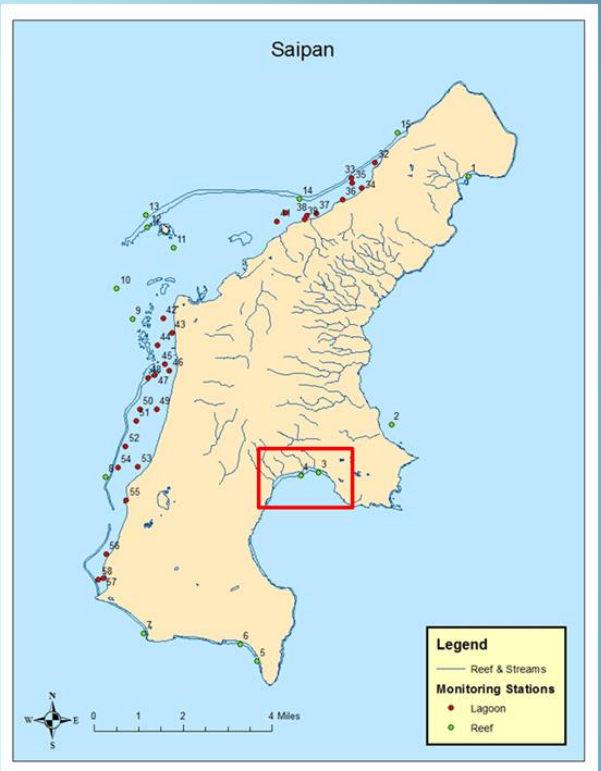
LAOLAO BAY; STATUS AND FUNCTION

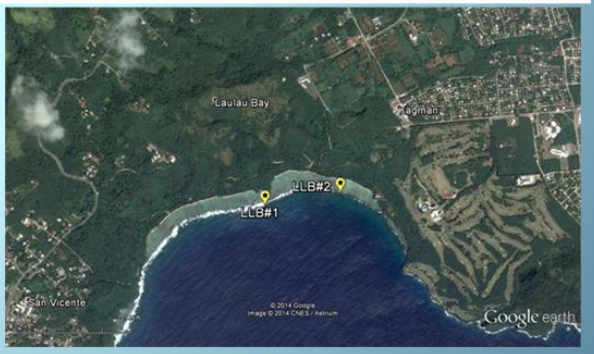
David Benavente

CNMI MMT

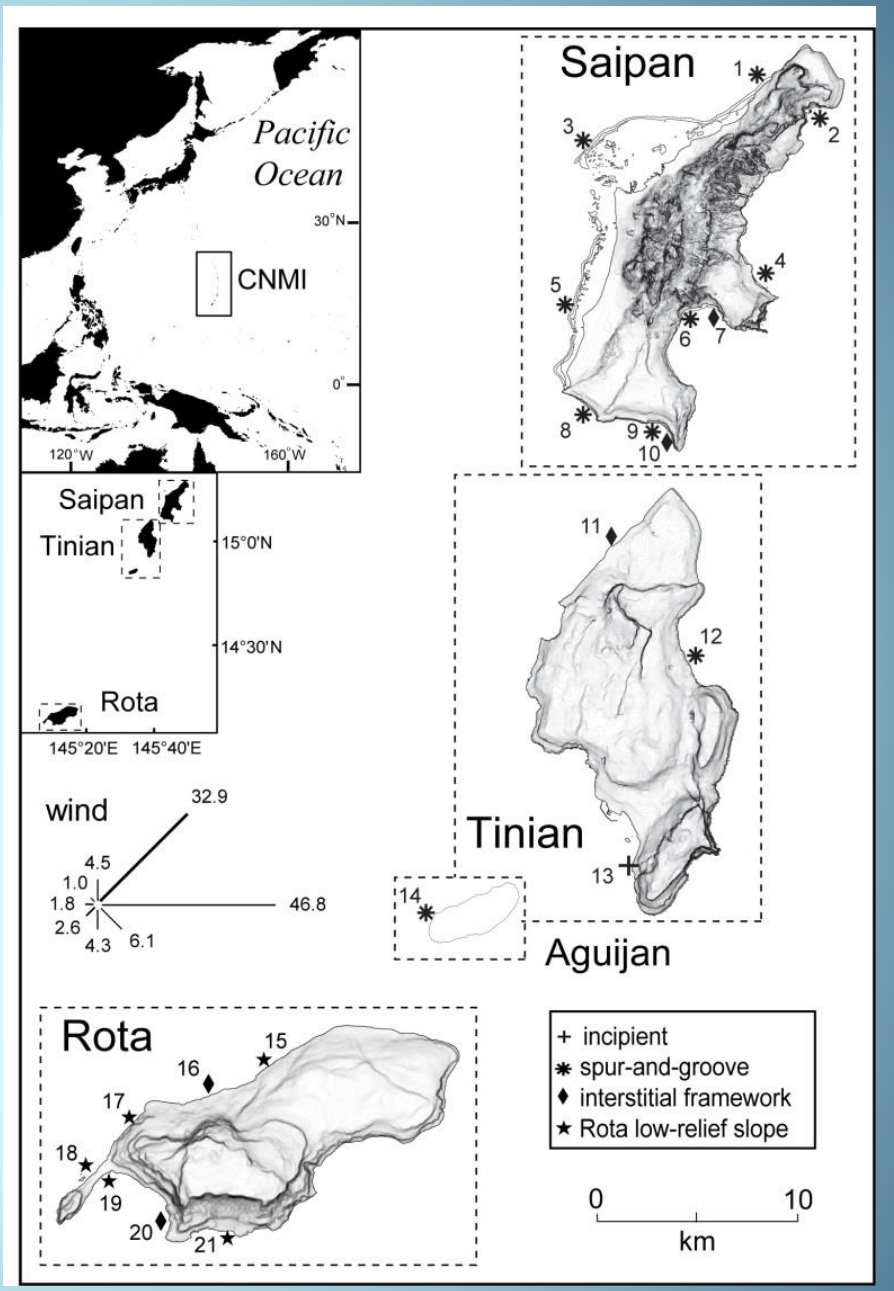
Outline

- Background (MMT)
  - Timeline
  - Studies and Findings
  - Future Steps

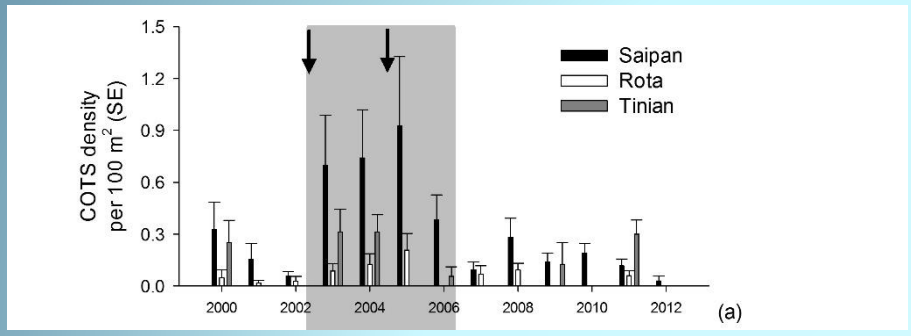


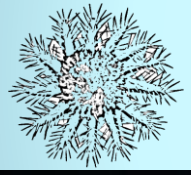


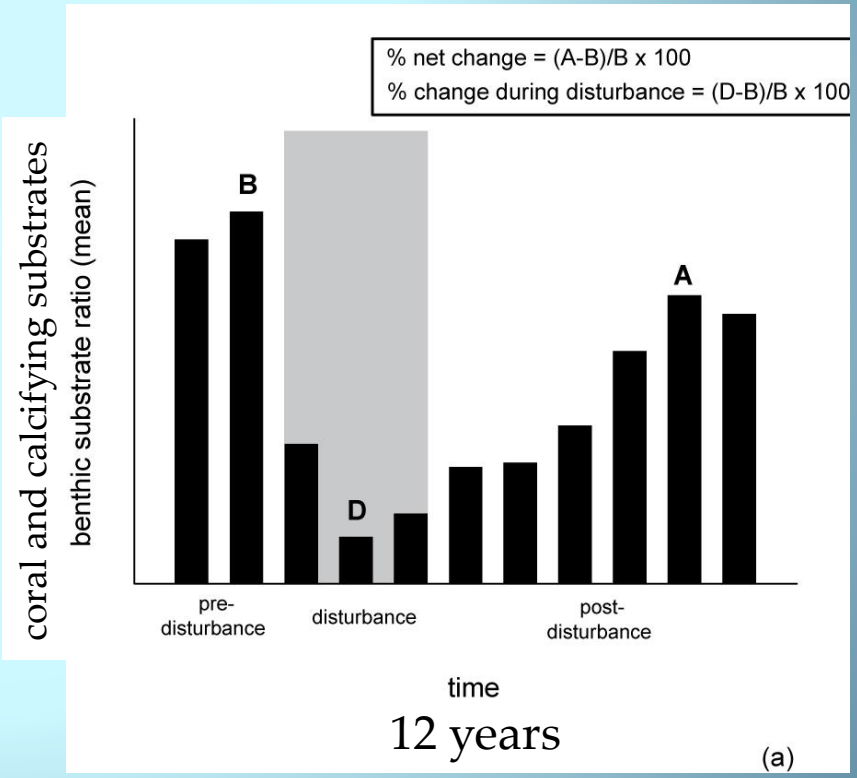
In the CNMI


