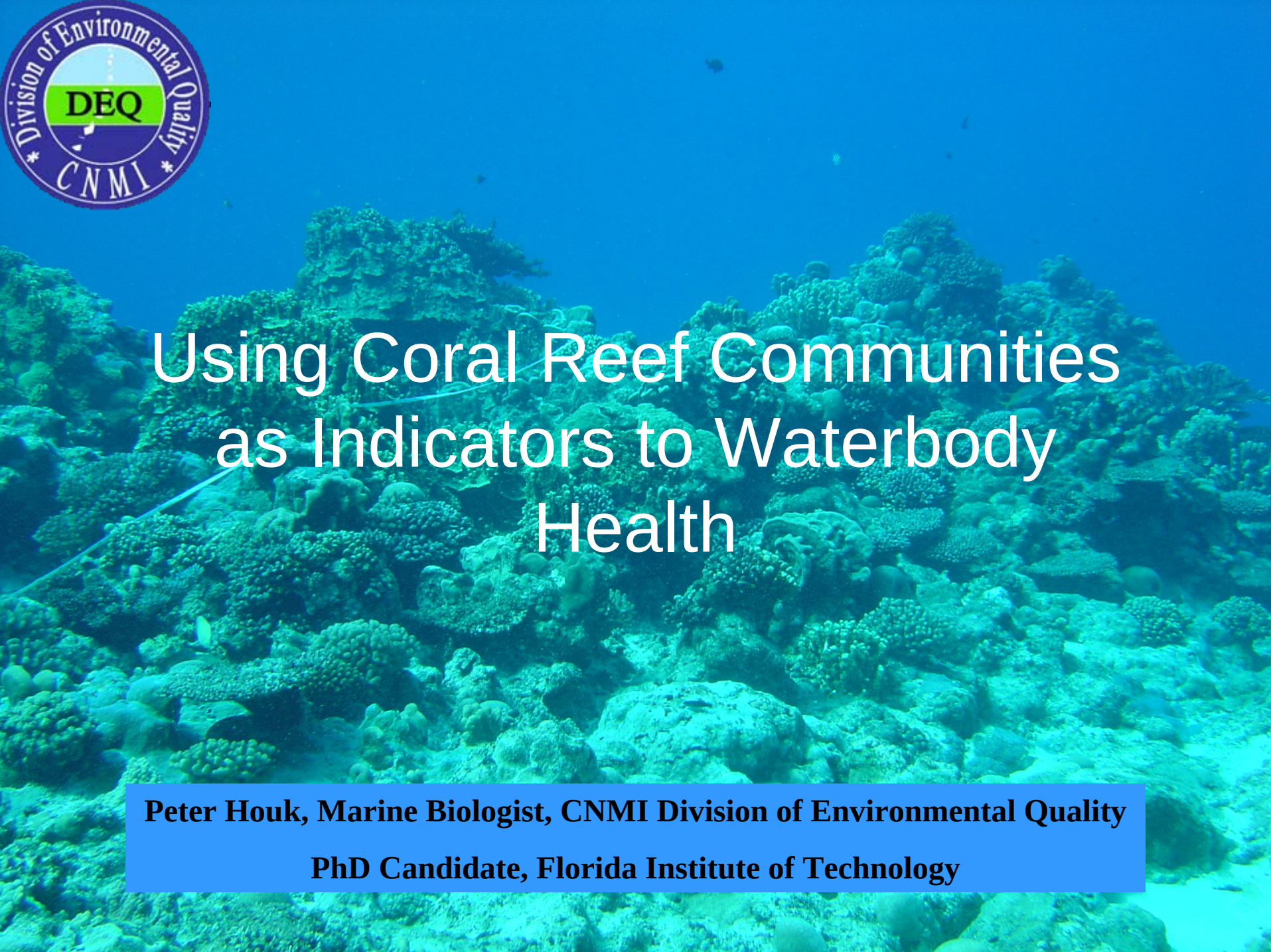

Using Coral Reef Communities as Indicators to Waterbody Health

Peter Houk, Marine Biologist, CNMI Division of Environmental Quality

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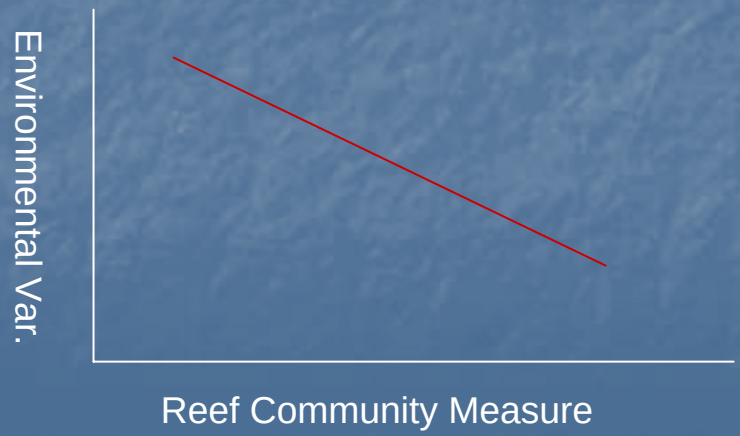
Relationships – Land and Sea

- Scientist have and will continue to provide information on how land-based pollution affects reefs
- Many available tools (e.g. methods), differ in complexity
