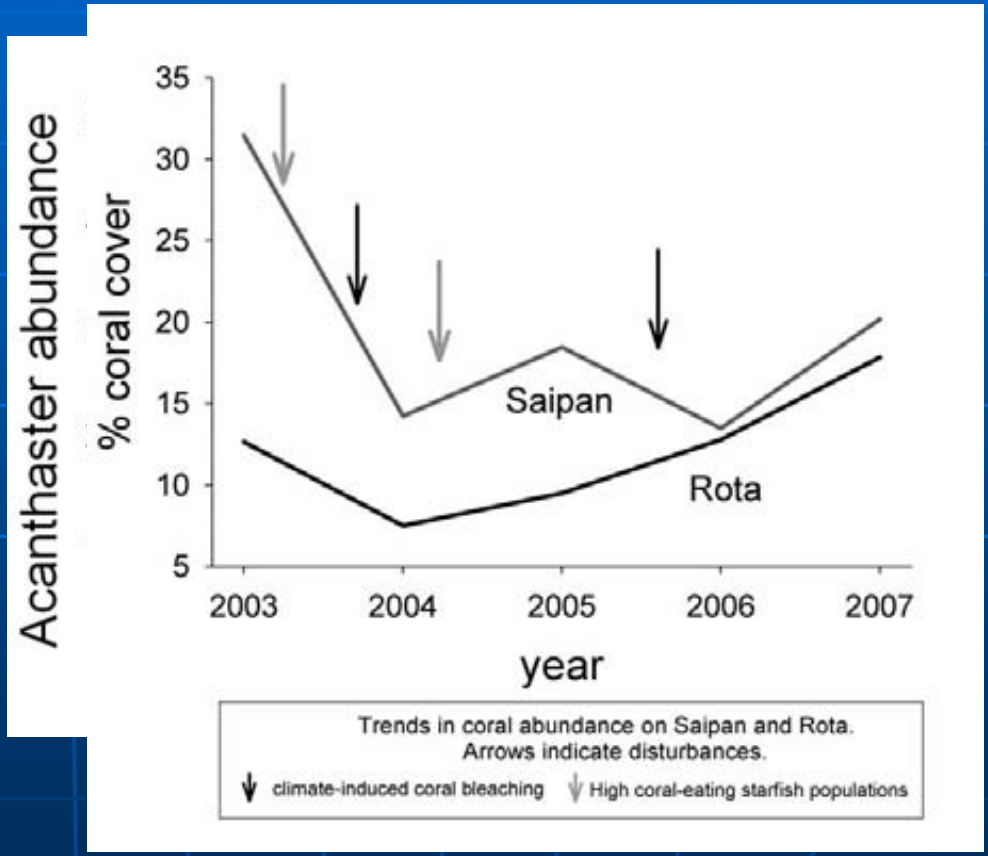
1) Characterization - 2) Spatial Distribution



