National Centers for Coastal Ocean Science

Center for Sponsored Coastal Ocean Science

Meeting Report

3rd Coral Reef Programs Review Meeting

Ft. Lauderdale, FL / March 23rd – 24th, 2005

Hosted by:

The National Coral Reef Institute
And
The Oceanographic Center, Nova Southeastern University

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National Centers for
Coastal Ocean Science
Center for Sponsored
Coastal Ocean Research

NCRI
NATIONAL CORAL REEF INSTITUTE

3rd CSCOR Coral Reef Programs Review Meeting

Ft. Lauderdale, Florida / March 23 – 24, 2005

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National Centers for
Coastal Ocean Science
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3nd CSCOR Coral Reef Programs Review Meeting

Ft. Lauderdale, Florida / March 23 – 24, 2005

Meeting Report

1. BACKGROUND

The NOAA Center for Sponsored Coastal Ocean Research (CSCOR) holds an internal program review meeting for its active coral reef programs. The major goal of the program review is to bring together the Lead Principal Investigator and Project Manager from each project so that they can share their successes and failures in a forum-like format, and thus benefit from their collective experiences. A second goal is to promote communication between programs so that individual projects can benefit from their collective. A third goal is to inform the representatives from the programs of any revisions in NOAA's internal processes and grants management practices in order to facilitate their grant proposal writing, project implementation, and project reporting requirements.

The meetings are held on a yearly basis and are hosted by one of the programs institutions with the venue alternated between the Atlantic and Pacific regions. The outcome from our initial meeting clearly demonstrated the value of the forum approach to promote collaboration between CSCOR programs. CSCOR decided to build on this success by inviting representatives from other entities that are involved in activities with or of interest to CSCOR programs. Invited non-CSCOR participants are typically drawn from the region of the program hosting the meeting on that given year. Also, because CSCOR's various coral programs are considered either core or collaborative programs within NOAA's Coral Reef Conservation Program (CRCP), CSCOR has included a senior representative from CRCP as a regular attendee to the review meeting.

The 2005 CSCOR Coral Reef Programs Review meeting was hosted by the National Coral Reef Institute (NCRI) based at the Oceanographic Center of Nova Southeastern University in Ft. Lauderdale, Florida on Wednesday March 23rd and Thursday March 24th. The CSCOR coral programs participating in the 2005 meeting were: Coral Reef Ecosystem Studies-Caribbean; Coral Reef Ecosystem Studies-Micronesia; the Hawaii Coral Reef Initiative Research Program (HCRI – RP); the National Coral Reef Institute; and the newly established Caribbean Coral Reef Institute. The NOAA participants aside from CSCOR and CRCP in the 2005 meeting were: the Southeast Fisheries Science Center, the National Undersea Research Program (represented by the Caribbean Marine Research Center and the National Undersea

Research Center), the Atlantic Oceanographic and Meteorological Laboratory, the Center for Coastal Environmental Health and Biomolecular Research, the Center for Coastal Fisheries and Habitat Research, the Center for Costal Monitoring and Assessment. Table 1 provides a list of the participants.

As part of the 2005 meeting, the participants attended a special meeting of NCRI Principal Investigators held on Tuesday March 23rd prior to the CSCOR review meeting. The purpose of attending this event was to allow CSCOR's other coral programs to learn in more detail about the work performed by NCRI. Field site visits and other activities were also planned. On Tuesday afternoon some of the review meeting participants had the opportunity to visit NCRI's field research sites off Ft. Lauderdale. Following the CSCOR meeting, some of the participants also had the opportunity to visit the site of the Aquarius underwater habitat and Molasses Reef off Key Largo.

Oral Presentations

Oral presentations were given during the NCRI Principal Investigators Session and the CSCOR Coral Reef Programs Review Meeting. Summaries or transcripts and PowerPoint slides (if used) of the presentations are provided in this report. The information provided in these presentations should not be construed as official NOAA policy unless otherwise noted. Any data, figures, or photos provided in these slides should not be used without the appropriate authorization of the authors. Questions concerning any of the presentations should be addressed directly to the presenters.

For any additional information on the presentations, please contact Dr. Felix A. Martinez (felix.martinez@noaa.gov; 301-713-3338 x153) or Dr. Michael J. Dowgiallo (michael.dowgiallo@noaa.gov; 301-713-3338 x161).

NOAA/NOS/NCCOS
Center for Sponsored Coastal Ocean Research
3rd Coral Reef Program Review Meeting
March 22 – 25, 2005; Ft. Lauderdale, Florida

Hosted by:
The National Coral Reef Institute

Schedule of Activities

Monday, 03/21

Arrive at Ft. Lauderdale

Tuesday, 03/22

9:30 – 12:30	NCRI P Presentations
1:30 – (?)	Dive trip to local site (Optional)

Evening Free

Wednesday, 03/23

9:30 – 4:45	CSCOR Coral Reef Programs Review Meeting (Day 1)
6:30 – (?)	Reception/Dinner at TBD

Thursday, 3/24

9:30 – 4:30	CSCOR Coral Reef Program Reviews Meeting (Day 2)

Evening Free

Friday, 3/25 (Optional)

7:30 – (?)	Dive/snorkel trip Florida Keys (Aquarius Underwater Laboratory)

NOAA/NOS/NCCOS
Center for Sponsored Coastal Ocean Research
3rd Coral Reef Programs Review Meeting
March 22 – 25, 2005; Ft. Lauderdale, Florida

Agenda

Day 1 (Wednesday, 03/23)

9:30 – 9:45	Opening - Introduction of Participants - Meeting Objectives
9:45 – 10:45	Program Overviews I - CRES – Micronesia (Richmond – UH) - CRES – Caribbean (Appeldoorn – UPR)
10:45 – 11:00	Break
11:00 – 12:00	Program Overviews II - HCRI – RP (Hamnett/Davidson – UH) - CCRI (Appeldoorn – UPR)
12:00 – 1:00	Lunch[1]
1:00 – 1:30	Program Overviews III - NCRI (Dodge/Riegl – NSU)
1:30 – 3:00	Invited Programs I - SEFSC (Bohnsack) - CCFHR (Johnson) - AOML (Hendee)
3:00 – 3:15	Break
3:15 – 4:45	Invited Programs II - PIMS/CMRC (Arrington) - CCEHBR (Woodley) - NURC/UNC-W (Rutten)
4:45 – 5:00	Review Day 1
5:00	ADJOURN

Evening Activities:

6:30	Reception/Dinner at Rustic Inn Crab House[2]

Day 2 (Thursday, 3/24)

CSCOR ONLY SESSION

9:15 – 10:30 CSCOR Topics
- Grant Management (Hilmer – CSCOR)
- CSCOR's Identity: Refining our Niche (Dowgiallo – CSCOR)

10:30 – 10:45 Break

OPEN SESSION

10:45 – 11:00 Objectives for Day 2

11:00 – 12:30 NOAA Topics I
- NOAA Coral Conservation Program Update (Golde – ORR)
- NOAA Coral Reef Marine Sanctuaries (Golde – ORR)
- NOAA Integrative Coral Reef Mapping, Monitoring, and Assessment (Monaco – CCMA)
- NODC/CoRIS Metadata Reporting (Hamilton – NODC)

12:30 – 1:45 Lunch[1]

1:45 – 2:15 NOAA Topics I I
- Rapid Response: Disease Outbreak Investigations (Woodley – CCEHBR)

2:15 – 3:15 Discussion Topics I
- Joint Dedicated Publication (Davidson – HCRI, Martinez – CSCOR)
- Implications of *Acropora* listing under ESA (Dowgiallo – CSCOR)

3:15 – 3:30 Break

3:30 – 4:30 Discussion Topics II
- Open

4:30 – 4:45 Closing Comments (Martinez – CSCOR)
- Summary Day 2, Action items

4:45 ADJOURN

<u>Evening Activities:</u>

None scheduled

NOTES:

1. Catered lunch at meeting facility. Cost TBD, payable morning that day.
2. Reception and Dinner are optional. Limited menu. Cost TBD.

LIST OF ACRONYMS:

NOS = National Ocean Service
NCCOS = National Centers for Coastal Ocean Science
CSCOR = Center for Sponsored Coastal Ocean Science
COP = Coastal Ocean Program
CRES = Coral Reef Ecosystem Studies
UPR = University of Puerto Rico
HCRI – RP = Hawai'i Coral Reef Initiative – Research Program
UH = University of Hawai'i
CCRI = Caribbean Coral Reef Institute
NCRI = National Coral Reef Institute
NSU = Nova Southeastern University
SEFSC = Southeast Fisheries Science Center
CCFHR = Center for Coastal Fisheries and Habitat Research
AOML = Atlantic Oceanographic and Meteorological Laboratory
PIMS = Perry Institute of Marine Science
CMRC = Caribbean Marine Research Center
CCEHBR = Center for Coastal Environmental Health and Biomolecular Research
CCMA = Center for Coastal Monitoring and Assessment
NODC = National Oceanographic Data Center
CoRIS = Coral Reef Information System
ORR = Office of Response and Restoration

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List of Participants

CSCOR PROGRAMS

Dr. Richard Appeldoorn	University Of Puerto Rico – Mayaguez/Caribbean Coral Reef Institute (Executive Director) and Coral Reef Ecosystems Studies – Caribbean (Lead Principal Investigator)
Dr. David Ballantine	University Of Puerto Rico – Mayaguez/Caribbean Coral Reef Institute (Co-Chair Management Board) and Coral Reef Ecosystems Studies – Caribbean (Co-Lead Principal Investigator)
Ms. Kristine Davidson	University of Hawaii/Hawaii Coral Reef Institute – Research Program (Program Manager)
Dr. Richard Dodge	Nova Southeastern University/National Coral Reef Institute (Executive Director)
Ms. Carol Fretwell	Nova Southeastern University/National Coral Reef Institute (Coordinator)
Dr. Michael Hamnett	University of Hawaii/Hawaii Coral Reef Institute – Research Program (Lead Principal Investigator)
Ms. Lilliam Ramirez	University Of Puerto Rico – Mayaguez/Caribbean Coral Reef Institute (Program Manager)
Dr. Robert Richmond	University of Hawaii/ Coral Reef Ecosystems Studies – Micronesia (Principal Investigator)
Dr. Bernhard Riegl	Nova Southeastern University/National Coral Reef Institute (Assistant Director)

INVITED PROGRAMS

Dr. Albrey Arrington	Parry institute of Marine Science/Caribbean Marine Research Center (Science Director)
Dr. Jim Bohnsack	National Marine Fisheries Service/Southeast Florida Science Center
Mr. Doug Hamilton	National Oceanographic Data Center, Coral Reef Information System
Dr. Jim Hendee	Atlantic Oceanographic and Meteorological Laboratory, Coral Reef Early Warning System
Dr. David Johnson	National Centers for Coastal Ocean Science/Center for Coastal Fisheries and Habitat Research (Director)
Mr. Otto Rutten	University of North Carolina/Wilmington/National Undersea Research Center
Dr. Cheryl Woodley	National Centers for Coastal Ocean Science/Center for Coastal Environmental Health and Biomolecular Research

NOAA HEADQUARTERS

Dr. Michael Dowgiallo	National Centers for Coastal Ocean Science/Center for Sponsored Coastal Ocean Science
Ms. Helen Golde	Office of Response and Restoration/Coral Reef Conservation Program
Mr. David Hilmer	National Centers for Coastal Ocean Science/Center for Sponsored Coastal Ocean Science
Dr. Robert Magnien	National Centers for Coastal Ocean Science/Center for Sponsored Coastal Ocean Science (Director)
Dr. Felix Martinez	National Centers for Coastal Ocean Science/Center for Sponsored Coastal Ocean Science
Dr. Mark Monaco	National Centers for Coastal Ocean Science/Center for Coastal Monitoring and Assessment/Biogeography Program

NCRI PRINCIPAL INVESTIGATORS

Mr. Kenneth Banks	Broward County Environmental Protection Department
Dr. David Gilliam	Nova Southeastern University
Mr. Kevin Helmle	Nova Southeastern University (Ph.D. Student)
Mr. Kevin Kohler	Nova Southeastern University
Dr. Sam Purkis	Nova Southeastern University
Dr. Mahmood Shivji	Nova Southeastern University
Dr. Richard Spieler	Nova Southeastern University
Dr. Bernardo Vargas-Angel	Nova Southeastern University

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4. NCRI Principal Investigators Session

This half-day session was hosted by NCRI to showcase the work that they have been carrying out in support of NOAA's mission to conserve and manage our coastal and marine resources through a comprehensive understanding of coastal ecosystems. The session was chaired by Dr. Richard Dodge, Dean of the Oceanographic Center at Nova Southeastern University (NSU) and Director of NCRI. NSU is the home NCRI.

Dr. Dodge opened the session by providing an overview of the Oceanographic Center and emphasizing the ideal geographical location of the center and the strong atmosphere of academic and research provided by NSU, the eighth largest private, non-profit university in the U.S. Thirteen talks were given during this session. Summaries of the presentations are given below.

a. Partnerships and Influence of NCRI Science on National and International Coral Reef Management *Dr. Bernhard Riegl; Nova Southeastern University*
Dr. Riegl opened with the comment: Why fund us? His answer was direct – Our science is applicable to management practices. ''Despite the fact that we are academics we understand that management is important''. Within the work encompassed by NCRI, there exist both national and international partners. Through the mapping and monitoring projects NCRI provides data for our partners and our biggest example is NOAA. From the global monitoring network, NCRI is partners with CNMI in the Mariana Islands and the County in St Johns River. NCRI also works with NGO's both inside and outside the US national boundaries such as the World Wildlife Fund (WWF) and The Nature Conservancy. Our collaboration and partnerships built within the UAE and Qatar involve both capacity training and the establishment of management systems. These networking relationships also involve key players such as the UAE Petroleum Institute. Without these powerful managers on board, progress is difficult to achieve. There also exist World Bank projects in Africa and The Philippines, particularly for reef restoration.

b. The Successful NCRI-Broward County Environmental Protection Department (EPD) Model of Science-management Collaboration *Mr. Kenneth Banks; Broward County Environmental Protection Department*
Mr. Banks spoke from a local government perspective concerning the gap between science and management. He re-iterated the preconceived management misconception that investing money in science is a waste. With the increased need for management strategies, there is an increased need for furthering scientific research to create appropriate strategies. Dr. Richard Spieler of NCRI has exemplified this idea with his research on artificial reefs. Management needs to know answers to the following questions: where to put them? How big they need to be? What type of material is required? How well spaced? Etc. All these questions can only be answered through scientific research. This research has been particularly applicable in Broward where physical anthropogenic pressures are constantly exerted on the environment, e.g., cables, dredging, groundings, etc. Another example of this collaborative work involved Dr. Riegl and his group concerning monitoring. They are currently working on a classification system that provides important information for establishing protocols.

They are also able to identify latitudinal patterns and offshore trends. These zonation patterns assist in evaluating key management issues. NCRI is very important for bridging the gap between science and management and assisting in providing information to help create management strategies.

c. Coral Reef Mapping from Space *Dr. Samuel Purkis; Nova Southeastern University*
Dr. Purkis uses a multi-sensor approach (satellite, airborne, vessel-based acoustics) to cover all the areas for the global monitoring network. Initially low resolution images from ASTER or LANDSAT are used for a primary investigation. Later the data is interpreted from high resolution IKONOS imagery. He discussed the methodology for processing the data from space to the sea floor and vice versa, taking into account the scattering and absorption optical properties of both the air and sea. He discussed which tools are used in the field to take these measurements and how the data are relayed into an algorithm to interpolate reflectance from space to reflectance in the field. He also touched on the need for depth measurement. The accuracy of the benthic habitat maps in for example Vieques, Puerto Rico are 85% with 6 substrate types. Here the team had all the in-situ measurements required. In Honduras, it was not feasible to transport the acoustic tool; hence the data set was lacking information. In these instances he uses an alternative method involving fractals and wave transform which also provides high accuracy. The benthic habitat map can be used to create this all important link with ecology. Time series data assists in understanding the transition mechanisms and phase shifts of habitats. At present this is being used in the Arabian Gulf.

d. Management Orientated Assessment of Corals in Broward County *Dr. Bernardo Vargas-Ángel; Nova Southeastern University*
Dr. Vargas-Ángel discussed the structure and function of coral stresses on *Acropora cervicornis.* He investigates population structure, abundance, distribution, and reproduction of the corals. This data can also be compared to data collected in the Bahamas. He looks at the relations between corals and algae in the area. From both his histological studies and seasonal studies, it is now clear that the Acropora spawn in late July/ early August for 2-3 nights, 5-8 days after the full moon. His studies have also involved the collection of gametes in order to observe metamorphosis, but so far they have only managed to observe the fertilization stage, but not beyond that. They have also observed asexual reproduction; hence the links in reproduction are still unclear. Another aspect of his work concerns diseases such as white band disease. The corals off Broward are not immune to white band but appear more resilient than in other areas. Histopathological research is the only means of truly understanding coral stress biology, although external observation is also important. The work carried out by his group can assist in identifying gross morphological changes which can be identified and monitored in the field. They have put together an index of stress, which is now being researched within the laboratory. His work in this field links directly with the beach renourishment project in that he has developed with Dr. Gilliam an important tool that will be applied by management to ameliorate adverse effects on corals. Finally he pointed out the use of electron microscopy for viewing the toxological changes in corals.

e. Fish Census of Artificial Reefs in Broward County; Preliminary Survey of the Marine Fishes of Southeast Florida; and Nearshore Hardbottom Fishes of Broward County *Dr. Richard Spieler; Nova Southeastern University*

Dr. Spieler introduced Broward reefs to the group, i.e., consist of 3 reef ridges with crest forms. His findings show the offshore reefs had a higher population of larger fish, while the nearshore reefs had a larger population of juvenile fish. His fish count observations show striking results in that no legal sized grouper were found! This, he indicated, is a sure sign that management is needed in the area. His research is a starting point for further research. His work is also interesting for concerns held about the beach renourishment project because the beach renourishment covers those nearshore hard bottom areas, where juveniles populate. However the baseline research carried out in Hollywood from 2000 showed a 63% drop in abundance of these juveniles. This heavy change, where no renourishment has taken place, indicates the natural fluctuations of juveniles in the region. It is therefore difficult from the fish population perspective to draw any hard evidence concerning its effects. Dr Spieler and his group also observed fish populations on shipwrecks between the 2nd and outer reef. They observed more fish on the ships, more juveniles than on the surrounding reefs and different types of fish, e.g., snapper. The data collected does not support the simple aggregation hypothesis because of two reasons (i) there exist different species on the ships and (ii) it is unlikely that the ships are attracting fish stocks off the reef.

f. CPCe's Coral Point Count with Excel Extensions *Mr. Kevin Kohler; Nova Southeastern University*

Mr. Kohler explained the use of CPCe and had a demonstration for attendees to use during the breaks. He has created this software in conjunction with input from various NCRI and other projects which is freely available to the science community from the NCRI website. It enables the user to analyze digital imagery on a pixel by pixel basis and then to download the findings into an excel sheet. The user can trace the sizes of individual colonies and other benthic features. It uses a simple windows system which has been adapted and tailored according to feedback from users within the field. The University of Hawaii has been particularly helpful as a user in providing feedback.

g. NCRI Monitoring Network *Dr. Bernhard Riegl; Nova Southeastern University (Note: the official PowerPoint presentation can be found later as part of the CSCOR presentations.)*

The NCRI monitoring network is a long-term observatory system. This is an important area of research, considering the accelerated global changes that have taken place, which have been well documented in the 1990's. In the Pacific NCRI is using IKONOS images which have been provided by NOAA in carrying out this research. In the Arabian Gulf several NCRI monitoring sites have been established with considerable monitoring resulting in several papers already published in two highly respected journals of marine science: Marine Ecology Progress Series and the Journal of Sedimentary Research. Roatan in Honduras was used instead of The Cayman Islands due to lasting effects of hurricanes on the latter; Cabo Pulmo, Mexico is another reef system of interest for the network. This monitoring provides the opportunity to link remote sensing to ecology, to biomarker research and genetics, and to provide the unique opportunity to compare and

link sites throughout the world. Dr. Riegl showed the management interests resulting from this research, these concerned for example connectivity patterns, i.e., *Acropora*-dominant beds in Roatan and yet 0.01% of potential beds in Vieques. Possible likelihoods for regeneration drivers include ENSO / high energy driving systems. These are found off Mexico and hence the monitoring network's interest in this area.

h. Southeast Florida Coral Reef Evaluation and Monitoring Project (SECREMP)
Dr. David Gilliam; Nova Southeastern University
Dr. Gilliam is working on two monitoring programs, one at a local level with Broward County Environmental Protection Department and the other at the state level with the Florida Department of Environmental Protection and Florida Fish and Wildlife Commission. Together there are monitoring sites in Miami-Dade, Broward, and Palm Beach Counties. More are planned soon for Martin County. The sites are situated on the 1st, 2nd and 3rd reefs and on the nearshore hardbottom area. The sites aim to target special areas of interest. From a management perspective it is vital that the area is monitored due to: the large population resident in the surrounding area, the number of groundings that occur in this area, and outfalls that are presently in place. This project is an extension of the State of Florida, Florida Keys monitoring initiative (CREMP) in that research methodologies are comparable and it is a fully co-operative effort. One effect of the monitoring to date includes the spotting and monitoring of previously unknown *Lyngbia sp*. *Lyngbia* is a cyanobacteria which has been found to proliferate in the area.

i. Investigations on Coral Skeletal Density *Mr. Kevin Helmle; Nova Southeastern University*
Dr. Richard Dodge and Kevin Helmle have researched the density bands in coral skeletons. These are revealed as the annual dark and light bands when the skeleton is X-radiographed and can be analyzed. The density changes provide a means of accessing chronological changes, such as those associated with the influence of man or climate. As well as the changes in oxygen isotopic ratios and trace elements, there are also fluorescent signals that can be observed. These records can date up to 500 years in the past from a single coral. Another advantage of this technique is a more comprehensive understanding of the calcification at certain times due to the CO2 cycle. The X-radiograph density system allows the analysis of these changes. It is a multi-proxy approach to validate the information. Other researchers have access to this information through the website. NCRI has a large archive of samples and once again this latitudinal research has far reaching implications for management strategies.

j. Restoration Design and Post Restoration Monitoring Project *Dr. Richard Spieler; Nova Southeastern University*
Funding arose as a result of a settlement by the US Navy and the State of Florida from grounding by a nuclear submarine on a Broward County coral reef. Management devoted a portion of the settlement to a project designed to provide answers about what techniques can best restore injured coral reefs. Hence, this restoration study identifies various substrates that have the potential to kick start coral recruitment and to attract and maintain fish populations. The approach adopted is a holistic ecosystem approach to restoration. Identical replicate restoration modules (ReefBalls™) have been used for this

research. Dr. Spieler showed how these were constructed and deployed. Within the balls there are four different types of filler in the central void space: large recruitment uses concrete blocks, small uses a wire meshing, as well as mixed (block and mesh) and empty treatments. Each ball is also equipped with two recruitment plates one mounted horizontally and one vertically with different substrates to assist in recruitment. Two species were particularly observed: *Montastrea cavernosa* and *Meandrina meadrites*. The two species showed significant difference in transplant hostility; the first maintained or expanded overage in 100% of cases, whereas the latter suffered 72.5% of varying degrees of tissue mortality. The fish aggregation was greatest in the large recruitment balls with the concrete blocks, although all sizes showed good fish recruitment. A new project which is just starting, concerns investigations of multiple ecosystem factors, by including the monitoring of invertebrates attracted onto an artificial substrate.

k. Establishment and Maintenance of a Coral Nursery *Dr. David Gilliam; Nova Southeastern University*

This project assesses the potential to utilize unattached corals of opportunity that would otherwise perish as restoration tools for injured reefs. This research is particularly collaborative in that Broward County and local volunteer dive organizations participate directly. This project seeks to improve restoration after reef damage. There are four mechanisms for restoration: (i) restore stony corals, by re-attaching corals from the injury area, (ii) take healthy corals from another area, (iii) take laboratory-grown corals and re-attach to injury area, or (iv) take dislodged corals as a result of unnamed, often natural events and add to an injury area. The latter methodology is investigated in this project. Loose, dislodged corals are attached to artificial substrate in what is called a "Nursery." This site and similar corals in a nearby natural site are monitored for colony size and health. Comparison between the two shows remarked success of the transplants. The volunteer divers can do up to three dives a day. Before each dive, they are trained in species identification and procedures to follow. They are also briefed on the value of their contribution and often educational talks are held in the evening, too. They assist in the coral injury transplant process and monitoring. A graduate student compared tagged colonies on artificial substrate to tagged colonies on naturally occurring sites and found the results comparable for re-growth. Hence, this project is not only useful for management applications but also for community outreach activities.

l. Habitat Equivalency Analysis *Dr. Richard Dodge; Nova Southeastern University*

Dr. Dodge and Mr. Kevin Kohler have developed a computer program that is a resource management tool. The program assists in quantifying the amount of compensation that is owed to a Resource Trustee by a Responsible Party following to an injury to a coral reef resource. Through the Habitat Equivalency Analysis procedure, calculations provide how much replacement or compensatory habitat is required to equal the amount of natural resource services that were lost as a result of the injury (from the time of injury to the time of recovery). The program has many parameters for inputting injury and compensatory information such as: area of injury, relative services of the two injured and compensatory habitats, amount of lost services from the injury, time duration of the lost services, and the trajectory towards full services reached by the compensatory habitat. These aspects require scientific expertise in order to enter the correct data; however it is a

tool for compensatory action used by resource managers. The project Visual_HEA is based on the NOAA HEA formulas and works in a Graphical User Interface for user convenience. The program is available free of charge. It is a useful management tool for assessing required compensation for planned or unplanned injuries to natural resources.

m. Genetic Connectivity and Cryptic Biodiversity in Florida and Caribbean Reef Invertebrates *Dr. Mahmood Shivji; Nova Southeastern University*

Determining the extent of biological connectivity among coral reefs is a critical information need for improved spatial management of reefs and design of effective marine protected areas (MPAs). This research is using genetic relationships among populations of reef species as a measure of connectivity. DNA sequences (mitochondrial cytochrome oxidase I gene) from four invertebrate species with contrasting reproductive life histories (i.e. brooders with no pelagic dispersal stages verses broadcast spawners with pelagic dispersal stages) are being examined to assess connectivity among the Florida reef tact and between Florida and Caribbean-wide reefs. The species selected for study are commensal, living inside a host sponge, and are therefore exposed to the same small-scale hydrodynamic environment. This common micro-habitat prevents dispersal patterns between species from being potentially confounded by differences in hydrodynamic environment, as might occur if comparing connectivity between species occupying different habitats. The study results thus far from three species (two brooding amphipod morphospecies 3 and 4 from the Leucothoe spinacarpa species complex, and the broadcast spawning brittle star, Ophiothrix lineata) show that there is a high degree of genetic connectivity in the Florida reef tract (West Palm Beach to Key West), regardless of brooding or broadcast spawning reproductive life history. Connectivity studies with the fourth species, the broadcast spawning host sponge Callyspongia vaginalis, are in progress. For amphipod morphospecies 3, the study has examined connectivity Caribbean-wide. In contrast to the Florida reef tract results, the data show highly divergent, reciprocally monophyletic genetic lineages at each location sampled (Florida combined, Bimini, Bahamas, Belize, Honduras, Puerto Rico), indicating no connectivity among Caribbean wide reefs or between Florida and Caribbean for this brooding species. Superimposing the major current patterns of the Gulf Stream on the genetic data suggest a correlation which may explain the connectivity patterns observed. Furthermore, the high genetic divergences between populations of the amphipod morphospecies 3 strongly indicate the presence of cryptic species, despite being morphologically identical. The latter results point to the importance of incorporating genetic approaches along with traditional morphological taxonomy if we are to gain a truer assessment of the extent of coral reef biodiversity.

5. CSCOR Coral Reef Programs Review

The CSCOR Coral Reef Program Review meeting ran for two days. The first day focused primarily on presentations by the Principal Investigators of the CSCOR-sponsored projects. These presentations give an overview of the coral reef related work sponsored by CSCOR and provide an update on their progress. Also on the first day, there were presentations by representatives of other NOAA and NOAA-sponsored programs that were invited to speak about their coral reef work. The invited speakers gave general overviews of their programs and facilities and discussed the coral research activities within their programs. The second day began with two CSCOR-only presentations. The topics of these two presentations were considered of limited interest to non-CSCOR participants. The open session followed with presentations intended to provide information on NOAA coral reef activities relevant to all programs present. Transcripts (including questions to the presenters) of the presentations are provided in sections 6 – 10 next.

Note: CSCOR would like to acknowledge the invaluable work of Ms. Charlotte Purkis in providing the transcripts for the meeting.

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6. CSCOR Programs

a. Coral Reef Ecosystem Studies – Micronesia *Dr. Robert Richmond; University of Hawaii*
(Note: for this talk there is only a summary of the presentation and not a transcript. There is a transcript of the questions to Dr. Richmond)
Dr. Richmnod presented on behalf of CRES, a group effort which involved many participants. It is a combination of watershed studies, including data collected from Southern Guam. Comparative watershed studies were carried out, one with no mangrove and another included the buffering effects of the mangroves. The various attributes of each were discussed. The main land-based problems include forest fires which are related to hunting and various other local actions. On a clear day the visibility is normally good but has the potential to change frequently. The whole watershed area covers 5 km^2. One particular project investigated the sediment quantities in the water and related these to the watershed practices. Dr. Richmond showed a map indicating the spatial, temporal, and aerial distributions within the watershed area, indicating the clear differences within the watershed. The distance and time of plumes could be related to mass spawning events which could also be used as an indicator for reproductive failure. They had made a linear model of sediment and freshwater discharge to the south of the island. A few graphs showed the correlation between rainwater and sediment load. Wind was added as another factor. He had included a graph of wind verses the log transform of sediment load. The wave action model allows one to discern the difference between the sources of sediment load. He pointed out the effect from the Tsunami swell in the South. The algae that normally sit on the bottom produced as a result of increased nutrients and over fishing get completely uplifted by wave action. These are good tools for managing the watershed and understanding the mechanisms that eliminate and retain sediment. He showed another set of data from inside and outside the station, where the resuspension totals could be calculated and compared to the land-based sediment. The models show that a wind component has to be added. A model was drawn up by a student which characterized the land-based and in situ activities. They researched what this means for the coral reefs. They looked at species composition through moving window analysis in order to understand the changes in coral composition. This was carried out at 50-m increments up to 300-m, where the community structure remains constant. The sediment load was high, even when compared to the Yangtze and the Mississippi Rivers. These results have been tied into other diagnostic tools for research purposes. Dr. Richmond explained that death is a very crude estimate of stress; he believes if we research coral reefs using mortality as an indicator, it is too late for effective mitigation procedures. He showed a balloon-type diagram which indicated which environments are significantly different from each other. When the balloons touch (or overlap), the environment is not significantly different; when they do not touch, there is a significant difference.

From a social perspective, Dr. Richmond discussed the role of the manager as stuck between fishermen, environmentalists and commercial stakeholders. Most importantly, resources cannot be wasted on mitigation measures that are not going to be effective. Protein determination is another tool to assist scientists in providing management with appropriate supportive research. In Yap, there was an anthropogenic incident. Semi

permeable membrane filters were used to find which chemicals were involved in the spill. It's a very useful tool to identify responsibility. This incident went to court and this data held up as solid information. No scientists tried to challenge the case. Organophosphates were identified from a nearby farm which no one knew existed. This is a very nice technique if you know the biological characteristics of potential sources. Now we are looking at the *Porites* gene composition and will hopefully be able to identify the number of genotypes present. The biomarkers of exposure to pollutants graph indicates permissible levels and also provides an idea of change. This is also important for mitigation procedures.

In Palau they have been able to document the changes in sediment over time, and relate this to coral growth. Palau developments are a concern, particularly the development of the new capital, where the mangroves are being destroyed for future housing. The sediments are getting further and further out into the watershed. The land-based activities combined with the manual destruction of the mangroves compound the reduction of mangroves regions. As the mangroves are destroyed, so the sediment increases and reaches further out into the watershed. The scientific results were given at a local meeting in the local language. The results were spectacular; within 6 weeks, dramatic changes were implemented and now there is national legislation to protect the watersheds. This approach has been utilized throughout the island, integrating across the ecosystems, e.g., in Pohnpei. Here capacity building is a large part of the work carried out… although there is always the issue of outside experts. There are now local people who have the expertise to implement appropriate process that fall in line with local culture. Congressional delegates from Palau were taken out into the field, where they could see, learn and assist in implementing appropriate polices. The most rewarding aspects of the research have been the effective application of science within these cultural boundaries.

<u>Questions:</u>
(Dr. Monaco): So you are saying that some people felt there was a problem in the local environment and consequently they needed data that could stand up in court? It is obviously paramount that you have indigenous capacity on the ground? It appears to be very gratifying work.
(Dr. Richmond): Yes here west meets east, however it is often the tragedy of the commons that no one does anything. There is always worry about an outside expert coming in. All we did was really put on paper what they already knew. We have managed to build confidence in the relationship between them and us. A footlocker course will be held later this year to train the local people in community colleges so they can collect and monitor the data themselves, this will include even seniors and juniors in high school.
(Dr. Magnien): How did you measure accumulation rates? And how do you distinguish between resuspended sediment?
(Dr. Richmond): We used a combination of techniques on a 75 day basis, recorded using real time instruments, sediment traps at various levels, turbidity meters, etc. The turbidity at the mouth of the river was measured and compared with the flux across the

river. Also characteristic components, e.g., diatoms present. It was a combination of physical instruments and biological observation.

b. Coral Reef Ecosystem Studies – Caribbean *Dr. Rich Appeldoorn; University of Puerto Rico – Mayaguez*
(Dr. Appeldoorn): This research concerns the development of a model that identifies sediment loads and their sources. It covers areas spanning watersheds to individual plots Sediment run offs relate to rainfall and slope. The graph of sediment production verses slope differed around Puerto Rico by several orders of magnitude. This diversity is due to the slope and age less sediment to run off. Another issue faced is drought. We wanted to know if the impacts found on land relate to the sediment record. There were two cruises over the past 3 years that cover offshore to very nearshore areas. Lead activity was used to determine the sedimentation process. From the results, large-scale sedimentary events, e.g., storms were easily identified. The cores that were taken offshore produced similar sedimentation rate results -3 cm / year. In the nearshore areas, a decrease in lead-210 activity indicated a decrease in sedimentation rate. These results were collected close to the mangroves. We concluded that mangroves are an important contributor to the sedimentation rate. In shore, in front of the reefs we noticed high sedimentation rates. One aspect of the research used fatty acid signals to distinguish between the terrestrial and the marine sediments. In these instances, the alkanes to fatty acids ratio were determined. However we did not find the signal that we were expecting. The shoreline to shelf edge graph shows, the further from the shore, the smaller the amount of fluorescence indicating a reduction in terrestrial presence. 1.5 years ago there was a large rain event and we collected data a month later. The data indicated that the majority of the sediment inshore stays inshore and is terrestrial. We also collected fluorescence and turbidity data following the hurricane events this year; Jeanne and Ivan. Turbidity related to wind patterns and fluorescence to the terrestrial & freshwater fluctuations. We observed high turbidity changes and low temperature changes, where there were high winds and low rainfall. Where Hurricane Jeanne passed directly over the top, there was considerable rain. This showed as a large fluorescence peak. The large quantity of rain also affected the salinity / freshwater ratio.

Dr. Dave Ballantine's work concerns the impact on the bottom by looking at concentrations of nitrogen within the coral tissues. He observed higher signal within the inner reef, however he did experience problem with the tools. The biggest problem is coral diseases. There over 12 diseases identified: bleaching in summer of 03, recovery was quick with the exception of the inshore reef. White plague type 2 had significant impact on 2 offshore sites in 2003. Yellow blotch disease in the mid-shelf reef had a high impact in the summer 2004 and autumn. In addition to looking at incidents we observe the impacts, e.g., for black band disease where a whole section of reef died within 10 days. In terms of white band disease, they believe to have isolated the cause, although the final stage of the research has not been completed yet. White plague has been found in healthy areas of *Halamida*, they predict that *Halamida* may act as a reservoir for the disease. The question now arises as to how to deal with a disease reservoir? It is *Aspergillosis*, a species of fungus, which cause this disease. The two groups working on this observed different dynamics. This is an organism wide disease, with lots of disease

species present. This observation has been confirmed through genetic sequencing. It is a large problem within the area. A component of the work concerns the coral community structures and dynamics and how recruitment dynamics translates to the community structure. The two inshore, midshore, and offshore reefs are all very different in their compositions.

The work looks at reef communities in general and monitors how they change over time. He showed a series of slide observations over the period of a year. The increase in algal cover show high resolution changes. Are they annual cycles or patterns causing phase shifts? He feels these questions have not yet been adequately addressed. In order to research this effectively, an ecosystems approach needs to be adopted.

One of the most challenging aspects of the research concerns the social component of the program. How can we best utilize local knowledge (the fisherman) in order to create reserves that work? Presently we are producing a fishermen's approach which use their descriptive information. For example, when they talk about habitat, they describe key factors which affect fisheries from their perspective. Software is being developed to incorporate all this local information. The scientific development of trophic structures and biological information can therefore be compared to the fishermen's observations. As a result, habitat and fisheries management is becoming a shared responsibility. The fishermen have an institutional memory and this provides solid historical collective information that can be used within the management realm. In the past these differences have caused barriers between the fisherman and the management.

Finally, we looked at spawning aggregations at Mona Island, as it interestingly provides an ecological barrier between the two islands of Puerto Rico and the Dominican Republic. Three cruises last year and this year took place in co-operation with marine fisheries and other partnership organizations. We have documented Yellow Fin Grouper, Tiger Grouper (were even deeper, but same location), Yellow Tail Parrot Fish and Blue Tang.

Questions:
(Dr. Monaco): What were the depths of the spawning aggregations compared to the instrumentation?
(Dr. Appeldoorn): The instrumentation was used at 75 ft.
(Dr. Magnien): Question about disease and the use of biomarkers?
(Dr. Appeldoorn): He agreed that it is clear, there is social stress related to biomarker use.
(Dr. Richmond): There are presently discussions taking place on this.

c. Hawaii Coral Reef Initiative – Research Program *Ms. Kristine Davidson and Dr. Michael Hamnett; University of Hawaii*
(Dr. Hamnett): All the information on past reports is available as power point presentations on our website. This provides a comprehensive account of the past work. The non-economic value of Hawaii reefs, whereas it was previously the economic last year, is the main consideration of the research carried out now. Herman Caesar carried out some research on the economic value, unfortunately the research was not considered

particularly beneficial from a biological perspective. The economic value stems from the use of reefs by people, but the non-economic stems from peoples valuation as an ecosystem. There has been a second request for proposals for further research into this matter. The results were collected in 3 phases. There were three focus groups and a 1600 household survey that was conducted by phone. The household survey was conducted as a stratified random survey, which included all stakeholders, fishermen, & local residents from all 4 counties. The survey aimed to determine what kinds of people are doing what kind of activities and how often. The results showed a range of activities which occurred more than once in the last 12 months. The most shocking information was 26% of the population line fished as a hobby. The next category considered frequent users, who used offshore resources in the last 12 months. The survey also asked peoples perceptions of threats to coral reefs. Why people value the coastal resources? And what should be done to protect the coral reefs? Many people believed that more areas should be protected. This important aspect of the research needs to be impressed onto the politicians.
(Ms. Davidson): Alien and Invasive species: what are the alien invertebrates? No one expected the Orange Keyhole Sponge. The *Carijoa* is overgrowing right over the coral beds and the posts on the piers. The diseases are not as wide spread as say in Florida; however they are an important part of the research required. Another program concerns the integrated monitoring of coral reefs. CRAMP, WAP, and DAR are paying for half of the funds; HCRI is paying for half of the monitoring and it is a state-wide program.
(Dr. Hamnett): The monitoring had to be changed so that is could be sustained. DAR has been pushed to do the monitoring themselves. We have also encouraged them to become more efficient by using the data they have collected for other uses. It is a state function paid for by state funds, hence it can be terminal; we need to promote sustainability.
(Ms. Davidson): Bio-station modeling has been created as a children's game, where kids can create their own reef. It teaches kids at high school and community managers how the dynamics all fit together.
(Dr. Hamnett): Getting the coral reefs biologists and all the other stakeholders to talk to each other is one aim/achievement. It wasn't until an economist was on board that this program was really brought together.
(Kristine Davidson): Population dynamics studies have also been carried out.
(Dr.Hamnett): Reproduction and recruitment is very low in Hawaii.
(Kristine Davidson): What is the next step in the estimating the non-economic value of the reefs? The results from the previous research have been handed down for analysis. We need to understand the effects and spread of invasive species, with mitigation procedure of how to minimize effects. We also need to ascertain how much fishing the resource can withstand.
(Dr.Hamnett): Relatively few proposals were received for fishing research; it is the biggest issue, but no one proposes to do anything about fishing.
(Ms. Davidson): Pollution effects & disease. What information helps the managers? For coastal development issues we make recommendations to assist management solutions. Nearshore recreation and what the value is of it? More games have been made and two are being taken to the management level. These games link population dynamics with the oceanography issues. Regulatory review was the issues that came out of the focus groups. What are the regulations? How do they work? How do they relate to other

jurisdictions? It is a state linked question. How well is the state managing the regulation? It is a general consensus that Hawaii is over regulated and under managed. Booklets have been put together on the statistics of enforcement and the regulations. These have taken the threats and personified them in order to involve every stakeholder in the society. The booklets are being distributed to navigational captains.
(Dr. Hamnett): Pushing much more on the management and the use of the information. They feel they don't really have a handle on the dynamics and the status of the reefs around the islands. The household survey should have been carried out a long time ago and this should have been transferred into political action. A family day was carried out at a local aquarium; it was a collaborative effort, government, FFWS, NOAA etc 1600 kids showed up. They are doing another one because it was such a success. The level of awareness needs to be increased in order to put pressure on legislators. The management agencies need to get their act together.
(Ms. Davidson): A curriculum is also being put together for school kids with supplementary information for investigation which including disease; this initiative promotes science within the youth. Once a week, a newsletter is sent out to legislators to update them on research and information. This is an important way of communicating information. All the art work is contributed by kids, community colleges; they are a group of talented undergraduates.

Questions:
(Ms. Fretwell): The LAS in Florida seems very similar to the HCRI work carried out?
(Ms. Davidson): HCRI follows a very integrated process, talking to people at DAR there is constantly communication taking place. There are yearly round table meetings. It works well because it's small.
(Dr. Monaco): Do you have statistical information about your household survey?
(Ms. Davidson): Yes all the information is collected and we would like to put this together.

d. Caribbean Coral Reef Institute *Dr. Rich Appeldoorn; University of Puerto Rico – Mayaguez*
CCRI is a co-operative program between management and research, modeled on HCRI. The aim is for research and monitoring to feed into management strategies. The management committee determines which projects should be funded. We are currently funded through 2 grants although this may drop. Ten projects consider resource assessment, MPA design, and reef processes. We have gone back to re-evaluate our monitoring strategies in order to attain more robust data. From this we hope to make some cost-benefit estimates of what has to be done and what can be dropped in terms of monitoring. The West coast platform is the most economically important area; side-scan sonar is being used to monitor this. We also presently have an assessment on ornamental fisheries. MPA design issues take place in, for example Mona Islands where there is no real management plan at the moment. The research entails: relations between species distribution and habitat distributions and a sociological component for the new MPA strategies. There was an effort in the '90's in Turrumote, however there were problems following Hurricane George, then the elections, so the effort was slowed somewhat. The issues are now being brought back to the local communities and being reformalized.

Spawning aggregation information is being collected through fisherman interviews, the scientists then go out with them to ground truth. The survival of recruits in coral recruitment identifies water quality and pollution issues. There also exist problems of algal overgrowth, e.g., cyanobacteria. Another example is fire coral; we need to know about the processes involved. Genetic variability in *Acropora*, are there genetic bottlenecks for *Acropora* able to reproduce? We utilize the use of a cruise station to look at physiology, metabolism, levels of light, spectral images and ground truth information.

Phase 2 of CCRI, will be to look at sedimentation processes, identifying sources and sinks, terrestrial and offshore. RFP was sent out yesterday for quarterly meetings, NGO's, Sea Grant, federal agencies, etc were all pulled together. Focal areas were identified and summarized. Outreach is not top priority; however it is an important aspect to the research. We include additional organizations such as those involved in tourism, the planning board, FFWS, etc. The final reports include direct applications of research so that managers can appreciate the research. The website has not been set up but will be. A coral calendar was produced. The University of Puerto Rico always brings out a calendar and we persuaded them to focus it solely on corals. This encompassed all our programs.

e. National Coral Reef Institute *Dr. Richard Dodge; Nova Southeastern University* (Dr. Dodge): NCRI is not an independent institute but part of Nova Southeastern University. *(Dr. Dodge gave a geographic summary)* NSU is the 8th largest private university in the U.S., largest library in the state. The Oceanographic Center is where you are at the moment. It has 10 acres and is next to Port Everglades. The Center is broadly based in physical, chemical and biological oceanography. We pride ourselves on our internal institutes, e.g. the Guy Harvey Institute and NCRI. The background of NCRI was founded with congressional support with a key background and to undertake research. In 1999, as a result of papers presented at our international conference, our mission and which directions were most appropriate were determined. The initiatives involve monitoring, assessment, and restoration. NCRI is also helping to host the ICRS in 2008.

Research that is being carried out was summarized yesterday. Mapping has a large emphasis covering both large scale and small scale morphology. We also benefit from 3D Lidar information for the reefs found offshore. The Lidar database can be used for understanding past impacts. The Army Corps wants to remove top of 3rd reef, but our research can argue that its preservation may be of both economical and environmental benefit.

Our research findings include: observed accumulations of *Acropora cervicornis* in the area in the north of Broward County, so far from the Keys; sediment stress using biomarkers, and histological research to determine the effects of beach renourishment. When certain levels of stress are reached, then the beach renourishment program should be stopped. There is also fish research that is being carried out, particularly on genetic projects concerning the connectivity between reef sites within the NCRI monitoring network. Growth bands and annual accumulations of coral skeleton, calcification rates

have changed. Increased CO_2 in the sea will also cause coral density to change. The restoration work evaluates the effects of fisheries using, for example, the reef balls, testing different substrates and the complexities within the balls and how these effect recruitment. Nursery work and the collection of corals of opportunity that are taken to the nursery which can then be transplanted where required. The CREMP project on fish assessments initiated in the Keys now reaches all the way up to Martin County. We hope to add more research sites so as to reach the same density as in the Keys. This will help us understand the historical changes. In Puerto Rico, we had funding for naval work on the eastern end of Vieques. This research included sediment surveys and fish observation. We expect to go back either this year or next year to partner and collaborate further with our work. Habitat maps have been laid in Vieques; this has provided an important data set with which to base more comprehensive research.
Note: this and the following talk were given in tandem. Questions related to this talk were asked at the end of the next presentation.

f. NCRI Coral Reef Monitoring Network *Dr. Bernhard Reigl; Nova Southeastern University*
(Dr. Riegl): Why do we need a monitoring network, is this duplication? Are we re-monitoring? What we are carrying out is a new approach to coral reef dynamics. The progress has been satisfactory. It was set up because NOAA wants a thorough assessment for a benchmarking progress. Initially the goals had to be achieved by the end of the first year; the expectations were met and published in high impact journals. The sites have been installed in The Pacific; the island of Tinian will probably not be continued. The Arabian Sea sites have been finished. The WWF and our Partners in UAE paid for this work. This work was finished and is published. This was really a practice pilot study. It worked and yes you can use satellite information as a monitoring tool. The monitoring network is the biggest within NCRI, one PI for each group: genetics, remote sensing and biology. Each has a very specific role and these three groups work closely together. In the Atlantic, all the data has been collected in Broward, Biscayne, and Puerto Rico. Roatan was chosen in Honduras. There is a truly worldwide set on maps. Therefore, whatever happens in today's climate will be picked up in a uniform report. The work gives managers a tool, so why is this useful?

From the image we produce a pixel map we can then identify what is going on in a pixel to pixel basis. This does not compete with the traditional monitoring. We can answer questions, such as where are the areas with dense corals and dead corals? And what neighbors what? Is this whole spatial pattern random or is there a probability in neighboring pixel content? The answer is yes; the results do tie in with normal ecology dynamics as the formation of biological systems can and do represent a Markovian distribution. We can therefore move out of on site mapping and view images in time, in which we can then identify changes. This is now being undertaken in Vieques in Puerto Rico. We know that these areas have seen changes in *Acropora*, the optical properties of yesterday and today show evidence for these real changes. Surprisingly, in Honduras there is huge *Acropora* life and the genetic work can identify the connectivity between the two. There is apparent isolation between places in the Caribbean. This is very important for management practices. The last point concerns the spatial and temporal

dynamics. Who drives the temporal dynamics? This can be investigated in the Pacific, where, the eastern Pacific shares fauna with the central Pacific. We know it is connected with the El Niño events. We have been working with our Mexican partners investigating energy analysis. The ENSO peak has been identified in the Galapagos. There are other sites in the Pacific that show the ENSO peak, but this may be driven by the Indian Ocean? Although most places in the Pacific do not have these.

Questions:

(Dr. Monaco): Are the stations in the Atlantic Puerto Rico and St. Croix permanent sites? And how many times do you visit?

(Dr. Dodge): We visited Vieques once, and we have plants to return and revisit those permanent sites.

(Dr. Monaco): On the North of St. Croix, there are 800 sites which have more information concerning chemical and biological information so we could share the information? So there is opportunity for collaboration.

(Dr. Dodge): It depends what data can be released, although our recent work can now be released, permission has been given.

(Dr. Magnien): It appears there is a lot of potential collaboration; management strategies can be adopted especially from the developing countries such as Palau. I would like to encourage co-operation.

(Dr. Richmond): Most managers are not sure about their regulatory framework. Getting a legal person in can help can be effective in facilitating strategies. There was no resistance during our regulatory review, although, at the Task Force meeting there was an issue of transparency from the person who hired and funded the project.

(Dr. Dodge): Our as part of the beach renourishment project has developed a unique measurement technique that has the potential to shut down a major project. The contract specified that we would develop, through an extensive laboratory experiment, an index for assessing coral stress utilizing both observational and histopathological parameters.

(Dr. Magnien): How can you insure there is no conflict of interest, what did you have to do?

(Dr. Dodge): The first step is that we were contracted to provide a scientifically valid coral stress index through application of scientific research. Hence there is no conflict in providing what is desired (and contracted for). There is also a second validation in that we will publish the results through a peer-review process. Our work was to develop a tool that monitored coral stress; it is a management decision as to whether it is actually utilized to stop the sedimentation renourishment project when stress reaches the appropriate threshold

(Dr. Riegl): NCRI does not consult, when asked to produce an indicator; the work is finished and handed to a monitoring program. NCRI does not manage the management program.

(Dr. Magnien): If the indicator shows there is a problem and management says no, we won't do anything, what can you do?

(Dr. Dodge): There is very little NCRI can do if the managers decide not to use it. NCRI's role was to provide a valid indication of coral stress and that is what we are doing. We are directly assisting management in this regard by providing a valid tool.

(Dr. Riegl): We have an example of this where a site was lost in the Gulf, because the Sheik has built an artificial island. Researchers do not have the legislative clout, to instigate changes, but we can provide a good tool, but we have no driver if the tool is used inappropriately.
(Dr. Magnien): Who do you provide the tool to? Is the data publicly available in real time?
(Richard Dodge): The results are provided to Broward County. This is a public agency and hence all data is publicly available.
(Dr. Riegl): There are a lot of projects that remain outside NCRI because of the contract not to consult.
(Dr. Dodge): NCRI has conducted extensive research to design a tool and provide information on how it should be used. Management has to deal with many issues which not only involve science but also involve politics. There are some environmental activists who feel that any activities of man can irreparably harm coral reefs. Management has to balance various user groups. Management needs valid tools to understand and protect the resource. NCRI is providing a useful tool to help avoid injury from sediment to corals. This tool is likely to be of considerable utility for managers elsewhere.

7. Invited Programs

a. Southeast Fisheries Science Center (SEFSC) *Dr. Jim Bohnsack; National Marine Fisheries Service*

(Dr. Bohnsack): We have a strong link with the University of Miami. We were looking to progress on the monitoring. The Broward County work has been kept separate, but it is now involved. In the National Marine Sanctuary, we take an ecosystem approach. The main threats identified are population threats. There exists a rich species context, with 389 primary and secondary reef species. There exists lots of zoning. We have seven different levels from no spear fishing to no take zones. These are researched and identified by looking at the management issues within the management. We take into account the different kinds of reefs, lifecycle monitoring results, and various habitat associations. We stratify the information into maps and classify into seven strata from outer to patch and inshore. These are classified by habitat. (*He showed examples of patchy and hard bottom (fishermen call this live bottom) areas.)* We look at how the fish respond to the habitat. The largest no take area is off the Tortugas. Monitoring takes place inside and outside the zones. The Sherwood Forest area in the Tortugas is an example where we used two-stage stratification. We take the maps and randomly select points, we classify it by habitat, then sample in a 200/200 cell if the area has coral in it. Divers go in and sample, get approx 7 points per dive, these are replicated by the 2 divers per cell. We select the cells with coral, then put in the samples. This research is co-coordinated with people who study corals. With fish, this technique is no good; here we use a circular plot to encompass mobility. The co-efficient of variation needs to be as small as possible; by increasing the sample size, we reduce the co-efficient. The diver stands in the middle and assesses everything within the circle. All species are identified. For each species the abundance is identified, we then estimate the maximum and minimum size. This methodology creates information on species composition, abundance and size. There are all-purpose tools to assist in this descriptive analysis. In order to optimize the results with time has taken several years to perfect. It takes 20-25 minutes to do one circular sample. This is then correlated with the transect approach adopted by coral biologists. This is really a tool to assess how the habitat works. This work is mapped onto a topographic map in the Tortugas. Most work is focused on the reef tract in Florida. Also some ground truth mapping has been done in order to re-align the aerial data previously obtained. In 2002 we did a Keys wide cruise, 8 organizations with 52 divers. National Sea Research Center with Otto's group and the University of Florida, both groups used the stratified sampling technique. For each particular cruise, we take data, do a design, assimilate, do a multi-species assessment, then re-design for next year. We are constantly optimizing the approach to increase our efficiency. It is an iterative learning process. (*He showed a survey precision graph, where by 1999 the co-efficient of variance was considerably reduced. He showed a map for the Grey Snapper where the data is collected from the fishermen's boats and should show similar results.)* They found this is the case, when looking for legal sized fish. With fishing you kill off the oldest and biggest ones first so it shouldn't affect the juveniles in the population. Several graphs of fishing showing average fish size was indeed dependant upon fishing. At the moment we are killing 5 times faster than should be. We see a lot of Black Grouper all along the Keys; however the adult populations are few. *(He showed an*

example of a multi-species approach using a spotting ratio. The graph showed the 30% over fishing mark.) By definition, 64% are over fished. On Y axis there is the rate of over fishing and on the x axis the over fished. This information is spatially managed by zones. By looking particularly at marine reserves, the idea is that fish survive and grow; you witness increased abundance, increased diversity, and a spill over effect out of the reserves. In addition, more eggs get advected into the ocean current and into the fishing ground. Reproduction dispersal is probably the most important factor for fishermen. In the Keys sanctuary, sampling took place from '94-'96, to insure all cells were sampled, and re-sampled in '97 and '98. Within 3 years there was a 400% increase in stocks. Hurricanes also cause recruitment as a following event. The map of Yellow Snapper density monitored for the marine reserves showed significant increases after the hurricanes, but also over time. The non-exploited species show no patterns of change, the exploited species took off after 5 years, particularly Yellow Tail and Grey Snapper. People said, the areas are much too small to have any effect and secondly fishermen won't obey the law. However the response was amazing, when only removing the fishing aspect there are huge changes witnessed. This research also provided the opportunity to learn about habitat relationships.

Questions:
(Dr. Appeldoorn): Black Snapper improved hugely why was that / how did you know?
(Dr. Bohnsack): There are pictures of the fishermen fishing around the no take zones, but 20% of populations remain within the no take zone. We carried out a hypothesis testing design, but you need good maps to make this effective. In addition, fishermen are saying they are seeing more fish.
(Dr. Shivji): Even small areas have good effects with spill over etc, but is there a problem of limiting the gene pool because the areas are so small?
(Dr. Bohnsack): We have a geneticist at FAU researching this more thoroughly. However, fishing itself removes the population selectively, so the reserves should be selecting the wild type genes, so I would argue the opposite.
(Dr. Shivji): From a genetics perspective it's better to have multiple small no take zones covering a whole range of habitat, also more spill over etc.
(Dr. Bohnsack): Sociological benefit, no pain, no gain. Yes it's a good idea.

b. Center for Coastal Fisheries and Habitat Research (CCFHR) *Dr. David Johnson; National Ocean Service, National Centers for Coastal Ocean Science*
(Dr. Johnson): There are three projects that I am going to look at: (i) the designation of the Tortugas National Park, (ii) the coral recovery report, and (iii) a project looking at the invasive lion fish. (i) In order to build an assessment of the effectiveness of the reserve, we look at a cross section of the entire ecosystem. In addition to the integrated assessment, we look at remote sensing technology. There is one cruise that uses multi-beam surveys and another map showing survey sites. The surveys are worked on 30-m transects across the reefs and 30-m across sand. We also take fish surveys using an eco-sounder and carry out beam trawls to look at the effects of trawling.
(ii) Coral recovery and model ship groundings. (iii) Finally there is a large amount of hard bottom along the Florida coastline. The project spans 5 years, when the lion fish was discovered off the coast on North Carolina. People have seen them but now

identified that they are a common species. There is now a study into the distribution of the species. We do not believe that these species can live in the winter in certain areas. Unfortunately, the hurricanes meant the surveys were more limited but lion fish were still found at 17 of 19 sites. We are much further along with the invasion of the species. The collaborators are included in the presentation.

Questions:
(Dr. Dowgiallo): Have you investigated the possibility of different species present in the lion fish?
(Dr. Martinez): How do the density variances change?
(Dr. Johnson): We believe the distribution is continuous.
(Dr. Martinez): In Puerto Rico and the Bahamas?
(Dr. Appeldoorn): There are occasional sightings of lion fish.
(Dr. Johnson): Has anyone seen them in the Keys?
(Mr. Rutten): No
(Dr. Arrington): Does the depth matter?
(Dr. Johnson): Yes they are found at the deep diving limits, however, the juveniles are found in shallow water.
(Dr. Monaco): Looking for corroboration.

c. Atlantic Oceanographic and Meteorological Laboratory (AOML)/Coral Reef Early Warning System (CREWS) *Dr. Jim Hendee; Office of Oceanic and Atmospheric Research, AOML*
(Dr. Hendee): The stations are being assembled. The stations take reading of wind speed, sea temp, salinity, a rain gauge, PCO_2, current etc. Each station synthesizes the data in real time. The first station was established at Lee Stocking Island and sticks 10 m above water surface, there are now stations at St Criox in Salt River Bay in U.S. Virgin Islands. There will be an outreach program for the kids with the use of a camera. La Parguera in the south west of Puerto Rico has a CTD, light sensor, transmissometer, and panfluorometer. The data can also be transmitted at a distance away from the station. We also wish to assemble stations in Jamaica, Belize, Australia on Heron Island, and in the Pacific. *(He showed a time plan for installing these stations at each site.)* The software environmental information synthesizer provides information of the physical and environmental response for example fish and coral spawning. You can get raw data not just the export data and this is held in an online database. For coral reef health and monitoring you can download the information yourself for research. For the knowledge engineering part, the table shows how the data is digested. It looks at numbers, discerns the drastically low to drastically high, if they stay in those high or low measurements over time they are then fed into an if /when system. The indicators can then show coral bleaching. There is always seven days worth of data, if there was a coral bleaching event, then you can go back to the data and view the most stressful conditions for the coral.

The panfluorometer: This is the only direct measurement for seeing coral bleaching up to two weeks before it actually bleaches. When the corals are healthy the ratio is high, when it drops the corals are under stress. This was tested in Lee Stocking Island.

Measurements were taken with a light gun on the hour every hour. When summer comes we expect the fluorescent numbers drop, these will feed back into the decision system. Chromophoric Dissolved Organic Material comes from mangroves etc. If the area is well mixed we see stress. Photobleaching takes placed when the water is very quiet. We believe that this causes bleaching too. The expert system can monitor 10, 000 different scenarios, as long as a sensor can be placed and the symptoms can be fed into the system manager. PCO_2 data is monitored; the feature was picked up when the hurricane passed over.

All the users can get together so they can utilize the data. This comes from recommendations from the Ocean Commission to integrate data. G2 is the system that is put forward for managing this integrated data. G2 is used by NASA and the CIA. It has different bridges into different commercial databases, so the data can come from all different sources. Data can now also be taken in from satellites and can be used for wide spatial areas. It has a telewindow, which can be operated by remote windows; users can make their own application that can be served online. We wish to integrate data from all partners, NOAA, and Australian and academic institutions. However it is not supposed to work on archive data. G2 is also used for scheduling for hurricane use. He showed a user page that will be accessible online. You get spread sheet type data which can be used. Next week we hope to have the first lots of usable data. There are different user types, e.g., administrator, expert etc., from which you can link to maps, metadata and calibration data. This will all go into the same database. Latest coral bleaching alerts will be sent out; also advisory service for info will be updated.

There are many new applications, such as the DNA sensor for harmful algal blooms, and CO_2 system for measuring coral growth (total alkalinity). The Quiet Ocean hypothesis, developed from anchovy fishing, where the greater the concentration of chlorophyll thus phytoplankton which can be relayed into zooplankton development. These types of hypothesis can all be monitored through the satellite information; in addition, ship intrusion system and a tsunami type warning system, etc.

This is the approach for an integrated field-based system. Need domain expert system advice. The field team is very important because they need to clean sensors; they are the people who go out every 2 weeks to check that the stations are working well. There is high quality data coming out from them and consequently the data isn't cheap!

<u>Questions:</u>
(Dr. Martinez): Cost?
(Dr. Hendee); $100K to set up the initial system, then there are the additional calibration costs and maintenance charges.
(Dr. Martinez): How do you plan to continue funding?
(Dr. Hendee): For example, in the Puerto Rico station we require a graduate student to maintain the station. Dr. Richmond is also going to research/collaborate. Plan to put the sticks out into the Pacific when partners are found. At the moment are just correcting the system.

d. Caribbean marine Research Center (CMRC) *Dr. Albrey Arrington; Perry Institute of Marine Science (PIMS)*
(Dr. Arrington): There is a lot of confusion about the Perry Institute of Marine Science, as nested within PIMS is the Caribbean Marine Research Center. CMRC represents the NURP aspect of PIMS. We have gone through recent strategic planning! Very positive, the entire board walked away with a new mission to conduct and support scientific research. We now address, the management applications of information being gathered. There are four groups of main research; Fisheries, Coral Reefs (coral reefs and coral physiology), Ecosystems (estuaries, particularly Andros and the trajectory of restoration, what types of methods for restoration), and Marine Biodiversity (promoting the awareness of extinction). PIMS has conducted and supported science from 2000 – 2004 with respect to SCUBA diving. We concentrate on advanced methods of scientific diving such as nitrox or trimix diving. The current capabilities include the capacity to support SCUBA. We have 3-5000 scientific dives per year. There is a trimix training scheme for people to start accessing the deeper life (algae in particular, maybe the lion fish?). We have safety and emergency support for all divers. We run technical diving training courses with the use of Lee Stocking Island (LSI) as a technical diving center, although we are looking for partnerships with other universities so people can come and get trained in order to conduct their research.

Concerning the Reefs at Risk, PIMS is in a relatively un-impacted area and the use of LSI as an unaffected site is of importance. We are looking for synergy with funding. We have 3 main pots of money – CMRC/NURP, NCRCP, and CCRI. The full proposals are sent out from PIMS, all groups confer in order to insure correct allocation of funds. We provide the logistical support for the research. We have a mindset to partner with other groups to insure the funding can reach further. Our research goals are now the exploration of the deep reef.

Questions:
(Dr. Dowgiallo): Is Lee Stocking Island still pristine, even with the development that is taking place?
(Dr. Arrington): If you compare LSI with Puerto Rico, yes it's clean. However we aim to get as large a portion of the surrounding area of LSI as a marine reserve to insure that it remains as untouched. It should be pristine for a length of time. These conditions also hold because of the large shelf, which cause it to absorb the impacts more slowly than if the shelf was maybe less deep. Despite these changes we can assess real time changes.

e. Center for coastal Environmental Health and Biomolecular research (CCEHBR) *Dr. Cheryl Woodley; National Ocean Service, National Centers for Coastal Ocean Science*
(Dr. Woodley): The marine complex houses five different marine agencies: College of Charleston, the state of South Carolina Department of Environment, Satellite research facility, & more for a total of 5 agencies. Together they form the Hollings Marine Laboratory. The laboratory holds the biology, genomics, cryogenics facility, and aquatic production facility. The scientific focus is to bring together science and biotechnology particularly environmental/public health. The marine analytical assurance program

develops standards. Marine genomics houses all the groups and looks at antibiotic resistant and linkages to human health; these primarily concern algal blooms and involve the mass culturing of algae and identification of the toxins. We aim to understand the signals defined by the corals. Area of the research for maintaining coral cultures as well as bio and chemical challenge work. Bioindicators is her main line of work. Here, we strive to take the data from analysis and synthesis and utilize this information, bringing together genomic data, physiology, and other knowledge systems to provide a better understanding. The NMR facility is a new addition, used for substructural analysis, it is a regional resource used for structural chemistry, cancer research, and metabalomix (which is created during the metabolic process). Some researchers are interested in whether this can be used for coral research. Efforts look at the interactions of organisms within the ocean and how humans impact the ocean. We recently received a reward as a center of excellence for Oceans and Human Health.

The coral research that is taking place in Charleston focuses on coral health and disease. (*Slide to show the distribution of coral disease globally.)* There are reports that there is more of an emerging issue of disease in the Pacific. On the host side we are dealing three different kingdoms and the definition of disease also includes non infectious, anthropogenic types of disease agents. The stress response, defense, and detox can be measured through cellular diagnostics, which answer simple diagnostic questions. Is the cell stressed at the cellular level? If so, the goal is to identify the mechanisms of action and link these to some form of causation. How well do the cellular issues link to community issues? *(A slide shows which techniques were used for which level of identification.)* In March we created a coral biopsy and by August it was completely healed; we observed the opposite response from another coral. There were little stress signals for the healed coral and in the areas where there was no healing there were larger indicators of stress. Tacked onto this research was two-dimensional gel electorphoresis, which compared a healthy and unhealthy coral by looking at protein analysis through a mass spectrometer and sequencing types of information. The data was selected by PI and the spots can be identified according to their color. Here we could identify relative amounts of protein for diseased and healthy coral. Parallel with the protein track is the genomics track. We have a Qbot that picks from 96 sample well plates. The rationale for using the genomics is that there is a huge amount of data available for looking at protein interaction. The summary of coral EST clones is available form the website. An example is the *Montastraea*, where a number of different clones can be identified differently. There are new research proposals to analyze *Acropora* and *Porities* (not sure which or both) this will also help identify diseases. The microbiology research into gorgonians and one deep sea coral looks at the microbial shifts. These shifts are not proven to be reliable, so we are retesting these. *Acropora* disease outbreak research is also being carried out. We are looking at the mucus in gorgonians using microphoresis. One predominant bacterium is available as a defense system against pathogenic defenders. Microbian community analysis is still at the forefront of research. The microbial information explodes when studying the unhealthy corals. There is a Ph.D. who is looking at several techniques, taking histological sections and looking at bacterial aggregates, we are cutting out these aggregates and analyzing them. Trying to identify what the bacterial aggregates are doing in both a healthy and diseased situation.

