

C R C P



NOAA PACIFIC CREIOS WORKSHOP

CORAL REEF ECOSYSTEM

INTEGRATED OBSERVING SYSTEM



NOVEMBER 18-20, 2008

HONOLULU, HI

NOAA Pacific CREIOS Workshop

Hilton Waikiki Prince Kuhio Hotel, Honolulu, HI

November 18-20, 2008

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NOAA Pacific CREIOS Workshop - Overview

Hilton Waikiki Prince Kuhio Hotel, Honolulu, HI

November 18-20, 2008

Executive summary

The NOAA Coral Reef Conservation Program (CRCP) is reviewing and potentially revising long-term plans for its monitoring and mapping activities, collectively known as the Coral Reef Ecosystem Integrated Observing System (CREIOS), to ensure they are cost-effective, aligned with management needs, and allow for the timely delivery of required products and services to all essential users, given funding constraints. As a first step in a strategic planning effort to strengthen the link between science and management goals, the CRCP will bring together Pacific coral reef ecosystem managers and CRCP scientists at a three-day workshop during November 2008 in Honolulu, Hawaii.

Workshop objectives

- 1) Identify mapping and monitoring needs to address management for coral reef conservation
- 2) Identify possible products and solutions to meet management needs
- 3) Gather input on national mapping and monitoring needs

This facilitated workshop is intended to be a forum for discussing managers' needs for monitoring and mapping data to achieve the common goals of increasing understanding of coral reef ecosystems and improving coral reef ecosystem health. NOAA and other scientists will participate alongside the managers in order to discuss scientific capabilities and identify location-specific needs directly from the managers.

Expected outcomes

- Management needs for coral reef ecosystem monitoring, mapping, and data in the U.S. Pacific, at local and regional levels
- Efficient and cost-effective solutions to address management needs
- Data, products or tools required to assess and improve the health of coral reef ecosystems.

The outcomes from the meeting will inform strategic long-term funding decisions with regard to the CRCP's CREIOS program. The CRCP will not be making funding decisions as part of this workshop; however, this is a critical opportunity for the managers and NOAA service providers to provide input that will be used to frame various funding scenarios to be considered for FY10 planning and beyond.

Specific monitoring and mapping needs developed by each local management agency will be critical for the CRCP to evaluate its mapping and monitoring activities. This information will guide the balancing of location-specific monitoring programs that are designed to address managers' data needs with CRCP's national program needs, while taking advantage of existing monitoring expertise. Potential reallocation of monitoring efforts may redistribute responsibilities among agencies (*i.e.*, via CRCP monitoring grants), NOAA service providers, and other relevant entities, but will ensure that monitoring efforts at all levels are aligned and working toward meeting coordinated management objectives.

Workshop format

The CRCP has enlisted a trained facilitation team from NOAA Special Projects to (1) assist all parties in articulating their views and needs, (2) ensure that all participants get equal opportunity to give input, and (3) help explore creative ways to better integrate CREIOS activities with management needs. The facilitators have extensive experience in objectively mediating meetings between NOAA offices and external partners such as Fishery Management Councils and the Gulf of Mexico Alliance.

Workshop preparation

The workshop will require preparation on the part of both the managers and NOAA service providers to articulate management needs and evaluate current activities well in advance of the workshop. The CRCP has been using a combination of one-on-one phone calls, group conference calls, email requests, and site visits to each location to engage decision-makers, managers, and scientists in developing location-specific lists of management and monitoring needs.

Pacific CREIOS Workshop – Agenda

Hilton Waikiki Prince Kuhio Hotel, Honolulu, HI
November 18-20, 2008

Purpose of Workshop

Gather input to guide the future direction of mapping and monitoring activities of NOAA’s Coral Reef Conservation Program.

Workshop Objectives

- 1) Identify mapping and monitoring needs to address management for coral reef conservation
- 2) Identify possible products and solutions to meet management needs
- 3) Gather input on national mapping and monitoring needs

Weekly schedule at-a-glance

Monday November 17	Tuesday November 18	Wednesday November 19	Thursday November 20
Travel	8:00 - 12:25 Registration Welcome remarks from Kacky Andrews Breakout groups: defining needs Jurisdictional panel presentations & discussion	8:30 - 12:10 NOAA technical panel presentations & discussion Breakout groups: potential products and solutions	9:00 - 12:00 NOAA’s National Program presentation & Town Hall discussion Closing remarks from Kacky Andrews
	12:25 Lunch (on your own)	12:10 Lunch (on your own)	Travel
	1:25 - 5:35 Jurisdictional panel presentations & discussion Breakout groups: refining needs	1:10 - 5:35 Breakout groups: potential products and solutions Breakout groups: refining solutions	
Evening - Social Event TBD	Evening - Dinner (on your own)	Evening - Social Event TBD	

Detailed Agenda

Monday Evening - Social Event (to be determined)

Day 1 - Tuesday, November 18

8:30 – 12:25 Morning Session

- Registration and Coffee
- Welcome (Kacky Andrews – NOAA Coral Reef Conservation Program Manager)
- Workshop Objectives and Expectations
- Introductions
- **Breakout Groups: Defining Needs**
Objective: Jurisdictions develop primary topics to focus discussion on.
Participants from the 4 jurisdictions (CNMI, Guam, American Samoa, and Hawai'i) will break into groups by jurisdiction with a facilitator to discuss mapping and monitoring needs with respect to management issues and actions.
- **Panel Presentation and Discussion: Jurisdictional Mapping and Monitoring Needs to Address Management Efforts**
Objective: Share and clarify management needs from jurisdictions.
Each jurisdiction will present their mapping and monitoring needs, followed by a facilitated panel discussion. Each panel will have 60 minutes, as follows:
 - (15 minutes) - Presentation of mapping and monitoring needs.
 - (10 minutes) - Additional comments from the panel
 - (30 minutes) - Discussion - questions and answers from audience.

12:25 - 1:25 Lunch (on your own)

1:35 – 5:35 Afternoon Session

- **Panel Presentation and Discussion: Jurisdictional Mapping and Monitoring Needs to Address Management Efforts**
- **Breakout Groups: Refining Needs**
Objective: Identify additional needs based on presentations from other jurisdictions and revisit primary topics.
Participants will break into groups by jurisdiction with a facilitator to discuss the outcomes from the panel presentations and discussions.

- **Report Outs from Breakout Groups**
Objective: Share refined information from break out groups with all participants. (15 minutes per group) - A representative from each group will present the results of the breakouts.
- **Wrap Up of Day 1**

Evening (on your own)

Day 2 - Wednesday, November 19

8:30 – 12:10 **Morning Session**

- **Review Day 1 Outcomes and Objectives for Day 2**
- **Panel Presentations and Discussions: NOAA's Solutions to Address Management Efforts**
Objective: Share information on NOAA's capabilities and services, and clarify product and information needs from participants.
NOAA experts in 4 areas of technical expertise (biological monitoring, physical monitoring, water quality monitoring, and mapping) will present NOAA's capabilities and services, followed by a facilitated panel discussion. Each panel will have 30 minutes, as follows:
(20 minutes) - Presentation of current products and potential solutions.
(10 minutes) - Discussion - questions and answers from audience.
- **Rotating Breakouts by Jurisdiction/Technical area: Brainstorming Potential Products and Solutions**
Objective: Jurisdictions and NOAA experts brainstorm and have dialogue about specific products and services needed to address management needs.
Each jurisdiction will break out with each NOAA technical panel and a facilitator to discuss potential products and solutions.

12:10 - 1:10 **Lunch** (on your own)

1:35 – 5:35 **Afternoon Session**

- **Rotating Breakouts by Jurisdiction/Technical area: Brainstorming Potential Products and Solutions**
- **Breakout Groups: Refining Solutions**
Objective: Identify primary products and solutions based on NOAA presentations and breakout group discussions.

Workshop Agenda

Participants will break into groups by jurisdiction with a facilitator to discuss the outcomes from the panel presentations and discussions.

- **Report Outs from Breakout Groups**

***Objective:** Share refined information from break out groups with all participants.*

(15 minutes per group) - A representative from each group will present the results of the breakouts.

- **Wrap Up of Day 2**

Evening - Social Event (to be determined)

Day 3 - Thursday, November 20

9:00 – 12:00 Morning Session

- **Review Day 2 Outcomes and Objectives for Day 3**
- **“Town Hall” Presentation and Discussion: NOAA’s National-Scale Mapping and Monitoring Goals, Needs, and Activities (Kacky Andrews)**
***Objective:** Gather input on national-level mapping and monitoring needs.*
A facilitated forum for comment on and discussion of NOAA’s national program for mapping and monitoring in U.S. coral reef areas.
- **Wrap Up**
- **Next Steps (Kacky Andrews)**

12:00 Adjourn

Pacific CREIOS Workshop - Attendees

Hilton Waikiki Prince Kuhio Hotel, Honolulu, HI

November 18-20, 2008

Last	First	Affiliation
Andrews	Kacky	NOAA Coral Reef Conservation Program
Arzayus	Felipe	NOAA Coral Reef Conservation Program
Bohnsack	Jim	NOAA Southeast Fisheries Science Center
Brainard	Rusty	NOAA Coral Reef Ecosystem Division
Brighthouse	Gene	NOAA Fagatele Bay National Marine Sanctuary
Brown	Paul	National Park Service - American Samoa
Brown	Eric	National Park Service - Hawaii
Brown	Val	NOAA Pacific Islands Regional Office
Burdick	Dave	Guam Coastal Management Program
Caldow	Chris	NOAA Center for Coastal Monitoring and Assessment
Carroll	Ben	American Samoa Department of Marine and Wildlife Resources
Castro	Fran	CNMI Division of Environmental Quality
Chaston	Kathy	NOAA Coastal Programs Division
Christensen	John	NOAA Center for Coastal Monitoring and Assessment
Clark	Athline	Papahānaumokuākea Marine National Monument
Cruz	Jesse	Guam Environmental Protection Agency
Dalzell	Paul	Western Pacific Fisheries Management Council
Davis	Gerry	NOAA Pacific Islands Regional Office
Eakin	Mark	NOAA Coral Reef Watch
Everson	Al	NOAA Pacific Islands Regional Office
Fenner	Doug	American Samoa Department of Marine and Wildlife Resources
Friedlander	Alan	NOAA Center for Coastal Monitoring and Assessment
Goldberg	Jeremy	American Samoa Department of Commerce
Gombos	Meghan	NOAA Coastal Programs Division
Gutierrez	Jay	Guam Division of Aquatic and Wildlife Resources
Hamnett	Mike	University of Hawaii
Hendee	Jim	NOAA Atlantic Oceanographic and Meteorological Laboratory
Houk	Peter	CNMI Division of Environmental Quality
Jokiel	Paul	Hawaii Institute of Marine Biology
Kavanaugh	Stephanie	NOAA Special Projects Office
Kenyon	Jean	NOAA Coral Reef Ecosystem Division

Workshop Attendees

Last	First	Affiliation
Kosaki	Randy	Papahānaumokuākea Marine National Monument
Koss	Jen	NOAA Coral Reef Conservation Program
Lujan	Vange	Guam Coastal Management Program
Maragos	Jim	US Fish and Wildlife Service
McElwee	Kris	NOAA Coral Reef Conservation Program
Miller	Joyce	NOAA Coral Reef Ecosystem Division
Monaco	Mark	NOAA Center for Coastal Monitoring and Assessment
Morgan	Jessica	NOAA Coral Reef Conservation Program
Newlin	Michele	NOAA Coral Reef Information System
Nishimoto	Robert	Hawaii Division of Aquatic Resources
Peau	Lelei	American Samoa Department of Commerce
Philibotte	Jason	NOAA Pacific Islands Regional Office
Rooney	John	NOAA Coral Reef Ecosystem Division
Schroeder	Bob	NOAA Coral Reef Ecosystem Division
Seki	Mike	NOAA Pacific Islands Fisheries Science Center
Starmer	John	CNMI Coastal Resources Management Office
Thur	Steven	NOAA Coral Reef Conservation Program
Tibbatts	Brent	Guam Division of Aquatic and Wildlife Resources
Torres	Cecilia	NOAA Coral Reef Conservation Program
Trianni	Michael	CNMI Division of Fish and Wildlife
Vargas-Angel	Bernardo	NOAA Coral Reef Ecosystem Division
Waddell	Jenny	NOAA Center for Coastal Monitoring and Assessment
Wallace	Nancy	NOAA Special Projects Office
Walsh	Bill	Hawaii Division of Aquatic Resources
White	Susan	Papahānaumokuākea Marine National Monument
Wilhelm	Aulani	Papahānaumokuākea Marine National Monument
Wiltse	Wendy	US Environmental Protection Agency

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**NOAA Coral Reef Conservation Program
Pacific CREIOS Workshop
Honolulu, HI – November 2008**

**American Samoa
Interviews Summary**

Interviews conducted by:

Alan Everson, NOAA, NMFS, Pacific Islands Regional Office
Fatima Sauafea-Leau, NMFS, Pacific Islands Regional Office

Interview Participants:

American Samoa Department of Commerce
<i>Coral Reef Advisory Group</i>
American Samoa Department of Marine and Wildlife Resources
Environmental Protection Agency
<i>Water Quality Management</i>
National Park Service
NOAA Fagatele Bay National Marine Sanctuary

The following is a compilation and summary of the answers provided by the interview participants to a series of questions posed by the interview team in preparation for the NOAA Pacific CREIOS workshop.

BROAD-SCALE MANAGEMENT GOALS

1) What are American Samoa's priority issues or threats?

- Habitat loss / degradation
 - Coral Reef Ecosystem Health
 - Decline in reef health due to pollution
 - Decline in reef health due to disease
 - Increasing abundance of brown algae
 - Need for monitoring program
 - Understand affect of climate change on reef health

American Samoa

- Increased sedimentation
- Mangrove and wetland habitat loss and decline
 - Significance to coral reef health
- Fisheries Management
 - No physical capability to write regulations (governance/enforcement)
 - Overfishing in general and of large reef fish
- Climate Change
- Marine Protected Areas
 - Need to develop strategies to establish MPAs
- Population Pressure/Human Impacts
 - Negative impact on reef health
 - Priority threat to the coastal environment
- Land Base Sources of Pollution
 - Need tie in with other resources or LAS
 - Improve water quality
 - Impacts of increased nutrient input
 - Impacts of piggeries on water quality
 - Impacts of human activities
- Information/Governance
 - Interference of federal agencies/Lack of local empowerment/Federal regulations that limit ability to enforce (governance/enforcement)
 - Translation of scientific information to management/legal terms
 - Need for better interagency communication and cooperation (governance/enforcement)
 - Increase capacity to carry out management actions (governance/enforcement)
 - Lack of enforcement (governance/enforcement)

2) What are American Samoa's priority management actions?