Pacific Ocean
30°N
0°
120°W
160°W
CNMI
Saipan
Tinian
Rota
15°0'N
14°30'N
145°20'E
145°40'E
wind
32.9
4.5
1.0
1.8
2.6
4.3
6.1
46.8
Saipan
1
2
3
4
5
6
7
8
9
10
Tinian
11
12
13
Aguijan
14
Rota
15
16
17
18
19
20
21
+ incipient
✱ spur-and-groove
♦ interstitial framework
★ Rota low-relief slope
0
10
km

Quantifying recovery rates







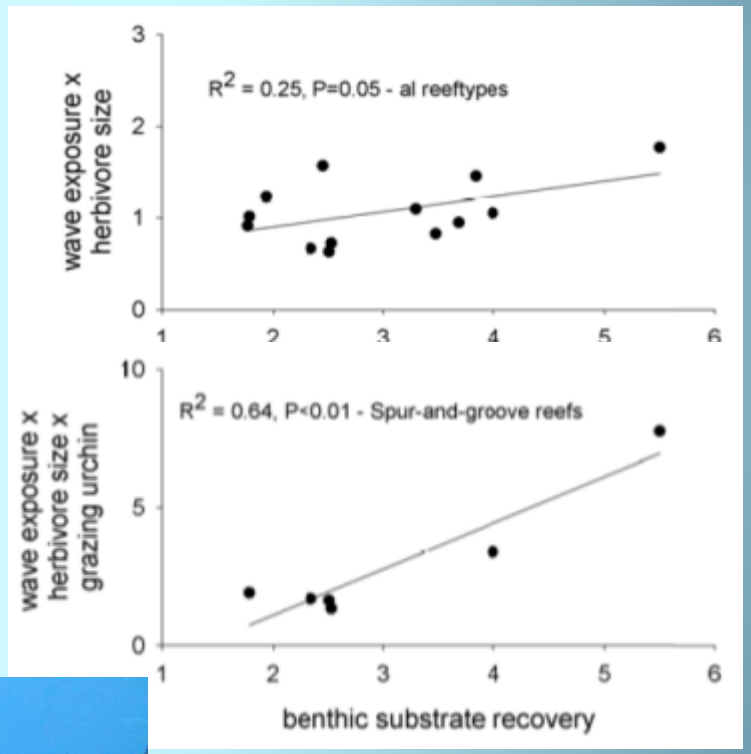
Understand habitat change?

