

Marine Benthic and Fish Communities in Hanalei Bay, Kaua'i Since 1992: Spatial and Temporal Trends in a “Resilient” Hawaiian Coral Reef Ecosystem



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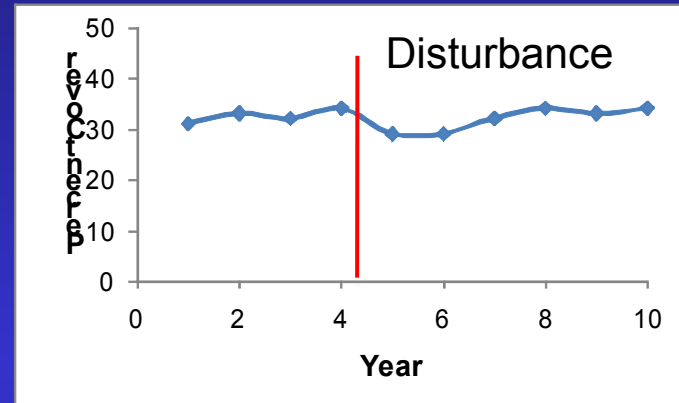
² NOAA/NOS/NCCOS/CCMA/Biogeography Team, Silver Spring, MD & The Oceanic Institute, Waimānalo, HI



Resistance vs. Resilience

- Resistance – The ability of an ecosystem to withstand disturbance without undergoing a phase shift or losing neither structure nor function (Odum, 1989).

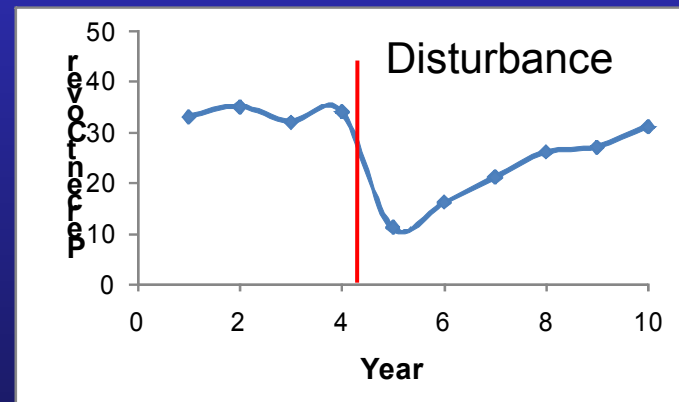
Acclimatization
Adaptation
Morphology
Upwelling
Currents
Physical Protection



- Resilience – The capacity of a system to absorb or recover from disturbances while maintaining its functions and services (Carpenter et al., 2001)

Reproduction
Connectivity
Species/Functional Diversity
Shifting Geographic Range

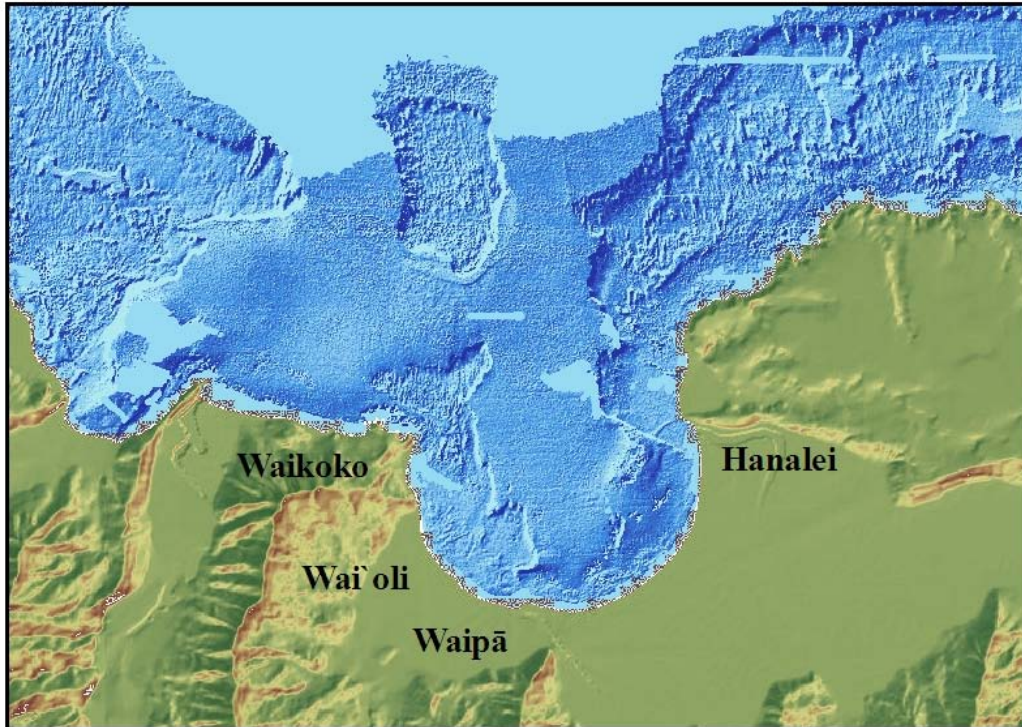
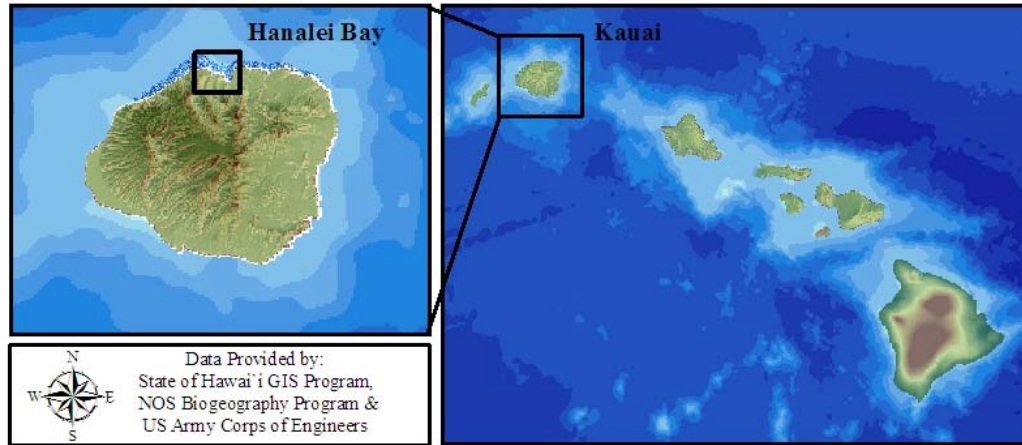
(Grimsditch and Salm, 2006)