- Fisheries Management
 - Protection and management of large reef fish
 - Spawning seasons for targeted species
 - Research on spawning aggregation sites
 - Working on establishing Spear fishing regulations on reef fish
 - Research on interactions between fisheries & ecology
 - Community based fisheries management programs
 - Identify habitat availability and fish populations

American Samoa

- Managing people who use the resources (governance/enforcement)
- Special managed areas/marine protected area
 - Sanctuary Management Plan review process
 - MPAs as tool to manage near shore fisheries
 - No take MPA program
 - Community based fisheries management program
- Needed Research/Monitoring
 - Coral bleaching
 - Coral disease
 - Baseline monitoring assessments
- Land Based Sources of Pollution & Watershed Based Management
 - Reduction of sediment and nutrient inputs
 - Piggery Compliance Program
 - Beach and Stream Monitoring Program
- Coral reef ecosystem protection and restoration
 - Including mangroves and wetlands (associated habitat)
- Population Pressure
- Education

3) What kind of mapping/monitoring data gaps need to be filled as related to these management actions?

- Monitoring information on the affects of climate change
- Coral Reef Health
 - Monitoring information on sedimentation, nutrients and affects on reef health
 - Establishment and continuation of monitoring of coral bleaching and disease events
 - Mapping and monitoring of associated habitats (e.g., mangroves, wetlands)
- Data Dissemination
 - Translation of scientific information into a “user friendly” format for managers and its use in policy making
 - Need data that is accessible for management (Google Ocean could be a new tool)
- Fisheries Management

American Samoa

- Maps of outside banks used by big reef fish
- Need to sustain funding for ecological and fisheries monitoring that influences fishery management actions and decisions
- Maps of spawning area of reef fish, determine the locations of spawning aggregation sites, starting with traditional knowledge
- Continued need for information on larger fish in inaccessible areas (Rose and Swains) which is being supplied by CRED
- Population Pressure
 - Mapping of societal trends, movement, areas of development, urban runoff, etc
- Need satellite imagery of the island and the software to process the information
- Need maps on the spatial distribution of resources for designing MPAs
- Need LIDAR near shore bathymetric data
- Need current data
 - To inform management decisions
 - Need sea surface current information on larvae dispersal
 - Need better understanding of the interconnectivity in water current data and oceanographic information
- Need to produce a detailed oceanographic picture or report of the islands
- Establish baseline health of the resources

4) What management questions need to be answered?

- Land Based Sources of Pollution
 - What are the impacts of sedimentation and what are the resources of pollution in the harbor area?
 - Where is sediment and nutrient stress and how severe is it and what is causing it?
 - How are current land use practices affecting water quality?
- Fisheries Management
 - There is a lack of consensus on the issue of over-fishing, need fisheries data to get at that question.
 - What are the different factors significantly affecting fishery resources?
 - Why are we setting up no-take MPAs? 20% no-take might not be enough to sustain the resource
 - What is the cause of low abundance of large fish (natural or human impact)?

American Samoa

- What is the role of fishing, sediment, nutrients and chemicals?
- Where are/were the spawning aggregations?
- What can the government do to better assist? (governance/enforcement)
- What are practical metrics for the field manager to determine whether our coral reef ecosystem is being harvested sustainably?
- Regional summaries of the population status of key coral reef sharks and fish would help put a broader perspective on their low abundance in local waters. In other words, are regional conservation measures needed in addition to local measures?
- Where are the most important reefs for fish habitat or the healthiest reefs to protect?
- How can enforcement capabilities be improved to improve MPAs? (governance/enforcement)
- How to use data and information for making management decisions: need to have dataset available and in user friendly formats for local scientists and managers to examine local issues.
- Need periodic assessments and need to continue to monitor

5) What are American Samoa's agencies' long term and short term goals which could be achieved using mapping and monitoring data?

Short Term

- To improve the relationship and connection between land-based and marine data
 - Need to do more analysis and see what and how the information can be used for an ecosystem protection
 - Need to see a MPA Network between DMWR's Community-based Fisheries Management Program and the Two Samoa – "Connectivity of MPAs"
- To improve the Community-based Fisheries Management Program and have effective management of resources within MPA sites
 - Need mapping and monitoring assistance to locate spawning areas within the MPA sites for better management
- To gain access on mapping and monitoring data to allow analysis for comparison
- To have open collaboration on data sharing (not just one person but all scientists)
- To determine what the reef is like and especially the large fish population on South Bank

American Samoa

- To determine what the source of the nutrients being used by the brown algae (Dictyota) that has appeared recently?
- To take water quality data and use it on a map to show high stress areas
- To develop a map to improve management needs
- To complete near-shore bathymetry
- To establish and finalize a monitoring program adding water quality
- Recognition of which agencies have fisheries mandate (governance/enforcement)
- To document current fish harvest in National Park areas
- To train and build capacity of local resource staff on how to utilize tools and use for education purposes (capacity assessment)

Long Term

- Need to have more sound policies for prevention measures (governance/enforcement)
- Monitoring of near-shore areas where indication of decline on fish stocks
- To protect and maintain population of target species
 - Need to look at all management tools to sustain and maintain reef resources, so mapping would assist to identify and locate areas to protect and manage
 - Sustainable fishery management (use products to formulate fishery management decisions)
 - Sustainable level of bag limit and distribution of resources
 - Need to document the harvest in National Park areas to better understand what sustainable harvest is
- Predicting and preparing for bleaching
- Establishment of a Two Samoas Archipelago monitoring program
 - Detailed multi layered GIS map for marine resources issues & socio-economic concerns (immigration, fisheries, etc)
- Mapping reef banks on the shelf around Tutuila, mapping South Bank
- To see how relevant the water quality standards are and what are the needs (research) to make the standards more appropriate
- To monitor primary production and long-term water current
- Need 10 more years of research on coral reef with additional focus on carbon dioxide increase
- Develop and maintain a monitoring program that will assist in implementing management actions

- Sanctuary's Management Plan Review Process
 - FBNMS do not want to duplicate efforts but maximize and assure support is provided

INFORMATION GAPS AND NEEDS

1) Is the lack of mapping/monitoring data one of the biggest impediments keeping American Samoa from achieving these management goals, or are there other obstacles that are larger/more primary than lack of mapping/monitoring data? (e.g. lack of political will, legal authority, or enforcement capability)

- Analysis – What does the data tell us?
 - The Coral Reef Ecosystem Monitoring Report for American Samoa is great but it doesn't tell how the data or information can be used
 - Data to improve and formulate regulations and management decisions
 - Need a “user-friendly” format of the information collected and reported
- Continue monitoring conducted by CRED every 2 years and conduct a more in-depth analysis
- Lack of political will and authority to enforce regulations (governance/enforcement)
- Agency mandates and authorities (governance/enforcement)
- Lack of expertise to do monitoring and guide monitoring needs (capacity assessment)
- Enforcement Capabilities is a major weakness due to lack of funding (Capacity Assessment)
- Lack of mapping
 - Need time series to see changes over-time to apply to management

2) What data or information best assists American Samoa's agencies in achieving their goals?

- Both large scale and location-based info is very important to support fisheries information and management purposes
 - Mapping and monitoring data is needed
 - Need science to be incorporated with traditional knowledge to enhance capabilities and make management decisions

American Samoa

- Location-based data is very important
- Larger scale data is helpful to a certain extent
 - CRED should conduct their monitoring and mapping activities every 6 months to be more consistent with the local data and monitoring/mapping activities.
 - Quicker dissemination of data collected (2 years is too long)
- Need a summary or integration of all studies for better understanding
- Larger scale and location-based are both very important to support each data and for management decisions
 - Large scale survey and data set is very important to make sure local data is in regional perspective
 - Local data is important for larger scale to make useful for local management
- Large scale survey and data set is very important especially the maps of abundance of fish in the Pacific Ocean
- Turn over of staff issues in that you lose institutional knowledge about what studies and information are available (capacity assessment)

DATA AND INFORMATION PRODUCTS

1) Of the following, what data/information products are useful?

- **Bathymetry**
 - Bathymetry is very useful on an island scale at all islands focusing on depth parameter
 - For South Bank, very useful down to below the dropoff (150m?)
 - Bathymetry is very useful but need to add near-shore
- **Habitat Mapping**
 - GIS, reef zonation scale and all habitat parameters
 - Might be great if live coral patches or cover could be discerned on reef flat, and this done for images at different dates, and then summary graph showing average trend was produced - essentially using it as a way to monitor coral cover on reef flats over much larger areas than can be done by snorkeling. One opinion is that the deeper the water, the less secure the habitat mapping from satellite images.
 - Should be done every 2 years, very important

- **Biological Monitoring**
 - Focus more on larger scale
 - Very useful for islands we can't get to, top of the list is Swains and Rose, followed by Manua. Good for all the things that fill gaps of what we can't do on Tutuila, and useful as replication for what we can do.
 - Should be done every 2 years, very important
 - Biological monitoring is the most important type of information
 - Need size information on fish
 - Need to have transects to show absences and abundance of large reef fish

- **Water Quality Monitoring**
 - Primary effort and very important for EPA
 - Something we don't do, other than some sediment traps. Might be good in bays like the harbor and Vatia.
 - Less important than other data and products
 - EPA already does water quality monitoring

- **Oceanographic Monitoring**
 - Very important on an island scale or regional scale
 - Larger scale to support the "Two Samoa" initiatives
 - Circulation pattern along coast line for network of MPAs
 - Beyond us, knowledge of current pattern would be useful for the question of larval connectivity
 - Very useful to collect information on drifter trends and water current

- **Fisheries Stock Assessments**
 - Very important on fish stock from larger scale
 - We'll have a better idea of whether more needs to be done and who might best be able to do it after the upcoming fisheries workshop
 - Most important type of information collected

- **Ecological Forecasting**
 - Excellent coral bleaching products NOAA puts out. If there are other kinds of ecological forecasting, would be very interesting to learn more about them.
 - Most important type of information collected

- **Models**
 - EPA collected enough to set up models
 - Very useful for oceanographic data

- **Decision Support Tools & General Comments**
 - Need GIS software, ENVI software is needed and would be useful for EPA

2) What types of training do American Samoa's agencies require to use the data or products?

- Need mapping and monitoring training
- Need basic understanding of the data/information products
- Need to find a way to achieve the Two Samoa Initiatives (governance/enforcement)
- Need to use the Coral Reef Ecosystem Monitoring Report for American Samoa but it is too abstract
- Need to have all managers in American Samoa to be certified divers
- Need mapping and monitoring training for the Community-based Fisheries Management Program, one of the weaknesses with staff in the program is fish identification (capacity assessment)
- Need a training on metric system and conversions for staff
- Need biological monitoring for staff to improve data collection
- Need technical support on GIS (software, computer, tools, services) only one GIS specialist within CRAG agencies (technical capacity)
- Need to learn to use PRIMER and more about modern statistics and statistical programs (technical capacity)
- Need software for satellite pictures (technical capacity)
- Need to build local capacity by having local resource staff attend conferences on tools and software products (monitoring/mapping) (capacity assessment)
- Need NOAA to present on what tools, products, and services are available and make recommendations on how to use in management
- Need concurrent license - license for multiple GIS computer use on piggery and water quality work (technical capacity)
- Need just raw data - it will be very helpful to have the raw data
- Need evaluation or check-in to see how useful the products given, need to assess the usefulness of products provided
- Need a call center or "service desk" for help when needed

Other Topics:

- Overall favorable impression of the current NOAA mapping/monitoring program

American Samoa

- Products were useful for calculating trends in abundance and therefore were useful for management, especially the oceanographic/current information
- CRED data complements other ongoing monitoring work (e.g. useful to help identify trends that could be investigated in greater detail, such as the decline in large fish species at Rose that may be due to poaching)
- Suggestions for ongoing NOAA mapping and monitoring
 - Delivery of products and analysis on quicker timeframe
 - The reports need more specific detail, maybe access to the raw data files for other analysis
 - Suggest that RAMP cruises could be run on a 3-year cycle and still be effective (more time for data analysis and reporting)
 - Suggestion that Western Samoa should be added due to connectivity issues
 - Questions have arisen over the accuracy and statistical rigor of some of the monitoring data, since it is just one snapshot in time
 - The offshore banks are not surveyed by CRED and still have healthy population of large fish and other species. In this regard, the CRED data does not present a true picture of overall fish abundance. Because of this limitation, the data is not directly useful for local management.
 - CRED data is invaluable; need to have information interpreted and utilized for management purposes.

American Samoa

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**NOAA Coral Reef Conservation Program
Pacific CREIOS Workshop
Honolulu, HI – November 2008**

**Commonwealth of the Northern Mariana Islands
Interviews Summary**

Interviews conducted by:

Valerie Brown, NOAA, NMFS, Pacific Islands Regional Office
Kathy Chaston, NOAA, NOS, OCRM Coastal Programs Division
Alan Everson, NOAA, NMFS, Pacific Islands Regional Office

Interview Participants:

Coastal Resources Management
<i>Natural Resource Planning</i> <i>Coral Reef Program</i>
Division of Environmental Quality
<i>Nonpoint Source Pollution</i>
Division of Fish and Wildlife
<i>Fisheries</i>

The following is a compilation and summary of the answers provided by the interview participants to a series of questions posed by the interview team in preparation for the NOAA Pacific CREIOS workshop. The summary does not provide a consensus of management issues and priorities in CNMI.

BROAD-SCALE MANAGEMENT GOALS

1) What are CNMI's priority issues or threats?