Laolao Bay, 1950’s

Laolao Bay, 2012

Fish and recovery status

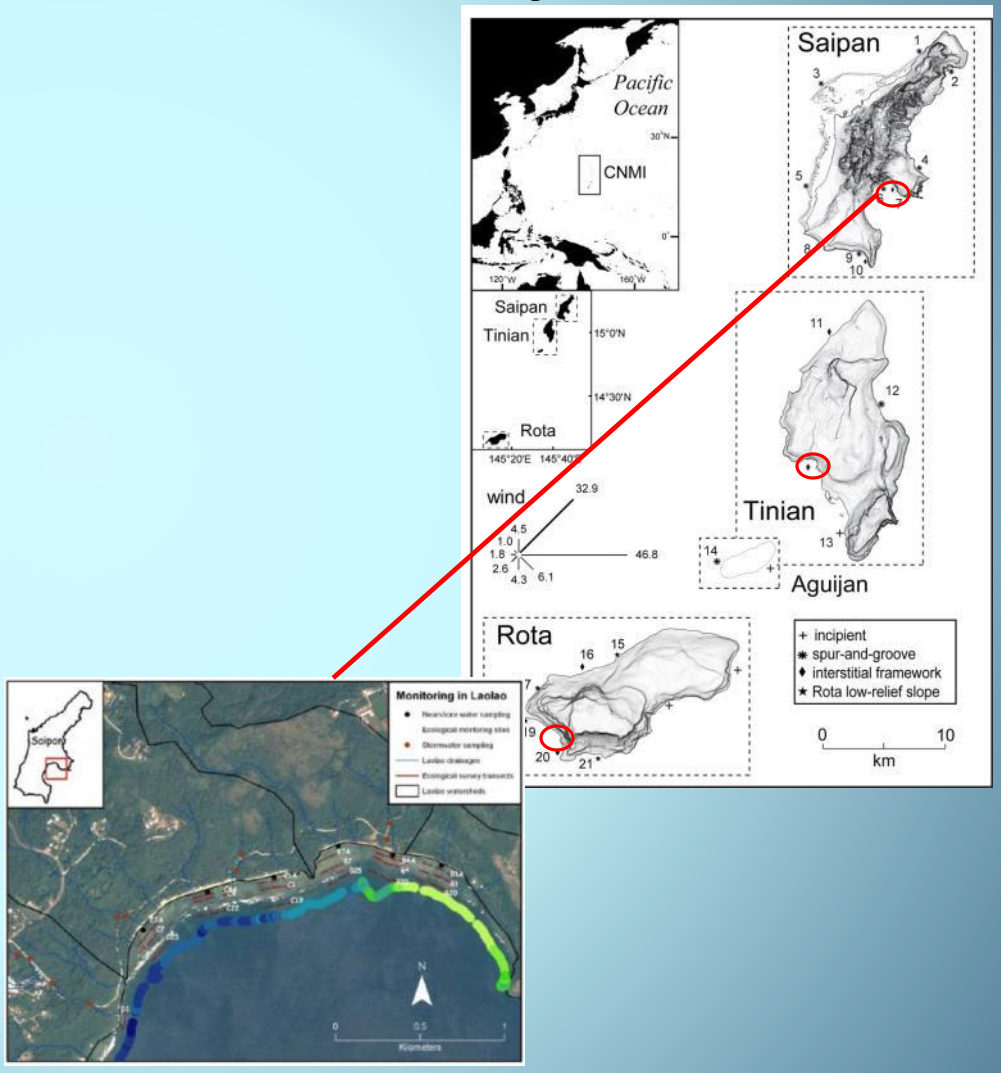
- Recovery in corals to *Acropora* and *Pocillopora* dominated states well predicted by herbivores
  - Wave exposure co-variate