We need to understand the mechanisms of action and marry these sciences so as to understand the cause and effect relationships.

Questions:
(Dr. Hamnett): So when the bacteria present in a healthy coral is affected the coral gets becomes diseased?
(Dr. Woodley): Yes, however, the balance within a community is disturbed through opportunistic conditions.
(Dr. Magnien): Comment on the similarities and differences with Bob Richmond, you said the differences are Bob's systems are much simpler?
(Dr. Woodley): The technologies are very similar. The work in the Keys showed that deep corals bleached and shallow corals didn't. There was a tolerance to buffer the change in the shallow corals but not in the deep corals. Another example in the upper Keys, pulses of xenobiotic responses in fish and snails and coral at certain uses in time.
(Dr. Martinez): Yes but what do you mean by simple?
(Dr. Woodley): The choices of smoking guns are much reduced.

f. National Undersea Research Center (NURC) *Mr. Otto Rutten; University of North Carolina – Wilmington*
(Mr. Rutten): We are part of NOAA's undersea research centers and part of the National Undersea Research Program. What do we do? Well we try to provide advanced technology. This includes ROV's and AUV's (autonomous) will be arriving later this year. There is a slight separation between North Carolina and Key Largo, Carolina is mostly into ROV's and the diving is handled mostly from Key Largo. We support the work of the sanctuaries and get researchers into the field using TRIMIX. The NOAA directive plan promotes our work with the national marine sanctuary, in that they tell us their areas of concern. Proposals are due in August and then the decision of who to fund is decided. Leveraging as much as possible, fisheries, NOAA, sanctuary and cost share as much as possible, we have good partnership arrangements. The biggest partnership is with NASA as a means of training astronauts, in addition they actually pay us! This enables us to further our research capabilities. We also get on TV, which is good promotion for us. The NURC Florida Program established in 1991 and was started by researching parts of the Caribbean in St Croix and ended up by coming to the National Marine Sanctuary. We have a lot of education and outreach. There is the Aquarius program and the Florida Day boat program (8 divers, covers the area from Miami to Key West and to the Tortugas). We provide technical assistance as experts in the area. We give money, provide the vessel and get to lots of stations. You have a captain and dive master, so it is safe. We supply all the dive gear and the boat has two small labs, which are very simple and have accommodation for up to 20 scientists.

Aquarius is 43 ft long, 9 ft in diameter and typically houses 4 scientists. Its saturation diving, located off Key Largo on Conch reef. With saturation diving you have almost unlimited time and can dive up to 9 hours a day, you can monitor all day long, have electronic computer control and internet. The mission is usually 10 days following which you have 16 hours decompression. There is a lot of risk management training, lots of

safety briefings, a lot of protocols, safety equipment and maintenance. NASA has brought along their technology to us! Aquarius has CO_2 scrubbers, atmospheric pressure control, phones, cell, internet, video wireless telemetry system, waste removal. There is a buoy that sits on top of Aquarius that provides all the signals, inside there is at least two of everything. He explained what it looks like on the inside: a lot of safety features. On the reef there are cable lines laid out to prevent people getting lost and navigate around the reef. There are spots for air and gazebos. Plug in a hose on the first stage to re-fill. You check in at the stations for safety reasons too. Only concentrate on coral reef scientific research, examples include nutrients, pollution from septic systems, injection wells etc. There are education and outreach although NURC doesn't allow us to spend money on it. People always want to write articles on the work they carried out.

8. NOAA Headquarters

a. Grants Management: Current Issues *Mr. David Hilmer; National Ocean Service, National Centers for Coastal Ocean Science, Center for Sponsored Coastal Ocean Research*

(Mr. Hilmer began by summarizing the updates from the last meeting.)

(Mr. Hilmer): We are moving towards an increased use of 'grants.gov'. I have Information on how to sign up for it and use it. NOAA 'grants online' has also been rolled out, but not to recipients yet. There exist, 900 grant programs, which constitute $350 billion in annual awards. The applications are therefore becoming more standardized. You can find which grant opportunities are available on the website and apply for the grants. You need to search for a download application package. This process will take place for FY06 grants. This information will be published on 'grants.gov'. The nicest features on this website are the search features. You can also sign up for an email service. Screen shots were included in his presentation.

(Ms. Davidson): How does this work?

(Mr. Hilmer): Grants on line will send you an email to inform you of your application. You will receive a number that is specific to you.

(Ms. Davidson): Will it be confidential?

(Mr. Hilmer): Yes - It's a three step process; assume the universities have already signed up. Log in as your registered member. There is a check list on the website on how to sign up. I have provided the information in the booklets so you can follow the process. You only need to apply once to register for all the grants available. You will be assigned a user role as a PI. Incidentally, this application is only functioning on pc's not mac's at the moment. And 424's are the authorized organization representative.

(Ms. Fretwell): Is it the applicant or organization that fills in the form?

(Mr. Hilmer): I believe its both. The form SF424 R&R is a government-wide form. The expected adoption date is March 30th. The news is, it should all be set up by then.

(Ms. Davidson): If there is a re-budget after March 30th, which form is used? Is 'grants.gov' used for these applications and re-submissions?

(Mr. Hilmer): Yes, there is a form you can download and fill in for re-budgets

(Ms. Fretwell): Are the changes for 424A and COP Budget, which are replaced with this form?

(Mr. Hilmer): 'Grants online' is specific to NOAA only; all applicants use 'grants.gov' to submit applications. 'Grants online' is a tool for management of NOAA grants after they have been awarded and the Federal Register notices. Grants are downloaded from 'grants online'. You can compare awards processing on the 'grants online' packages.

(Dr. Richmond): Is there a separate website for grants on line?

(Mr. Hilmer): Yes

(Ms. Davidson): Are the tools available and when do we get the password?

(Mr. Hilmer): 'Grants online' is still not rolled out to recipients, this will happen sometime in the late summer; it is not ready yet. The recipients' grants' management, will be received through 'grants online' and in order to make award action requests. These can all be requested through 'grants online'. One authorized representative is to be trained through webinar.

(Ms. Davidson): For the R and R, the technical details of each project application are dependant upon the user, how do we process this when it hasn't yet been decided? There is a lot of information that is being required and we do not have this information at the time of application.
(Ms. Fretwell): We have 14 projects; do we need to do one application for each project or one for all projects, because the detailed information differs per project?
(Mr. Davidson): There is so much information we do not know the details until further down the line, e.g., equipment. This is a dramatic policy change. The re-budget needs to be squeezed out now so as we don't submit using the new system!
(Mr. Hilmer): Don't panic, there may be a grace period?
(Ms. Davidson): This is for our proposal next year and we don't have the information.
(Ms. Fretwell): Is this going to other government agencies (third parties) or is it only to you. Who are the recipients of the applications?
(Mr. Hilmer): The grants management division, but is all within NOAA.
(Ms. Fretwell): Can it be red flagged by someone not in our line?
(Dr. Hamnett): They will have to realize that we don't fit into this structure?
(Mr. Hilmer): The people we work with do understand and there are exceptions.
(Mr. Hilmer): We can't answer all these questions now. It is a task-driven work flow; always go to the tasks bar for all actions, accepting the award workflow.
(Ms. Fretwell): Is the vocabulary still the same NOAA vocabulary?
(Mr. Hilmer): Yes it has stayed the same. Anyway … workflow is described on the slide. Managing the award and award action requests, this is where you submit resubmissions and re-budgets. 'Grants online' deployment has been delayed due to the bugs being removed internally. Clean up also needs to be handled. The website addresses are included in the handout.
(Ms. Davidson): Will we be informed when we start using this? This is happening very fast. Do we get the login from the system or from the institution?
(Mr. Hilmer): It's a two step process
(Ms. Fretwell): Will this be clarified?
(Mr. Hilmer): Yes
(Dr. Richmond): Partnerships, will we have to assure that all partners have the correct numbers?
(Ms. Davidson): I heard there are exceptions for independent associations who are exceptions to the process?
(Dr. Richmond): Is this the case?
(Mr. Hilmer): There are special exceptions that will be realized within NOAA.

b. CSCOR's Identity: Refining our Niche *Dr. Michael Dowgiallo; National Ocean Service, National Centers for Coastal Ocean Science, Center for Sponsored Coastal Ocean Research*
(Dr. Dowgiallo): There is no power point presentation; this is a more informal discussion. I would like to run through a history of how we got where we are and what we are looking for in the CSCOR objectives. NCOS was managing HCRI in 1998 and NCRI. In 2001 the Puerto Rico monitoring program was started. In 2002 the portfolio was expanded. The Coral Reef Task Force then called for ecosystem coral reef management. This was adhered to through a peer review competitive process. Then Guam was added.

There is now a collection of projects, no clear underlying theme apart from that they all address regional problems and management structures for these issues. We knew these projects were to be long term, multidisciplinary with definitive management outcomes as a product. They all address the priorities of NOAA and the Marine Conservation Act of 2000. In 2004 however, there was a change and these individual programs became formally a part of the NOAA program. They became core programs which are formally part of the budget that is part of the Coral Conservation Fund. Traditionally these were phased programs, which were all integrated under the coral fund. Over the last two years there has been an evolution, with Rob coming on board and with a better understanding of what's going on. It is ecosystem skilled and a multi-disciplinary approach etc. We have now evolved into three clear institutes, in addition to the competitive programs. The NCCOS director wants these programs to have a commonality, be distinct and yet complement the other NOAA programs. The common bond is the provision of timely, high quality science to provide management practices. This is unique within NOAA, in that you are the only programs that do long-term ecosystem, multidisciplinary projects with a management action aim. In CSCOR, we need to open and freely refine the definition of these three institutes, in the knowledge that the portfolio will expand. We need to present a clear message and this has to be conveyed in a strategic management process. Dr. Magnien needs to explain this to Dr. Spinrad in NOS and we need to speak as one body. We need three potential outcomes (i) need to convey a message of who we are and what we do on the website, (ii) need to send this also into a brochure for all to use, and (iii) the key accomplishments of the institutions need to be listed.

Open Discussion:
(Dr. Magnien): How to sustain these programs is the real challenge. We need to hear it from internal NOAA people, i.e., a consistent word needs to be spread out, about the institutes. The message must be succinct; i.e., this is what we do and here is a track record. Going through branding and re-identification NOAA / NOS, etc., identity is really important, it's all got to coincide with the mission and mandates of all our organizations. It's really not hard to synthesize our understanding and our capabilities, all we need, is to sell as our main product line. Ecosystem management is one key, it shouldn't be a struggle; it just needs to be done.
(Dr. Hamnett): There are some buzz words we can use: 'building capacity to utilize scientific information for management', 'local capacity', 'partnerships', 'partnership with centers of excellence' and 'local resources'.
(Dr. Magnien): We need two aspects how we do it and what we do. Let's brain storm!
(Dr. Dodge): 'Local capacity', is it clear what we mean, i.e. discerning between infrastructure or expertise?
(Dr. Dowgiallo): 'Building capacity to use scientific information'
(Dr. Martinez): We need to identify the role of the institution, how we interact with local managers and that we can act really quickly. These are the types of things NOAA in Washington cannot implement.
(Ms. Davidson): 'Faster turnaround' / 'quick response'
(Ms. Fretwell): 'Timely filling and identifying needs'
(Dr. Dowgiallo): 'Demand driven science'.

(Dr. Dodge): There are three Institutes, however two are structured differently from the third. NCRI is fundamentally different.
(Ms. Davidson): You work with the local managers in say, the Arabian Gulf.
(Dr. Dowgiallo): You all work with agencies either locally or internationally.
(Dr. Richmond): The question really concerns whether there is life after the program. We enhance the capability of the local people to continue the program. We are sensitive to which materials are provided and what capacity is left. What is the dependency on the external resources? We are acting in a culturally appropriate manner, within local context. We provide the knowledge that can be used by local mangers and policy makers. We encompass both multi and inter-disciplinary, social and physical scientists. The programs are not individual projects; they involve science that is taken through the whole cycle. How the cycle is implemented by the policy makers and looking at the end product.
(Dr. Riegl): Capacity development/building, we are not the management agency, we are working with them. We do not and cannot have the role to implement what we have taught. Should we not 'provide the tools for capacity building'?
(Dr. Magnien): I think we need to define capability building.
(Dr. Richmond): 'We insure the decision makers have the correct information on which to base their decisions'. This is what we do in Micronesia; we explain to the locals …if you do this, this will be your end point. We provide capacity to understand the science and to implement it, but the decision to act is a local decision.
(Dr. Hamnett): Getting managers to understand science is pretty tricky and a lot of time must be invested to do this.
(Dr. Dodge): NCRI does not do this as a mandate. NCRI's focus is on high-quality science. This science often has management applications. NCRI works with the Local Action Strategy groups to also facilitate good reef management.
(Dr. Magnien): You should be? Or maybe you need to consider doing this?
(Dr. Martinez): You do it; Tuesday was great example with Broward County representative (Mr. Banks). Maybe it's an informal mission that should be made formal. It will make it easier.
(Ms. Fretwell): We can't make a specific link, Hawaii and Puerto Rico go out and capacity build, we don't do that. We are part of a private university, not a state university and we intend to stay that way in order to maintain our independence from state so that we can do work elsewhere.
(Dr. Dodge): NCRI is fundamentally different than HCRI and CCRI, yet we do share some common themes.
(Dr. Magnien): Sitting talking here, just because HCRI and CCRI are based locally and NCRI is more international, it doesn't matter.
(Dr. Dowgiallo): The demand-driven science is managed by the institutes.
(Dr. Dodge): The Spain meeting has 'applied' and ''demand driven'' theme to it.
(Dr. Magnien): You always have to sell work as applied all the time, but realistically you just have to package the research for your funder …. That's the way it is.
(Dr. Hamnett): Is it management orientated? The managers just say they don't know and we need population dynamics in order to know whether it's really been done and having impact.

(Dr. Richmond): Management responsive. As you have overseen, the programs develop and change, from blue book to green book. The continuity allows us to respond to the management needs as they begin to develop, e.g., climate change and biodiversity issues.
(Dr. Dowgiallo): Cheryl Woodley's involvement and the potential for disease to spread within the Pacific is shared research and this is what has been led.
(Dr. Appeldoorn): You believe we can/do sell our work within the context of the other centers. This means we can/should draw information from other institutes, e.g., the biomarkers studies.
(Dr. Richmond): I fully agree with Rich especially with biomarkers, efficiency and more quickly research can be adapted.
(Dr. Hamnett): By building relationships over time we form trust relationships. It is this that allows the interaction between science and management and science and science.
(Kristina Davidson): Provided there exists the arena for discussion and dialogue.
(Dr. Dowgiallo): I will write up this info concerning: accomplishments, the profound accomplishment of each institute and the level of maturity that several of the programs have reached is amazing and needs to be capitalized on, particularly the legal ramification of findings.
(Dr. Magnien): These actions and making a difference are really important.
(Dr. Hamnett): For Peace Corps info, I was asked do you have statistics about what you have done? This lady in Fiji said no, we tell stories. This combines the examples of projects as narratives. People remember stories. This is the way to communicate messages.
(Dr. Dowgiallo): We have very solid supporters.
(Dr. Dodge): Thank you CSCOR for your help and assistance.

c. NOAA Coral Reef Conservation Program *Ms. Helen Golde; National Ocean Service, Office of Response and Restoration*
(Ms. Golde): I have worked for just under 3 months with the Coral Conservation Program. Roger was supposed to present today, but unfortunately can't. My aim is to provide a brief overview of the coral reef conservation program within NOAA. This is carried out by the NOS office part of the Conservation Program. There are a couple of important drivers. The key was the 2000 – 2001 jump to 27 million in funding. In 2006 the president budget request is still for a 1.5 million increase to the LAS *(local action strategies)*. This will be added to the grants pot for the LAS work.
(Dr. Hamnett): We are in, then out of the presidents' budget. From the NOAA end, where are we?
(Ms. Golde): Presently you are out!
(Dr. Hamnett): What happens if we don't get this increase?
(Ms. Golde): Hmmm, we can't lobby for what's in the president's budget but we can make people *very* aware. Concerning the Coral Reef Task Force, Roger Griffiths is chair of the steering committee. Also, additional help for resolutions come from the Task Force. The National Action Plan came out of the Task Force. So the second goal is to implement this National Action Plan. This is where we get money out the door for on the ground work. The action strategies are written and being implemented. The act is up for re-amendment this year. Concerning the grants program, we have a competitive grants management system for national and international grants. The research grants are pretty

wide open; they are for extra mural projects. The RFP is not out yet for Y06, as the 05 money is presently being spent. The website is the best way to find out where / when to apply for '06. It will probably be around Christmas!

The Conservation Fund is money that goes to, for example, NFWF *(National Fish and Wildlife Foundation)*, they then seek applications for additional projects. Part of this funding is for work in collaboration with an NGO. Emergency Response, at present it's very difficult to get money out the door for these types of responses.
(Dr. Hamnett): There exists a small grant fund from the University of Colorado, which is quick access money.
(Ms. Golde): That sounds good, although we are also looking at emergency response with the national marine sanctuaries. A lot of work is carried out in partnership with other folks. How the money is divided up between NOAA will be discussed. The money comes in; previously came into NMFS and NOS, now all the money comes into NOS as one big pot. The matrix program in NOS, the coral program has pieces all across NOAA. NOS is really the matrix manager for NOAA. See handout for which divisions within NOAA work with coral. We have 4 of 5 NOAA line offices. There are senior personnel who manage the four lines and talk as a senior council once a week. The schematic represents the ideal world, however vertical line work is more realistic. The operating principles of local and regional implementation, concern the state and territories capacity building. A lot of our time is, as you can see, spent on administration. Then there are the key coral jurisdictions. Within NOS, there is CSCOR, SPO, the Quiet chart and intra-mural projects. There exist allot of monitoring and mapping projects, $3 million goes to managing the Hawaiian reserve. Outreach and education is still very important. Getting info out into the community, discussing the threats, LAS is an important part of this. These workshops take part of this money, e.g., partnerships with high school teachers through the Department of Education. We generally look at a 3 year time span, targeting input with managers for coral reefs. We are dedicated on a regional basis to understanding the regional issues of coral reefs. We will be identifying the core activities and eliminate them from the main funding pool, by funding them up front. This helps us allocate funds more efficiently to other projects. We aim for better co-ordination across the program/NOAA. Please inform us regarding the leveraging of resources as we wish to insure the best use of resources. The communication of accomplishments assists in our justification for money to be spent; we need transparency for the projects, evaluation procedures and improving partnerships.

<u>Questions:</u>
(Dr. Shivji): You say you must have a 1 to 1 match, can an academic partner with NOAA? Or do you mean that you can't use federal $ to federal $'s?
(Ms. Golde): You would need an NGO but you could apply via the inter-mural process.
(Dr. Monaco): 8 of 10 $ go straight back out the door.

d. NOAA Coral Reef Marine Sanctuaries *Ms. Helen Golde; National Ocean Service, Office of Response and Restoration*
(Ms. Golde): Within the 4 main sanctuaries, we look for opportunities and aim to facilitate research in the sanctuaries. They can provide boats and have fundamental

familiarity with the sites. However we need to carry out an evaluation of status and needs for the sanctuaries. The focus areas within the sites required characterizations. Before new sites are added, the old sites have to be appropriately characterized. This is carried out through ocean observing and the integrated observing programs. Assessment needs to be made on how we are managing within the larger ecosystem. This project has been dormant for 10 years. We are working on key tools to evaluate for potential new sites, this is occurring at a regional level too.
Questions:
(Dr. Hamnett): Is NOAA changing the way it is managing funds for the sanctuaries?
(Ms. Golde): Now most employees are contractors who have their benefits paid for by their employer. This is because it is becoming increasingly difficult to get a government job. So the sanctuaries are presently in the process of applying for these contracts.

e. NOAA Integrative Coral Reef Mapping, Monitoring, and Assessment *Dr. Mark Monaco; National Ocean Service, National Centers for Coastal Ocean Science, Center for Coastal Monitoring and Assessment*
(Dr. Monaco): I will explain what we have been doing in terms of integrated mapping and monitoring. Alan Freelander, Richard Appeldoorn and NCRI all also do mapping. Jim Bohnsack talked about his fisheries mapping independently. We are interested in stratifying our sampling, knowing the individual species, applying management action, developing models, and doing work with the local government organizations.

The Mapping work: 1992-'98 in S Florida NOAA's charting activities partnered to classify this map and produce a benthic habitat map. It took 6 years to do. his now needs to be re-done. There is a mapping implementation plan to come back and start next year. We also did the Virgin Islands. The Pacific maps have only just been made. Our products include: a hard copy data atlas and a digital format. In Hawaii we published in 2002 and our first sets of maps were sent out. The sensors include satellite to airborne and now we use multi-spectral data. I cannot say we map *all* shallow water areas as there are always areas that cannot be mapped due to cloud cover etc. He showed an example of a map, with structure and cover, there are 20 bottom types, produced using a dual classification system.

Monitoring: It's a two pronged approach; where we invest $1 million in monitoring. The objectives and complimentary work will be reviewed every 4 years (although 2 years presently) to determine the status of the reefs. There is the list of who is receiving money at the moment. There are 14 jurisdictions that will receive money in order to write these reports every 4 years. The 14 jurisdictions need to be brought into alignment for congress. NOAA simulates the information. We want to get them up to a level to produce a thorough report for the management community. Rich does for example the CRES program in Puerto Rico. Random stratified points and these are collected to compliment the stationary data. There has been some comparative work with 60's and 70's data e.g. with Coneys and Red Hinds. We need to figure a way to classify these maps accurately. We need 90% accuracy and geo-referencing within 5 m. To get these types of results we need to get into the water. We obtain transects across all ecosystems including the life stages of these animals. They are ecosystem maps, not just coral reef

maps. We are able to understand the environment and make relations between habitat and how the ecology responds to these changes. It is seascape ecology work, with richness and biodiversity. There is map for Puerto Rico representing habitat distribution, where, the rich colors show biodiversity richness. In Hawaii, the work by Freelander concerns fishing activities. Alan is taking the same process in and outside the no take areas using the same methodology as applied to Puerto Rico. The results show, if you don't catch them, they'll be there. By looking at 14 areas around the Hawaiian Islands, we can identify the effects of management action. This has been to implement no takes and then remove them on a yearly basis; the results show this is not particularly effective. Assessment: There is a list of assessment tools and how the integration takes place.

Questions:
(Dr. Purkis): The 15-20 classes you discuss using, are they site specific?
(Dr. Monaco): They are pretty much global, but there is some increased specialization per area.
(Dr. Magnien): Is there a quantitative technique to detect changes over time?
(Dr. Monaco): From mapping there would have to be repeatability, routinely. At the moment we don't but we would like to, maybe in collaboration with NCRI to achieve these results. It's a matter of allocating fiscal resources to people resources.
(Dr. Magnien): 2 paths, with two options (i) characterize as much as possible, (ii) look for change over time.
(Dr. Monaco): Some people are doing site specific work, e.g., the fishery resources use Jim Bohnsack's approach. It really comes to a resource question and local capacity.
(Dr. Shivji): Benthic and fisheries diversity, what do you mean by diversity from NOAA's perspective, do you have a definition?
(Dr. Monaco): We are talking from at a community development level, not from a genetic perspective.
(Dr. Shivji): Genetic diversity is indeed different and if you can look at it from a genetic perspective it can enforce you to take a different management perspective.
(Dr. Monaco): We are working with a geneticist, to help with these matters, although there is not major research going into this at the moment.

f. CoRIS Metadata Reporting *Mr. Doug Hamilton; National Environmental Satellite and Data Information Service, National Oceanographic Data Center*
(Mr. Hamilton): We need to understand the kind of information that is coming out of the projects. CoRIS is a service to work and assists in providing information that is useful to you. The design and content has been updated and changed. Doug works part time for the NODC. Doug will explain what CoRIS is and the type of information gathered and how the archiving of data at NODC works. The vision and goals were expressed in early 2001 to scope out what was required. It's not all strictly data, in as much as it includes aerial photography records. The staff participates in weekly meetings and remains in touch with the Coral Program. CoRIS is the coral projects database. The metadata is stored in a database which is then translated into CoRIS for users. The metadata includes either a linkage to another database / source where the data is held, or the user can learn more about the type of data. The link to publications is not here on the slide, but there is a special subset for publications. A search therefore goes to both the data and to the

publications. Not all data sets are available on line. If this is the case the search results would provide contact information for the holder of the data. CoRIS.NOAA.gov is the first line linkage to data search tools and to white papers, general articles about coral reefs and several of the professional email conversations. There are links to other websites and NOAA's coral reef activities. There is a glossary of terms which also include images, with approx 3000 in the glossary.

Project data and the relation to NODC and CoRIS: This is the designated ocean archive for data. Its mission is to provide access to archive data. All data is therefore passed onto NODC. If you send data to NODC, it will be also made available to CoRIS. We need to be advised of your data. If you write a proposal there is a products, outcomes and effective dates for outcomes. This goes into the project database and we are provided with reports. All this info is forwarded to CoRIS and the effective data is used to follow up on collecting data.

For tracking the project descriptions we contact the principal investigators. CoRIS does take the funding time into account before making contact. Each year there is a report to say what is new to the database. If it's a reference journal we provide the citation. Karen Taylor is the person to contact if you want to have publications made available on CoRIS. With data products, the system is different as the format is so different. They may or may not be available online. We need to know where it's stored, how to access it and reference the information. The .doc can be available by email. This contains all the information required in order to make the data set available to users. There is a whole list. This is quite self explanatory.

Questions:
(Dr. Martinez): Please provide file?
(Mr. Hamilton): Yup! Harry Iredale is the contact for the data. We have found it very helpful to sit one on one and visit the scientific groups to see how the data is collected, also for the scientists to understand how the data can be transformed into metadata. If you think its helpful then ask for a visit. The FGDC format for the metadata can be observed also on the web. In order that CoRIS provides comprehensive information from the coral conservation program it is important that people submit their data. There exists an administrative order on ocean data acquisition, where all data should be provided to a national archive data center.
(Dr. Martinez): Does that national archive center have to be NODC?
(Mr. Hamilton): No, it can be National Geodetic for example.
(Dr. Martinez): Is there a way that NODC can filter the data and identify if it needs to go to CoRIS? If we supply to CoRIS within a year are we conforming to the order?
(Mr. Hamilton): Yes and Yes
(Ms. Davidson): We had a problem with the Hawaiian data. NODC was having trouble identifying which data sets should be going to CoRIS and which to NODC.
(Dr. Martinez): Maybe we should have a separate meeting to co-ordinate this data handling better?
(Mr. Hamilton): Yes, maybe a formal agreement should be made to insure the correct people get a copy.

The important dates for us are: projected, expected and projected.
(Dr. Johnston): Do you know what % of data makes it to NODC from NOAA funded projects?
(Mr. Hamilton): There are many ocean data sets that indeed never make it. In terms of CoRIS, it's much better to just check per fiscal year 2003/2004.
(Dr. Monaco): It's a change in culture for people to submit their data, I think?

9. Special Presentation

a. Rapid Response: Disease Outbreak Investigations Dr. Cheryl Woodley; *National Ocean Service, National Centers for Coastal Ocean Science, Center for Coastal Environmental Health and Biomolecular Research*
(Dr. Woodley): In 2002 the Coral Health and Disease Consortium was started. It includes 50 partners, which comprise both networks of scientist and partners, e.g. NOAA, USGS, Department of the Interior, state and industry partners, and a cross-section of sciences. We all come together with a common goal. We participate in many programs and bring a lot to the table from individuals who know a lot about corals and nothing about disease, to a lot about disease and nothing of corals. Disease investigation and other working groups are summarized on p.64 and 65 of the National Research Plan Document for Coral Disease and Health. It is a complex arena of agent and host diseases. From the organizational meeting in 2002 there were 9 departments established, we are now reorganizing these groups. The consortium is an open group; all we ask is for partners to volunteer both time and expertise in order to meet the goals. The genomics work involves the sequencing of genome. The diagnostic resources available rely on having a common nomenclature to talk across the disciplines. The USGS, National Wildlife Health laboratory is a strong partner that we have working with whom there is much follow up.
Diagnostic assays: Roy Richardson has made a probe to detect white plague. The sequence for white pox is known and the lab has the tools to diagnose this. We need to get the functionality of the host in order to apply to coral tissue antimicrobial peptides. These then form elongated proteins that stick to the bacterial cell membranes. You can then identify the amount of antimicrobial peptide present in the tissue. The International Registry of Coral Pathology has 246 specimens that have been documented. Shaun has a bibliography available on coral diseases and she plays an invaluable role with international pathologists to compare what they have seen and come to a consensus. Another interesting resource is Dr. Sylvia Galaway's literature research resource. We are also interested in developing a lab rat that can be used for research. In addition we have a three-tiered web tool with 3 characteristics and series of questions to key out diseases that exist and are already known about. We review the evidence that has been brought together and form some framework as to how disease research is coordinated. During the Madison workshop, veterinarian pathologists reviewed and accepted a project to produce a book with information on current disease for use as a desk reference. This type of reference book is updated regularly. A non-infectious side of research concerns eco-toxicology and health. *Marine Pollution Bulletin* has expressed a desire to offer efforts in the Pacific. Hawaii wants to hold a workshop to determine the issues that are specific to the Pacific, how to prepare for these types of scenarios and prepare a vision for action.

Educational resources: We will be holding the 2nd Biscayne National Park for Environmental Forensics. Here, legal, managers and scientists will work together on understanding how interactions take place in order to make the mitigation procedures work better, e.g., how do you lay out a crime scene? And what analysis needs to be done in order to support the case? There are global problems with corals in 1996 4 diseases were described, by 2004 there are 29 described. The Caribbean is a hot spot, but we

don’t know what is happening within the disease. There are anomalies, parasites, growth anomalies; are they tumors? Viruses are presently not researched in corals and bacteria get the most press. Are toxins and traumas that are generally not infectious stem from anthropogenic sources? We need the ability to go out, investigate and document in a formally thorough manner answering questions concerning the culprits for driving these events. This is how we wish to scope out our rapid response. We want a 3 tiered response, level 2 supports the response and level 3 decides to go out and investigate. The Flower Gardens is an example of a level 3 investigation, where the magnitude and the distribution stretch up to a 15-m diameter area of tissue loss. It looks like white plague, but experience tells us you cannot diagnose in the field. Research needs to be carried out within the laboratory. Deepening the scenario, there are various types of information that need to be identified. In addition, an assessment needs to be made of the environmental effects going on that may not be biological. If dealing with rules of infection, always work clean to dirty. We learned this in the amphibious world, where the scientists transferred the virus. One should not handle corals any differently; quarantine methods should be adhered to. What is the prevalence and what is the extent of the area affected? She showed slide of coral without its skeleton! Information can be synthesized into knowledge and this can be synthesized into action, plead for assisted work and collaboration.

10. Open Forum Discussion Sessions

The second day of the CSCOR review meeting ended with two discussion sessions. These sessions allow CSCOR to consider issues of interest to our coral programs in an "open forum" format. The sessions are moderated by the meeting organizer but allow a free form exchange of ideas. Two topics were discussed in this year's meeting: 1) a joint dedicated publication; and 2) implications of the listing of *Acropora spp.* as threatened or endangered species.

a. Joint Dedicated Publication *(Lead by Ms. Kristine Davidson & Dr. Felix Martinez)*
(Dr. Martinez): CSCOR provides an opportunity for programs to get together and make them available to the wider public.
(Ms. Davidson): We could have a publication that shows the commonalities and differences, either at a scientific or a management level. Is there interest to do this?
(Ms. Fretwell): There are pros and cons to peer review publications, often the PI has a destination publication already in mind and this falls within a specific discipline. Therefore this may not work? Kristine made a good suggestion yesterday, take it out of the science journal realm, and publish in an appropriate social science journal, to show what science has been able to transfer to the management community and beyond.
(Ms. Davidson): If there is resistance, then discuss the program or its role, the interactions that occur between managers in different jurisdictions. There are of course resource management type journals.
(Ms. Fretwell): We could discuss the interaction from last year to this year, with the accomplishments in a narrative form?
(Dr. Martinez); Will it be a single publication with multi authors?
(Ms. Davidson): We should put together the results and mechanisms for those results?
(Carol Fretwell): For example, diseases in corals and through what mechanism are we sharing this information?
(Dr. Johnson): This is coral ecosystem ecology, where we talk about the science, the advancement of the technique, how it is used and its effect. Programs have been implemented within regions of the country which have very different management structures. We can address: what can be done about the changes in the coral reef ecosystem? And how can the managers make these changes?
(Dr. Appeldoorn): David *(Dr. Johnson)* outlines several different approaches; we need to pick one of these? For example, the changes those management systems might think about, but approach it from a more scientific point of view?
(Dr. Riegl): Who is going to do the work? Let's decide?
(Dr. Dodge): Special issue on science and methods? If it's a management issue it's more a glossy manual.
(Dr. Martinez): We have 3 different sociopolitical environments, in Palau stakeholders can have ownership and implement changes quickly. This is a unique situation to bring the information together?
(Dr. Riegl): Are we duplicating work that's already brought out and done?
(Dr. Hamnett): You mean there are 3 coral reef monitoring programs, three stories and in each the history and the context is different.

(Dr. Richmond): It can be a review to the Coral Reef Task Force, where there is not even a definition for coral reefs within the federal policies! There exist huge gaps. In Palau the scenario is indeed different. The island press was approached, concerning specific island information, here; the local people have the senior management positions. The traditional cultures really understand what's going on. One can compare inline with the U.S. federal policy. Science and policy (ecology like) takes science and puts it into a policy context and questions how to develop strategies. There is a lack of a regulatory framework within the U.S., within the framework of Washington; the local agencies do not have any regulatory jurisdiction to implement. We are therefore faced with the tragedy of the commons. Maybe capturing the island committee idea is the right way to go?
(Dr. Riegl): What would be your recommendation?
(Dr. Richmond): It's a good opportunity to put together a synthesis, with an example of the Pacific islanders being brought together with western scientists. At least here, some information is being passed through the caste system, because people are worried that it may get forgotten. So part of the approach is to archive and document this information, maybe from an anthropological perspective. There exists a lot of knowledge. Within NOAA there are not enough inter-disciplinary programs so this is a unique experience that should be documented.
(Dr. Shivji): Are you saying this should be a policy document?
(Dr. Richmond): No it's really bringing together the science, the history and, the culture? Why does it work in Palau and not in Guam? It works in Palau because you can sit with these people and explain it and they have a cultural system but no official law. In Guam there is plenty of legislation and a 2 year electoral system. Is it a legacy or an opportunity? The law from 1889 is what is empowering the Army Corps of Engineers for permitting, when coral reefs were considered a navigational hazard.. Can you protect using NEPA? No because this only does water quality … the science has been there for over a decade but the policy has not yet caught up with it. There are in effect 8- 10,000 MPA which belongs to the chiefs and managed by them. This is a great idea and it works.
(Dr. Monaco): As an outsider and insider and with the movement to integrate the Institutes. Should this paper not be a combined effort to get our message out?
(Dr. Richmond): Social, biological, and physical sciences, this is a synthesis project, bring in an economist. This will really bring something out of CSCOR.
(Dr. Hamnett): As well as who we are, what we do, what do we represent; add some stories of achievement, e.g., the monitoring, Palau, and then common problems faced.
(Dr. Richmond): Every project requires an evaluation and this takes the form of a story. The story is the implementation.
(Dr. Hamnett): The disease story in the Caribbean, global warming, and how the monitoring network can detect those changes. We need approx one page written per story.
(Dr. Magnien): The brochure could show a synopsis.
(Dr. Shivji): What is the purpose of all this?
(Dr. Hamnett): Well one audience is say, the people involved in Aquarius?
(Dr. Magnien): We should put at least something together on the website to start with, how it's going to be done still needs to be decided. How elaborate?

(Ms. Golde): We can't say here is a brochure saying here's why you should fund us, but the Institutes can in effect say this!
(Dr. Richmond): ''Ecological applications'' website, looking to capture the scientific community on Capitol Hill, *Frontiers* is another journal. There is a regulatory framework that facilitates implementation of our efforts. Most scientists are not trained to communicate this information into the policy arena. We need to explain what it is they need to hear and why they need to hear it.
(Dr. Shivji): One proposes a policy journal and the other is a glossy journal?
(Dr. Martinez): It is an either/or?
(Dr. Magnien): NOAA will do one anyway.
(Ms. Davidson): Do we all want to a publication on this topic?
(Dr. Martinez): The national academy of sciences is proposing to do a coral reef study. Should we implement something?
(Dr. Richmond): Especially with The Commission on Ocean Policy, it is a great opportunity to put together a paper in one of these journals.
(Dr. Magnien): We have this meeting for a reason, it is an objective study. We don't have to wait. I think we are looking for a single synthesis from a variety of information. Cemented from the laws and regulations present in this country.
(Dr. Monaco): What's the outline?
(Dr. Richmond): Policy and implementation has not stood up?
(Ms. Davidson); Will it be one single synthesis paper?
(Dr. Riegl): It has to be a really rounded statement? Do we have all the parts to the puzzle from the 3 institutes? Do we want to embark on this already?
(Dr. Martinez): Bob, could you put something together and send it to me and I will review it and we can take it from there.
(Dr. Dodge): There is a recently published policy/science document; is this the type of document that we want to publish?
(Dr. Magnien): Let us identify where we are at the moment? There will always be a gap, but we should put something together and re-address the situation from there.
(Carol Fretwell): We have very little past experience; can you provide someone who can give us some policy information? We need some help.

b. Implications of *Acropora spp.* listings under the Endangered Species Act *(Lead by Drs. Michael Dowgiallo & Margaret Miller)*
(Dr. Dowgiallo): This was brought to my attention a week ago, while working with the people in NMFS. I am not an acroporid expert. From what I can gather, since 1991 the acroporids were listed as an endangered species. These were then removed because there was insufficient information to name them as such. In 1999 information from analysis in 1998 and some more federal evidence became available. In 2004 the acroporid species became a species of concern. On March 4th 2004, the Center for Biological Diversity, ascertained the critical habitat be designated as *Acropora prolifera,* as it is a naturally rare occurring species in the natural environment. However, once it is designated as endangered it is apparently a felony to remove it? In 2005 a 'very' large report was comprised by the biological review team named: The Atlantic *Acropora* Status Review. This is available on the web.

(Dr. Miller): There was a petition for a 1 year legal frame for them to listen or not. However, the review team was not put together for 6 months. This document was not supposed to give legal advice, just factual information. The scientific decision as made that they should list both *Acropora* species as threatened. Section 4d on the Endangered Species Act authorizes what is and isn't threatened and what the implications are for dealing with endangered species.
(Dr. Dowgiallo): The two immediate questions we need to find out are: what programs do we have? And what are going to be the impacts to future field activities?
(Dr. Miller): Section 10 defines to what level they are defined as threatened. You will probably need to get a special permit in order to research these.
(Dr. Martinez): Most field studies are only one year projects, if you have to wait 10 months to get a permit, what are the implications?
(Dr. Miller): There may be a way of working around it? There must be a certain amount of flexibility. NMFS can delegate to state and regional permitting authorities, so the whole process can be much faster. The biological review teams are different for these species since there is much we still don't know about them. There is definitely a recognition that research is of primary importance for these species, because we do not know how to counteract the diseases nor identifying potential habitats. It may be a separate step, but possibly the use of remote sensing techniques? Bernardo was called upon for the deliberations for the team assessment.
(Dr. Martinez): You can not damage critical habitat, if you are doing an experiment where there is no *Acropora*. The critical habitat designation will have to be done very carefully. The need to pin point areas that are critical for the species to exist… Who makes those designations?
(Dr. Miller): Extensive consultations with all the states; there is also public comment associated with these changes.
(Ms. Fretwell): Will these listings show up on the coral list?
(Dr. Miller): One NOS member is involved, there are also NOAA members. The process of conducting the workshop should help in forwarding this information.
(Ms. Golde): There are some very strict protocols that need to be implemented?
(Dr. Miller): These documents were not agency reviewed, so this particular assessment is the independent scientific assessment.
(Dr. Magnien): Are you moving this forward and taking it through into a larger review process?
(Dr. Miller): Not at the moment, that is the regulatory jurisdiction of NMFS.
(Dr. Magnien): Is there a way we can get some feedback to help contribute to the decision-making process?
(Dr. Miller): Participation in the assessment process has already involved scientists, however the recovery plan procedure, will definitely require participation.
(Ms. Golde): This is the work of the habitat office; there is a way that the NOAA Coral Program can become involved. We have access to all these people so let's work with NOAA and across NOAA on this problem.
(Dr. Miller): There will be independent teams that will be brought together for the review process.
(Dr. Shivji): Will it affect areas outside the U.S.?

(Dr. Miller): No, the application of the law only applies only within U.S. waters for critical habitat and permitting. However, the monitoring and assessment for recovery may become an international issue.
(Dr. Martinez): IUCN will step in and make it on an international basis.
(Dr. Dowgiallo): We can look at this problem NOAA wide and review the process.

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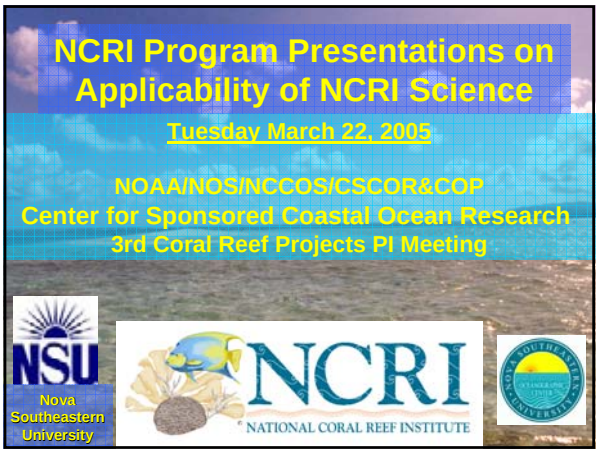
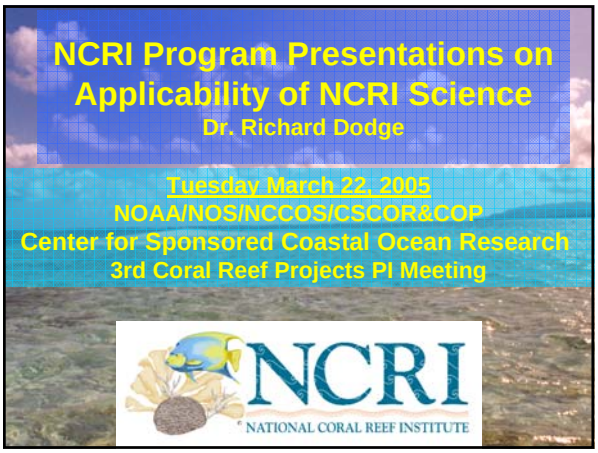

NCRI Program Presentations on Applicability of NCRI Science
Tuesday March 22, 2005
NOAA/NOS/NCCOS/CSCOR&COP
Center for Sponsored Coastal Ocean Research
3rd Coral Reef Projects PI Meeting
NSU
Nova Southeastern University
NCRI
NATIONAL CORAL REEF INSTITUTE


NCRI Program Presentations on Applicability of NCRI Science
Dr. Richard Dodge
Tuesday March 22, 2005
NOAA/NOS/NCCOS/CSCOR&COP
Center for Sponsored Coastal Ocean Research
3rd Coral Reef Projects PI Meeting
NCRI
NATIONAL CORAL REEF INSTITUTE

Nova Southeastern University
We go the distance...
NSU

Nova Southeastern University
NSU
8th Largest Independent University in Nation
Over 22,000 enrollment
Largest in Southeast US.
15 Divisions
>$220 million budget.
232 acres Main Campus
Distance Ed
New Library

Overview: NSU Oceanographic Center
10 acres, Ft. Lauderdale
Port Everglades entrance channel
access to oceans & reefs
Broad Phys. and Biol. Oceanography
Full-time faculty & staff - 31
MS, Ph.D. programs
Port Everglades Intracoastal to Atlantic
The Mission of the Oceanographic Center is to carry out innovative, basic, and applied research and to provide high-quality, graduate and undergraduate education in a broad range of marine-science.

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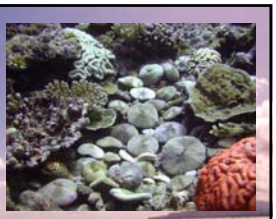
Partnerships and influence of NCRI science on national and international coral reef management

Dr. Bernhard Riegl

NCRI
NATIONAL CORAL REEF INSTITUTE

NCRI's goals are:

- Assessment
- Monitoring
- Restoration of coral reefs.



These goals were selected to assure that research done at NCRI is directly applicable to management.

While NCRI therefore has roots in academia, there is a clear mandate for excellence in management-related coral reef research

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National partners in management-related research:

-NOAA
-National Parks Board
-US Fish and Wildlife Service
-Florida Department of Environmental Protection
-Florida Fish and Wildlife Conservation Commission
-CNMI Department of Fish and Wildlife
-CNMI Coastal Resources Management
-St. John's River Water Management District
-Broward County Department of Planning and Environmental Protection
-Also Dade and Palm Beach Counties

NCRI

International NGO partners in management-related research:

-World Wildlife Fund
-The Nature Conservancy

The Nature Conservancy

NCRI

International partners in management-related research

NCRI

-Environmental Research and Wildlife Development Agency (Abu Dhabi, UAE)
-Qatar Supreme Council for the Environment and Natural Reserves
-Dubai Department of the Environment
-World Bank, GEF Targeted Coral Reef Research

NCRI has been providing assistance with:

-Reef assessments and mapping
-Protected area siting
-Protected area planning
-Management master plans
-Assessment of environmental legislation
-Installation of national coral reef monitoring plans
-Capacity building of field- and managerial staff
-Restoration Expertise

NCRI

International academic partnerships and training:
•Costa Rica: Universidad de Costa Rica
•Mexico: Centro de Investigationes Cientificas Marinas
•Qatar: University of Qatar
•UAE: Petroleum Institute, UAE University
•South Africa: University of KwaZulu-Natal
•Austria: Karl-Franzens-University Graz
NCRI

9:45-9:55 AM (10 Min)
The successful NCRI-EPD model of science-management collaboration
Ken Banks, Broward County
ENVIRONMENTAL PROTECTION DEPARTMENT
Formerly known as Department of Planning and Environmental Protection
NCRI

The Successful NCRI-EPD Model of Science-Management Collaboration

Kenneth Banks
Broward County Environmental Protetion Department

The gap between science and management

- The lack of basic science
- Management perception of basic science
- Management need for action strategies
- Interpretation of scientific results
- Management benefit/cost and science funding

Science at NCRI with management applications

Areas of research:

Artificial reefs

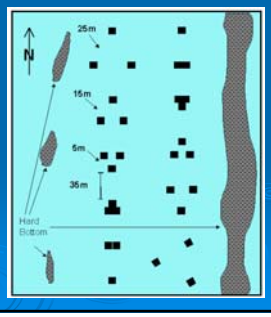
Fish and coral recruitment

Science at NCRI with management applications

Areas of research:

Artificial reefs

Spatial relationships



Science at NCRI with management applications

Areas of research:

Artificial reefs

Depth relationships

Complexity

Science at NCRI with management applications

Areas of research:

Artificial reefs

Material affects

Science at NCRI with management applications

Areas of research:

- *Artificial reefs*
- Reef restoration

Science at NCRI with management applications

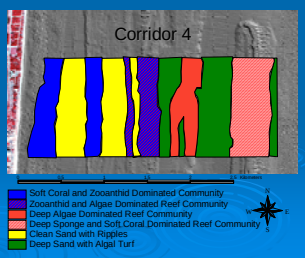
Areas of research:

- *Artificial reefs*
- *Reef restoration*
- Project monitoring

Science at NCRI with management applications

Areas of research:

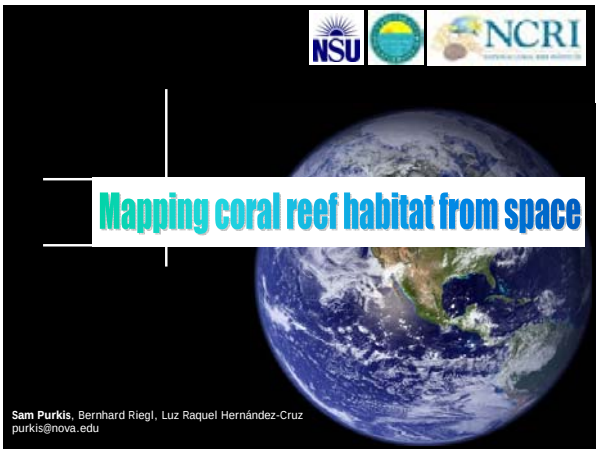
- *Artificial reefs*
- *Reef restoration*
- *Project monitoring*
- Reef mapping and classification



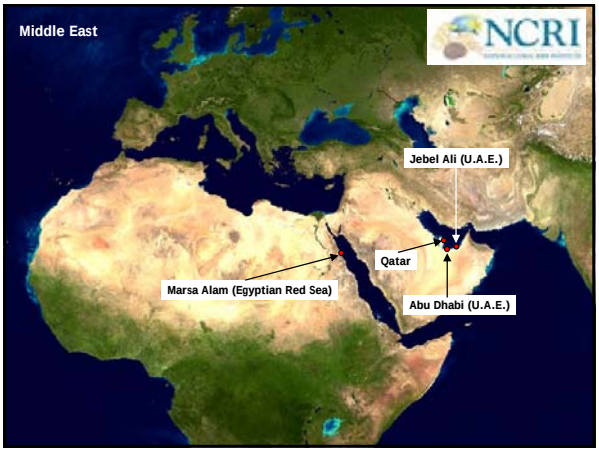
Science at NCRI with management applications

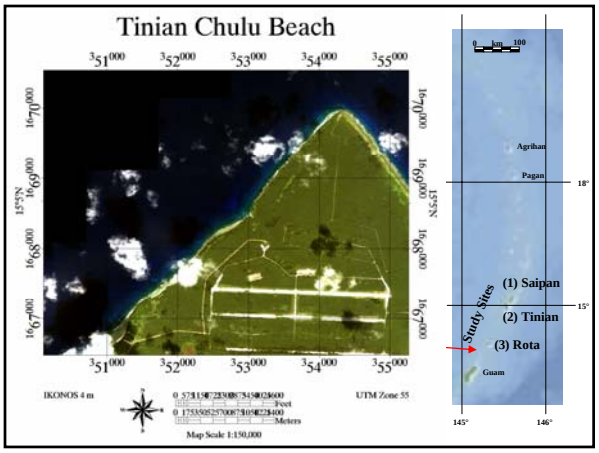
<u>Summary</u>

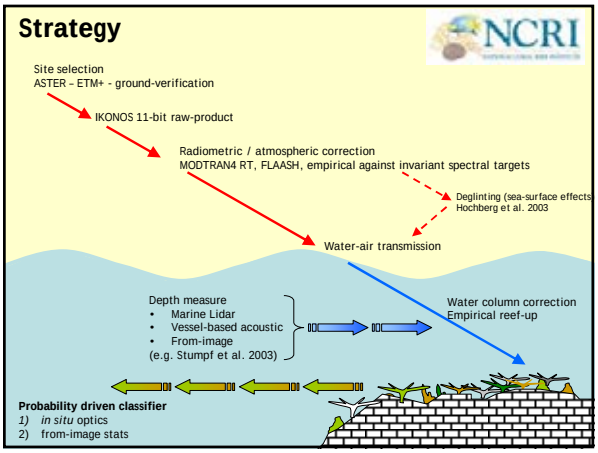
Scientific research carried out by NCRI has provided information directly applicable by environmental managers. Basic science is still needed in many areas and should be a high priority for federal funding programs.

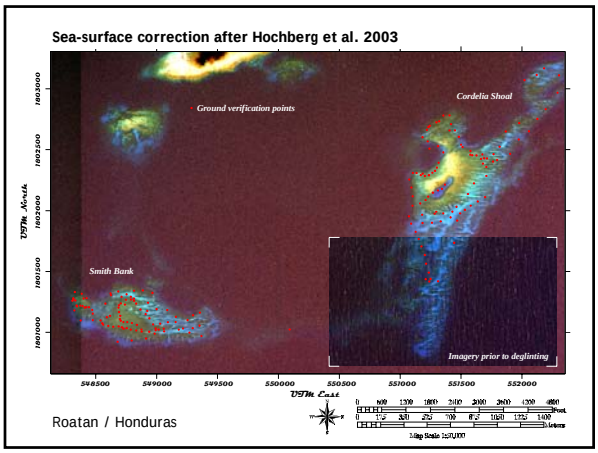


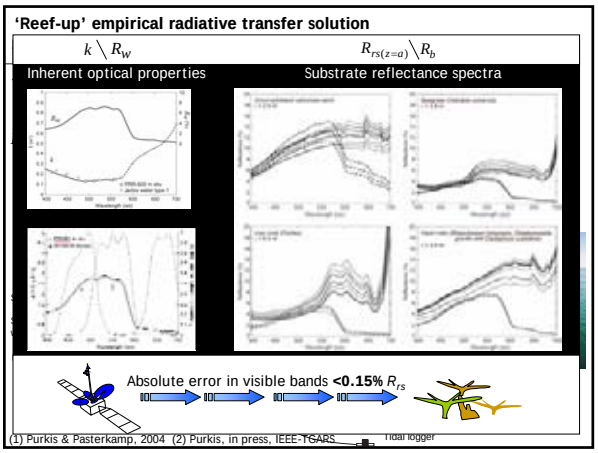
- Strategy focused to fulfill the objectives of the NCRI Monitoring Network
- High resolution monitoring of a limited study area tuned to detect changes in benthic character at metre – kilometre scale
- Sites selected on the basis of the abundance of communities susceptible to disturbance and perceived to react with a pronounced phase-shift (i.e. live corals and in particular Acroporid dominated areas)
- Integrated multi-sensor approach to ensure the production of **ecologically relevant** and **accurate** thematic maps of carbonate depositional environments
- Primarily satellite based, with ancillary use of airborne Lidar (E.A.A.R.L) and vessel-based acoustic systems (QTC, Echoplus and RoxAnn)

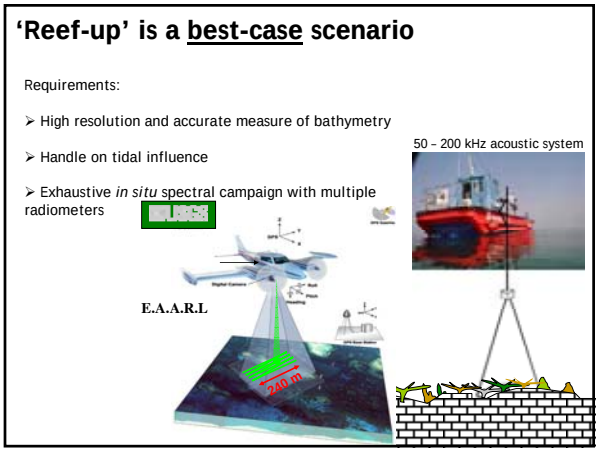


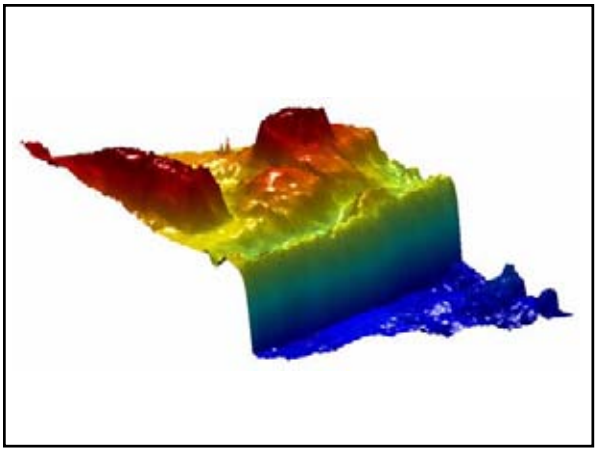


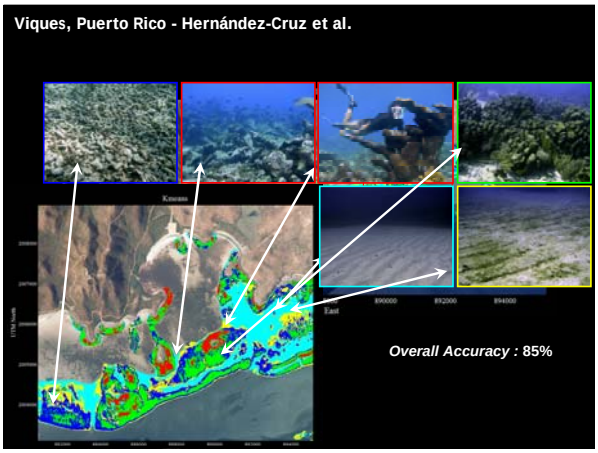




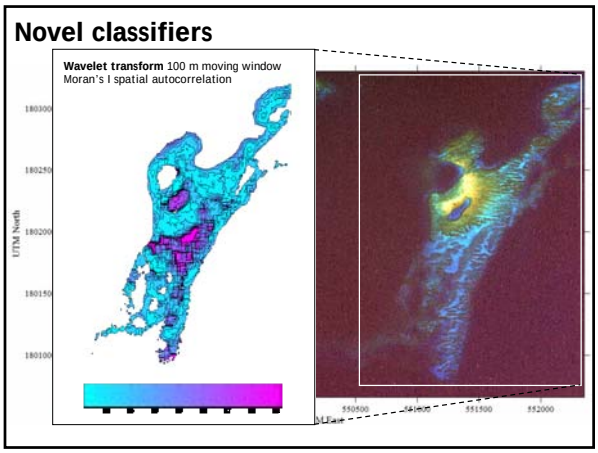


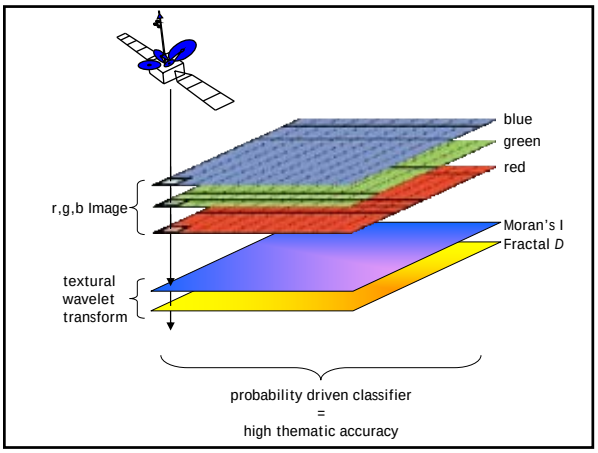


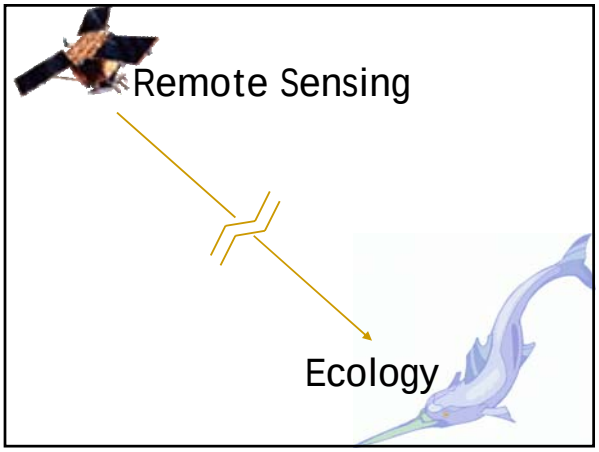


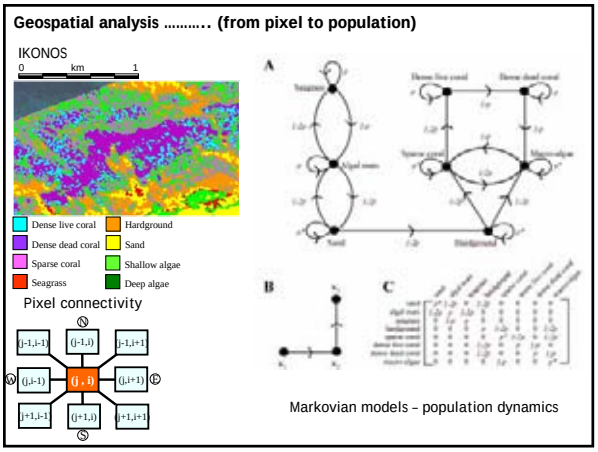


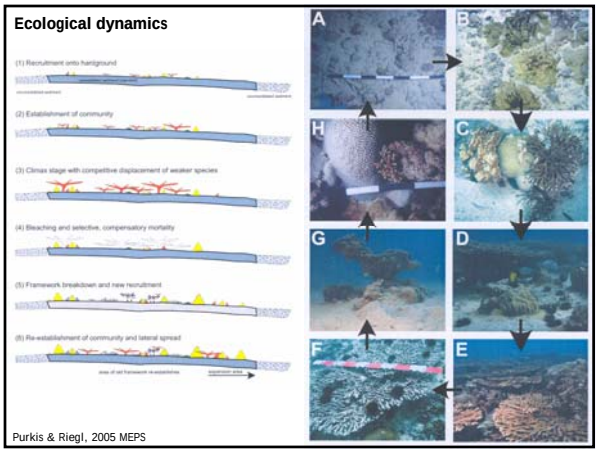
BUT
...what happens when we lack the required ancillary data ?


Novel classifiers
Wavelet transform 100 m moving window
Moran's I spatial autocorrelation
UTM North
180300
180250
180200
180150
180100
550500
551000
551500
552000


blue
green
red
r,g,b Image
Moran's I
Fractal D
textural
wavelet
transform
probability driven classifier
=
high thematic accuracy


Remote Sensing
Ecology


Geospatial analysis ..... (from pixel to population)
IKONOS
0
km
1
Dense live coral
Hardground
Dense dead coral
Sand
Sparse coral
Shallow algae
Seagrass
Deep algae
Pixel connectivity
(j-1,i-1)
(j-1,i)
(j-1,i+1)
(j,i-1)
(j , i)
(j,i+1)
(j+1,i-1)
(j+1,i)
(j+1,i+1)
A
B
C
Markovian models – population dynamics


Ecological dynamics
A
B
C
D
E
F
G
H
Purkis & Riegl, 2005 MEPS

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Management-Oriented Assessment of Corals in Broward County

Bernardo Vargas-Angel

Prepared for:
NOAA CSCOR-COP
Dania Beach, March 22, 2005

National Coral Reef Institute Nova Southeastern University

INSTITUTIONAL MISSION

CORAL AND CORAL COMMUNITY ASSESSMENT

STRUCTURE AND FUNCTION

Acropora cervicornis
Demographics
Reproduction
Disease

Coral Stress Biology
Tissues
Proteins
Genes

EFFECTIVE MANAGEMENT AND EDUCATION

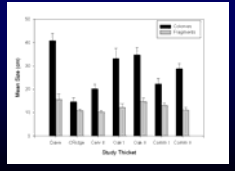
Significance

- Unusual occurrence of a thriving *Acropora cervicornis* in Broward County.
- Dramatic population reductions throughout the Caribbean, with losses of up to 98% in the Florida Keys.
- The *Acropora cervicornis* thickets off Broward Co. represent the largest extant population in the continental US.
- These thickets develop in close proximity to highly urbanized area.
- Advancement of scientific research and public awareness regarding the ecological importance of these unique communities.

Distribution and Mapping

Coral community surveys to understand changes in space and time

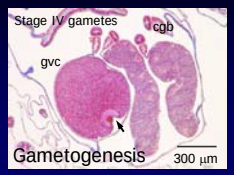
Structure and Abundance



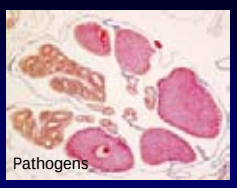
Summary statistics (mean % cover) of coral community structural parameters at the study sites (surveys May 2001–2002).

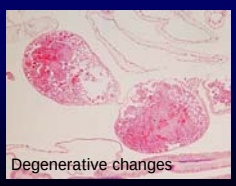
Site	% coral cover	% *Acropora cervicornis*	%Non-*Acropora*	% macro algae	% dead cover	% hard bottom
Dave	27.7	25.9	1.8	4.9	11.9	44.5
Coral Ridge	7.8	7.5	0.3	1.0	38.2	21.1
Cervicornis II	5.5	4.9	0.6	5.1	3.6	63.6
Oakland I	14.9	14.4	0.5	2.8	1.1	76.3
Oakland II	10.5	9.9	0.6	5.5	2.3	75.2
Commercial I	15.2	14.6	0.6	16.3	2.2	55.7
Commercial II	18.6	16.3	2.3	7.8	5.05	60.9
Average	14.3	13.4	0.9	6.1	10.0	53.7

Reproductive Biology



Coral Diseases





Fireworm Predation

Prevalence of *Acropora cervicornis* predation by the corallivore polychaete *Hermodice carunculata* at the study sites (surveys July-August 2002).

Site	Prevalence (% quadrats affected)	Mean number scars m^{-2}	Size of scars (cm)
Dave	25.0	1.4	4.8
Coral Ridge	17.1	0.4	3.2
Cervicornis II	29.3	0.5	3.1
Oakland I	28.9	1.5	4.4
Oakland II	35.3	1.0	4.5
Commercial I	65.2	2.3	3.9
Commercial II	4.7	0.1	4
Average	29.3	1.0	3.9

Management Implications

- Assessment of Broward Co. population abundance, structure, and reproductive potential.
- Means to evaluate the potential for natural recovery of previously impacted populations.
- Provided advice to local managers (status and long-term monitoring).
- Dissemination: national and international conferences.
- Effective education: Master's Thesis, interns.
- Training: Coral reproduction.

Coral Stress Biology

Goal

- Use higher resolution tools to quantify thresholds of sedimentation stress in scleractinian corals in Broward.

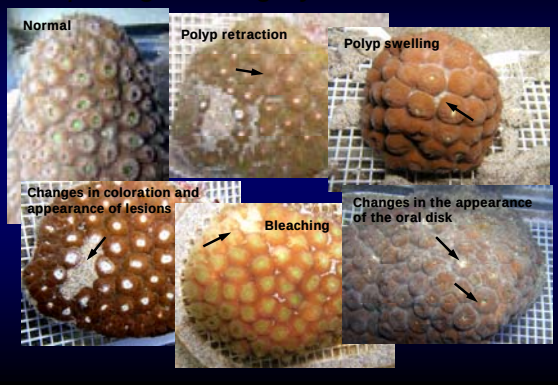
Endpoint

- Provide evidence to identifying cause-and-effect relationships between sedimentation stress and the responses of individual reef-building corals.