- Simple, universal, quantitative relationships are rare but necessary to create biocriteria...and ultimately assess impacts

Quantifying Relationships

- Establish a predictive knowledge base between environmental and biological measures
- What biological community measures?
- What environmental variables?

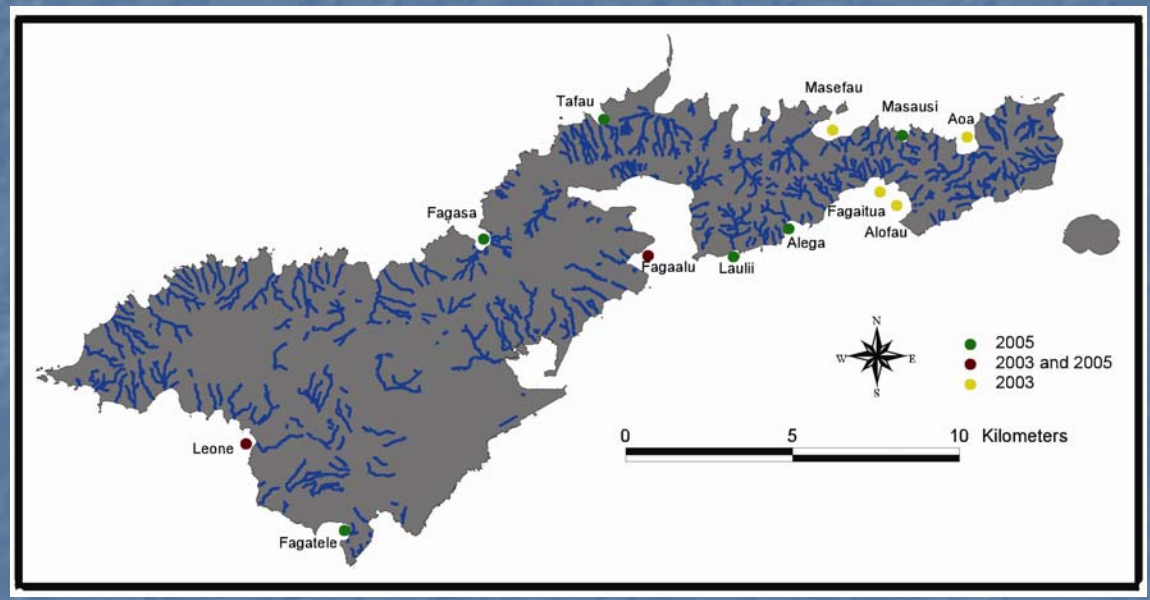


American Samoa Example

- Gather baseline coral reef ecosystem data
  - Many sites (replicates)
  - Differing environments
- Key = account for biological variance