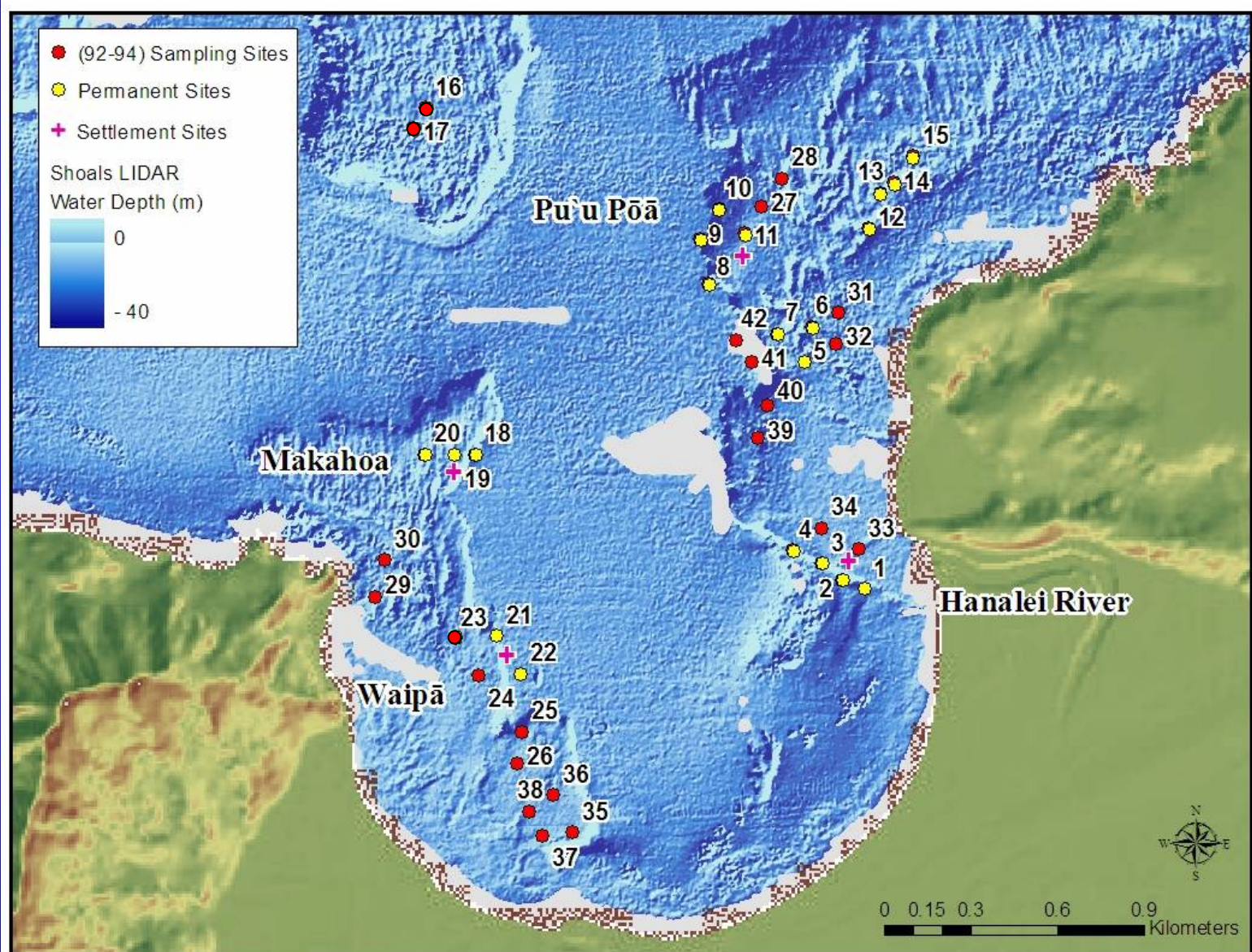
Objectives

- Determine trends in percent cover of sessile benthic marine macroinvertebrate (e.g., **corals**, zooanthids, sponges, etc.) and algal (e.g. fleshy macroalgae, crustose coralline, and turf algae) assemblages
- Document trends in fish assemblage characteristics (**species richness**, abundance, **biomass**, **diversity**, trophic composition)
- Document spatial and temporal patterns in settlement rate of hard corals
- Investigate physical parameters (**currents**, **waves**, **river discharge**) and anthropogenic factors (**population**) that may explain observed trends in benthic and fish communities