Objectives

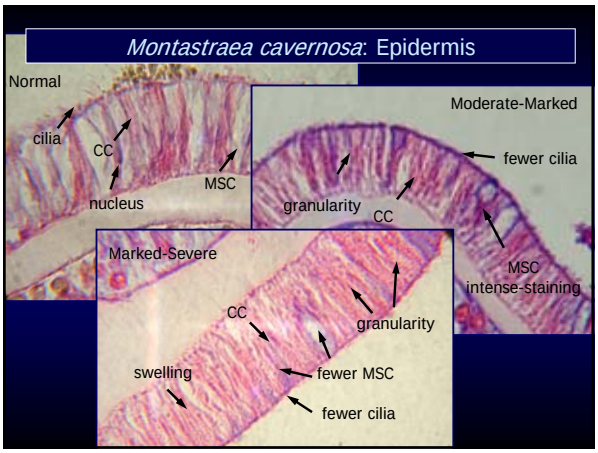
- To develop a histological rating scale of sedimentation stress in scleractinian corals to help assess coral health condition during dredging for beach restoration activities in Broward County, FL.

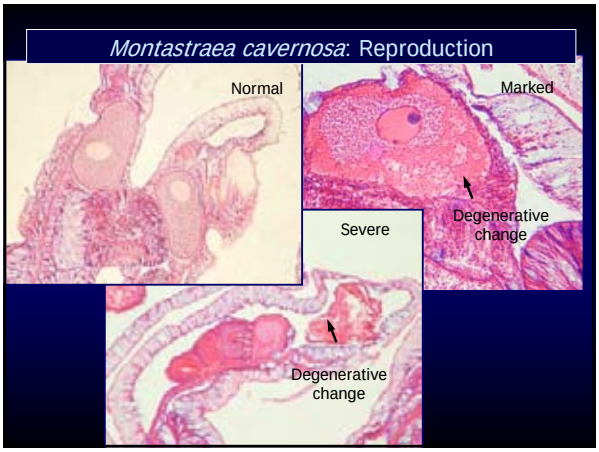
Morphological integrity



Provisional rating scale for changes in gross morphology observed on experimental specimens of *Montastraea cavernosa* exposed to increased levels of sedimentation.

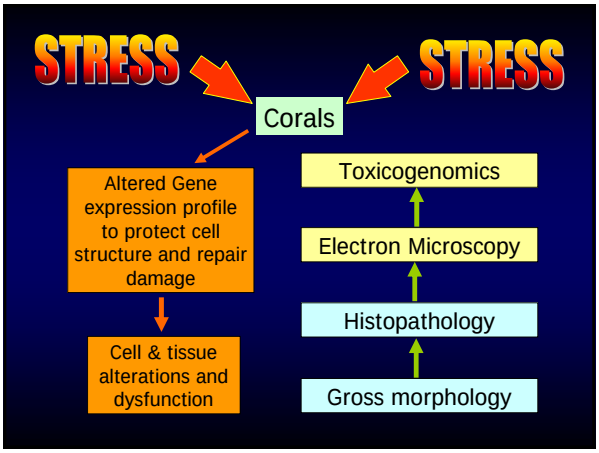
Range	Diagnosis
Normal	Color appears normal, and natural texture lines. Polyps fully extended or loosely retracted. No swelling.
Mild	Same + possible presence of small sand accumulations between polyps. Slight swelling
Moderate	Slight changes in coloration (darker, possible focal bleaching). Normal texture lines may begin to disappear. Evident polyp swelling. Changes in the appearance of the oral disk. Possible extrusion of mesenterial filaments. Presence of mucous sheets, sand accumulations between polyps.
Severe	Same + polyps tightly retracted, or looking deflated/flattened, with sunken-in oral disk areas. Appearance of lesions. Presence of mucous sheets; inability to remove excess sediments.



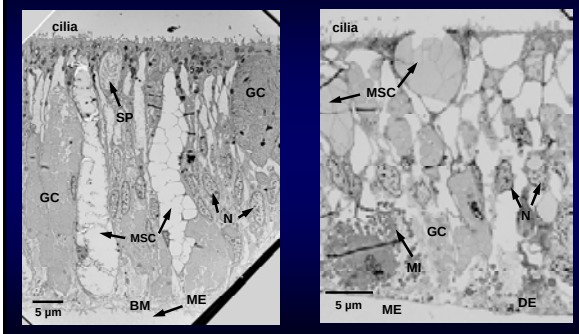


Rating scale for tissue changes seen in histopathological examinations of experimental specimens of *Montastraea cavernosa*, based on the relative condition of tissue and selected cellular elements (mucous secretory cells, mucoid material, zooxanthellae, and nuclei), stained with Harri's hematoxylin and eosin (abbreviations: EP, epidermis; CE, calicoblastic epithelium; GD, gastrodermis; MS, mesenteries; MSC, mucous secretory cells; ZOOX, zooxanthellae).

Range	Epidermis and coenosarc	Middle polyp region	Lower polyp region
Normal	Good integrity and structure. Distinct nuclei. No swelling. MSC more numerous around oral disk.	Abundant clear-staining MSC in MS. MSC in GD not swollen. MS and CE intact, clear structural integrity.	Scattered MSC. GD thick with clear structural integrity. CE intact, clear structural integrity.
Mild	Same + slight swelling of MSC. Mucoid material staining more intensely.	Same + increase in MSC size and abundance of mucoid material.	Same + slight increase in mucous in GD, and changes in staining properties (darker).
Moderate	Widespread swelling of MSC. Change in staining properties. Possible increase in ZOOX densities.	Increased number of MSC, color intensifying. Increased mucoid material. Presence of granularity and cell debris in GD and CE.	Same + Presence of cell debris and biogenic accumulations in GD and CE. Increased mucoid material Apparent ZOOX degradation.
Marked	Cell atrophy, increased cell debris. Swollen MSC. EP appears flattened, cilia not discernible. Possible localized necrosis.	Cell atrophy. MSC begin to coalesce, Increased debris, and biogenic accumulations in gastrodermal cells and MS. Atrophy of CE. Decrease in mucoid material. Possible localized necrosis.	Increased cell debris, and biogenic accumulations in gastrodermal cells and mesenterial filaments. Atrophy of the CE. Possible gamete degradation. Possible localized necrosis.
Severe	Atrophy; possible loss of cells. Clear loss of tissue integrity. Localized to widespread necrosis.	Atrophy. Increased cell debris and clear loss of tissue integrity. Possible localized to widespread necrosis.	Atrophy. Increased cell debris and clear loss of tissue integrity. Possible localized to widespread necrosis.



Montastraea cavernosa: Epidermis



Enzymatic Biomarkers

- Monitor exposure to environmental stress and assess its physiological and biological effects.
  - Exposure (e.g., metallothionein, heat shock proteins).
  - Physiological effect (e.g., lipid peroxide, ubiquitin).
  - Potential risk (e.g., manganese superoxide dismutase).

Coral DND and RNA Gene Expression

- cDNAs (or gene fragments) isolated using various molecular methods
- Classes of Genes on Array:
  - responsive to xenobiotics (a chemical compound that is foreign to a living organism).
    - metals & pesticides.
  - cellular integrity.
  - oxidative stress.
  - Respiration.
  - post-translational processing.
  - Apoptosis.
  - Ribosomal.

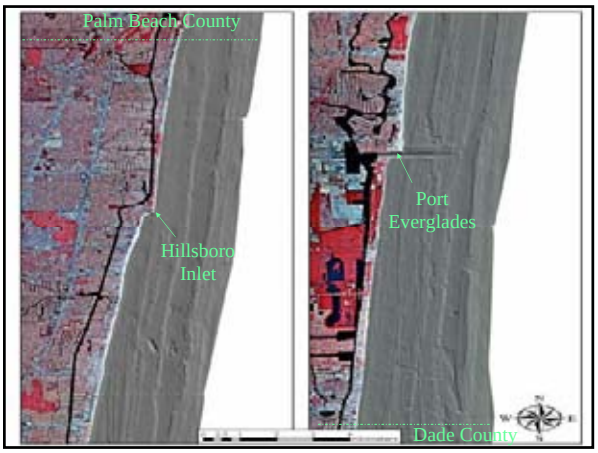
Endpoints: Coral stress biology study

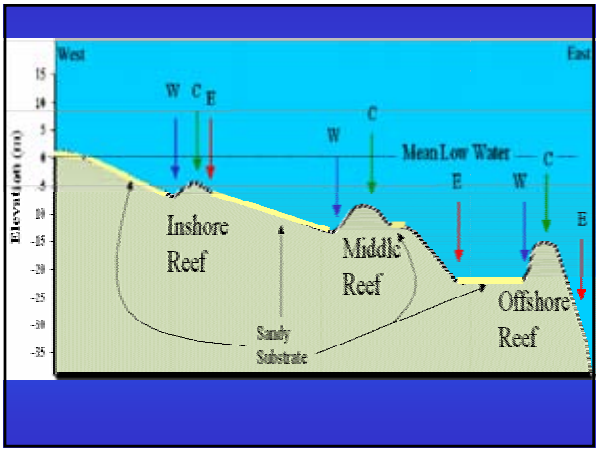
- To determine if health of individual colonies varies among sites, with those impacted by dredging.
- To identify effects on coral health.
- Advance our understanding in coral ecotoxicology.
- Tool for managers to assess specific impacts (threat-based testing).

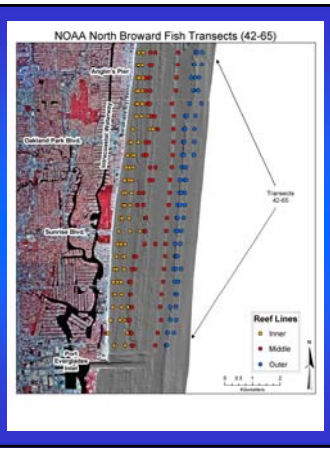
Management Implications

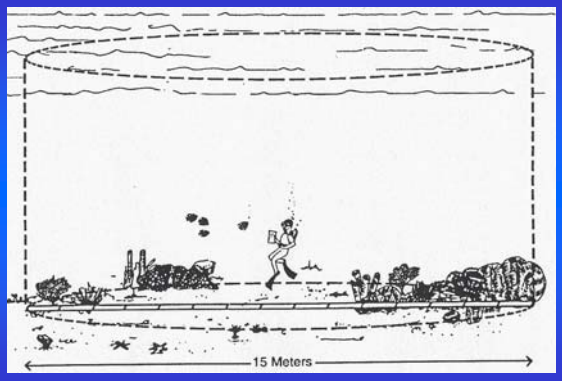
- Effective education, instruction, and dissemination.
- Provided a tool to assess stress during dredging operations.
- Collaborative projects: University of Miami, Broward Co., UCF, College of Charleston, Georgia Tech,

Coral Reef Fish Census Offshore Broward County, Florida



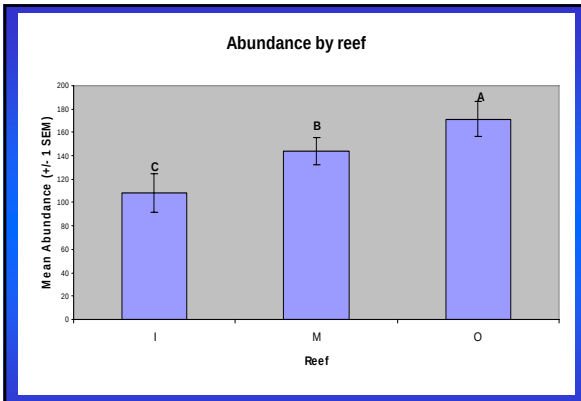




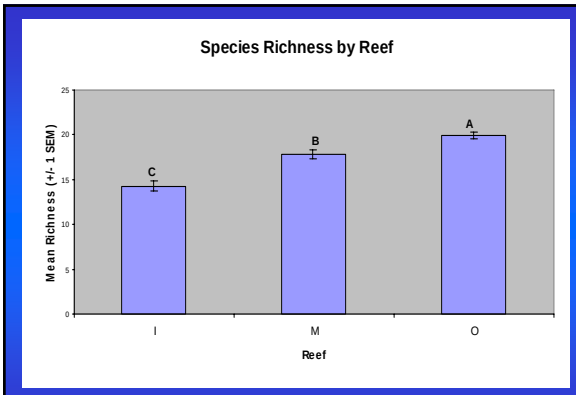


Fish Assemblage Structure

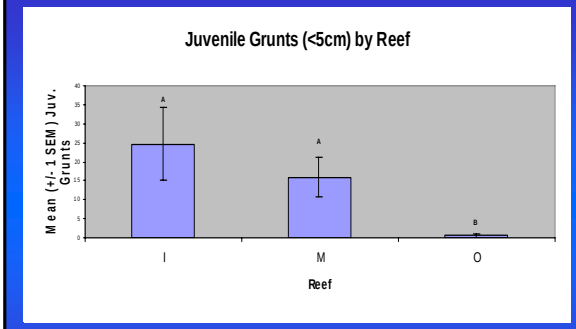
- 667 sites between August ’98 & November ’02
- 86,463 total fish
- 52 families
- 208 species
- Inshore Reef: 143 spp. (11 exclusively)
- Middle Reef: 169 spp. (8 exclusively)
- Offshore Reef: 173 spp. (18 exclusively



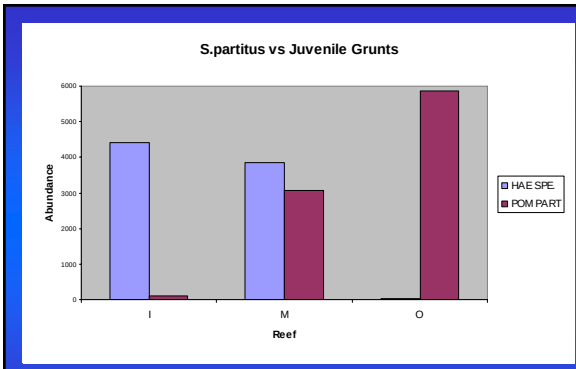
Mean (+/- 1 SEM) abundance for each reef tract. Different letters (A,B,C) indicate significantly different reefs (p<0.05, ANOVA, SNK).



Mean (+/- 1 SEM) species richness for each reef tract. Different letters (A,B,C) indicate significantly different reefs (p<0.05, ANOVA, SNK).

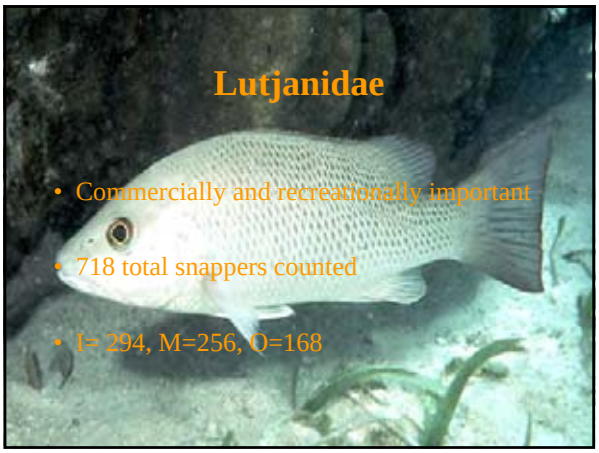


Mean (+/- 1 SEM) juvenile grunts (<5cm) by reef. Different letters (A, B) indicate significantly different means.



Graph of total juvenile Haemulids and *S. partitus* by reef.

Species	# Total	# Legal
Epinephelus adscensionis	4	0
Epinephelus cruentatus	127	18
Epinephelus fulvus	2	0
Epinephelus guttatus	8	3
Epinephelus morio	232	2
Mycteroperca interstitialis	1	0
Mycteroperca phenax	8	0
Mycteroperca venenosa	1	0

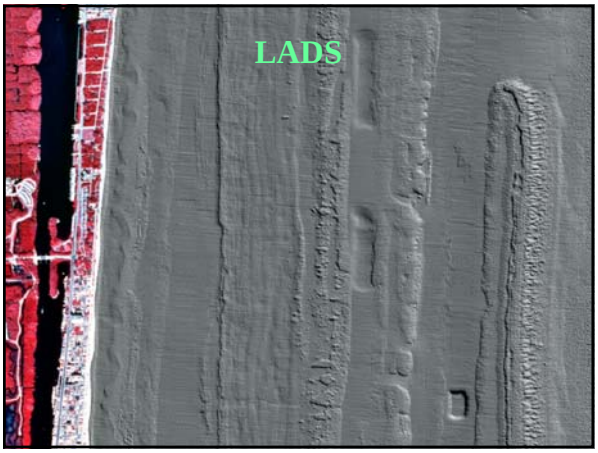


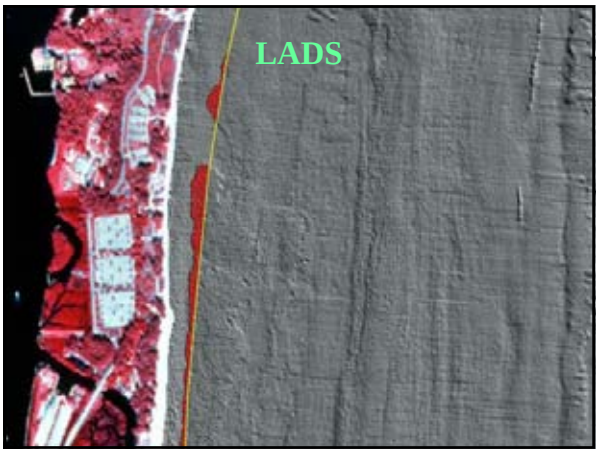
Snappers		
Species	# Total	# Legal
Lutjanus analis	84	16
Lutjanus apodus	34	27
Lutjanus griseus	188	72
Lutjanus synagris	99	71
Ocyrus chrysurus	312	33
Lutjanus jocu	1	0

Total and legal size snappers counted.

Conclusions

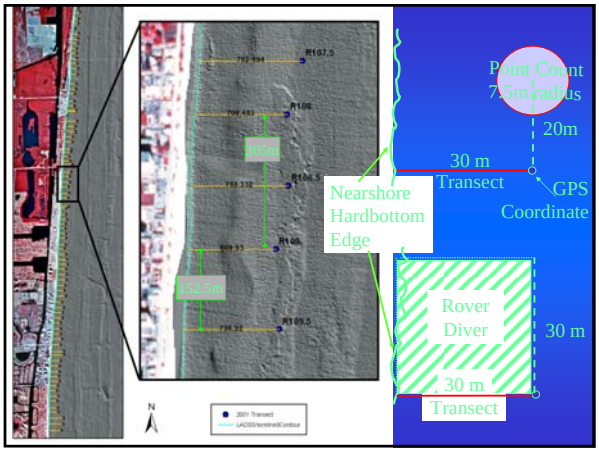
- Baseline data for determining change
- Management decisions
- Starting point for more detailed studies





Purpose

- Assess Nearshore Hardbottom Fish Community
- Establish 'Baseline'
- Determine Effect of Anthropogenic Influence (Post-Construction)



Methods

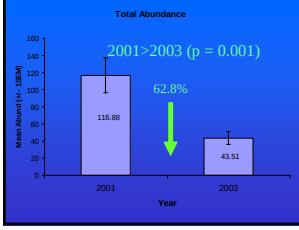
- June-August 2001- 200 sites
  - North and South of Port Everglades
- August 2003- 89 Sites
  - South of Port Everglades Only
- Compare South Only to Examine Variation
  - Univariate
  - Multivariate

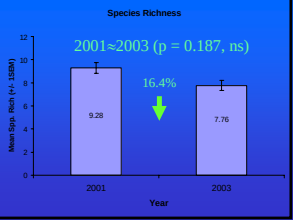
Results

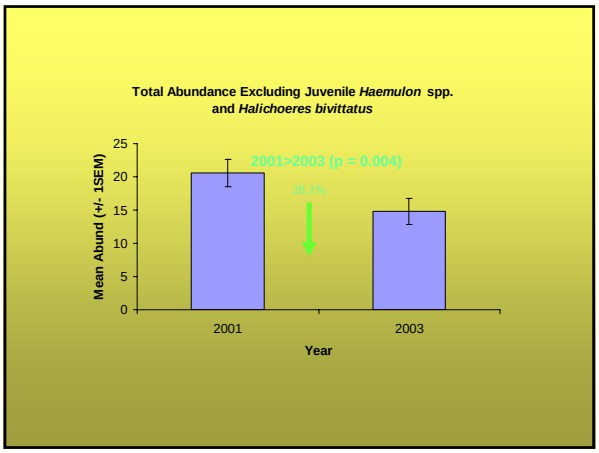
- General
  - 30685 Fishes and 163 Species
  - Major Species
    - **Juvenile (<5cm TL) *Haemulon* spp. (Haemulidae)**
    - ***Halichoeres bivittatus* (Labridae)**
    - ***Haemulon aurolineatum* (Haemulidae)**
    - ***Haemulon plumierii* (Haemulidae)**
    - ***Haemulon flavolineatum* (Haemulidae)**
    - ***Stegastes variabilis* (Pomacentridae)**
    - ***Sparisoma radiatus* (Scaridae)**

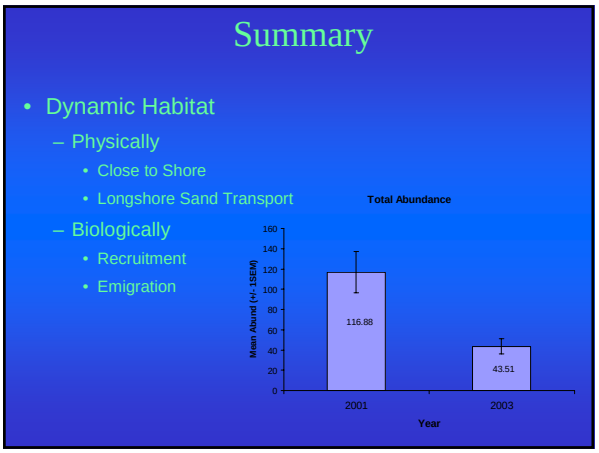
Results

- Univariate (t-test)
  - Point-Count
  - **Transect-Count**
    - More Effective in this Habitat (Baron et al., 2004)



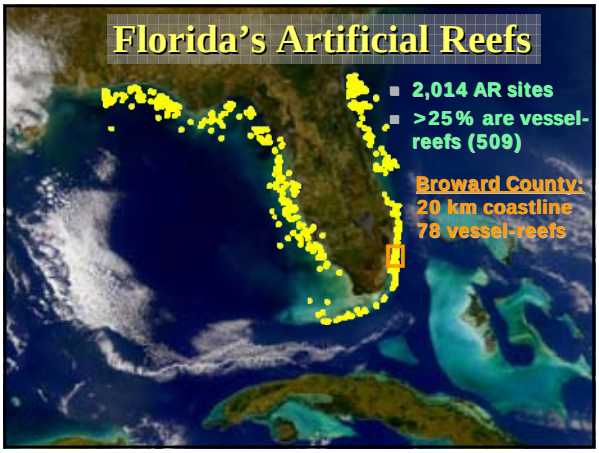


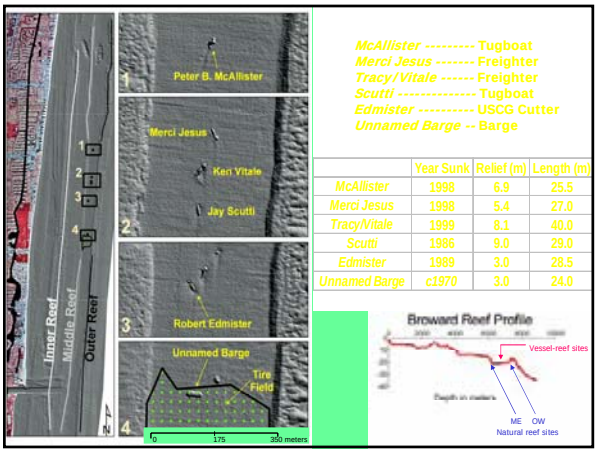




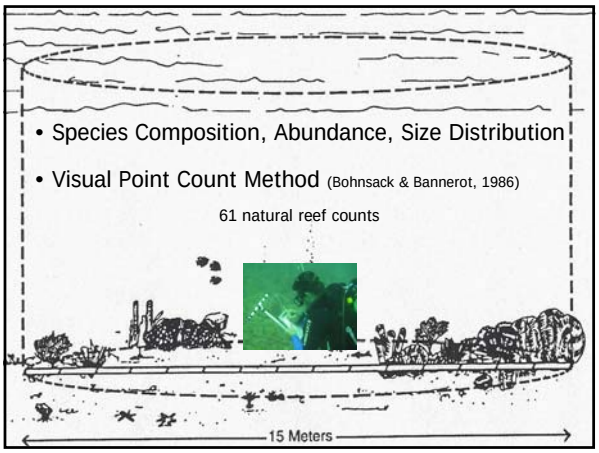
The "Take-Home"

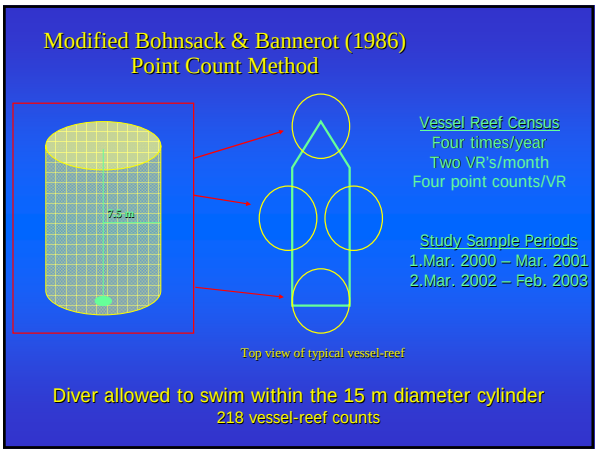
- Use All Available Methodologies
- Some Species and Size-classes Are Highly Variable
- The More Pre-impact Data, the Better
- The Need for Caution When Attempting to Correlate Assemblage Change to a Anthropogenic Event

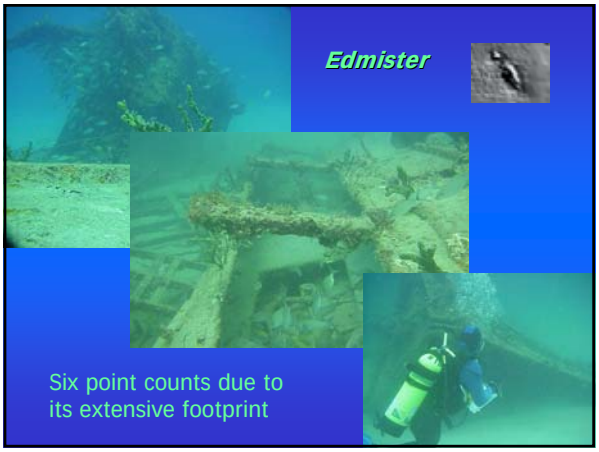


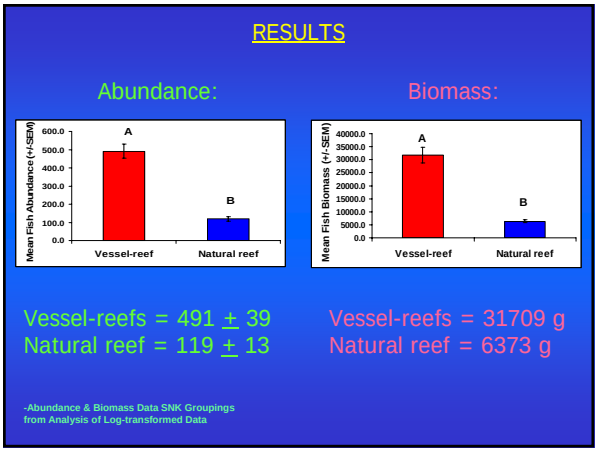


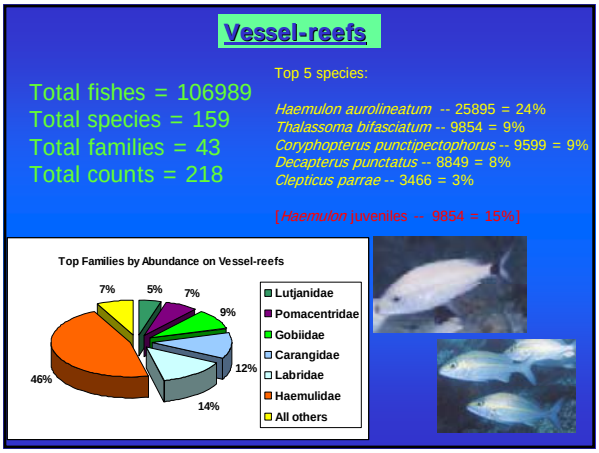
	Year Sunk	Relief (m)	Length (m)
McAllister	1998	6.9	25.5
Merci Jesus	1998	5.4	27.0
Tracy/Vitale	1999	8.1	40.0
Scutti	1986	9.0	29.0
Edmister	1989	3.0	28.5
Unnamed Barge	c1970	3.0	24.0

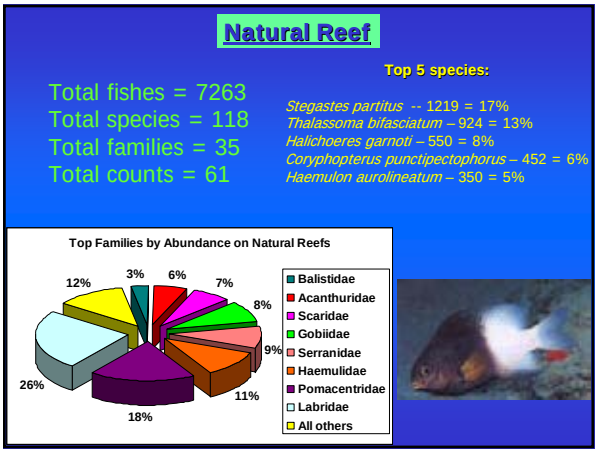

• Species Composition, Abundance, Size Distribution
• Visual Point Count Method (Bohnsack & Bannerot, 1986)
61 natural reef counts
15 Meters


Modified Bohnsack & Bannerot (1986)
Point Count Method
7.5 m
Vessel Reef Census
Four times/year
Two VR's/month
Four point counts/VR
Study Sample Periods
1.Mar. 2000 – Mar. 2001
2.Mar. 2002 – Feb. 2003
Top view of typical vessel-reef
Diver allowed to swim within the 15 m diameter cylinder
218 vessel-reef counts

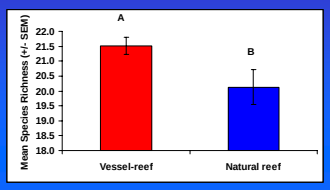

Edmister
Six point counts due to
its extensive footprint


RESULTS
Abundance:
Biomass:
Mean Fish Abundance (+/-SEM)
Mean Fish Biomass (+/-SEM)
A
B
Vessel-reef
Natural reef
Vessel-reefs = 491 ± 39
Natural reef = 119 ± 13
Vessel-reefs = 31709 g
Natural reef = 6373 g
-Abundance & Biomass Data SNK Groupings
from Analysis of Log-transformed Data


Vessel-reefs
Total fishes = 106989
Total species = 159
Total families = 43
Total counts = 218
Top 5 species:
Haemulon aurolineatum -- 25895 = 24%
Thalassoma bifasciatum -- 9854 = 9%
Coryphopterus punctipectophorus -- 9599 = 9%
Decapterus punctatus -- 8849 = 8%
Clepticus parrae -- 3466 = 3%
[Haemulon juveniles -- 9854 = 15%]
Top Families by Abundance on Vessel-reefs
7%
5%
7%
9%
12%
14%
46%
Lutjanidae
Pomacentridae
Gobiidae
Carangidae
Labridae
Haemulidae
All others


Natural Reef
Total fishes = 7263
Total species = 118
Total families = 35
Total counts = 61
Top 5 species:
Stegastes partitus -- 1219 = 17%
Thalassoma bifasciatum – 924 = 13%
Halichoeres garnoti – 550 = 8%
Coryphopterus punctipectophorus – 452 = 6%
Haemulon aurolineatum – 350 = 5%
Top Families by Abundance on Natural Reefs
12%
3%
6%
7%
8%
9%
11%
18%
26%
Balistidae
Acanthuridae
Scaridae
Gobiidae
Serranidae
Haemulidae
Pomacentridae
Labridae
All others

Species Richness



Vessel-reefs:

59 exclusive species
16 spp. Rare; 12 spp. Cryptic
13 fisheries important species

Natural reef:

18 exclusive species
10 spp. Rare
1 fisheries important species

Recreational and Commercial Importance

Blackfin Snapper, *Lutjanus buccanella*

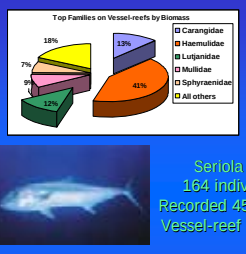
Over 1100 fish surveys performed by NSU Oceanographic Center on natural reefs in Broward County from 1995-2002

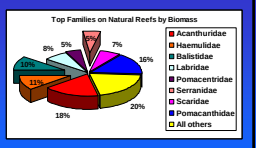
NO BLACKFIN SPAPPER EVER RECORDED!

Vessel-reefs:
Observed in 60 counts (28%)
Total abundance = 597 individuals
Mean size = 19 cm; Max = 40 cm; Min = 4 cm
90% in the 15-20 cm size class

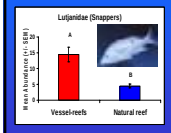
ONTOGENETIC MIGRATIONS?
JUVENILE HABITAT LIMITATIONS?

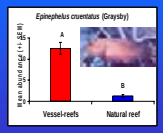
Recreational and Commercial Importance





Seriola spp.
164 individuals
Recorded 45x ~ 21%
Vessel-reef exclusive



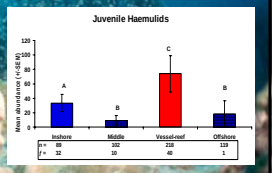


Epinephelus morio, Red Grouper
44 individuals
Recorded 30x ~ 49%
Natural Reef Exclusive

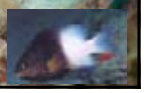
Juvenile Abundance

	Vessel-reefs	Natural reef
Total juveniles =	26%	25%
Dominant juvenile spp. =	*Haemulon* spp.(58%)	*Stegastes partitus* (58%)

Unnamed Barge & Edmister
80% of *Haemulon* juveniles
↑Complexity; ↓Relief

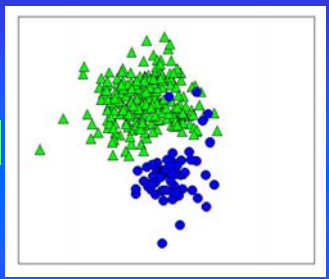


Important Prey Species



MDS of Bray Curtis between reefs

▲ Vessel-reefs
● Natural Reef



ANOSIM

Groups	R-Statistic
Vessel-reefs vs. Natural reef	0.718*

R>0.75: Well Separated
R>0.50: Overlapping but Clearly Different
R<0.25: Barely Separable

SIMPER

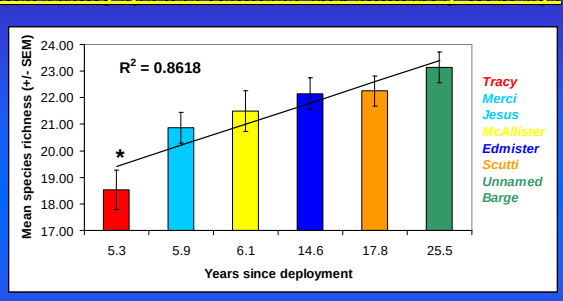
Groups Vessel-reef & Natural reef

Average dissimilarity = 74.18 25.82% Similar

Species	Vessel-reef Av.Abund	Natural reef Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Tomtate *	118.75	5.74	4.49	1.33	6.05	6.05
Mask Goby	44.03	7.41	3.10	1.05	4.18	10.23
Purple Reeffish	14.25	0.30	2.75	1.33	3.70	13.93
Yellowhead Wrasse	2.36	9.02	2.32	1.53	3.13	17.06
Bicolor Damselfish	9.27	19.98	2.26	1.33	3.05	20.11
Creole Wrasse	15.90	2.18	2.23	0.95	3.00	23.12
Bluehead Wrasse	44.97	15.23	2.15	1.18	2.90	26.02

- Tomtate utilizing shelter in feeding grounds
- Planktivores dominated on Vessel-reefs (54%) and contributed at least 24% to total dissimilarity

Increasing species richness and similarity with age



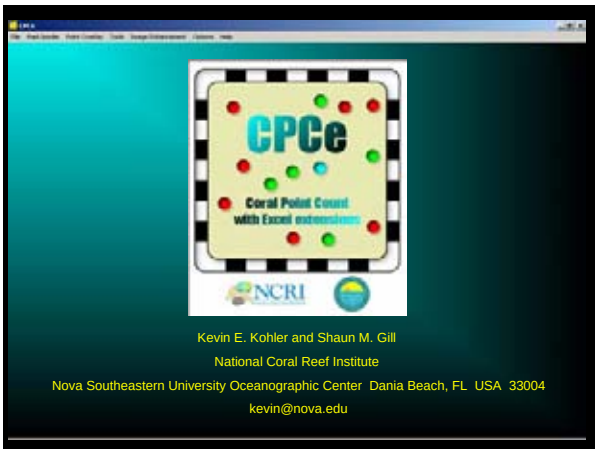
SIMPER

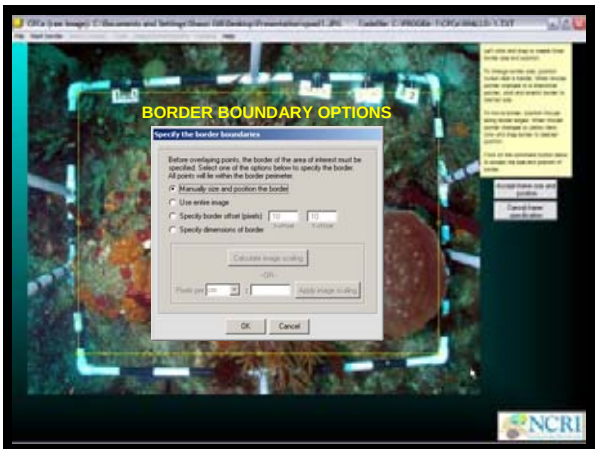
Unnamed Barge vs. Natural Reef = ↑test similarity (29%)

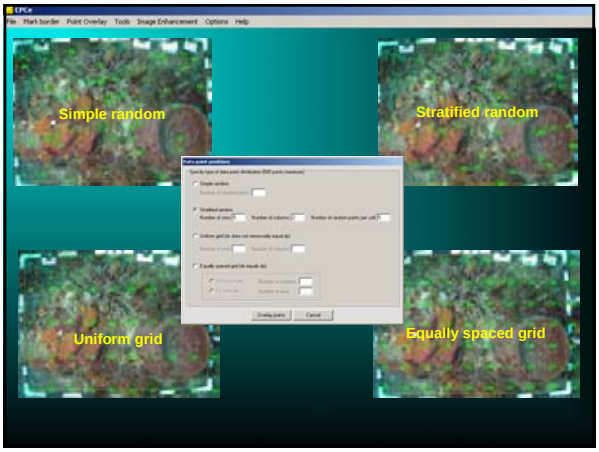
Richer Fouling Community = ↑food ↑refuge
↑Age = ↑ Larval Interactions

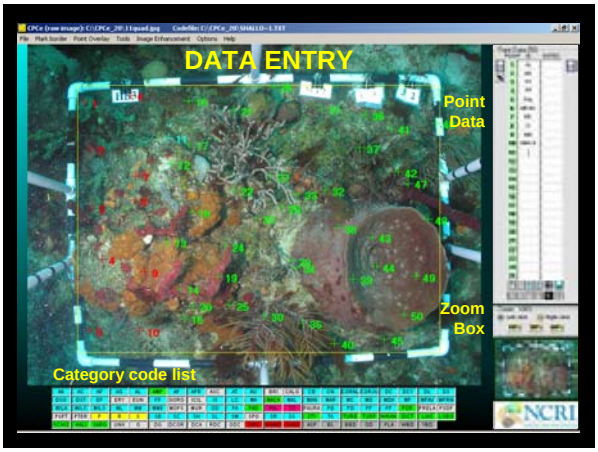
Summary

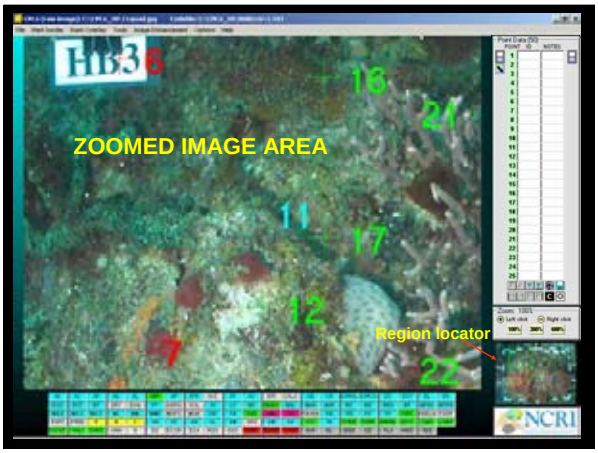
- Vessel-reefs have greater abundance, biomass, and species richness
- Vessel-reef fish assemblages are clearly different from natural reefs
- Vessel-reefs may provide ancillary juvenile habitat for deepwater species
- Vessel-reefs harbor more recreationally and commercially important species
- Data do not support a simple aggregation hypothesis

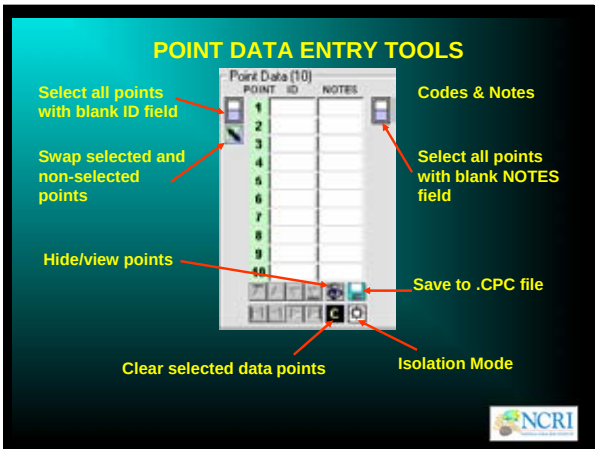

CPCe
Coral Point Count
with Excel extensions
NCRI
Kevin E. Kohler and Shaun M. Gill
National Coral Reef Institute
Nova Southeastern University Oceanographic Center Dania Beach, FL USA 33004
kevin@nova.edu


BORDER BOUNDARY OPTIONS
NCRI


Simple random
Stratified random
Uniform grid
Equally spaced grid


DATA ENTRY
Point Data
Zoom Box
Category code list
NCRI


ZOOMED IMAGE AREA
Region locator
NCRI


POINT DATA ENTRY TOOLS
Select all points with blank ID field
Swap selected and non-selected points
Hide/view points
Clear selected data points
Codes & Notes
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Save to .CPC file
Isolation Mode
Point Data (10)
POINT
ID
NOTES
NCRI

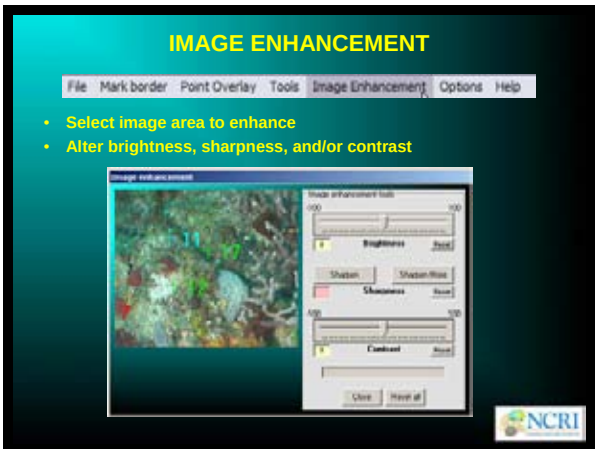
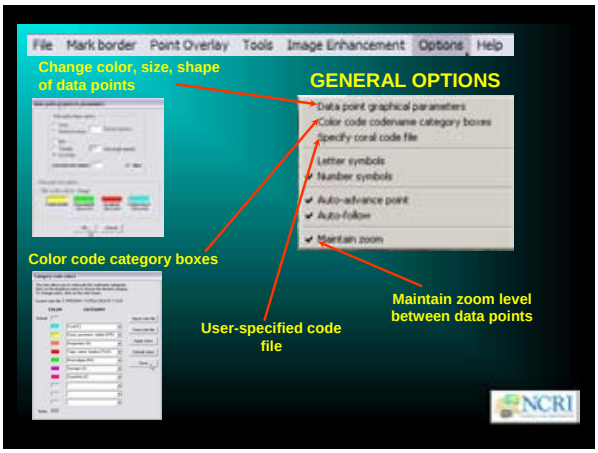
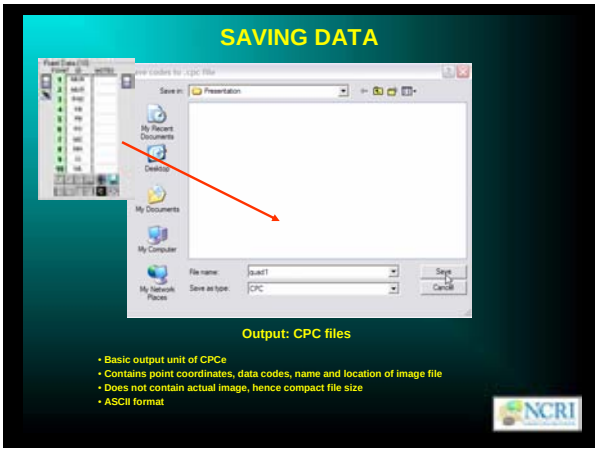
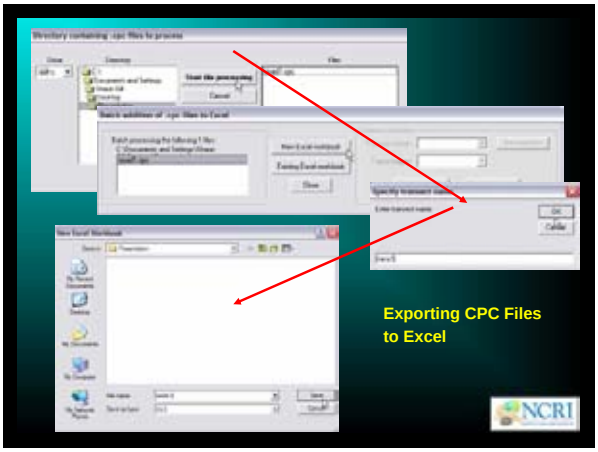
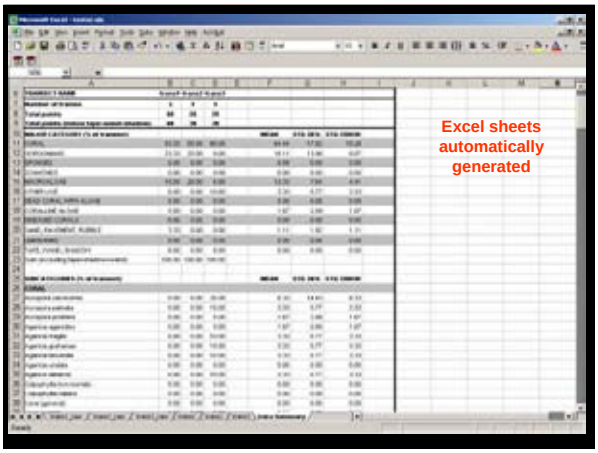


IMAGE ENHANCEMENT
File Mark border Point Overlay Tools Image Enhancement Options Help
• Select image area to enhance
• Alter brightness, sharpness, and/or contrast
NCRI


File Mark border Point Overlay Tools Image Enhancement Options Help
Change color, size, shape of data points
GENERAL OPTIONS
Data point graphical parameters
Color code codename category boxes
Specify coral code file
Letter symbols
Number symbols
Auto-advance point
Auto-follow
Maintain zoom
Color code category boxes
User-specified code file
Maintain zoom level between data points
NCRI


SAVING DATA
Output: CPC files
• Basic output unit of CPCe
• Contains point coordinates, data codes, name and location of image file
• Does not contain actual image, hence compact file size
• ASCII format
NCRI


Exporting CPC Files to Excel
NCRI


Excel sheets automatically generated

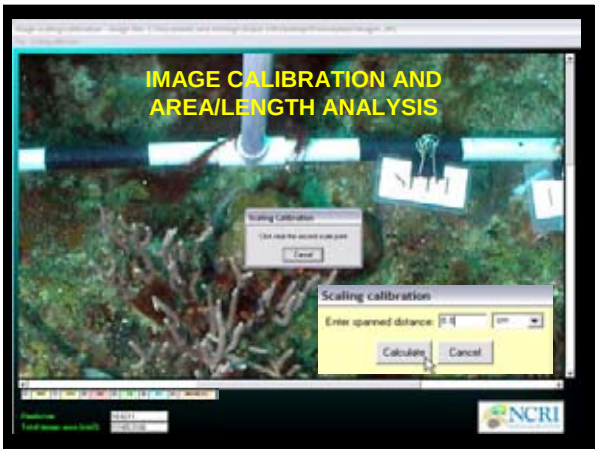
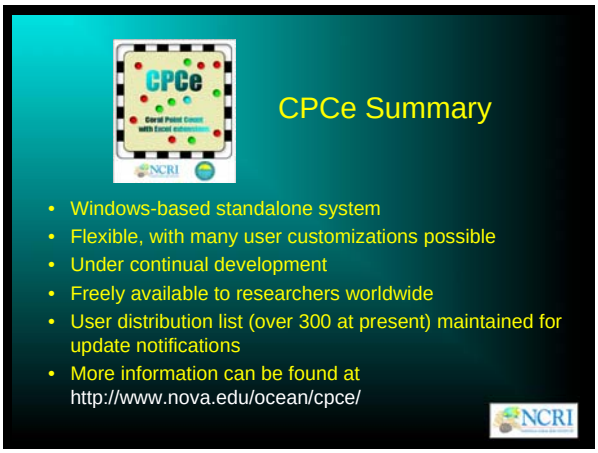


IMAGE CALIBRATION AND AREA/LENGTH ANALYSIS
Scaling calibration
Calculate
Cancel
NCRI

AREA ANALYSIS
NCRI


CPCe Summary
• Windows-based standalone system
• Flexible, with many user customizations possible
• Under continual development
• Freely available to researchers worldwide
• User distribution list (over 300 at present) maintained for update notifications
• More information can be found at http://www.nova.edu/ocean/cpce/
NCRI

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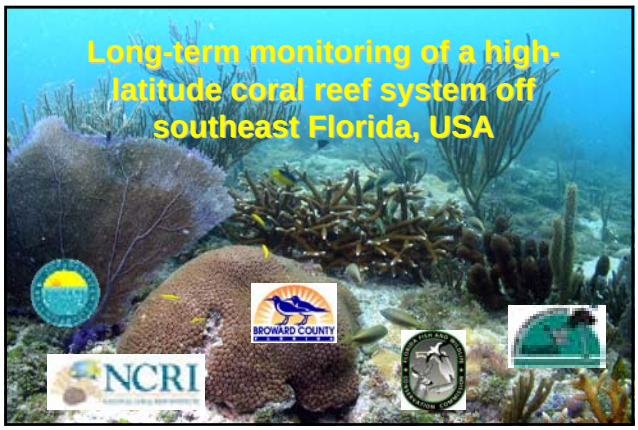
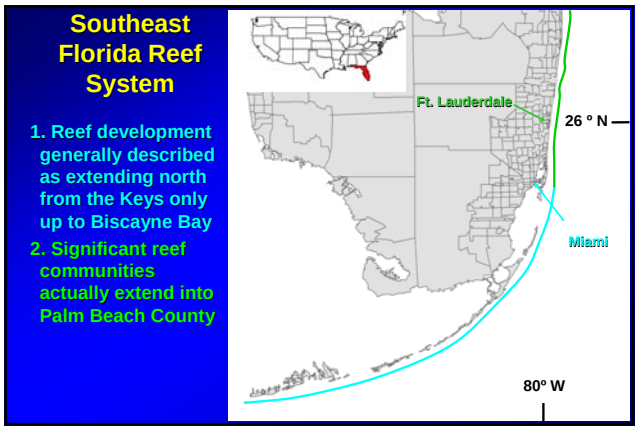
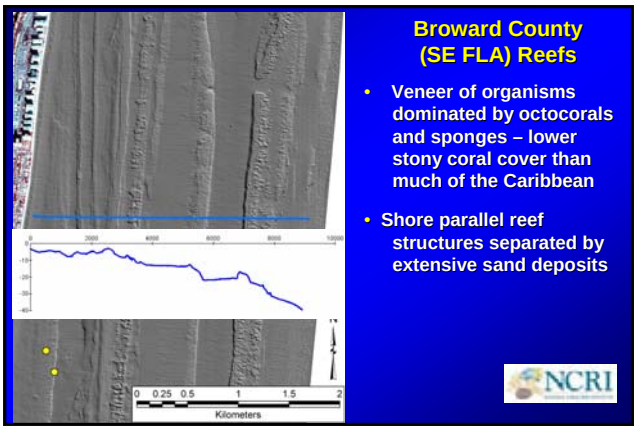
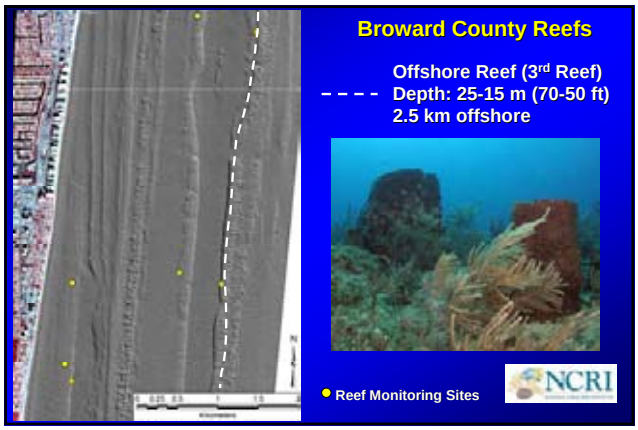
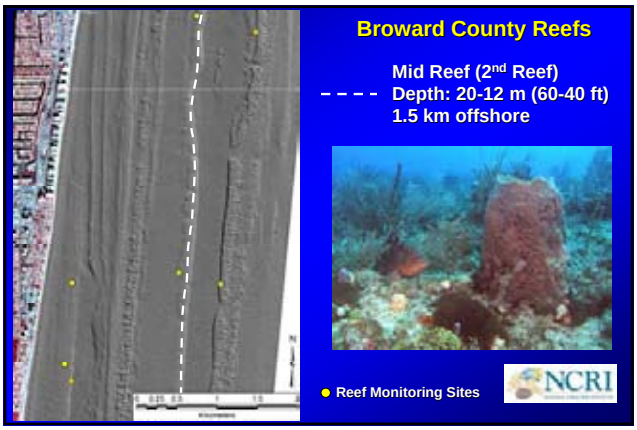

Long-term monitoring of a high-latitude coral reef system off southeast Florida, USA
BROWARD COUNTY
NCRI

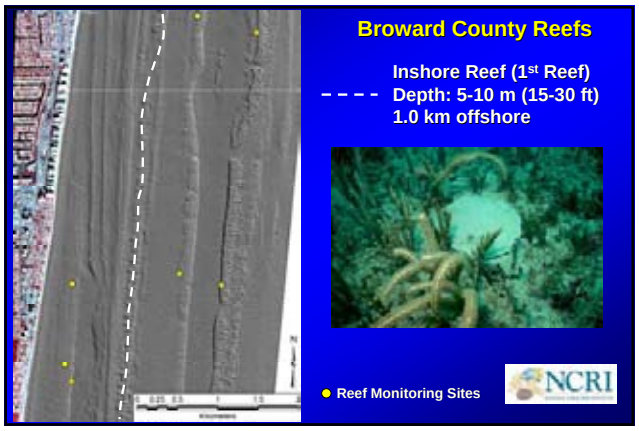
SE Florida Coral Reef Ecosystem Management – Monitoring Programs
2 Monitoring Programs
1. Local Management Level – Broward County Environmental Protection Department (EPD)
2. Regional Management Level – Florida Department of Environmental Protection (DEP) and Florida Wildlife Research Institute (FWRI) (SECREMP)

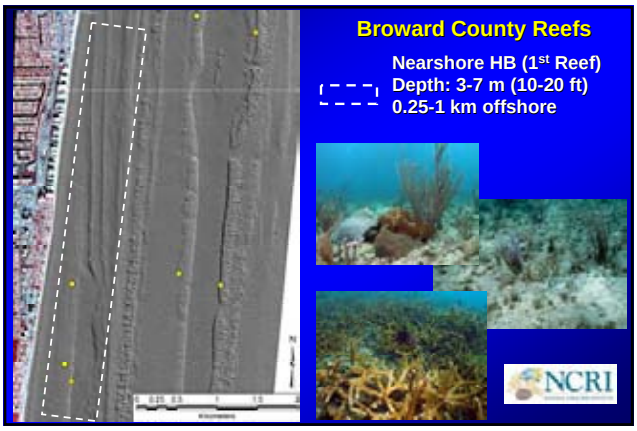

Southeast Florida Reef System
1. Reef development generally described as extending north from the Keys only up to Biscayne Bay
2. Significant reef communities actually extend into Palm Beach County
Ft. Lauderdale
26 ° N
Miami
80° W

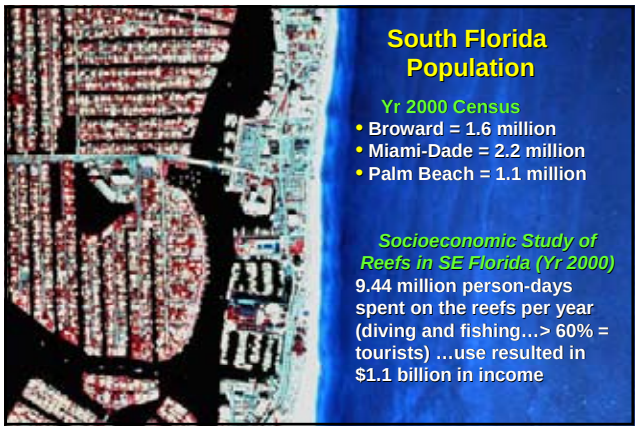

Broward County (SE FLA) Reefs
• Veneer of organisms dominated by octocorals and sponges – lower stony coral cover than much of the Caribbean
• Shore parallel reef structures separated by extensive sand deposits
0 0.25 0.5 1 1.5 2
Kilometers
NCRI


Broward County Reefs
Offshore Reef (3rd Reef)
Depth: 25-15 m (70-50 ft)
2.5 km offshore
Reef Monitoring Sites
NCRI

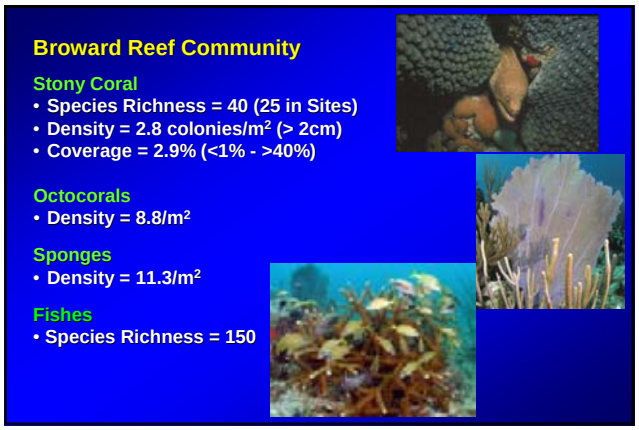

Broward County Reefs
Mid Reef (2nd Reef)
Depth: 20-12 m (60-40 ft)
1.5 km offshore
Reef Monitoring Sites
NCRI


Broward County Reefs
Inshore Reef (1st Reef)
Depth: 5-10 m (15-30 ft)
1.0 km offshore
Reef Monitoring Sites
NCRI


Broward County Reefs
Nearshore HB (1st Reef)
Depth: 3-7 m (10-20 ft)
0.25-1 km offshore
NCRI


South Florida Population
Yr 2000 Census
• Broward = 1.6 million
• Miami-Dade = 2.2 million
• Palm Beach = 1.1 million
Socioeconomic Study of Reefs in SE Florida (Yr 2000)
9.44 million person-days spent on the reefs per year (diving and fishing…> 60% = tourists) …use resulted in $1.1 billion in income

Anthropogenic Stressors
• Ports – 2 Ports in Broward with several major ports in adjacent Counties
• Ship Groundings – 4 in 2 yrs
• Sewer Outfalls
• Dredge Projects


Broward Reef Community
Stony Coral
• Species Richness = 40 (25 in Sites)
• Density = 2.8 colonies/m² (> 2cm)
• Coverage = 2.9% (<1% - >40%)
Octocorals
• Density = 8.8/m²
Sponges
• Density = 11.3/m²
Fishes
• Species Richness = 150

Expansion of the Coral Reef Evaluation and Monitoring Project To Southeast Florida
NOAA
MIAMI-DADE
BROWARD COUNTY FLORIDA
NCRI
ERM

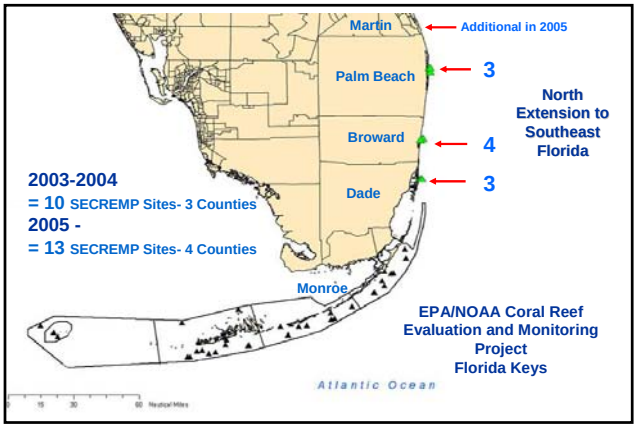
Southeast Coral Reef Evaluation and Monitoring Project (SECREMP)

Regional Partners
- FL Department of Environmental Protection (DEP)
- FWCC Florida Marine Research Institute (FWRI)
- NCRI/NSUOC

Reef Monitoring
- 2003 – FWRI & NCRI – established 10 sites in 3 Counties
- 2004 – NCRI – continue monitoring 10 sites
- 2005 - NCRI & FWRI – 10 sites + 3 new sites in Martin Co.

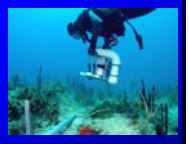
Purpose

Provide relevant and timely information on status and trends of Florida's coral reef and hard bottom resources with respect to coral species richness, benthic cover, and coral disease = Regional Management Level



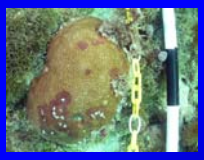
SECREMP (Kinds of Geo-referenced Data):

- Stony coral biodiversity:
  Station Species Inventory- Station inventory of stony coral species presence
- Benthic Cover (Coral + other Functional Groups):
  Digital Video Transects- 3 trans filmed / station
- Coral Disease, Bleaching:
  Photo-documentation - determine condition and status of infected colonies
- Bio-eroding Sponge:
  Survey- Survey of the coral species effected and aerial extent of coverage for sponges of the genus Cliona.