American Samoa Example

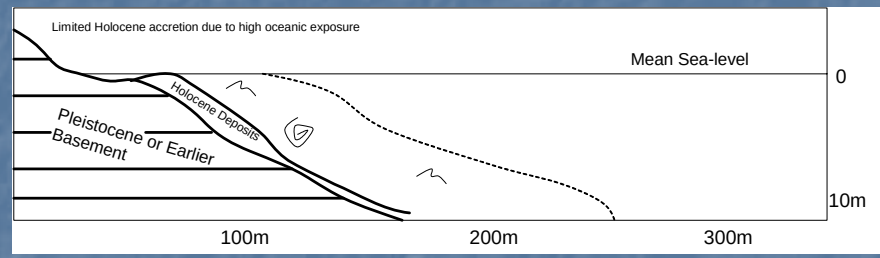
- 1) What data exists –
  - Human population
  - Watershed sizes
  - Exposure
  - Geology
  - Other NPS data

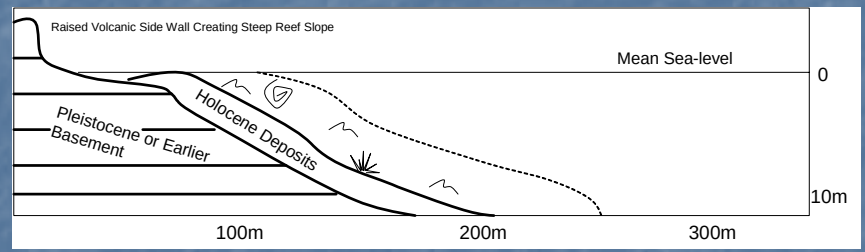


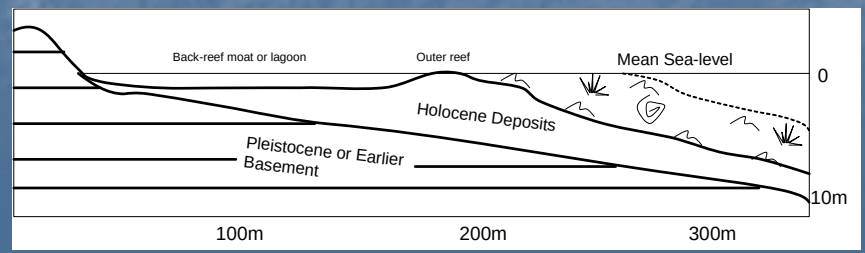
- Site selection based upon available data
  - 12 sites based upon HPD levels and geological settings

American Samoa Example

- First, account for natural variance due to non-anthropogenic, environmental factors
- 3 geomorphology classes found during surveys -