Study Area



Study Sites

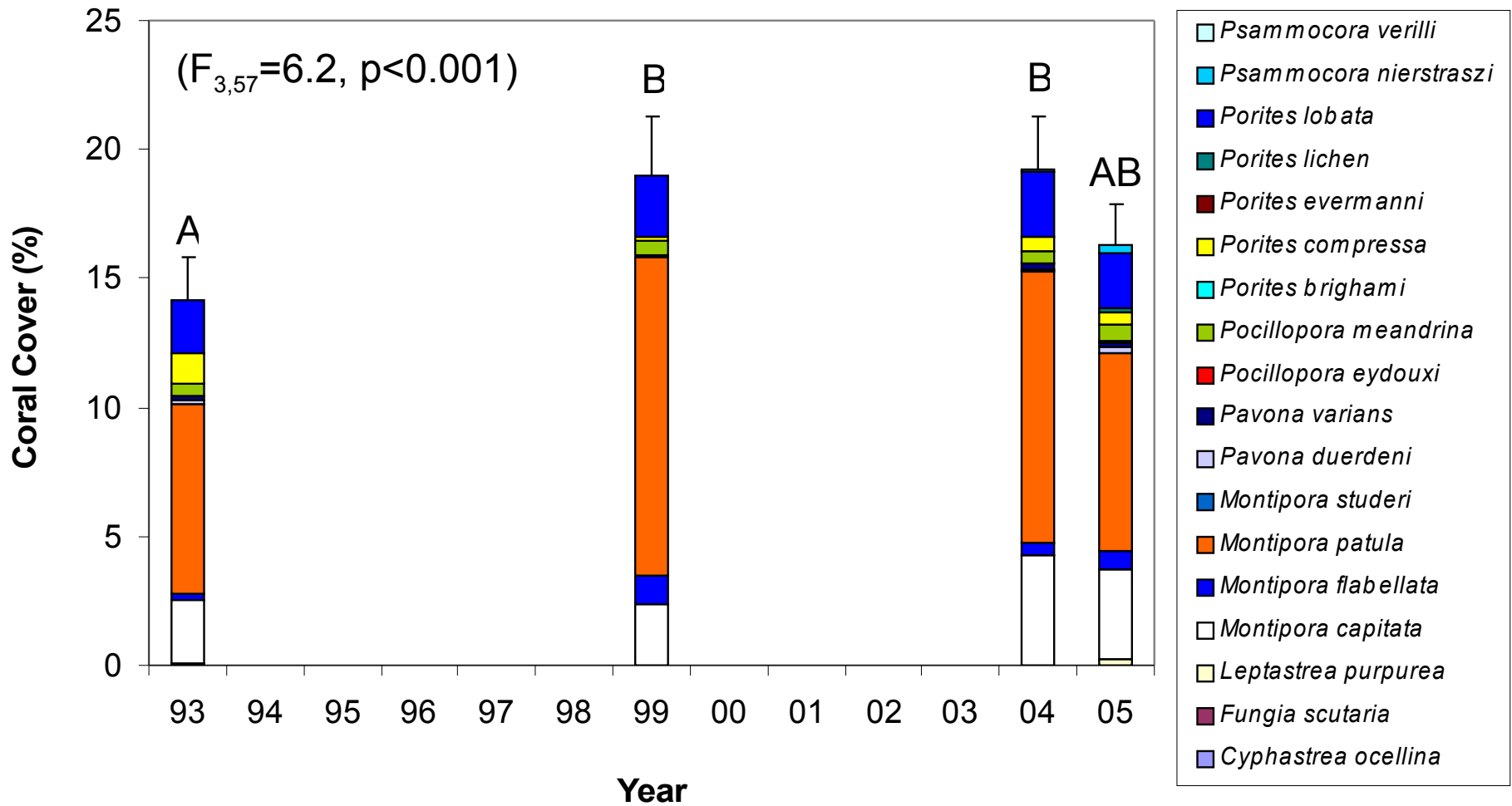


Methods

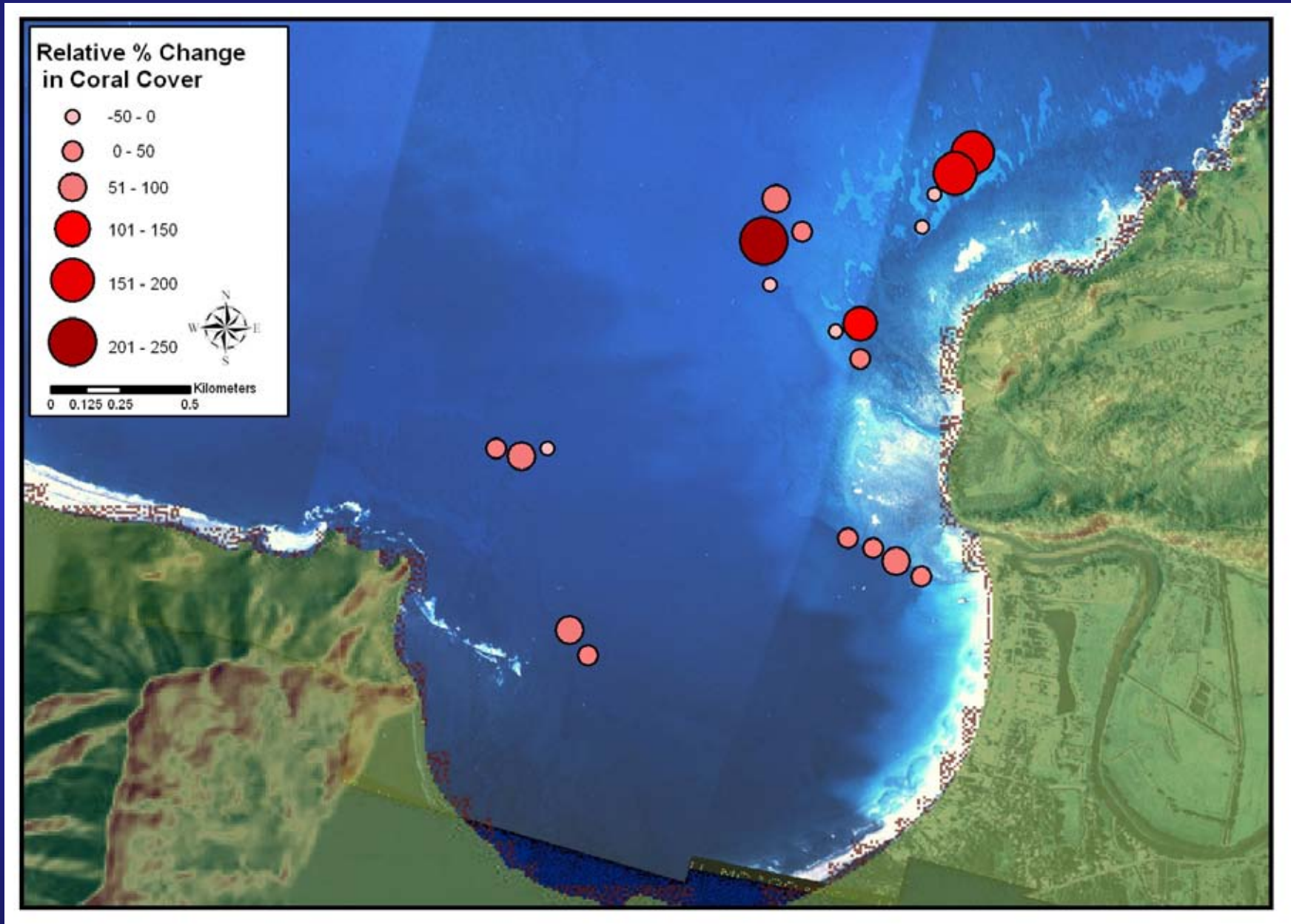
- 1.) Benthic Habitat (93,99,04,05)
Biotic cover (coral, algae, macroinvertebrates)
Abiotic (depth, habitat complexity, habitat type)
- 2.) Fish Censuses (92-94,99,03,04,05)
25 m x 5 m belt transects
- 3.) Coral Settlement (03-05)
Terracotta tiles
- 4.) Physical Parameters (05)
(currents, waves, river discharge, web)
- 5.) Population Statistics (DBEDT website)