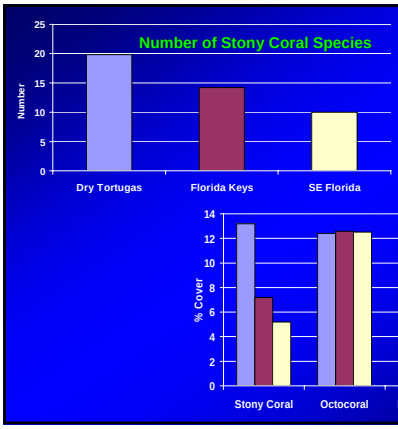
SECREMP

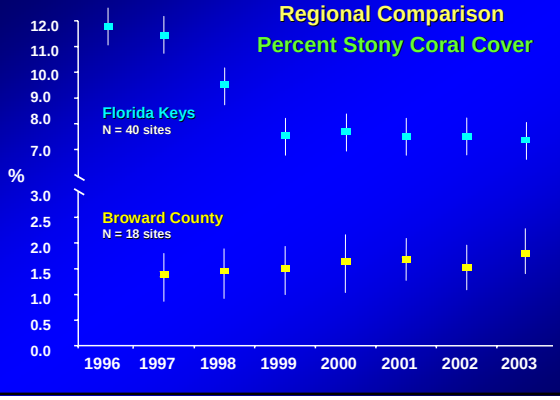
Coral Diseases: 2003 - 2004

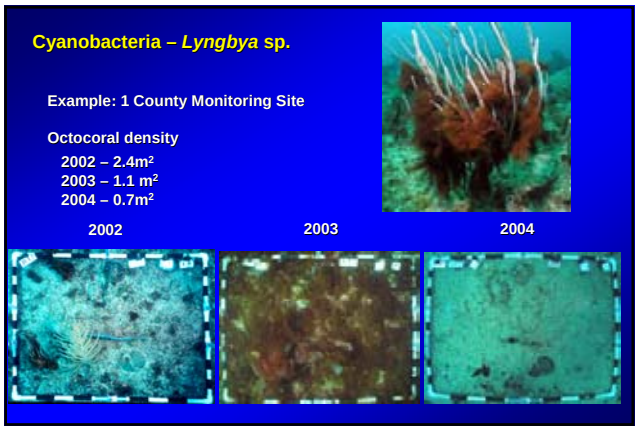


Year	No. Sites	No. Stations	No. Colonies
2003	7	7	NA
2004	4	8	22

Species	2003	2004
Solenastrea bournoni	P	1
Dichocoenia stokesii	P	1
Diploria clivosa	P	1
Montastrea cavernosa	P	0
Montastrea annularis	P	1
Siderastrea siderea	P	18






Cyanobacteria – *Lyngbya* sp.
Example: 1 County Monitoring Site
Octocoral density
2002 – 2.4m²
2003 – 1.1 m²
2004 – 0.7m²
2002
2003
2004

FWRI – Carl Beaver, Walt Jaap, Mike Callahan, Jim Kidney, Selena Kupfner, Shannon Wade
NSUOC/NCRI - Brian Ettinger, Dan Fahy, Elizabeth Fahy, Shaun Gill, Jamie Monty, Lauren Shuman, Brian Walker, Lance Robinson
BC EPD – Ken Banks, Lou Fisher, Dave Stout, Joe Ligas

Investigations on Coral Skeletal Density:

Coral Density and Sclerochronology

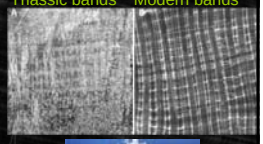
Caribbean Salinity Experiment (CASE) Coral Coring Cruise

Richard E. Dodge and Kevin P. Helmle

Sclerochronology

- Density banding in corals
- A brief history:
  - Jurassic (144 ma) and maybe Triassic (230 ma)
  - 1934 T.Y.Ma reports annual patterns in skeleton
  - 1958 Nuclear testing at Eniwetok Atoll (+ 13 yrs)
  - 1971 Annual nature of density banding confirmed (Knutson *et al.* 1972)

Triassic bands Modern bands

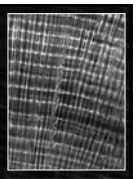


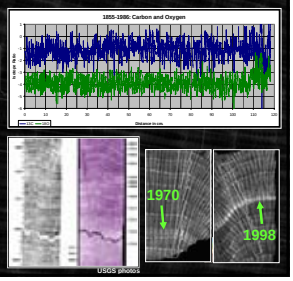
Coral Density Banding

- Skeleton has annual bands that provide record of growth over time
- Variations in growth rate reflect environmental influence
- Chronological reliability provides a framework for interpreting impacts
  - Anthropogenic
  - Climate Change

Coral skeletal records

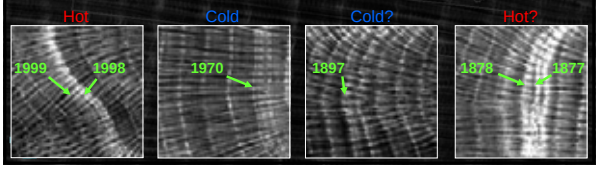
- Annual density banding
  - Extension, density, and calcification
- Isotopic ratios
  - Carbon ($\delta^{13}C$)
  - Oxygen ($\delta^{18}O$)
- Elemental ratios
  - Sr/Ca, Mg/Ca, etc.
- Skeletal fluorescence
- Skeletal stress bands





Stress Bands from Hot or Cold Temperatures

- Stress bands:
  - Decreased extension and increased density
  - Distinctly lighter bands on X-radiograph
- Examples from:
  - 1998-99 stress band following 1997-98 mass bleaching
  - 1970 stress band following cold 1969 winter



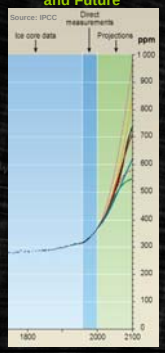
Carbon Dioxide and Calcification

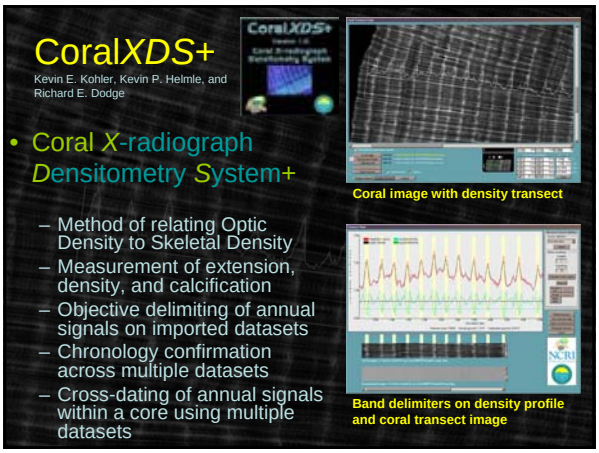
- CO_2 levels are consistently predicted to rise
- Increase in CO_2 results in decrease of the calcium carbonate ($CaCO_3$) saturation state

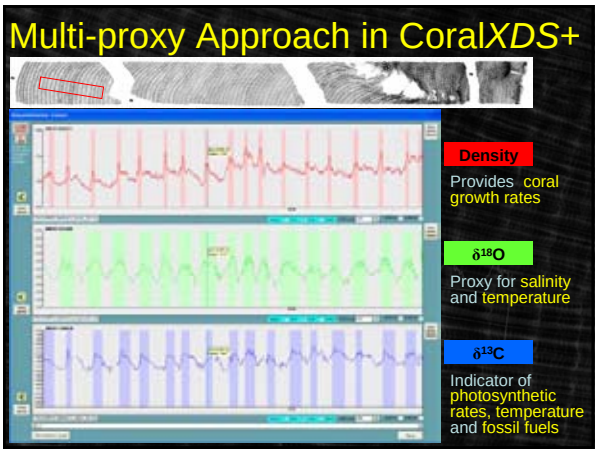
$$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow HCO_3^- + H^+ \leftrightarrow CO_3^= + 2H^+$$

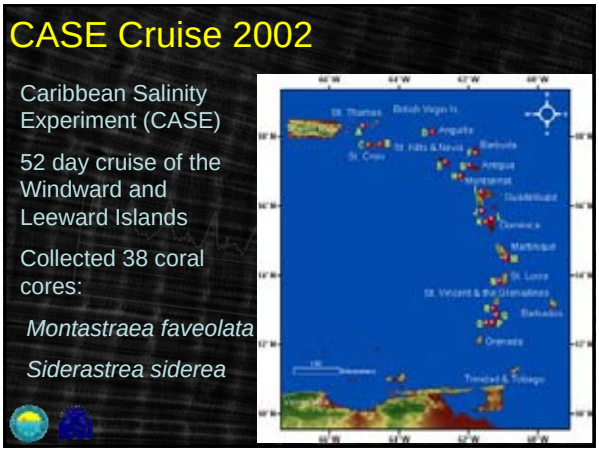
- Positive relationship between calcification and saturation state
- Calculated values suggest that calcification declined ~10% over the last century.

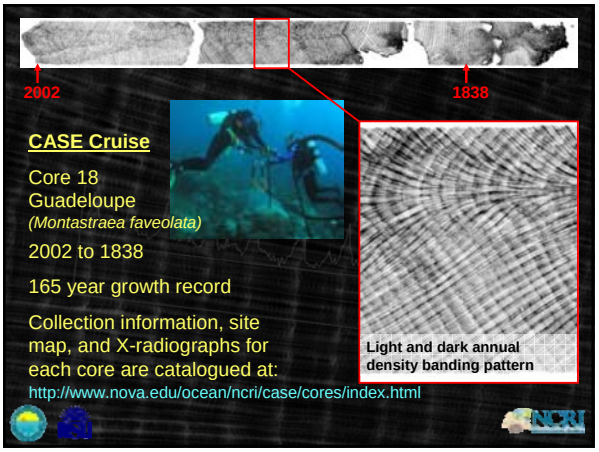
CO_2 Past, Present and Future

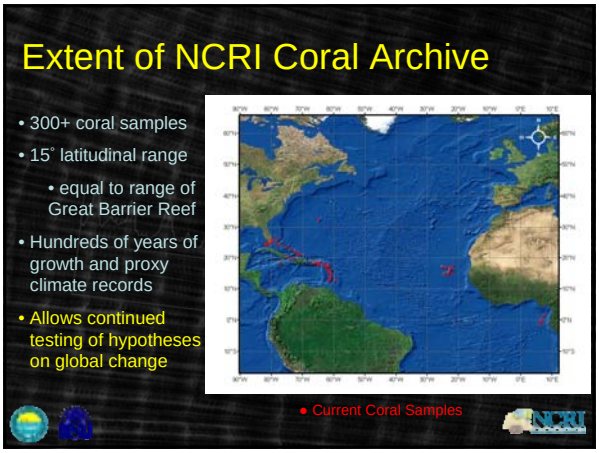



CoralXDS+
Kevin E. Kohler, Kevin P. Helmle, and Richard E. Dodge
• Coral X-radiograph Densitometry System+
– Method of relating Optic Density to Skeletal Density
– Measurement of extension, density, and calcification
– Objective delimiting of annual signals on imported datasets
– Chronology confirmation across multiple datasets
– Cross-dating of annual signals within a core using multiple datasets
Coral image with density transect
Band delimiters on density profile and coral transect image


Multi-proxy Approach in CoralXDS+
Density
Provides coral growth rates
δ18O
Proxy for salinity and temperature
δ13C
Indicator of photosynthetic rates, temperature and fossil fuels


CASE Cruise 2002
Caribbean Salinity Experiment (CASE)
52 day cruise of the Windward and Leeward Islands
Collected 38 coral cores:
Montastraea faveolata
Siderastrea siderea


2002
1838
CASE Cruise
Core 18
Guadeloupe
(Montastraea faveolata)
2002 to 1838
165 year growth record
Collection information, site map, and X-radiographs for each core are catalogued at:
http://www.nova.edu/ocean/ncri/case/cores/index.html
Light and dark annual density banding pattern


Extent of NCRI Coral Archive
• 300+ coral samples
• 15˚ latitudinal range
• equal to range of Great Barrier Reef
• Hundreds of years of growth and proxy climate records
• Allows continued testing of hypotheses on global change
• Current Coral Samples

Hypotheses-based restoration study for mitigation of a S.E. Florida U.S.A. coral reef damaged by the grounding of a nuclear submarine.

Introduction:

The *United States Submarine* Memphis ran aground in approximately 10 meter depth on a coral reef off southeast Florida February 25, 1993. Extensive physical damage to the reef substrate and injury to the coral community were attributed to the initial grounding and subsequent attempts to free the submarine from the impacted reef.

U.S.S. Memphis

As part of the damage mitigation, we examined the potential of differing substrates to increase coral recruitment to, and survival on, artificial reefs and the interaction between fish assemblages and the coral recruitment dynamic.

Thus, with an eye to restoration, we are looking at multiple components of the ecosystem (structure, substrate, fishes and corals)

Experimental Design

- 160 Reef Balls™ were organized into 40, 4-module reef units
- 4 treatments: iron, limestone, coral transplants or plain concrete
- 4 treatments of structural complexity (empty, small, mixed, large)

Study site: 2nd reef tract off Broward County, FL, USA.

Artificial reef construction

Mould preparation prior to the day's concrete pour.

Pouring 'mud'.

Breaking down moulds the following morning.

A day's work ready to be moved.

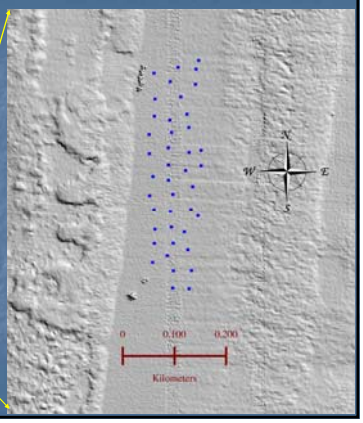
One hundred sixty Reef Balls at NSUOC.

Artificial Reef Deployment

Reef Balls were placed in sets of 4 termed a 'quad'...

a square configuration with 3-m sides.

Quad array



Small fill:

Plastic cage material with 1.9 cm square mesh.

Plastic mesh cones were cable-tied into the reefs...

to provide small refuge fill.

Large fill:

Two hundred cinder blocks were used...

to provide large refuge fill.

Four types of quad fill complexity:

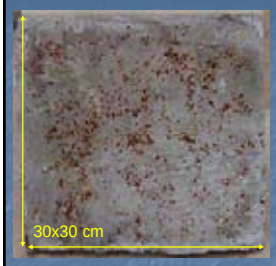
1) Empty - no fill
2) Small - cage in each RB
3) Mixed - 1 empty RB, two cage, one block
4) Large - 4 block in each RB

Ten quads (randomly chosen) received each type of complexity.

Settlement plate construction:

Three hundred twenty settlement plates were constructed at the same time as the artificial reefs.

Settlement plate treatments:



Settlement plate with iron treatment

Settlement plate with $CaCO_3$ treatment

Settlement plate attachment:

Attachment sites were brushed clean of biota

Concrete mixture:
2 parts Type II cement
2 parts molding plaster
1 part sand

Settlement plate attachment:

Each Reef Ball received two plates of the same treatment

Transplant RB with both plates attached

Coral transplants:

Collecting corals for transplantation using 4 inch core barrel

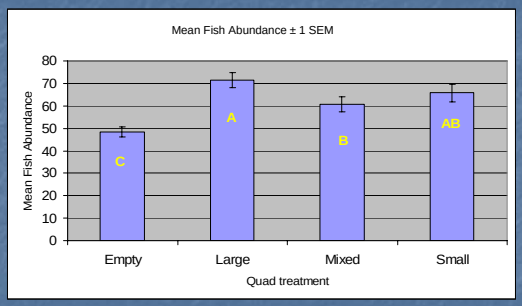
Transplants epoxyed into transplant ball

Coral transplant species:

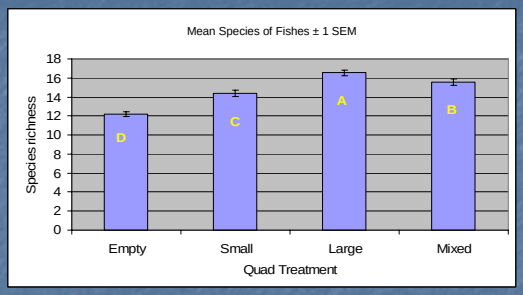
Montastraea cavernosa transplant

Meandrina meandrites transplant

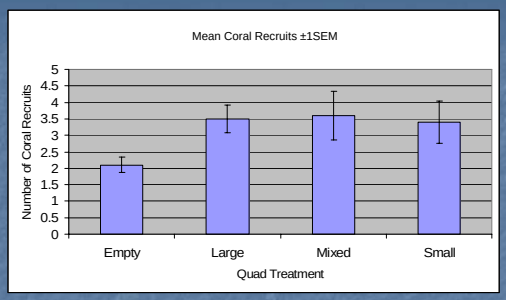
Fish Abundance



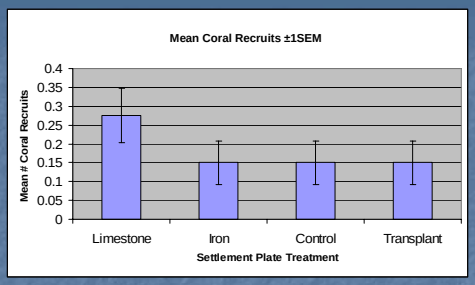
Fish Richness



Coral Recruitment



Although no significant difference is found between quad treatments for coral recruits, when Empty is compared to Filled, the difference is significant (P=0.03).



Mean coral recruits associated with settlement plate treatments (p≈ 0.08, ANOVA).

Preliminary Conclusions

The following factors need to be taken into account in the design of artificial substrate for coral reef restoration

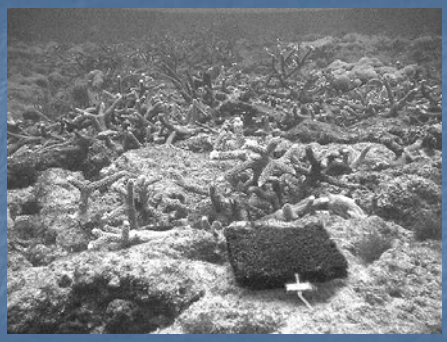
- Differing reef complexity yields differing fish assemblages
- Differing reef complexity yields differing numbers of corals
- Limestone may be superior to iron or concrete for coral recruitment/survivability
- There are species-specific differences in transplant mortality

An additional 12 months of funding have been requested from FWC

New Project

We are continuing this line of ecosystem-restoration research.

In May, we will deploy 32 modules with differing structural complexity and with, or without, invertebrate-attracting artificial substrate. We will examine the effects of the these structures, and the resulting biota, on fishes, corals and non-coral invertebrates.



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Coral Reef Restoration and
the Use of Corals of Opportunity
and Coral Nurseries
NCRI
BROWARD COUNTY

Reef Damage - Restoration

Sources of Donor Corals

Corals of Opportunity

Formation of Corals of Opportunity
Hurricane Floyd, 1999
C/V Hind Anchor Damage, 1988
Bioerosion

Fate of Corals of Opportunity

Coral Nursery Project Team

- Local academia (National Coral Reef Institute of Nova Southeastern University Oceanographic Center [NSUOC/NCRI])
- Local government regulatory and management agency (Broward County Department of Planning and Environmental Protection [BC EPD])
- Local NGO (Ocean Watch Foundation [OWF])

Project Objectives

1. To establish a cooperative effort among scientists, resource managers, and community members, who will serve as the coral nursery team
2. To create a coral nursery to rescue and cache corals of opportunity
3. To collect data to be used by resource managers on species and size specific success and growth rates of transplanted corals of opportunity
4. To use healthy and stabilized corals of opportunity as a source of transplant donors for future restoration of coral reef habitat

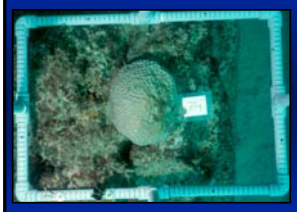
Project Methods

Dive 1 = Coral Collection

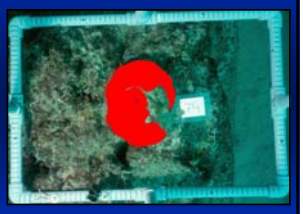
Project Methods Continued

Dive 2 = Transplantation & Data Collection

Transplanted Coral Monitoring



Transplanted Coral # 74



Transplanted Coral # 74

Control Coral Monitoring

Attached Control Coral # A 14

Loose Control Coral # I 16, both

As Found Initially (Top) and Upright (Bottom)

Project Results

Associated with Project Goals:

1. To establish a cooperative effort among scientists, resource managers, and community members, who will serve as the coral nursery team

- Members of NSUOC/NCRI, BC EPD, and OWF have participated in 20 transplantation field days, 24 monitoring field days, and 7 seminars

Project Results Continued

Associated with Project Goals:

2. To create a coral nursery to rescue and cache corals of opportunity

- 350 transplanted corals of opportunity have been collected representing 17 species, as well as 60 attached control and 28 loose control corals

Project Results Continued

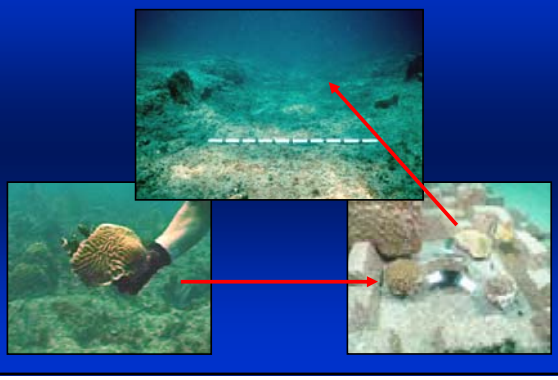
Associated with Project Goals:

3. To collect data to be used by resource managers on species and size specific success and growth rates of transplanted corals of opportunity
   - 95% survivorship of corals of opportunity
   - 96% survivorship of attached control corals
   - 67% survivorship of loose control corals

Conclusions

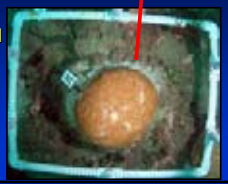
- The creation of an integrated project team is an effective way to both increase public awareness and accomplish the goals of the project
- The survivorship of transplanted corals of opportunity is nearly identical to that of naturally attached corals, and is higher than that of corals of opportunity left detached
- Corals of opportunity are readily available
- The species composition of corals of opportunity appears to reflect the species composition of natural corals

4. Ultimate Goal



June 2003
CV Alam Senang Grounding

Summer 2005
Working with FL FWC/FWRI



Funding and Support Provided By:
National Fish and Wildlife Foundation
National Oceanographic and Atmospheric Administration
NCRI
Nova Southeastern University Oceanographic Center and the National Coral Reef Institute
Broward County Environmental Protection Department
OceanWatch Foundation

HEA (Habitat Equivalency Analysis)

- HEA is a means to determine the amount of (compensatory) restoration required to provide natural resource services (from another source) equivalent to those lost, due to and following the injury.

Kevin E. Kohler & Richard E. Dodge, National Coral Reef Institute
Nova Southeastern University
Tuesday, March 22, 2005: Presentation to NOAA CSCOR

HEA: A Useful Solution For: Determining Compensation for Lost Natural Resources

- Injury to Natural Resources = loss of services of the resource from time of injury to recovery.
- How should the Resource Trustee determine the kind and size of a compensatory action for these lost services?

HEA Principles

- Natural resources are viewed as natural assets that provide services throughout their lifetime.
- Discounting is used to reflect the willingness to pay more for something now than in the future.
- Total value of asset = (present) value of the future stream of all services (discounted) over time.

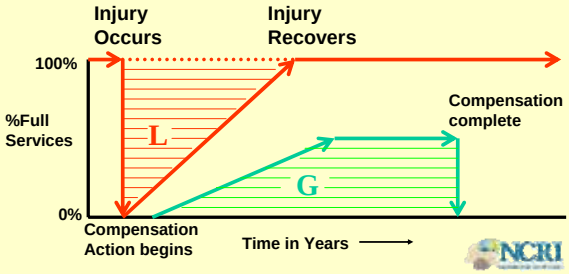
Basic HEA Procedure

- Assess the injury to natural resources
- Determine services lost from injury to recovery
- Decide on restoration action (type)
- HEA determines amount of compensatory action to be created such that:

  Services GAINED (provided by) the compensation over its life time EQUALS Services LOST from the injury.
- Service valuation as a function of time is critical.

Calculating Compensatory Habitat

L= Total Services (area-yr) of Injured Area Lost from injury
G= Total Services (area-yr) Gained by compensatory action



NCRI has developed: Visual_HEA Software Utility

- Calculates Amount of Compensatory Area
- Allows comparison of restoration alternatives under multiple scenarios of injury recovery, service levels, and restoration type
- Freely available to researchers worldwide
- User distribution list maintained for update notices
- More information can be found at http://www.nova.edu/ocean/visualhea/

HEA: structured framework for important biological parameters

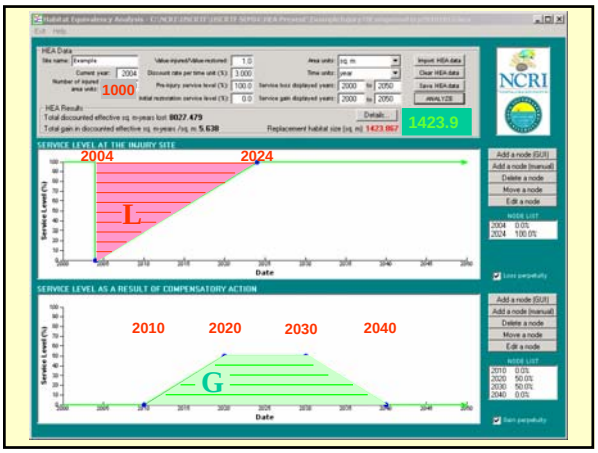
INPUT

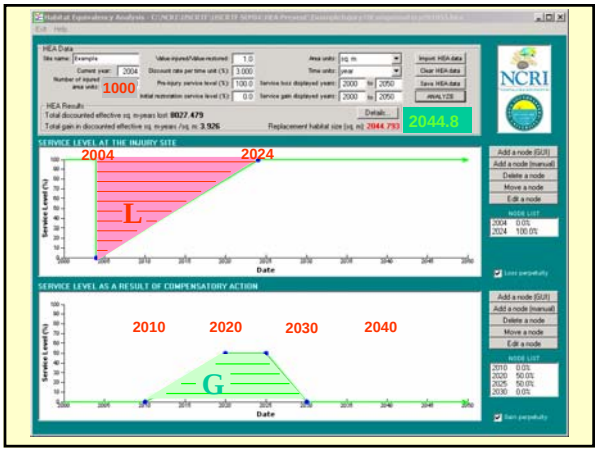
- Amount of Injury (area)
- Nature of Natural Recovery (Amount, Duration, & Recovery Time Profile)
- Nature of Compensatory Action (trajectory towards equilibrium, persistence)
- Value ratio of Services
- Discount Rate (%)

OUTPUT

- Amount of Compensatory Action (area) today to compensate for the loss of services of injury

HEA Formulas are published and publicly available:
NOAA. 1995 (Revised 2000). Habitat Equivalency Analysis: An Overview
We have developed a free program, Visual_HEA, to facilitate calculations.



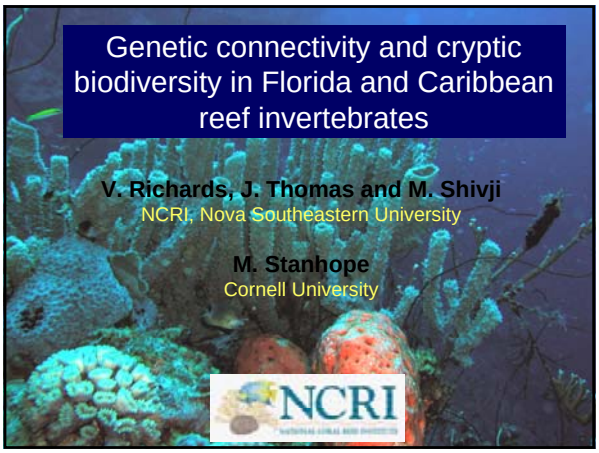


Summary: HEA (Habitat Equivalency Analysis)

- HEA is a means to determine the amount of (compensatory) restoration required to provide natural resource services (from another source) equivalent to those lost following the injury.

- Visual_HEA provides a user-friendly interface to input necessary injury and restoration parameters, and allows the quick assessment of multiple time and valuation scenarios.

Visual_HEA is available free of charge for non-commercial use. Go to:
www.nova.edu/ocean/visual_hea/
for more information.



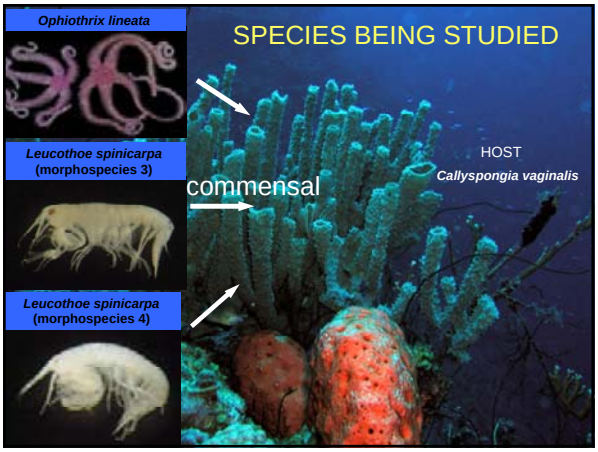
EFFECTIVE SPATIAL MANAGEMENT OF REEFS AND MPA DESIGN

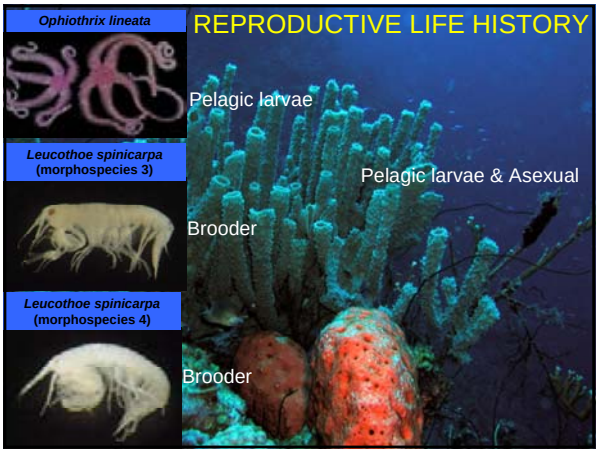
Requires:

- Reliable estimates of dispersal and connectivity among reefs
- Assessment of biodiversity (genetic)

NCRI GENETICS RESEARCH QUESTIONS

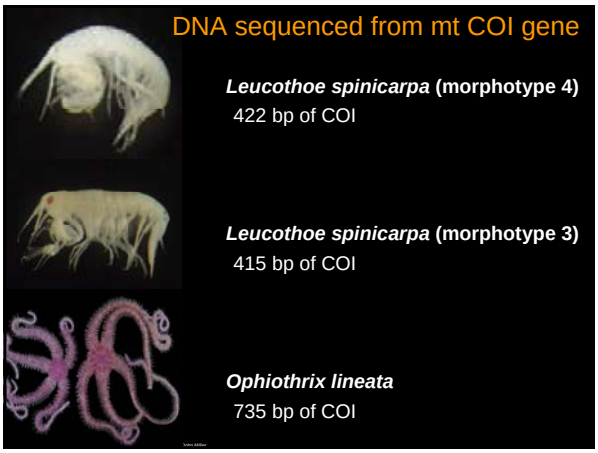
1. How connected are Florida reefs?
2. How connected are Caribbean reefs to each other and to Florida reefs?
   (NCRI Monitoring Network)

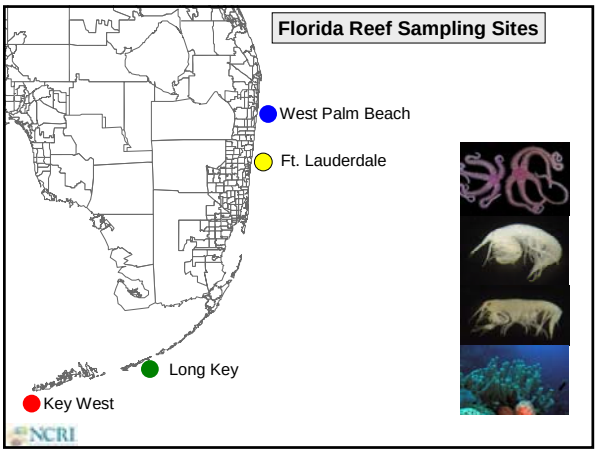


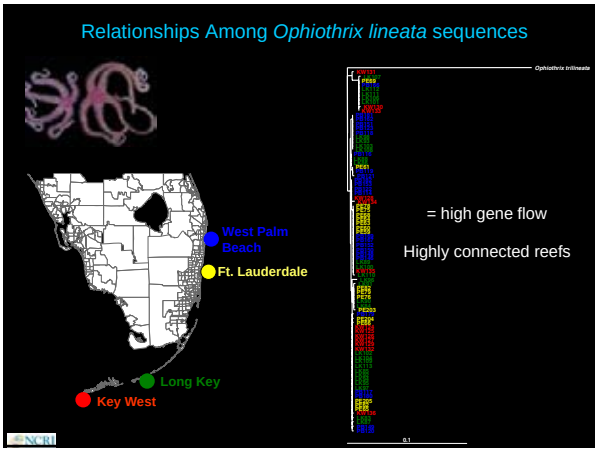


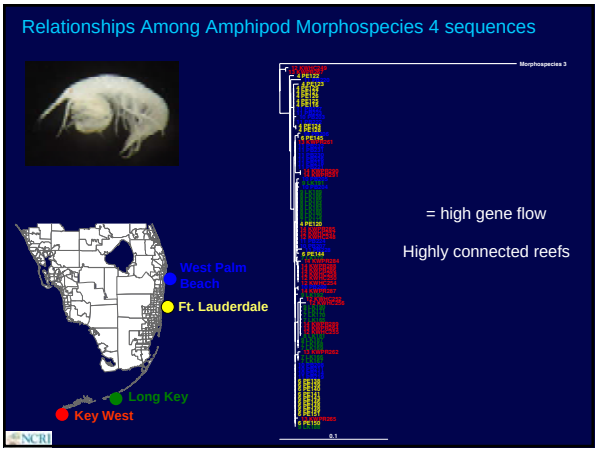
ADVANTAGES OF APPROACH

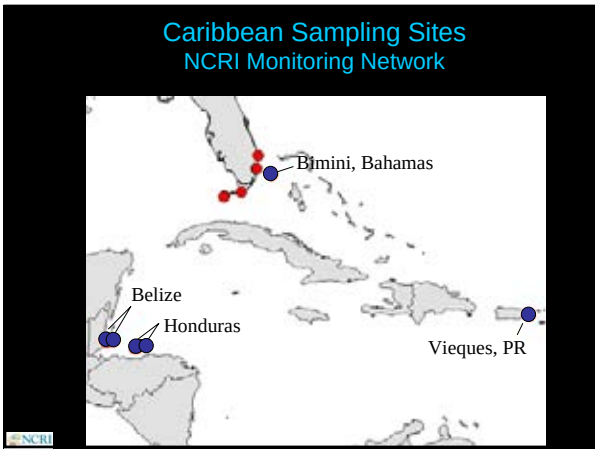
- Multi-species view of connectivity
- Diverse reproductive life histories
  brooders – predict low dispersal & connectivity
  pelagic larvae – predict high dispersal & connectivity
- Common micro-habitat (host sponge) for all species
  i.e. all species are subject to the same small scale hydrodynamic environment

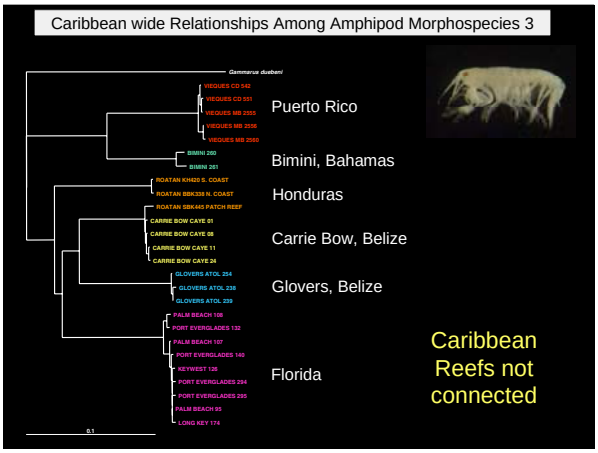

DNA sequenced from mt COI gene
Leucothoe spinicarpa (morphotype 4)
422 bp of COI
Leucothoe spinicarpa (morphotype 3)
415 bp of COI
Ophiothrix lineata
735 bp of COI

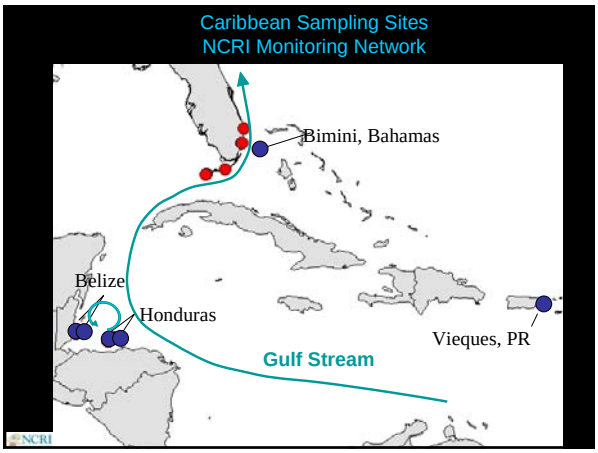

Florida Reef Sampling Sites
West Palm Beach
Ft. Lauderdale
Long Key
Key West
NCRI


Relationships Among Ophiothrix lineata sequences
West Palm Beach
Ft. Lauderdale
Long Key
Key West
= high gene flow
Highly connected reefs
NCRI


Relationships Among Amphipod Morphospecies 4 sequences
West Palm Beach
Ft. Lauderdale
Long Key
Key West
= high gene flow
Highly connected reefs
NCRI


Caribbean Sampling Sites
NCRI Monitoring Network
Bimini, Bahamas
Belize
Honduras
Vieques, PR
NCRI


Caribbean wide Relationships Among Amphipod Morphospecies 3
Puerto Rico
Bimini, Bahamas
Honduras
Carrie Bow, Belize
Glovers, Belize
Florida
Caribbean Reefs not connected



TAKE AWAY MESSAGE

- Florida reefs appear highly connected.
- Caribbean-wide reefs mostly unconnected to each other and to Florida reefs.

  (tentative – based on examination of one brooding species)
- Genetic analysis indicates potentially high levels of undetected cryptic biodiversity in Caribbean reefs.

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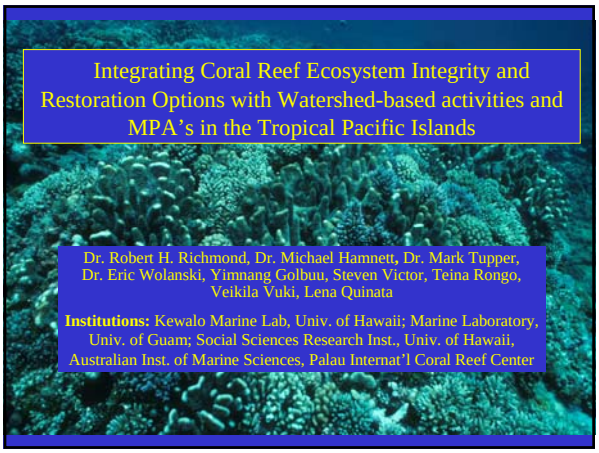
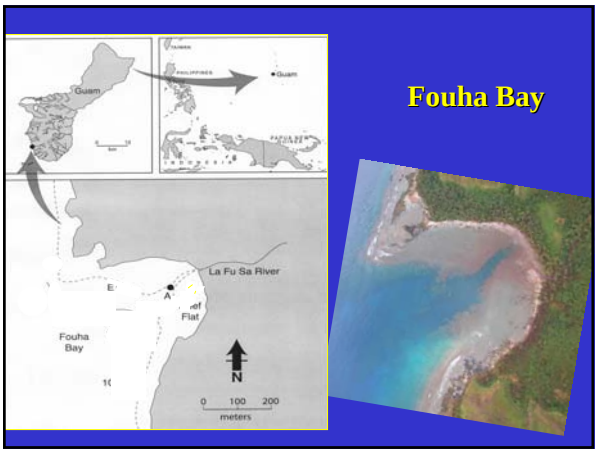
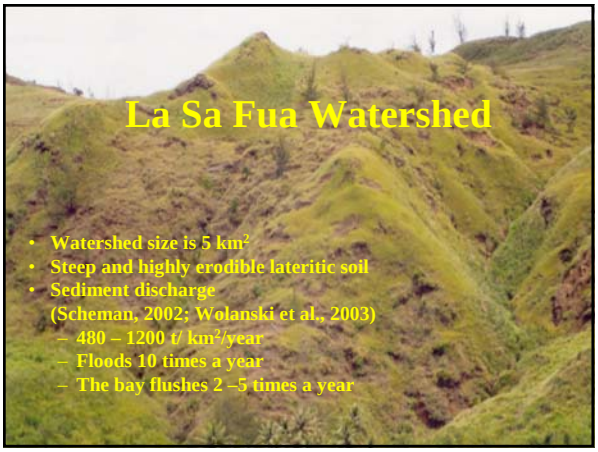
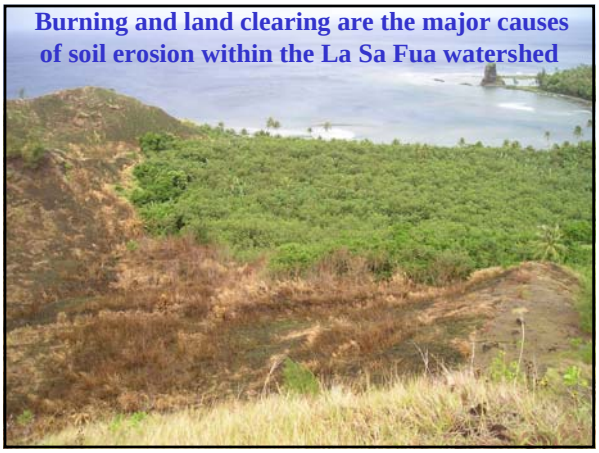
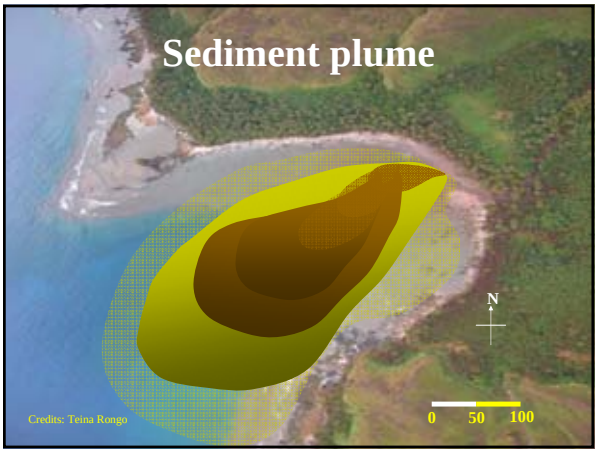

Integrating Coral Reef Ecosystem Integrity and Restoration Options with Watershed-based activities and MPA's in the Tropical Pacific Islands
Dr. Robert H. Richmond, Dr. Michael Hamnett, Dr. Mark Tupper, Dr. Eric Wolanski, Yimnang Golbuu, Steven Victor, Teina Rongo, Veikila Vuki, Lena Quinata
Institutions: Kewalo Marine Lab, Univ. of Hawaii; Marine Laboratory, Univ. of Guam; Social Sciences Research Inst., Univ. of Hawaii, Australian Inst. of Marine Sciences, Palau Internat'l Coral Reef Center

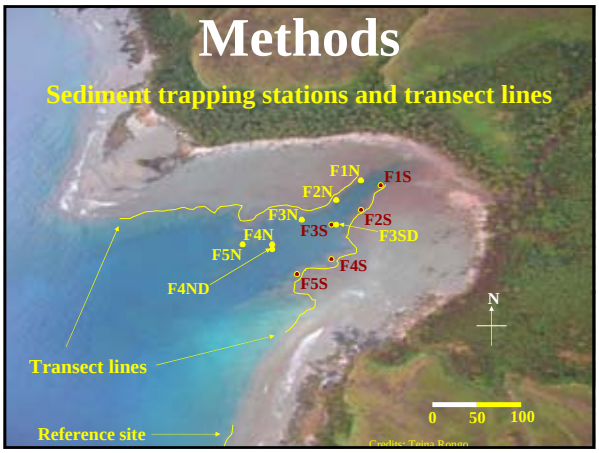

Fouha Bay
Guam
La Fu Sa River
Fouha Bay
Flat
N
0 100 200
meters

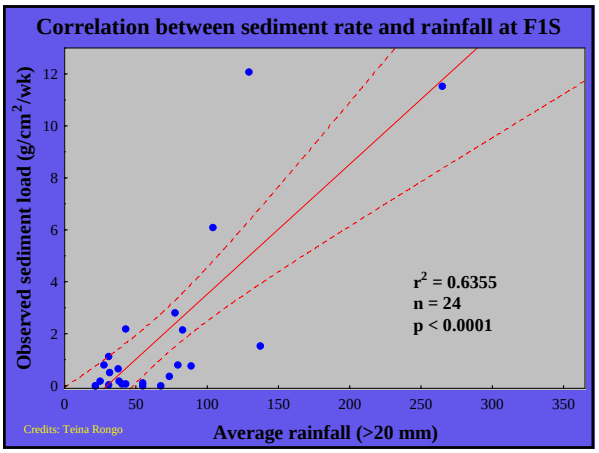
Study Site 1 – Fouha Bay, Guam

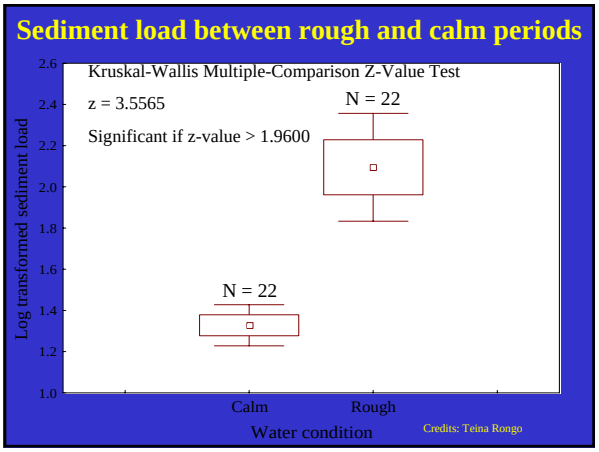

La Sa Fua Watershed
• Watershed size is 5 km²
• Steep and highly erodible lateritic soil
• Sediment discharge
(Scheman, 2002; Wolanski et al., 2003)
– 480 – 1200 t/ km²/year
– Floods 10 times a year
– The bay flushes 2 –5 times a year

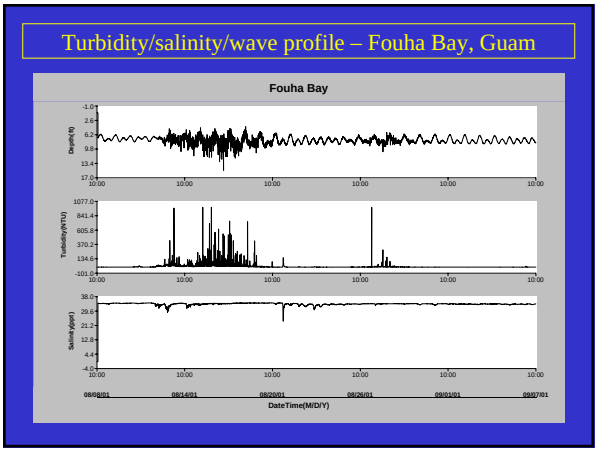

Burning and land clearing are the major causes of soil erosion within the La Sa Fua watershed

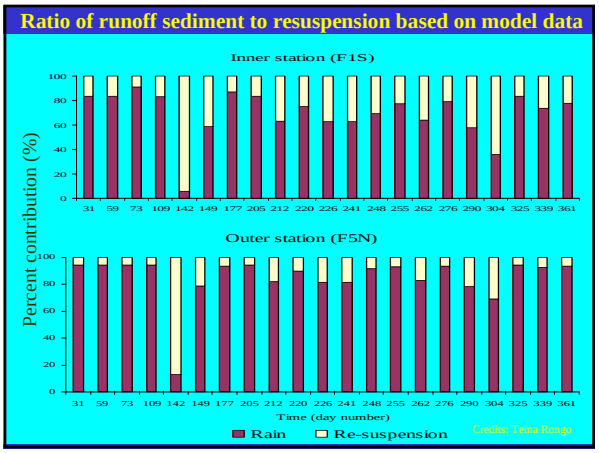

Sediment plume
N
0 50 100
Credits: Teina Rongo

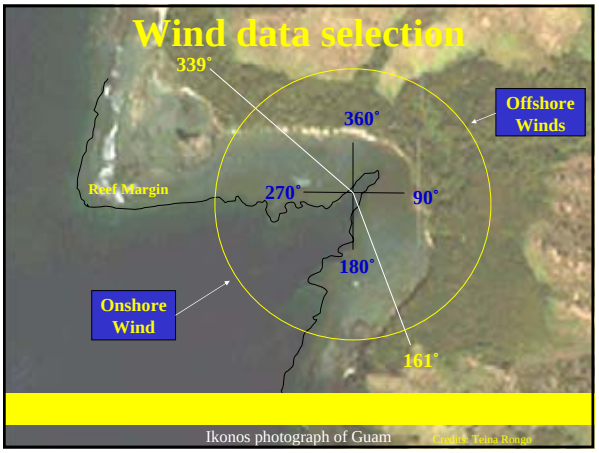

Methods
Sediment trapping stations and transect lines
F1N
F1S
F2N
F2S
F3N
F3S
F3SD
F4N
F5N
F4S
F4ND
F5S
N
Transect lines
Reference site
0 50 100


Correlation between sediment rate and rainfall at F1S
Observed sediment load (g/cm²/wk)
Average rainfall (>20 mm)
r² = 0.6355
n = 24
p < 0.0001
Credits: Teina Rongo


Sediment load between rough and calm periods
Kruskal-Wallis Multiple-Comparison Z-Value Test
z = 3.5565
Significant if z-value > 1.9600
N = 22
N = 22
Log transformed sediment load
Calm
Rough
Water condition
Credits: Teina Rongo


Turbidity/salinity/wave profile – Fouha Bay, Guam
Fouha Bay
DateTime(M/D/Y)


Ratio of runoff sediment to resuspension based on model data
Inner station (F1S)
Outer station (F5N)
Percent contribution (%)
Time (day number)
Rain
Re-suspension
Credits: Teina Rongo


Wind data selection
339˚
360˚
270˚
90˚
180˚
161˚
Offshore Winds
Onshore Wind
Reef Margin
Ikonos photograph of Guam
Credits: Teina Rongo

Stationary model equations

Stationary model (SM):

SM =IF ($R_{obs} > R_{lim}$, kr_1 (R_{obs}) + kw (W_{obs})), IF ($R_{obs} < R_{lim}$, kr_2 (R_{obs}) + kw (W_{obs}))

Stationary + swell (SM + S):

SM+S = IF (SI = 0, SM), IF (SI > 0, k (SM)

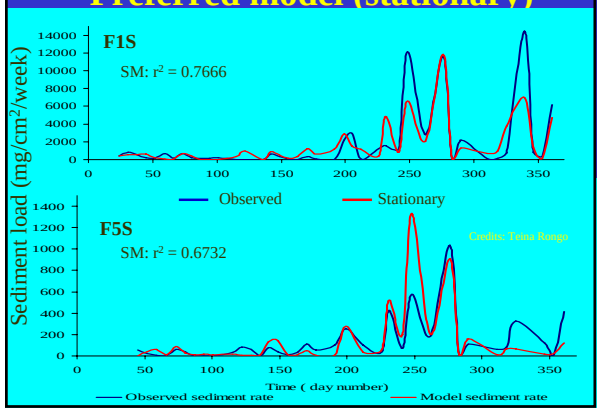
Stationary + swell + strong wind (SM + S + Ws):

SM + S + W_s = IF [$W_{obs} > W_{lim}$, k (SM + S), IF ($W_{obs} < W_{lim}$, SM + S)

SM = stationary model
R_{obs} = observed rainfall
R_{lim} = rainfall with some limit
kr_1 = first rain constant
W_{obs} = observed wind
kr_2 = second rain constant
kw = wind constant
S = swell
SI = swell index
k = constant
W_s = strong wind
W_{lim} = wind with some limit

Credits: Teina Rongo

Preferred model (stationary)



Categories

1. Large encrusting
   - *Montipora* spp.
   - *Galaxea* spp.
   - *Cyphastrea* spp.
   - *Psammacora* spp.
   - *Coscinarea* spp.
   - *Pavona varians*
2. Small encrusting
   - *Stylocoeniella armata*
   - *Porites vaughani*
   - *P. solida*
   - *Acanthastrea echinata*
3. Massive
   - *Porites lutea*
   - *P. Australiensis*
   - *P. Lobata*
4. Sub-massive
   - *Favia* spp.
   - *Favites* spp.
   - *Platigyra* spp.
   - *Goniastrea* spp.
   - *Leptoria phrygia*
   - *Monastrea curta*
5. Large branching
   - *Millepora* spp.
   - *Pavona divaricata*
   - *P. venosa*
   - *Porites rus*
   - *P. annae*
6. Small branching
   - *Acropora* spp.
   - *Pocillopora* spp.
7. *Leptastrea purpurea*

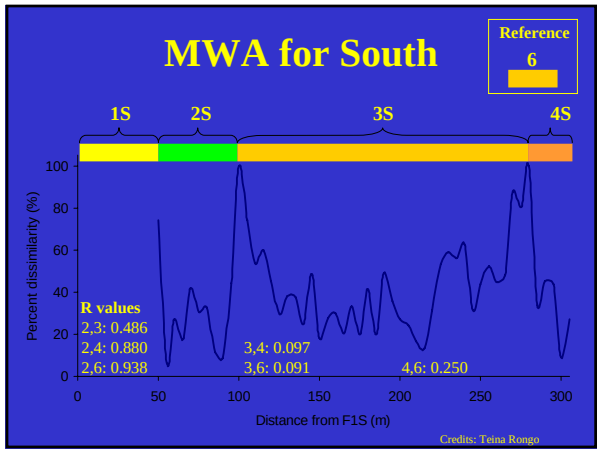
Moving Window Analysis (MWA)

Bray-Curtis dissimilarity distance:

$$D_{jk} = \sum_{i=1}^{p} \frac{|(y_{ij} - y_{ik})|}{(y_{ij} + y_{ik})}$$

Credits: Teina Rongo

MWA for South

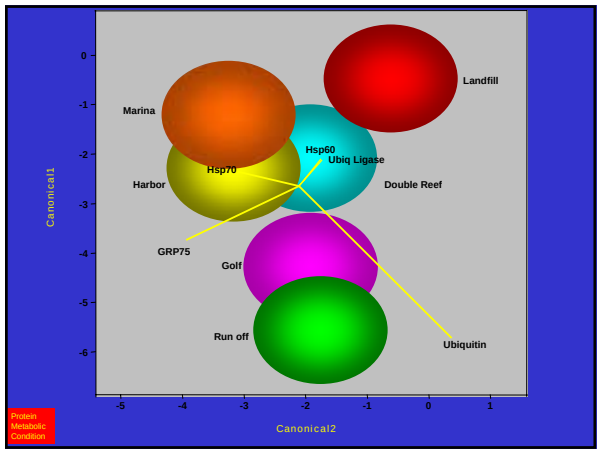


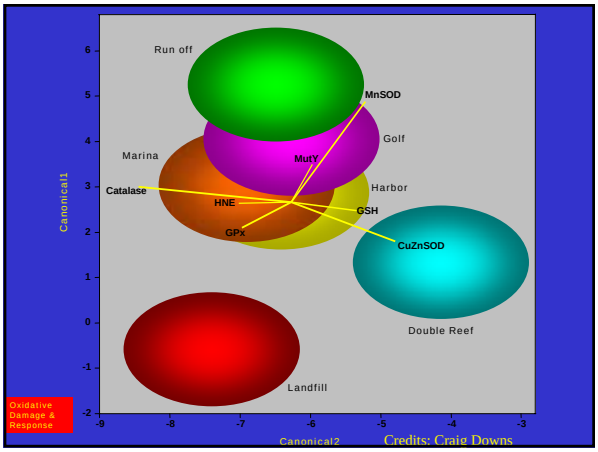
Sediment yield

Wolanski, presentation (2002)

River	Watershed Area (10^6 km^2)	Load (10^6 tonne year^{-1})	Yield (tonne km^{-2} year^{-1})
Yangtze	1.9	480	252
Amazon	6.1	1200	190
Mississippi	3.3	210	120
Ganges/Brahmaputra	1.48	2180	1670
Mekong	0.79	170	215
Fly	0.076	116	1500
Cimanuk	0.0036	15.7	6350
R & B (1978)	**5 X 10^{-6}**	**4.71 X 10^{-6}**	**1**
La Sa Fua (2002)	**5 X 10^{-6}**	**2.4 X 10^{-3}**	**480**
THIS STUDY (2003)	**5 X 10^{-6}**	**5.05 X 10^{-5}**	**20**

Mortality is a Rather Crude Indicator of Stress



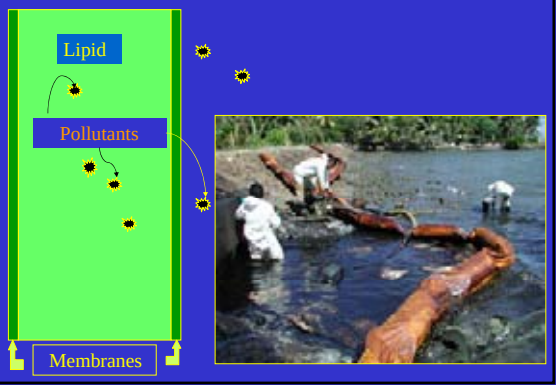


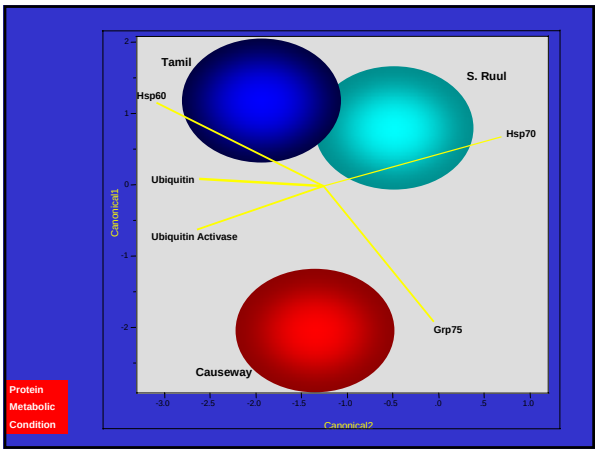
Credits: Craig Downs

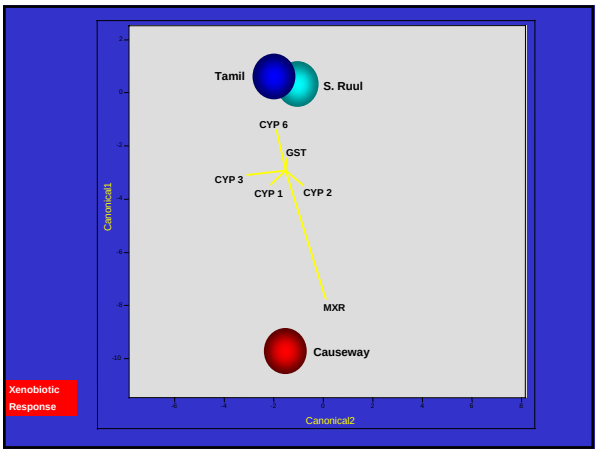
Grounding Incident

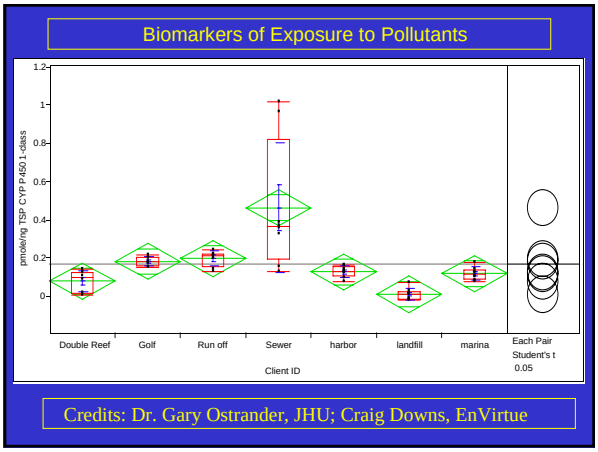
Intermediate Fuel Oil

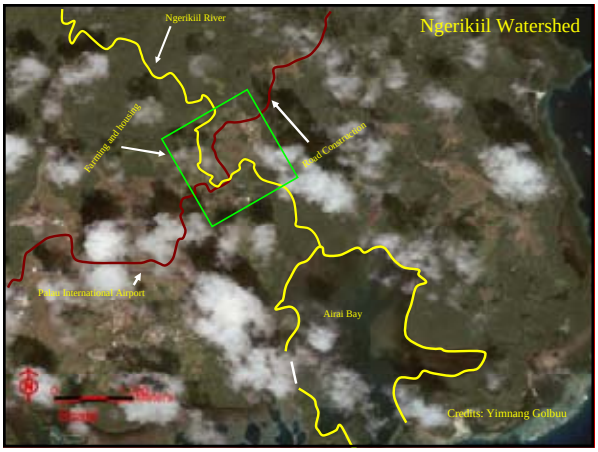
Semi-permeable Membrane Devices (SPMD's)



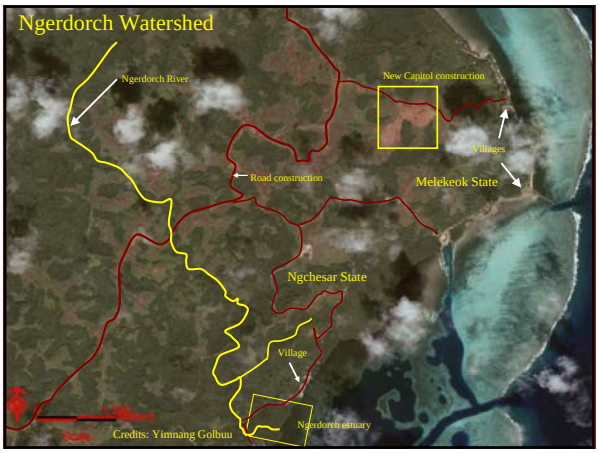

Tamil
S. Ruul
Hsp60
Hsp70
Ubiquitin
Ubiquitin Activase
Grp75
Causeway
Canonical1
Canonical2
Protein
Metabolic
Condition


Tamil
S. Ruul
CYP 6
GST
CYP 3
CYP 1
CYP 2
MXR
Causeway
Canonical1
Canonical2
Xenobiotic
Response


Biomarkers of Exposure to Pollutants
pmole/mg TSP CYP P450 1-class
Double Reef
Golf
Run off
Sewer
harbor
landfill
marina
Each Pair
Student's t
0.05
Client ID
Credits: Dr. Gary Ostrander, JHU; Craig Downs, EnVirtue


Ngerikiil River
Ngerikiil Watershed
Aimeliik Bay
Credits: Yimnang Golbuu

Credits: Yimnang Golbuu



Sediment Summary

	Ngerikiil Land use Change	Ngerdorch Little Change
Catchment Size (km^2)	19	39
Mean estuarine SSC(mg/L)	500	19
Mangrove area/catchment area	3.8%	3.8%
Trapping in mangroves	15-30%	28-44%
Sediment yield ($tons/km^2/year$)	150	1.9
	Y.Golbuu et al., 2003 ECSS 57, 1-9	S.Victor et al. In press (WEM)

Credits: Yimnang Golbuu

Stakeholder Involvement

ACKNOWLEDGEMENTS

Dr. Sandra Romano, Steven Victor, Dr. Eric Wolanski, Yimnang Golbuu, Sarah Leota, Dr. Scheila McKenna, Victor Bonito, Cynthia and Keana Richmond, Gerry Davis, Noah Idechong, Andy Tafileichig, Dr. Chuck Birkeland, Dr. Gary Ostrander, Craig Downs, Dr. Mike Hadfield, Teina Rongo, Aja Reyes, Dr. Vekila Vuki

National Institutes of Health –SCORE Program

NOAA CSCOR/COP/CRES

U.S. Environmental Protection Agency - STAR

National Science Foundation

Dept. of the Interior, OIA

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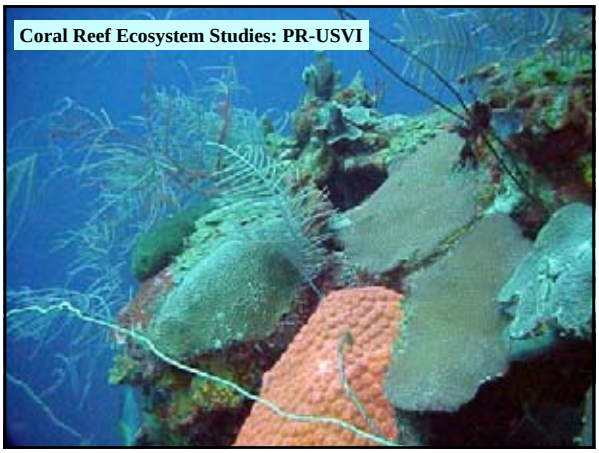
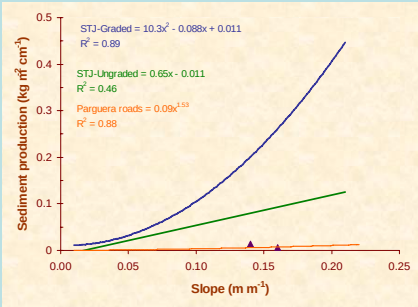
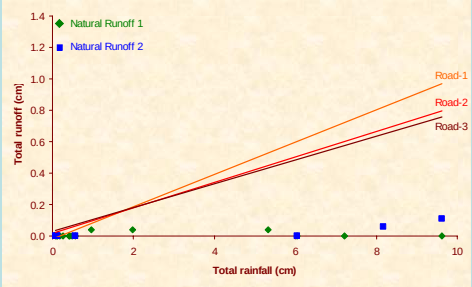


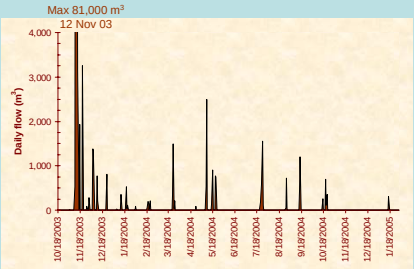
Modeling sediment production from disturbed surfaces



Plot-scale runoff response measurements



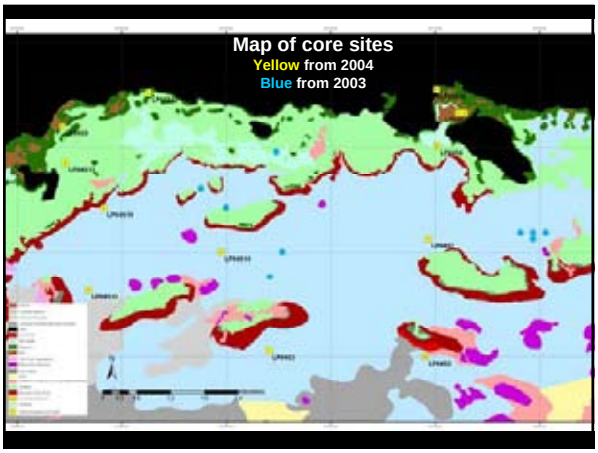
Watershed-scale runoff measurements

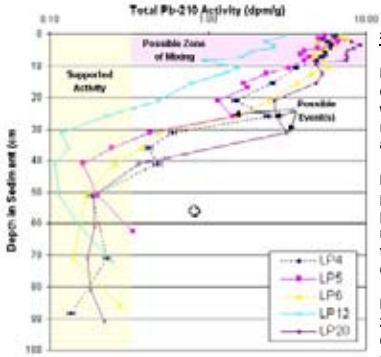


Queb. Poblado
Preliminary data

What's the concern/hypothesis?

Coastal development has led to increased terrestrial sediment accumulation in coral reef areas.



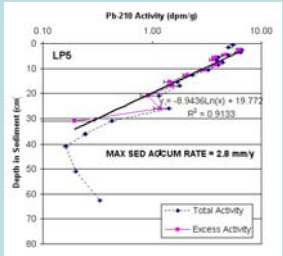


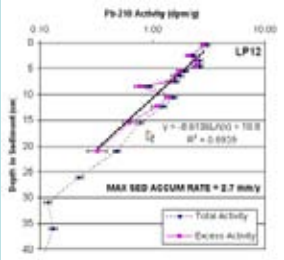
^{210}Pb Data from 2003

Revealed log-linear decreases in activities with depth, probably reflecting steady-state accumulation.

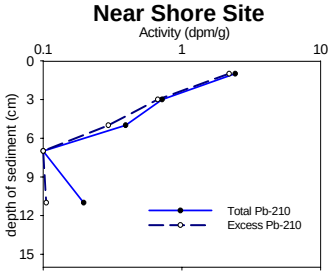
Prominent peaks in activity profile may be related to fine-grain layers deposited by events.

But, cores collected in 2004 sampled a greater diversity of environments.



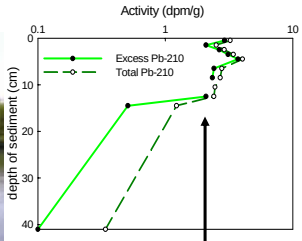


Near Shore Site



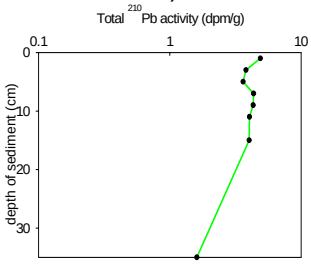
Rapid decrease of ^{210}Pb with depth suggesting a low accumulation rate. Interestingly, this core was adjacent to the mangroves where higher rates of accumulation were anticipated.