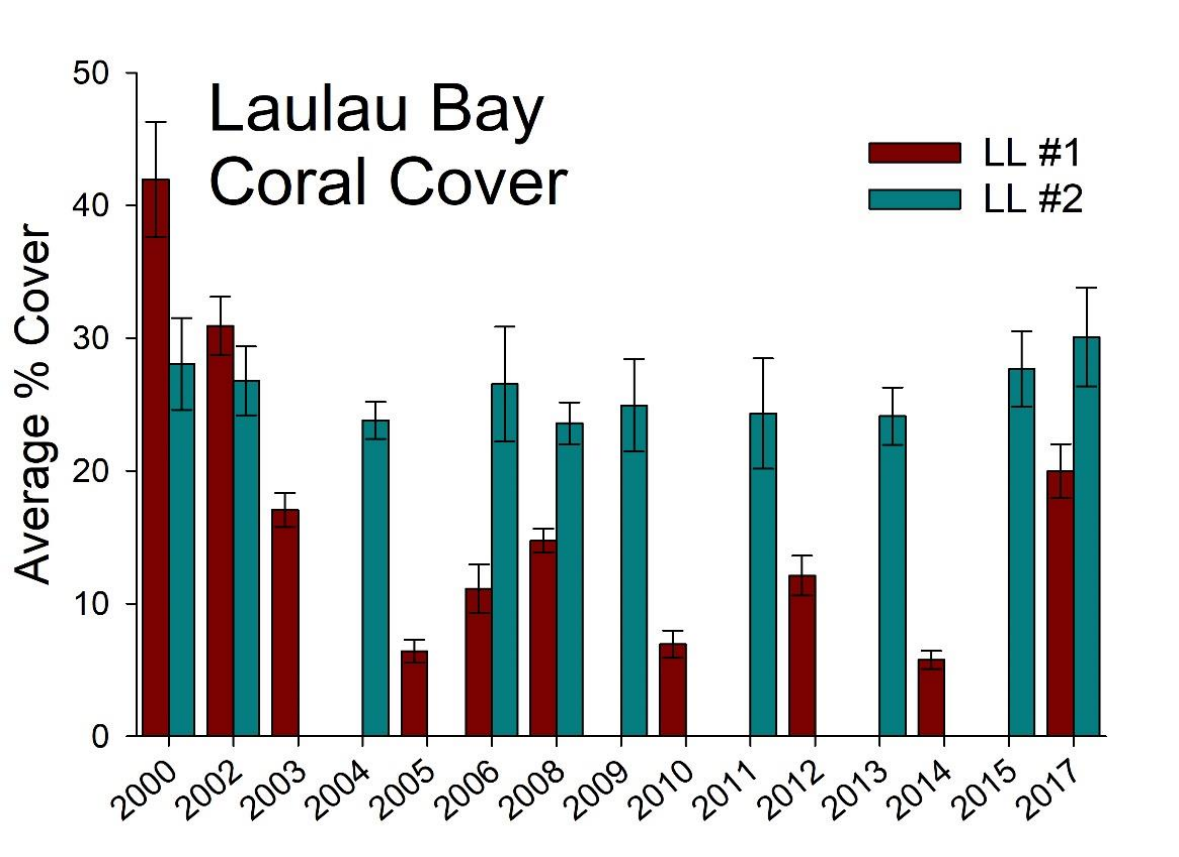
Houk MMT, 2014

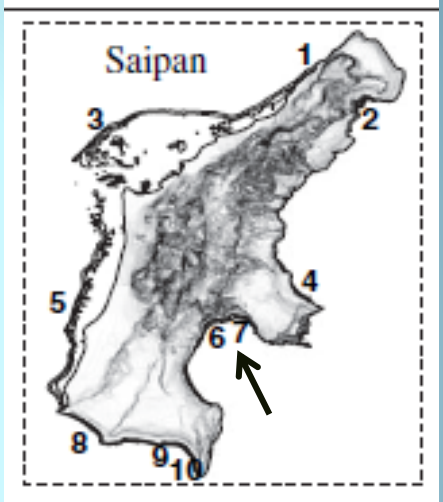
Water quality as secondary driver

- Red circles indicate karst watershed and connectivity with groundwater



Laolao Bay, the case of limited recovery





1992 Laolao Bay study as a basis

QUANTITATIVE MARINE BASELINE SURVEY

BIOLOGICAL RESOURCES AND WATER QUALITY

BAHIA LAULAU AND UNAI LAULAU KATTAN AREAS
SAIPAN, MARIANA ISLANDS

FINAL REPORT
DRY AND WET SEASONS OF 1991

PREPARED FOR
SC PROPERTIES
SAIPAN

SUBMITTED BY
CHEENIS PACIFIC COMPANY
SAIPAN

APRIL 1992

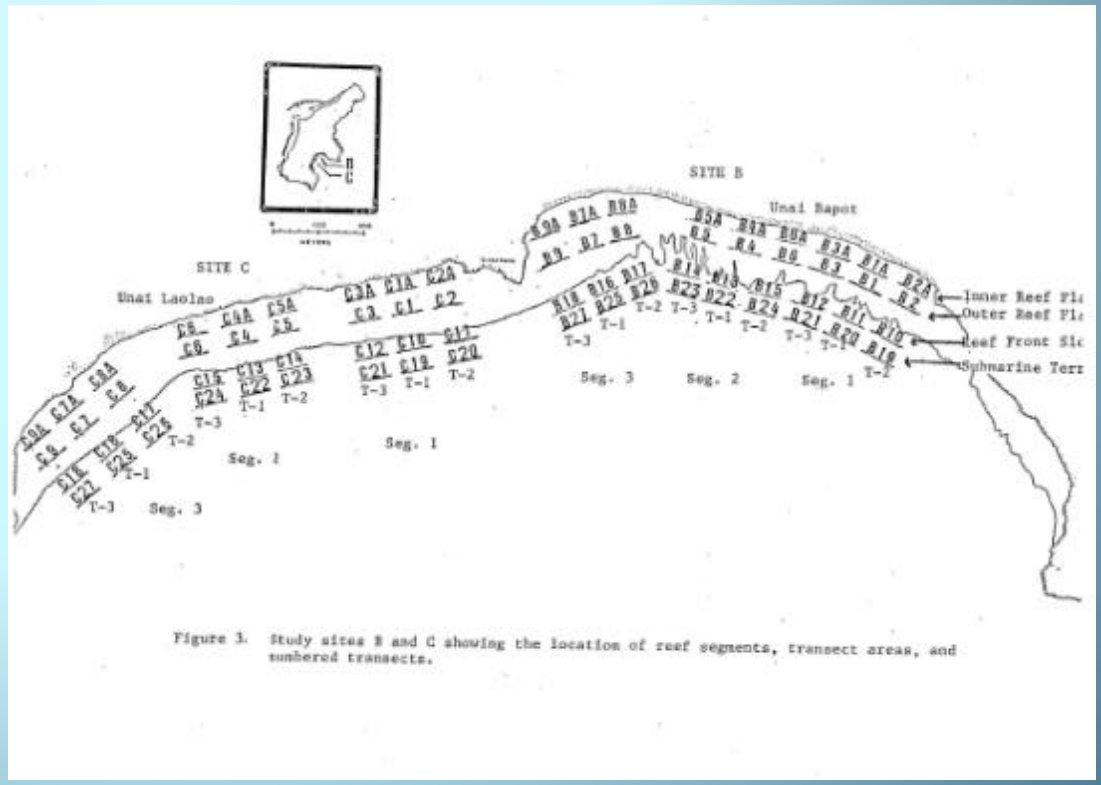
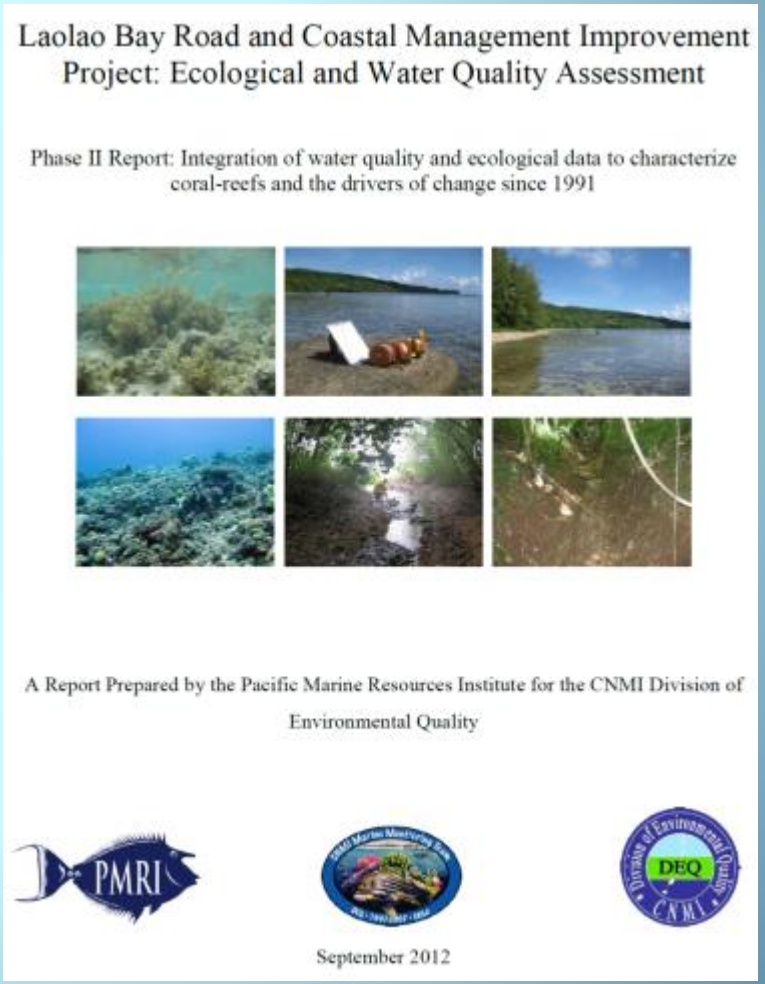