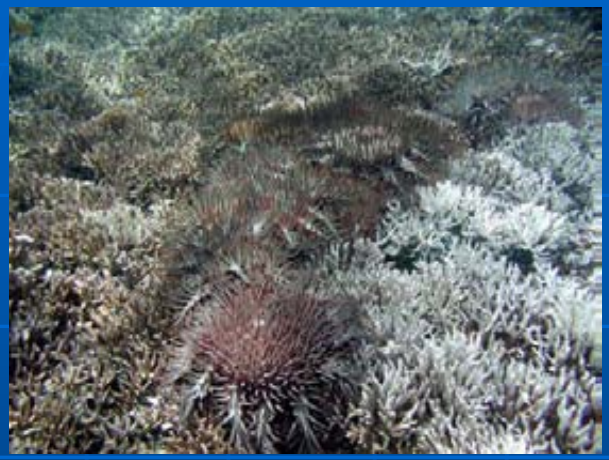
Houk and van Woesik, Marine Ecology

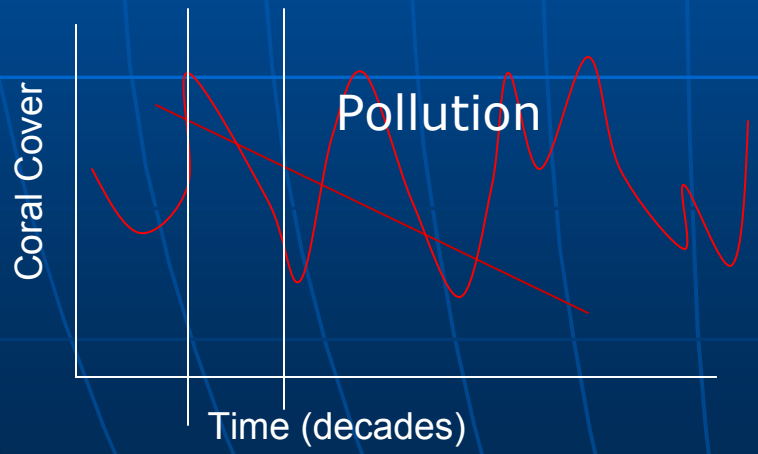
Understand natural disturbances

- Climate induced bleaching
- COTS – starfish
- Typhoons



Problems with coral cover

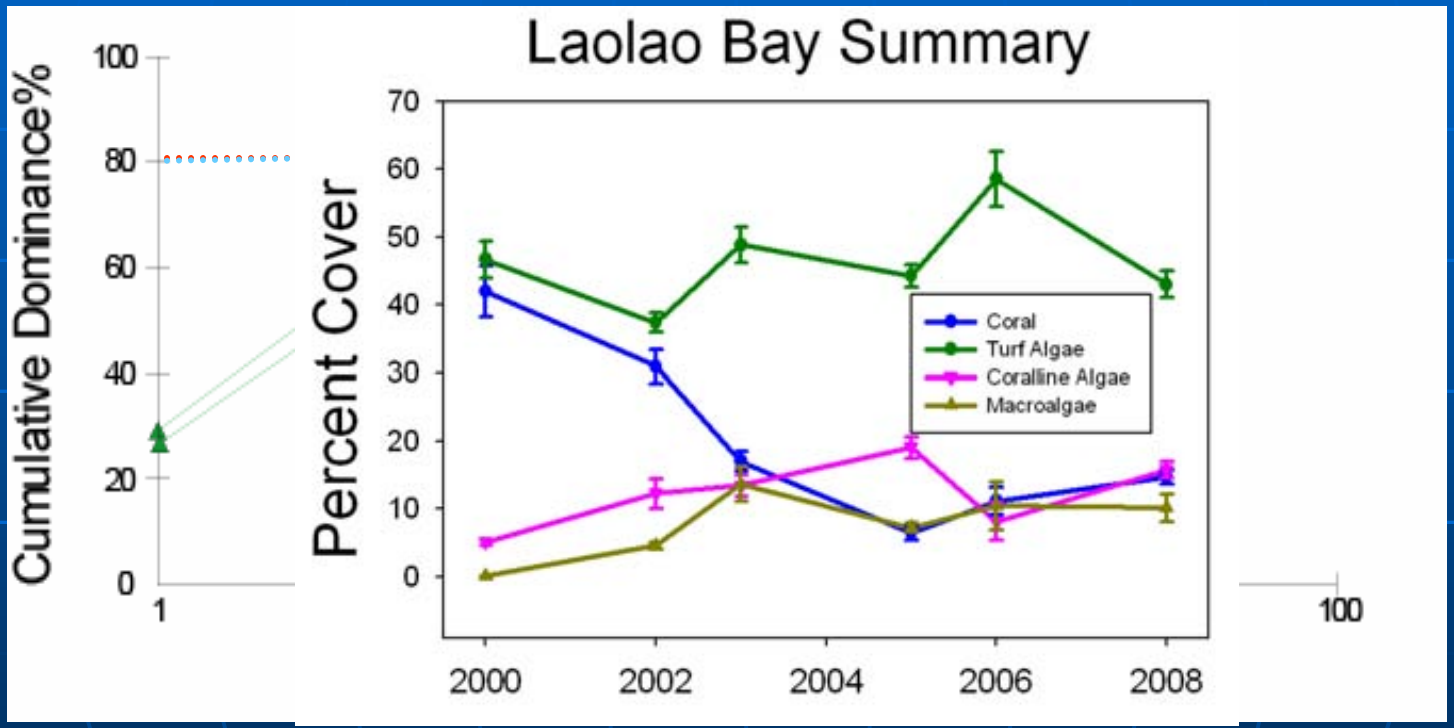




Must move beyond coral cover

And beyond island scale

Site-level data benefits

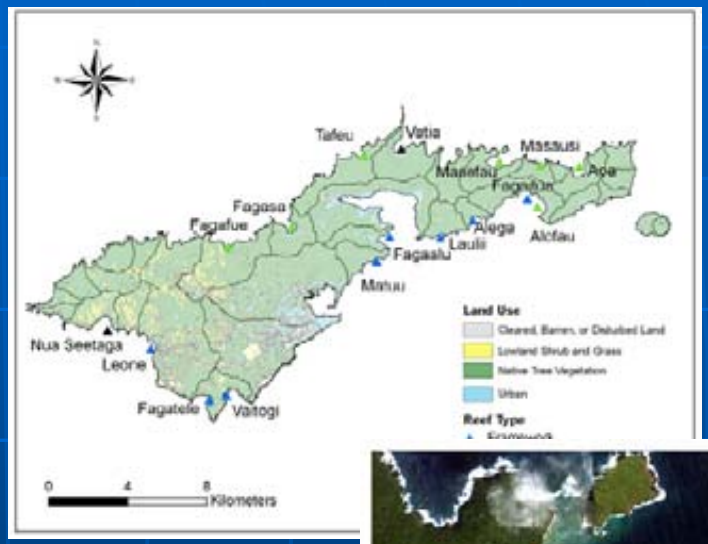


15 Species made up 80% of the cumulative dominance in 1991

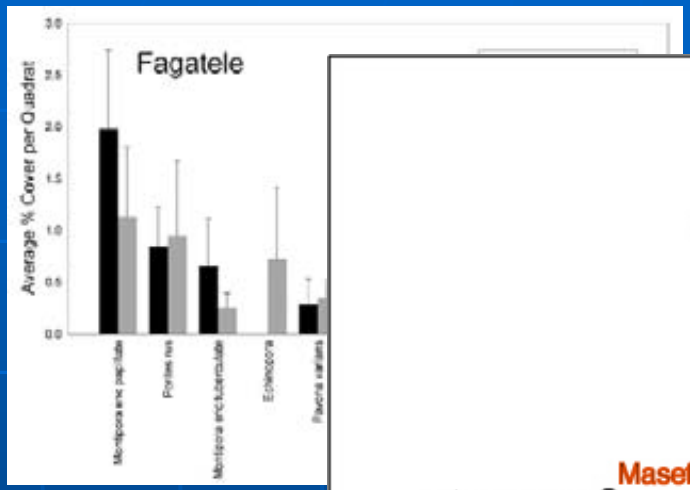
5 Species made up 80% in 2007

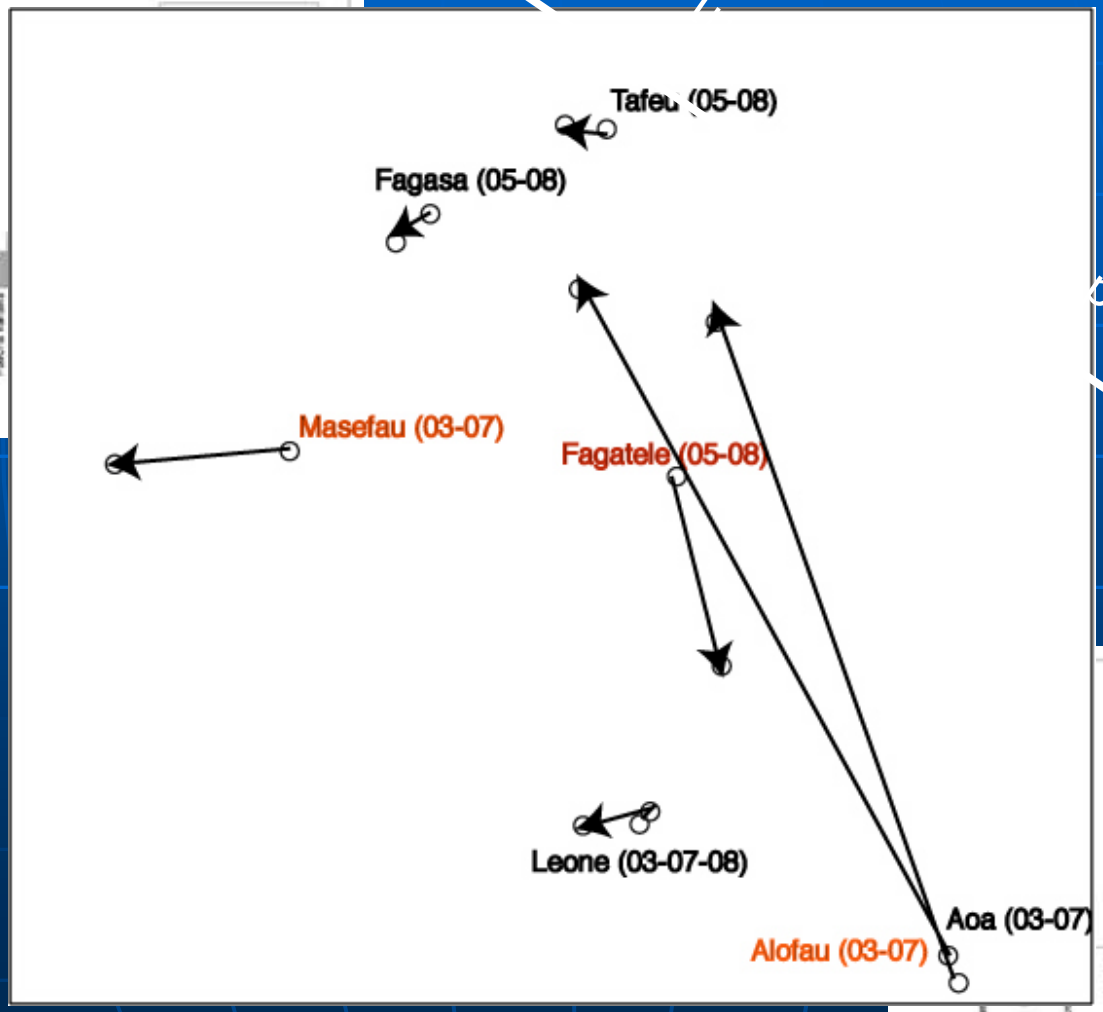
American Samoa

- Similar program
  - Limit goals and scope to land-based pollution only