Phosphorescent Bay

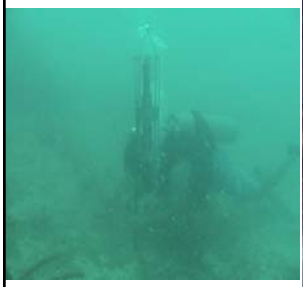


Channel closure at Phosphorescent Bay may have resulted in a change in this notable change in sediment accumulation.

Reef Front, Site 3



Gamma data from Site 3 suggest a steady-state profile may be found. Counting of deeper samples will be conducted.

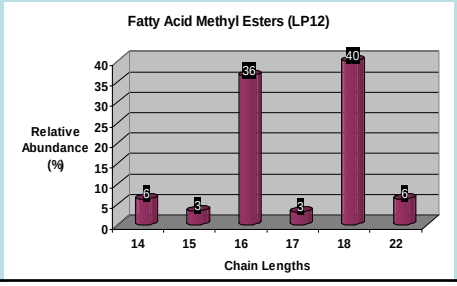


Inshore: Las Pelotas

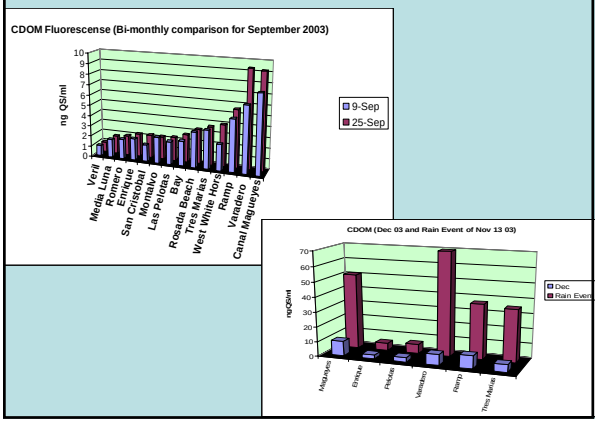
Shelf-edge: Weinberg

Goal: to determine relative quantities of terrestrial/ marine materials in sediments using fatty acid biomarkers.

Terrestrial: $\delta^{13}C$, C_{25}-C_{35} n-alkanes, and C_{23}-C_{34} fatty acids, etc.
Marine: C_{17}-C_{20} n-alkanes, cholesterol, dinosterol, etc.



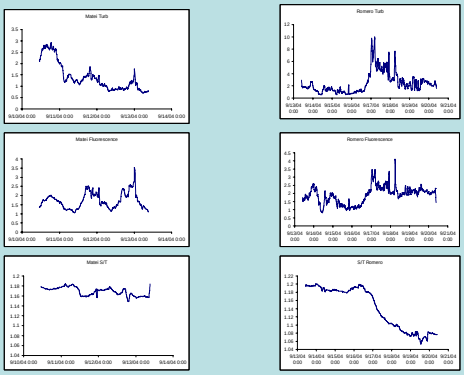
CDOM Concentration as a Tracer of Terrestrial Inputs

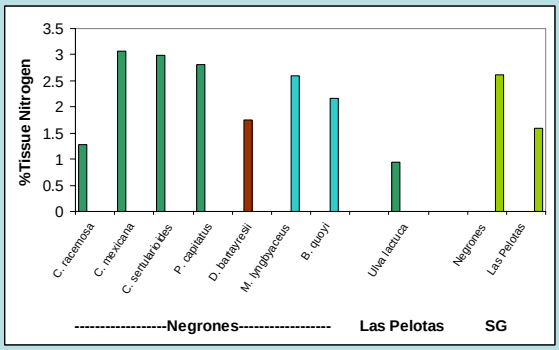


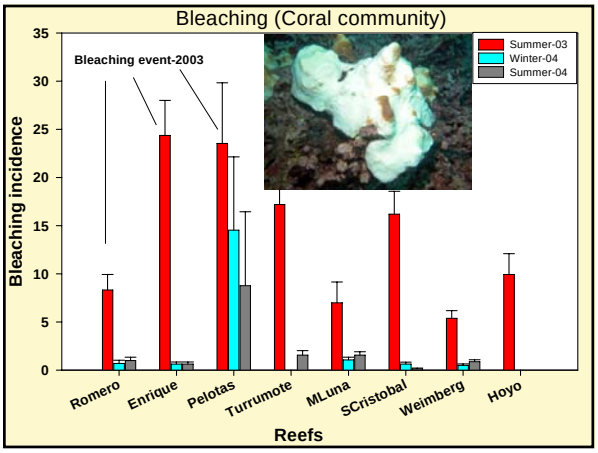
September 2004:Hurricane Trajectories

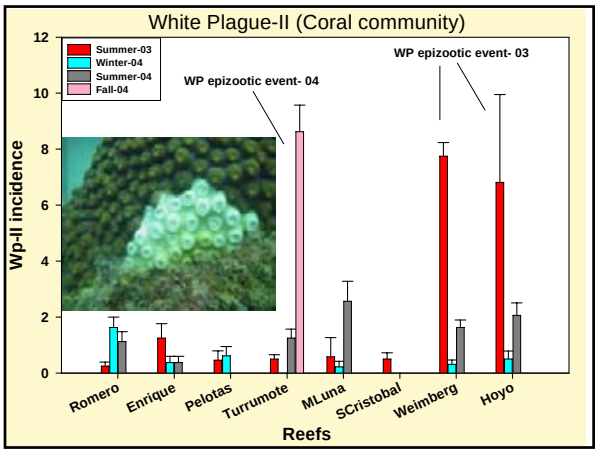
Effects of Ivan

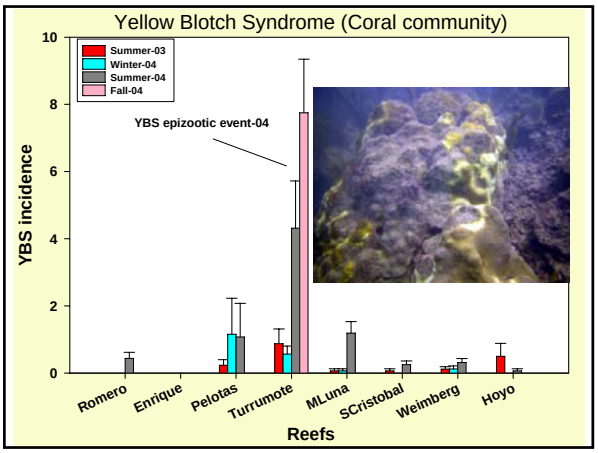
Effects of Jean

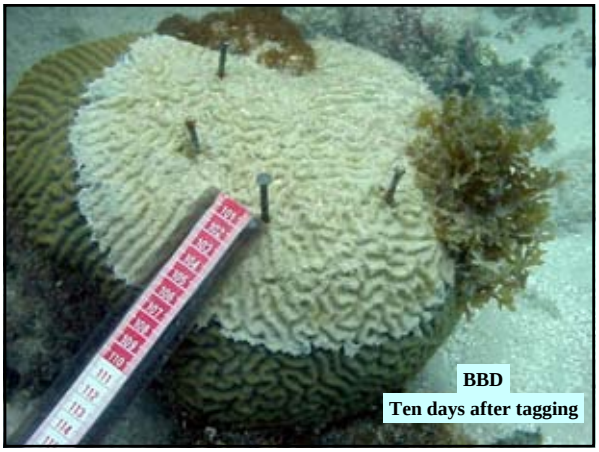






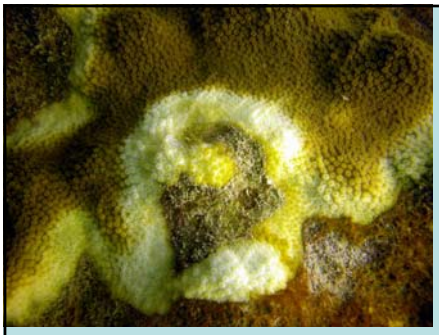






White Band Disease

Isolate from *A. cervicornis* with WBD when reinoculated onto healthy *A. cervicornis* caused WBD. The isolate was identified as *Vibrio carchariae/harveii*



Yellow Blotch Disease

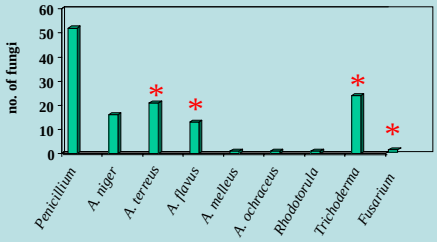
Yellow blotch affected coral colonies were found to have a high concentration of different species of *Vibrio*.

Disease Reservoir ?

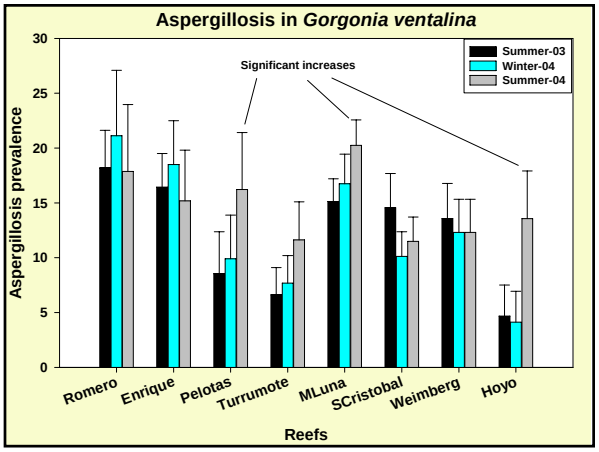
Bacteria from White Plague, *Aurandimonas coralicida,* found in Halemida

Sea fans were assayed for the normal microbiota associated with healthy, diseased and healthy areas of diseased colonies. Metabolic profiles and amount of fungi were significantly different among the different sources

Fungal community



* Confirmed by sequencing

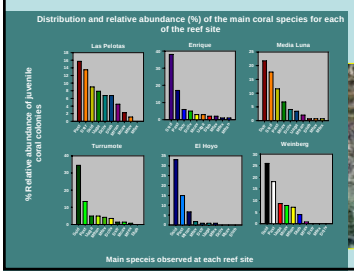


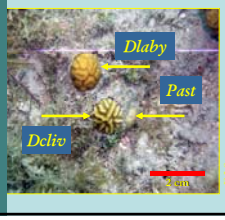
Recruitment

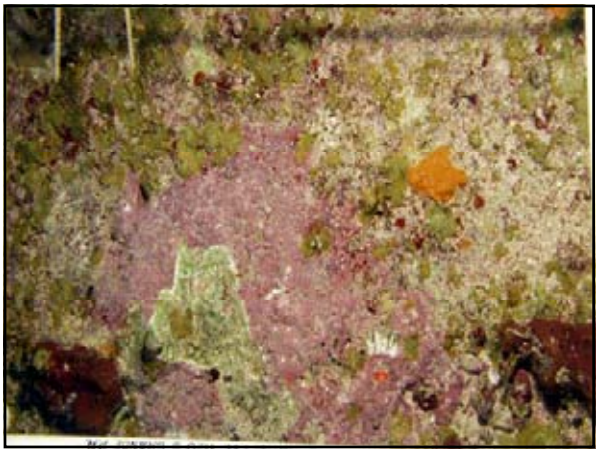
Density of juveniles highest for shallow & intermediate depths

Between 23 to 31 species of juvenile corals were present across reefs zones. Highest for the mid-shelf zone.

Most common: *S. siderea*, *P. astreoides* , *D. clivosa*, *D. strigosa*, *M. cavernosa*.

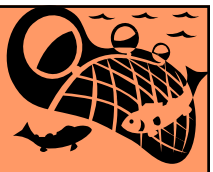






New Species of Algae

Interview Activity



West Coast
- Three interview schedules: species and ecology, habitats, and life history of species
- Two sets of interviews
- 50 Fishermen

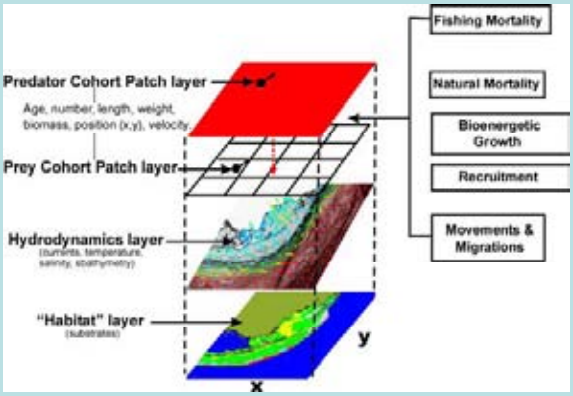
South Coast
- 100 In-depth interviews on species
- In-depth interviews on landscape
- Success and knowledge
- Ethnographic observations of the fishing activities in the region.

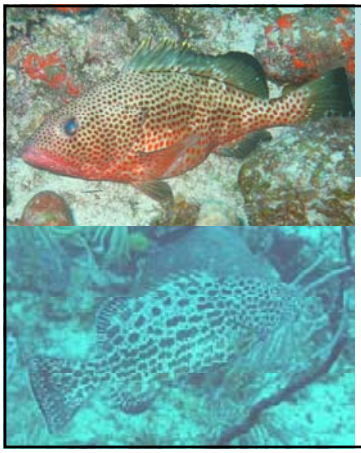
Qualitative and quantitative data

- Information on species (behavior and stocks)
- Description of the food chain (similar to social networks)
- Description of habitats
- Key issues affecting the fisheries
- Complex construction of themes and topics
- Software for social and cultural analysis

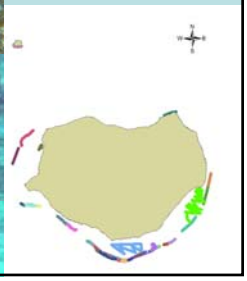
- A theme that emerges very strongly is that a discourse of **Coastal Ecological Memory as Social Resistance** has developed.
- Fishers and other coastal residents see themselves as the stewards of the coastal environment, keeping track of more powerful stakeholders' polluting activities around coastal areas.
- This collective ecological memory resulting from decades of watchfulness is an environmental history of sorts, and informs resistance against unilateral intervention by state regulatory agencies.

GeoSpatial Model of Biophysical Dynamics

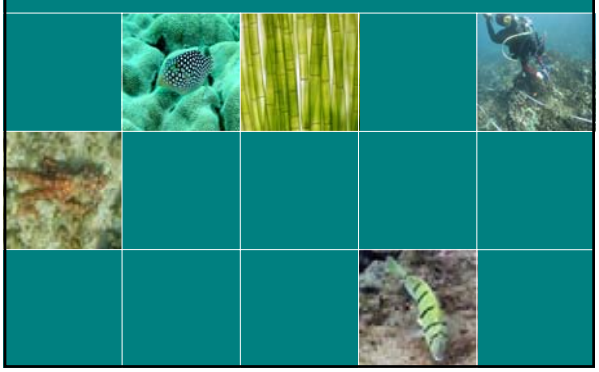




Spawning Aggregations
At Mona Island
Yellowtail Parrotfish
Redhind
Yellowfin Grouper
Tiger Grouper
Blue Tang ?



Hawaii Coral Reef Initiative
Research Program



Past Projects

Please visit our website for a full list of past projects, reports, and results.

www.hcri.hawaii.edu

FY04 Projects

Non-economic value of Hawaii's coral reefs.

PI: B. Ankersmit

Most popular activities for Hawaii's households

N = 1600

- Wading or walking on beach (68%)
- Ocean swimming (66%)
- Picnicking, sunbathing, beach sports (64%)
- Playing in the ocean (58%)
- Snorkeling (32%)
- Surfing (29%)
- Pole-line fishing for recreation (26%)

Alien and Invasive Species

1. Assessment of Orange keyhole sponge in Kaneohe Bay (PI: S. Coles)
2. Reproduction & development of *Carijoa* (PI: R. Toonen)
3. Impacts of alien algae on native seagrasses (PI: C. Smith)
4. Disease in coral and reef fish on Maui (PI: T. Work & G. Aeby)
5. How many fish does it take to keep out alien algae? (PI: C. Birkeland)

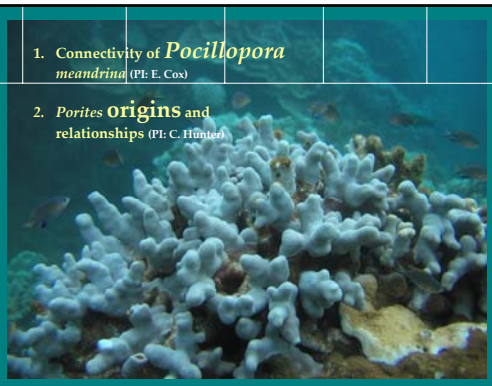
Integrated monitoring of coral reefs (PI: I. Williams)

Status of Coastal Reefs surrounding the main Hawaiian Islands

"Gaming" the main Hawaiian Islands' Coastal Reefs

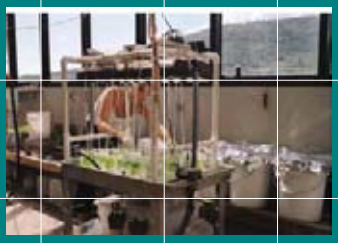
ReefRanger (PI: J. McManus)

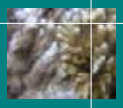
1. Connectivity of *Pocillopora meandrina* (PI: E. Cox)
2. *Porites* **origins** and relationships (PI: C. Hunter)



Population Dynamics of Coastal Reefs surrounding the main Hawaiian Islands

FY2005 Priorities





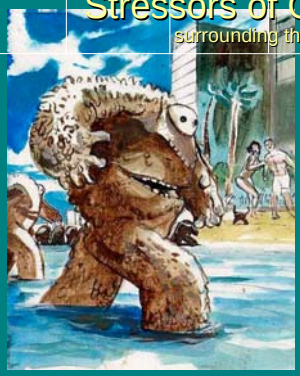
Non-economic value of the main Hawaiian Islands' coastal reefs.

Build upon the 2004-2005 statewide random sample household survey and focus groups.

How do Hawaii's reefs enhance our quality of life?

Stressors of Coastal Reefs

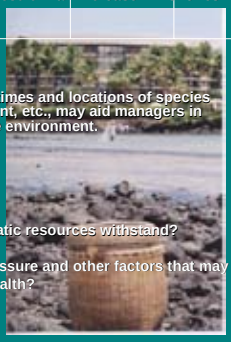
surrounding the main Hawaiian Islands



- Understand the effects of invasive marine plants and animals on native species and reef ecosystems
- Develop methods for preventing the introduction and spread of new invasive marine species, through hull fouling and other means.
- Recommend management activities to avoid or minimize impacts.

Alien Species

- Can no-take marine protected areas alone, assist in restoring reef fisheries?
- Can the minimal use of certain gear types result in an increase in fisheries?



- A reference that combines information on times and locations of species spawning, or critical locations of recruitment, etc., may aid managers in assessing the impact of uses in our marine environment.
- How much fishing effort can Hawaii's aquatic resources withstand?
- Is there a relationship between fishing pressure and other factors that may influence overall resource populations' health?

Fishing Pressure

Pollution

Examine how pollution affects Hawaii's nearshore reefs. Make practical management recommendations to prevent marine pollution that negatively impacts coastal reef ecosystems. Selected projects would recommend management activities to avoid, minimize and mitigate negative impacts

Disease

What is the prevalence and incidence of disease?

Can disease be readily classified and illustrated?

What are the linkages between anthropogenic stressors and disease?

Is there variation in susceptibility to disease?

Coastal Development

Discuss how the identified ecological functions may be vulnerable to anthropogenic influences

Identify, describe and spatially illustrate coral reef ecological functions throughout the Main Hawaiian Islands

Make recommendations for management solutions

Nearshore Recreation

Fishing

Snorkeling

Surfing

Kayaking

Scuba Diving

Swimming

Evaluate the value of nearshore recreation. Quantify its impacts. Recommend ways to improve marine recreation management so that these activities will not degrade Hawaii's marine ecosystems.

What is a useable model, approach, or system that could indicate to managers when there is too much impact for an areas?

Is there a practical method to determine the levels of use and the impacts from that use?

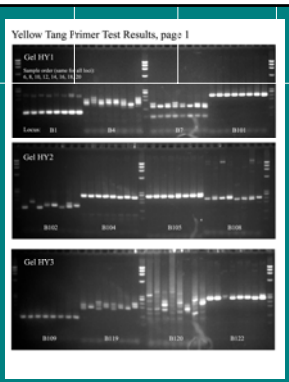
What recommendations can be given to resource managers?

- Resource assessments and monitoring are crucial to understanding the health of coral reef ecosystems. HCRI-RP is soliciting proposals for question-driven monitoring and assessment of Hawaii's coral reef ecosystems.
- Any sites proposed for monitoring under this program should be selected based on a strategy to distinguish the effects of natural variability versus anthropogenic impacts. Impacts induced by global climate change are not a priority unless they can be related directly to local management decisions.

Status of Coastal Reefs surrounding the main Hawaiian Islands

"Gaming" the main Hawaiian Islands' Coastal Reefs

(1) become familiar with coral reef ecology;
(2) gain insight into the life history of certain keystone marine organisms and better understand the specific roles they play and contributions they make towards maintaining equilibrium on a coral reef;
(3) better understand the relationships between various trophic levels on a coral reef; and
(4) manipulate variables (natural and anthropogenic) that would alter the health of a coral reef ecosystem



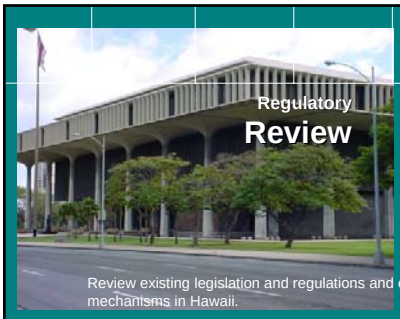
What are important coral reef keystone organisms around the main Hawaiian Islands and how do they contribute to the health of coral reef ecosystems?

Are the populations of these organisms genetically distinct or a single population? What links exist between the life histories, reproductive patterns and genetic structures for these population(s)?

What are the coastal current patterns within the Hawaiian Archipelago, and how do these affect recruitment patterns of fishes and invertebrates?

What are the effects of invasive algae on recruitment of corals and other benthic invertebrates?

Population Dynamics of Coastal Reefs surrounding the main Hawaiian Islands



Regulatory Review

Review existing legislation and regulations and enforcement mechanisms in Hawaii.

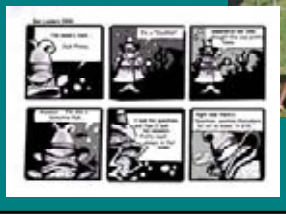
Collect and review relevant practices in other appropriate jurisdictions.

Compile relevant scientific data.

Provide options for revisions, amendments or replacement of existing regulations and enforcement mechanisms.

Produce technical documents and videos.

Participate in public outreach and education activities

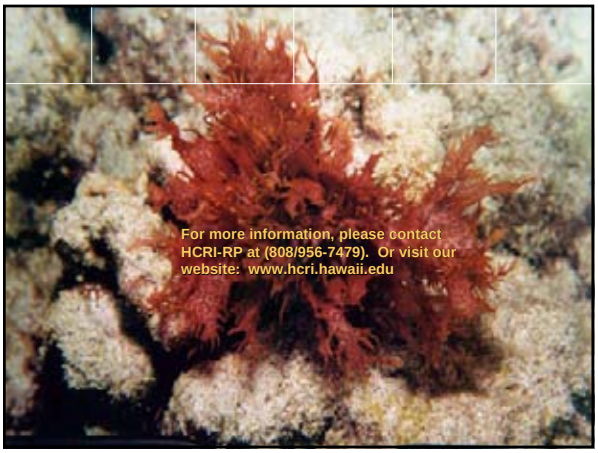


Key Dates

February 10, 2005: Optional Letters of Intent DUE, preferably electronically (hcri_rp@hawaii.edu) by 4:00 p.m. HST. **Please ensure that you have no viruses!** The file name must include the last name of the principal investigator.

February 28, 2005: Responses by the HCRI management committee to the letters of intent will be sent out.

March 28, 2005: Proposals DUE, in electronic form **and** 12 hard copies by 4:00 p.m. HST.



For more information, please contact HCRI-RP at (808/956-7479). Or visit our website: www.hcri.hawaii.edu

CARIBBEAN
CORAL REEF
INSTITUTE

Caribbean
Coral Reef

Institute

Co-operative Program:

University of Puerto Rico – Mayagüez

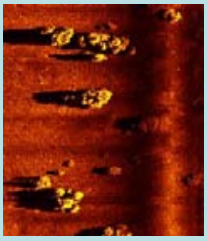
NOAA, Center for Sponsored Coastal Ocean Research

Research Needs

Development of New Techniques & Approaches

Basic & Applied Science

Management



Monitoring & Management Assessment

Caribbean
Coral Reef

Institute

CCRI as an Approach to Research

- Modeled after Hawaiian Coral Reef Initiative
- Develop, implement, and administer research and monitoring activities
- Interact with government agencies, public and private organizations
- Utilize fully the resource base of the region to collaborate and conduct research

Caribbean
Coral Reef

Institute

Structure of CCRI

- Permanent Staff
  - Executive Director
  - Program Manager
  - Assistant Manager
- Management Committee
- Technical Advisory Committee

Caribbean
Coral Reef

Institute

Management Committee

- Establish priorities for research and associated activities.
- Issue requests for competitive, peer-reviewed proposals.
- Approve projects for inclusion in the Institute.
- Review research and monitoring results

Caribbean Coral Reef

Institute

Current Research

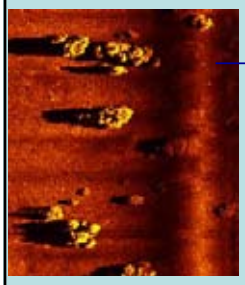
Funded through 2 grants
10 Projects
3 Areas
- Basic Resources Assessment
- MPA Design
- Reef Processes

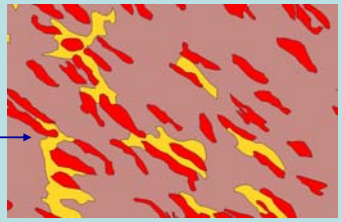
Resources Assessment

Coral Reef Monitoring

Resources Assessment

Habitat Mapping

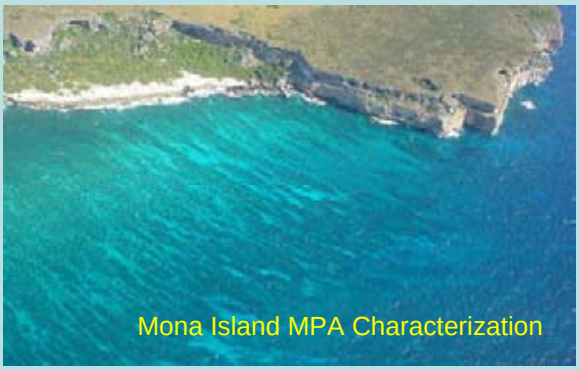




Resources Assessment

Ornamental Fisheries Phase II:

MPA Design



Mona Island MPA Characterization

MPA Design

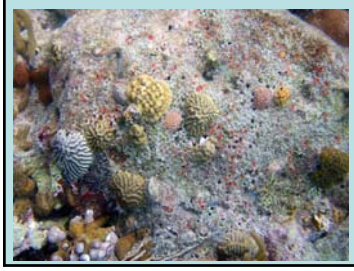
New Strategies for MPA Development: Re-visiting Turrumote

MPA Design

Spawning Aggregations

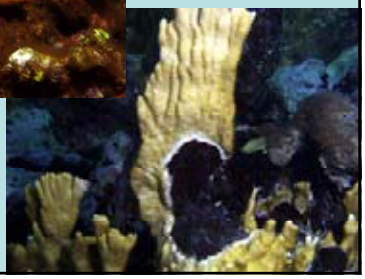
Reef Processes

Coral Recruitment



Reef Processes

Algal Overgrowth



Reef Processes

Genetic Variability in *Acropora*

Infrastructure Improvement

CREWS Station Enhancement

Pulse Amplitude Modulated (PAM) Fluorometer

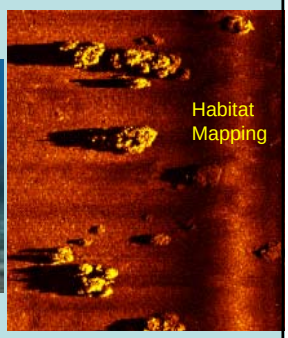
Biospherical light sensors (three bands of UV plus PAR)

CTD

CCRI Phase II

- 3 Year Program
- First year:

Coral Reef Monitoring



Habitat Mapping

CCRI Phase II

First year:

Cross-shelf Sedimentation Patterns and Processes

Based on CRES Samples

Extent of terriginous transport
Integrate with CRES studies

Methods:
- Grain size
- Carbon
- Mineralogogy/Trace metals

Years 2 and 3: RFP Process

In conjunction with CMRC

Over 70 experts polled:
- NGO's (6)
- Academia + UPR SGCP & WRRI
- Local Agencies - DNER, EQB, Planning Board
- Federal Agencies – EPA, USGS, FWS, NMFS, CFMC

First Quarterly Meeting

5 Focal Areas

Caribbean Coral Reef Institute

Years 2 and 3: RFP Process

Focal Areas

- Basic assessment of resources
- Understanding reef processes
- Research to enhance the MPA process
- Water quality and coral reef health
- Dynamics of coral diseases and syndromes

Caribbean Coral Reef Institute

Outreach

Goal: Communicate Results to Managers, Stakeholders, Scientists

- DNER as Co-Chair ⇒ CR Advisory Comm.
- Open & Announced "Quarterly" Meetings
- Research Applications in Final Reports
- Brochures on Research Results
- CCRI Web Site
- Links to Other Forums

Overview Presentation
NCRI Projects
FY 2004, 2005, & 2006

Drs. Richard Dodge & Bernhard Riegl

Center for Sponsored Coastal Ocean Research

3rd Coral Reef Projects PI Meeting
March 22-24, 2004; Dania Beach, Fla

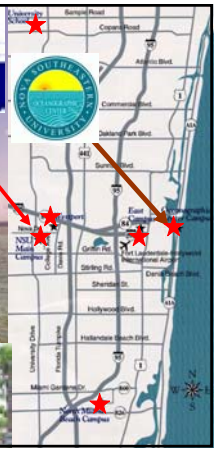
NCRI
NATIONAL CORAL REEF INSTITUTE

Nova Southeastern University

We go the distance...

Nova Southeastern University

- 8th Largest Independent University in Nation
- Over 22,000 enrollment
- Largest in Southeast US.
- 15 Divisions
- >$220 million budget.
- 232 acres Main Campus
- Distance Ed
- New Library



Overview: NSU Oceanographic Center

- 10 acres, Ft. Lauderdale
- Port Everglades entrance channel
- access to oceans & reefs
- Broad Phys. and Biol. Oceanography
- Full-time faculty & staff~31
- MS, Ph.D. programs

Port Everglades Intracoastal to Atlantic

The Mission of the Oceanographic Center is to carry out innovative, basic, and applied research and to provide high-quality, graduate and undergraduate education in a broad range of marine-science.

Overview: NSU Oceanographic Center

- **Academics:** **BS**: Biology, Marine Biology, Environmental Science/Studies (with FCAS); **MS**: Coastal Zone Management; Marine Biology; Marine Environmental Sciences; Physical Oceanography; **Ph.D.**:Oceanograph
- **Research:**
  - Physical Oceanography
  - Marine BioGeological Oceanography
  - Coral Reefs: Ecology/Monitoring/Assessment
  - Fish, Deep Sea, Micro, Molecular, Ballast
- **Internal Institutes:** NCRI, GHRI, Coastal Studies

NCRI GHRI CORE SFOMC

Collaborative History: e.g.,

NOVA SOUTHEASTERN UNIVERSITY

Oceanographic Center, Ft. Lauderdale, FL, announces the formation of

NCRI
NATIONAL CORAL REEF INSTITUTE

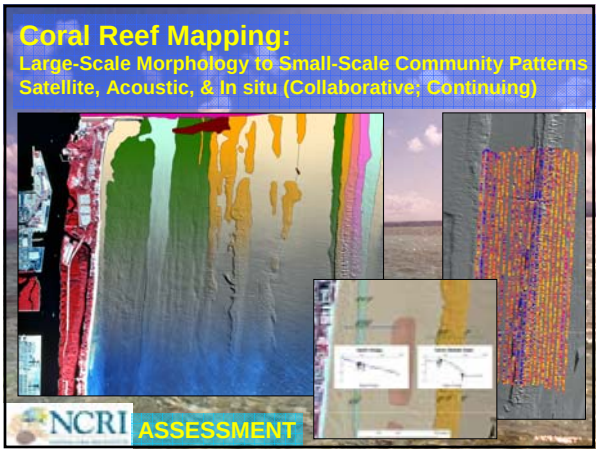
NCRI: National Coral Reef Institute:
A Center for Coral Reef Assessment, Monitoring, and Restoration

NCRI
NATIONAL CORAL REEF INSTITUTE
Is helping to meet the goals & objectives of the USCRTF and to implement the NAP
Background: Congressional Support "for the Establishment of a National Coral Reef Institute to Conduct Research on Coral Reef Assessment, Mitigation, Monitoring, and Restoration."
Rationale: ID Gaps & Constraints in Reef Knowledge, Active Research & Funding; Hypothesis-Based Science Into Emerging Coral Reef Disciplines, Including Reef Restoration.

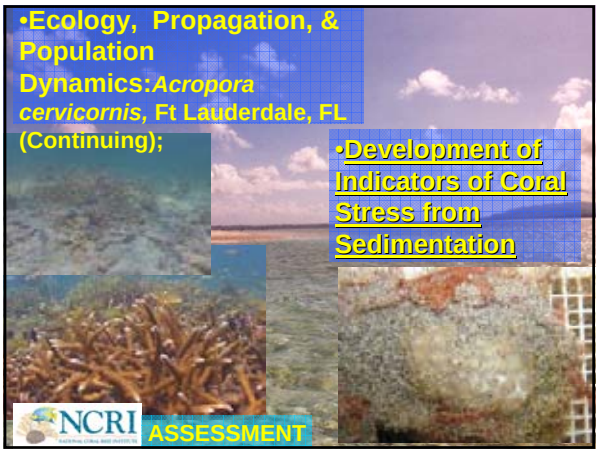
International Conference Results
Bulletin of
MARINE SCIENCE
Summary: coral reef research & management
51 papers, 768 pp, 2001 pub.
➢Assessment
➢Biodiversity and Community Dynamics
➢Impacts and Stressors
➢Monitoring
➢Restoration
➢foldout comparison of 18 monitoring programs
NCRI
NATIONAL CORAL REEF INSTITUTE

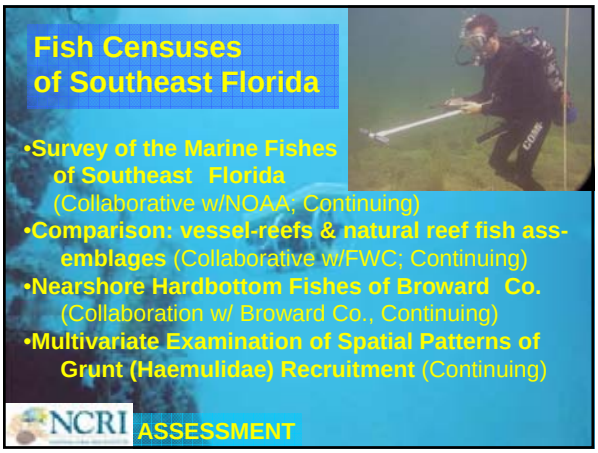
11th International Coral Reef Symposium
REEFS FOR THE FUTURE
Ft. Lauderdale, Florida 2008
Coordinated by:
Local Organizing Committee
Endorsed by:
Host Country Endorsement Committee
A U.S. partnership of:
The U.S. Coral Reef Task Force
The State of Florida

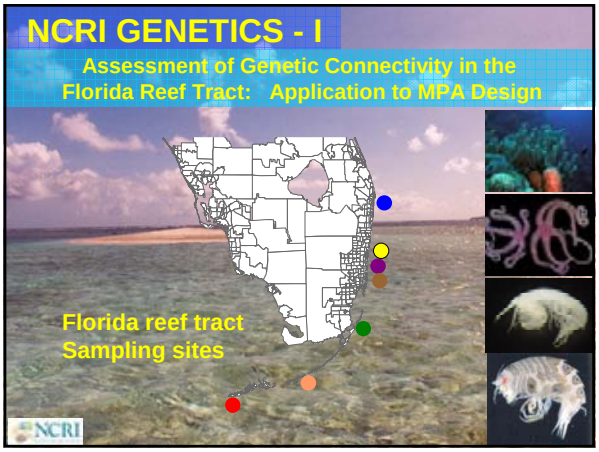
NCRI
NATIONAL CORAL REEF INSTITUTE
Initiatives:
• Conducting Active Research
–Assessment
–Monitoring
–Restoration
• Providing Funding & Program Support
• Establishing Partnerships & Collaborations

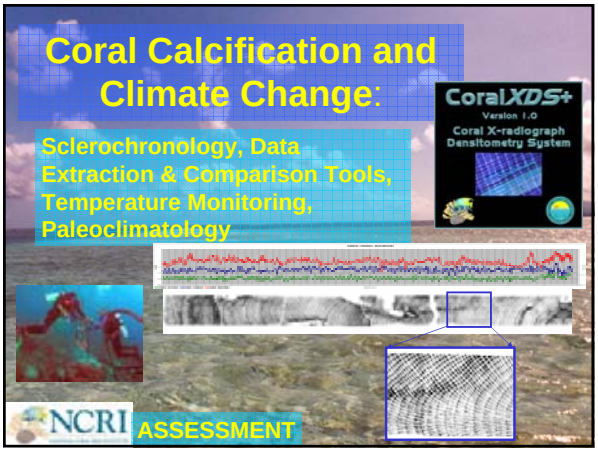

Coral Reef Mapping:
Large-Scale Morphology to Small-Scale Community Patterns
Satellite, Acoustic, & In situ (Collaborative; Continuing)
NCRI
ASSESSMENT

Fly Thru of Southeast Florida Reefs via Laser Bathymetry
NCRI


•Ecology, Propagation, & Population Dynamics: *Acropora cervicornis*, Ft Lauderdale, FL (Continuing);
•Development of Indicators of Coral Stress from Sedimentation
NCRI
ASSESSMENT

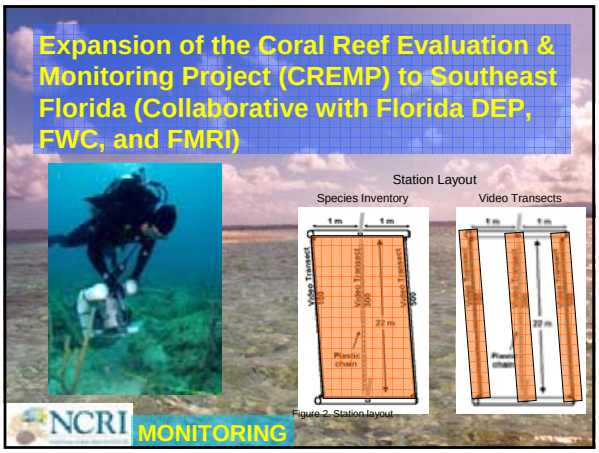

Fish Censuses of Southeast Florida
•Survey of the Marine Fishes of Southeast Florida (Collaborative w/NOAA; Continuing)
•Comparison: vessel-reefs & natural reef fish ass-emblages (Collaborative w/FWC; Continuing)
•Nearshore Hardbottom Fishes of Broward Co. (Collaboration w/ Broward Co., Continuing)
•Multivariate Examination of Spatial Patterns of Grunt (Haemulidae) Recruitment (Continuing)
NCRI
ASSESSMENT

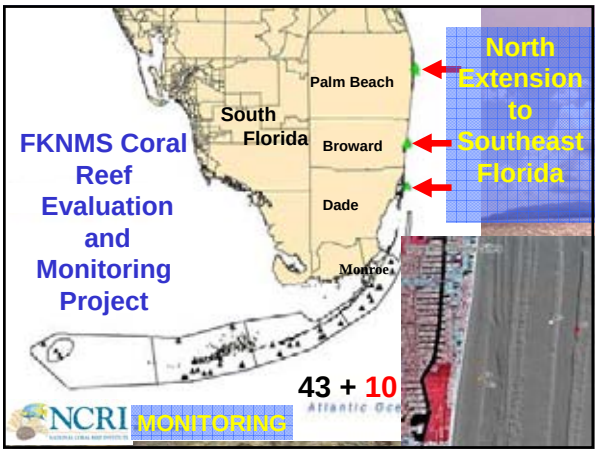

NCRI GENETICS - I
Assessment of Genetic Connectivity in the Florida Reef Tract: Application to MPA Design
Florida reef tract Sampling sites
NCRI

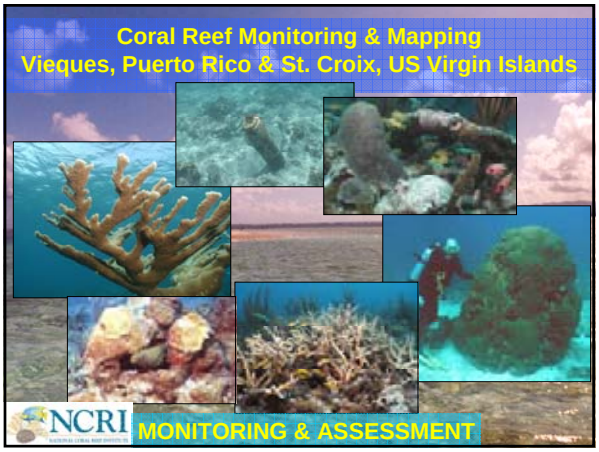

Coral Calcification and Climate Change:
CoralXDS+
Version 1.0
Coral X-radiograph Densitometry System
Sclerochronology, Data Extraction & Comparison Tools, Temperature Monitoring, Paleoclimatology
NCRI
ASSESSMENT

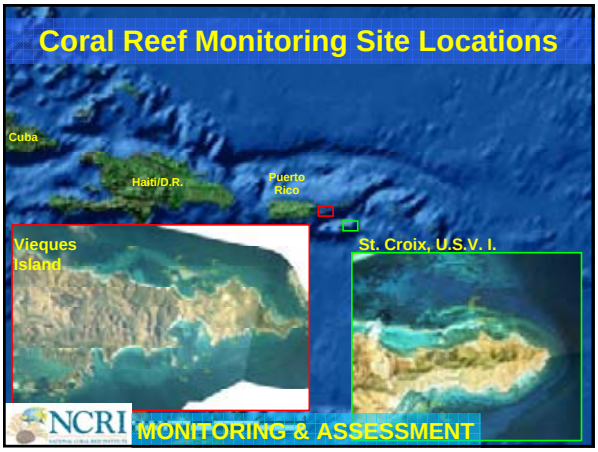
Restoration Design and Monitoring (Collaborative with Broward Co; Cont.)
Restoring a damaged reef
Arranging the new reef
Reef balls
Reef to be revitalized
Increasing Fish Assemblage Richness & Abundance on Concrete Artificial Reefs with a Novel Invertebrate Recruiting Substrate. (New)
NCRI
RESTORATION

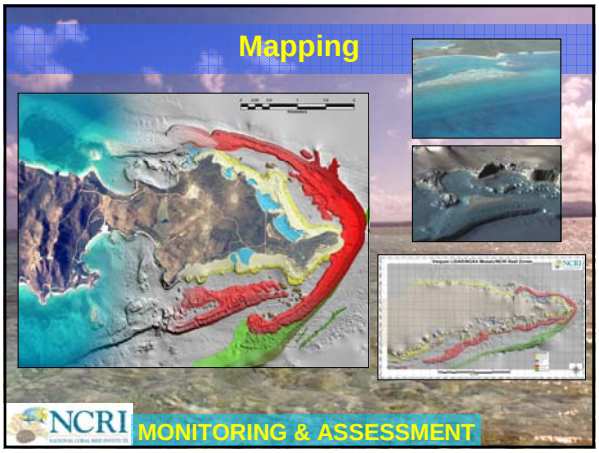
Establishment and Maintenance of a Coral Nursery (Collaborative w/ Broward Co. DPEP & NFWF; Continuing w/BC DPEP)
Comparison of Fish at Selected Artificial Reefs and Natural Substrate in Southeast Florida (Collaborative with Broward Co. DPEP; Continuing)
NCRI
RESTORATION

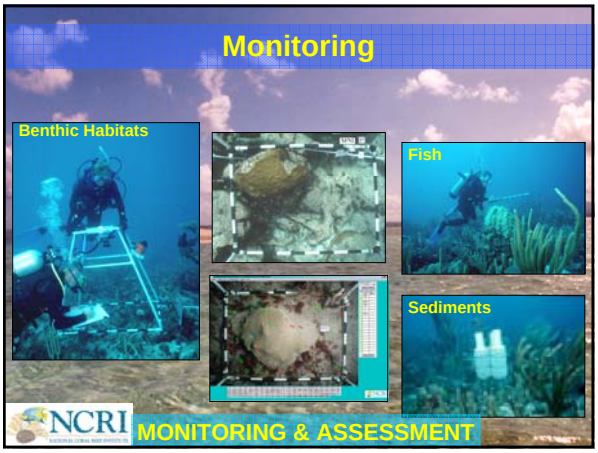

Expansion of the Coral Reef Evaluation & Monitoring Project (CREMP) to Southeast Florida (Collaborative with Florida DEP, FWC, and FMRI)
Station Layout
Species Inventory
Video Transects
Figure 2. Station layout
NCRI
MONITORING

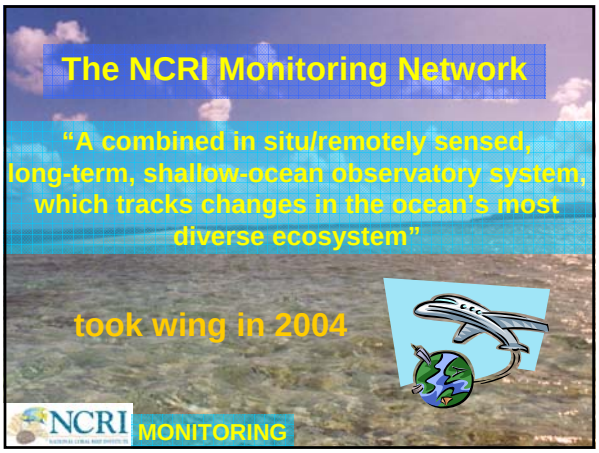

FKNMS Coral Reef Evaluation and Monitoring Project
Palm Beach
South Florida
Broward
Dade
Monroe
North Extension to Southeast Florida
43 + 10
NCRI
MONITORING

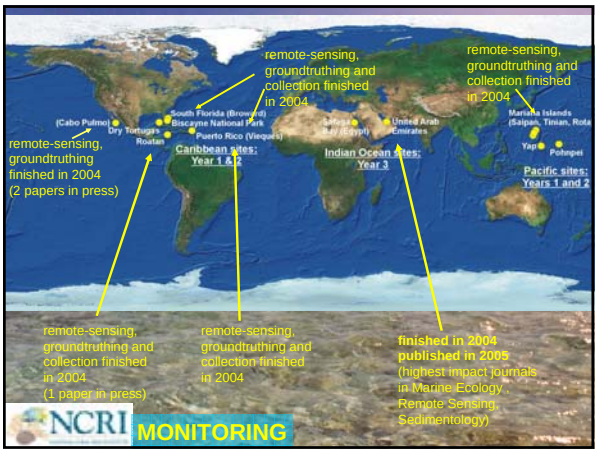

Coral Reef Monitoring & Mapping
Vieques, Puerto Rico & St. Croix, US Virgin Islands
NCRI
MONITORING & ASSESSMENT

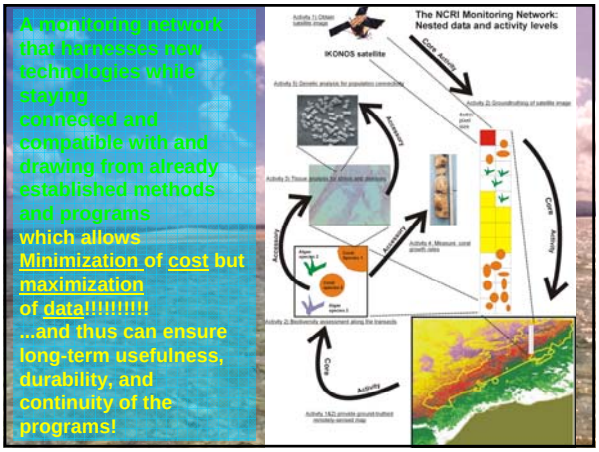

Coral Reef Monitoring Site Locations
Cuba
Haiti/D.R.
Puerto Rico
Vieques Island
St. Croix, U.S.V. I.
NCRI
MONITORING & ASSESSMENT

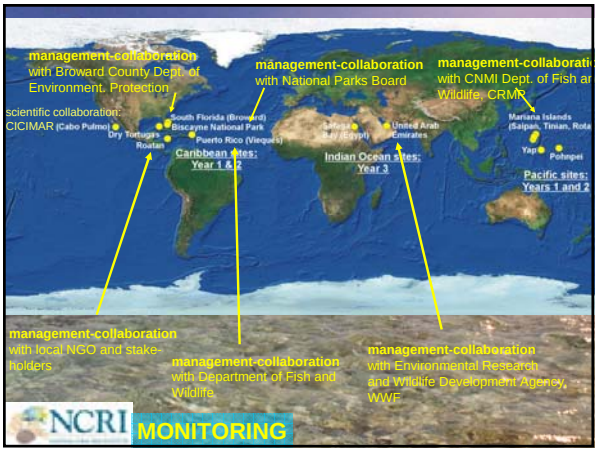

Mapping
NCRI
MONITORING & ASSESSMENT

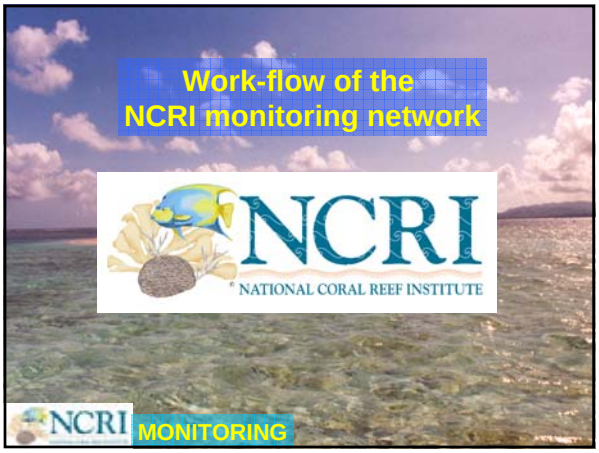

Monitoring
Benthic Habitats
Fish
Sediments
NCRI
MONITORING & ASSESSMENT

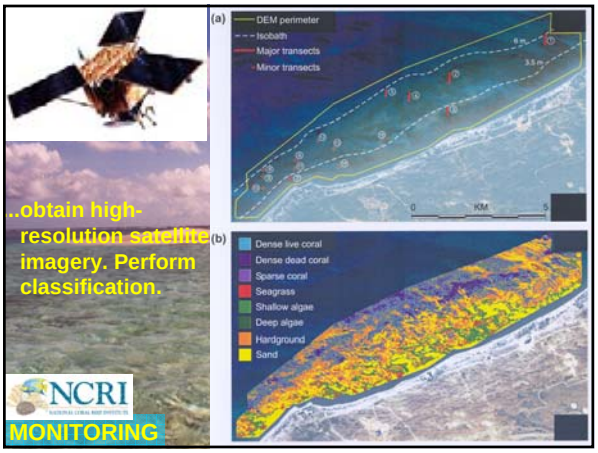

The NCRI Monitoring Network
"A combined in situ/remotely sensed, long-term, shallow-ocean observatory system, which tracks changes in the ocean's most diverse ecosystem"
took wing in 2004
NCRI
MONITORING

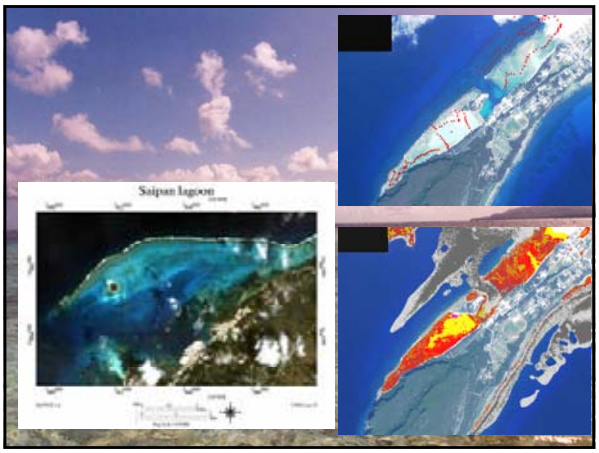

remote-sensing, groundtruthing and collection finished in 2004
remote-sensing, groundtruthing and collection finished in 2004
remote-sensing, groundtruthing finished in 2004 (2 papers in press)
(Cabo Pulmo)
Dry Tortugas
Roatan
South Florida (Broward)
Biscayne National Park
Puerto Rico (Vieques)
Caribbean sites: Year 1 & 2
Sharm el Sheikh (Egypt)
United Arab Emirates
Indian Ocean sites: Year 3
Mariana Islands (Saipan, Tinian, Rota)
Yap
Pohnpei
Pacific sites: Years 1 and 2
remote-sensing, groundtruthing and collection finished in 2004 (1 paper in press)
remote-sensing, groundtruthing and collection finished in 2004
finished in 2004 published in 2005 (highest impact journals in Marine Ecology, Remote Sensing, Sedimentology)
NCRI
MONITORING

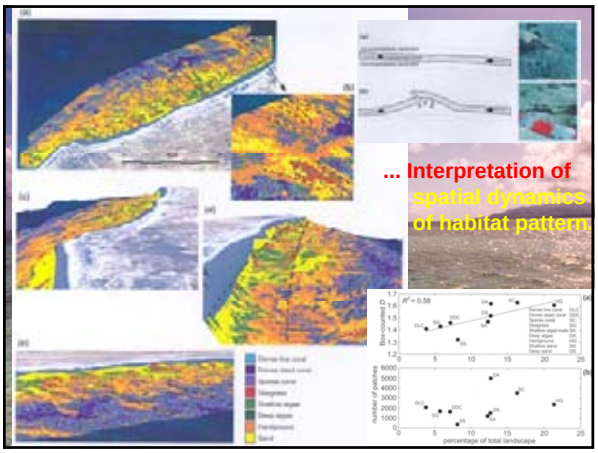

A monitoring network that harnesses new technologies while staying connected and compatible with and drawing from already established methods and programs which allows Minimization of cost but maximization of data!!!!!!!!!!
...and thus can ensure long-term usefulness, durability, and continuity of the programs!
The NCRI Monitoring Network: Nested data and activity levels
IKONOS satellite
Core Activity
Accuracy
Accuracy
Accuracy
Core Activity
Core Activity

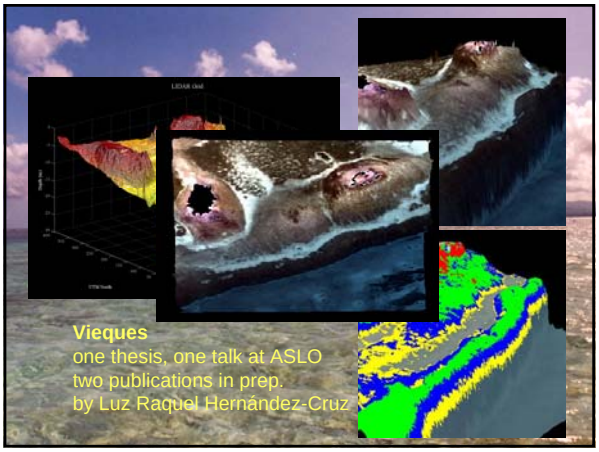

management-collaboration with Broward County Dept. of Environment. Protection
management-collaboration with National Parks Board
management-collaboration with CNMI Dept. of Fish and Wildlife, CRMP
scientific collaboration: CICIMAR
(Cabo Pulmo)
Dry Tortugas
Roatan
South Florida (Broward)
Biscayne National Park
Puerto Rico (Vieques)
Caribbean sites: Year 1 & 2
Sharm el Sheikh (Egypt)
United Arab Emirates
Indian Ocean sites: Year 3
Mariana Islands (Saipan, Tinian, Rota)
Yap
Pohnpei
Pacific sites: Years 1 and 2
management-collaboration with local NGO and stake-holders
management-collaboration with Department of Fish and Wildlife
management-collaboration with Environmental Research and Wildlife Development Agency, WWF
NCRI
MONITORING

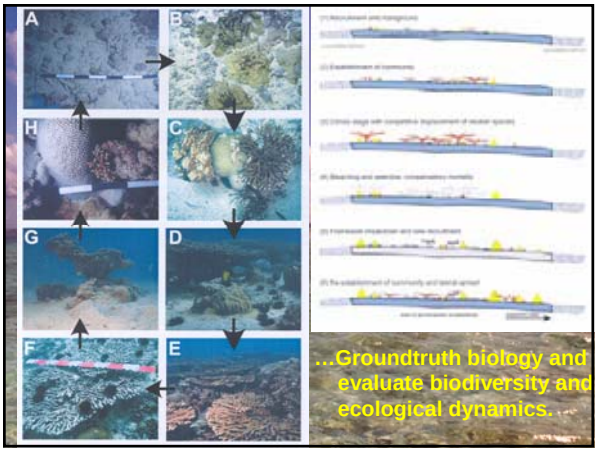

Work-flow of the NCRI monitoring network
NCRI
NATIONAL CORAL REEF INSTITUTE
NCRI
MONITORING

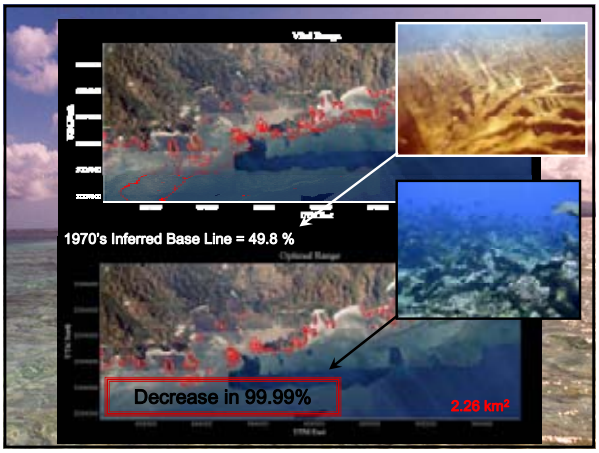

..obtain high-resolution satellite imagery. Perform classification.
(a)
DEM perimeter
Isobath
Major transects
Minor transects
KM
(b)
Dense live coral
Dense dead coral
Sparse coral
Seagrass
Shallow algae
Deep algae
Hardground
Sand
NCRI
MONITORING

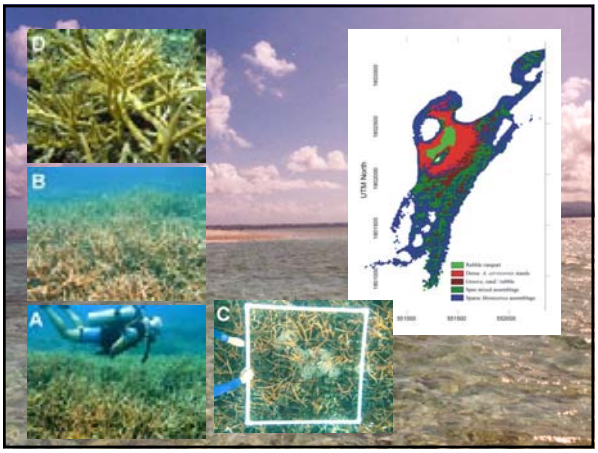

Saipan lagoon

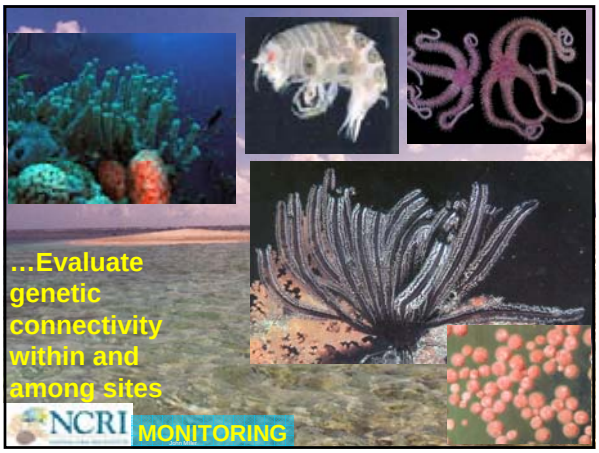

... Interpretation of
spatial dynamics
of habitat pattern

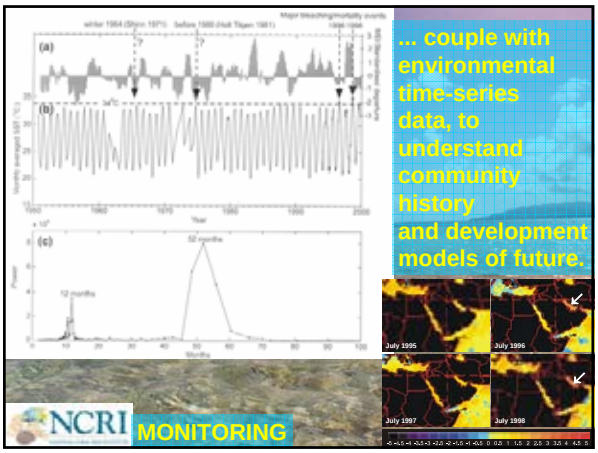

Vieques
one thesis, one talk at ASLO
two publications in prep.
by Luz Raquel Hernández-Cruz

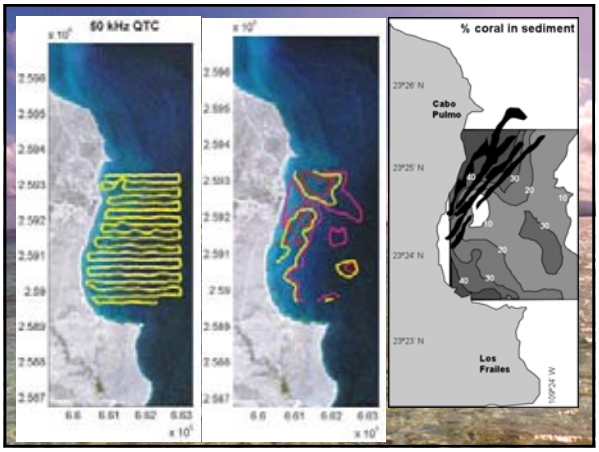

A
B
H
C
G
D
F
E
...Groundtruth biology and
evaluate biodiversity and
ecological dynamics.