Figure 3. Study sites B and C showing the location of reef segments, transect areas, and numbered transects.

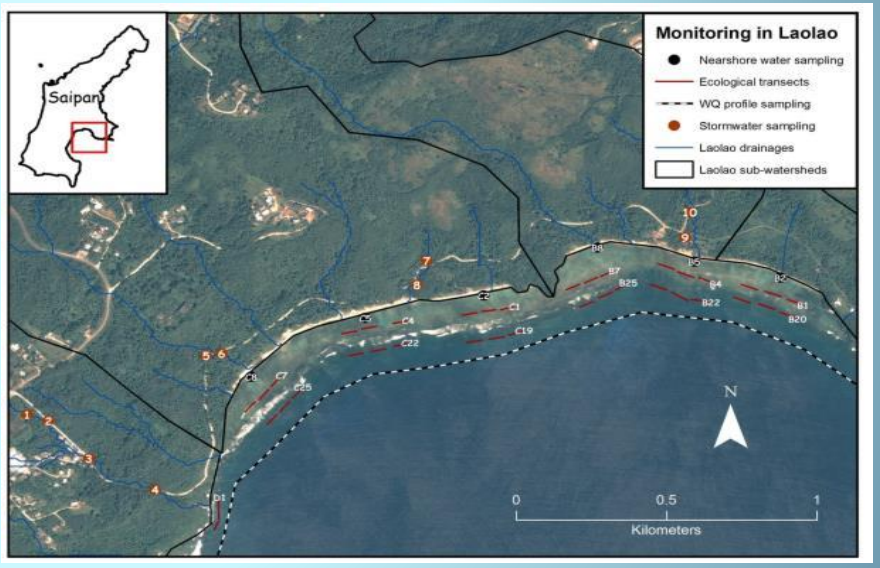
2010 Revisit

- ARRA-funded Road and Coastal Management Improvement Project”
- Suggested major change to coral and fish assemblages
- Called for more in depth examination into the nature and consequences of change



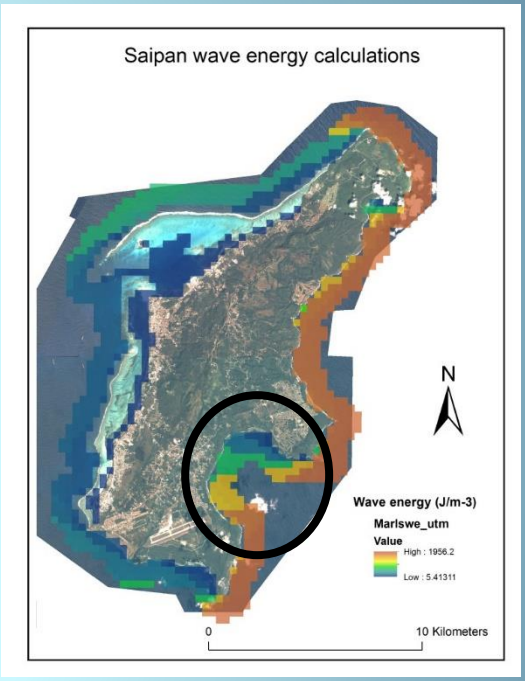
Building upon 2010 study

- Wealth of benthic, coral, and algal assemblage data
- Combined, integrated analyses



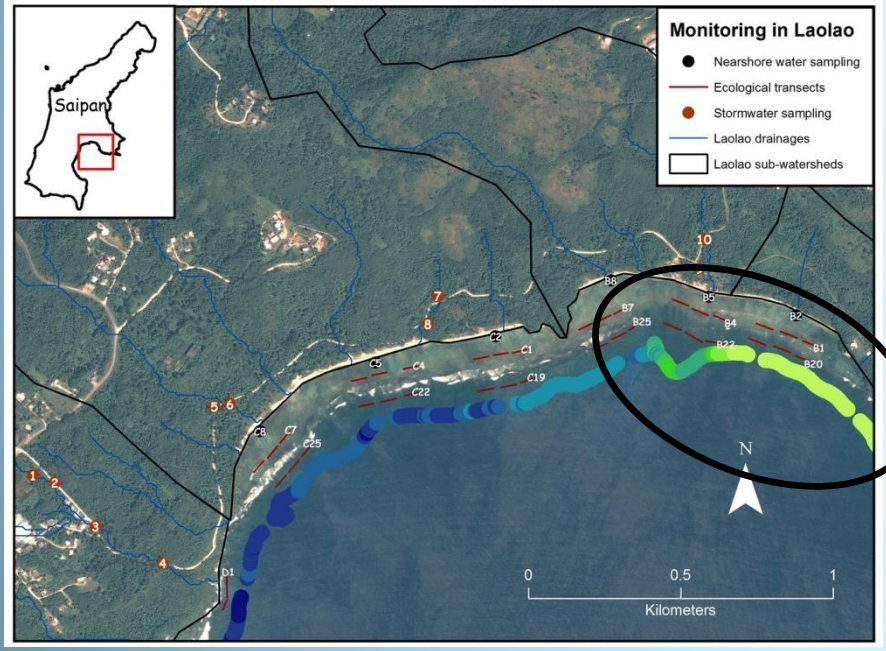
Environmental data incorporated

- WQ sampling
  - 1992 and 2010
  - Turbidity, nitrates, ammonia, phosphates, pH, dissolved oxygen
- Wave exposure
  - Pixel calculations based upon 10-year records
  - Strong gradient in Laolao of interest