- Land Based Sources of Pollution causing habitat degradation:

Non-point source (worse on 3 populated islands)

- Development activities
- Secondary unpaved roads, drainage improvements
- Upland runoff
- Urban runoff
- Agriculture – sediment, contaminants (illegal pesticides)

Commonwealth of the Northern Mariana Islands

- Off-roading, burning, poaching mostly Rota
- Septic Systems
- Confined Animal Facilities (just a few)

Point Source

- Outfalls with improper treatment
 - Sewage Collection system concerns
- Development
 - Wetland Concerns - Only 3% of wetlands left due to filling during Japanese time – concern with 404 permits due to expected loss of Army Corps and CRM staff wetland delineator. Could really use more technical staff for permitting review.
 - Dredging causing habitat degradation
 - Fishing
 - Sustainability of marine resources
 - MPA Poaching
 - Some interviewees concerned with increased fishing pressure - low wage earners, many have lost their jobs, will catch whatever they can eat especially in the lagoon.
 - There are cultural interaction issues (non-resident aliens vs. local)
 - Need for increased fish research, monitoring / data collection
 - Expanded creel
 - Inability to monitor unexpected fishing ventures
 - Different funding sources for commercial vs. recreation
 - Life history data
 - Functional Ecological Relationships
 - Lack of fisheries data for Laulau CAP
 - Support for SCUBA, net, dynamite, poison, bans
 - Climate Change
 - Sea Level Rise
 - Coastal Erosion
 - Recreational impacts
 - Trampling, feeding fish, heavy diver use, poor access, etc.
 - Lack of Enforcement
 - Inability to monitor unexpected fishing ventures
 - MPA Poaching
 - Need to ensure more people are penalized for breaking law

- Need for Science to answer local management questions
 - Monitoring is light – need more detailed information for performance reporting (ex. Talakhaya watershed project).
- Imbalance of monitoring and management – funding for monitoring not growing with management.
- Lack of Strategy – particularly for fisheries LAS
- Military Build-up
 - Increase in recreation ,fishing, more business and people
- Concerns with Pew Monument
 - Pew Monument and Micronesia Challenge taking away from regular DFW management efforts.

2) What are CNMI's priority management actions?

- Watershed level data gathering
- Site-specific focus
 - Implementing Lau Lau CAP
 - Upland runoff and burning leading to sedimentation
 - Have plans but need 2 million to complete plans and studies and implement
 - Obyan Beach Road Improvement and Stormwater Control A&E Plan
 - Implement plan estimated at less than \$500k for erosion control
 - Talakhaya on Rota
 - Community planting to reduce sedimentation affecting MPA
- Non-Point Source Pollution
 - Trying to implement stormwater and engineering controls, but challenging as CIP money previously used is now spent on other priorities
 - Integrated with 6217 planning grants
 - Need 310 money back
 - Need paving of key sites, need sedimentation basins, etc.
 - Still need more than \$2 million
- Fisheries Management
 - Commercial fish data collection
 - Boat creel
 - Nearshore creel – West Side Lagoon
 - Life history data
 - In-situ monitoring of MPAs

3) What kind of mapping/monitoring data gaps need to be filled as related to these management actions?

Monitoring

- Need NOAA to talk more to each other, other federal agencies, and most importantly the jurisdictions to focus and strategize efforts to get the most out of them. A lot of good ideas and projects out there, but many of them never reach their full potential due to lack of dialogue with local jurisdictions or other groups. Example: benthic habitat maps are not as accurate as they could be.
- Concern about need for oversight
 - Suggested possible need for a “Pacific Monitoring Office” to hold local agencies accountable and to provide QA/QC, technical assistance, funding and ensure quality data for management.
- Many islands with specific needs
- Water quality/ Oceanography
 - Continuous water quality monitoring (IKON not perfect but a good start)
 - Weather
 - Stream flow in watershed
 - Currents
 - Waves
 - Basic water quality - CTD, turbidity/TSS, DO, chlorophyll
 - Snapshots of WQ using remote sensing - higher spatial level WQ with better resolution
- Fish data
 - Need more data about fisheries stock assessments, creel, etc – in situ
 - Concerns about limited data availability outside MPAs
 - Expand the creel to all three islands – Saipan, Tinian, Rota
 - Need to have dedicated staff to collect data / oversee data collection and ensure data sharing between agencies
 - Fish movement in and around MPAs
 - Invasive species surveys
 - More survey work for stock assessments – more like RAIOMA cruises, rather than current MARAMP protocols which are not useful for stock assessments
 - Would like to see cruise focused on fisheries questions only
 - Data preparation for Magnuson Requirements
- Need to understand how watersheds function as systems and where pollution is coming from and where it is going.

- Watershed data – flow, land use, quantity and quality of water, sources along drainage
- Model/equation – rates of erosion from unpaved roads
- Project specific monitoring tied to priority projects addressing non-point source pollution. Are they successful?
- Data visualization / Translation
 - We need more understanding of this data and the science behind threats – might require talks with people from DC to educate higher level managers (sometimes “experts” get more attention than agency staff)
- Need staff to assist
 - Maybe grad students,
 - NOAA staff to assist - might be beneficial, however, there are some concerns about effectiveness and how this might be done.

Mapping

- Tsunami inundation maps, due to climate change want to look at sea level rise. Have a lot of erosion on western side of island, particularly Micro Beach and the northwest side of Managaha (estimated USGS model project cost 75-100k).
- Talakhaya project on Rota would benefit from monitoring and mapping to look at success of revegetation. Also, could use something similar on Laulau. Currently, developing Micronesian Challenge indicators with NRCS to look at measuring upland success.
- Refine benthic habitat in areas outside of the lagoon
 - Local agencies don't have capacity to refine, but if NOAA does it they need to work closely with CNMI agencies
- More frequent acquisition of satellite imagery (timeframe would depend on questions)
 - Use this to track land use / cover changes (change analysis)
- Updated aerial photos every year – particularly for southern islands
- Watershed GIS layers – CRM and DEQ already have several data layers. Need to refine current DEQ RFP to avoid redundancy of past work. Main focus in new RFP should be site assessment to fill gaps after contractor has reviewed what shapefiles are already in the possession of CRM and DEQ offices.

4) What management questions need to be answered?

- More detailed information for areas with generalized downward trend.
- Is fish recovery cycle issue due to overfishing, land based sources of pollution, or larger global cycle?
- Are fisheries regulations/management efforts effective?
- What is role of herbivory in relation to coral reef health given global climate change?
- What are current circulation patterns, local, archipelagic, and regional scale?
- Concern that RAMP cruises don't have good questions, just collect data and then have to do reverse science to use it – monitoring is too broad.
- What is the spatial scale of influence of specific drainages on coral reefs?
- What are the non-point source impacts to reefs?
- What are the physical characteristics that impact habitats? (ex. pH, salinity, etc.)
- What are the resources down to 100m (end of the photic zone)? (quasi priority limited resources to do much with the data right now)
- What is the temporal variation in various water quality parameters?
- What are times to take action – example predictive model for bleaching, can increase enforcement of sediment control measures during watches?

Watershed questions

- How do specific BMPs reduce sedimentation / pollution on reefs?
- Which BMPs are most effective?
- How does the watershed function as a system? Inputs, outputs, flows?
- What is the best the way to delineate watersheds for management prioritization and action?
- How much erosion occurs on unpaved roads? What is best management technique for balancing impervious surfaces – there are drawbacks to impervious surfaces, but may be better than erosion of unpaved – how to balance?
- What type of strategies / BMPs are most effective for land based management, which have been proven to work, given local availability of resources or materials? (ex. can't access some types of filters)
- Fisheries questions
 - See DFW Research Priorities below:

- 1) One of the more pressing needs from a fisheries management perspective, is the need to be able to collect data that are of a commercial origin. Although this is viewed as something that seems intuitively obvious to both managers and researchers, the reality is that little money is available for such purposes. Although this may seem the responsibility of the Western Pacific Regional Fisheries Management Council, NOAA NMFS/NOS is the only agency that can provide such funding. Without data from both commercial and non-commercial sources, the possibility of being able to conduct formal stock assessments will be significantly reduced, thereby imparting continued uncertainty into estimates of stock status. Time-series of harvest are essential, and, for example, relying on a sole-source of funding, as we currently do for inshore creel survey currently conducted for Saipan Lagoon, will not adequately address this need. The survey is currently spatially limited and expanding it throughout the populated southern islands of the CNMI will not be a possibility without another funding source, preferably the management authorities, NMFS/NOS.
- 2) Additionally, we need to expand the scope of the RAMP (or commence other) cruises to include fisheries independent surveys of primary coral reef food fish species so that estimates of standing stock biomass can be produced. This activity would be extremely beneficial to stock assessments, which will be a significant need as per the recent amendments to the Magnuson-Stevens Act, which has strict language regarding the elimination of overfishing in all waters under the U.S.
- 3) Another significant need is the elucidation of the functional ecological relationships of coral reef fish. Much work along these lines has been conducted in the Caribbean and Australia, and it is not always possible to transfer such knowledge between jurisdictions. This aspect is germane to understanding the impacts of harvest on ecosystem function.
- 4) More life history data needs to be collected. Such data is vital to understanding species vulnerabilities to changes in their environment. Life history parameters differ between jurisdictions and we are finding that these parameters vary within jurisdictions also. Understanding the high degree of plasticity of life history parameters is a major challenge in providing reliable estimates of stock status in order to ensure sustainability.
- 5) The re-mapping of shallow nearshore coral reefs. We need to have depth contours associated with shallow nearshore reefs. Many reef organisms are depth specific. Conducting surveys would be much more cost-effective if good estimates of shallow nearshore reefs existed. A prime example is the recent Tinian Marine Survey. A considerable amount of time and fuel was spent locating potential sampling sites within a pre-designated depth zone. As accurate contour maps did not exist, the process was inefficient. 0-10 feet.

5) What mapping/monitoring capabilities does CNMI have? What activities do the agencies undertake? What products do they produce?

- Marine Monitoring Team (headed by CRM, DEQ)
 - Monitor coral cover, algae, invertebrates, water quality
 - Sites throughout populated southern islands
 - Sonde tows
 - Lack of dedicated staff, borrow from other activities and programs
 - For details see: <http://www.cnmicoralreef.net/monitoring.htm>
 - Publications : <http://www.cnmicoralreef.net/rp/pubs.htm>
- DFW Marine Protected Area Monitoring
 - Fish
 - Invertebrates (fisheries species)
- Other DFW Surveys
 - DFW surveys to ascertain the effectiveness of management measures i.e. recent lagoon surveys to evaluate resources following the net use restrictions
 - Recently completed surveys to evaluate sea cucumber resources
 - Recently initiated study focusing on nearshore soft sediment bivalve population/life history characteristics
- DFW Creel Surveys
 - DFW creel surveys in Western Saipan Lagoon (would like to expand)
 - Non-commercial and commercial data through assistance of WPacFIN (DFW)
- Limited GIS
- Watershed management through upland restoration

INFORMATION GAPS AND NEEDS

- 1) Is the lack of mapping/monitoring data one of the biggest impediments keeping CNMI from achieving these management goals, or are there other obstacles that are larger/more primary than lack of mapping/monitoring data? (e.g. lack of political will, legal authority, or enforcement capability)**

- A number of impediments, no clear ranking, but mapping / monitoring data is one of them:
- Capacity
 - Lack of qualified people
 - Difficulties hiring locally
 - DFW needs positions for data management and creel program
 - Need training to increase staff capacity
 - Would be helpful to have someone come out to train while working on a project – IA with EPA is a good example – maybe 3 months or so temporary assignment
- Lack of Information
 - Mapping / monitoring data needs to be more targeted to jurisdictional needs
 - Quality of Data / Information is the biggest impediment
 - Example – MARAMP interesting but not useful for fisheries biology work
- Lack of Enforcement
 - Better ways to levy penalties – too subjective due to administrative review of civil penalties
 - No enforcement of invertebrate permit law
 - Need training
- Lack of Political Will
 - Government works against itself
 - Example – Lau Lau planning group vs. group maintaining the road
 - Issues with Government Posturing
 - Example - preventing passage of Fisheries Act.
 - More information might help build political will to address these issues
 - Maybe GIS visualizations or models
- Need more coordination between the resource managers/scientists and the other government agencies.

DATA AND INFORMATION PRODUCTS

1) Of the following, what data/information products are useful?

- **Bathymetry**
 - Useful, zone 0-30ft is a target, shallow lagoon and nearshore needed

- LIDAR
 - Would like to see integration with benthic habitat maps
 - Southern islands the priority
- **Habitat Mapping**
 - Yes, but at better resolution
 - Original effort went overboard with cover, not useful
 - Recommend using ecological based habitats – consistent assemblages of representative species, rather than cover
 - Structure is useful, but have spent too much time refining
 - NOAA's maps were a good first step but it is not the tool they need to address local management needs
 - Would like to see depth tied into this (maybe 3D drape over bathy data?)
 - Terrestrial habitat mapping also useful, particularly land use change analysis
- **Biological Monitoring**
 - Useful, recommend 2 scales
 - Archipelago wide – currently doing this for southern islands, using stratified approach at similar habitat with similar factors (ex. exposure to waves) recommend longer time scale – every 2 years or so
 - Smaller scale – special area, sometimes one time or more extensive sampling to capture seasonality
 - All taxa – fish, coral, inverts
 - Particularly those that are appropriate metrics of integrity or resilience for a functioning ecosystem
 - See DFW research priorities
- **Water Quality Monitoring**
 - Desperate need
 - Standard parameters, but need higher temporal resolution (continuous monitoring), access to data in a timely manner
 - Island wide scale
 - Snapshots of wider area
 - Temporal trends
 - Need sediment monitoring (not tubes)
 - Nutrients if possible useful
 - Some concern for contaminants (Hg hits in WERI study)
- **Oceanographic Monitoring**
 - Currents mapping / modeling – to look at connectivity, oil spill response, for island and smaller scale
 - DFW deploying ACDPs on FADs
 - Wave exposure values may be of use

- **Fisheries Stock Assessments**
 - Yes – in situ abundance data at good spatial scale, island-wide creel data
 - Really interested in fisheries ecology - need good measures to look at community structure, genetics?
 - Fisheries independent surveys on cruise of archipelago
 - Ecological relationships of coral reef fish
 - Life history data
 - See DFW research priorities

- **Ecological Forecasting**
 - Yes, BleachWatch useful, other satellite data also useful
 - Would like better pixel size – improved resolution similar to other US jurisdictions
 - ENSO
 - Potential for COTS forecasting based on Peter Houk's work
 - Maybe for fisheries management – spawning forecasting, combine traditional knowledge for spawning times

- **Models**
 - Yes could be useful for the following:
 - Currents
 - Watershed processes
 - Outfall mixing models
 - Fisheries ecosystem stock assessment models
 - MPAs
 - Groundwater (USGS did a model, but need to refine)
 - Sand movement in lagoon
 - Inundation maps
 - Linking land use change, cause and effects – particularly for sedimentation
 - Other types of models to look at natural variation with in the archipelago

- **Decision Support Tools**
 - Potentially useful, but so far most tools they know about have had limited usefulness
 - CAP seems to be working well for some agencies, but not all
 - Productivity sensitivity analysis – to meet Magnuson requirements
 - GIS based tools – tied to road thing or for NPS but needs refinement
 - Arc tool for terrestrial habitat assessments that PSC provided training on recently.