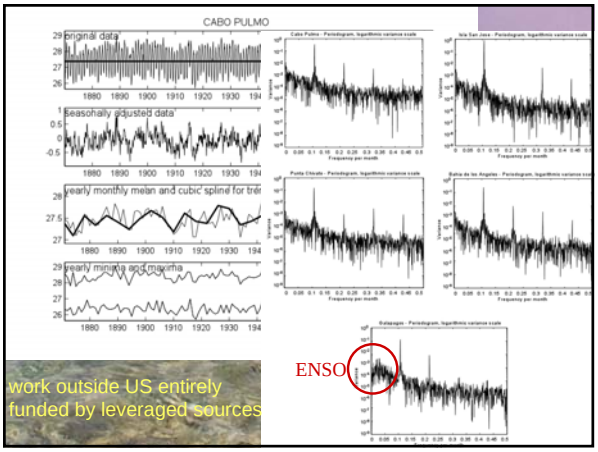

1970's Inferred Base Line = 49.8 %
Decrease in 99.99%
2.26 km²

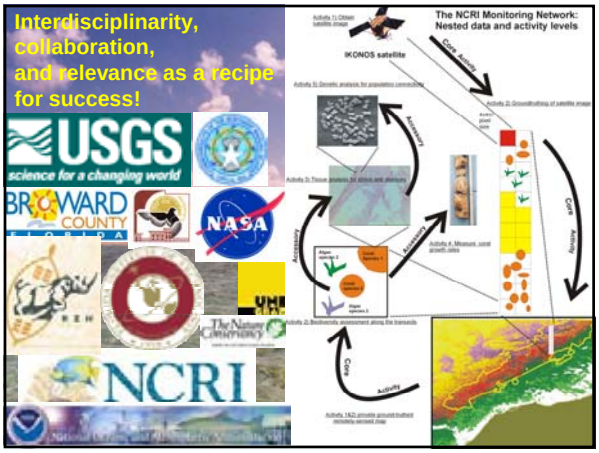

D
B
A
C


...Evaluate genetic connectivity within and among sites
NCRI
MONITORING


... couple with environmental time-series data, to understand community history and development models of future.
NCRI
MONITORING
July 1995
July 1996
July 1997
July 1998

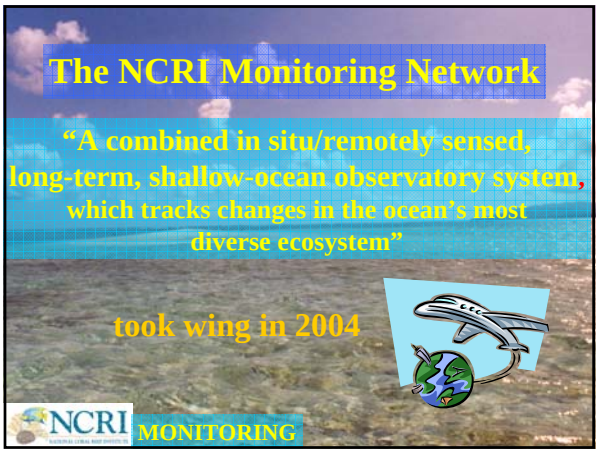

50 kHz QTC
% coral in sediment
Cabo Pulmo
Los Frailes

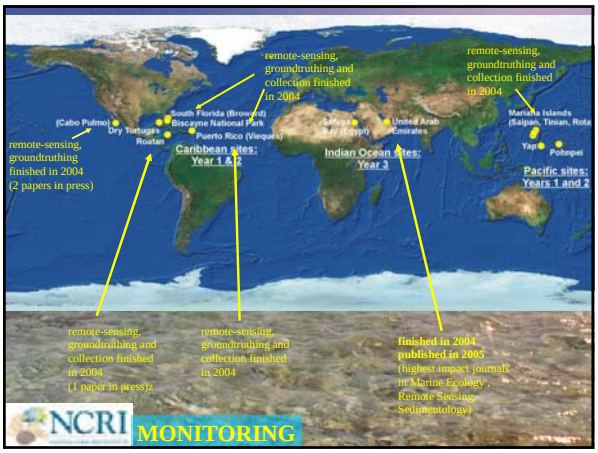

CABO PULMO
original data
seasonally adjusted data
yearly monthly mean and cubic spline for trei
yearly minima and maxima
ENSO
work outside US entirely funded by leveraged sources

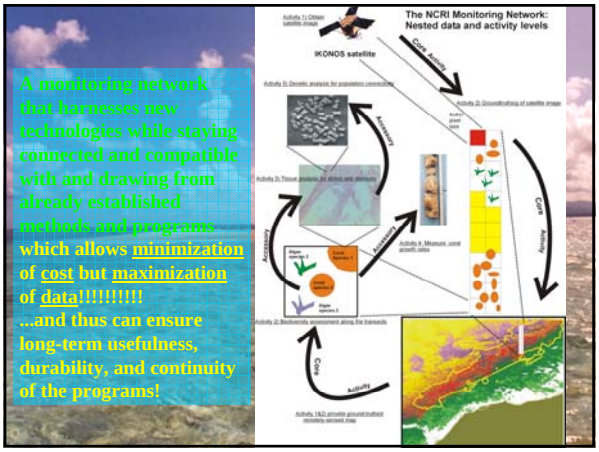

Interdisciplinarity, collaboration, and relevance as a recipe for success!
USGS
science for a changing world
BROWARD COUNTY
FLORIDA
NASA
NCRI
The NCRI Monitoring Network: Nested data and activity levels
IKONOS satellite

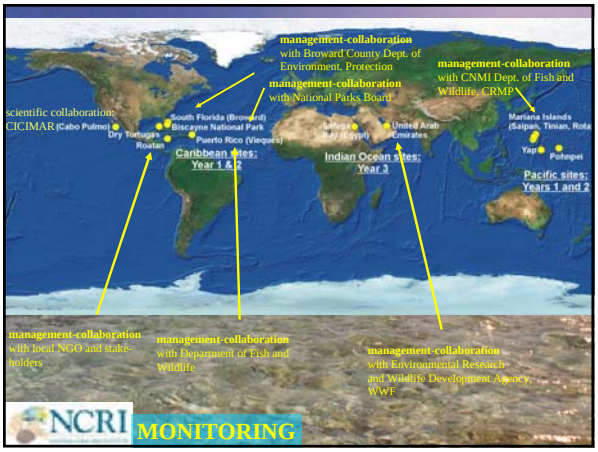
NCRI
Making Information resulting from NCRI programs available to Managers
•Projects and partnerships with Broward County & other counties of SE Florida
•Support & participate in SEFAST, LAS
•Partner & collaborate with State of Florida DEP/FMRI
•Partner & collaborate with federal agencies including USGS, NOAA, NMFS, DOI
•Conference & meeting sponsorships
•REPORTS & SCIENTIFIC PUBLICATIONS

Overview Presentation
NCRI Projects
FY 2004, 2005, & 2006
Drs. Richard Dodge & Bernhard Riegl
Center for Sponsored Coastal Ocean Research
3rd Coral Reef Projects PI Meeting
March 22-24, 2004; Dania Beach, Fla
NCRI
NATIONAL CORAL REEF INSTITUTE


The NCRI Monitoring Network
"A combined in situ/remotely sensed, long-term, shallow-ocean observatory system, which tracks changes in the ocean's most diverse ecosystem"
took wing in 2004
NCRI
MONITORING


remote-sensing, groundtruthing and collection finished in 2004
remote-sensing, groundtruthing and collection finished in 2004
(Cabo Pulmo)
Dry Tortugas
Roatan
South Florida (Broward)
Biscayne National Park
Puerto Rico (Vieques)
Caribbean sites: Year 1 & 2
Sahara & Red (Egypt)
United Arab Emirates
Indian Ocean sites: Year 3
Mariana Islands (Saipan, Tinian, Rota
Yap
Pohnpei
Pacific sites: Years 1 and 2
remote-sensing, groundtruthing finished in 2004 (2 papers in press)
remote-sensing, groundtruthing and collection finished in 2004 (1 paper in press)z
remote-sensing, groundtruthing and collection finished in 2004
finished in 2004, published in 2005 (highest impact journals in Marine Ecology, Remote Sensing, Sedimentology)
NCRI
MONITORING


A monitoring network that harnesses new technologies while staying connected and compatible with and drawing from already established methods and programs which allows minimization of cost but maximization of data!!!!!!!!!!
...and thus can ensure long-term usefulness, durability, and continuity of the programs!
The NCRI Monitoring Network: Nested data and activity levels
IKONOS satellite
Core Activity
Accuracy
Accuracy
Accuracy
Core Activity
Core
Activity


management-collaboration with Broward County Dept. of Environment, Protection
management-collaboration with National Parks Board
management-collaboration with CNMI Dept. of Fish and Wildlife, CRMP
scientific collaboration: CICIMAR
(Cabo Pulmo)
Dry Tortugas
Roatan
South Florida (Broward)
Biscayne National Park
Puerto Rico (Vieques)
Caribbean sites: Year 1 & 2
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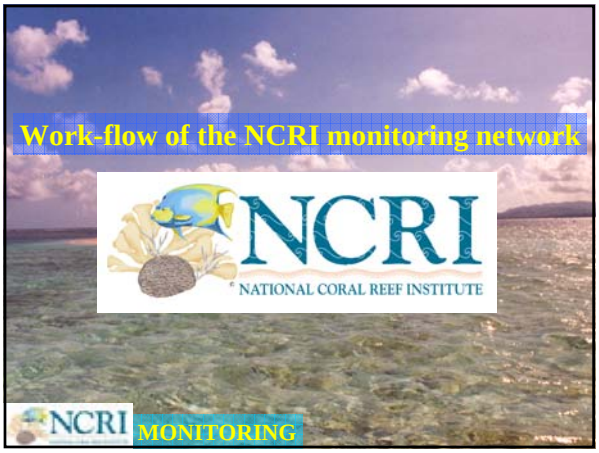
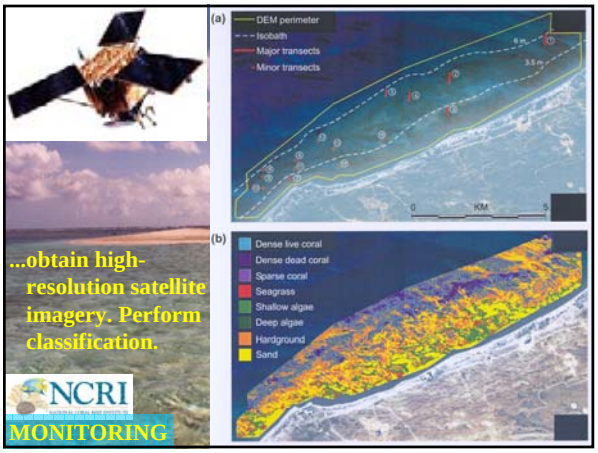
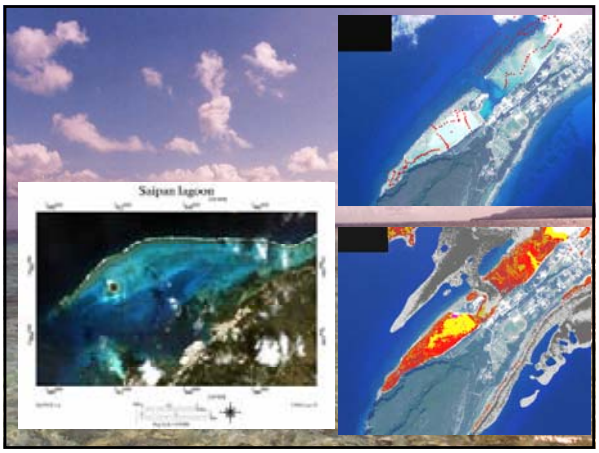
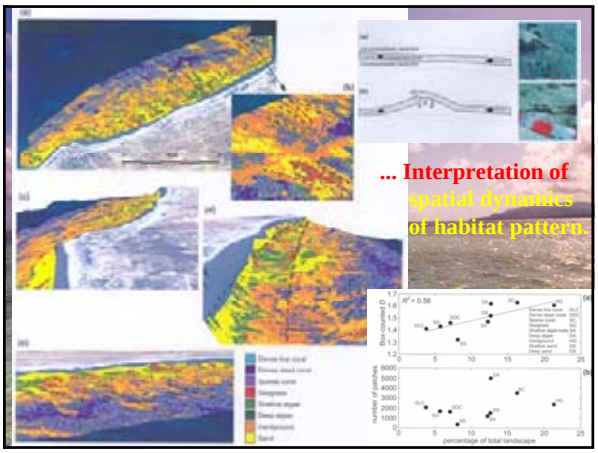
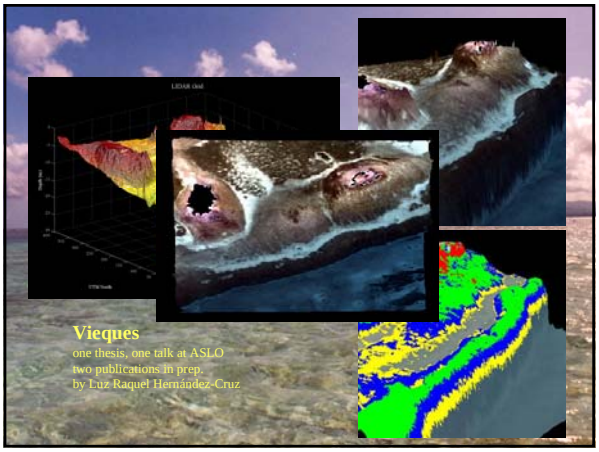
United Arab Emirates
Indian Ocean sites: Year 3
Mariana Islands (Saipan, Tinian, Rota
Yap
Pohnpei
Pacific sites: Years 1 and 2
management-collaboration with local NGO and stake-holders
management-collaboration with Department of Fish and Wildlife
management-collaboration with Environmental Research and Wildlife Development Agency, WWF
NCRI
MONITORING


Work-flow of the NCRI monitoring network
NCRI
NATIONAL CORAL REEF INSTITUTE
NCRI
MONITORING


...obtain high-resolution satellite imagery. Perform classification.
(a)
DEM perimeter
Isobath
Major transects
Minor transects
KM
(b)
Dense live coral
Dense dead coral
Sparse coral
Seagrass
Shallow algae
Deep algae
Hardground
Sand
NCRI
MONITORING


Saipan lagoon


... Interpretation of
spatial dynamics
of habitat pattern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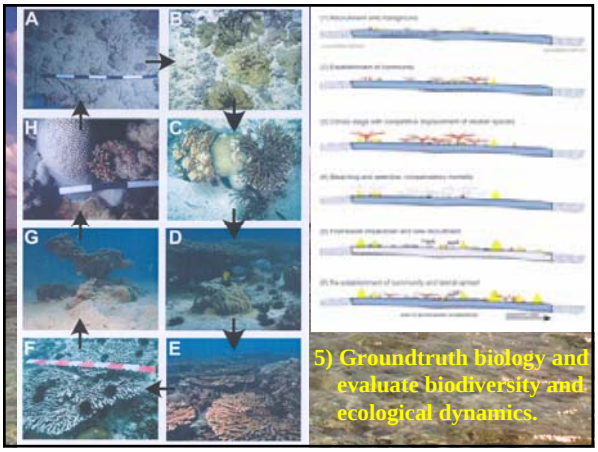
A
B
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H
5) Groundtruth biology and
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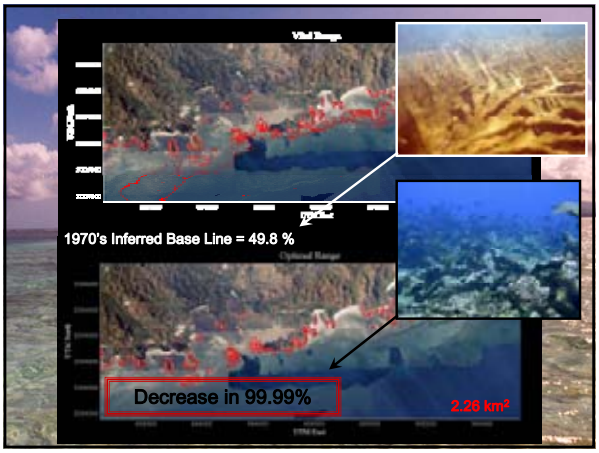
ecological dynamics.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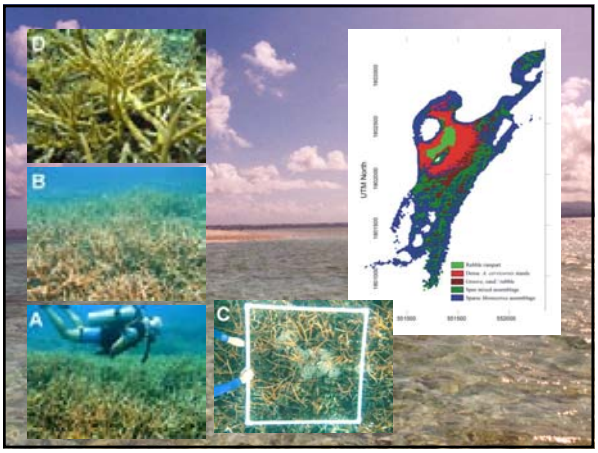
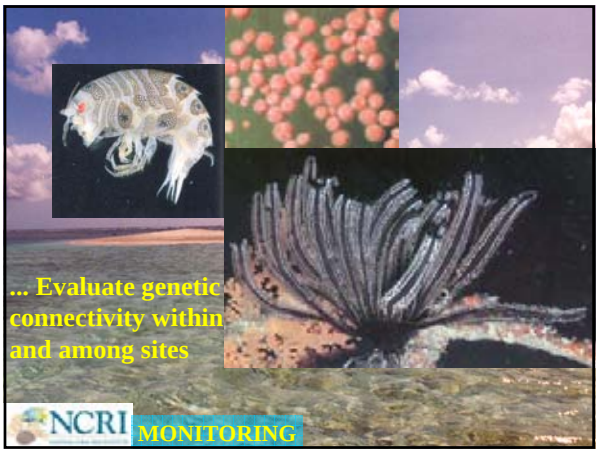
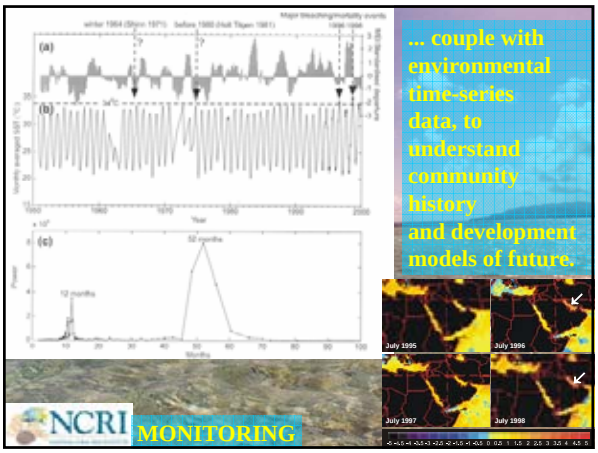
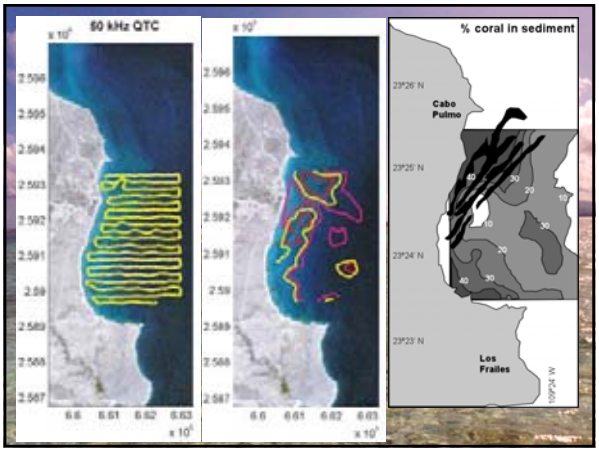
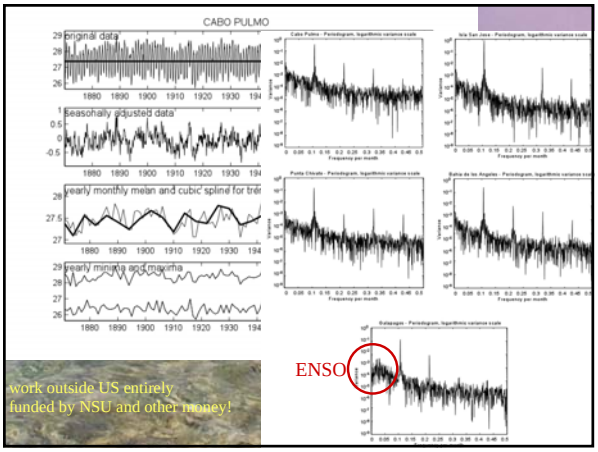
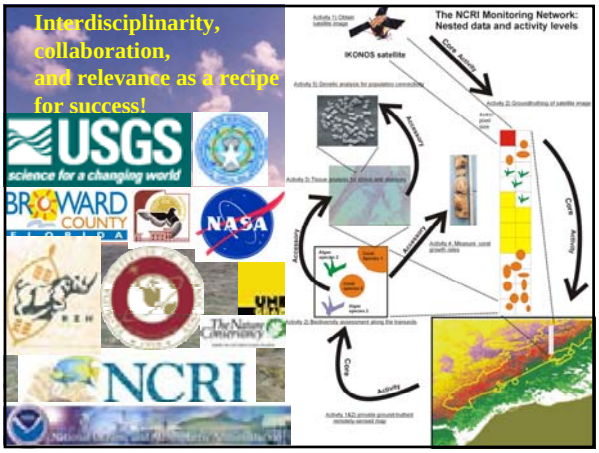

D
B
A
C


... Evaluate genetic connectivity within and among sites
NCRI
MONITORING


... couple with environmental time-series data, to understand community history and development models of future.
NCRI
MONITORING
July 1995
July 1996
July 1997
July 1998


50 kHz QTC
% coral in sediment
Cabo Pulmo
Los Frailes


CABO PULMO
original data
seasonally adjusted data
yearly monthly mean and cubic spline for trei
yearly minima and maxima
ENSO
work outside US entirely
funded by NSU and other money!


Interdisciplinarity, collaboration, and relevance as a recipe for success!
USGS
science for a changing world
BROWARD COUNTY
FLORIDA
NASA
NCRI
The NCRI Monitoring Network: Nested data and activity levels
IKONOS satellite

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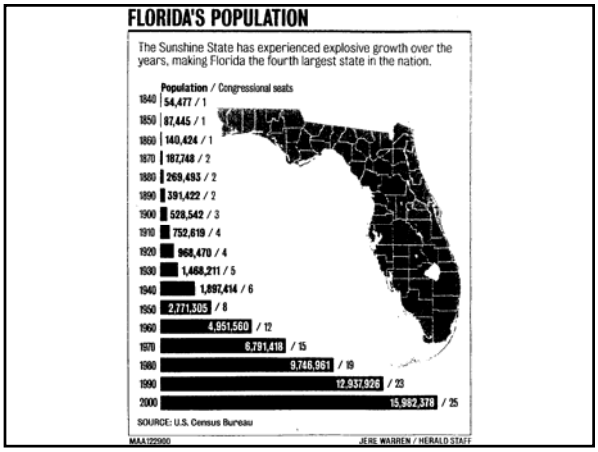
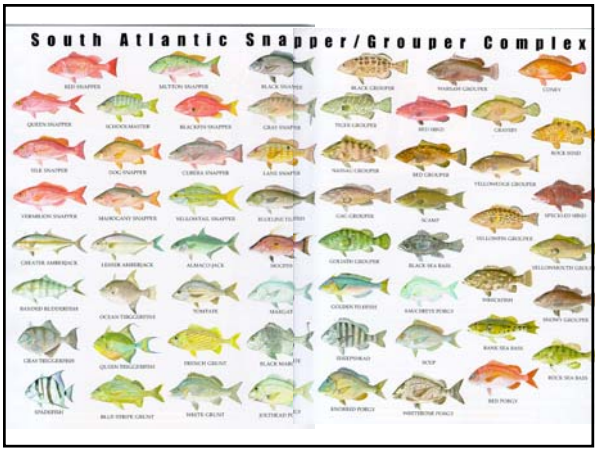
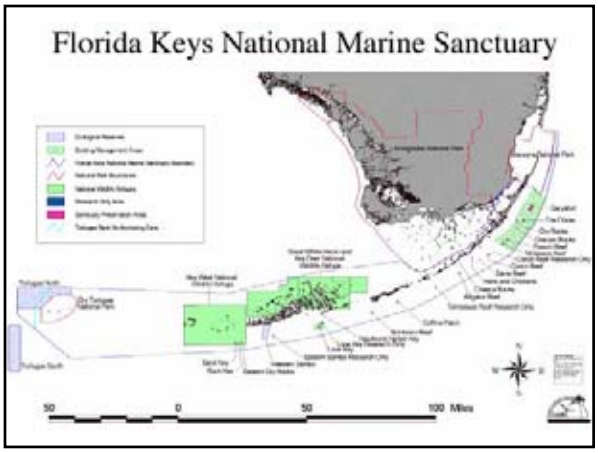
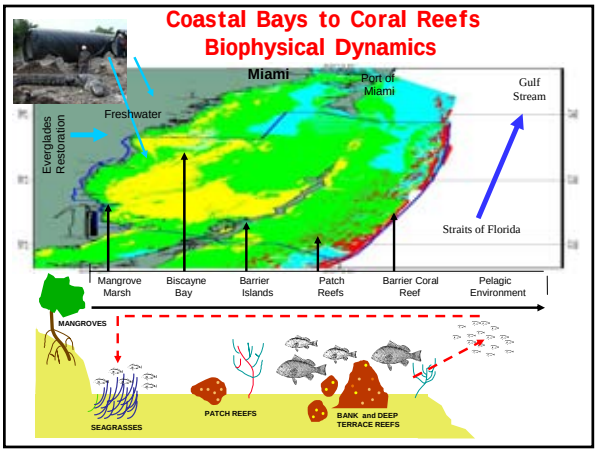
Monitor Coral Reef Fish Populations
Florida Keys and Tortugas
SEFSC, NOAA Fisheries
James A. Bohnsack, Douglas E. Harper
David B. McClellan, J. Javech
RSMAS, University of Miami
Jerald S. Ault, Steven G. Smith, J. Luo,
G.A. Meester, E. Franklin, H. Molina

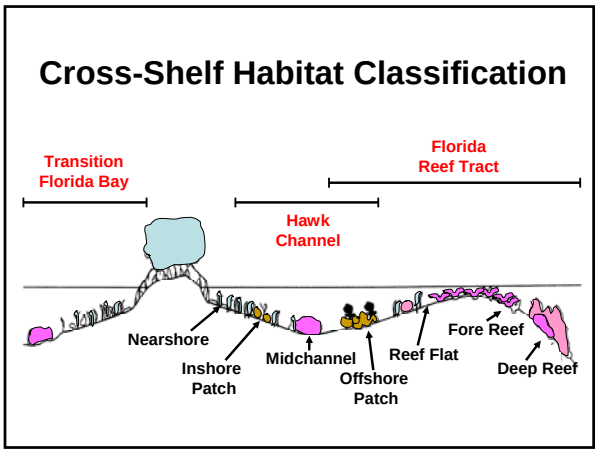
FLORIDA
Miami
Gulf of Mexico
Florida Bay
Florida Keys National Marine Sanctuary
Florida Straits

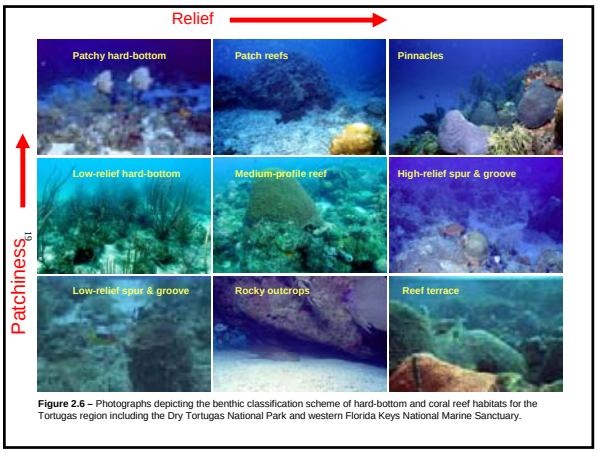

FLORIDA'S POPULATION
The Sunshine State has experienced explosive growth over the years, making Florida the fourth largest state in the nation.
Population / Congressional seats
1840 54,477 / 1
1850 87,445 / 1
1860 140,424 / 1
1870 187,748 / 2
1880 269,493 / 2
1890 391,422 / 2
1900 528,542 / 3
1910 752,619 / 4
1920 968,470 / 4
1930 1,468,211 / 5
1940 1,897,414 / 6
1950 2,771,305 / 8
1960 4,951,560 / 12
1970 6,791,418 / 15
1980 9,746,961 / 19
1990 12,937,926 / 23
2000 15,982,378 / 25
SOURCE: U.S. Census Bureau
MAA122900
JERE WARREN / HERALD STAFF

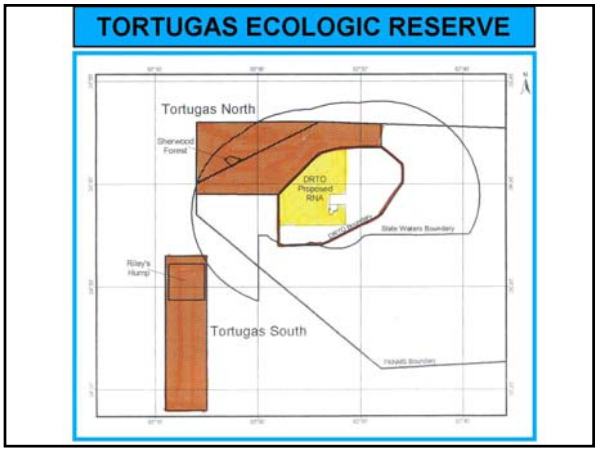

South Atlantic Snapper/Grouper Complex

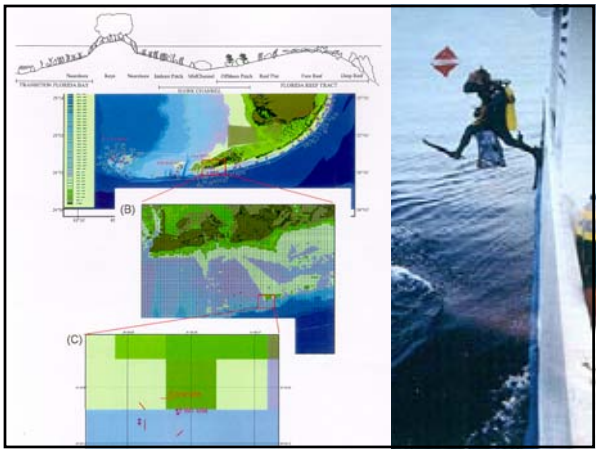

Florida Keys National Marine Sanctuary

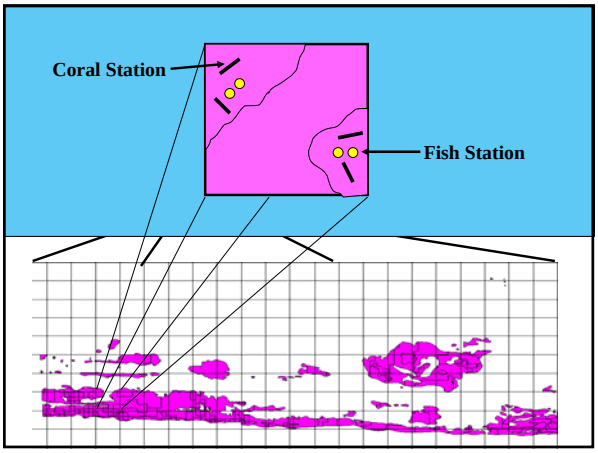

Coastal Bays to Coral Reefs
Biophysical Dynamics
Miami
Port of Miami
Gulf Stream
Freshwater
Everglades Restoration
Straits of Florida
Mangrove Marsh
Biscayne Bay
Barrier Islands
Patch Reefs
Barrier Coral Reef
Pelagic Environment
MANGROVES
SEAGRASSES
PATCH REEFS
BANK and DEEP TERRACE REEFS


Cross-Shelf Habitat Classification
Transition Florida Bay
Florida Reef Tract
Hawk Channel
Nearshore
Inshore Patch
Midchannel
Offshore Patch
Reef Flat
Fore Reef
Deep Reef


Relief
Patchiness
Patchy hard-bottom
Patch reefs
Pinnacles
Low-relief hard-bottom
Medium-profile reef
High-relief spur & groove
Low-relief spur & groove
Rocky outcrops
Reef terrace
Figure 2.6 – Photographs depicting the benthic classification scheme of hard-bottom and coral reef habitats for the Tortugas region including the Dry Tortugas National Park and western Florida Keys National Marine Sanctuary.


TORTUGAS ECOLOGIC RESERVE
Tortugas North
Tortugas South


(B)
(C)


Coral Station
Fish Station

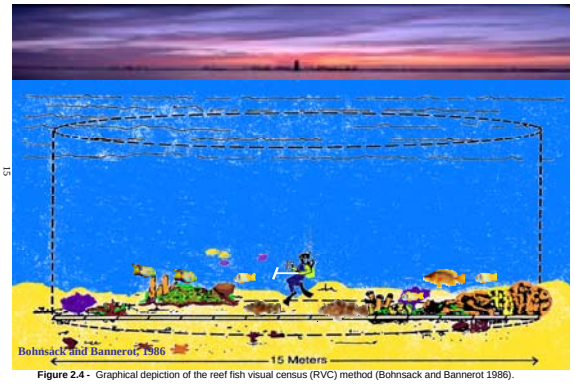
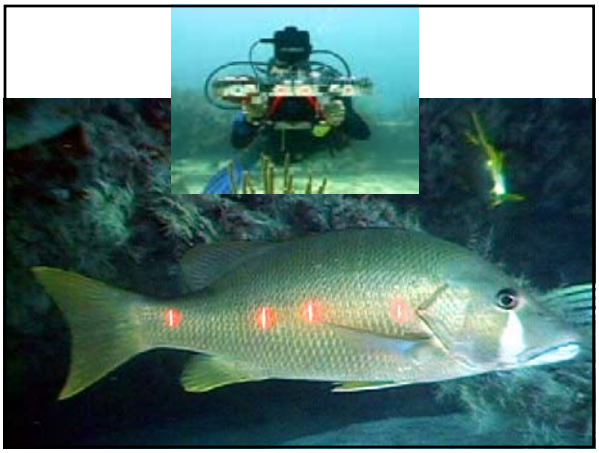


Figure 2.4 - Graphical depiction of the reef fish visual census (RVC) method (Bohnsack and Bannerot 1986).



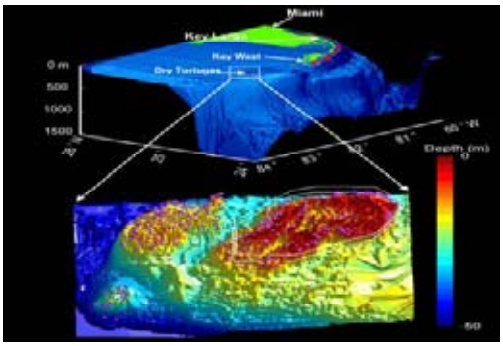


Figure 1.1 - Three-dimensional maps of the Florida Keys coral reef ecosystem showing: (A) South Florida and the coral reef tract (red) from Key Biscayne to the Dry Tortugas; and (B) the bathymetry of the Tortugas region showing Dry Tortugas National Park, Tortugas Bank and Riley's Hump where the purple balls represent primary sampling units from the millenial RVC and reef habitat surveys.

2

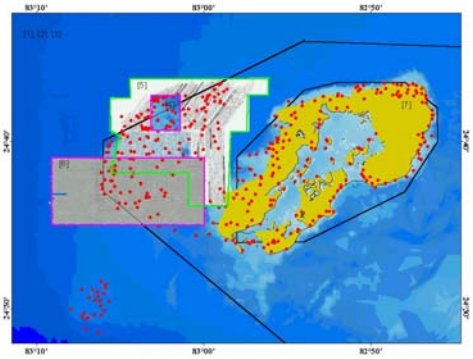
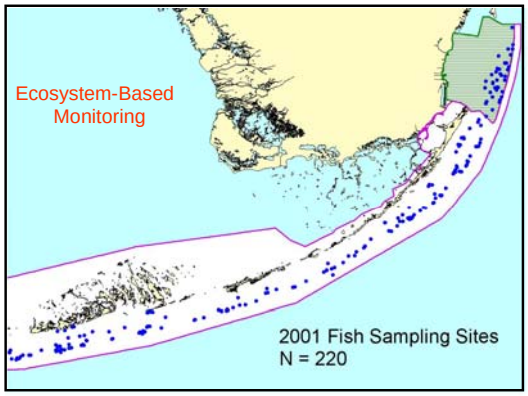
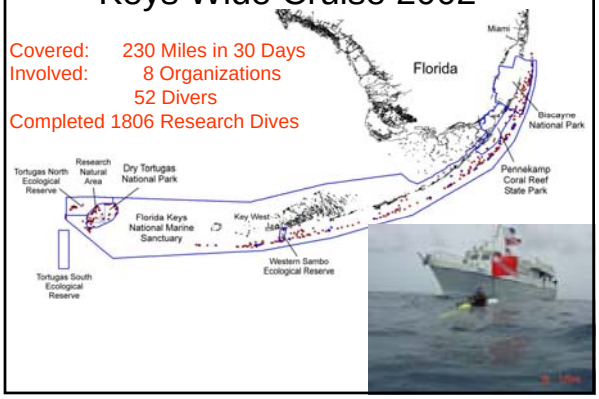


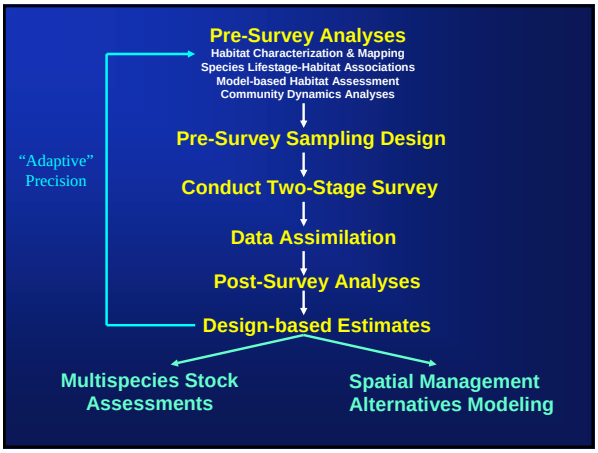
Figure 2.2 - Graphical depiction of georeferenced data sources used to characterize marine habitats in the Tortugas region. See text for further explanation.

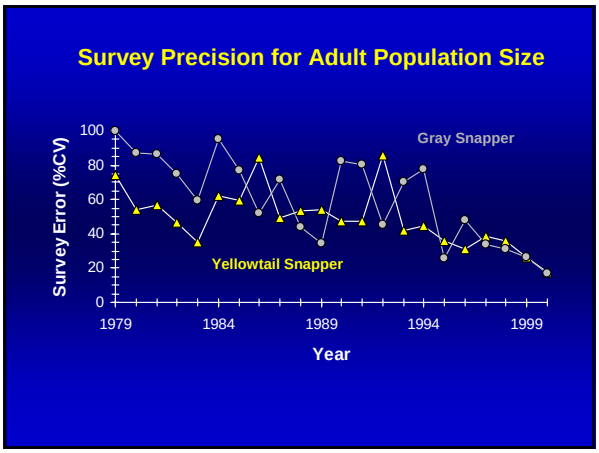


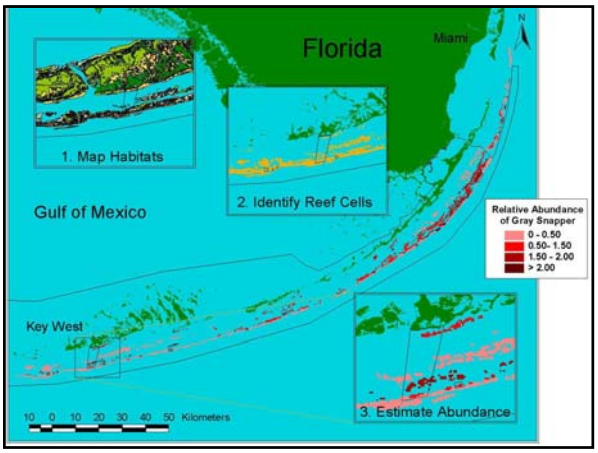
Keys Wide Cruise 2002

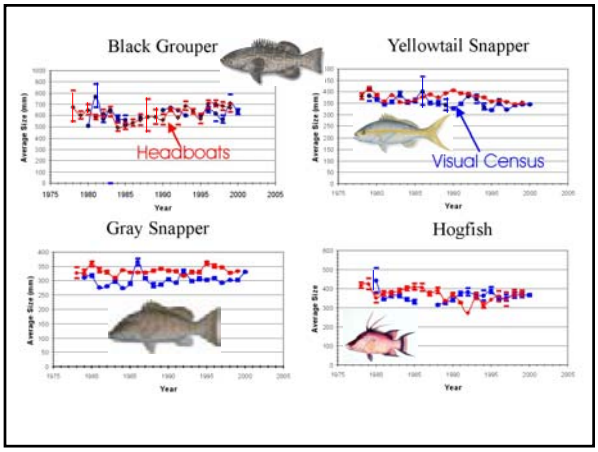
Covered: 230 Miles in 30 Days
Involved: 8 Organizations
52 Divers
Completed 1806 Research Dives

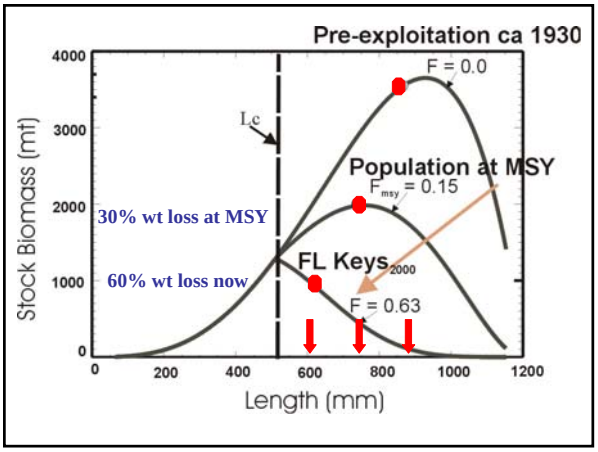


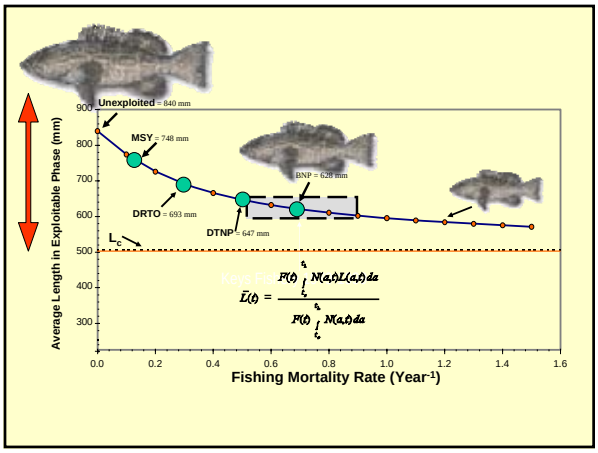


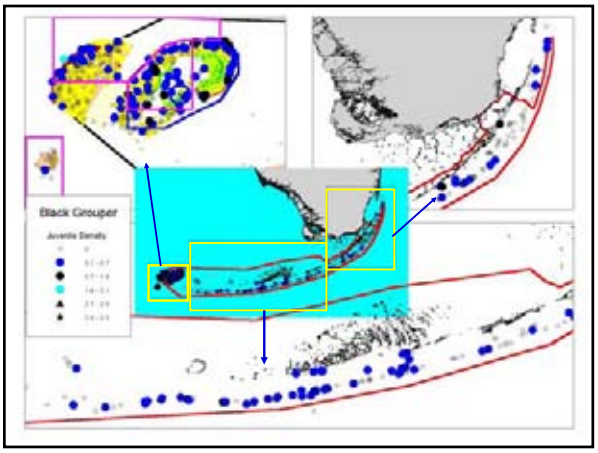

Survey Precision for Adult Population Size
Survey Error (%CV)
100
80
60
40
20
0
Gray Snapper
Yellowtail Snapper
1979
1984
1989
1994
1999
Year

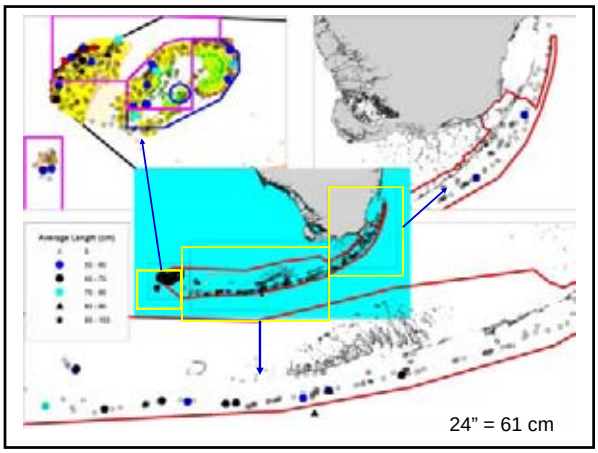

Florida
Miami
1. Map Habitats
2. Identify Reef Cells
Gulf of Mexico
Relative Abundance of Gray Snapper
0 - 0.50
0.50- 1.50
1.50 - 2.00
> 2.00
Key West
3. Estimate Abundance
Kilometers

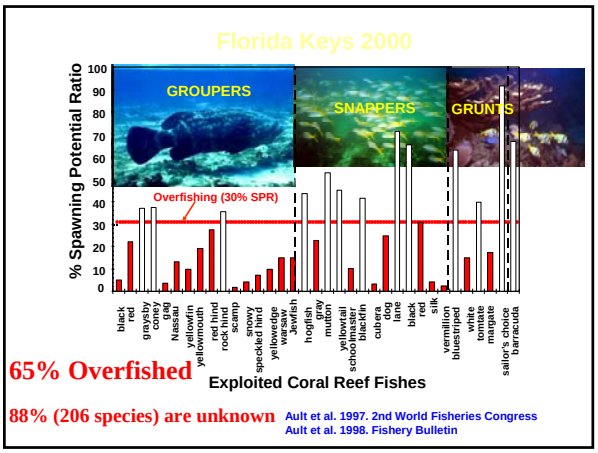

Black Grouper
Yellowtail Snapper
Headboats
Visual Census
Gray Snapper
Hogfish
Year

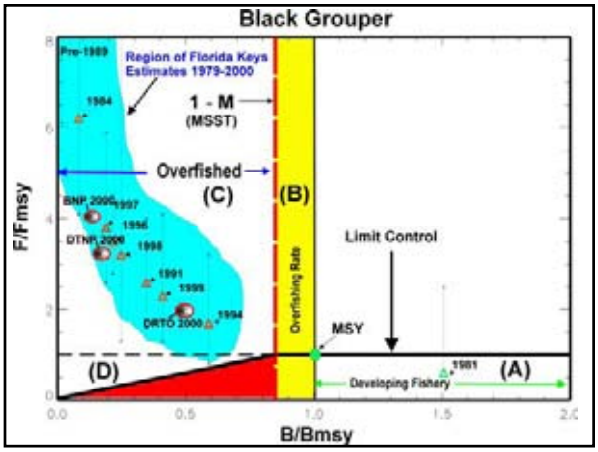

Pre-exploitation ca 1930
F = 0.0
Lc
Population at MSY
F_{msy} = 0.15
30% wt loss at MSY
60% wt loss now
FL Keys 2000
F = 0.63
Stock Biomass (mt)
Length (mm)

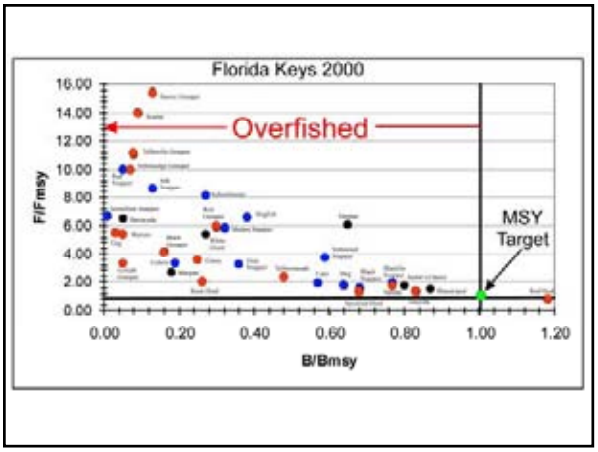

Unexploited = 840 mm
MSY = 748 mm
BNP = 628 mm
DRTO = 693 mm
DTNP = 647 mm
L_c
Average Length in Exploitable Phase (mm)
Fishing Mortality Rate (Year^{-1})

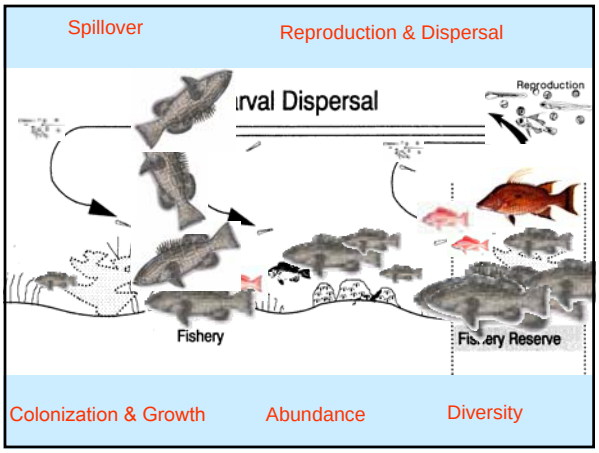

Black Grouper

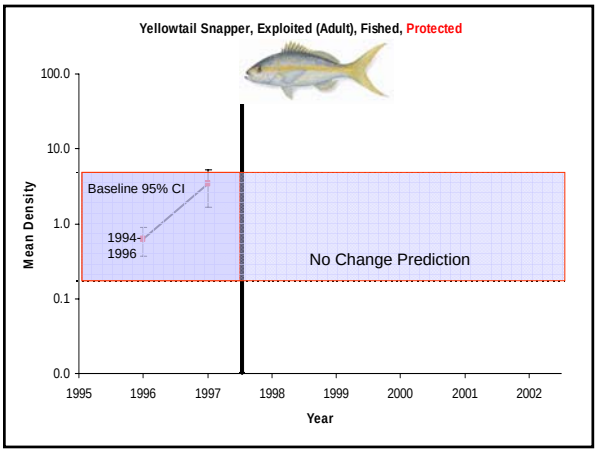

24" = 61 cm

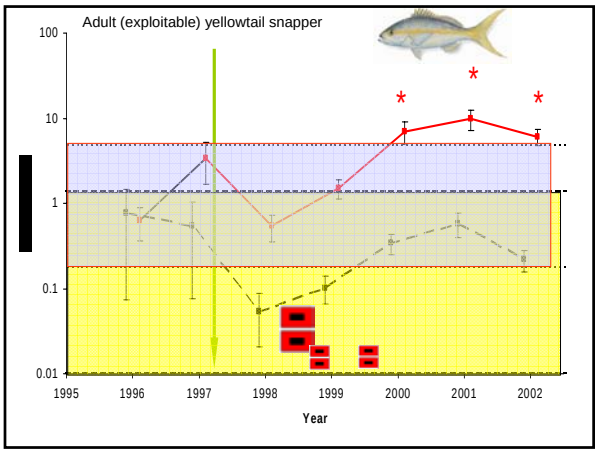

Florida Keys 2000
% Spawning Potential Ratio
GROUPERS
SNAPPERS
GRUNTS
Overfishing (30% SPR)
65% Overfished
Exploited Coral Reef Fishes
88% (206 species) are unknown
Ault et al. 1997. 2nd World Fisheries Congress
Ault et al. 1998. Fishery Bulletin

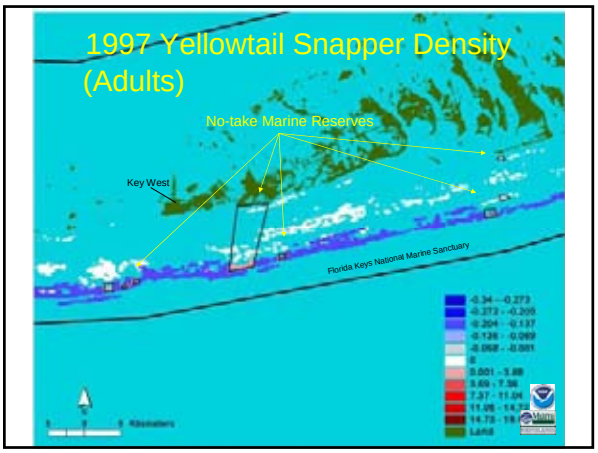

Black Grouper
Region of Florida Keys Estimates 1979-2000
1 - M
(MSST)
Overfished
(C)
(B)
Limit Control
MSY
(D)
(A)
Developing Fishery
Overfishing Rate
F/Fmsy
B/Bmsy

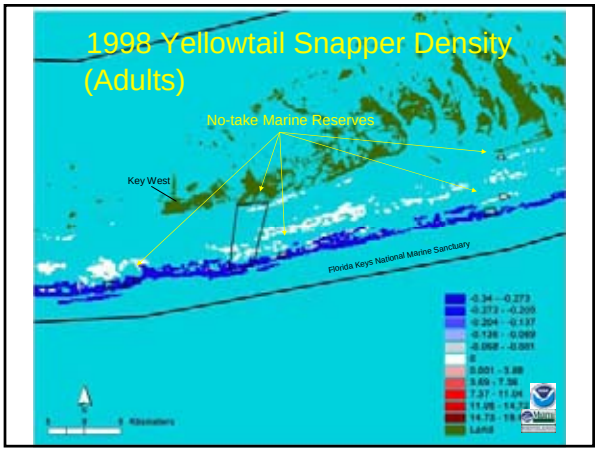

Florida Keys 2000
Overfished
MSY
Target
F/Fmsy
B/Bmsy

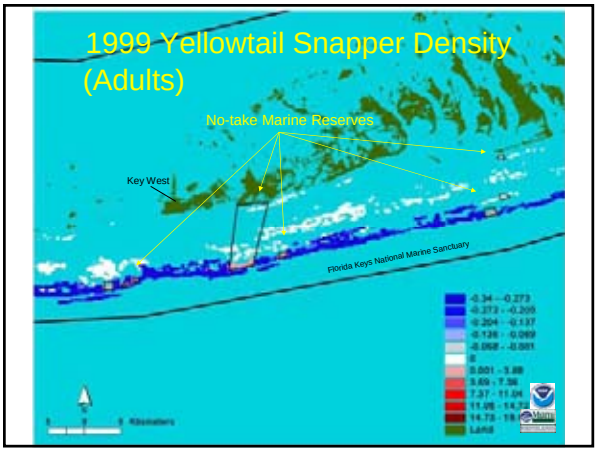

Spillover
Reproduction & Dispersal
Larval Dispersal
Reproduction
Fishery
Fishery Reserve
Colonization & Growth
Abundance
Diversity

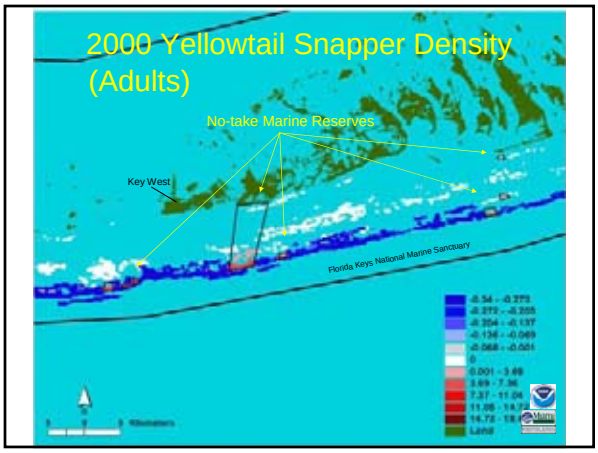

Yellowtail Snapper, Exploited (Adult), Fished, Protected
Baseline 95% CI
1994
1996
No Change Prediction
Mean Density
Year

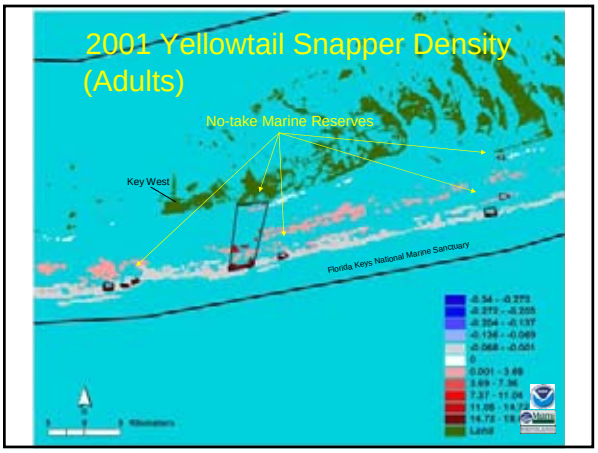

Adult (exploitable) yellowtail snapper
100
10
1
0.1
0.01
1995
1996
1997
1998
1999
2000
2001
2002
Year

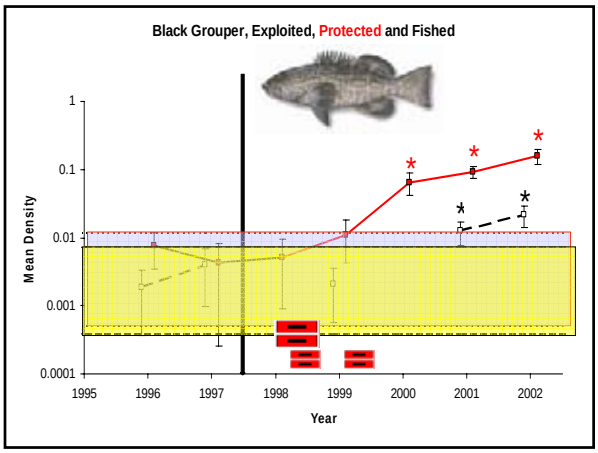

1997 Yellowtail Snapper Density (Adults)
No-take Marine Reserves
Key West
Florida Keys National Marine Sanctuary

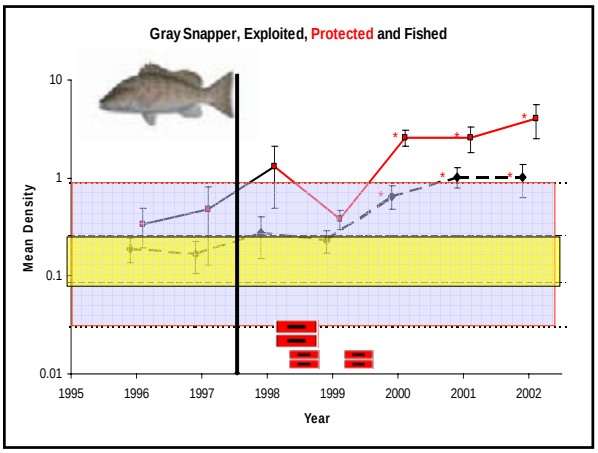

1998 Yellowtail Snapper Density (Adults)
No-take Marine Reserves
Key West
Florida Keys National Marine Sanctuary

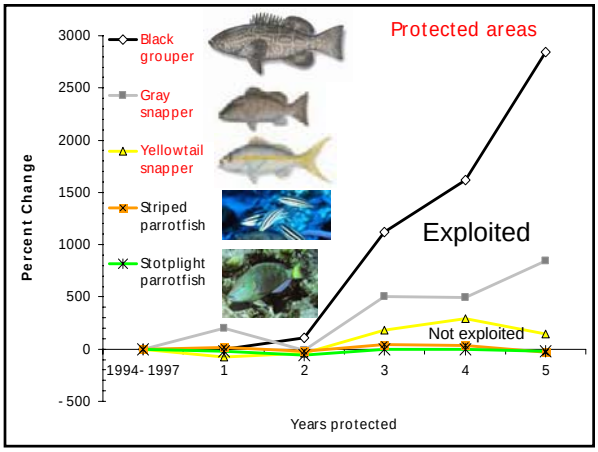

1999 Yellowtail Snapper Density (Adults)
No-take Marine Reserves
Key West
Florida Keys National Marine Sanctuary


2000 Yellowtail Snapper Density (Adults)
No-take Marine Reserves
Key West
Florida Keys National Marine Sanctuary


2001 Yellowtail Snapper Density (Adults)
No-take Marine Reserves
Key West
Florida Keys National Marine Sanctuary

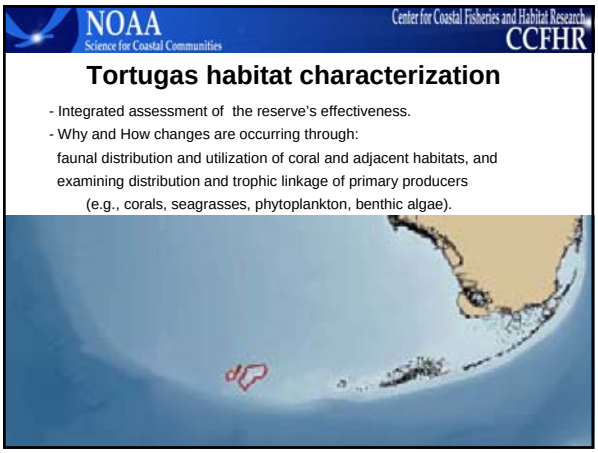

Black Grouper, Exploited, Protected and Fished
Mean Density
1
0.1
0.01
0.001
0.0001
1995
1996
1997
1998
1999
2000
2001
2002
Year


Gray Snapper, Exploited, Protected and Fished
Mean Density
10
1
0.1
0.01
1995
1996
1997
1998
1999
2000
2001
2002
Year

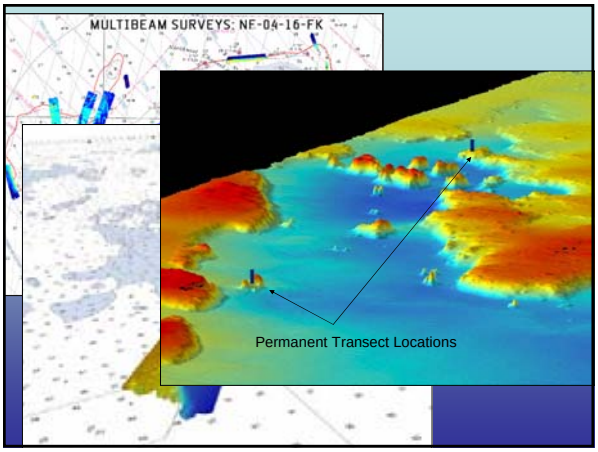

Protected areas
Black grouper
Gray snapper
Yellowtail snapper
Striped parrotfish
Stotplight parrotfish
Exploited
Not exploited
Percent Change
3000
2500
2000
1500
1000
500
0
- 500
1994- 1997
1
2
3
4
5
Years protected

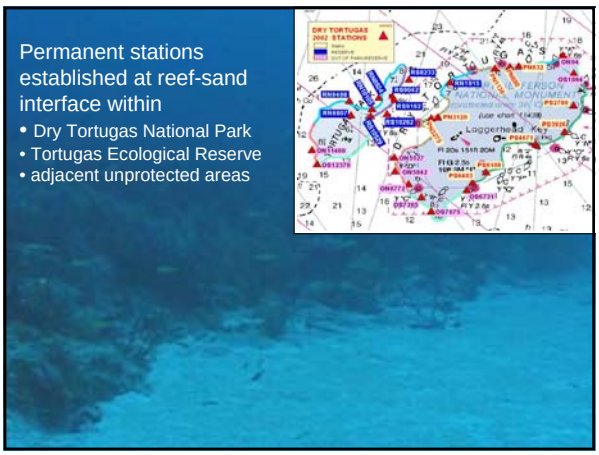
Looe Key Reef 1983
Acropora

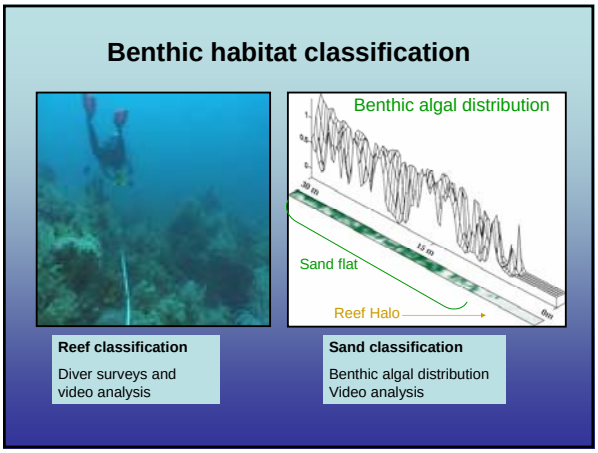
NOAA
Science for Coastal Communities
Center for Coastal Fisheries and Habitat Research
CCFHR
Coral Reef Ecosystem Research at CCFHR
NOAA/NCCOS Center for Coastal Fisheries and Habitat Research, Beaufort, NC
• Tortugas Ecological Reserve effects of "no take"
• Coral Recovery Modeling
• NC Hardbottom, survey of lionfish


NOAA
Science for Coastal Communities
Center for Coastal Fisheries and Habitat Research
CCFHR
Tortugas habitat characterization
- Integrated assessment of the reserve's effectiveness.
- Why and How changes are occurring through:
faunal distribution and utilization of coral and adjacent habitats, and
examining distribution and trophic linkage of primary producers
(e.g., corals, seagrasses, phytoplankton, benthic algae).

Additional evaluation of resource, characterization and distribution
• Comparison of remote sensing methods – Ikonos, Quickbird, and aerial photography – together with multibeam sonar


MULTIBEAM SURVEYS: NF-04-16-FK
Permanent Transect Locations

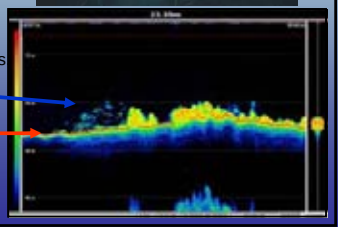

Permanent stations established at reef-sand interface within
• Dry Tortugas National Park
• Tortugas Ecological Reserve
• adjacent unprotected areas


Benthic habitat classification
Benthic algal distribution
Sand flat
Reef Halo
Reef classification
Diver surveys and video analysis
Sand classification
Benthic algal distribution
Video analysis

Fish Surveys

Visual fish censuses were conducted along 30 m transects over reef and sand habitats at their interface at each permanent station.

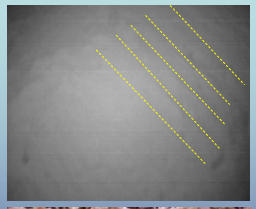
A Simrad EQ60 Echosounder was used for remote fish surveys



Gear Impact

Soft bottom surrounding the banks was sampled at night for prey species using a fine-mesh beam trawl.

Comparative analysis continues to determine how elimination of commercial shrimp trawling will influence this community.



NOAA Science for Coastal Communities — Center for Coastal Fisheries and Habitat Research CCFHR

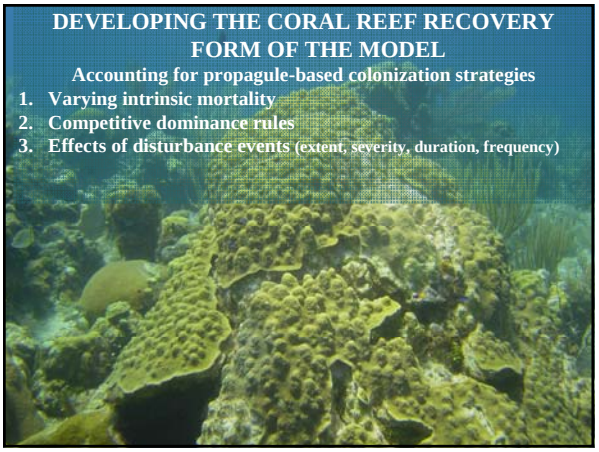
Coral Recovery Model

Developed a spatially explicit coral recovery model to balance biological realism and restoration reality

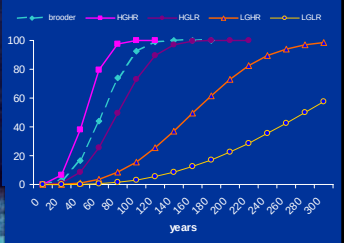
DEVELOPING THE CORAL REEF RECOVERY FORM OF THE MODEL

Accounting for propagule-based colonization strategies

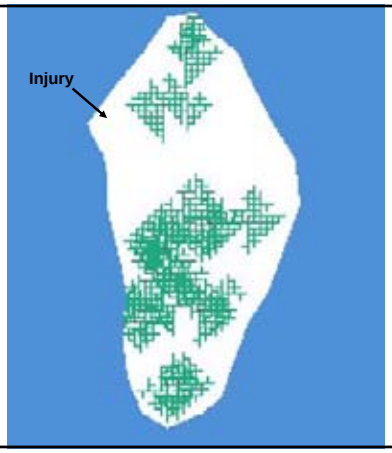
1. **Varying intrinsic mortality**
2. **Competitive dominance rules**
3. **Effects of disturbance events (extent, severity, duration, frequency)**



Coral recovery modeling



model	growth	recruitment
brooder (dotted line)	0.5cm/yr	3.0/m²/20yr
High growth/High recruitment	1.0cm/yr	1.50/m²/10yr
High growth/Low recruitment	1.0cm/yr	0.2/m²/10yr
Low growth/High recruitment	0.5cm/yr	0.2/m²/20yr
Low growth/Low recruitment	0.5cm/yr	0.04/m²/20yr



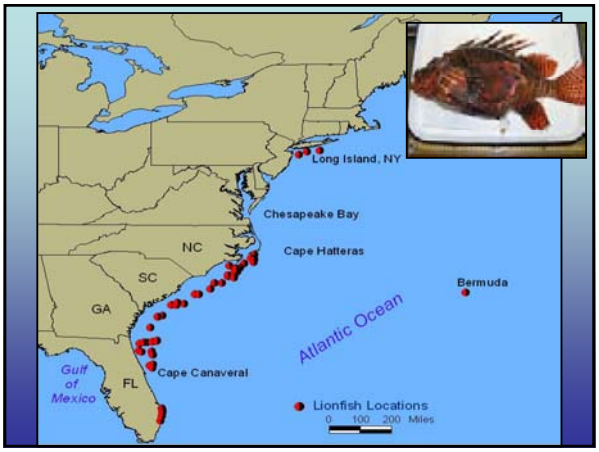
NOAA
Science for Coastal Communities
Center for Coastal Fisheries and Habitat Research
CCFHR

North Carolina hardbottom communities

Considered to be the most biologically productive habitat on the continental shelf and supporting a wide variety of fishes and shell fish resources, hardbottom communities form the basis for a variety of economically valuable fisheries

Invasive lionfish are also attracted to these habitats and are now known to be thriving.

CCFHR is examining the ecological role and the possible impact of lionfish to the hard bottom communities and fisheries.