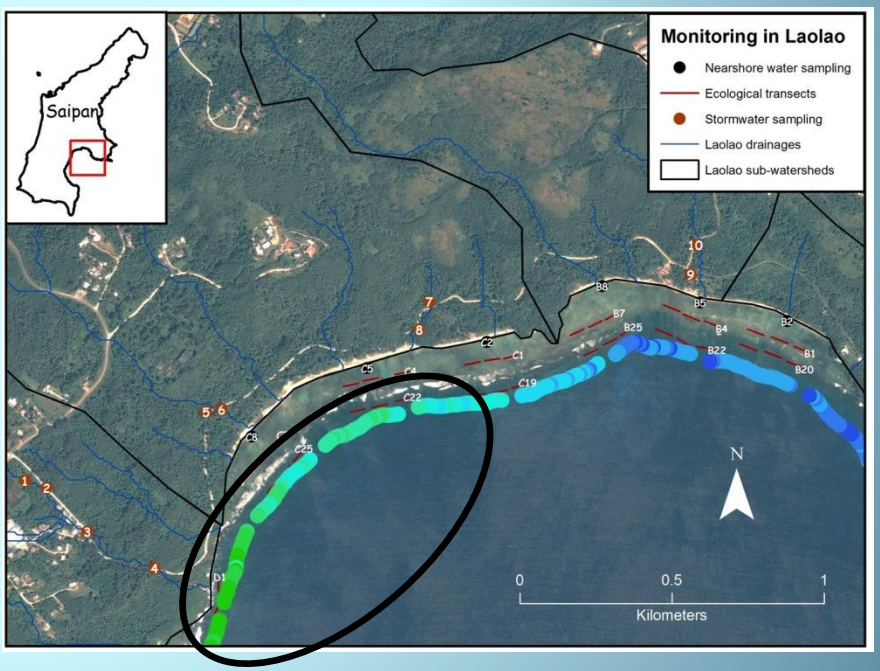


Watershed geology and salinity

- Full and new moon periods, no rainfall
- Mid-moon, rainfall

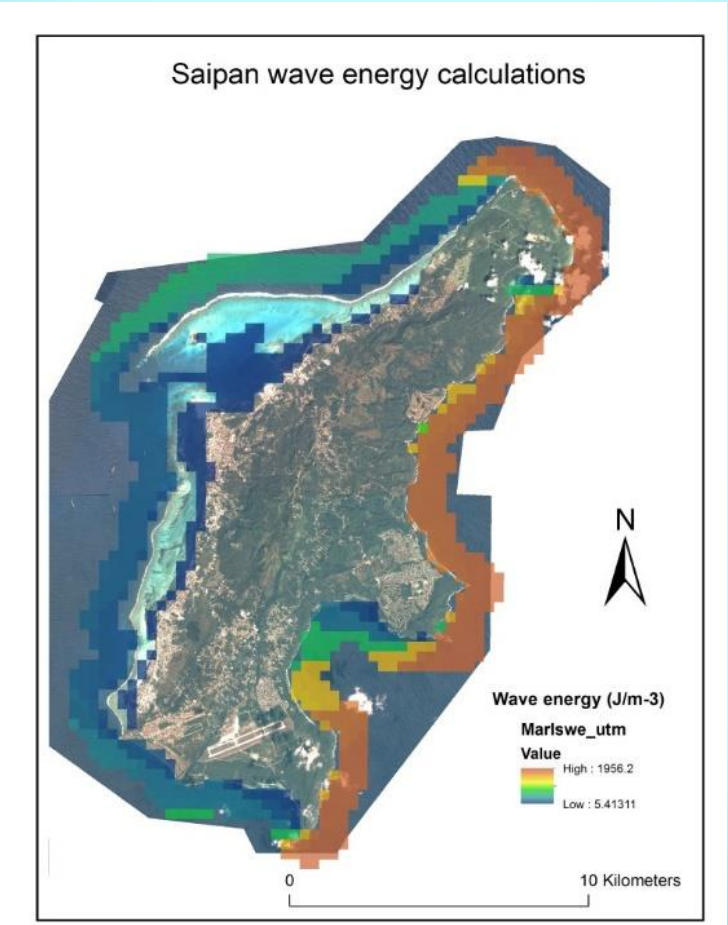


Karst in the east (groundwater)



Volcanic bedrock in the west (surface flow)