- **Other**

- Regular acquisition of satellite data (Quickbird 1m resolution) hyperspectral data would be useful, especially for nearshore to look at habitat changes

2) What information is lacking (i.e., gaps)?

- Biological – including fish
- Water quality
- Oceanography
- Decision support tools
- MARAMP reports – clean accurate data
- Fish data – stock assessments, life history
- Bathymetry / habitat mapping

3) What product delivery mechanisms are preferred? (printed reports, electronic documents, CDs, GIS datasets, websites, automated emails)

- No printed reports
- Would like to see a website with a tight dataset (QA/QCd) that can be subset and downloaded online, with sufficient metadata and some instruction available on how to interpret things like oceanography data
- Electronic is good, websites more useful - easier to google – FTP site
- Spreadsheets
- GIS datasets are extremely useful as a tool for permitting and education. Especially if you could get sediment loading models, stormwater flow rates in uplands.
- Library access to papers and journals is a challenge
- Updates announced via email
- Appropriate metadata should be available for all data
- Need data in a timely manner

4) What data formats are preferred? (raw text, spreadsheets, images/graphics, GIS, binary/HDF, Google Earth, technical reports, scientific papers)

- Would rather create the images/graphics themselves for specific questions rather than waiting for a book or webpage of graphs that may or may not answer their questions (some may be useful, but depends on what they are and how the data is represented)
- Archive of imagery/video/photos available
- Appropriate datasets delivered as soon as possible – within one year, two at most
- Technical reports and scientific papers – may be useful or may just be irritating
 - Peer reviewed scientific papers are useful, but not if they hold up data, and only if they are useful for management
 - Definitely don't want something like CRED ASRAMP report - too big
- Would like to see archive of all of these papers/reports available in one place (and not have to track them down individually as when using CoRIS)
- Would like support for accessing journals and libraries – very limited access hard to get funding for subscriptions
- Like GIS data
- Spreadsheets

5) What data products and formats are currently used?

- NOAA not very good about telling us what is available, so probably are not using things that might be useful. CoRIS tells you things exist, but doesn't help you track it down and find it.
- Oceanography data might be useful, but need some direction on how to use.

6) What types of training do the CNMI agencies require to use the data or products?

- GIS / RS
 - Challenge to keep up to date
 - CSC GIS training was useful but need to follow up
 - Remote sensing
 - Other analysis tools
 - GIS and habitat mapping tool
 - Training on re-projecting data due to the problems with the WGS84 – maybe just one or two people
 - ARCIMS and how to use so people could look at it on the web – library or home. Would need format similar to something like Google Earth to use.
 - Maybe assign some one out here to work with agencies and train them
- Oceanographic data interpretation

- Statistics Training
- Programming and modeling - such as S+
- Training for technical staff
 - Captain's licenses
 - Fisheries biology/ecology
- Make Training announcements more broadly known – let them know about trainings on Guam – easier to allocate travel if NOAA adds to grants and provides invitational travel.

7) Does the CNMI have software and/or hardware needed to access or utilize these data?

- Statistics packages
- GIS – more licenses
- Sigma Plot or other graphing software
- RS – ER Mapper
- S+ upgrades
- CRM - new scanners.
- DFW -their own plotter
- Need more flexibility in monitoring grants to facilitate purchase of equipment – boats, trucks – not every year, but once in a while for support of the monitoring work.



**NOAA Coral Reef Conservation Program
Pacific CREIOS Workshop
Honolulu, HI - November 2008**

**Guam
Interviews Summary**

Interviews conducted by:

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Interview Participants:

Bureau of Statistics and Plans
<i>Guam Coastal Management Program</i>
Guam Department of Agriculture
<i>Director's Office Division of Aquatic and Wildlife Resources Fisheries Section Wildlife Section Soil and Forestry Resources Division</i>
Guam Environmental Protection Agency
<i>Environmental Monitoring and Analytical Services Division Environmental Planning and Review Division</i>
National Park Service
<i>War in the Pacific NHP</i>
US Department of Agriculture
<i>Natural Resource Conservation Service Pacific Islands Area - West Office</i>
US Fish and Wildlife Service
<i>Guam National Wildlife Refuge</i>
Department of the Navy
<i>Naval Facilities Engineering Command Marianas</i>
The Nature Conservancy
<i>Micronesia Program</i>
University of Guam
<i>Marine Laboratory</i>

The following is a compilation and summary of the answers provided by the interview participants to a series of questions posed by the interview team in preparation for the NOAA Pacific CREIOS workshop.

BROAD-SCALE MANAGEMENT GOALS

1) What are GUAMS's priority issues or threats?

- Habitat loss / degradation (terrestrial watershed impacts)
 - Land based sources of pollution
 - Non-point source
 - Erosion / Sedimentation
 - Watershed management
 - Human actions on land impacting reefs: burning, ungulate grazing, off-roading
 - Loss/compromised health of native terrestrial flora and fauna
 - Mitigation / restoration
 - Coral Disease
- Increased development
 - Military Expansion and associated development
 - Infrastructure needs
 - Grading/clearing – exposed soil w/o plans for cover/buildings
 - Need mitigation policy
 - Shoreline access
- Fisheries Management
 - Creel surveys
 - Data to support new regulations
 - Federal management of offshore areas
- Lack of Information
 - Cumulative / secondary impacts
 - Tracking of habitat degradation/development and mitigation
 - Climate change impacts
- Marine Protected Areas
 - Indigenous issues
 - Recreational impacts
- Population Increases
 - Recreational impacts increasing
 - Overfishing
- Lack of Capacity
 - Institutional, lack of staff, lack of leadership

- Enforcement
- Invasive Species
 - Prevention and monitoring
- Community apathy
 - Need data to be understandable – provide information public can understand
 - Need to counter groups trying to destabilize management efforts
 - Need better education/engagement/outreach

2) **What are Guam's priority management actions?**

- Watershed based management
 - Watershed planning
 - Reforestation, erosion protection
 - Non-point source pollution control/management
 - Review/permitting of coastal development
 - GIS/data management
 - Update water quality standards
 - Critical habitat
- Community engagement / Involvement / Management
 - Social marketing / behavior change
 - Managed areas
 - Political leadership outreach and support
- Planning / Zoning
 - Shoreline erosion control/management
 - Coastal hazards
 - Rezone coastal waters
 - Permitting – 404 permits, state level 401 permits
 - Federal consistency
- Military Buildup
 - Habitat loss
 - Secondary impacts – increased population, guest workers
- Fisheries Management
 - Obtaining life history information for key fish species
 - Monitoring marine preserves
 - Information for updating fisheries regulations outside of MPAs
 - Indigenous fishing issues
- Special managed areas/marine protected area

- Planning and implementation – trying to move more towards community / government partnerships in management of areas
- Identifying priority areas
- Protected area networks
- Monitoring
 - MPAs and priority watersheds/management areas
 - Fish / shellfish advisory
 - Beach
 - Measuring effectiveness of management actions
- Enforcement
 - Increasing capacity and effectiveness
- Invasive Species Control
 - Prevention (more terrestrial and freshwater at this time)

3) What kind of mapping/monitoring data gaps need to be filled as related to these management actions?

- Large-scale and fine-scale currents/temperature information (locally and regionally)
- Continuous, long-term, unattended (telemetry or occasional data retrieval) water quality monitoring (mainly TSS, but also interested in conductivity, temp, PAR, etc.)
- Island-wide reef assessments – general reef health, COTS, large fish abundance (currently filled by MARAMP, working on local program but limited capacity and funding, difficulty accessing banks and north and east coasts)
- Regular (every 3-5 yrs) long term socioeconomic monitoring and mapping
- Monitoring of short-term and long-term impacts of DoD activities
- Updated vegetation/land cover mapping, and terrestrial LIDAR
- Updated, detailed wetlands mapping
- Regular satellite/aerial imagery updates as well as land use change detection analysis (Vic noted that PSC/CSC working on C-CAP for Guam)
 - Particularly note changes in high priority vegetation, beach side clearing, clearing
- Updated flood zone (FEMA), hazard mapping

- Although bathymetry mapping has occurred for most of nearshore and offshore waters, still some gaps between nearshore LIDAR data (from 2001 and 2007) and multibeam data collected by AHI in 2007
- Deeper water habitat mapping - possibly using backscatter data
- Non-point source pollution source identification
- Reef fish spawning areas
- Recreational impacts – monitoring and mapping
- GIS application to track development
- Stream flow monitoring – sediment transport, outfall impacts
- Climate change impacts
- Clear linkages between terrestrial erosion control efforts and coral reef health – assessment of efforts to help prioritize and choose methods
- Data to assist prioritization of management efforts
- Detailed monitoring for restoration efforts – for example Cetti mitigation
- More accurate benthic habitat maps

4) What management questions need to be answered?

- How successful are watershed restoration efforts in improving river and nearshore marine water quality and ultimately, improving the health of freshwater and nearshore marine ecosystems?
- Are the marine preserves exporting larvae and adult fishes to adjacent, non-protected areas? Are they improving overall reef fisheries health? Are they large enough?
- What are the impacts (mainly, cumulative and secondary) of coastal development to terrestrial and nearshore marine resources?
- Are education/outreach projects effectively reaching the target audience(s)?
- What are the attitudes and perceptions of current and proposed management actions?
- What level of fishing is sustainable for various groups of reef fishes on Guam?
- What are new techniques to reduce development impacts to resources?
- Where is sediment going?
- What are proper water classifications?
- What is the bioavailability of contaminants in the sediment?

Guam

- What are the priority watersheds for management?
- What are the changes in benthic habitat in the Marine Preserves? Are they different than outside areas?
- Are mitigation sites (Masso, Cetti – DoD mitigation sites) effective?
- What is the life history of popular food fish species (habitat use, size at first reproduction, fecundity, etc)?
- What is the status of harvested invertebrate species and what management actions should be implemented to keep these fisheries sustainable?
- Are Guam's pelagic fisheries part of a Western Pacific stock or are they a contiguous population with the Central Pacific stock?
- Which sites on Guam act as sources of larvae, which as sinks? How is larval dispersal impacted by currents at local, island, archipelagic, and regional scales?
- Are Guam's reefs being impacted by invasive species? Does Guam need to take further action to prevent the introduction of marine invasive species?
- Are PCBs and other contaminants bioavailable to fisheries resources? Where are these bioavailable sources?
- What is causing the degradation of Guam's reef habitats (land based sources of pollution, fishing, climate change)?
- What are the impacts of military activities, including radiation leaks?
- What are current patterns?
- Data for reef flats - reef flats should be part of monitoring program
- How will climate change, sea-level rise impact park terrestrial resources?
- What is the connection between coastal erosion and sea level rise?
- Why is coral recruitment low?
- Data to show that MPA's are effective
- Can we show tangible long-term benefits to communities from protected areas that may have been displaced them when established?
- What is the bare minimum monitoring we need to detect meaningful change?
- If we design protected areas with adequate representation and replication of key habitat types, will we then also adequately cover things like connectivity and inclusion of reefs exhibiting bleaching resilience / resistance in the absence of these data?
- Will we eventually have the technology to develop reasonably good benthic habitat maps using remote sensing and very little ground-truthing (so expensive to try to get to very remote outer islands)?

Guam

- What are the current patterns around Guam and regionally? How current patterns affect coral reef resilience?
- How does coral disease prevalence in Guam change over time? What are the ecological impacts of coral disease?
- How do microbes, temperatures and nutrients affect ecotoxicology?
- What resources are included in the GNWR? What is the status of the GNWR's resources? Is management at GNWR effective?
- What is best management for these resources based on the refuge's goals and capabilities?
- See list of priority research projects from Guam CRI below:

Priority studies/projects for Guam

Development of cumulative and secondary impacts tool with a Phase I consisting of a compilation of data repository of spatially referenced studies, reports, theses, datasets pertaining to Guam's coral reef ecosystems and fisheries.

Study of nearshore and offshore currents for Guam and the Marianas to assist with connectivity questions (i.e., where are the source and host areas of fish and coral larvae).

Feasibility study of coral nursery for the rehabilitation of Guam reefs.

Technical and legal assistance reviewing Department of Defense development projects.

Technical assistance related to ecological modeling, establishing regulations on a quantitative sustainable fisheries catch as well as effort, permits, bag and size limits and seasonal closures.

A baseline socioeconomic measuring attitudes and perceptions of the various communities (i.e., Filipinos) on Guam with respect to Guam's marine preserves and coral reef ecosystems.

A social marketing campaign focusing on eliminating arson in Guam's southern watersheds.

Organization of large-scale, multi-agency, long-term, volunteer-based watershed restoration for Guam (in partnership with NRCS, DoD, AmeriCorps, Office of Response and Restoration)

Technical assistance and training for Guam's Coral Reef Rapid Response Team with regard to vessel groundings, bleaching events, and disease outbreaks.

Technical assistance and support for a community based monitoring program, supplementing Guam's comprehensive coral reef monitoring strategy.

High resolution multi-beam sonar mapping of remaining unmapped Guam's nearshore waters.

Orthographic/satellite imagery to detect land-use change especially with regard to Department of Defense projects and associated private development.

Research, technical support, funding for identifying viable "green-building," "smart-growth," etc. techniques and technologies.

5) What mapping/monitoring capabilities does Guam have? What activities do the agencies undertake? What products do they produce?