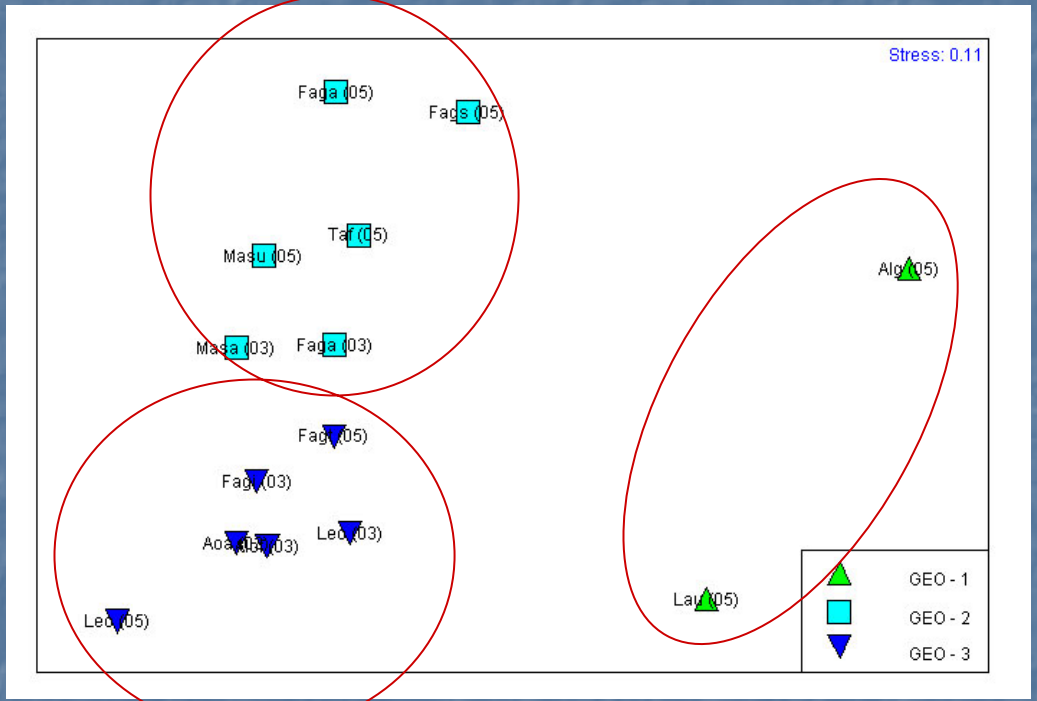






American Samoa Example

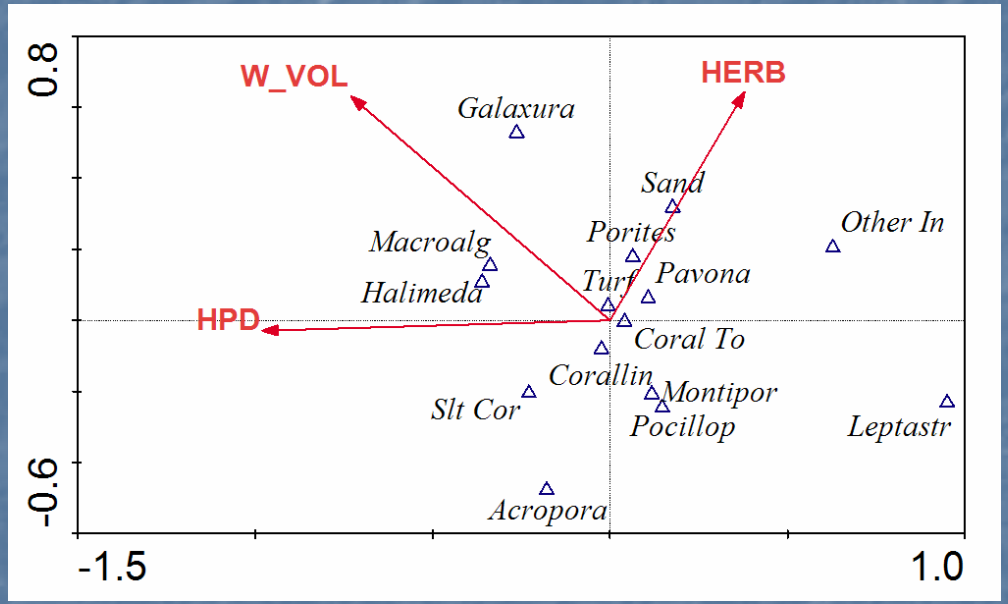
- Geomorphology has a significant relationship with overall coral community structure
- Separate further analyses into “Geo – Classes”



ANOSIM Global R = .85, p<.05

American Samoa Example

- Use canonical correspondence analyses to test how much biological variance is explained by environmental variables
- Infer relations
- Which measures and variables are best suited?