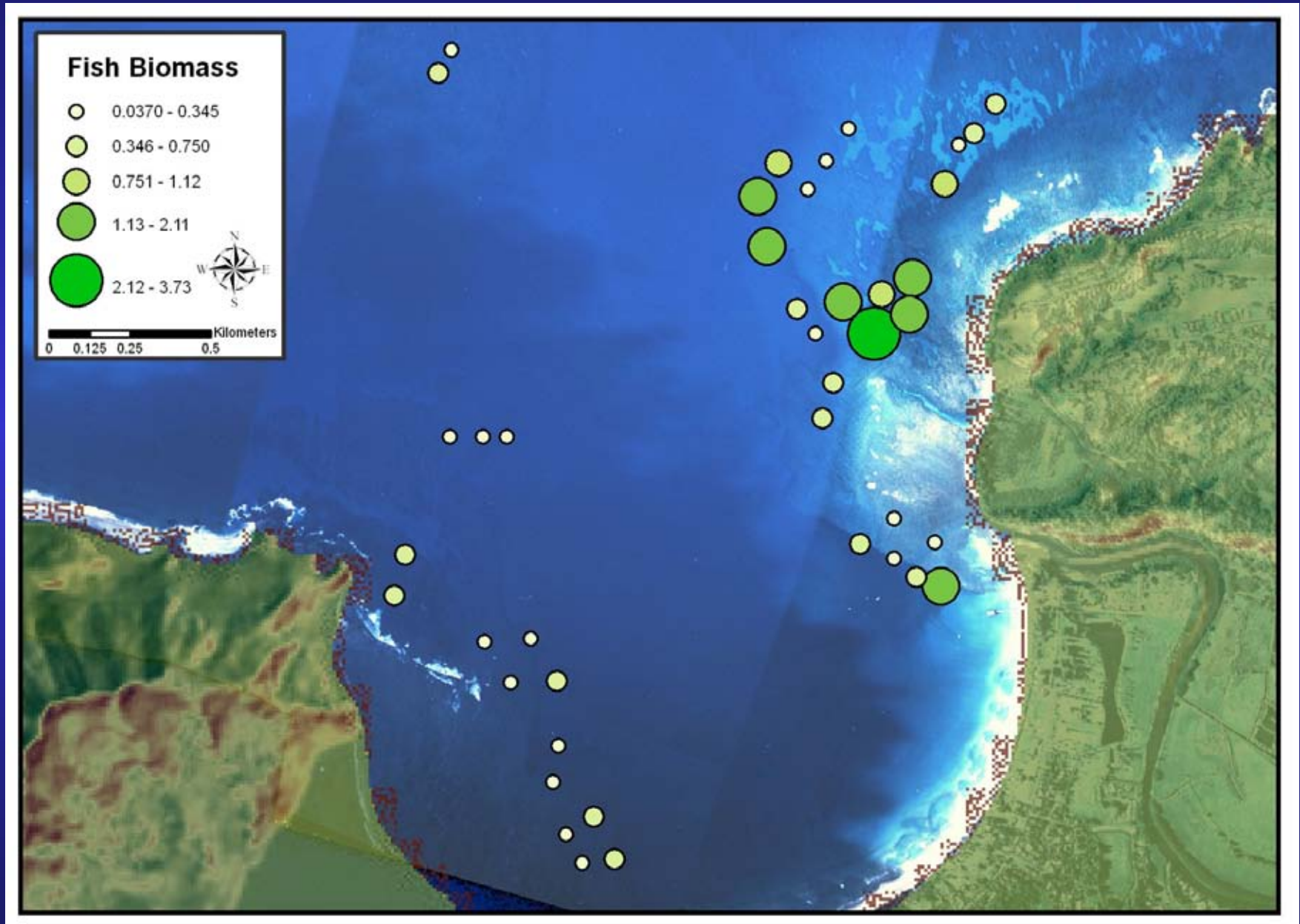
Results – Coral Cover Patterns



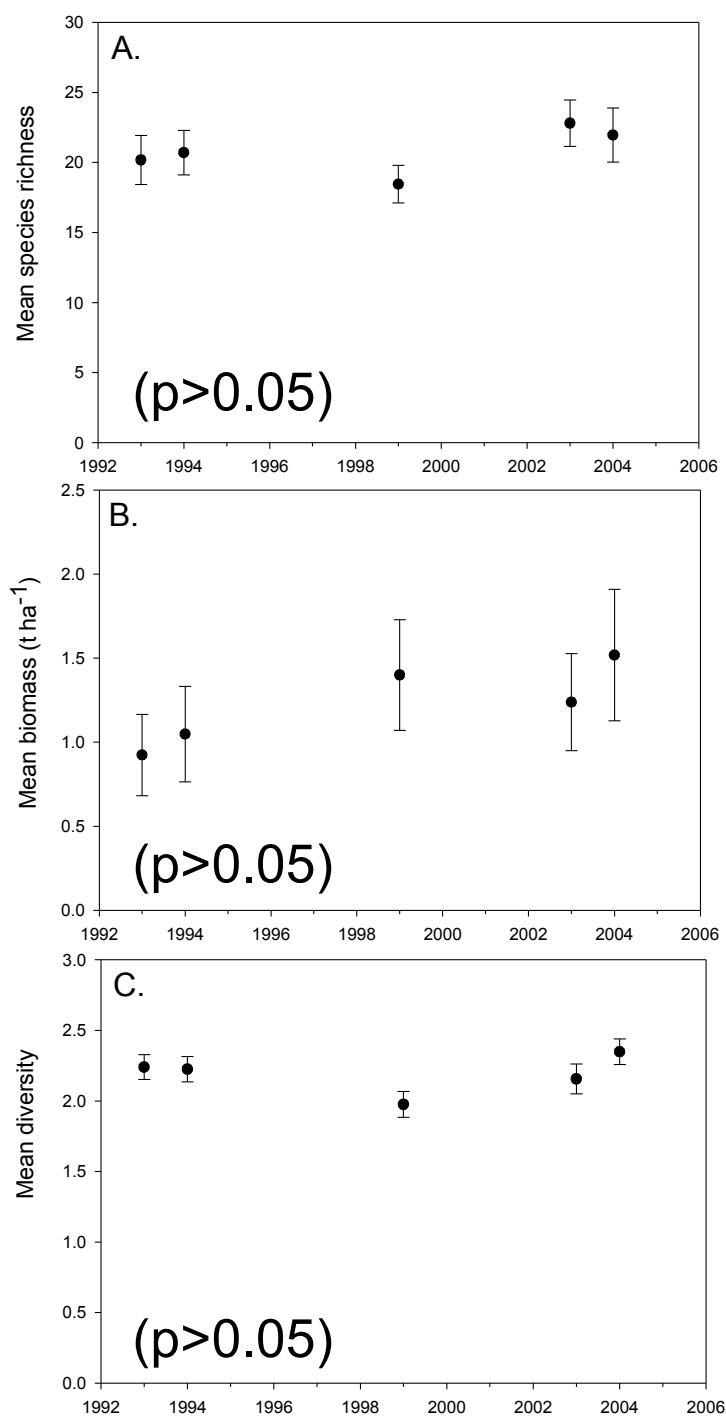
Results – Coral Cover Spatial-Temporal Patterns



Results – Fish Biomass Patterns



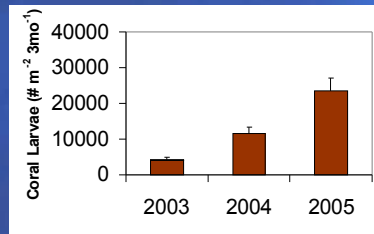
Results – Fish Assemblage Characteristics



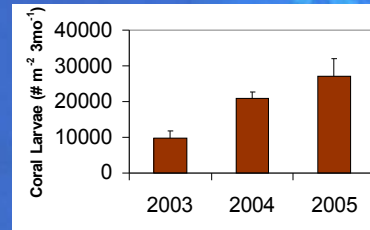
Results – Coral Settlement Patterns

Year: ($F_{2,66}=48.7, p<0.001$)

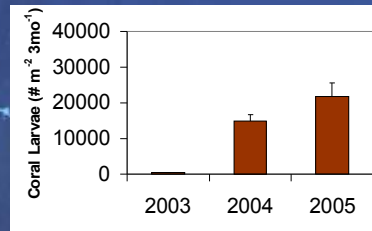
Site: ($F_{1,35}=44.6, p<0.001$)