- Have ability to carry out benthic habitat mapping; produced the Guam Coastal Atlas – while based on NOAA Biogeo data, essentially mapped inshore areas from scratch – had limited ability to map foreereef areas
- Recently purchased island-wide terrestrial and nearshore marine lidar data; includes nearshore data for most of coastline
- No ability to map deep water areas within territorial waters (rely on NOAA to do this – collected multibeam sonar data)
- In first year of long-term coral reef monitoring program; difficulties with procurement, but will be getting equipment soon; have 3 graduate students from the UOG Marine Lab working part-time as monitoring assistants; have not been able to collect data yet; will begin collecting data to use in power analysis shortly
- Creel survey – dataset back to the mid 1970’s
- Marine Preserve Biological monitoring – limited to fish and basic substrate, but part of larger monitoring team and may expand
- Terrestrial species monitoring
- DAWR produces annual reports, summaries and statistics
- EMAS Monitoring
 - Monitoring as defined in WQ Monitoring Strategy
 - Laboratory
 - Beach
 - Environmental Monitoring and Assessment Program – coastal waters 0-60ft, with deeper areas in Apra – biological, water quality, sediment contaminants
 - Fish Shellfish advisory program
 - Status and Trends Monitoring
 - Water quality for MPA monitoring
- Navy INRMP Projects
- Part of National Park Service Pacific Wide monitoring program (<http://science.nature.nps.gov/im/units/pacn/>)
- Sedimentation and coral recruitment studies
 - Includes monitoring of erosion in upland portions of park
 - Reports available at <http://www.nps.gov/wapa/parkmgmt/index.htm>
- UOG faculty conduct targeted research
 - Coral disease

- Interactions between taxa
- Fisheries

INFORMATION GAPS AND NEEDS

1) Is the lack of mapping/monitoring data one of the biggest impediments keeping Guam from achieving these management goals, or, are there other obstacles that are larger/more primary than lack of mapping/monitoring data? (e.g. lack of political will, legal authority, or enforcement capability)

- Not really. Clearly, monitoring and mapping are important, but even with lack of really good long-term monitoring data, there is still enough evidence to suggest that the condition of many of Guam's reefs and associated biological communities are highly compromised and enough evidence to understand major threats. Time is of the essence, and we need A LOT of help in addressing what are the greatest local threats to Guam's reefs – sedimentation, overfishing, non-point source pollution - so that we can be better prepared to confront climate change. For the most part, we know what we need to do (watershed restoration, restoring reef fish stocks island-wide through combination of marine preserves, banning of destructive fishing methods, and science-based, species-specific fisheries regulations).
- Major problems are the lack of capacity to carry out required management actions (e.g., large-scale watershed restoration); lack of public support/engagement/participation, lack of political will (especially when it comes to major threats such as the military expansion, unrestrained and poorly planned coastal development).
- More enforcement support to increase effectiveness – bodies, improved efficiency in monitoring activities. Biggest impediment for some agencies.
- Need help developing messages from monitoring data, to support behavior change and develop legislation. Ex. Visualization mapping, NOAA could develop a high quality documentary team tied to social marketing or have NGOs do it – but either way a team of experts to help develop public engagement campaigns.
- Major problem is the lack of capacity to carry out necessary work.
 - People – trouble recruiting and hiring qualified people, pay scale? GovGuam system?

- GIS training
- More enforcement support to increase effectiveness – bodies, improved efficiency in monitoring activities
- Political will for updates to regulations
 - Groundings / reef damage
 - Larger fines for existing regs
 - Review process for regulations taking too long (years)
 - Special Interests Groups undermining conservation efforts
- Lack of data is important as well (for some agencies more than others)
 - Particularly about life history of targeted species, stock assessment
 - For non-resource decision makers need detailed, reliable data
 - Need data to link terrestrial and coral reef management
 - Historical data – gray literature that documents habitat, flora and fauna – need this to be easier to access and find
 - Need single repository of GEODATA for Micronesia
 - Staff to support all islands in region and sharing of data
 - Consistent and accurate metadata for all GEODATA

DATA AND INFORMATION PRODUCTS

1) Of the following, what data/information products are useful?

- **Bathymetry**
 - Recognize that bathymetry data is important for benthic habitat mapping, geological studies, fisheries management, current studies, and other applications
 - Would like to see suitable data to refine EFH including bottomfish
 - May need additional for specific projects (OTEC / SWAC)
- **Habitat Mapping**
 - Benthic habitat mapping would be more useful at higher resolution (1/4 acre or less, ideally 1-5m) with better accuracy
 - Cover type is too detailed or needs more ground truthing – highly inaccurate – need to revise accuracy assessments
 - Deeper areas using backscatter could be coarser
 - Due to lack of detail/errors not useful for change detection, except maybe for seagrasses

- Deeper area mapping for areas too deep for satellite interpretation, useful for mapping refugia, bottomfish EFH, etc.
- Refined EFH maps
- Mangrove change mapping
- For terrestrial mapping (USFS), would like more ground validation and a much better idea of remaining areas of native limestone forest, somewhat degraded limestone forest, and highly disturbed native forest.
 - Land Use Change – tracking loss of native habitats and increase in impervious surfaces / development, repeated regularly, maybe more detailed for priority watersheds
- **Biological Monitoring**
 - Island-wide assessments and long-term site-based monitoring of benthos and associated biological communities are essential
 - Particular attention to MPAs/control sites, mitigation areas, priority management areas
 - Larval transport, settlement.
 - Develop invasive species monitoring
 - Need to be more frequent – maybe CRED type people could be stationed on Guam to assist
 - Need to integrate programs to maximize benefits
- **Water Quality Monitoring**
 - Critical component of long-term, site-based monitoring – especially in areas adjacent to watershed restoration projects
 - Need continuous measurements for as many parameters as possible, minimally salinity, temp, TSS or turbidity, DO, pH chlorophyll, nutrients if suitable devices exist
 - Also interested in contaminants, endocrine disruptors, bioavailability
 - Interested in development of bioindicators – might give a better indication of how nutrients or contaminants are impacting the environment
 - Information to set TMDLs
- **Oceanographic monitoring**
 - CURRENTS! – local, archipelagic, and regional scales - to look at connectivity, larval dispersal, recruitment, sediment transport
 - Sea surface temperature - important for coral bleaching-related information
 - Waves – direction and height for west side
- **Fisheries Stock Assessments**
 - Critical for reef fisheries management
 - DAWR has one of most robust programs in Pacific, but they are facing staff capacity issues and the program has not been as active as it needs to be
 - Genetic analysis of fish stocks of interest

- Larval dispersal, duration, recruitment
- Reef fish and bottomfish
- Pelagic – is Western Pacific population linked to Central
- Freshwater – are reservoirs impacting migration upstream, questions about marine phase dispersal, larval duration
- Data to support consumption advisory program – particularly for key species
- What are contaminant impacts on fish stocks
- **Ecological forecasting**
 - Bleaching forecasts will be helpful. Haven't really taken advantage of new forecast abilities yet, but plan to.
 - Other types of models would be useful – predictor for COTS, Terpios, cyanobacteria blooms, fisheries models, larval recruitment predictors, socio-economic impacts,
 - ENSO useful
- **Models**
 - Current/temperature models to help understand/predict larval transport patterns (self-seeding or not?), understand/predict sediment/pollutant transport patterns, help understand patterns of coral bleaching (and identify resilient or particularly susceptible reef areas)
 - Rainfall impacts on discharge through seeps, stormwater impacts to recreational beaches
 - Link from terrestrial actions to coral reef
- **Decision support tools**
 - Decision-support tool based on a model of cumulative and secondary impacts to aquifer and nearshore water quality in order to improve land use planning
 - ID resilient areas
 - Fisheries – determine sustainable fishing levels
 - Water Quality Standard Setting
 - Zoning
 - SQRT values?
 - Bioassessment – use of marine organisms for monitoring
 - Determine diver densities (or other recreational uses)
 - Coastal Hazards – sealevel rise

2) What information is lacking (i.e., gaps)?

- Large-scale and fine-scale currents/temperature information (locally and regionally)
- Continuous, long-term, unattended water quality monitoring (mainly TSS, but also interested in conductivity, temp, PAR, etc.)

- Island-wide reef assessments (lack of access) – general reef health, COTS, large fish abundance
- How to tie impacts from land to coral health. Need to translate data into management actions.
- Capacity
- Life history information for fish – larval dispersal, aggregation sites, habitat utilization (includes fish stock assessment, habitat mapping, current modeling, etc.)
- Information on invertebrates
- Data translated to promote Public Awareness
- Good detailed habitat maps
- Better tracking of land based sources of pollution
- Data on fishing in nearshore federal waters – NPS, Navy, Air Force, Refuge
- Islandwide database for sedimentation and other data – prioritize restoration efforts and track changes better

3) What product delivery mechanisms are preferred? (printed reports, electronic documents, CDs, GIS datasets, websites, automated emails)

- What is not useful – announcements in NOAA newsletters filled with all kinds of other news/products/announcements – likely will not read entire newsletter
- Recommend stand-alone product announcement – snail mail and email to various people within a single agency to eliminate problem of information not being disseminated to the appropriate persons, potentially a specific listserv
- For major product announcements, perhaps phone calls to POCs, others
- GIS database tied to a bibliography or linked to data/report websites
- Have someone present data to them – go over it or announce/explain in person
- Printed documents somewhat useful, need website or CD with files for things like maps
- GIS datasets
- Websites are a good way to interface to obtain data - likely need announcement

4) What data formats are preferred? (raw text, spreadsheets, images/graphics, GIS, binary/HDF, Google Earth, technical reports, scientific papers)

- All – depends on the product
- Need access to raw (corrected) data
- GIS is especially useful
- Ability to extract data through a database
- Images and Graphics are useful
- Would like more translation into useful products that could be used to target behavior change, ex. Visualization mapping
- Some agencies prefer technical reports/scientific papers as they back up their decisions better

5) What data products and formats are currently used?

- Multibeam sonar data – GeoTIFF, other raster formats are fine
- Benthic habitat data (polygons and ground-truthing points) – shapefiles, other vector formats are fine
- Coral bleaching watches/warnings – automated emails
- Coral bleaching forecasts – Google Earth
- Status of the Reefs report
- Technical Reports
- SST

6) What types of training do the Guam agencies require to use the data or products?

- Remote Sensing
- Modeling – at least understanding models and how to use them to answer local management questions - may need training on any models (e.g., currents) that may be developed if they need to be run locally
- GIS training
- New GIS tools – visualization, web stuff
- Statistical Analysis training

- Potentially for cumulative/secondary impact tool being developed
- Note that for some of these it may just be more useful to hire a specialist
- Database
- Fisheries stock assessment
- Water quality data collection and data interpretation
- Help with GIS projection issues – how to get around this issue.
- Microbiological techniques (may be limited to few agencies)

7) Does Guam have software and/or hardware needed to access or utilize these data?

- Most agencies have sufficient resources to purchase software/hardware, but need training for staff to use it well
- Explore open-source/free software
- GIS software for visualization and web based information dissemination

Other Topics:

- Internship program - monitoring
- Focus more on locally based monitoring
- Less frequent CRED surveys—too large scale to be effective
- More effective enforcement
- Want to see a more regional approach
- Trying to work with other agencies – keep up coordination / cooperation
- Tanguisson Advisory – still don't know what caused poisoning
- Long Term monitoring of cleanup sites – not sure how to maintain monitoring when DoD decides to close a project
- Local Rules and Regs need development
- Concern about lack of community engagement and how data gets translated (or rather doesn't get translated) for community understanding. Wants to see public better informed (including better science engagement in schools).

Guam

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**NOAA Coral Reef Conservation Program
Pacific CREIOS Workshop
Honolulu, HI – November 2008**

**Hawaii
Interviews Summary**

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National Park Service
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Papahānaumokuākea Marine National Monument
<i>NOAA</i>
US Fish and Wildlife Service
<i>Pacific Remote Islands National Wildlife Refuge Complex</i>
Non-Governmental Organizations
<i>Castle Foundation The Nature Conservancy Community Conservation Network</i>

The following is a compilation and summary of the answers provided by the interview participants to a series of questions posed by the interview team in preparation for the NOAA Pacific CREIOS workshop. The summary does not provide a consensus of management issues and priorities in CNMI.

BROAD-SCALE MANAGEMENT GOALS

1) What are Hawaii's priority issues or threats?

- Fisheries
 - Lack of information to conduct proper stock assessments
 - Overfishing
 - Fisheries over-exploitation
 - Overfishing of target species such as opihi (limpets) and nearshore reef fishes
 - Responsible fishing, protected areas, sustainable use.
 - Detect the status and trends of marine resources within the park boundaries

- LBS
 - Land-use
 - Down-stream effects on reefs

- Overuse
 - Alien algae, land-based sources of pollution, recreational overuse, overfishing, lack of enforcement

- Invasive species
 - Invasive alien species
 - Marine alien species
 - Working with communities in sites and addressing threats (LBSP, alien algae, overuse, overfishing). Also, alien algae control (K Bay) – trying to remove all invasives in north part of bay over next 3 years (not just with communities).

- Climate change
 - Without doubt the major threat is climate change. We all must work to cap, reduce and eventually eliminate carbon dioxide emissions from fossil fuels. Otherwise we are headed for disaster within this century with the elimination of reefs as we know them in as little as 20 to 40 years. Any other conservation work is meaningless given this framework. The dire future for coral reefs has been documented by the latest IPCC report and was the focus of ICRS.

- Water quality
 - Physical, biological and chemical integrity of the nation's waters
 - Clean Water Act

- Marine Debris
 - Marine debris, climate change, protected species

- General
 - NPS Inventory and monitoring program. This includes:
 - Biodiversity inventories and coastal resources threats in shallow and sub-tidal near-shore areas.
 - Vital signs health monitoring, includes 3-4 marine indicators
 - Marine benthic communities
 - Associated fish communities
 - Marine and freshwater water quality (protocol is in peer review)
 - Fisheries Harvest in future for some parks, if \$ available.
 - Ecoregional planning, to be done in 2008 – then CAP in all sites (benthic habitat maps, DAR work from MHI cruises has been helpful in ecoregional and CAP).
 - Trying to create a dashboard with ~12 measures of how we're doing – a social measure (extent to which communities demonstrate capacity to co-manage), biological (changes in the water), political/govt (is there evidence trust is being built, more effective rulemaking, enforcement, compliance) – need it spatially referenced as well. How much is enough (work, improvement)? How healthy is healthy? Could be socioeconomic and biological monitoring support for this.

2) What are CNMI's priority management actions?

- Fisheries
 - Bottom-fish related stuff, monitoring projects to help determine management actions
 - Secondary actions would involve controlling overfishing
 - Decrease take of marine resources, difficult because things are spread out over various agencies
 - Research and support for conservation of marine resources, e.g. NPS recruitment study on West Hawaii, collaboration with UH and DAR.
- MPAs
 - Expansion of a coherent network of marine reserves, protection of key herbivores, reduce land-based impacts
 - Kolokoko Honokohau compendium, this is park specific, ruled that you can only fish using traditional materials for fishing gear
 - Effectiveness testing of MPA's
 - Hawaii Volcanoes agreement with Kalapana community (east side of park coast. This restricts fishing to residents of Kalapana community).
- LBS
 - Secondary actions would involve controlling land-derived sedimentation and nutrient runoff

- Overuse
 - Installation of mooring buoys at Koloko-Honokohau (KAHO) on the Kona coast
- Invasive species
 - Removal attempts at KAHO of invasive alien algae such as *Acanthophora spicifera*
- Climate change
 - Reduce and eliminate greenhouse gas emissions with emphasis on carbon dioxide
- Marine Debris
 - Marine debris clean up
- Research
 - NPS research on coral and non-coral invertebrate recruitment will hopefully be used in collaboration with State fish recruitment and connectivity data. Have some comprehensive data sets for West Hawaii from South shore to North Kohala.
- Protected species
 - Recovery of the endangered Hawaiian monk seal through protection of key habitat areas used for pupping
 - Recovery of protected species
- General
 - Inventory and mapping – NPS have collected first few years of data, now at reporting stage
 - Review of permits for research and monitoring – everything is prohibited unless permitted
 -

3) What kind of mapping/monitoring data gaps need to be filled as related to these management actions?