Wave exposure

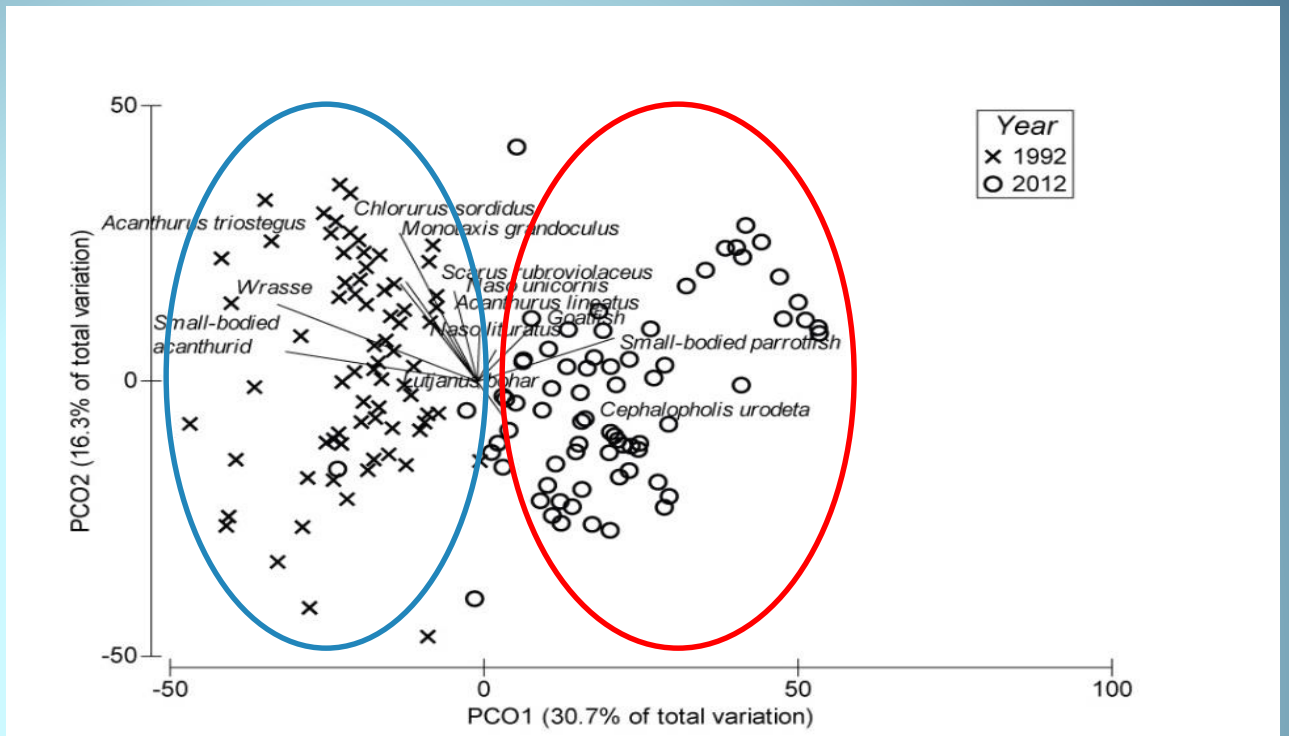


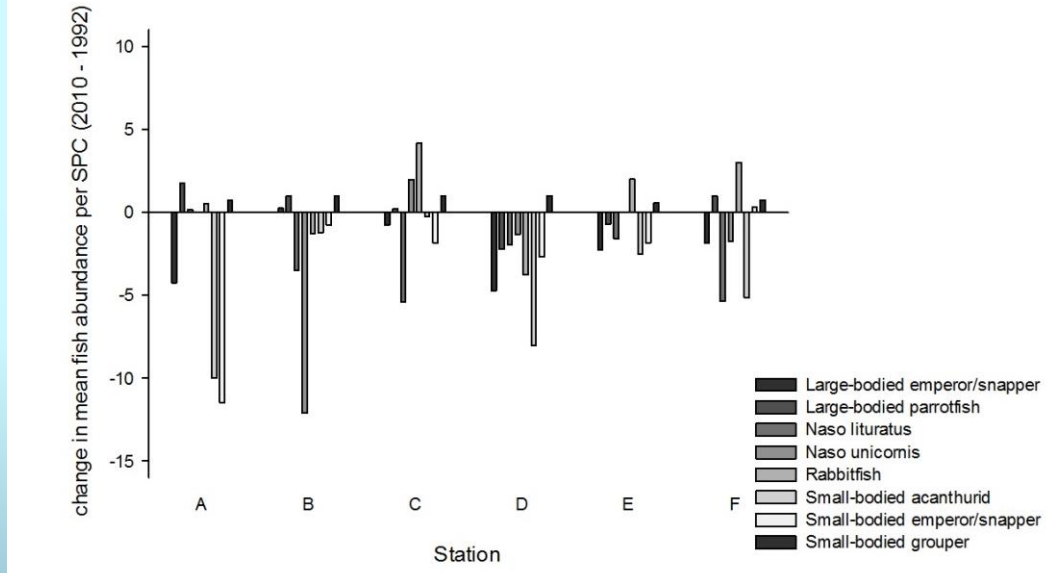
NE Exposure in the west

NE protection in the east

Fish

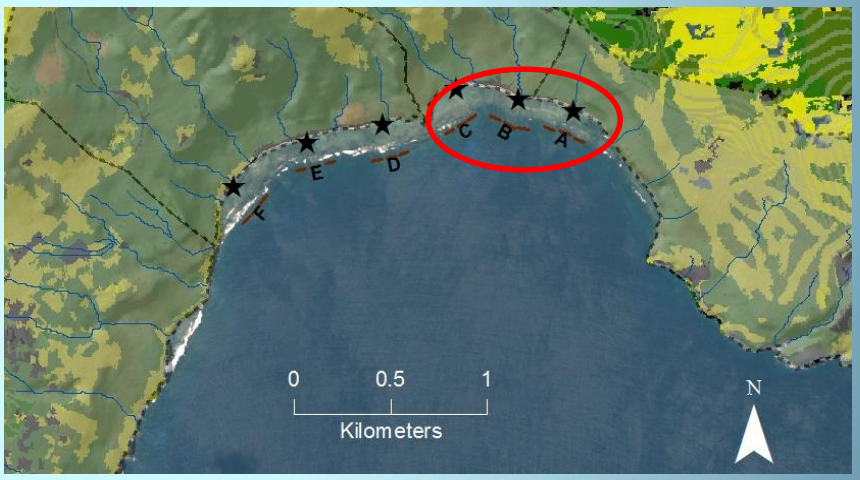
- Significant shifts in fish assemblages
- Decrease in density of most fish