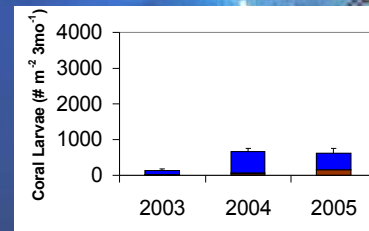
Makahoa



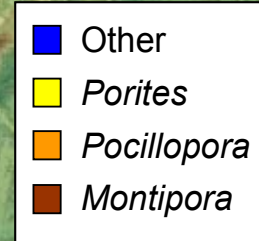
Pu'u pōā



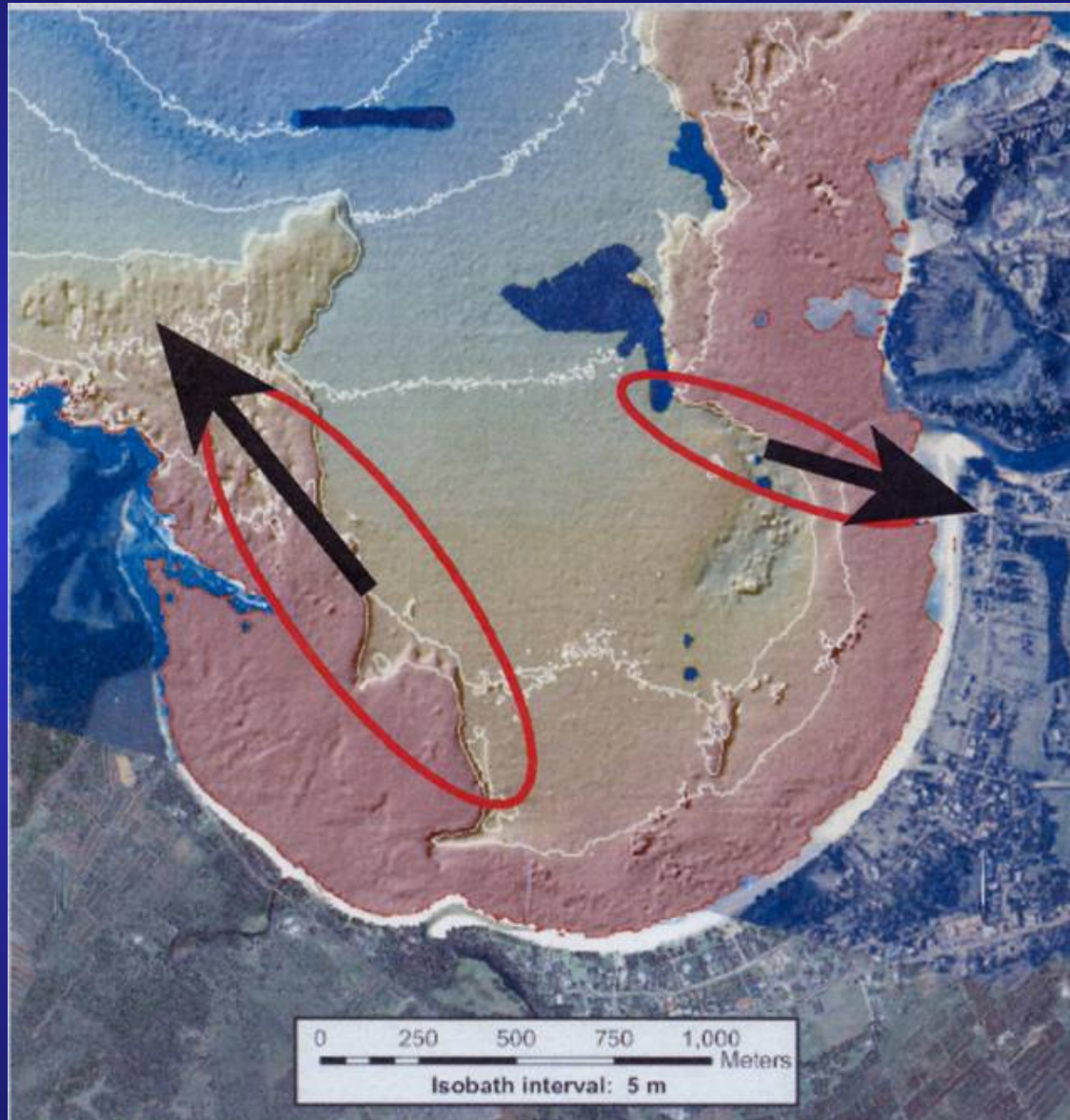
Waipā



Hanalei

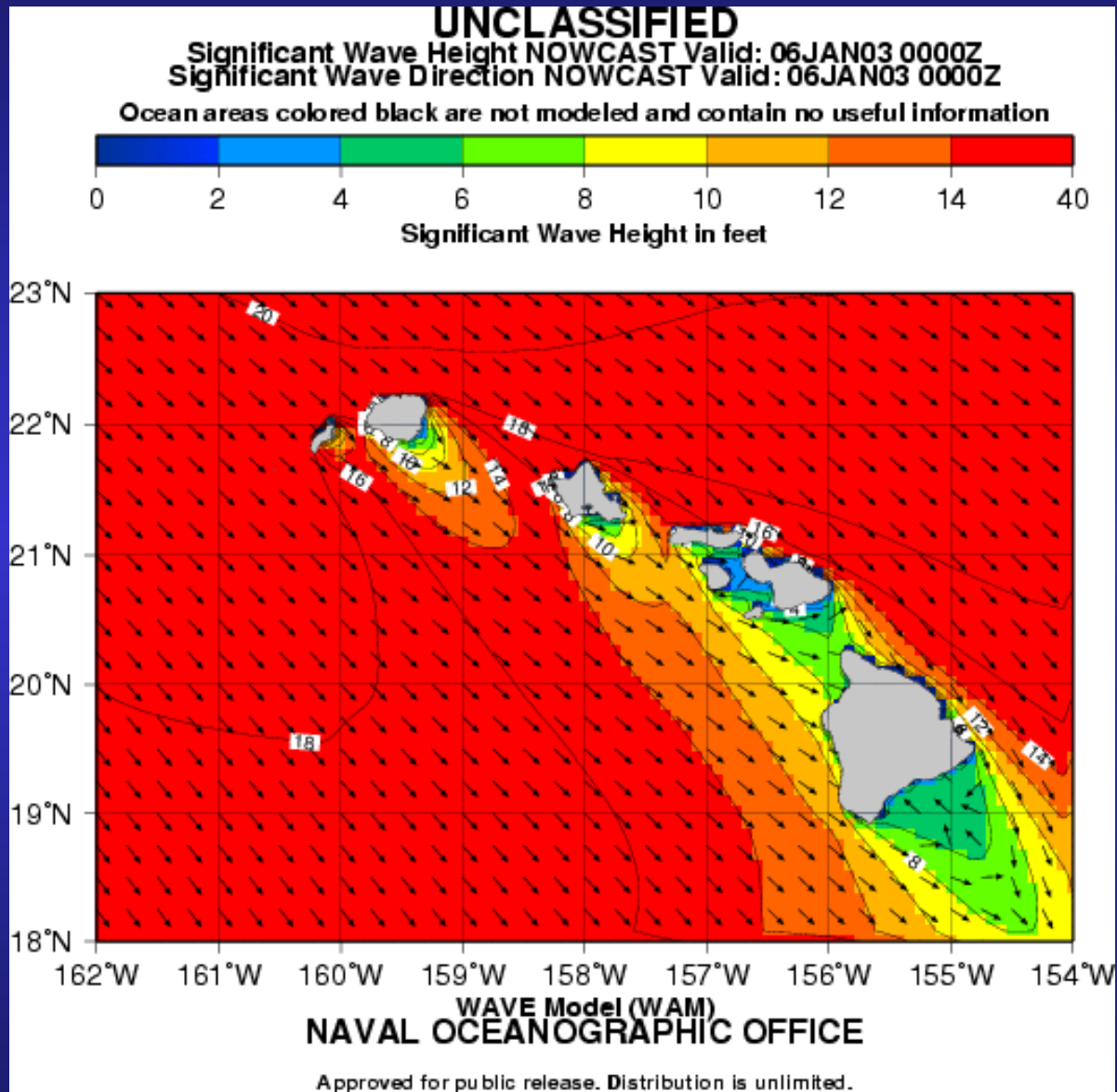