Mapping

- Mapping – aerial mapping good, need layers on top of topography – LIDAR
- Shallow waters – have LIDAR, deeper waters - have multi-spectral technology – there is a gap between these areas – need to fill in this GAP
- Would be good to have multi-spectral topography in shallow area
- NOAA is providing a lot of the marine mapping data for parks

Hawaii

- Have USGS data for 3 W Hawaii National Parks, this includes marine benthic habitat maps, need data for all NPS Pacific Islands parks
- Need higher resolution data imagery, NPS is limited by capacity and funding
- Mapping deep (>25m) water habitats around the park that would be useful in the protection of the monk seal
- Mapping needs – partnership with Office of Hawaiian Affairs and UH to map coastal impacts to marine areas (social, cultural, biological resources on land and in water). Benthic maps are helpful for their baseline assessments: looking at target species in each community and ground truth as well as see emerging threats (e.g., anchor damage, COTS). Done in Hookena, Haena. Scale is community – very small. However, benthic habitat mapping doesn't need to be at a fine scale – they use Google Earth, collect GPS data and add to it. Community-based baseline mapping is partly community building. By comparing their mapping with benthic habitat maps, they build trust in what scientists have done. Traditional knowledge is another priority.
- Water Quality data
 - Aerial flights– infrared technology that measures changes in temperature, to map freshwater incursions – information needs to be GIS accessible
 - Broad scale water quality mapping from hyper-spectral imagery
 - EPA is limited by means to collect data
 - Utilize satellites to monitor water quality across large areas (nutrients, sediment)
 - Hyper-spectral mapping state-wide – was used on Maui to map algal blooms
 - Track discharge plumes with high resolution imagery
- Development-related land-based pollution
 - Benthic habitats maps don't provide prioritization information for development activities such as dredging. e.g. wetlands- regional assessment that prioritizes wetland value
 - LIDAR for disposal sites for dredged ocean material
 - Bathymetry for dredge material disposal sites.
- More nearshore LIDAR
- MGAP process: Benthic habitat maps were useful at that scale. How helpful is this going to be to managers (there are already things they don't use) – will more, finer-scale data help or are there better investments? Finer scale data could be useful at specific sites
- Mapping is critical to define extent of habitat type/ classifications and to allocate sampling effort among habitat types.
- Everything is based on maps. Focus is on shallow reef. Ground-truthing is needed especially to deeper reefs. Significant area not mapped especially tops of banks.

Many years of mapping left. Need this to understand trends of ecosystem over time

Monitoring

- Need to focus attention on near-shore
- Need an effort to do this along the coastline
- Broad scale status and trend data on fish resource, target fish and reef condition. Socio-economic monitoring is needed, water quality (but only if done properly and rigidly)
- Water Quality data
 - Aerial flights– infrared technology that measures changes in temperature, to map freshwater incursions – information needs to be GIS accessible
 - Comprehensive state-wide characterization of water quality
 - Identification of impaired waters
 - Actions to improve water quality
 - Linking benthic habitat mapping with water quality to identify source
 - Remote sensing for turbidity and nutrients, e.g. Craig Glen on Big Island. HI is using hyper-spectral imagery to identify freshwater plumes from the island
- Water quality standards and biocriteria
 - Determine if standards for sediments and nutrients are protective of sensitive coral reef habitat
 - Guidance for water quality criteria that are protective for sensitive coral reefs in addition to biological criteria
 - Need better bacterial indicators for tropical environments, can't help with human health MRSA [Methicillin-resistant Staphylococcus aureus], are endangering people who collect samples, need robotics to monitor pathogens (e.g. leptospirosis)
 - Assessing condition of coral reef ecosystem
 - Thresholds for permitting to protect aquatic life
 - Biocriteria comparison across jurisdictions (currently not comparable)
- Development-related land-based pollution
 - 404 program and coral reefs.
 - Compare value of coral reefs with potential impacts e.g. Apra Harbor, Pago Pago
 - Consider high value vs. low value reef when selecting sites for development
 - Assuming that every reef is valuable is not an effective approach for military projects
- We need support to continue the CRAMP monitoring activity. Funding is lacking, so many of our sites are not being surveyed annually. We have good support on Maui, so those sites have been done annually with extremely good results. Williams et al. report shows that all of the sites on Maui are declining except for

the two with high levels of protection (Molokini and Ahihi Kinau). We need this type of information throughout the Archipelago.

- 4 of 11 NPS Pacific Islands parks are being monitored for some marine vital signs now. CRED has apparently collected REA data from south side of Hawaii Island and offshore from Haleakala. NPS has a peer reviewed marine benthic monitoring protocol that they can share; capacity is only limiting factor.
- Desire to monitor fishing activities within park boundaries both remotely and through visitor use surveys
- Need life cycle of species – very few exist, which leads to a lot of finger-pointing. (This work won't be done in HI for at least a decade if NOAA doesn't do it.)
- Start with community needs – differ in land-based impacts, fishery, and recreation threats. Need information about climate change and ocean acidification – is there much we can do given these larger threats out of our control? Don't understand ecosystem relationships well.
- PRIA, AS work has been really helpful for Monument designation to demonstrate threats and status (DAR publication coming out is from MHI cruises; was able to look at human population and fish stocks, regardless of habitat health)
- Need user-friendly, real-time data downloaded on a laptop to be useful. Need to think beyond DAR for state users. DOCARE needs data for assessing performance, including economic (creel survey). Need algorithms for getting at % predator biomass – how precise is the science for estimating in bays, around islands (especially when #s are very low)? Are we just guessing or estimating well?
- Sometimes data sits and doesn't get analyzed
- Stock assessment or other estimates of abundance for evaluation of impacts of proposed permits

4) What management questions need to be answered?

- Fisheries
 - What are the broad status and trends and what are the factors driving change, how effective are current management actions – gill net ban, MPAs, etc.
 - Fisheries and shifting baselines. Need fish dependent and independent data. Independent is collected at 4 national parks in Pacific Islands. Need dependent data at all sites. NPS is developing protocols to collect fisheries dependent data but no funding to implement at present.
- MPAs
 - What are the broad status and trends and what are the factors driving change, how effective are current management actions – gill net ban, MPAs, etc.

- Land Based Sources of Pollution
 - Watershed prioritization, modeled and mapped for all major watersheds
 - Need help with watershed planning
 - Identifying land-based pollutant sources thru land-use maps etc. – would like these in a picture/GIS format
 - How does biocriteria compare across jurisdictions?
 - Are standards sediments and nutrients protective of sensitive coral reef habitat?
 - What are the thresholds for biological life for permitting?
 - Can we consider value of coral reefs when selecting development sites?
- Overuse
- Invasive species
 - Marine algae species range, e.g., Kaloko-Honokohau has done invasives project – just published in Pacific Science Journal. Have an invasive in another park that has limited range at present, but limited capacity to get a handle on it. NPS_UH project to inventory alien/invasive and other algae at several Pacific Islands National parks, scheduled for completion 2010.
- Climate change
- Water quality
 - What is the condition of water-quality State-wide?
 - What actions are needed to improve water quality?
 - Are water quality criteria protective for sensitive coral reefs?
 - What contaminants and other pollutants are making it to groundwater and effecting reefs, especially at Kaloko-Honokohau National Park. Other NPS parks apparently not issue at present. Nutrients and sedimentation are issues elsewhere.
- Research
 - Is coral recruitment limited on West Hawaii Coast? NPS-UH-DAR have been collecting data, will hopefully continue this to tease out natural variability. So far recruitment levels are very low for most of coast, relative to elsewhere.
- Wetlands
 - Map where there were historically – many have been developed. Link loss of wetland to coastal health, e.g. areas where there is only pavement and no coral cover were probably healthy reefs prior to development. Need historical information, drainage, accumulation patterns.
- Protected species

- General
 - Information on specific impacts to resources and how we implement actions to address these. Need outreach to public and policy makers.

5) What are the long-term and short-term goals that NOAA can help you achieve using mapping and monitoring data?

Short Term

- Do not have infrastructure to do mapping and monitoring, do not have boats, NOAA has boats and can reach the difficult to reach sites, windward sides of islands, etc. So just provide data.
- Difficult to say, continue what we have and start socio-economic monitoring.
- Mapping will directly drive where monitoring efforts are located.

Long Term

- Get out to the NWHI, get information from these areas. Will increase fishing restrictions, monitoring in difficult sites will provide much needed information especially for potentially closed areas. Haumakua Coast. Large liners have kind of moved on, but will also have small boat fishery.
- Good data for Big Island and parts of Maui but extend data for all Hawaiian Islands. Filling in the gaps. Links between cause and effect of things driving reef conditions.
- Understand the range of natural variability over time, e.g. abundance of coral reef fauna. NWHI can be control to look at natural variability and help define anthropogenic impacts in Main 8.

6) What mapping/monitoring capabilities does Hawaii have? What activities do the agencies undertake? What products do they produce?

- Statewide monitoring program which does not include Kauai or Molokai, started with WHAP surveys on Big Island, expanded to Maui and Oahu. Fishery dependent survey monitoring on Maui. Not really doing any of their own mapping. Do not produce base layers. Annual report – DJ and NOAA coral reef annual report.
- Lay gill net monitoring, set-up around fixed monitoring sites, difficulty to do stock assessments without random sampling protocol.
- Limited marine capabilities, primarily Maui and Kona sides, Kauai. Molokai Lanai no activities, no managed areas.

- State-wide benthic and fish monitoring by DAR
- The Coral Reef Assessment Monitoring Program (CRAMP) at HIMB
- CAP – Zero/ a GIS person maybe, monitoring programs in part of the state with NOAA funding.
- Activities – benthic, fish monitoring, based around management activities
- Products – public presentations, scientific papers, internal documents and reports, 2 pagers
- EPA
 - 305b Status of the State’s water, integrated report that identifies impaired water
 - State produces and EPA approves
 - Royal EPA – national coastal condition report (how does it scale up or down, what is EPA doing and how could NOAA complement this)
 - Ocean survey 2010 scheduled. Not sure if Hawaii will be included (funding dependent). Minimum will be West and East coast. Periodically survey US jurisdictions.
- TNC does monitoring of nearshore resources for fish and habitat health and changes over time in sites where they and partners work with communities (little overlap with CRED) – are building internal capacity and have been doing for ~3 years; would be good to coordinate with NOAA. Coordinate with State on their nearshore monitoring (NOAA, HIMB, DAR); DAR does/will help coordinate and share data.
- Understanding of Ecosystem function, basic characterizations of Monument resources.

INFORMATION GAPS AND NEEDS

1) Is the lack of mapping/monitoring data one of the biggest impediments keeping Hawaii from achieving these management goals, or are there other obstacles that are larger/more primary than lack of mapping/monitoring data? (e.g. lack of political will, legal authority, or enforcement capability)

- One feeds a bit into the other, lack of mapping makes it more difficult to plan future monitoring and stock assessments. Only 1 year on Oahu for monitoring information. Impedes ability to go out to public and make statements.
- Lack of a state budget, cut backs, may lose positions, may cut monitoring (fish and habitat) project because it is all contract positions.

- Monitoring could be the biggest impediment; historically money was not put into monitoring, driven by public comments previously. As an agency, DAR does not have the data to be making these rules. Coral money supporting a lot of internal activities, staff and monitoring activities. HIMB charges a fee to rent a boat, DAR does not. If DAR cannot bring money to the table they can bring people.
- Not lack of data, political will.
- Already quite a lot of information out there but not reaching decision makers, not used to build public consensus, putting data in right hands (but some questions where lack of monitoring data is a problem)
- Yes, is a threat, can't tell you what the condition of water quality is state-wide in HI.
- Biggest impediment is new threats: don't know what we're losing and assessment is difficult. Shifting base-line and cumulative impacts.
- Climate change – developing nations are increasing emissions, can't measure impacts
- EPA can't keep up with emerging products (eg. pharmaceuticals). New pharmaceuticals and chemicals, things we're not looking for, and have no idea about the interactions of substances and cumulative impacts
- On the climate change issue the problem is the unwillingness of managers to deal directly with the CO₂ issue. They skirt the issue by arguing that it is beyond their mandate. On the contrary, Terry Hughes (ICRS Darwin Award Plenary) stressed that we have a major role in educating the world about the seriousness of the problem. The reefs are the first major ecosystem to be destroyed, but the others will follow quickly. Also, we can put a cap on emissions and go to alternative energy as demonstrated in numerous talks at the Task Force Meeting earlier this year. So we must use education and outreach to get this message out to the public and to our leaders.
- Yes it is, along with political will, enforcement and communication between managers and scientists. Lack of mapping data limits driving monitoring information. Maps are used to position 30 random transects (15 fixed and 15 random), can also infer large scale ecological change from mapping
- No, higher priority activities include management authority over the marine boundary within the context of a marine managed area and having a larger law enforcement presence
- Logistical impediments and financial impediments always
- Mapping and monitoring are among management goals – in the absence of local human activities to manage, we can watch and understand processes. Anything that better informs us about understanding improves management.

- What will change political will? Maybe credible trend data is necessary (but not sufficient) – then that part of mapping and monitoring is important. Otherwise, it's WAAAY down on the scale of importance. Causal links are one of the most beneficial types of information – e.g., injection wells are the big problem (even though that particular statement has been backed off from) – this kind of link between a stressor and a response can lead to management decisions. Working with communities – herbivore assessments and trends are good
- Conclusion that 76% of reef species are in trouble, 2% are healthy is useful. But maybe it's in building a case that something needs to be done, more than helping make a management decision. Good to compare herbivore data in remote areas to define ecosystem services from pristine environment (e.g., Palmyra) rather than trying to reconstruct it from impacted areas (MHI).
- If we had data, especially on causal links, maybe could make better management decisions, but can't carry them out because of lack of political will. Better to understand resources management in terms of food security because that better relates to communities.