COLLABORATORS

- C.J. Beegle-Krause, NOAA Office of Response and Restoration
- Susan Bell, University of South Florida
- Mark Finkbeiner, NOAA/CSC
- Margaret Hall, Florida Fish and Wildlife Conservation Commission, State of Florida
- Steve Macko, University of Virginia
- Mark Monaco, NOAA/NOS/NCCOS/CCMA
- Jim Reid, Caribbean Science Center, USGS, Gainesville, FL
- Gary Shigenaka, NOAA Office of Response and Restoration

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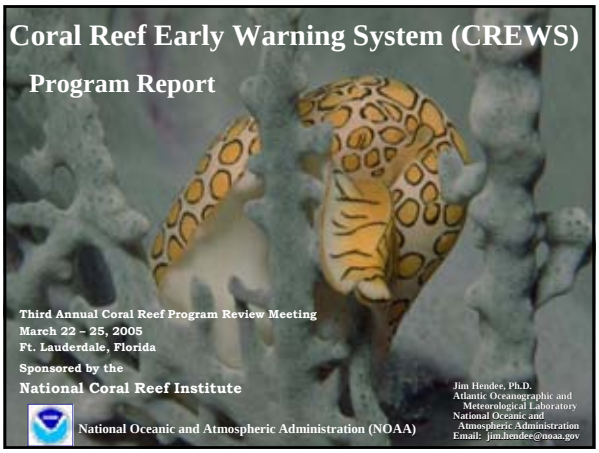


The Coral Reef Early Warning System (CREWS) Network:

marine environmental monitoring to support research and marine sanctuary management

A CREWS Station is a "smart" meteorological and oceanographic monitoring platform installed near coral reef areas, software-configured to ensure the gathering of high quality data and the eliciting of automated alerts when specified environmental conditions occur (e.g., those thought to be conducive to coral bleaching)

Response to Coral Reef Task Force Monitoring Group's recommendation for a network of up to 18 stations at all major U.S. coral reef areas by 2010

CREWS stations provide hourly *in situ* data...
Air temperature, wind speed and direction, barometric pressure, PAR and UVR above and below the water, sea temperature and salinity (near-surface, near-bottom)
* (optional: pCO2, fluorometry, tide level, PAM-fluorometry, transmissometry, nutrients, acoustic monitoring, Web cam, etc.)

...and information synthesis products
Surface-truth for satellite products, coral bleaching alerts, data quality alerts; and matching patterns as proscribed by biologists, oceanographers and the public (fish & invertebrate spawning, migration, bloom conditions, good fishing and/or diving conditions, etc.)

A true interagency, international collaborative effort!

(your logo goes here)

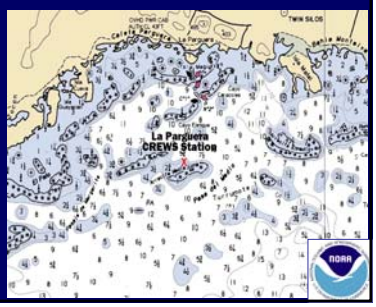
CREWS Stations:
Lee Stocking Island, Bahamas, and...

Salt River Bay National Historical Park and Ecological Preserve, St. Croix; US Virgin Islands

Logistics are now being arranged for installation of a CREWS station in SW Puerto Rico, near La Parguera, during late February or early March, 2005.

- Dr. Roy Armstrong of University of Puerto Rico will be chief collaborator.
- Part of the new Caribbean Coral Reef Institute effort (NOAA/UPR collaboration).

Instrumentation will include the basic suite, but will within a year include a special acoustic modem platform for monitoring remotely from the station.

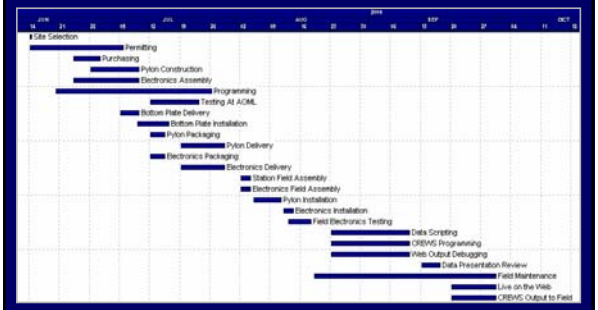


Non-CRTF CREWS Stations

CARICOM/GEF/NOAA
Mainstreaming Adaptation to Climate Change (MACC) Project
Jamaica, Barbados, Bahamas, etc.

World Bank/GEF
Mesoamerican Barrier Reef System (MBRS) project
Belize
Targeted Research Initiative
Heron Island, Palau, Philippines, Puerto Morelos, Zanzibar

Idealized Gantt chart shows the many phases involved in a CREWS station installation



The CREWS software has three principal components:

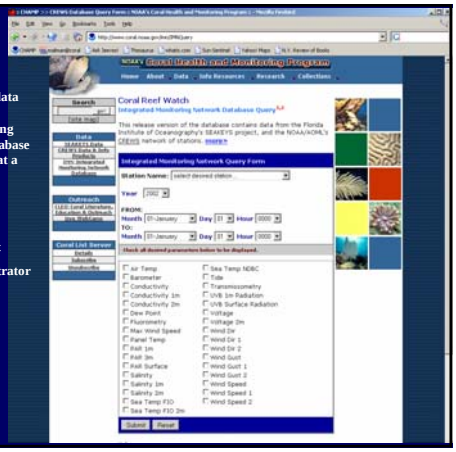
* Raw data parser--makes columnar data report from raw data stream
* Environmental Information Synthesizer for Expert Systems (**EISES**)
* Expert system (type of Knowledge Based System) for coral bleaching

EISES/CREWS is a unique expert system deployment for marine ecosystem monitoring, a type of ***Environmental Decision Support Systems***

Quality-controlled data are placed on the Integrated Monitoring Network Oracle database server for retrieval at a later time.

This effort requires:

- **Data QC Specialist**
- **Database Administrator**
- **WebMaster**



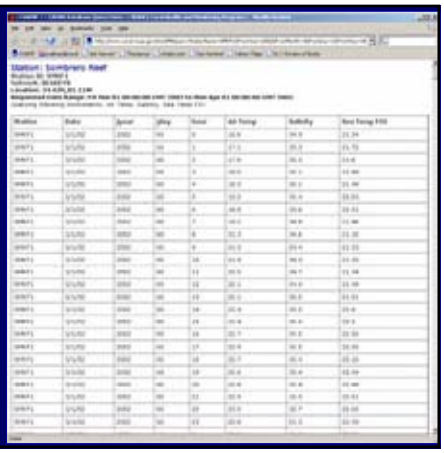
The users choose a station name, year and date range, and parameters of interest. To retrieve the data, the user presses the Submit button at the bottom of the page.

The data are returned in a separate Web page. Instructions are given at the bottom of the page for saving in various formats.

Example:

To save the data for use in Microsoft Excel spreadsheet program, save this page results as follows:

Microsoft Internet Explorer Select 'File', then 'Save as' option. When file dialog appears, select save as type to be 'Web Page, HTML only'. Enter file name as appropriate. Once file is done saving Open Microsoft Excel and select 'File', 'Open' option and locate the file you just saved. Finally, save the file in Excel as an '.xls' type.



Data Grouping in CREWS

Subjective Data Ranges:

ul	unbelievably low	av	average
dl	drastically low	sh	somewhat high
vl	very low	hi	high
lo	low	vh	very high
sl	somewhat low	dh	drastically high
		uh	unbelievably high

Subjective Periods of the Day:

Abbrev	Period	GMT Time	Local (5 hours)	Local (4 hours)
(Basic Periods)				
midn	midnight	0300 - 0600	2200 - 0100	2300 - 0200
pdaw	pre-dawn	0600 - 0900	0100 - 0400	0200 - 0500
dawn	dawn	0900 - 1200	0400 - 0700	0500 - 0700
morn	morning	1200 - 1500	0700 - 1000	0800 - 1100
midd	mid-day	1500 - 1800	1000 - 1300	1100 - 1400
psun	pre-sunset	1800 - 2100	1300 - 1600	1400 - 1700
suns	sunset	2100 - 2400	1600 - 1900	1700 - 2000
even	evening	0000 - 0300	1900 - 2200	2000 - 2300
(Large Groupings)				
all	all-day	0300 - 0300	2200 - 2200	2300 - 2300
dayl	daylight-hours	0900 - 2400	0400 - 1900	0500 - 2000
nite	night-hours	0000 - 0900	1900 - 0400	2000 - 0500
dayb	dawn-morning	0900 - 1500	0400 - 1000	0500 - 1100
aftn	afternoon	1800 - 2400	1300 - 1900	1400 - 2000

Rule: High Sea Temp + High Noon Irradiance + Low Winds (Julian Day: 172 to 264...Season: Summer)

	ul	dl	vl	lo	sl	av	sh	hi	vh	dh	uh
IF sea temp									all (24) dayl (15) nite (9) dayb (6) aft (6) basic (3)	all (48) dayl (30) nite (18) dayb (12) aft (12) basic (6)	
and: irradiance										mid (6)	mid (12)
and: wind speed		all (24) dayl (15) nite (9) dayb (6) aft (6) basic (3)	all (24) dayl (15) nite (9) dayb (6) aft (6) basic (3)								

THEN

Conditions are [probably/possibly] conducive to mass coral bleaching.

Software Actions:

Add up all the points in parentheses for conditions that hold and output in an "alert" which shows totals for each parameter, as well as combined total. Total points act as an environmental index for stress, in this case, coral bleaching probability.

See key for day-period designations (e.g., "dayl" means daylight hours)
"Basic" refers to any of the 3-hour periods, except (in this case) any during night time.

~~~~ Coral Bleaching Alert for Sombrero Key, 08/12/1998 ~~~~

Rule-T4 (9)
Conditions possibly favorable for bleaching night-hours on 08/12/1998, because FIO sea temperature was very high (about 31.2).

Rule-TWT1 (48)
Conditions favorable for bleaching on 08/11/1998, because FIO sea temperature was very high (about 31.2) during mid-day, wind speed was very low (about 5.9), during mid-day, and tide was very low (about -4.40) during mid-day.

Rule-T5 (6)
Conditions possibly favorable for bleaching afternoon on 08/11/1998, because FIO sea temperature was very high (about 31.5).

Rule-T8 (3)
Conditions possibly favorable for bleaching evening on 08/11/1998, because FIO sea temperature was very high (about 31.0).

Rule-T8 (3)
Conditions possibly favorable for bleaching morning on 08/11/1998, because FIO sea temperature was very high (about 31.0).

Rule-T5 (6)
Conditions possibly favorable for bleaching afternoon on 08/10/1998, because FIO sea temperature was very high (about 31.3).

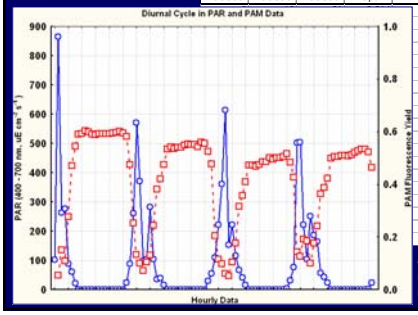
... [etc.] ...

~~~~~~~

High temperature points:	138
High temperature, low wind points:	0
High temperature, low wind, low tide points:	48
Number of rules triggered:	18

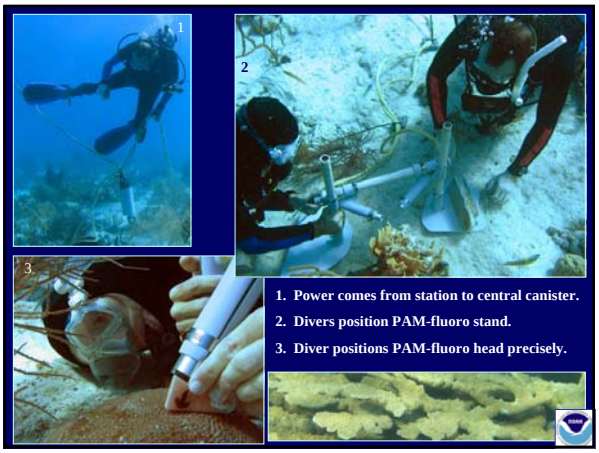
Pulse Amplitude Modulation (PAM) Fluorometry

- PAM-fluorometry data provide a measure of coral PSII health
- Provides early indication of coral bleaching prior to visible paling
- Usually measured with submersible diving PAM



BICU305	BICU330	BICU380	I-Depth	#1:PAR	#1:F	#1:Fm'	#1:Yield
				821	333	350	0.049
				78	268	315	0.15
				101	263	296	0.112
				-83	401	563	0.288
				64	647	1222	0.471
				24	630	1375	0.542
				0	336	833	0.597
				0	295	690	0.573
				0	263	633	0.585
				0	270	648	0.584
				0	248	583	0.575
				0	269	624	0.569
				0	238	568	0.581
				0	216	516	0.582
				0	217	512	0.577
				0	226	532	0.576
				0	220	523	0.58
				0	243	575	0.578
				0	244	587	0.585

Monstastrea faveolata
May 3-7, 2004
PAR data from PAM heads



1. Power comes from station to central canister.
2. Divers position PAM-fluoro stand.
3. Diver positions PAM-fluoro head precisely.

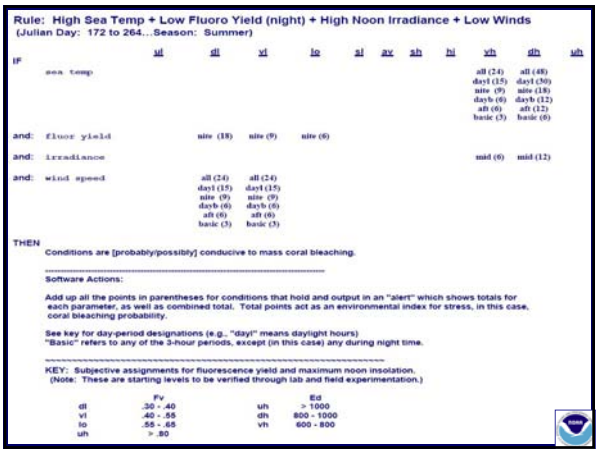
LSI CREWS station PAM-flurometery data

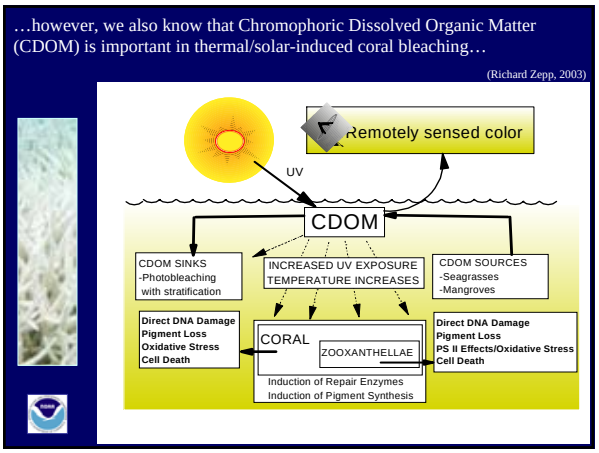
Meteorological and Insolation data…

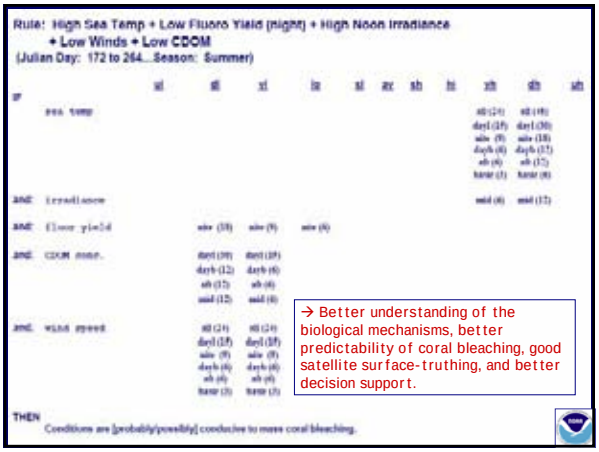
Date & Time				Meteorlogical Data					Surface Light Sensor				Underwater Light Sensor			
Date	jyear	jday	Hour	Baro	Air Temp	Wnd Spd	Wnd Dir.		BICS305	BICS330	BICS380	PAR-S	305 nm	330 nm	380 nm	PAR
1/28/2005	5	28	900	1018	21.7	19.5	62		0	0	0	0	0	0	0	0
1/28/2005	5	28	800	1018	21.7	20.4	58		0	0	0	0	0	0	0	0
1/28/2005	5	28	700	1019	21.8	20.5	64		0	0	0	0	0	0	0	0
1/28/2005	5	28	600	1019	21.9	20.5	60		0	0	0	0	0	0	0	0
1/28/2005	5	28	500	1019	21.8	19.2	75		0	0	0	0	0	0	0	0
1/28/2005	5	28	400	1019	21.8	20.6	64		0	0	0	0	0	0	0	0
1/28/2005	5	28	300	1019	21.6	21	63		0	0	0	0	0	0	0	0
1/28/2005	5	28	200	1019	21.6	20.8	59		0	0	0	0	0	0	0	0
1/28/2005	5	28	100	1018	21.5	20.7	57		0	0	0	0	0	0	0	0
1/28/2005	5	28	0	1018	21.5	19.5	34		0	0	0	0	0	0	0	0
1/27/2005	5	27	2300	1017	22.6	17.3	23		0	2	3	112	0	1	2	57

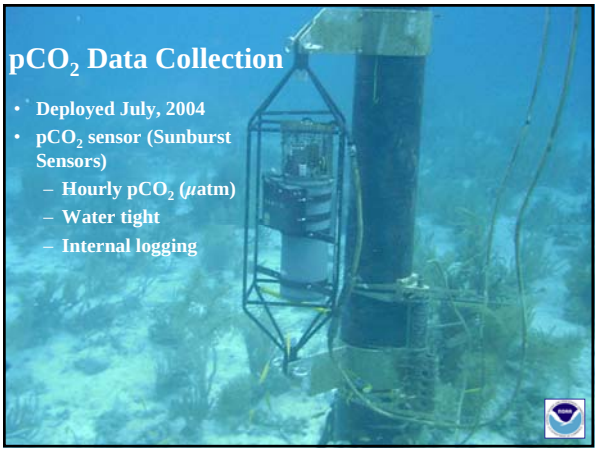
… as well as continuous oceanographic conditions and continuous PAM data on three different species…

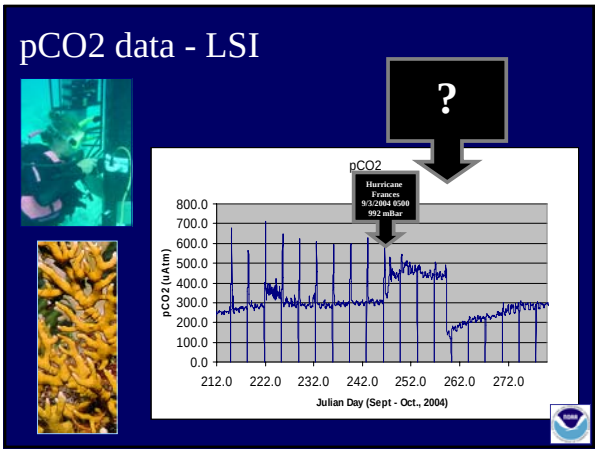
Upper CTD			Lower CTD			*Agaricia spp.*			*Porites asteroides*			*Sidastrea siderea*		
Depth (m)	SeaT3m	Sal	Depth (m)	Sal3m		PAM1 Fo	PAM1 Fm	PAM1Yield	PAM2 Fo	PAM2 Fm	PAM2Yield	PAM4 Fo	PAM4 Fm	PAM4Yield
1.273	23.3	36.99	5.143	37.07		442	954	0.537	587	1362	0.569	510	1145	0.555
1.309	23.8	36.95	5.176	36.96		462	1003	0.539	574	1333	0.569	513	1152	0.555
1.411	23.9	36.98	5.283	36.98		471	1021	0.539	611	1419	0.569	529	1169	0.547
1.55	24	36.96	5.417	36.98		465	1007	0.538	610	1419	0.57	519	1144	0.546
1.688	24.1	36.94	5.556	36.96		471	1022	0.539	616	1446	0.574	535	1172	0.544
1.788	24.1	36.97	5.659	36.98		477	1024	0.534	591	1380	0.572	544	1184	0.541
1.833	24.2	36.89	5.684	36.91		471	1014	0.536	583	1361	0.572	542	1174	0.538
1.765	24.2	36.97	5.628	36.9		471	1008	0.533	612	1488	0.589	533	1148	0.536
1.66	24.1	36.97	5.522	36.97		470	1002	0.531	604	1441	0.581	539	1152	0.532
1.53	23.5	37.06	5.391	37.07		479	993	0.518	676	1507	0.551	583	1209	0.518
1.429	23.1	37.11	5.274	37.16		509	916	0.444	826	1604	0.485	651	1162	0.44

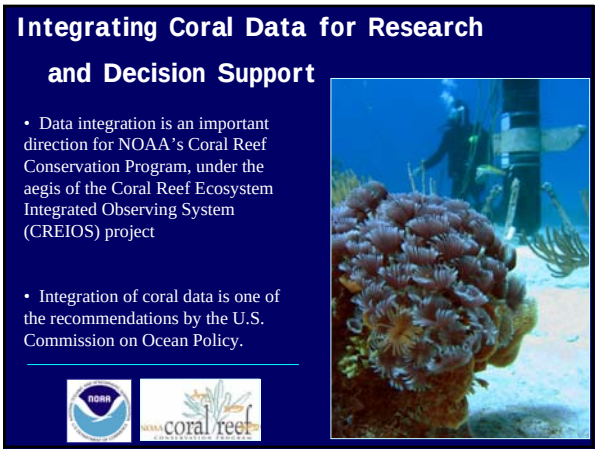

Rule: High Sea Temp + Low Fluoro Yield (night) + High Noon Irradiance + Low Winds
(Julian Day: 172 to 264...Season: Summer)
IF
sea temp
and: fluor yield
and: irradiance
and: wind speed
THEN
Conditions are [probably/possibly] conducive to mass coral bleaching.
Software Actions:
Add up all the points in parentheses for conditions that hold and output in an "alert" which shows totals for each parameter, as well as combined total. Total points act as an environmental index for stress, in this case, coral bleaching probability.
See key for day-period designations (e.g., "dayl" means daylight hours)
"Basic" refers to any of the 3-hour periods, except (in this case) any during night time.
KEY: Subjective assignments for fluorescence yield and maximum noon insolation.
(Note: These are starting levels to be verified through lab and field experimentation.)
Fv
dl .30 - .40
vl .40 - .55
lo .55 - .65
uh > .80
Ed
uh > 1000
dh 800 - 1000
vh 600 - 800


…however, we also know that Chromophoric Dissolved Organic Matter (CDOM) is important in thermal/solar-induced coral bleaching…
(Richard Zepp, 2003)
Remotely sensed color
UV
CDOM
CDOM SINKS
-Photobleaching
with stratification
INCREASED UV EXPOSURE
TEMPERATURE INCREASES
CDOM SOURCES
-Seagrasses
-Mangroves
Direct DNA Damage
Pigment Loss
Oxidative Stress
Cell Death
CORAL
ZOOXANTHELLAE
Induction of Repair Enzymes
Induction of Pigment Synthesis
Direct DNA Damage
Pigment Loss
PS II Effects/Oxidative Stress
Cell Death


Rule: High Sea Temp + Low Fluoro Yield (night) + High Noon Irradiance
+ Low Winds + Low CDOM
(Julian Day: 172 to 264...Season: Summer)
IF
sea temp
and: irradiance
and: fluor yield
and: CDOM conc.
and: wind speed
THEN
Conditions are [probably/possibly] conducive to mass coral bleaching.
→ Better understanding of the biological mechanisms, better predictability of coral bleaching, good satellite surface-truthing, and better decision support.


pCO2 Data Collection
• Deployed July, 2004
• pCO2 sensor (Sunburst Sensors)
– Hourly pCO2 (μatm)
– Water tight
– Internal logging


pCO2 data - LSI
?
pCO2
Hurricane Frances 9/3/2004 0500 992 mBar
pCO2 (uAtm)
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
212.0
222.0
232.0
242.0
252.0
262.0
272.0
Julian Day (Sept - Oct., 2004)


Integrating Coral Data for Research and Decision Support
• Data integration is an important direction for NOAA's Coral Reef Conservation Program, under the aegis of the Coral Reef Ecosystem Integrated Observing System (CREIOS) project
• Integration of coral data is one of the recommendations by the U.S. Commission on Ocean Policy.
NOAA
coral reef

***Integration, timeliness* and *information products* are key concerns of the U.S. Commission on Ocean Policy:**

Recommendation 26–9. Congress should fund the *Integrated Ocean Observing System (IOOS)* as a line item in the National Oceanic and Atmospheric Administration (NOAA) budget, to be spent subject to National Ocean Council direction and approval. IOOS funds should be appropriated without fiscal year limitation. NOAA should develop a streamlined process for distributing IOOS funds to other federal and nonfederal partners.

Recommendation 15-4. The National Oceanic and Atmospheric Administration, U.S. Geological Survey, and U.S. Environmental Protection Agency, working with other appropriate entities, should *ensure that water quality monitoring data are translated into timely and useful information products* that are easily accessible to the public and *linked to* output from the *Integrated Ocean Observing System*.

Recommendation 21–4. The *U.S. Coral Reef Task Force should identify critical research and data needs* related to coral reef ecosystems. These needs should guide agency research funding and be incorporated into the design and implementation of the *Integrated Ocean Observing System*.

The new generation of CREWS will utilize a new data integration and inferencing tool called G2 (by Gensym Corp.), used by…

- **NASA**
- **CIA**
- **FBI**
- **NSA**
- **NRO**
- **DOD**
- **FAA**
- **USAF**
- **USN**
- **DOE**
- **Biosphere II**
- **the Army's Knowledge Engineering Group**
- **the Joint Chiefs Decision Support Group**
- **the Defense Information Systems Agency**
- **the Joint Intelligence Center**
- **Boeing**
- **European Space Agency**
- **Inmarsat**
- **Intellsat**
- **Lockheed**
- **SatComm**
- **Iridium, and others**

- The G2 architecture will integrate data, images and documents from all *in situ*, biological and satellite stations, as well as from historical data (e.g., paleoecological data).
- Data will be served on the Web via custom application developed at AOML, ***and*** (more importantly) can be developed and manipulated remotely (e.g., at NASA, the Florida Keys National Marine Sanctuary, NOAA HQ, etc.) to provide for *custom* views of the data pool.
- Predictions, reports, alerts, etc. can be made using expert system inferencing and/or neural network within this architecture, in real-time, or not, as necessary.
- Backward chaining is an important and powerful feature.

New Web interface will integrate data from CREWS, CRED, AIMS, and SEAKEYS stations, satellite data, and other resources, using G2, and will still issue alerts as before, providing for greatly increased *modeling* power.

G2 can also be used for scheduling (good for logistics), and *disaster management*, which will make it of use to AOML's Hurricane Research Division, and hopefully other organizations.

Example page for Sombrero Key data request, to obtain integrated "raw" near real-time *in situ* and satellite data, as well as biota data.

- User clicks on data type and date range for the data, then clicks the Submit button at the bottom of the page.
- Data are returned in tabular format, and spreadsheet ready (as in IMN).
- User clicks on image to obtain biological data, and station images (above, below).

Example page for G2 products, and station and satellite information updates.

User Login: different access privileges for other menu choices.

Station: Details, info updates, links to maps, Landsat and other images.

Sensors: Metadata, calibration info, updates.

Biota: Latest monitoring data, links to more info.

Graphs: Wealth of x/y, scatter and other plots, of all variables.

Alerts: Latest bleaching and other alerts (next slide).

Rules: For Knowledge Engineers, and the curious.

Many Permutations ➡ Alert ≈ Threshold Environmental Indices ≈ Model Output

- Environmental stress-induced coral bleaching: high sea temp, light, CDOM, etc.
- Harmful (or other) Algal Bloom: sea temp, phytoplankton pigment(s), wave height, currents, nutrients, automated DNA sensor (e.g., Dr. Kelly Goodwin of AOML) etc.
- Coral growth: optical micrometer (Dr. Chris Langdon), pCO_2, pH, Talk, and/or O_2 kinetics, light, clouds, sea temp.
- Disease possibility/probability: sea temp, nutrients, currents, suspended sediments.
- Critical period concept (fishery success, ala Lasker, Feder, Theilacker and May [1971]): extended low winds + high light => concentrated phytoplankton bloom => concentrated zooplankton swarm => successfully feeding larval fish within CP.
- Larval drift predictions: need knowledge of larval life, currents, survival curves via temp/salinity combinations (e.g., Belize supplies larvae for spiny lobster).
- Migration cues: day length plus currents plus temperature clues, plus lunar period, plus…whatever.

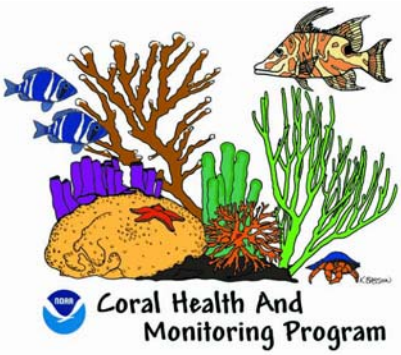
Theoretically possible model outputs (continued)…

- Ship intrusion into Sanctuary: Automatic Identification System Rule
- High effluvial input to reef: high sedimentation, lowered salinity, offshore transport.
- Seismic measuring devices: tsunami early warning [TSEWS?]
- Change in bottom topography (lots of "training" of neural network required), habitat change.
- Backward chaining: not predictive, but after something happens, automated look up for "chained" rules that may indicate cause(s).
- "Blackwater" and low-salinity lens intrusion (e.g., from Everglades).

So, we have one approach for integration--into a single user interface and information pool--for any number of data sources. What we *don't have* are the questions, and the basic knowledge from field and laboratory-based research.

Knowledge Engineering (the encoding of knowledge into an expert system) requires:

- the proper questions to ask
- the answers or models for the questions, based on research
- domain expert guidance and continuing user feedback
- very clean data, updated often
- ***research and integration partners!***



Coral Reef Early Warning System

Perry Institute for Marine Science

Caribbean Marine Research Center

D. Albrey Arrington, Ph.D.
Science Director

PIMS' Mission

Conduct and support innovative research and education that advance stewardship of our oceans and coastal ecosystems

PIMS Conducts Science

- Focus of in-house research programs:
  - Fisheries
  - Coral reefs
  - Ecosystems
  - Marine biodiversity

PIMS Supports Science

- CMRC, as part of PIMS, functions as NOAA's Undersea Research Center for the Caribbean region

As a NURP Center, CMRC Supports Research

CMRC Supports Research

NURP Centers 2002-2004

NOAA's Undersea Research Center	Human Occupied Submersibles	Remotely Operated Vehicles	Nitrox/SCUBA	Researchers	Institutions
Northeastern United States and Great Lakes Center at University of Connecticut	8	320	133	577	184
Mid-Atlantic Center at Rutgers University	0	42	532	150	34
Southeastern United States and Gulf of Mexico Center at University of North Carolina	106	353	23157	926	212
Caribbean Center at Caribbean Marine Research Center	0	0	10974	311	74
West Coast and Polar Regions Center at University of Alaska	177	189	2149	390	134
Hawaii and Western Pacific Center at University of Hawaii	204	134	0	122	59
Totals	495	1038	36945	2476	697

Current Capabilities

- Support 3000 to 5000 scientific dives per year
- More than 100 cylinders of various sizes on hand
- Unlimited air, Nitrox, and Trimix
- Spring 2005 Trimix training to 300'!

Safety/Emergency Support

- Recompression Chamber
- All staff have been trained in Dive Rescue Accident Management
- All staff trained in Oxygen first aid for diving accidents

CMRC Technical Diving Training Center for Scientific Diving

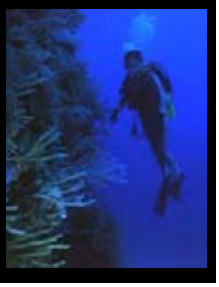
- Perfect environment(s) for technical diving training (i.e. deep water research sites within 5 minutes of the dock, same with deep caves
- Current infrastructure can support this technology, and we are increasing our capabilities
- Ability to support research in these environments AND train divers and instructors

CMRC Potential Collaborations

- Look for synergies among funding opportunities
- Comparative studies
  - Site comparisons
    - LSI as a reference site (minimal impacts)

CMRC Potential Collaborations

- Look for synergies among funding opportunities
- Comparative studies
  - Research Cruises
    maximize benefits of available resources
  - Advancing and applying new technologies: exploration of the deep fore reef



Questions?

Laboratory Support ~32,800sq ft

- Environmental Chemistry (12,375 net sq ft)
- Molecular Biology & Physiology (11,508 net sq ft) including BSL 3 capability
- Cryogenic Storage (3,800 net sq ft) including National Marine Specimen Bank
- Aquatic Production (5,147 net sq ft) including settled and raw seawater

Science Focus

To provide the science and biotechnology to understand linkages between environmental condition of the oceans and organism and human health.

Research Initiatives

- **Emerging Chemicals of Concern:** What are the appropriate methods for measuring emerging chemicals? What are their ecotoxicological impacts (molecules to ecosystems)?
- **Marine Analytical Quality Assurance:** What reference materials and methods are needed to improve the quality of analytical measurements in the marine environment? What materials need to be cryogenically archived for looking backward at pollution trends?

Research Initiatives

- **Marine Genomics:** What genes are influenced by environmental challenges? What assays best measure organism health and exposure?
- **Acquired Environmental Resistance:** What are the sources and causes of ACR? What is the persistence of ACR in the environment? What are the environmental and health risks associated with ACR? How can these risks be limited?

Research Initiatives

- **Harmful Algae Blooms:** What are the harmful algae of concern in the for Southeastern barrier island estuaries? How to they relate to human activities on the land?
- **Natural Products Chemistry:** What is the chemical structure of biotoxic molecules and how does the structure relate to the mode of activity?

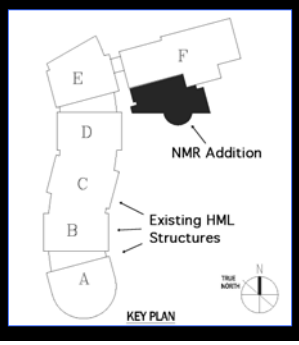
Research Initiatives

- **Animal Production & Seafood Safety:** Is stock enhancement a viable technology for restoring overfished stocks and expanding fishing opportunities? What is the appropriate method?

Research Initiatives

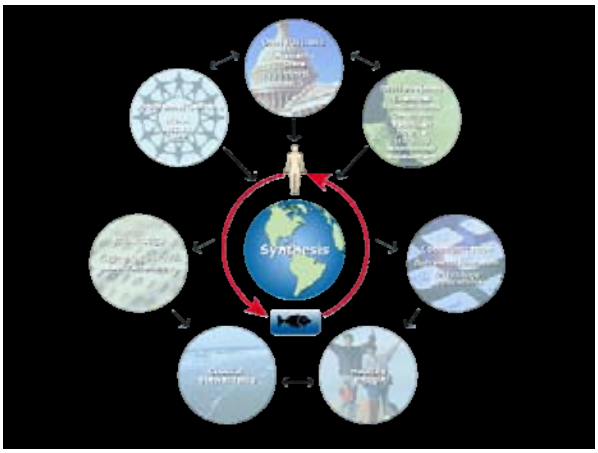
- **Field Validation of Indicators:** Do field responses of environmental indicators pattern laboratory responses? How can the specificity and reliability of indicator responses be improved?
- **Synthesis and Integration:** What are the most effective and efficient technologies for synthesizing the information contained in large, complex data sets?

Nuclear Magnetic Resonance Addition



Nuclear Magnetic Resonance Addition

- Structural chemistry
- Natural products chemistry
- Cancer research
- Environmental toxicology

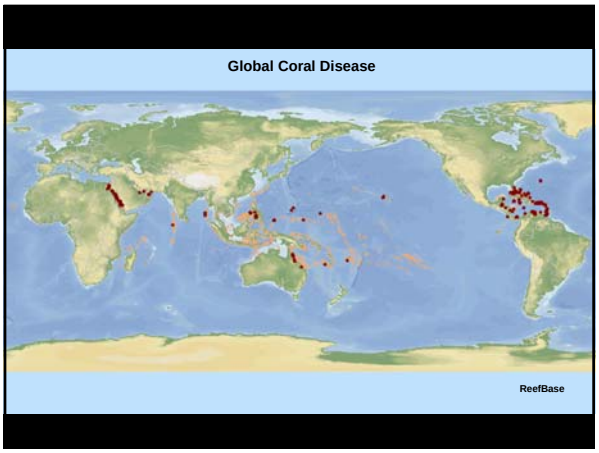


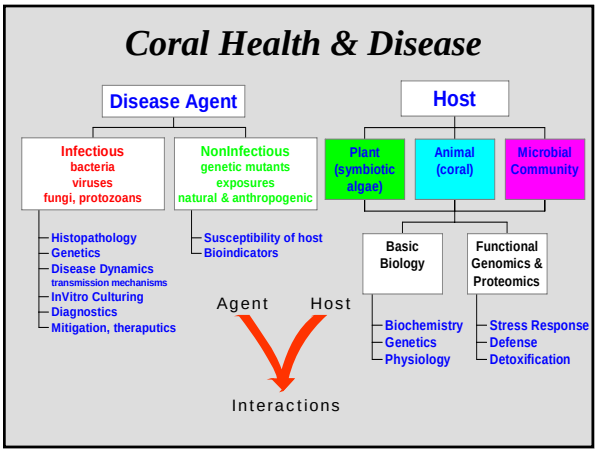
Ecosystem Health

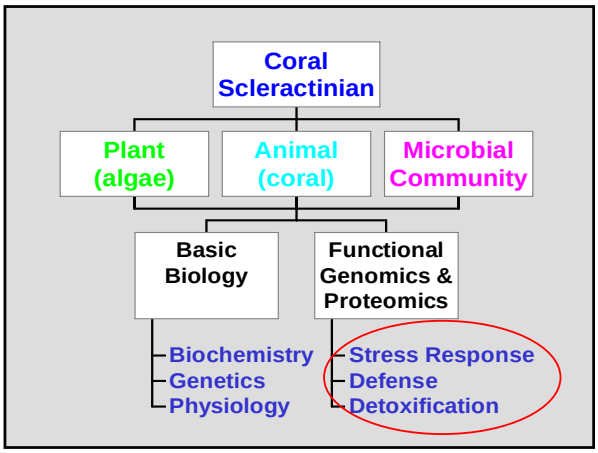
Coral Reefs

NOS CCEHBR

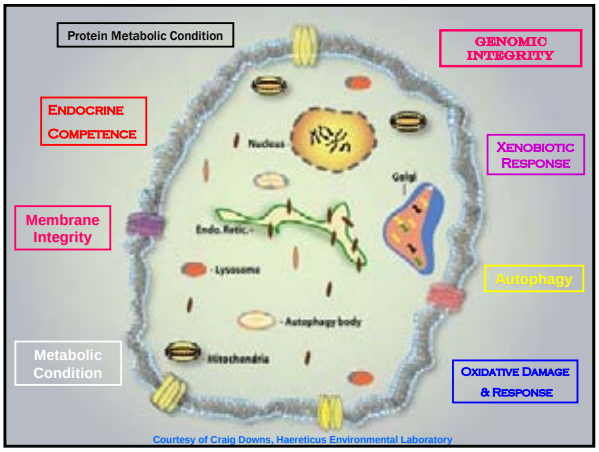
Coral Health and Disease Program







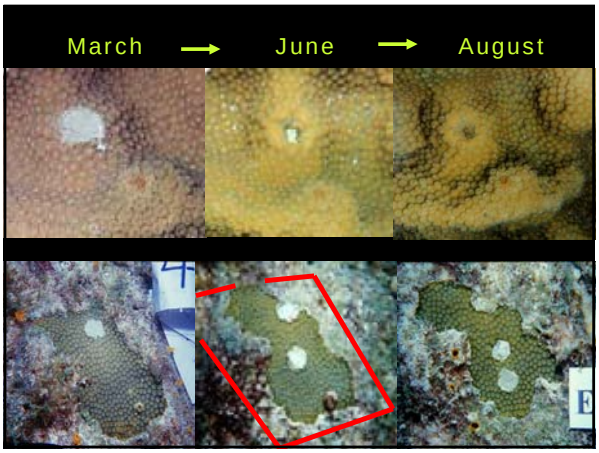
Cellular Diagnostics



Project Approach

Ecosystem
Community
Species
Population
Individual
Organ
Tissue
Cell ← *Stress*

Community Assessments *(Fisher)*
Foraminiferal Condition *(Hallock, Fisher)*
Coral Lesions and Regeneration *(Fisher)*
Cellular Diagnostic System (CDS)
(NOAA and EnVirtue)
Environmental Assessments
(Fisher and NOAA)



Proteomic Development
Biomarker Discovery

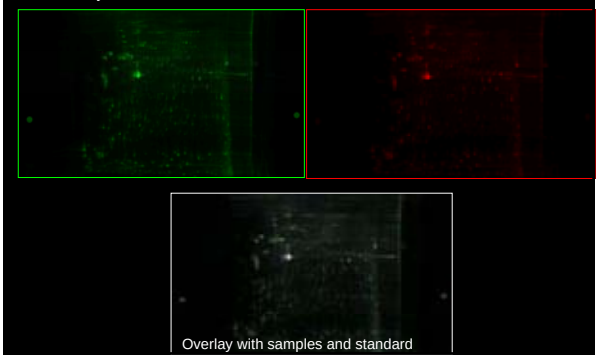
2-Dimensional Gel Electrophoresis can demonstrate differential changes in protein quantity and physiologically relevant modifications between samples of interest

Mass spectrometry can be used to characterize differentially expressed or modified proteins

Scanned 2D gel

Healthy Control

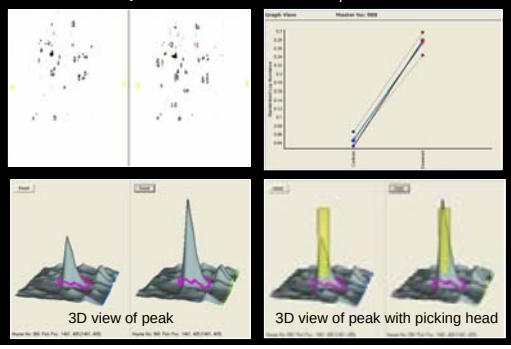
Diseased sample



Processed 2D-gel

Gel view after analysis

Relative protein levels



Genomics

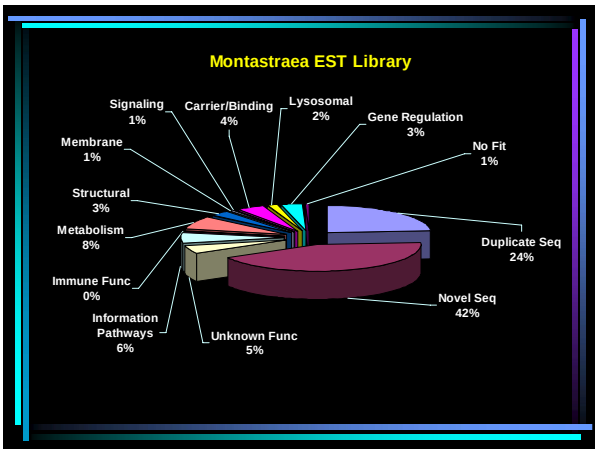
Genomic approach

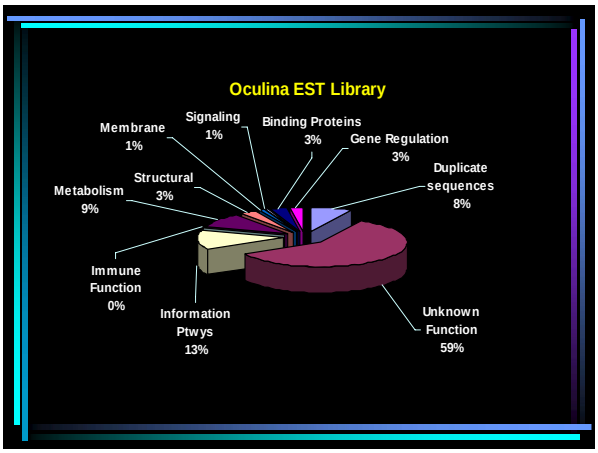
- Host-Pathogen-Environment interactions results in shifts in gene expression.
- Subtractive Library Construction and Characterization to Identify Genes of Interest
- Expressed Sequence Tags (ESTs) for Diagnostic Development

Summary of Coral EST Clones

Species	# of ESTs
M. annularis	2467
O. varicosa	417
P. porites	247

Sequences available at http://www.marinegenomics.org/

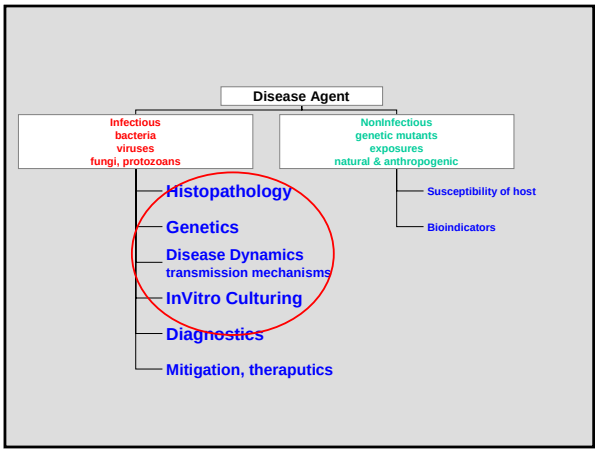




Coral Genome Sequencing

- Coral genome sequencing: *Porites lobata & Acropora palmata*
  National Human Genome Research Institute
  (G. Ostrander, PI)

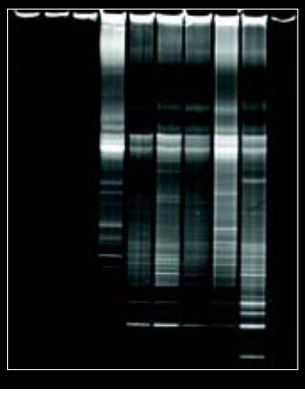
Microbial Community Analyses



Microbial Community Analyses

- Microbial Ecology of Gorgonian Mucus- healthy and diseased & quorum sensing
- Microbial Community Analysis of Deep Sea Coral
- Establishing the validity of microbial community shifts as indicators of coral condition
- Investigating the role of intra-tissue bacterial aggregates in health and disease of Acropora

DGGE



Microbial Diversity of Deep Water Coral

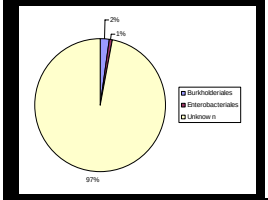
- *Fanellia* sp. a deep water gorgonian collected from the Adak Canyon off the coast of the Aleutian Islands
- Microbial communities assessed by 16s rDNA gene libraries
- Preliminary data supports the hypothesis that microbial diversity increases in response to stress or disease.

Healthy *Fanellia sp.*

'Diseased' or damaged *Fanellia* sp.

Coral Associated Microbial Community Analysis

A Healthy *Fanellia* sp. (n=94) 80% conf



B Diseased/Damaged *Fanellia* sp. (n=94) 80% conf.

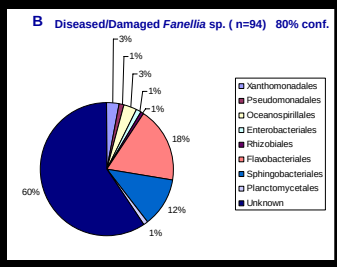
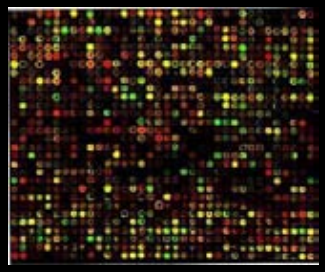


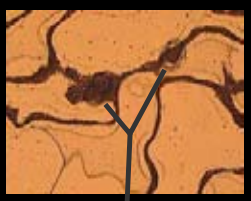
Fig 1. Percentages of 16s DNA clones (n=94) classified into phylogenic orders. **A**.) Microbial diversity of an apparently healthy sample of *Fanellia* sp. coral. **B**.) Microbial diversity of a damaged or possibly diseased *Fanellia* sp. coral. Data analized with the Ribosomal Database Project II classifier tool (Michigan State University) with an 80% confidence level (Cole, *et al.*, 2003).

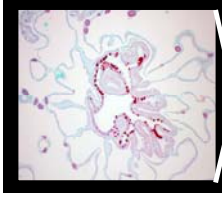
Functional Genomics

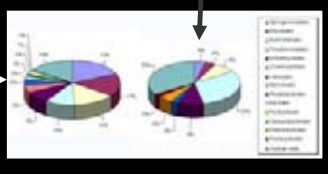
DNA microarray



Acroporid coral mortality in the Florida Keys and Dry Tortugas







To better understand how to conserve coral reef ecosystems, we not only must determine their health on a community scale, but understand the underlying mechanisms on an molecular and cellular scale.

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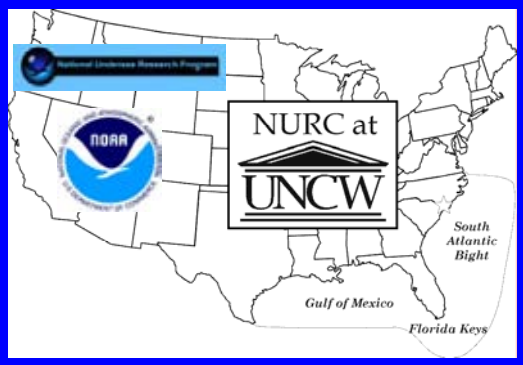
NOAA's Undersea Research Center



UNCW's National Undersea Research Center

World-class environmental science program

Science Directive

- NOAA Strategic Plan for FY 2003-2008
- NURP Science Guidance Document
- Florida Keys National Marine Sanctuary

Funding process

- RFP in April
- Proposals due in August
- Independent peer review panel in November
- Select projects based on peer review and our funding levels
- We provide small subcontracts in addition to operational and facility support

Leveraging Center Resources

- **Cooperative Agreement with FKNMS**
  - **ship grounding, keys-wide coral reef expedition, monitoring marine protected areas**
  - **boats**
- **NOAA**
  - **NMFS (fisheries work in Keys and Dry Tortugas)**
- **EPA**
  - **Logistical support to special studies program/NCORE**
- **USGS**
  - **Cooperative programs out of St. Petersburg**

NASA Partnership

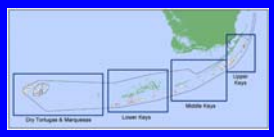
- NEEMO
- Canada- Center for Minimal Access Surgery

NURC Florida Program

- **Established 1991**
- **Research support unique in the Keys**
- **Useful research to support FKNMS**
- **Significant partnerships**
- **Substantial resource leveraging**
- **National educational and outreach opportunities**

Florida Dayboat Program

- Mission support for science groups up to eight divers
- Cover an area from Miami to Key West, oceanside and bayside
- Use Nitrox to increase bottom time
- Provide Nitrox training
- Provide technical assistance for equipment deployment and retrieval



Florida Dayboat Program

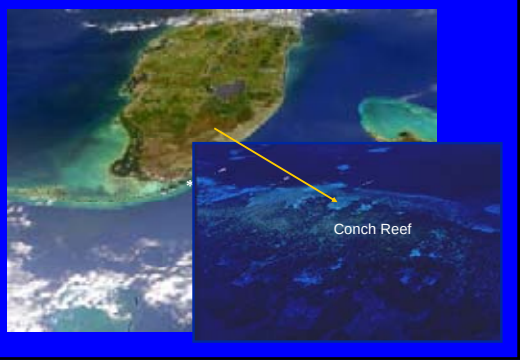
- Provides vessel (24 – 42 feet)
- Captain/ divemaster
- Dive gear(tanks, weights, BC's, regulators)
- Lab space
- Accommodations for twenty scientists

Aquarius Underwater Laboratory

Aquarius

- 43 feet long by 9 feet in diameter
- Houses 4 scientists and 2 NURC staff
- 4 miles from shore in 62 feet of water
- "Hatch depth" is 47 feet

Aquarius Undersea Laboratory: Located in the Florida Keys National Marine Sanctuary



Saturation Diving

- Nearly unlimited bottom time compared to surface-based operations
- 24 hour access to environment
- Capability to power equipment from Aquarius to outside
- Electronic and computer capability to control equipment, record data, and access internet
- Decompress for 16 ½ hours

Risk Management

- Training – 4 to 5 days of equipment familiarization and safety briefings
- Equipment inspection and maintenance
- Protocols
- Supervision – 24hr oversight of all operations

Life Support Needs: Living and working underwater

- Atmospheric Control
  - Carbon Dioxide Removal
  - Air Supply
- Communication
  - Voice
  - Video
  - Computer/Telemetry
- Food and Water
- Waste Disposal
- Power
  - A/C
  - D/C Emergency
- Comfort
  - Air Conditioning
  - Dehumidification

Life Support Buoy

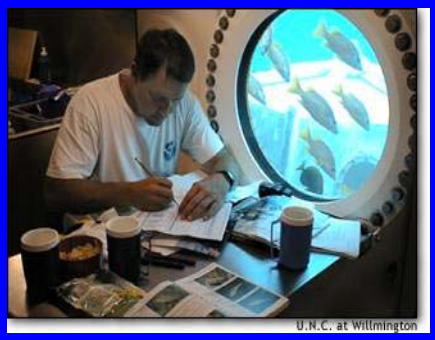
Inside the LSB: Generators and Compressors

Aquarius interior

Wet Porch with Supply Delivery

Main Lock

Galley Table and Large Viewport

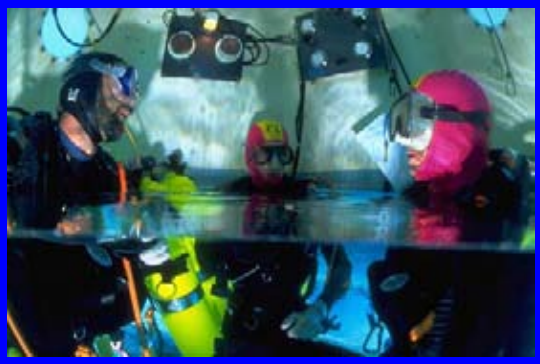


Galley and Berthing Area

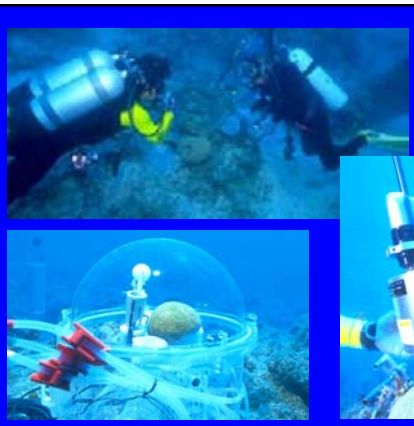
Early Morning Commute to the Reef

Underwater fill stations and communications

Underwater fill station



Scientists at work

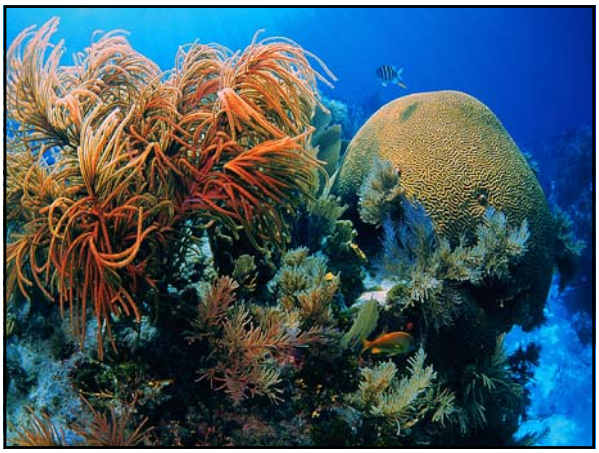


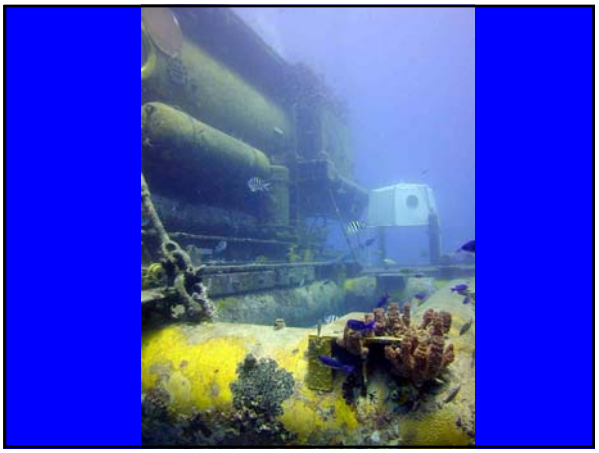
Science Achievements: Value of Research to FKNMS

- Determined patterns of nutrient input throughout Keys using instruments and indicator organisms
- Detected pollution from septic systems and injection wells
- Distribution, abundance, and potential causes of coral diseases
- Long-term underwater uv monitoring program
- Discovery of benthic foram bleaching
- Coral and sponge biology: feeding, growth, and reproductive studies
- Long-term monitoring of coral reef condition and fisheries in MPAs

Education and Outreach

- Aquarius presentations to schools, museums, and aquariums: Education Coordinator, NASA
- TV - National Geographic, Discovery Channel, ABC News 20/20, NBC Today Show, CNN, Learning Channel
- Print - Scientific American, National Geographic Magazine, Weekly Reader, LA Times, and much more





September 11, 2001

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Center for Sponsored Coastal Ocean Research
Coastal Ocean Program

Grants Management Update

Coral Reef PI Meeting
March 23-24, 2005
Ft. Lauderdale, FL

Updates from Hawai'i Meeting

- Continuations (both standard and Multi-year) due to GMD earlier, based on appropriation signed date (60 days for Multi-years, 90 days for standard continuations, 150 days allowed for new non-competitives)

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  - Rollout to recipients pending

GRANTS.GOV℠

FIND. APPLY. SUCCEED.℠

The Grants.gov Program is…

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- One of 24 Federal cross-agency E-Government initiatives designed to improve access to services via the Internet
- Managed by the Department of Health and Human Services, the largest provider of Federal grants

Grants.gov Provides Robust Functionality for the Grant Community

- Find Grant Opportunities
  - Search for available grant opportunities
  - Register to receive notification of grant opportunities

Grants.gov Provides Robust Functionality for the Grant Community

- **Find Grant Opportunities**
  - **Search for available grant opportunities**
  - **Register to receive notification of grant opportunities**
- **Apply for Grants**
  - **Search for and download application packages**
  - **Complete application packages offline**
  - **Submit completed application packages**
  - **Track the status of submitted applications**

"Find Grant Opportunities" features…

- **Flexibility to search on numerous criteria**
  - **Active and archived documents**
  - **Funding opportunity number**
  - **Dates and time frames**
  - **CFDA number**
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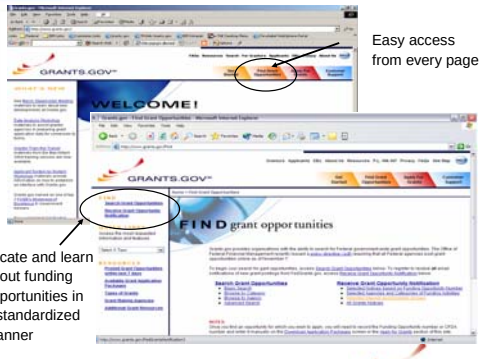
- **Email subscription service to receive email notification of all or select funding opportunities (e.g., CFDA #, agency, activity category)**

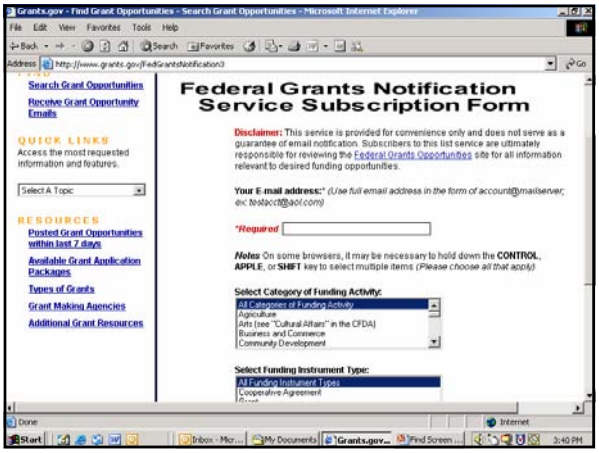
The "Find" tools…



Easy access from every page

Locate and learn about funding opportunities in a standardized manner

GRANTS.GOV



Preparing to Apply via Grants.gov: Overview

- **Preparing to Apply for grants via Grants.gov opportunities is a 3-step process**

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Get your authorized users "prepared to apply" today!
Grants.gov registration/authentication processes may take 7 days!