Current Patterns



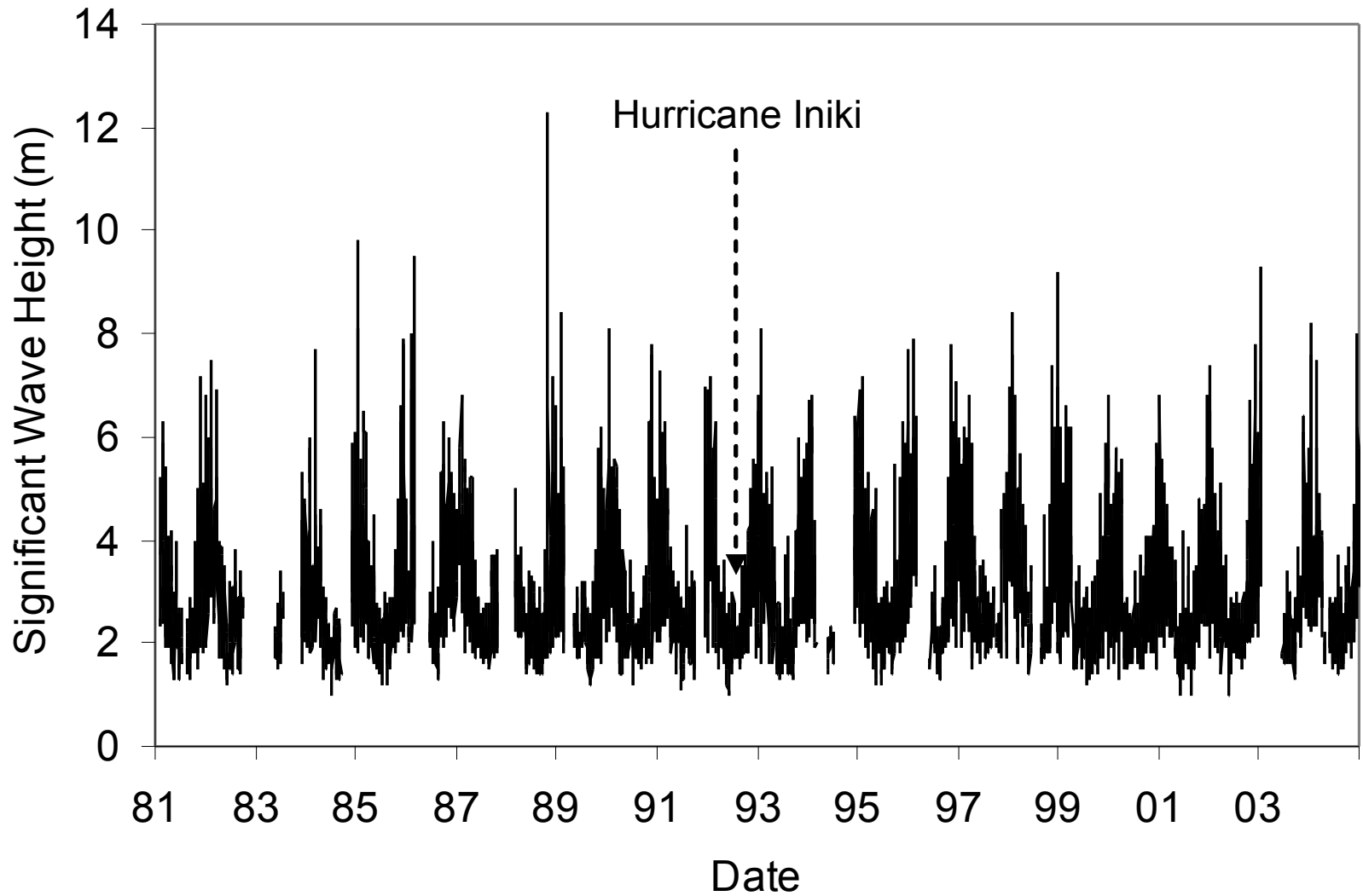
(Storlazzi et al., 2006)

Wave Climate



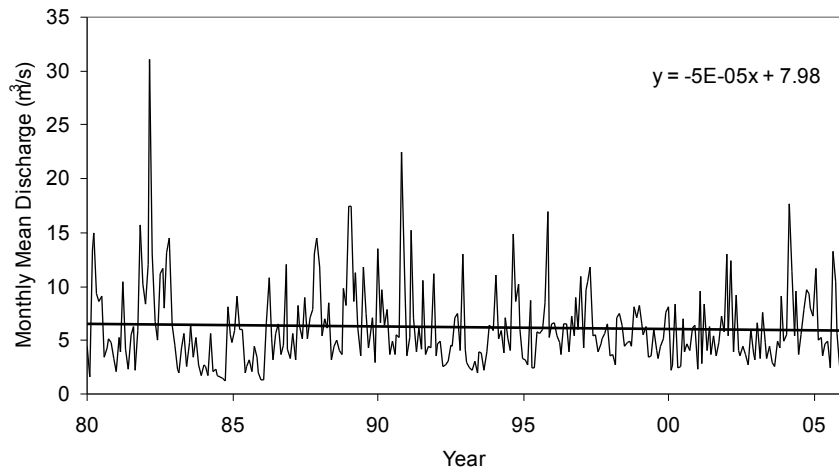
(US Naval Oceanographic Website)