2) What data or information best assist Hawaii's agencies in achieving their goals?

- Mapping and general population information, life history information (see Fisheries LAS)
- How do we approach alien invasive species? Mapping may help with this, can measure/watch spread of alien species. Is it possible to have a rapid response? Monitor ship harbors to guard against spread of alien algae.
- Large scale mapping is useful. DAR can do fine-scale mapping and monitoring, but this could be improved with more funds.
- Broad data on status and trends, being able to meaningfully measure management actions. In general, medium to large scale information is important, ecologically/sociologically meaningful scale would be the best.
- Large scale (island/state wide) and location-based: HI DOH has 3 priority watersheds in Hawaii – Hanalei, West-Maui, Waimanalo. Guam significant military build-up
- Large scale – to show trends of ecosystem
- Trying to create a dashboard with ~12 measures of how we're doing – a social measure (extent to which communities demonstrate capacity to co-manage), biological (changes in the water), political/govt (is there evidence trust is being built, more effective rulemaking, enforcement, compliance) – need it spatially referenced as well. How much is enough (work, improvement)? (How healthy is healthy). Could be socioeconomic and biological monitoring support for this.

Additional Question (NGOs only)

3) Are your management needs driving mapping/monitoring? If not, how could dialogue be improved?

- What CRED is doing is farther out and at a larger scale; is complementary to what's being done at finer scale nearshore but there's no real overlap. Is there a way to use both? Currently no overlap in mapping or monitoring. DAR is doing research relevant to managers (managing herbivores). That's a way to get science to answer management questions. Links to state, university, try to use similar methods, scales, habitat types so they can compare. Could have links to MHI RAMP, mapping. But have different methods and scales.
- Social monitoring, human use surveys, etc. could be used to get at extraction side – is it appropriate for NOAA? Maybe redirect funding to get at these questions – technical support.
- There is very little conversation between us (the NGO and the communities we work with) and the research community. To the extent this happens, it's through what we learn from other NGOs and relationships with individuals within the State. Communities have research and mapping questions – so far getting those answered has happened through relationships with individual researchers. There is no network to get from questions to science/mapping/monitoring to answer them.
- Ditto: recreational use impact assessment – need to be able to research this. Maybe redirect funding to get at these questions – technical support. Need info that supports causal links. Cause, impact, evaluation.
- New users of mapping and monitoring information – increasingly sophisticated community leaders; high schools required to do more rigorous science: could consume real-time(?) data; need understanding of science for policy – policy-makers currently exist in data-free zone. What policy-makers want is very difficult to give; they want simple answers on what's going on and what we should do about it. Organizations of fisher folk: free-divers, etc.
- Recommend you ask managers what scale and frequency is useful for the questions they have. In Palmyra, can RAMP data be integrated in a meaningful way into the long-term monitoring NGO is starting?

DATA AND INFORMATION PRODUCTS

1) Of the following, what data/information products are useful?

- **Bathymetry**
 - For planning surveys, backscatter and bottom hardness to stratify habitat maps, monitoring deep water corals etc. Fine scale – 1 meter, haven't seen data from Ahi. All State waters, dealing with Oahu primarily, areas with deep coral garden spots.
 - 1 m would be ideal
 - Especially for Maui County
 - Inshore stuff, current LIDAR data is good
 - For potential ocean disposal sites
 - Existing LIDAR is excellent and was obtained at great cost. More bathymetric data to fill in the missing data and deeper reef data is ongoing at NOAA and expensive.
 - Very valuable to have accurate maps – everything is based on those – unsure on scale resolution – need scale that most is important for understanding support of organisms – finer scale is always better but unclear if that gives you better understanding

- **Habitat Mapping**
 - Bottom fish habitat mapping
 - Nearshore areas, potential for watershed partnerships
 - scale is pretty good, but gaps in coverage, broad functional habitat groups, as it is, is good
 - Existing maps OK. They have been done twice at great cost. No need to do it again.
 - Very useful. Would like finer resolution but existing is OK.
 - Habitat mapping at deeper depths >25m at a resolution of a 100 m².
 - 4th most important [of this list], depending on scale
 - Very valuable will drive distribution of monitoring effort – more ground truthing is best – this in itself is a monitoring tool and can be used to look at changes over time when mapping/habitat classification are re-done.

- **Biological Monitoring**
 - Output from MIRAMP. Harder to reach areas complementary
 - Have it, but could use NOAA's help for windward side because of accessibility issues.
 - Need more resources to do monitoring
 - Good to have the data, use internal data a lot.
 - Need support for annual resurveys at existing CRAMP sites
 - Have contracted NOAA experts (e.g. Friedlander) to build capacity, which has been very useful. Haven't been able to access CRED data yet, lag to get data to managers. Suggest looking at NPS model, which mandates 1/3 funding to be used for data management and processing. This mandate was developed to try to reduce data lag time.
 - Yes (3 NGOs)

- Very useful – gives us ability to determine potential impacts of human activities and natural variability – larger samples are always better
- **Water Quality Monitoring**
 - Big information gap, would be helpful to have, may be doing some off of Maui.
 - Love to have more, but ground water monitoring would be essential
 - Limited by equipment. Need in situ probes to do thorough sampling, e.g. nitrate probes. DAR has field staff but don't have the right equipment.
 - Not aware that it is happening
 - All scales – state-wide and near-shore waters
 - Very expensive to do properly, even at a single site. Makes more sense to increase use of biocriteria being developed by CRAMP and others.
 - Have separate mandate for freshwater and marine waters. Work with State and local jurisdiction to fill in gaps. Have limited capacity – would be great to have more data from other agencies.
 - Yes (3 NGOs)
 - Not looking at human inputs – N/A
- **Oceanographic Monitoring**
 - Very important, recruitment of juvenile fish, SST, fish larval cycles are important, archipelagic scale, need meta-analysis of genetic connectivity.
 - Offshore stuff is to the wayside.
 - Within 3 miles is useful.
 - Not sure why it is a management priority at state level
 - Could help with state-wide monitoring
 - Better circulation data can help with predicting water quality and assessing off-shore plumes (within 100 fathoms)
 - Near-shore circulation information for TMDL's
 - Existing satellite and remote sensing products and oceanographic programs such as HOTS give us good regional information. At the local scale it is very expensive to do properly, even at a single site. Makes more sense to increase use of biocriteria and direct monitoring of benthic and reef fish populations.
 - Have data for Kaloko-Honokohau and Kalaupapa (Molokai). Same case as WQ, have limited capacity. Have equipment but don't always have staff/support to deploy equipment, analyze, interpret data. Could benefit from help of other agencies, need funding to keep instruments running. Can potentially share equipment.
 - Oceanographic monitoring of acoustic signals at a resolution of 1-2 km
 - Thermal qualities of water (for bleaching) or carbonate chemistry (acidification) is important – not much of that going on. Just starting some of this work.

- **Fisheries Stock Assessments**
 - Very important but do not have the ability to do it. Commercial database is problematic because of lumped categories.
 - Very important for nearshore fisheries, do not have the expertise.
 - Pelagic fisheries useful
 - If done, need to be done on a smaller scale than the State scale, maybe by island or smaller scale. If this can be done it would be very useful but may not be worth spending the money on.
 - No
 - This could come out of the monitoring program
 - NPS has 1 study in Guam and 1 in American Samoa for artisanal or subsistence fisheries. More support would be great.
 - Yes (3 NGOs)
 - N/A – fishing pressure is decreasing so we have opportunity to look at recovery when fishing stops. This is second tier monitoring.

- **Ecological Forecasting**
 - Not sure what it is. May be helpful as GCC
 - Not really helpful
 - Biggest issue is what is happening to reefs now and addressing key threats
 - Doesn't sound useful
 - I do not know what this means. Forecasts of impact of climate change (bleaching and ocean acidification) give us a forecast of the loss of reefs in this century.
 - Yes, highly valuable. Have used Coral Watch in American Samoa, Ofu Lagoon. Has also helped with process oriented research. From small biological scale to large ecological scale
 - Would like to see an early warning tool for Alien species, based on biological indicators. Same for coral disease.
 - Storm forecasting is also useful. It's also good for examining impacts of previous storms.
 - Especially as relates to global changes like acidification
 - Not much going on but potentially very valuable – be able to forecast ecosystem-level changes in response to perturbations by tweaking the parameters of the model

- **Models**
 - Somewhat important, not of primary importance
 - Not really useful
 - Doesn't sound useful to managers, scientists maybe
 - Our knowledge of the demise of reef this century is based on models as well as direct observation of mass bleaching events, disease and massive mortality. We have a climate change and coral model (COMBO) in press at L and O.

- Models are abstract and need more field validation and experimental information. Need for action is greater than need for more models.
- Yes, for sea-level rise and climate change. Parks and communities will be hugely affected.
 - Also, acidification rates and modeling on that are very important. HCRI is moving to site-based approach: throwing everything at Kahekili and Moanalua to get integrated look at those areas. Would be good if NOAA worked (or supported work) in areas where we think it's turning around and see why (e.g., K Bay). UH proposal: resolution is finer, different things come out as different colors – has been done in some areas, including K Bay
 - Not much going on but potentially very valuable – be able to forecast changes by utilizing models with predictive capabilities.
- **Decision Support Tools & General Comments**
 - Not really necessary
 - Informed expertise more useful than any tool.
 - We are developing the Ecological Gradient Model (EGM) that can assign a rank of reef health and value based on standard survey techniques. This could be a valuable decision support tool.
 - Yes, would like to see tools based on monitoring data, e.g. shows reefs at a threshold and provides management actions based on inputs. Would help bridge the gap between scientists and managers. Tools need to be scientifically rigorous plus easily useable/understood by managers.
 - Integrated in all the others, not a separate thing.
 - All information should support decision support tools

2) What information is lacking (i.e., gaps)?

- Bathymetric information, integration of existing maps and monitoring programs, stock assessments, time series information
- Getting data for periodic stock assessments – need to do stratified random sampling, using NOS habitat maps. Maps end at about 60 ft. Need more data at deeper areas. Shoals data, bathymetry data for rugosity. Finer scale habitat mapping down to 200 ft.
- Could use 1 package of all information that NOAA has, including GIS stuff
- Groundwater information and habitat mapping
- Information on specific impacts to natural resources and how we implement actions to address these.
- Socioeconomic stuff, water quality (but probably irresolvable), data sparse outside of populated areas.
- Fisheries dependent data

- Near-shore water quality, including groundwater quality and quantity
- Data analysis, synthesis, and interpretation capacity
- Bathymetry and habitat mapping – not enough
- Biological monitoring – not enough too small sample size
- Raw data (biologica, mapping, oceanographic) to support Monument specific decision support tools

3) What product delivery mechanisms are preferred? (printed reports, electronic documents, CDs, GIS datasets, websites, automated emails)

- Website when searching for PDFs of information. PDFs are best delivery mechanism.
- GIS data layer – would work nicely with stream info
- Hard copies of coral maps very useful for group discussions (digital are too slow), digital formal for GIS, database for resource managers
- GIS data sets, website would be nice if summarized and interpreted
- Websites, electronic and GIS data
- Electronic formats preferred but format is not the problem. Issue is having time to keep up with it all, automated emails would be a good way to stay information of new developments
- Printed reports, electronic documents, CDs, GIS datasets, websites, automated emails
- Raw data to support decision support tools
- Summarized products – data for dummies

4) What data formats are preferred? (raw text, spreadsheets, images/graphics, GIS, binary/HDF, Google Earth, technical reports, scientific papers)

- GIS layers, graphics
- GIS, access files
- Google Earth good, web-based data-base linked to GIS format, site specific data
- Two-page summaries of projects/reports (e.g. Friedlander's fish habitat)
- Prefer hard copies of report (if they're useable)

- Any form is fine as long as electronic, not really an issue, but GIS layers are good, Excel by default.
- All depending on question. Don't always need data but need to know where it is. Good to have a contact person to help put data into needed format. Images, Google Earth for non-GIS data users.
- Depends on the need. In general, graphic products, probing executive summaries are useful, plus raw data if specific to location and can be applied to management priorities. Maps are really good. NPS is building a geo-database for photos. This will provide a format and tool for managers to detect landscape changes, without needing technical training.
- Raw text, spreadsheets, images/graphics, GIS, binary/HDF, Google Earth, technical reports, scientific papers
- Online access not to raw data, but an interface where we can "ask" it questions – get spreadsheets or charts. Take a look at Intellisense – discovers and maps existing data (including but beyond NOAA data). Private sector/other NGOs are doing similar activities – do we or how can we share data or technologies?

5) What data products and formats are currently used?

- GIS layers, Microsoft access, SAS, Minitab
- GIS, access, websites – form of an atlas, cds, some printed copies
- Access, Xcel, GIS
- NAD 83 – EPA and State uses
- Everything

6) What types of training do the Hawaii agencies require to use the data or products?

- GIS training, GIS tools, more access training
- Limitations of products e.g. benthic habitat maps
- We're covered on database management – moving toward shipboard data entry directly into databases/ need some level of interpretation by coral biologist – even in summarized format.

7) Does Hawaii have software and/or hardware needed to access or utilize these data?

- GIS software on PC/MAC

- ArcGIS
- Fly-over 3-D tools (EPA doesn't have these tools)

Additional Question (NGOs only)

8) How well can you get at existing data?

- Can get data through relationships, but lots of other data they don't even know about. Forum for researchers to share info beyond federal researchers would be good. Also need translation from research scientist to manager. This translation is not within capacity of many NGOs or state agencies – would be effective to have a point person to do the translation and disseminate that information.
- Building partnership with DAR to get better access to raw or analyzed data, do the analysis, translate it ourselves.