"GEO 2" - CCA explains how environmental variables relate to multivariate benthos abundance datasets (p = .09)

American Samoa Example
(Biological Measure Selection)

- Use selected environmental variables for linear correlation analyses with site specific, biological statistics
- Choose significant measures that describe different aspects of coral/benthic community

Correlation Matrix	W_VOL	EXP	HPD	Q_DIV	T_DIV	GEO_D	POP_D	EVEN	BEN_RAT
W_VOL	1.00	-0.38	0.59	-0.61	-0.59	-0.60	0.09	-0.57	**-0.93**
EXP	-	1.00	0.41	-0.38	-0.07	-0.34	-0.08	-0.30	0.02
HPD	-	-	1.00	**-1.00**	**-0.87**	-0.66	-0.37	**-0.97**	-0.80
Q_DIV	-	-	-	1.00	**0.88**	0.68	0.35	**0.97**	**0.81**
T_DIV	-	-	-	-	1.00	0.43	0.60	**0.91**	0.69
GEO_D	-	-	-	-	-	1.00	-0.40	0.51	0.81
POP_D	-	-	-	-	-	-	1.00	0.51	-0.07
EVEN	-	-	-	-	-	-	-	1.00	0.73
BEN_RAT	-	-	-	-	-	-	-	-	1.00

Correlation matrix for all sites in ‘geomorphology class 2’

American Samoa Example

- Four biological measures selected
  - Coral diversity per unit area
  - Coral total biodiversity
  - Community evenness
  - Benthic substrate ratio
- Combine EPA guidance materials with what we learn to produce "rankings" for each biological measure

$$Ranking = \sum \frac{\text{Biological Measure (x)}}{\text{Biological Measure (x) (max value for geomorphology class)}}$$

American Samoa Example

Example: For Aoa, ranking for the biological measure "community evenness"

Biological Measure for site / Maximum measure for geomorphology 3 = Rank

2.3 / 2.81 = **.82** = Rank for evenness at Aoa

Watershed Name	Fish Diversity *(checklist)*	Average Biomass of Herbivores *(g/m^2)*	Average # of Grazing Urchins *(# per 100 m^2)*	Branching Coral Recruits *(# per 15 m^2)*	Coral Diversity *(quadrat surveys)*	Coral Diversity *(checklist)*	Average Geometric Diameter *(cm)*	Population Density *(# per 8 m^2)*	Coral Community Evenness *(Margalef's D-statistic)*	Benthic Ratio *(see caption for description)*
Alega (05)	96	2.37	0.00	0.13	14	50	6.75	8.50	1.49	0.78
Alofau (03)	no data	no data	0.08	no data	18	51	11.25	26.50	1.67	2.97
Aoa (03)	no data	no data	0.00	no data	37	75	11.07	27.25	**2.30**	3.97
Fagaalu (03)	no data	no data	9.67	no data	15	50	5.68	21.75	1.74	0.62
Fagaalu (05)	86	3.32	2.33	0.07	16	53	8.03	13.75	1.66	0.72
Fagaitua (03)	no data	no data	0.50	no data	22	65	8.41	26.00	2.48	2.73
Fagasa (05)	98	6.01	0.00	0.00	21	49	8.48	15.88	2.06	0.61
Fagatele (05)	99	3.97	0.00	0.33	29	88	7.91	26.75	**2.81**	2.49
Laulii (05)	98	2.36	0.00	0.47	24	42	12.10	10.63	2.22	1.64
Leone (03)	no data	no data	0.00	no data	23	68	10.58	21.00	1.94	2.34
Leone (05)	82	3.05	0.00	0.20	28	76	12.93	15.13	2.52	1.74
Masafal (03)	no data	no data	0.33	no data	27	69	6.75	31.75	2.94	0.86
Masausi (05)	128	2.89	0.17	0.27	27	60	9.60	14.13	2.72	1.82
Tafau (05)	145	4.48	0.91	0.73	32	72	10.49	22.25	2.99	1.97