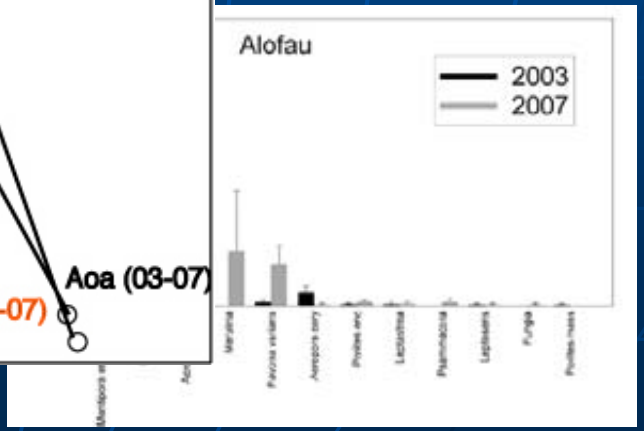


Disturbance in 2005



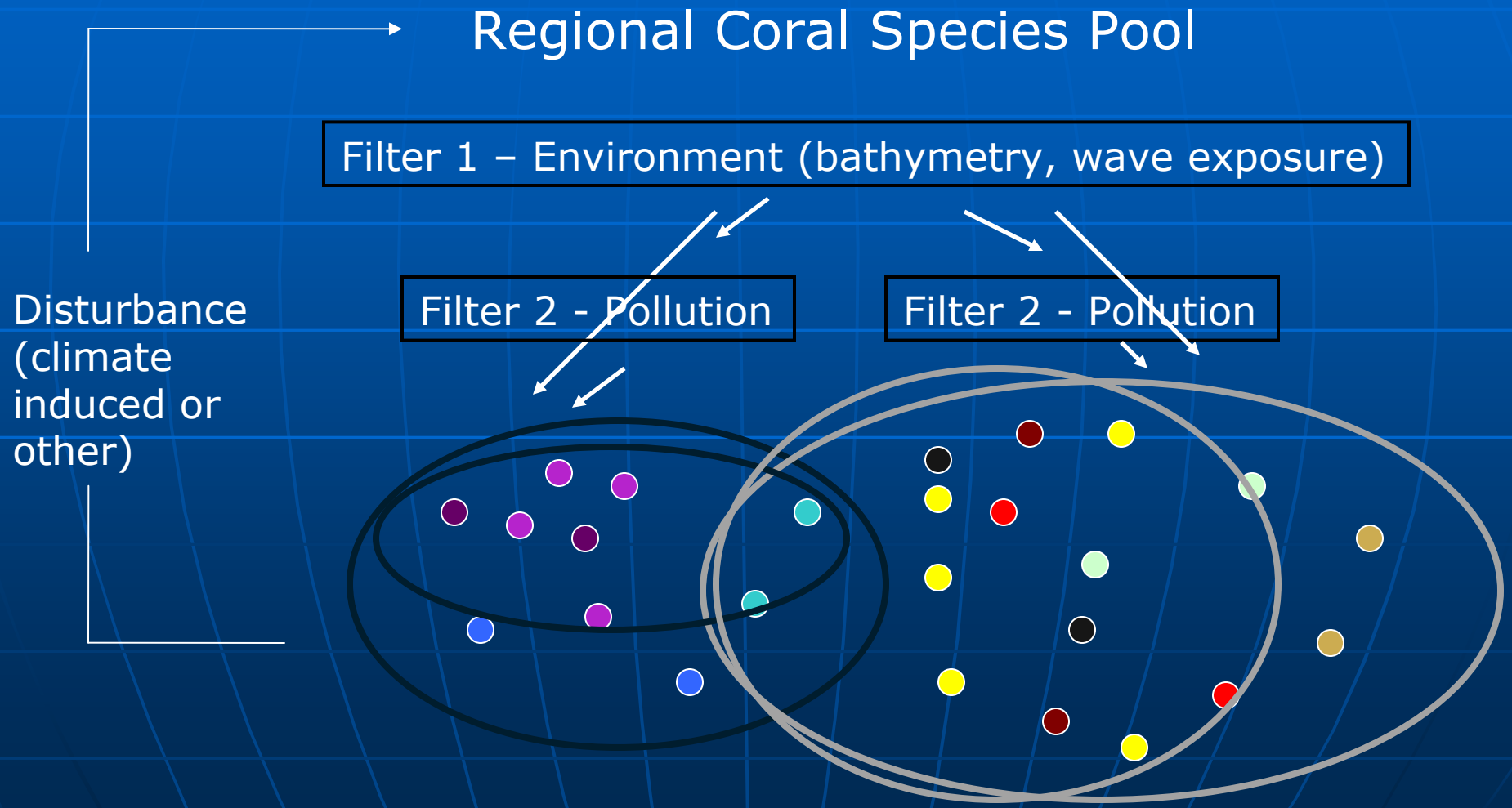


pollution

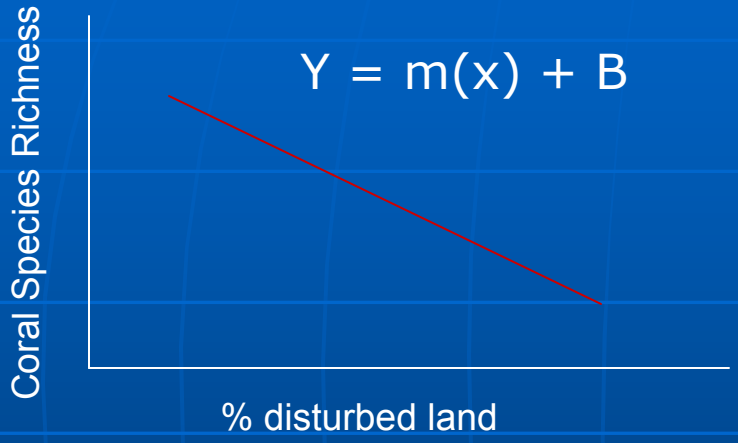


MDS Plot showing differences in coral assemblages between years

Common Themes



But how much and how fast?



…but more than one variable…

Coral diversity-per-unit-area – Consolidated reefs

Model	*Slope*	*SE*	*Intercept*	*P-Value*	*AIC*
watershed size2 : human population	-2.05E-04	7.07E-05	7.757	0.033	23.46
watershed size2 : disturbed land	-0.82	0.26	7.735	0.025	22.71
watershed size2 : human population : exposure	-7.60E-04	2.10E-04	7.598	0.016	21.42

of fit estimate for each model (see Material and Methods).

Reefs to watersheds

- Identify where ‘best’ reefs should exist
- Identify where compromised reefs exist
- Prioritize for management
  - Micronesia challenge and watershed planning

DEQ and ASEPA

- Use models to predict how many septic systems before negative change will occur
- How much urbanization?
- How many pigs?
- How much land clearing?

- Structure standards and regulations based upon findings

Biocritera and Territory WQS

- Current Language
  - shall not change benthic community with respect to a reference site
- Proposed Language
  - "At a minimum, coral species richness is one characteristic of nearshore (0-30 ft.) coral reef communities that should not significantly decline in comparison to one or more reference site(s) situated within a similar environment. A significant decline refers to a pairwise, statistical test of two means. A minimum of 20 replicated measures of coral species richness, at all reference and permitted sites, shall be collected at a uniform depth by haphazardly tossing a .5 m x .5 m quadrat at equal intervals within the site boundary. All coral species that lie partially or completely within the quadrat shall be identified for analyses. DEQ shall determine appropriate reference sites for all permitted activities."

Acknowledgements

To members of the Marine Monitoring Team…

Si Yu'us Ma'ase, Oloomway, and Thank You