Grants.gov streamlines the process for applying for grants

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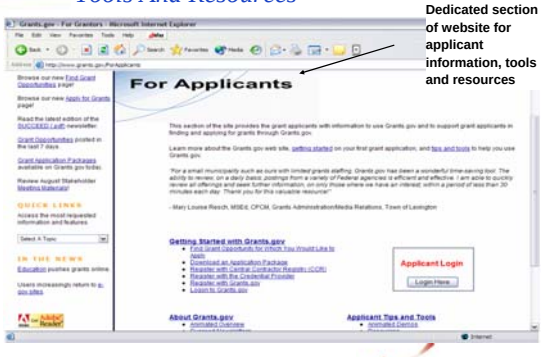
Grants.gov provides Grant Community Tools And Resources



Dedicated section of website for applicant information, tools and resources

SF-424 Research & Related

- **Government-wide Form, SF-424 R&R**

SF-424 Research & Related

- **Government-wide Form, SF-424 R&R**
  - **Federal Register Notice published on Sept. 3, 2004**

SF-424 Research & Related

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  - **OMB Approval Expected March 30, 2005**

SF-424 Research & Related

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  - **See handout for draft copy**

Grants.gov Resources

- **Applicant Training Demonstration - Complete Application Package**
  http://www.grants.gov/CompleteApplication#demo
- **Customer Online User Support**
  http://www.grants.gov/CustomerSupport
- **Outreach Communication Resources**
  http://www.grants.gov/Communications
- **Customer Feedback Findings Reports**
  http://www.grants.gov/MarketResearch

NOAA Grants Online

What Grants Online is Not

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- **NOT Grants.gov**

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  - **Specific to NOAA only**
  - **May expand to DOC-wide system in future (1-3 years)**

What Grants Online is Not

- **NOT Grants.gov**
  - **Grants.gov is the front-end for applicants**
  - **Prior to award, you are applicants**
  - **Only NOAA personnel, proposal reviewers and grant awardees interact with Grants Online**
  - **Specific to NOAA only**
  - **May expand to DOC-wide system in future (1-3 years)**
  - **May be replaced by government-wide system (5-7 years)**

WHAT IS GRANTS ONLINE?
NOAA Program Office Grants Management

- **NOAA Program Managers Develop and publish Federal Register Notices and Federal Funding Opportunities through Grants Online**

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  - Preparation of award materials

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- Grant Award Processing
  - Award document preparation
  - Clearances through multiple DOC and NOAA offices

WHAT IS GRANTS ONLINE? NOAA Recipient Grants Management

- NOAA Award Recipient Grant Management

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- NOAA Award Recipient Grant Management
  - Recipient Acceptance of Award
    - Agreement to terms of CD-450 or CD-451

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    - Financial Reports
    - Project Progress Reports

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- NOAA Award Recipient Grant Management
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    - Agreement to terms of CD-450 or CD-451
  - Reporting
    - Financial Reports
    - Project Progress Reports
  - Award Maintenance
    - Award Action Requests and Approvals
      - No Cost Extensions (Regular and Expanded Authorities)
      - Change in scope of work
      - 17 others (including “Other”)

Training

- Recipient Implementation Assistance

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  - One Authorized Representative Identified (see handout for user role definitions)

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Training

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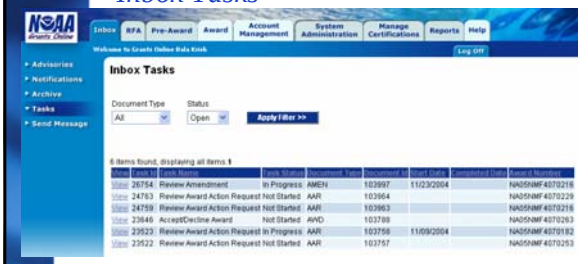
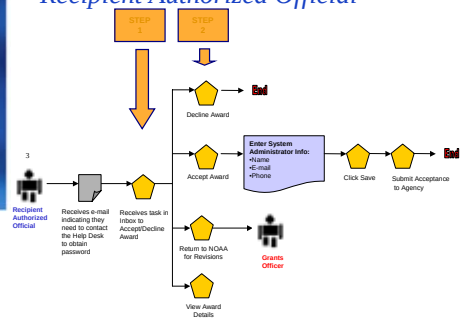
    - **Recipient system administration training Webinar**
  - **All active awards set up for recipient**
  - **RSA sets up all recipient users**
  - **Recipient users review recorded Webinar**
    - **Text User's Guide also available**
  - **Grants Online help desk available for issues**
    - **8:00 AM to 8:00 PM Eastern**

Startup Screen

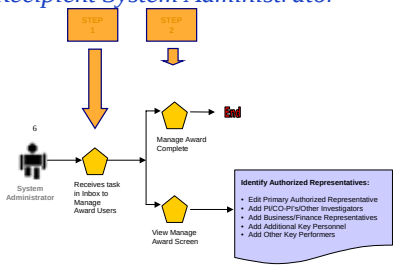
Inbox Tasks



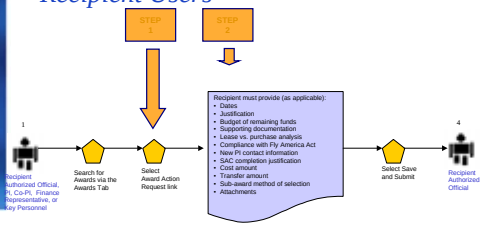
Accepting the Award: Role of Recipient Authorized Official



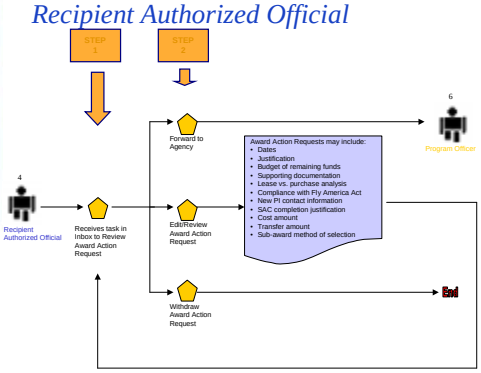
Managing Award Users: Role of Recipient System Administrator



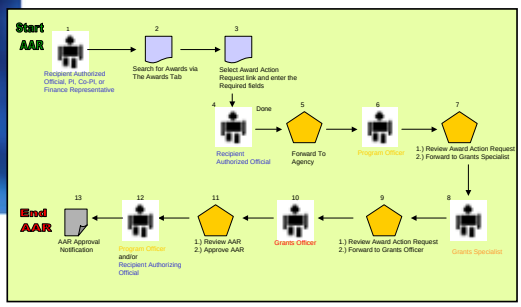
Award Action Requests: Role of Recipient Users



Award Action Request: Role of Recipient Authorized Official

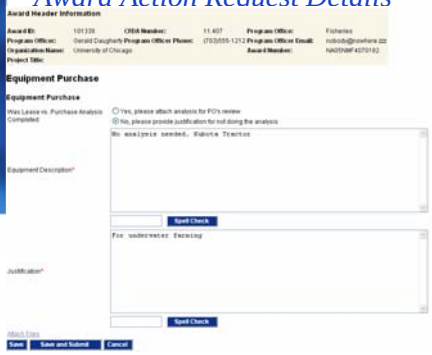


Workflow Overview – Award Action Requests



Initiate Award Action Request

Award Action Request Details



Award Action Request Workflow

Grants Online Deployment

- **Deployed to Program Offices January 2005**

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  - Need to clean up data migration for "organizations"

Helpful Websites and Email Addresses

- Grants Online Website
  - Looking For More Information About Grants Online?
    - Go to the Grants Online website at www.ofa.noaa.gov/~grantsonline
  - Have Questions About Grants Online?
    - Send questions to GrantsOnlineQandA@NOAA.gov
  - Looking for Grants Online Training?
    - Click the Grants Online Training tab on the website to view the recipient webinar
  - How Do I Obtain a Username and password?
    - Contact the Grants Online Help Desk
    - By Phone: 1-866-DOC-Grants
    - By Email: grantsonline.helpdesk@noaa.gov

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NOAA Coral Reef Conservation Program

National Oceanic and Atmospheric Administration
March 24, 2005

NOAA Coral Reef Conservation Program

Mission:	Conserve coral reef ecosystems
Goal:	Effective management to reduce threats to reef ecosystems
Strategy:	U.S. National Action Strategy (13 goals)
Reqmts:	Coral Reef Conservation Act (6 actions) U.S. Coral Reef Task Force (E.O. 13089)
Structure:	Cross-NOAA collaboration since 2000 Specific funding: $28.7 M FY2005 Formal matrix program

History of U.S. Action

1994 International Coral Reef Initiative established.
All Islands Coral Reef Initiative established.
International Year of the Reef.
U.S. Coral Reef Task Force, Executive Order 13089.
2000 1st U.S. National Action Plan to Conserve Coral Reefs.
New NOAA funding: $6 M
Coral Reef Conservation Act of 2000.
2001 NOAA funding: $27 M
2002 NOAA funding: $28.25 M
2003 NOAA funding: $26.25 M
2004 NOAA funding: $ 26.85M
2005 NOAA funding: $28.74 M
2006 NOAA funding request: $1.5 M increase for Local Action Strategy Support

Coral Reef Conservation Program: NOS Responsibilities

1. Interagency: Help lead and staff the U.S. Coral Reef Task Force
2. Legislative: Lead implementation of Coral Reef Conservation Act of 2000
3. Financial: Manage NOS coral funds ($27.6 M)
4. NOAA: Lead NOAA Coral Reef Matrix Program (Matrix Manager)

NOS Role #1: US Coral Reef Task Force

Members 12 Federal Agencies
7 States, Territories, Commonwealths
3 Freely Associated States

Tasks: lead and support U.S. Coral Reef Activities
map and monitor U.S. coral reefs
research coral reef degradation
reduce and mitigate coral reef loss
review existing authorities and navigational aids
assess U.S. international role in coral reef protection
promote conservation and sustainable use of coral reef ecosystems worldwide

Actions: U.S. National Action Plan (2000)
New Initiatives, such as Local Action Strategies
Increased Inter-Agency Coordination
Report to Congress: Progress Report

National Action Plan to Conserve Coral Reefs (2000)

Understand Coral Reef Ecosystems:

Goal 1: Map all U.S. coral reefs
Goal 2: Assess, monitor and forecast reef health
Goal 3: Conduct strategy research
Goal 4: Understand social and economic factors

Reduce Impacts of Human Activities:

Goal 5: Improve use of MPAs
Goal 6: Reduce impacts of fishing
Goal 7: Reduce impacts of coastal uses
Goal 8: Reduce impacts of pollution
Goal 9: Restore damaged reefs
Goal 10: Improve outreach and education
Goal 11: Reduce threats to intl reefs
Goal 12: Reduce impacts from intl trade
Goal 13: Improve coordination and accountability

NOS Role #2:
Coral Reef Conservation Act of 2000

Establish and implement for NOAA:

1. National Coral Reef Action Strategy
2. Coral Reef Grants Program
3. Coral Reef Conservation Fund
4. Emergency Response Grants
5. National Coral Reef Program
6. Reporting Requirements

Coral Reef Conservation Act of 2000

1. National Coral Reef Action Strategy

- Report to Congress (Oct 2002)
- Produced by NOAA and the Coral Reef Task Force
- Assesses priority threats by region
- Two year strategy to address threats
- Addresses 13 goals of the U.S. National Action Plan to Conserve Coral Reefs

Coral Reef Conservation Act of 2000

2. Coral Reef Grants Program

- Established in 2002
- Joint NOS/NMFS/OAR competitive matching grants
- Management, monitoring, research, international
- Many partners: States, Territories, FMCouncils, etc
- FY04: $8.4 M

3. Coral Reef Conservation Fund:

- Established 2002 with National Fish and Wildlife Fndn
- Leverage non-Federal resources and build private-public partnerships for coral reef conservation.
- Since 2002: $2.7 M NOAA + $4.8 M match = $7.5 M
- 84 projects, 15 countries

Coral Reef Conservation Act of 2000

4. Emergency Response Grants

- Authorizes grants for emergency situations

5. National Coral Reef Program

- Support for NOAA's role in the National Action Plan
- Fulfill NOAA's Federal Responsibilities
- Cross-NOAA planning and coordination
- Formal Coral Coordination Team
- Joint Annual Spend Plans (NOS, NMFS, OAR, NESDIS), Outyear initiatives

Coral Reef Conservation Act of 2000

6. Reporting Requirements

- Grants Effectiveness Report – Delivered to Congress, December 2004
  - Provides state-by-state summary of Federal and non-Federal contributions
- National Program Progress Report – Anticipated delivery to Congress, April 2005
  - Currently in final clearance with NOAA HQ

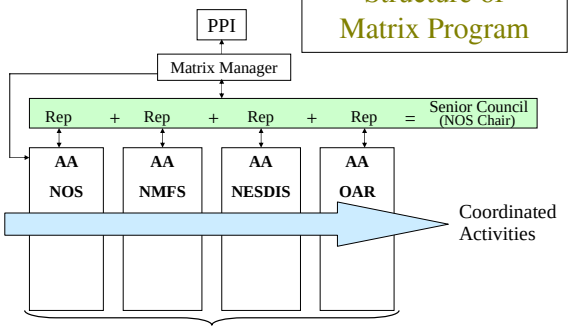
NOS Role #3:
Manage NOAA and NOS coral funding

Line Office	FY01	FY02	FY03	FY04	FY05
NMFS	$11 M	$11 M	$11 M	$0	$0
NOS	**$16 M**	**$16 M**	**$14 M**	**$25.6 M**	**$27.6 M**
NESDIS		$0.75 M	$0.75 M	$0.75 M	$0.65 M
OAR		$0.50 M	$0.50 M	$0.50 M	$0.49 M
TOTAL	**$27 M**	**$28.25 M**	**$26.25 M**	**$26.85 M**	**$28.74M**

NOS Role #4:
NOAA's Coral Reef Matrix Program

- NOS is "host" line office
- Matrix Manager in NOS
- Core Program
- Key Program Participants: NOS, NMFS, NESDIS, OAR

Structure of Matrix Program



Operating Principles

- *Scope:* National in scope, Regional/Local in implementation
- *Foster Partnerships:* state and territory governments, federal agencies, industry, NGOs, academia
- *Build Capacity:* state and territories
- *Implement Solutions:* institutionalize experience, explore new approaches

Primary Customers

- Internal
- External
  - State, Territory Governments
  - FMCouncils
  - Local Resource Managers
  - Resource Users
  - Private Sector
  - Federal Agencies
  - International Partners
  - Academia
  - Local Communities
  - NGOs

Key Stakeholders:
U.S. States and Territories

Pacific:
- Hawaii
- Guam
- Commonwealth of the Northern Marianas
- American Samoa
- Freely Associated States

Atlantic:
- Florida
- U.S. Virgin Islands
- Puerto Rico

NOS Partners

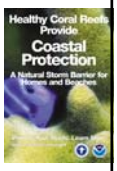
- Office of Response and Restoration (OR&R)
- National Centers for Coastal Ocean Science (NCCOS)
  - Center for Sponsored Coastal Ocean Science (CSCOR)
- International Program Office (IPO)
- Office of Ocean and Coastal Resources Management (OCRM)
- National Marine Sanctuaries Program (NMS)
- Special Projects Office (SPO)

NOS: Products and Services

Mapping and Monitoring	Management Support
•Comprehensive coral reef habitat maps, high-resolution topography maps, and GIS maps •Monitoring support, including grants to States and Territories, and establishing and sustaining monitoring stations •NOAA vessel, HI'IALAKAI (2004)	•Hawaii Coral Reef Valuation Study •NWHI Coral Reef Reserve •Coral Reef Conservation Fund and Coral Reef Conservation Grants to assist States and Territories in managing coral reef issues
Information	**Education/Outreach**
•Abandoned vessel database and website •Environmental Sensitivity Indices •NOAA-wide database on coral reef information (CoRIS) •State of the Reef Report	•Workshops on Coral Disease and Health; Fisheries Enforcement •New learning center dedicated to the NWHI •Education materials for elementary school students, incl. a coral reef textbook; Florida teacher training

NOS: Outreach and Communication

- Critical component of program activities to:
  - Translate scientific research *to build public support for management efforts*
  - Improve effectiveness of management *by understanding stakeholder motivations*
  - Affect user behavior *through skills-building workshops and trainings*
  - Promote informed decision making
  - Broaden constituent base
- Program Examples:
  - Local Action Strategies
  - Workshops (e.g. coral disease, fisheries enforcement)
  - CoRIS website
  - Education (brochures, exhibits, textbooks)



Revised FY06 Process (Draft)

- Determine overall program priorities
  - 3 year time horizon
  - focus on fewer priorities
  - input from coral reef managers
- Determine "core" activities to be funded
- Determine funds available for (more focused) competitive process

- Revised process under development
  - may change
  - may be implemented in phases

Opportunities

- Better coordination across CRCP
- Better leveraging of resources
- Highlighting of issues and priorities
- Communication of accomplishments
- Increased partnerships
- Improved defense of budgets

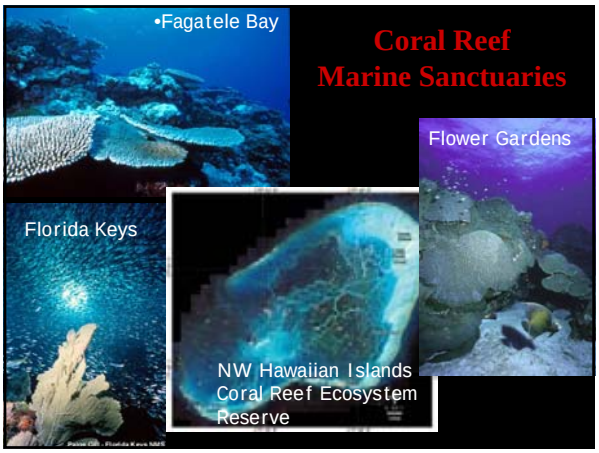
Contact Information

Office of Response and Restoration
Coral Reef Conservation Program (N/ORR)
1305 East West Highway, 10th Floor
Silver Spring, Maryland 20910
(301) 713-2989

Personnel

Office of Response and Restoration:

- David Kennedy – Program Manager
- Roger Griffis – Program Coordinator
- Helen Golde – Team Manager
- Kara Meckley – PPBES, cross-LO coordination
- Alissa Barron – Outreach and education
- Nate Cardoos – Newsletters and websites, CoRIS
- Beth Dieveney – CRTF Coordination
- Shannon Simpson – Legislative, budget, and NOS coordination



NMSP Opportunities

- Research Facilitation
- Conservation Science Needs – identified for each site, regionally, and for the system
- Publication – Special journal issues, Conservation Series
- Outreach – web sites (national and site-based)

Current Focus Areas

- Site characterizations (print, web, management tools, such as GIS)
- Reserve effectiveness
- Improvement of monitoring programs
- Ocean observing (enhancements, integration, data dissemination)
- Mapping and deep water characterization
- Ecosystem context for management and the identification of potential sanctuary sites

Points of Contact

SE and Gulf of Mexico Region – Billy Causey

- Florida Keys NMS — Brian Keller, Res. Coord.
- Flower Garden Banks NMS — Emma Hickerson, Res. Coord.

Pacific Islands Region – Allen Tom

- Fagatele Bay NMS — Nancy Daschbach, Mgr
- NW Hawaiian Islands CRER — Randall Kosaki, Res. Coord.

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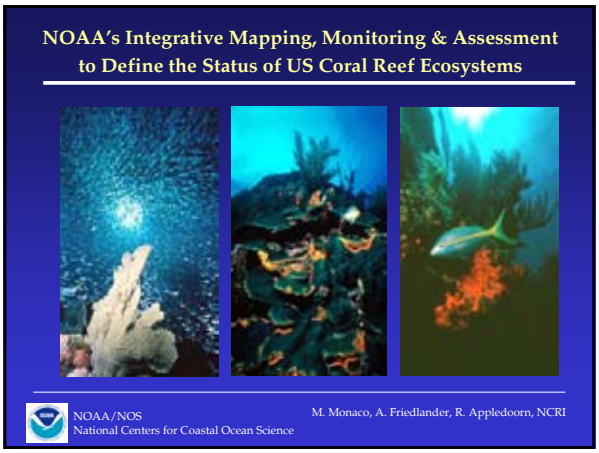
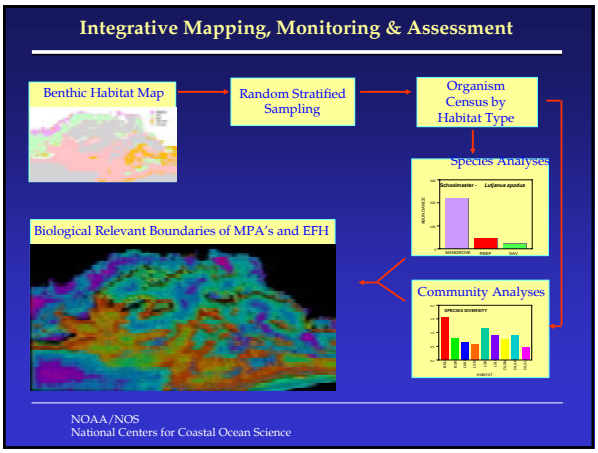
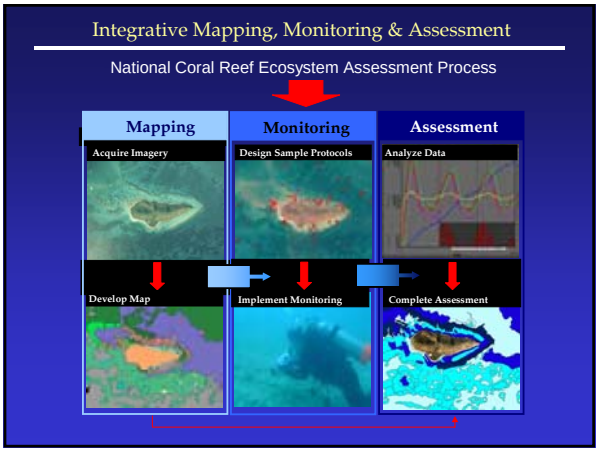
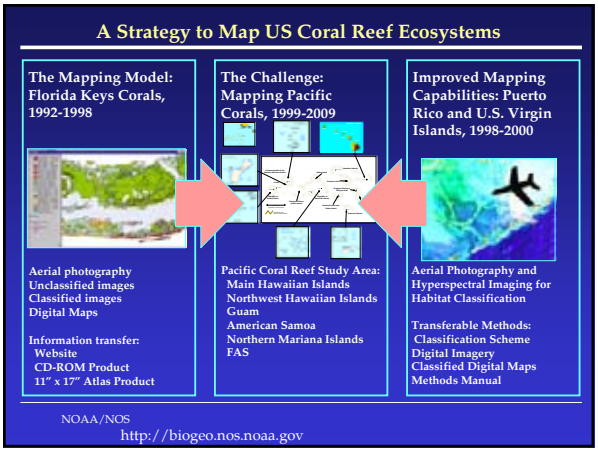
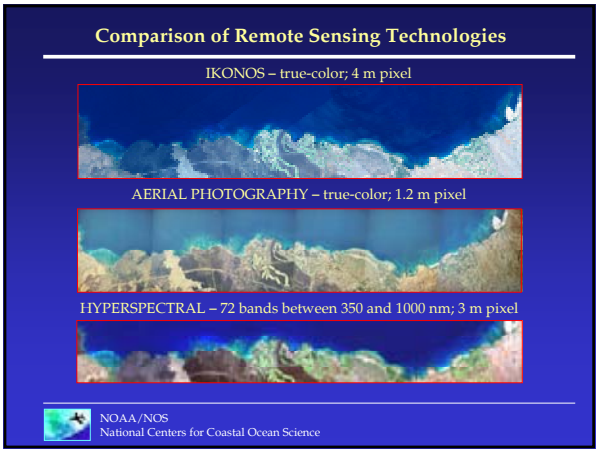
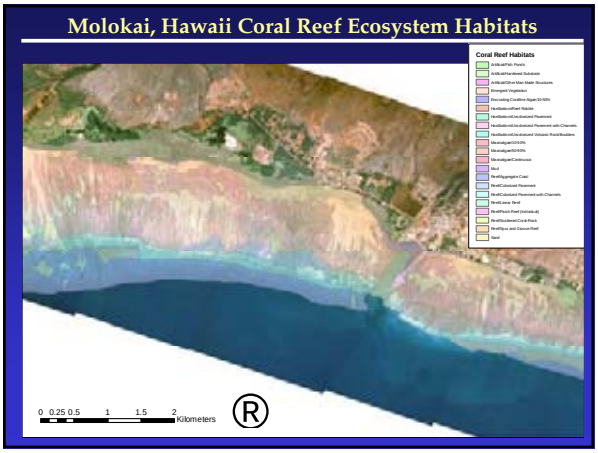

NOAA's Integrative Mapping, Monitoring & Assessment to Define the Status of US Coral Reef Ecosystems
NOAA/NOS
National Centers for Coastal Ocean Science
M. Monaco, A. Friedlander, R. Appledoorn, NCRI


Integrative Mapping, Monitoring & Assessment
Benthic Habitat Map
Random Stratified Sampling
Organism Census by Habitat Type
Species Analyses
Biological Relevant Boundaries of MPA's and EFH
Community Analyses
NOAA/NOS
National Centers for Coastal Ocean Science


Integrative Mapping, Monitoring & Assessment
National Coral Reef Ecosystem Assessment Process
Mapping
Monitoring
Assessment
Acquire Imagery
Design Sample Protocols
Analyze Data
Develop Map
Implement Monitoring
Complete Assessment

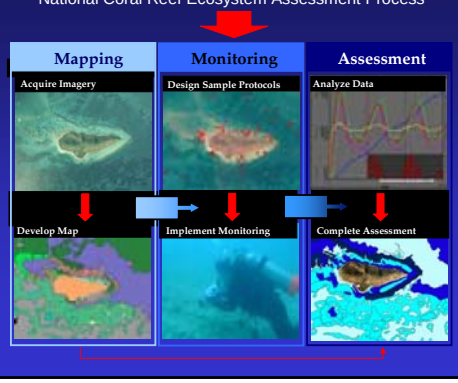

A Strategy to Map US Coral Reef Ecosystems
The Mapping Model: Florida Keys Corals, 1992-1998
The Challenge: Mapping Pacific Corals, 1999-2009
Improved Mapping Capabilities: Puerto Rico and U.S. Virgin Islands, 1998-2000
Aerial photography
Unclassified images
Classified images
Digital Maps
Information transfer:
Website
CD-ROM Product
11" x 17" Atlas Product
Pacific Coral Reef Study Area:
Main Hawaiian Islands
Northwest Hawaiian Islands
Guam
American Samoa
Northern Mariana Islands
FAS
Aerial Photography and Hyperspectral Imaging for Habitat Classification
Transferable Methods:
Classification Scheme
Digital Imagery
Classified Digital Maps
Methods Manual
NOAA/NOS
http://biogeo.nos.noaa.gov


Comparison of Remote Sensing Technologies
IKONOS – true-color; 4 m pixel
AERIAL PHOTOGRAPHY – true-color; 1.2 m pixel
HYPERSPECTRAL – 72 bands between 350 and 1000 nm; 3 m pixel
NOAA/NOS
National Centers for Coastal Ocean Science


Molokai, Hawaii Coral Reef Ecosystem Habitats
Coral Reef Habitats
0 0.25 0.5 1 1.5 2 Kilometers

Integrative Mapping, Monitoring & Assessment

National Coral Reef Ecosystem Assessment Process



National Coral Reef Ecosystem Monitoring Program

Cooperative Monitoring Studies - Meeting Local Management Needs & National Program Requirements

OBJECTIVES:

1) Provide leadership in the development and implementation of a national program to monitor US coral reef ecosystems.

2) Develop a "semi-coordinated" National network of monitoring sites,

3) Facilitate sharing of monitoring information among partners, and

4) Fill gaps in local monitoring coverage.

A coordinated coral reef ecosystem monitoring program provides a national assessment capability to track the status and trends of coral reef health, community structure, and condition of US coral reef ecosystems.

NOAA/NOS
National Centers for Coastal Ocean Science

2002 National Coral Reef Ecosystem Monitoring Program

Program Partners

- Puerto Rico
- US Virgin Island
- Hawaii (main 8 and NWHI)
- Guam
- American Samoa
- Commonwealth of the Northern Mariana Islands
- State of Florida,
- Members of Freely Associated States

NOAA Complementary Monitoring and Assessment Studies

NOAA/NOS
National Centers for Coastal Ocean Science

Monitoring Themes

Benthic Parameters	Water Quality Parameters	Fishery Parameters
Cover (live, dead, etc.)	Nutrients	Abundance & distribution
Abundance	Suspended solids	Size class distribution
Condition	Chlorophyll	Indicator species
Size class distribution	Turbidity	Diversity*
Indicator species	Temperature	Richness
Diversity*	PAR	Evenness

EXAMPLES

NOAA NOS Biogeography Program Field Activities

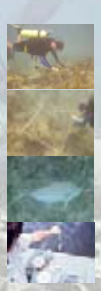
Baseline Characterizations of Coral Reefs and Associated Biological Communities around St. John, St. Croix, Southwestern Puerto Rico, and Hawaii

simultaneous collections

Fish Data Collected
- Abundance and Distribution
- Size Structure
- Trophic Dynamics (Gut Content Analysis)
- Habitat Utilization Patterns
- Community Structure (Diversity, Richness, etc.)

Fine-scale Habitat Characterization Data
- Coral Cover and Taxonomy
- Algal Cover and Taxonomy
- Seagrass Cover and Taxonomy
- Physiography
- Disease

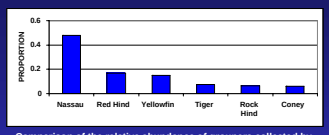
Water Quality Data
- Temperature
- Salinity
- Turbidity
- Dissolved Oxygen
- Nitrates



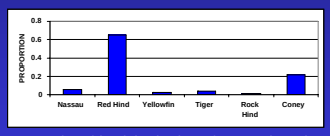
NOAA/NOS
National Centers for Coastal Ocean Science

Historical Data Analyses

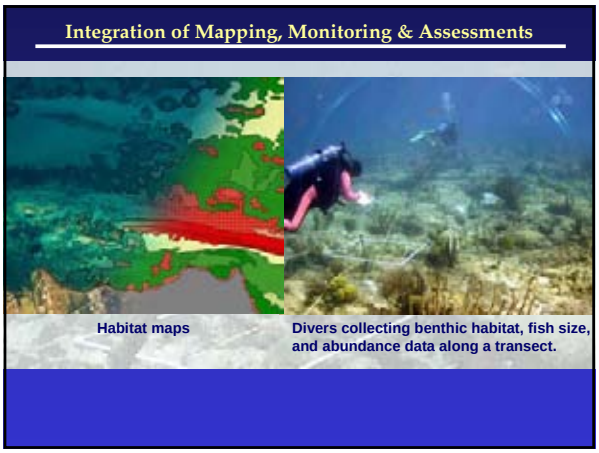
Abundance Comparisons

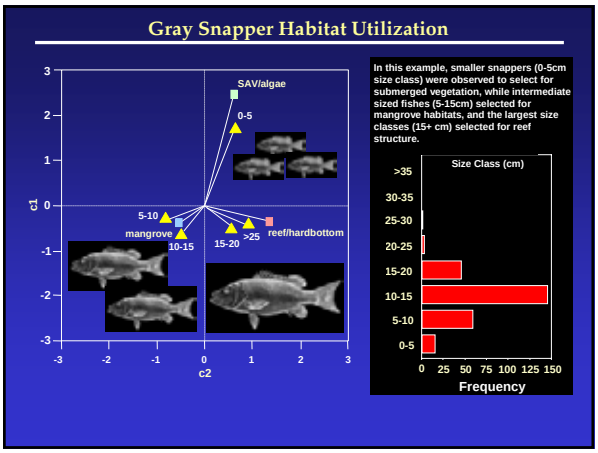


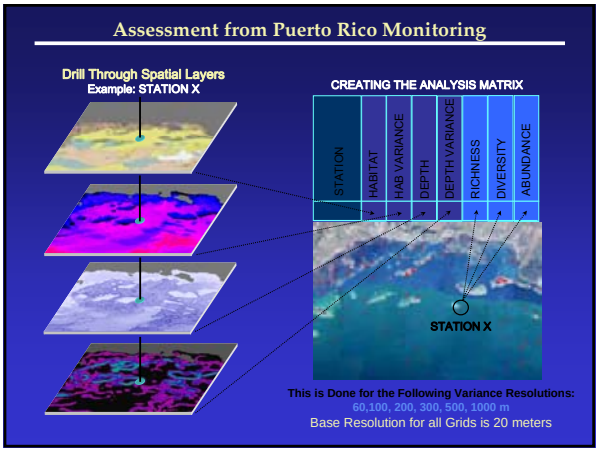
Comparison of the relative abundance of groupers collected by Randall, 1958-1961 around St. John, US Virgin Islands.

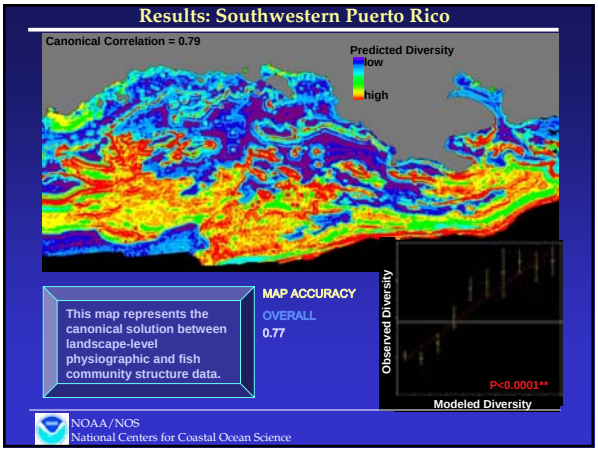


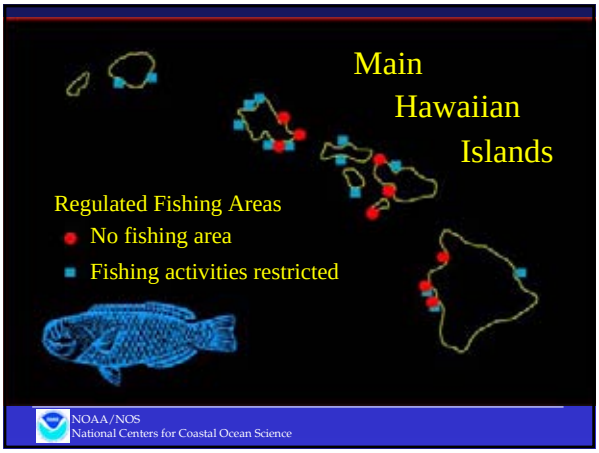
Comparison of the relative abundance of groupers observed by J. Beets, 1989-2000 around St. John, US Virgin Islands.

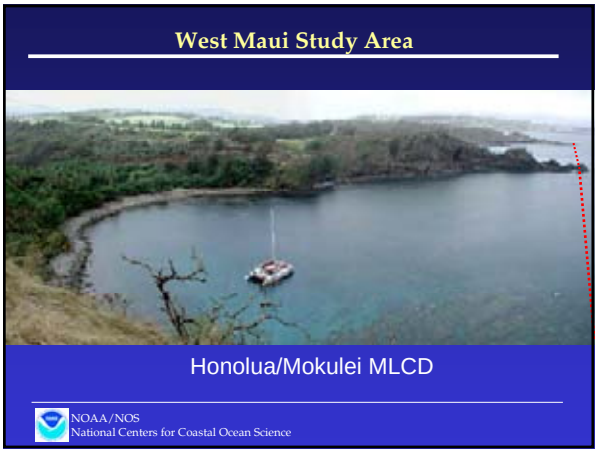

Integration of Mapping, Monitoring & Assessments
Habitat maps
Divers collecting benthic habitat, fish size, and abundance data along a transect.

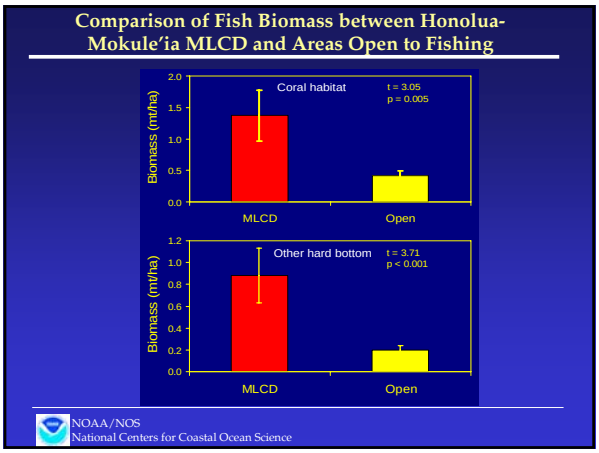

Gray Snapper Habitat Utilization
SAV/algae
0-5
5-10
mangrove
10-15
15-20
>25
reef/hardbottom
c1
c2
In this example, smaller snappers (0-5cm size class) were observed to select for submerged vegetation, while intermediate sized fishes (5-15cm) selected for mangrove habitats, and the largest size classes (15+ cm) selected for reef structure.
Size Class (cm)
>35
30-35
25-30
20-25
15-20
10-15
5-10
0-5
0 25 50 75 100 125 150
Frequency

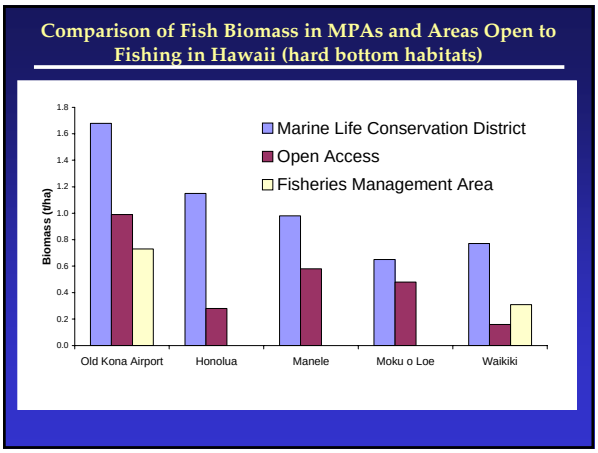

Assessment from Puerto Rico Monitoring
Drill Through Spatial Layers
Example: STATION X
CREATING THE ANALYSIS MATRIX
STATION
HABITAT
HAB VARIANCE
DEPTH
DEPTH VARIANCE
RICHNESS
DIVERSITY
ABUNDANCE
STATION X
This is Done for the Following Variance Resolutions:
60,100, 200, 300, 500, 1000 m
Base Resolution for all Grids is 20 meters

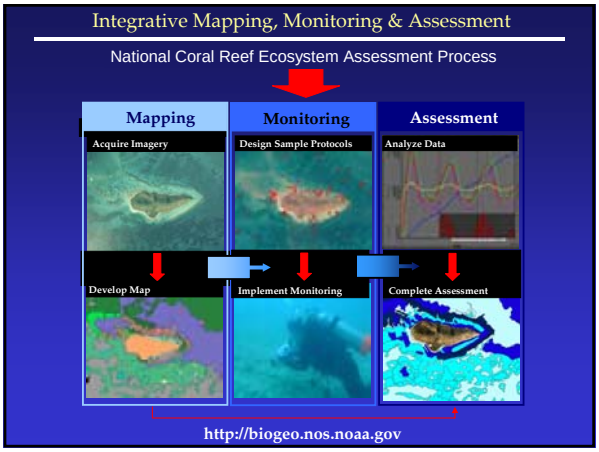

Results: Southwestern Puerto Rico
Canonical Correlation = 0.79
Predicted Diversity
low
high
This map represents the canonical solution between landscape-level physiographic and fish community structure data.
MAP ACCURACY
OVERALL
0.77
Observed Diversity
P<0.0001**
Modeled Diversity
NOAA/NOS
National Centers for Coastal Ocean Science


Main
Hawaiian
Islands
Regulated Fishing Areas
No fishing area
Fishing activities restricted
NOAA/NOS
National Centers for Coastal Ocean Science


West Maui Study Area
Honolua/Mokulei MLCD
NOAA/NOS
National Centers for Coastal Ocean Science


Comparison of Fish Biomass between Honolua-Mokule'ia MLCD and Areas Open to Fishing
Coral habitat
t = 3.05
p = 0.005
Biomass (mt/ha)
MLCD
Open
Other hard bottom
t = 3.71
p < 0.001
Biomass (mt/ha)
MLCD
Open
NOAA/NOS
National Centers for Coastal Ocean Science


Comparison of Fish Biomass in MPAs and Areas Open to Fishing in Hawaii (hard bottom habitats)
Marine Life Conservation District
Open Access
Fisheries Management Area
Biomass (t/ha)
Old Kona Airport
Honolua
Manele
Moku o Loe
Waikiki


Integrative Mapping, Monitoring & Assessment
National Coral Reef Ecosystem Assessment Process
Mapping
Monitoring
Assessment
Acquire Imagery
Design Sample Protocols
Analyze Data
Develop Map
Implement Monitoring
Complete Assessment
http://biogeo.nos.noaa.gov

NOAA Coral Reef Conservation Program
Coral Reef Information System (CoRIS)

CSCOR Coral Data, CoRIS and the NODC Archive

Doug Hamilton

National Oceanic and Atmospheric Administration
U.S. Department of Commerce
Silver Spring, MD 20910

March 2005

NOAA Coral Reef Conservation Program
Coral Reef Information System (CoRIS)

Overview

Part 1 - What is CoRIS?

- NOAA vision for coral data and information
- How CoRIS works
  - Within the Coral Reef Conservation Program
  - Operationally

March 2005

NOAA Coral Reef Conservation Program
Coral Reef Information System (CoRIS)

Overview (Continued)

Part 2 - CSCOR Coral Data, CoRIS and NODC

- The CRCP project database
- Procedures for adding data and publications to CoRIS and NODC
- What to provide and when to provide it

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NOAA Coral Reef Information System (CoRIS)

NOAA Vision and Goals for Coral Data

- Provide a **single point of discovery** for NOAA data and information of direct relevance to the management and preservation of the nation's coral reefs.
- Meet **information needs of NOAA managers** in the preparation of biennial assessments on the status and trends in US coral reef ecosystem conditions.
- Support NOAA's contribution to the **US. Coral Reef Task Force National Action Plan.**
- **Cross-cutting team**, using the best of NOAA coral reef efforts, to develop and populate the system.
- **User / constituent requirements driven** system.

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Coral Reef Information System (CoRIS)

How CoRIS Works within the CRCP

- Editorial Board provides oversight and guidance
  - B. Moore, E. Bayler, G. Mayer, D. Kennedy, R. Griffis (chair)
- Coral Reef Conservation Program staff participate in CoRIS Team meetings
- Participate in bi-weekly Coral Coordination meetings
- Coral projects database provides information about planned data products and contacts

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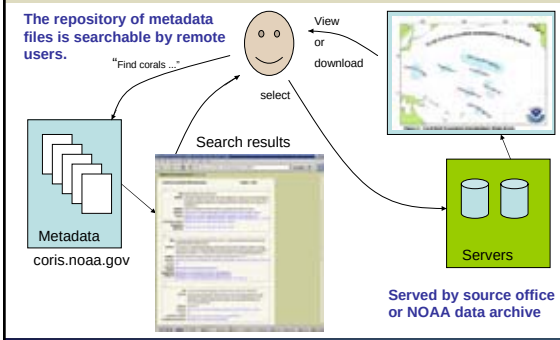
NOAA Coral Reef Conservation Program
Coral Reef Information System (CoRIS)

How CoRIS Works – Access to Online Data



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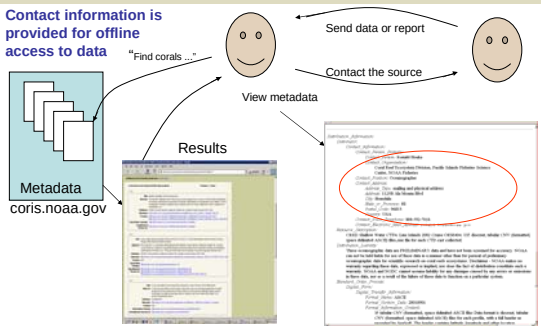
NOAA Coral Reef Conservation Program
Coral Reef Information System (CoRIS)

Access to Offline Data

Contact information is provided for offline access to data



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NOAA Coral Reef Conservation Program
Coral Reef Information System (CoRIS)

CoRIS Web Site

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NOAA Coral Reef Conservation Program
Coral Reef Information System (CoRIS)

Part 2 - CSCOR, CoRIS and NODC

1. NODC (the National Oceanographic Data Center) is the designated national archive for ocean data.
2. CoRIS is a project of the CRCP. It serves NOAA and the CRCP, and is housed in NODC.
3. The CoRIS mission is to provide access to NOAA coral data and information, and to archive coral data.
4. Any coral-related data provided to CoRIS is archived at NODC; publications are supplied to the NOAA Library.
5. Data documentation (metadata) are needed by CoRIS to provide access to data, and to archive data.
6. CoRIS is asked to report to the CRCP whether or not planned products are available.

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Coral Reef Information System (CoRIS)

Tracking Products – CRCP Project Plan

Sample CRCP Project Product description

Planned Date

March 2005

NOAA Coral Reef Conservation Program
Coral Reef Information System (CoRIS)

Tracking Products - CRCP Project Data Base Report

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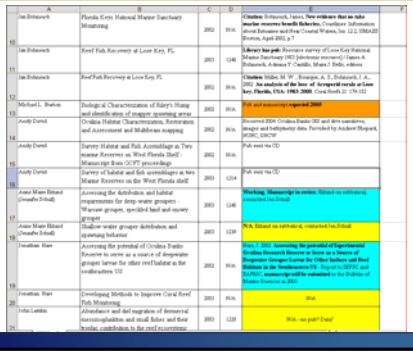
NOAA Coral Reef Conservation Program
Coral Reef Information System (CoRIS)

Tracking Products – CoRIS Tracking Spreadsheet



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NOAA Coral Reef Conservation Program
Coral Reef Information System (CoRIS)

Tracking Products – Summary

- CRCP Project descriptions include information about planned data products and publications.
- CoRIS uses that information to contact principal investigators about planned data products.
- CoRIS reports to the CRCP to identify those products that are available.

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NOAA Coral Reef Conservation Program
Coral Reef Information System (CoRIS)

Publications

- Send publications or citations to Karen Taylor, either electronically or in hard-copy format:
  - karen.taylor@noaa.gov
  - NOAA Coral Reef Information System
    1315 East-West Highway, SSMC3 4th Floor E/OC3
    Silver Spring, MD 20910-3282
- Please include the appropriate project information:
  - CRCP project name and ID number
  - project title
  - authors
  - product status if no final product

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NOAA Coral Reef Conservation Program
Coral Reef Information System (CoRIS)

Data Products

Information that is needed about data and data products:

- Who, what, when, where, why
- How to access data (online, offline)
- Metadata reference information

Information about data and data products needed by CoRIS and NODC.

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NOAA Coral Reef Conservation Program
Coral Reef Information System (CoRIS)

Data Products

- Send data and metadata, or information about data, to Harry Iredale:
  - Harry.Iredale@noaa.gov

  NOAA Coral Reef Information System
  1315 East-West Highway, SSMC3 4th Floor E/OC3
  Silver Spring, MD 20910-3282
- Please include the appropriate project information:
  - CRCP project name and ID number
  - project title
  - product status if no final product

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NOAA Coral Reef Conservation Program
Coral Reef Information System (CoRIS)

A good FGDC Metadata Reference

http://biology.usgs.gov/fgdc.metadata/version2/

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NOAA Coral Reef Conservation Program
Coral Reef Information System (CoRIS)

Summary - Providing Data and Information

(1) CRCP Projects

When: planned product date, plus time for funding delay

What: data, products, reports, publications that are identified in CRCP project plans

(2) Other Projects

When: "…within one year of data collection" (NAO 216-101)

What: data

Other data, products, reports and publications that would be useful are welcomed by CoRIS any time.

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NOAA Coral Reef Conservation Program
Coral Reef Information System (CoRIS)

Products to CoRIS, NOAA Library, and NODC

- Data and data products: send metadata to CoRIS
  - CoRIS provides access to data products and metadata
  - DATE: CRCP project product date
- Publication: send citation or copy to CoRIS
  - CoRIS sends citation and / or publication to NOAA Library
  - CoRIS provides access to the publication
  - DATE: CRCP project product date
- 'Archive' data set: send data and metadata to CoRIS
  - CoRIS stores data and metadata in the NODC Archive
  - CoRIS provides access to the data
  - DATE: CRCP project product date

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NOAA Coral Reef Conservation Program
Coral Reef Information System (CoRIS)

IMPORTANT DATES

PROJECTED
- Planned product date in CRCP project plans

EXPECTED
- Planned date plus # of months funding delay

PROTECTED
- Data are safely secure in the Archive

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NOAA Coral Reef Conservation Program
Coral Reef Information System (CoRIS)

CoRIS Contacts

Parmesh Dwivedi, Project Manager
(301) 713-3284 x164 Parmesh.Dwivedi@noaa.gov

Doug Hamilton, Operations Manager
(301) 713-3284 x102 Doug.Hamilton@noaa.gov

Harry Iredale, Metadata
(301) 713-3284 x170 Harry.Iredale@noaa.gov

Karen Taylor, Publications
(301) 713-3284 x122 Karen.Taylor@noaa.gov

March 2005

CDHC: Outbreak Event Response

Cheryl M. Woodley, PhD

NOAA NOS NCCOS
Center for Coastal Environmental Health and Biomolecular Research
Hollings Marine Laboratory
Charleston, South Carolina

CORAL DISEASE & HEALTH CONSORTIUM
SOLUTIONS TODAY FOR REEFS TOMORROW.

CDHC

Who are we?

Coral Disease and Health Consortium

Non-Profit Research Foundations

UNIVERSITY

State Govn'ts & U.S. Territories

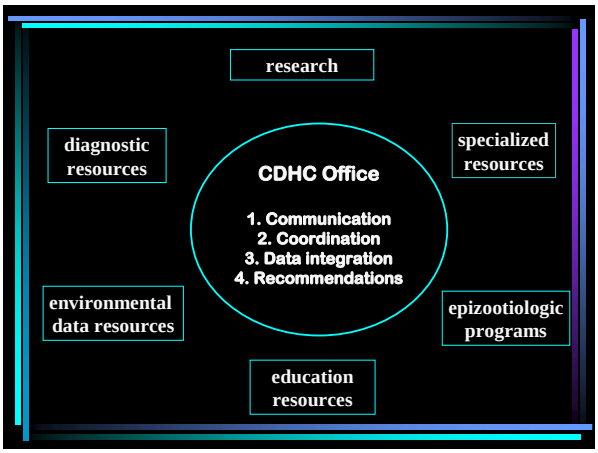
Industry

Coral Disease and Health Consortium

- Coral Biologists
- Ecology
- Environmental Microbiology
- Veterinary medicine
- Veterinary pathology
- Virology
- Aquatic Animal Health
- Toxicologists
- Histopathology
- Biochemistry
- Molecular Biology
- Cell physiology
- Human Medicine
- Biotechnology (Industry)
- Veterinary Diagnostics
- Resource Management
- Epidemiology

Vision:

- "To understand and address the effects of natural and anthropogenic stressors on corals in order to contribute to the preservation and protection of coral reef ecosystems."

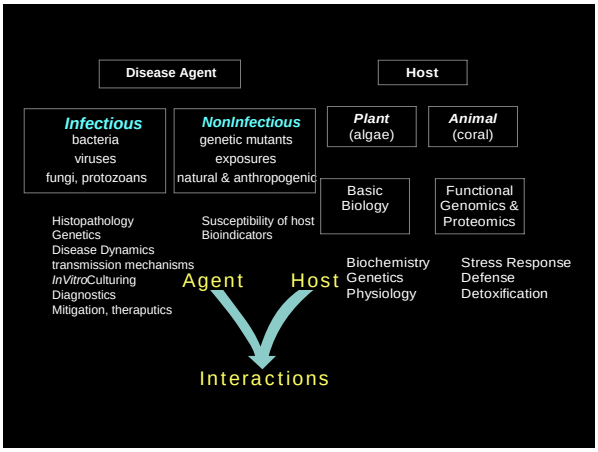


Coral Health and Disease: Developing a National Plan

Objectives

- Biology (6)
- Disease Identification and Disease Investigation (4)
- Disease Diagnostics (5)
- Environmental Factors Affecting Susceptibility and Infectivity (11)

» Summarized on pgs 64 & 65



CDHC at Work...

- Nomenclature
- Model System(s)
- Field Assessment of Coral Reef Condition
- Microbiology
- Toxicology
- Histopathology
- Molecular
- Bioinformatics
- Education and Outreach

CDHC

What are we doing?

Research & Development

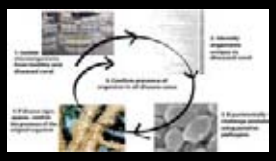
Coral Genomics

- EST sequences (~2500) for *Montastraea annularis, Porites porites* and *Oculina varicosa*
  http://www.marinegenomics.org/
- Coral genome sequencing: *Porites lobata & Acropora palmata*
  National Human Genome Research Institute
  (G. Ostrander, PI)

Diagnostic Resources

SETTING DIAGNOSTIC CRITERIA

Workshop with USGS National Wildlife Health Lab (Madison Wisconsin, April 2004)
Defined diagnostic criteria for selected syndromes including nomenclature and case definitions
http://www.nwhc.usgs.gov/Coral_Workshop/coral_workshop.html



Diagnostic Assay Development

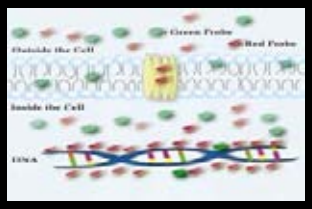
- DNA probe detect White Plague agent (Richardson et al) in freshly collected coral samples

Diagnostic Assay Development

- White Pox agent: DNA sequence analysis used to examine distribution

Diagnostic Assay Development

- IMCOMP assay (coral immuno-competence)



Specialized Resources

International Registry of Coral Pathology (IRCP)

- Repository of pathological material to facilitate the identification of disease etiologies and develop diagnostic criteria
- 246 specimens, 459 blocks of embedded tissues from 17 species and 11 locations, 3600+ slides
- Bibliography of 996 citations and 352 reprints on coral disease http://mrl.cofc.edu/oxford/coralreprint.html

Annotated Bibliography of Cnidarian Biochemistry

- >1870 references with abstracts, key words and annotations including journal articles, book sections, meeting reports, web source materials available as an ENDNOTE™ library and on CD
- Available at http://www.coral.noaa.gov/coral_disease

Model Systems & Coral "Lab Rat" Facilities

Coral "lab rat" species for the disease research community under development

Work in Progress.....

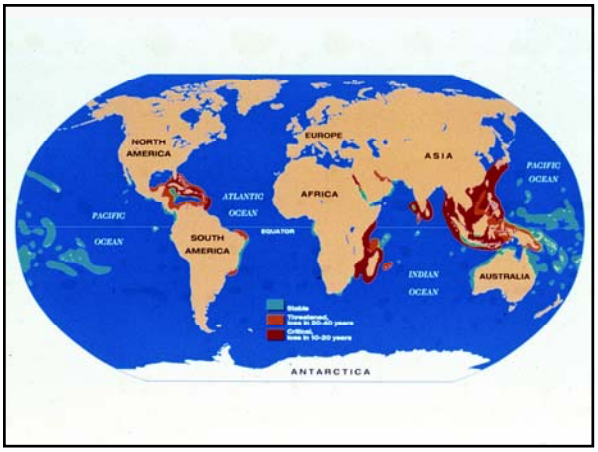
- Web Tool for Diagnosing Coral Disease
- Establish nomenclature review board to review data on newly described diseases
- "Diseases of Coral" - project accepted
- Special Edition of Marine Pollution Bulletin
- CDHC Pacific Workshop: *Vision for Action.*
- Rapid Response Teams

Education Resources

Education and Training

- Coral Reef Toxicology Workshop 2005 Theme: Environmental Forensics
- Univ of Hawaii's Pauley Program – Theme: advanced techniques
- Advanced Coral Histopathology – Spring 2005
- Diseases of Corals and other Reef Organisms –Mote Marine Lab Summer Course
- Rapid Response Teams – conducting an unusual mortality event investigation

Epizootiologic Programs



Coral disease

Aspergillosis

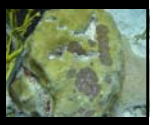
Yellow band

Before 1996: 4 diseases described

2004: 29 diseases described

White pox

Black band



Dark spots

Florida Keys

1996-2000

Aspergillosis

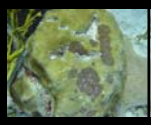
Yellow band

stations w/ disease: 26 -> 131
coral species w/ disease: 11 -> 36
Overall coral cover: decreased by 37%

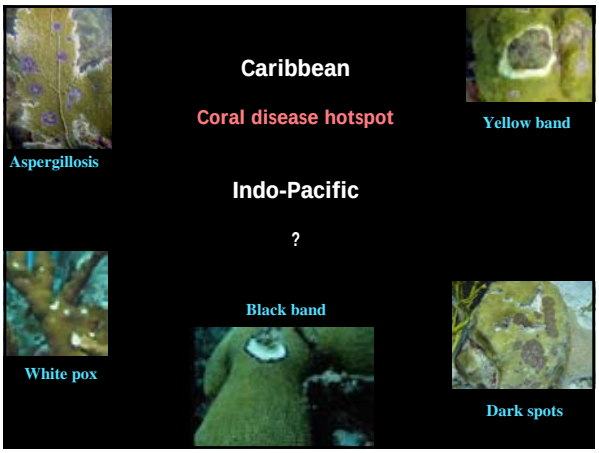
Porter et al. (2002)

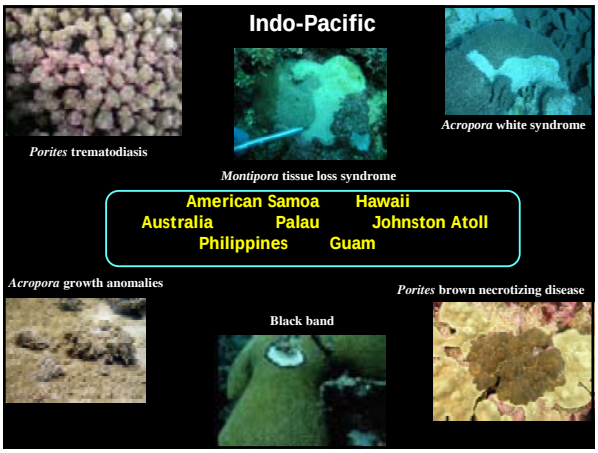
White pox

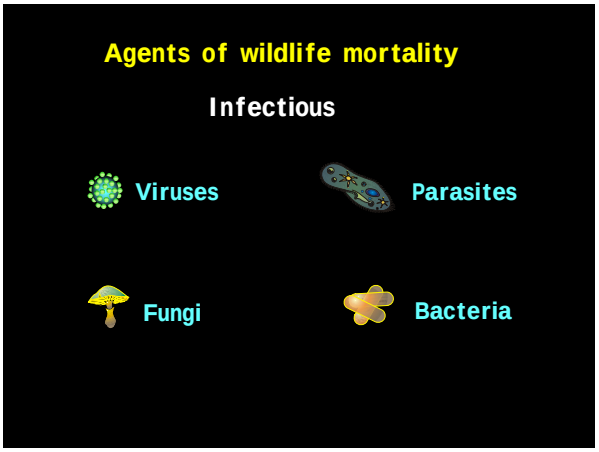
Black band

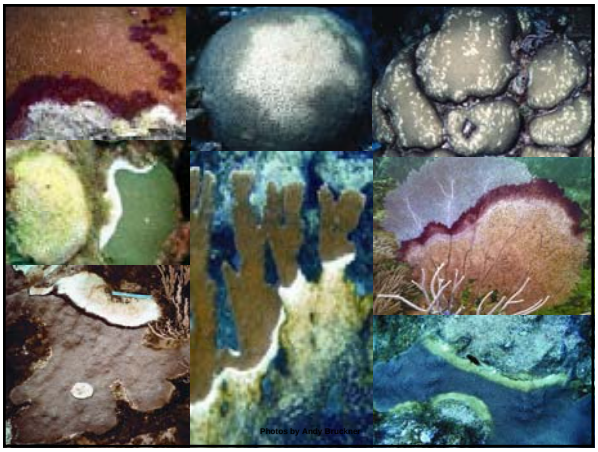


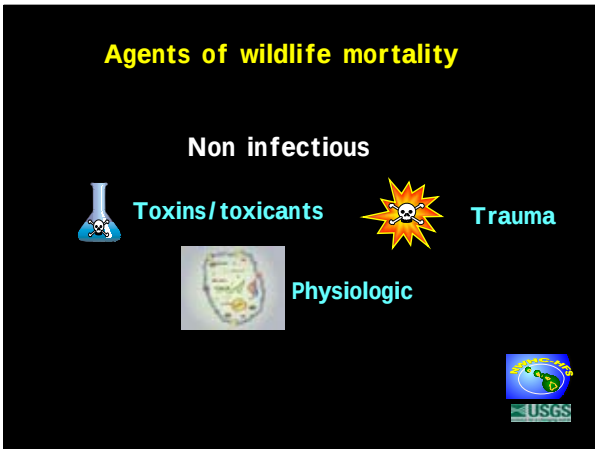
Dark spots


Caribbean
Coral disease hotspot
Yellow band
Aspergillosis
Indo-Pacific
?
Black band
White pox
Dark spots


Indo-Pacific
Porites trematodiasis
Acropora white syndrome
Montipora tissue loss syndrome
American Samoa
Hawaii
Australia
Palau
Johnston Atoll
Philippines
Guam
Acropora growth anomalies
Porites brown necrotizing disease
Black band

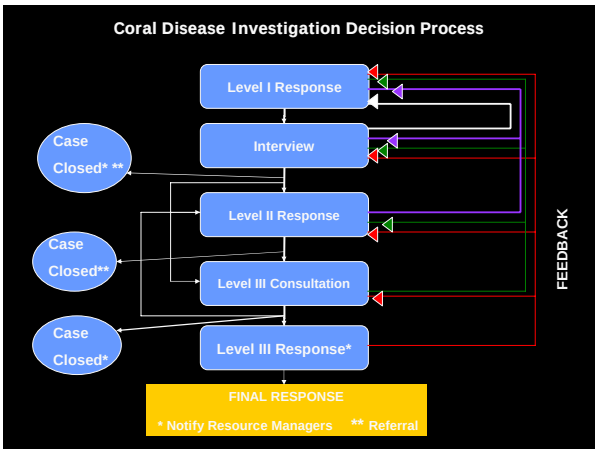

Agents of wildlife mortality
Infectious
Viruses
Parasites
Fungi
Bacteria

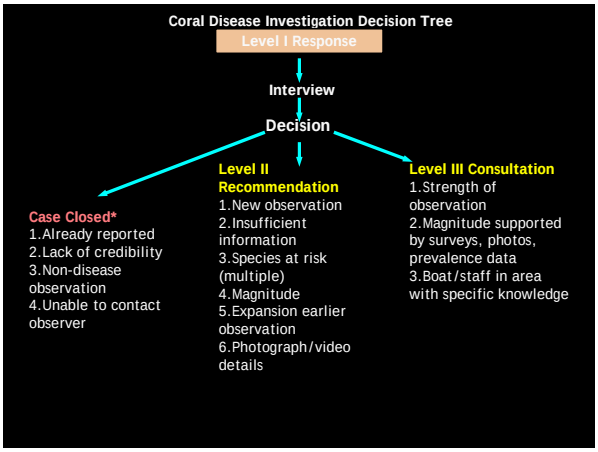

Photos by Andy Bruckner

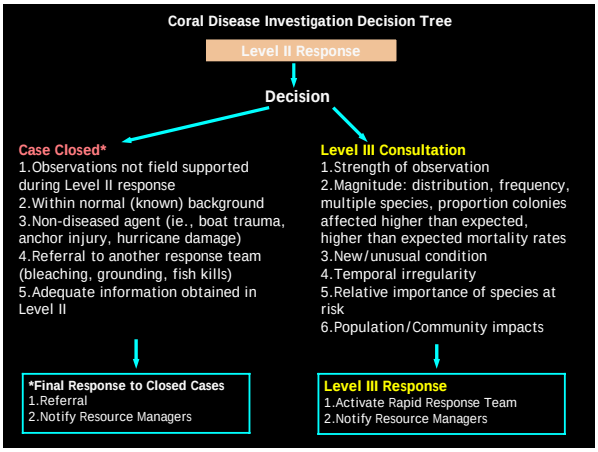

Agents of wildlife mortality
Non infectious
Toxins/toxicants
Trauma
Physiologic
USGS

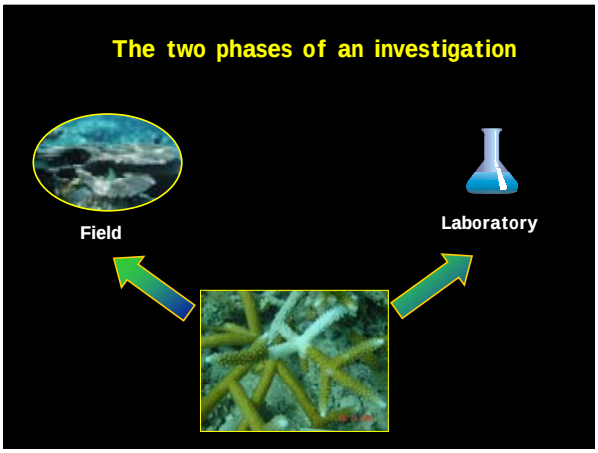
Leaking barrels
Vieques Island coral reef.

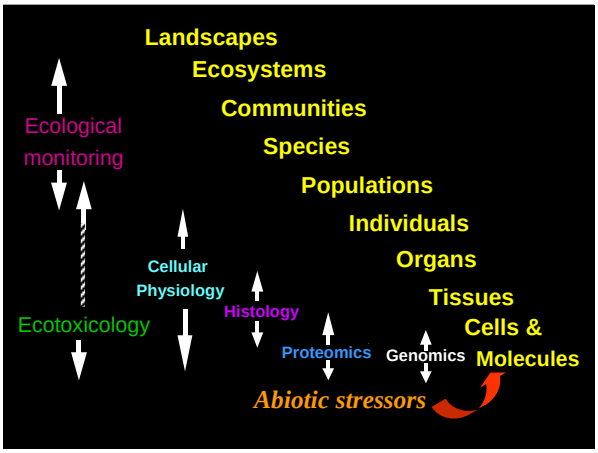
Rapid Response Teams


Coral Disease Investigation Decision Process
Level I Response
Interview
Case Closed* **
Level II Response
Case Closed**
Level III Consultation
Case Closed*
Level III Response*
FEEDBACK
FINAL RESPONSE
* Notify Resource Managers
** Referral


Coral Disease Investigation Decision Tree
Level I Response
Interview
Decision
Case Closed*
1.Already reported
2.Lack of credibility
3.Non-disease observation
4.Unable to contact observer
Level II Recommendation
1.New observation
2.Insufficient information
3.Species at risk (multiple)
4.Magnitude
5.Expansion earlier observation
6.Photograph/video details
Level III Consultation
1.Strength of observation
2.Magnitude supported by surveys, photos, prevalence data
3.Boat/staff in area with specific knowledge


Coral Disease Investigation Decision Tree
Level II Response
Decision
Case Closed*
1.Observations not field supported during Level II response
2.Within normal (known) background
3.Non-diseased agent (ie., boat trauma, anchor injury, hurricane damage)
4.Referral to another response team (bleaching, grounding, fish kills)
5.Adequate information obtained in Level II
Level III Consultation
1.Strength of observation
2.Magnitude: distribution, frequency, multiple species, proportion colonies affected higher than expected, higher than expected mortality rates
3.New/unusual condition
4.Temporal irregularity
5.Relative importance of species at risk
6.Population/Community impacts
*Final Response to Closed Cases
1.Referral
2.Notify Resource Managers
Level III Response
1.Activate Rapid Response Team
2.Notify Resource Managers


The two phases of an investigation
Field
Laboratory


Landscapes
Ecosystems
Communities
Species
Populations
Individuals
Organs
Tissues
Cells &
Molecules
Ecological monitoring
Ecotoxicology
Cellular Physiology
Histology
Proteomics
Genomics
Abiotic stressors

Disease Investigations

Field Observations
- Phone call from field observer, sent photos and description

Sampling Planning meetings to discuss:
- Number and type of samples
- Number of sampling sites
- Coordination with field researchers

Preparation for sampling trip
- Gather supplies required to take samples
- Pack equipment/reagents necessary for microbiology, DNA, RNA, and protein experiments

Sample Collection & Processing
- Each sample is collected with a purpose in mind
- Samples processing occurs in the field to maximize sample integrity

Microbiology → DNA, Culturing
RNA → Subtractive Libraries
Protein → 2-D Electrophoresis
Histology → Coral Tissue Bank

OUTBREAK INVESTIGATION

- Field Investigation
  - Gathering 'case history' data
  - Ecological data
    - prevalence, species affected and unaffected, extent of area affected
  - Diagnostic Data and Sample Collection
    - Lesion size, color, shape, distribution

Data collection

Pocillopora damicornis (**OD**); *meandrina* (**OM**); *eydouxi* (**OE**); *Montipora capitata* (**MC**); *flabellata* (**MF**); *patula* (**MP**) *Porites compressa* (**PC**); *lobata* (**PL**); *evermanni* (**PE**); *rus* (**PR**) ; *Pavona duerdeni* (**VD**); *varians* (**VV**); *L. incrustans* (**LI**) *F. scutaria* (**FS**); *C. ocellina* (**CO**); *L. purpura* (**EP**)

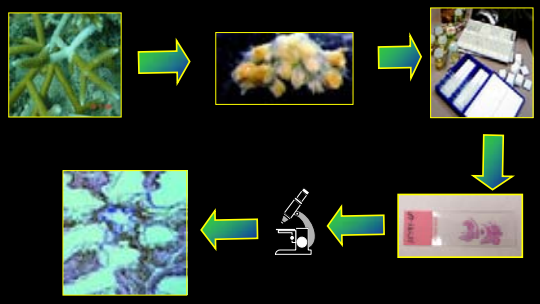
Step 1: Lesion T-Tissue loss D-Discoloration G-Growth anomaly	Step 5: Color of border (Chart on card)
Step 2: Distribution (See below)	Step 6: Width of border (Est. in cm)
Step 3: Lesion size-(est. largest dimension in cm)	Step 7: Skeleton intact (A) or eroded (B)
Step 4: Lesion color (Chart on card)	Step 8: Skeleton algal coverage (see below) A B C

Species	Date	Location	Depth	1	2	3	4	5	6	7	8	Comments
				T-D-G	A-B-C-D					A-B	A-B-C	
				T-D-G	A-B-C-D					A-B	A-B-C	
				T-D-G	A-B-C-D					A-B	A-B-C	
				T-D-G	A-B-C-D					A-B	A-B-C	
				T-D-G	A-B-C-D					A-B	A-B-C	
				T-D-G	A-B-C-D					A-B	A-B-C	
				T-D-G	A-B-C-D					A-B	A-B-C	
				T-D-G	A-B-C-D					A-B	A-B-C	
				T-D-G	A-B-C-D					A-B	A-B-C	
				T-D-G	A-B-C-D					A-B	A-B-C	

OUTBREAK INVESTIGATION

- Laboratory Investigations include
  - Histopathology
  - Traditional microbiology
  - Molecular microbiology
  - Cellular diagnostics
  - Proteomics
  - Toxicology (if indicated)
  - Environmental epidemiology

Pathology



Molecular microbiology
Cellular Diagnostics
Proteomics

DATA

↓

INFORMATION

↓

KNOWLEDGE

What's Next?

- Pilot test Levels I - III Response Protocols
- Finalize Response Protocol Manual
- Develop Communication and Media Plan
- Establish Regional Coordinators and Response Teams
- Conduct training for Response Teams
- Develop Database for Epizootiology

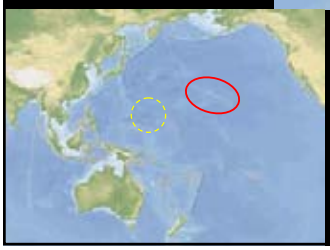
What's Next?

- Develop Outreach Plan
  - Work with response agencies to establish reporting network for Level I response
  - Work with local representatives to the CRTF to develop coral disease local action strategies
  - Assist coral monitoring programs incorporate health and disease in survey efforts
- Develop educational and training materials
  - Increase local coral disease expertise and response capabilities
- Develop strategy for contingency funding

Establish Regional Response Capabilities

South Florida & Flower Garden Banks

Caribbean



Hawaiian Islands

Territories and Freely Associated States

Coral Health and Disease: Developing a National Plan

Our lack of understanding of the underlying mechanisms of coral pathologies inhibits our ability to manage the growing coral health problems…..

Identifing the factors responsible for coral health decline and increased disease incidence, requires embracing a new paradigm of scientific investigation that uses new methods and new technologies that allows us to understand the mechanisms that link cause and effect relationships…..

- Please visit our website for continuing updates and new products from the ….

Coral Disease and Health Consortium

http://www.coral.noaa.gov/coral_disease/cdhc.html

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