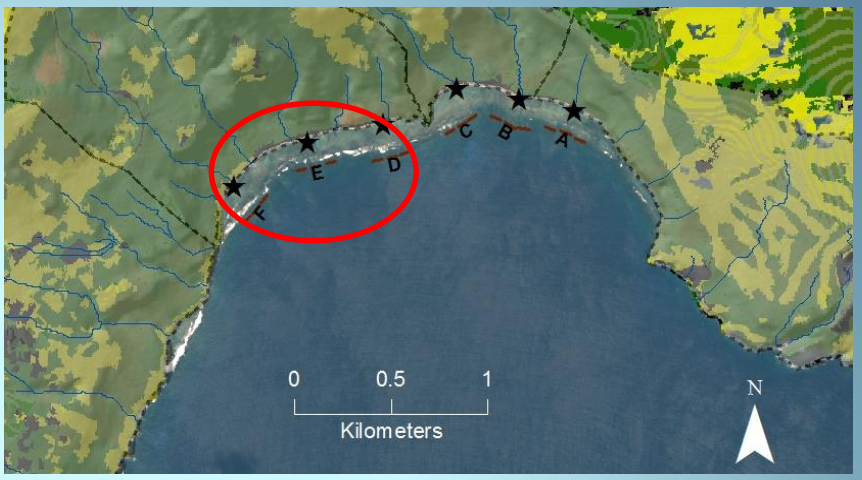
Eastern Laolao

- Least overall change with low wave exposure and karst (limestone)watershed influence

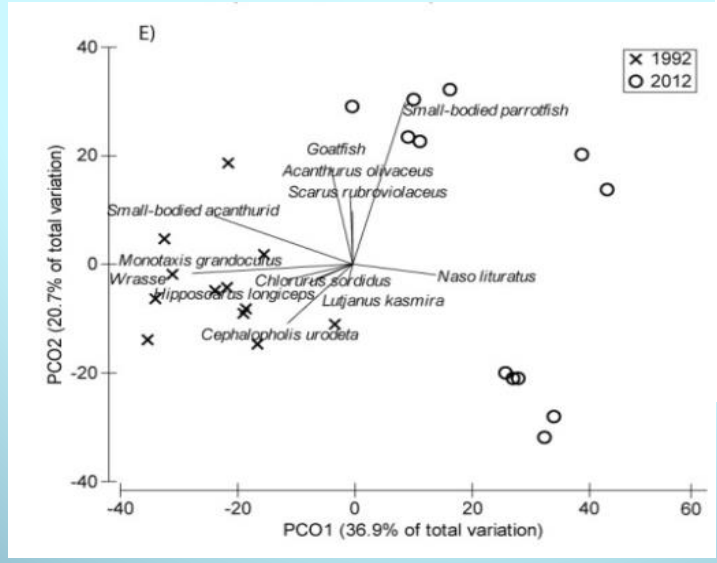


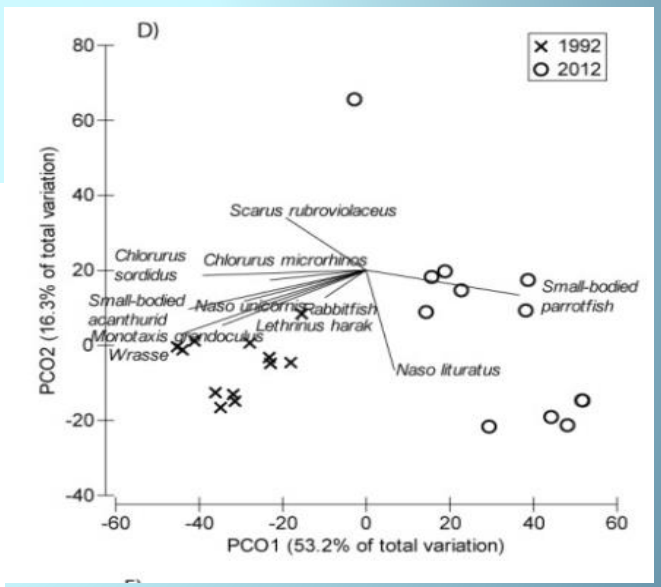
Low wave – already compromised in 1992?

Western Laolao



- Strongest shifts occurred in western Laolao

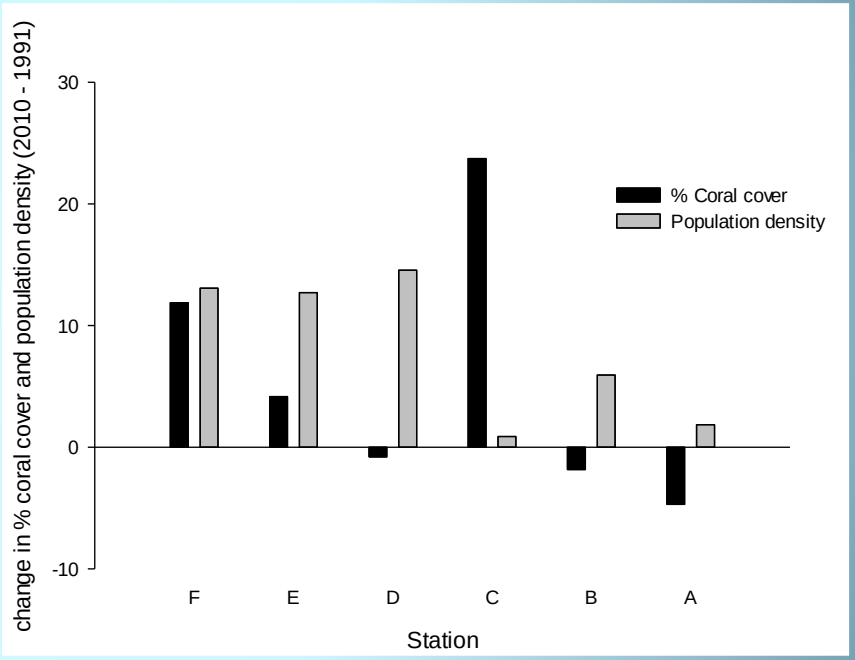




Greatest shifts – wave exposure – support studies of catch success in CNMI

Changes in Coral Assemblages

- Recovery expected
- Population density increased ubiquitously
- Coverage in some instances



Shift to smaller size classes

Partial mortality

Opportunistic recruits and post-settlement mortality

Houk and van Woesik, Mar. Ecol., 2010 – post-settlement mortality process, CNMI

Economic Value

Van Buekering et al. 2006 – Laolao Bay coral reefs nearly $3 million per km^2

Next Steps for Management

- Reduce sedimentation
- Maintain current infrastructure
- Resurvey 2010 sites for comparison
- Expand studies to look W Laolao