American Samoa Example

- ALUS ranking is as follows –

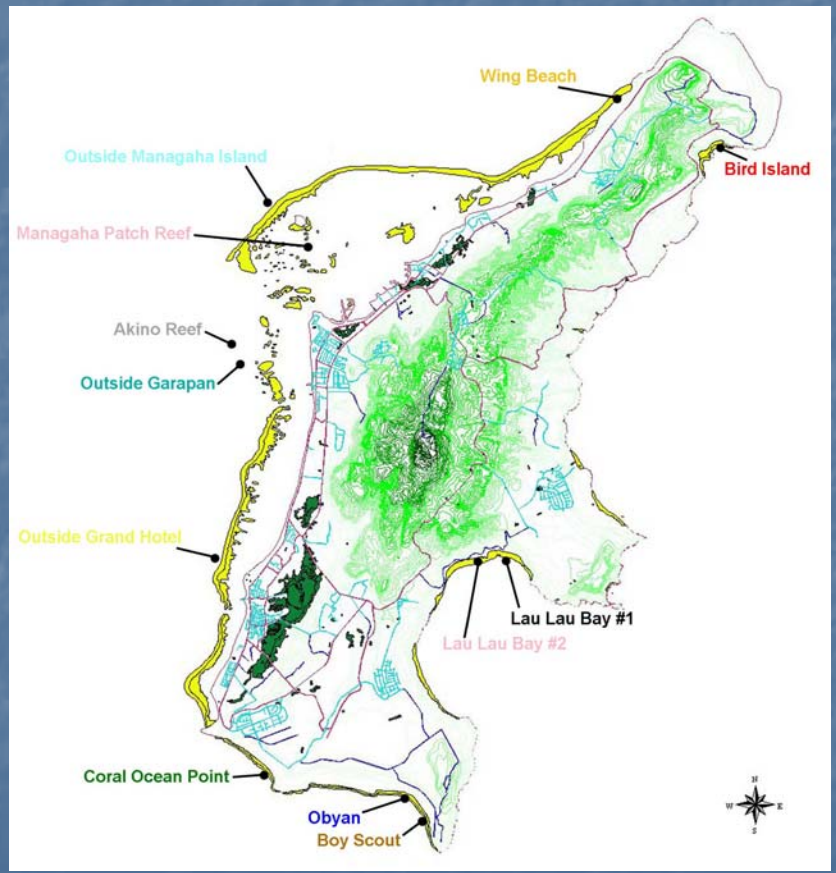
Overall Average =

0.8 – 1.0 = Fully Supportive
0.6 – 0.8 = Partially Supportive
0.0 – 0.6 = Non Supportive

Site	Geomorphology	Diversity per Unit Area	Total Diversity	Evenness	Benthic Substrate Ratio	Overall Average	ALUS Ranking
Alg (05)	1	0.58	1.00	0.67	0.47	**0.68**	**Partially ***
Lau (05)	1	1.00	0.84	1.00	1.00	**0.96**	**Fully ***
Faga (03)	2	0.47	0.69	0.58	0.32	**0.52**	**Not**
Faga (05)	2	0.50	0.74	0.56	0.37	**0.54**	**Not**
Fags (05)	2	0.66	0.68	0.69	0.31	**0.58**	**Not**
Masa (03)	2	0.84	0.96	0.98	0.44	**0.81**	**Fully**
Masu (05)	2	0.84	0.83	0.91	0.92	**0.88**	**Fully**
Taf (05)	2	1.00	1.00	1.00	1.00	**1.00**	**Fully**
Alof (03)	3	0.49	0.58	0.59	0.75	**0.60**	**Partially**
Aoa (03)	3	1.00	0.85	0.82	1.00	**0.92**	**Fully**
Fagi (03)	3	0.59	0.74	0.88	0.69	**0.73**	**Partially**
Fagt (05)	3	0.78	1.00	1.00	0.63	**0.85**	**Fully**
Leo (03)	3	0.62	0.77	0.69	0.59	**0.67**	**Partially**
Leo (05)	3	0.76	0.86	0.90	0.44	**0.74**	**Partially**