Wave History

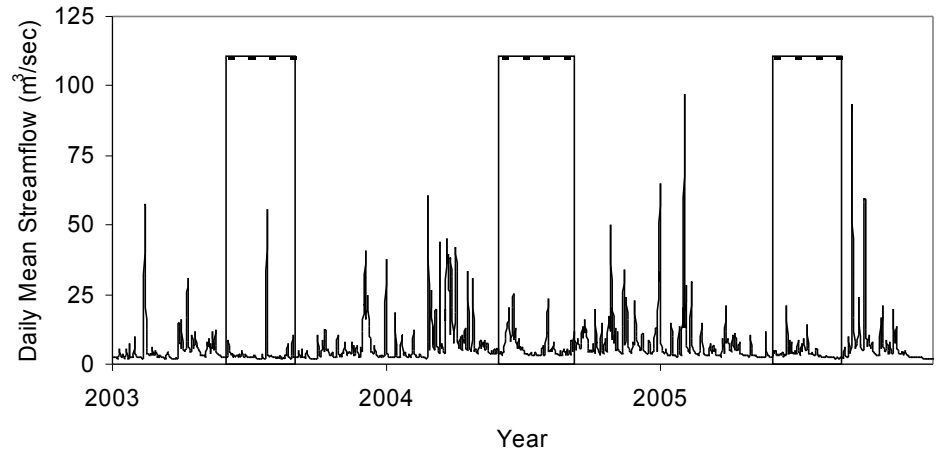


(NOAA Wave Buoy Website)

Hanalei River Discharge Levels

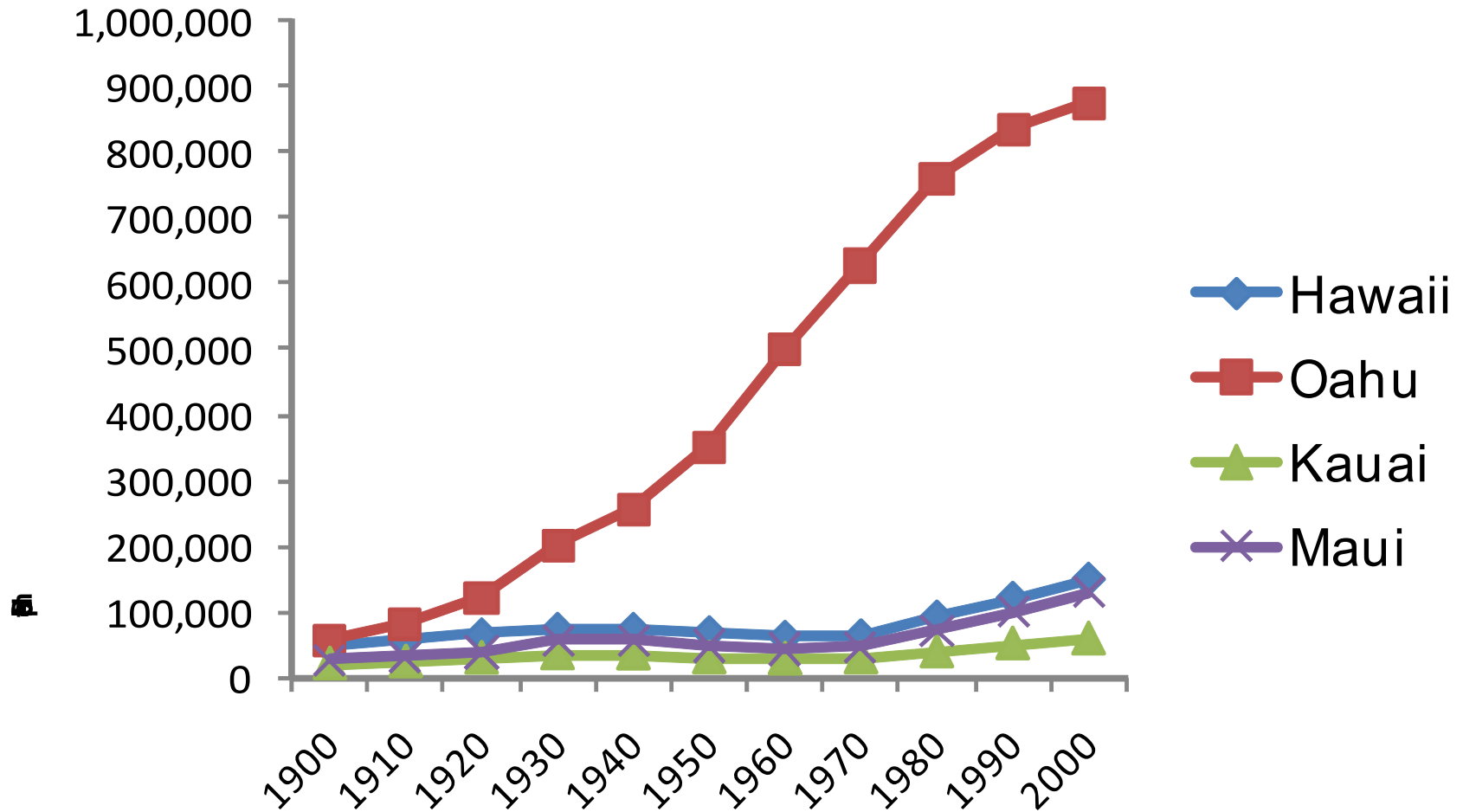


Long-term



During Coral Settlement Period

Hawai'i Population



- Population increase of 282% on Kaua'i since 1900
- Visitor traffic increase of 9% since 1990

(DBEDT Website)

Summary

- Benthos – Coral cover has increased slightly since 1992 and is highest at Waipā (24%)
- Fish – Communities appear stable with a slight increase in biomass of 38%
- Coral settlement – some of the highest in the world and may help explain the observed trends in coral cover.
- Current – clockwise direction of water and retention within the bay
- Wave climate – stronger northwesterly swell activity during winter months than elsewhere in Hawai'i
- River discharge – high but has decreased over time and is low during critical coral spawning periods
- Human population on Kaua'i has increased 282% since 1900
 - Less than Hawai'i (319%), Maui (482%) and Oahu (1,496%)

Management Implications

- Identify areas around Hawai'i such as Hanalei Bay that are:
 - Resilient – High reproductive output of coral
 - Resistant – Little change since 1992 despite dynamic environment
- Natural factors such as large wave events are likely more important in structuring the coral community than anthropogenic factors
- Mitigating local stressors such as overfishing, sedimentation, and excess nutrients may help areas like Hanalei continue to be both resistant and resilient to climate change

Acknowledgements

- Hanalei Watershed Hui – Carl Berg, Maka‘ala Kaumoana
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