CNMI Progress

- Similar to AS but
  - 24 versus 12 sites
  - 5 year dataset
    - Assess and evaluate change over time
  - Similar design and approach
  - Once completed – incorporate metrics into CNMI WQS



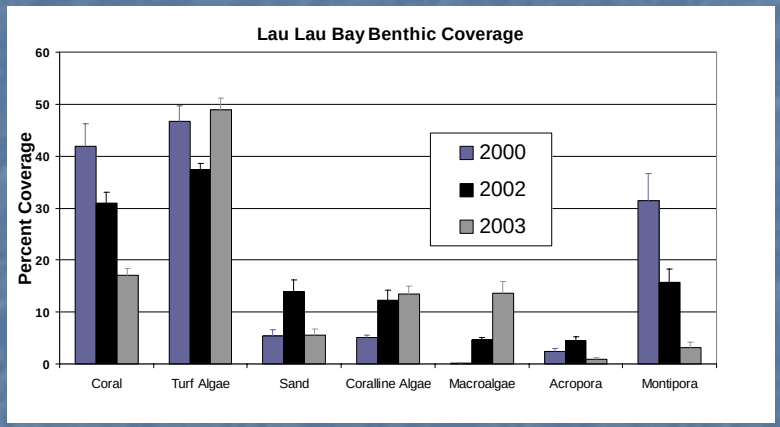
Saipan Island Monitoring Sites

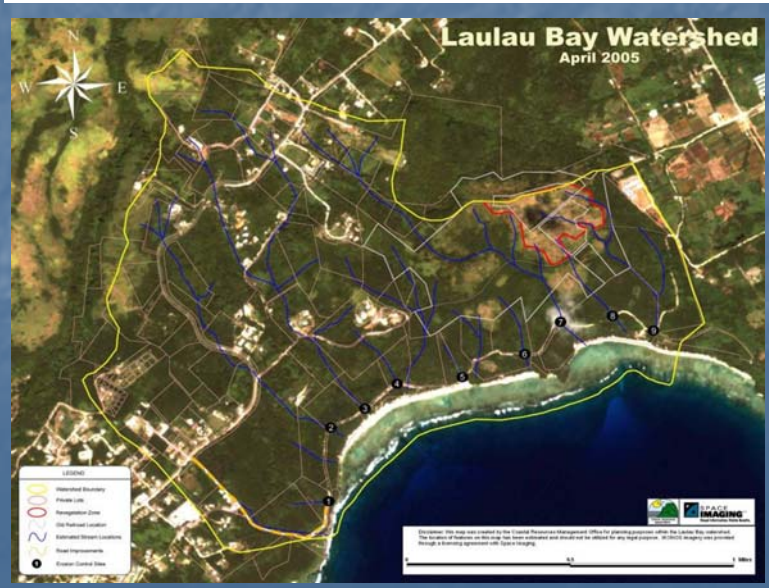
Biocritera and Territory WQS

- Current Language
  - shall not change benthic community with respect to a reference site
- Proposed Language examples
  - “Overall average of biological measures must be above .8 = class AA waters”
  - “Overall average can’t decrease due to golf course development”
  - “No single measure can decrease, relative to other sites in similar environmental settings”

Benefits Offered Through Biocritera Establishment

- Detect change over time accurately and in a timely manner, pertinent for management
- Similar goals as NOAA funded CRI Monitoring and Management Grant
- Provides a vector to combine federal resources for maximal benefit





Thank You!

- Report available from
  (deq.biologist@saipan.com)