Other Comments:

- Primary funds for monitoring was from DJ, which only allows for finfish.
- DAR coral monitoring funding has been very useful at producing results. One of the most important things that they do.
- Data should be compatible within regions and with past research. Continuity of methods through time.
- In addition to the Coral Reef Ecosystem Integrated Observing System (CREIOS) we need a Coral Reef Ecosystem Integrated Action System.
- Would also like dissemination of the summary of information collected from these interviews – thinks it would be very useful for managers.
- Mapping and monitoring themselves are management goals. Management for Monument might be the one-off because they are mainly trying to maintain the integrity and health of the system and there is a relative lack of human impacts/presence. Because of this they can only watch for trends in ecosystem health – therefore need to monitor for management. They have been undergoing evaluation and revisions to their monitoring program over the past three years. Monitoring methods were based on fixed sites rather than random sampling and often biased toward some of the aesthetically pleasing areas and not representative of system. They realize this was not necessarily the most accurate assessment of overall ecosystem status and trends, and need more of a “stock assessment model” to support management questions on habitat stratum or atoll-wide abundances and trends, permitting, etc. They are currently moving toward a random sample approach to their monitoring. They are also currently working on analysis of the data to see if they are getting the most bang for the buck. They are working with

Jerry Ault at University of Miami. They are having a meeting in October with three Monument trustees (NOAA/DOI/HI State) to review what has been found to date with new methods and should have some consensus about the type of monitoring they feel is most valuable.

Take-away messages (NGOs):

- Ridge to Reef site- and community based management are priorities
- Link between science and managers: want to have management questions guide mapping and monitoring activities instead of inverse. Also having staff dedicated to directing management-driven science and translating into management language
- Want big-scale threat information – climate change, acidification and how those will impact effectiveness of local conservation initiatives
- Benthic habitat maps, RAMP cruise most useful now, despite resolution, methods (monitoring) concerns. Remote area cruises useful in unexpected ways.
- Need monitoring to get at causal links and assessing success of management actions
- Monitoring at finer scale is more useful (e.g. community sites)
- Need easy, digestible, discoverable access to data, analysis and results
- Lack some important information (not mapping and monitoring) like life histories, ecosystem services, relationships, resources trends, etc.
- In the bigger picture of coral conservation management, mapping and monitoring are low on the priority needs list as other impediments to overcome are much greater (e.g. funding, capacity building, policy and regulatory framework, direct threat abatement for land-based pollutants, overfishing, recreational use, etc)
- Information is mostly needed to: 1) show causal links, 2) increase political will with credible data, and 3) determine effectiveness of management actions .
- This information needs to be provided in digestible, easy-to-understand ways to resource managers.

Other Topics:

- Capacity building with communities (e.g., fellowship).

Hawaii

- Governance (e.g. enforcement), but need to incorporate communities (e.g., Makai Watch) so they demand enforcement and rule-making.
- Improving the situation of ineffective governance, lack of trust between government, managers, and communities.
- Park Boundaries - cross jurisdictional efforts and cross deputization for personnel
- Specific to our park is the realignment of our cooperative management agreement with the State of Hawaii, DLNR. We are trying to establish concurrent jurisdiction with the State for marine waters so that we can address fishing pressure.
- Community-based co-management, improving conservation finance – coalitions of stakeholders (by bringing in Conservation International to talk to folks and raise money).

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**NOAA Coral Reef Conservation Program
Pacific CREIOS Workshop
Honolulu, HI – November 2008**

**Western Pacific Regional Fishery Management Council
(WPRFMC)
Interview Summary**

Interview conducted by:
Alan Everson, NOAA, NMFS, Pacific Islands Regional Office

Interview Participants:

Western Pacific Fishery Regional Management Council

The following is a summary of the answers provided by the interview participant to a series of questions posed by the interview team in preparation for the NOAA Pacific CREIOS workshop.

BROAD-SCALE MANAGEMENT GOALS

1) What are the mandates of the WPRFMC?

- Manage fisheries in federal waters and on the high seas. Develop fisheries management policy for the federal government

2) What are the priority issues/threats for the WPRFMC?

- Fishing
- Ecosystem and habitat
- Protected species
- Drafting Ecosystem fishery management plans

3) What are WPRFMC's priority management actions?

- Implement archipelago-based fishery ecosystem plans

Short Term

- Quantify habitat, monitor changes in reef fish abundance

Long Term

- Mag-Stevens Act meeting mandates to ensure sustainable reef fish fisheries

4) What kind of mapping/monitoring data gaps need to be filled as related to these management actions?

- Monitoring
 - Biomass estimates for coral reef species
 - Life history information
 - Quantify Impact from natural sources

5) What management questions need to be answered?

- Ability to set annual catch limits for reef fisheries
- To understand factors that influence changes in abundance of reef species

6) What mapping/monitoring capabilities does USFWS have? What activities does USFWS undertake? What products does USFWS produce?

N/A

INFORMATION GAPS AND NEEDS

1) Is the lack of mapping/monitoring data one of the biggest impediments keeping WPRFMC from achieving these management goals, or are there other obstacles that are larger/more primary than lack of mapping/monitoring data? (e.g. lack of political will, legal authority, or enforcement capability)

- Not getting the right products from the mapping/monitoring program

DATA AND INFORMATION PRODUCTS

1) Of the following, what data/information products are useful?

- **Bathymetry**
 - Useful for inhabited islands
- **Habitat Mapping**
 - Useful for inhabited islands. Synoptic mapping to track changes over time
- **Biological Monitoring**
 - Extremely important (life history information)
- **Water Quality Monitoring**
 - Yes for point source
- **Oceanographic Monitoring**
 - Yes
- **Fisheries Stock Assessments**
 - Critically important
- **Ecological Forecasting**
 - Yes
- **Models**
 - Extremely important for decision making

2) What information is lacking (i.e., gaps)?

- Life history information for fish
- Biomass estimates
- Factors effecting abundance

3) What product delivery mechanisms are preferred? (printed reports, electronic documents, CDs, GIS datasets, websites, automated emails)

- Electronic delivery
- Data summaries

4) What data formats are preferred? (raw text, spreadsheets, images/graphics, GIS, binary/HDF, Google Earth, technical reports, scientific papers)

- Raw text

5) What software and/or hardware needed to access or utilize these data are lacking?

- Data availability rather than software

Other topics:

- Why is there so much dissatisfaction with the program?
- Usefulness of CRED data for fishery management is very questionable
- There is a perception that the sampling has not been representative
- Not enough dialog between NMFS branches

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**NOAA Coral Reef Conservation Program
Pacific CREIOS Workshop
Honolulu, HI – November 2008**

**U.S. Pacific Remote Island Areas (PRIAs)
Interview Summary**

Interview conducted by:
Kathy Chaston, NOAA, NOS, OCRM Coastal Programs Division

Interview Participants:

U.S. Fish and Wildlife Service
Pacific Remote Islands National Wildlife Refuge Complex

The following is a summary of the answers provided by the interview participant to a series of questions posed by the interview team in preparation for the NOAA Pacific CREIOS workshop.

BROAD-SCALE MANAGEMENT GOALS

1) What are the mandates of the U.S. Fish and Wildlife Service (USFWS) in the PRIAs?

- Refuge manager for PRIA
- Areas managed as national wildlife refuges, wildlife first
- Mission is to protect then restore
- Johnston, airforce jurisdiction - 3 NM
- Kingman and Palmyra- 12 NM
- Palmyra – TNC partnership, Palmyra Research Institution (9 agencies)
- Baker, Jarvis, Howland – US- all managed as MPA's
- Rose Atoll – 3 NM boundary
- (see NWR in the Pacific web-site for more details)

2) What are the priority issues/threats for the USFWS in the PRIAs?

- Ship-wrecks at Palmyra and Kingman
- Palmyra – growth of *Coralomorph*
- Kingman –growth of cyanobacteria (is smothering reef)
- Had problems at Rose Atoll with invasion of Cyano
- War debris at Baker and Howland – causes pollution and invasive species – hope that new LBSP coral program focus is broad enough to consider this
- Episodic events that cause problems

3) What are USFWS's priority management actions?

- Restore circulation at Palmyra
- Funding to remove shipwrecks
- Interactions of iron and nutrients that can effect coral reefs

4) What kind of mapping/monitoring data gaps need to be filled as related to these management actions?

- Need to detect vessels using areas:
 - Remote sensing deployed at Rose Atoll
 - Data not real time
 - Enforcement thru remote detection – not feasible to station people year round

Short Term:

- Development of acoustic listening devices

Long Term

- CRED data for coral reef monitoring

5) What management questions need to be answered?

- When are vessels entering/leaving NWR's?
- How are iron and nutrients from ship groundings effecting coral reefs?

6) What mapping/monitoring capabilities does USFWS have? What activities does USFWS undertake? What products does USFWS produce?

- Permanent coral reef transects

U.S. Pacific Remote Island Areas (PRIAs)

- Palmyra consortium is developing a research management plan. Allow intensive monitoring.
- How to use Palmyra facility to compliment coral program?
- Co-author State of the Reefs Report

INFORMATION GAPS AND NEEDS

1) Is the lack of mapping/monitoring data one of the biggest impediments keeping USFWS from achieving these management goals in the PRIAs, or are there other obstacles that are larger/more primary than lack of mapping/monitoring data? (e.g. lack of political will, legal authority, or enforcement capability)

- Monitoring is biggest impediment, mapping is not an impediment.
- If CRED monitoring stopped, would be in trouble
- Enforcement capabilities also impediment – difficulty in establishing enforcement

DATA AND INFORMATION PRODUCTS

1) Of the following, what data/information products are useful?

- **Bathymetry**
 - Yes, remote sensing tools
- **Habitat mapping**
 - Real time data beneficial, data from web-site is good
- **Biological monitoring**
 - CRED tools refined
 - Suite of monitoring is good and repeated, resolution – Pacific-wide, local and regional is valuable.
 - Focusing on jurisdictional needs is fine as long as doesn't jeopardize PRIA monitoring cruises. CRED is good for showing status and trends.
- **Water quality monitoring**
 - No need

- **Oceanographic monitoring**
 - In relation to climate change. Refuges are vulnerable to sea-level rise and acidification, CRED is doing a good job already.
- **Fisheries stock assessments**
 - Long term mentoring to see biomass trends, Pacific-wide fish surveys are powerful for showing trends
 - CRED American Samoa report showed decrease in large fish biomass, especially in Rose Atoll
 - Long-term data is very important to show base-line is changing and how benchmark is changing
- **Ecological forecasting**
 - Knowing if bleaching will occur
 - Understanding interactions on a coral reef
 - What would happen if a coral species is removed?
- **Models**
 - No need
- Decision support tools
 - No need

2) What information is lacking (i.e., gaps)?

- Census of marine life – inventories – especially for permitting
- Oceanographic data
- Enforcement – ability to enforce from a far (know what is there)- EARS very useful if real time or quarterly
- Bathymetry for seamounts
- Deep water biological monitoring

3) What product delivery mechanisms are preferred? (printed reports, electronic documents, CDs, GIS datasets, websites, automated emails)

- GIS data sets, so data is mutually available
- List-serve useful to know what people are working on
- Local list-serve for coral reef scientists useful

U.S. Pacific Remote Island Areas (PRIAs)

- Quarterly forums
- Monitoring reports useful (American Samoa report very useful)
- Map products
- Data most important

4) What data formats are preferred? (raw text, spreadsheets, images/graphics, GIS, binary/HDF, Google Earth, technical reports, scientific papers)

- Data worked up
- Graphic representations good for showing trends
- Access to more info/data if needed
- Web-based is good for managers

5) What data products and formats are currently used?

None

6) What types of training do the CNMI agencies require to use the data or products?

None

U.S. Pacific Remote Island Areas (PRIAs)

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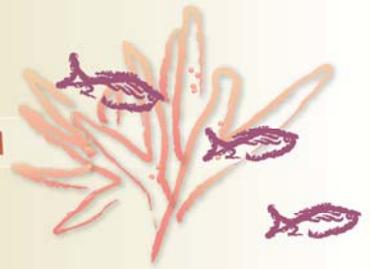
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C R C P

CORAL REEF CONSERVATION PROGRAM



CORAL REEFS are some of the oldest and most economically and biologically important ecosystems in the world, yet they face a number of serious threats including land-based pollution, overfishing, climate change and coral bleaching, coral disease, recreational overuse and misuse, and lack of public awareness.

THE NOAA CORAL REEF CONSERVATION PROGRAM supports effective management and sound science to preserve, sustain and restore valuable coral reef ecosystems for future generations.

PROTECTING OUR NATION'S CORAL REEFS

To address the complex nature of the threats that face coral reef ecosystems, the Coral Reef Conservation Program (CRCP) brings together expertise from across NOAA for a multidisciplinary approach to understanding and managing coral reef ecosystems. This partnership includes more than 30 offices from NOAA's National Ocean Service, National Marine Fisheries Service, Office of Oceanic and Atmospheric Research and National Environmental Satellite, Data and Information Service. The CRCP also facilitates and supports many partnerships with scientific, private, government and nongovernmental groups at local, state, federal and international levels.



The CRCP serves as the Secretariat for the U.S. Coral Reef Task Force (Task Force), which was established in June 1998 by Presidential Executive Order. Through the coordinated efforts of its members, including 12 federal agencies and 7 states and territories, NOAA and the Task Force have helped build and lead U.S. efforts to protect, restore and sustainably use the nation's valuable coral reef ecosystems.

As co-chair of the Task Force, and as directed by the Coral Reef Conservation Act of 2000 (CRCA), NOAA has the responsibility and expertise to help conserve coral reef ecosystems for future generations. To this end, the CRCP works with its partners to conduct coral reef mapping, monitoring and assessment, natural and socioeconomic research and modeling, outreach and education, and management and stewardship activities.



WHAT DOES NOAA DO TO PROTECT REEFS?

The CRCP addresses the priorities and mandates laid out by the Coral Reef Conservation Act and the nation's major blueprints for reef conservation: the National Action Plan to Conserve Coral Reefs and the National Coral Reef Action Strategy. The CRCP focuses on priority areas where NOAA has expertise and the ability to address key threats to reefs directly or through the work of partner organizations. NOAA's activities include:

- *Assessing and characterizing U.S. coral reefs through **mapping and monitoring***
- *Reducing impacts of **coastal uses** like land development, tourism and marine commerce*
- *Reducing the adverse impacts of **fishing***
- *Reducing the impacts of **pollution** from land and water*
- *Researching the causes of and effective responses to **coral disease***
- *Improving the use and effectiveness of **marine protected areas (MPAs)***
- *Reducing **international threats** to coral reefs*
- *Reducing the impacts of **climate change** on coral reefs, including mitigation of coral bleaching*
- *Researching **deep-sea coral** ecosystems*
- *Increasing **public awareness** through outreach and education*
- *Supporting research and management of the **Marine National Monument***
- *Coordinating three Coral Reef **Research Institutes** and related programs*
- *Coordinating two **grant programs** with seven categories for funding*

WHERE DOES NOAA CARRY OUT CORAL REEF CONSERVATION ACTIVITIES?

The CRCP supports coral reef conservation in the 7 U.S. states, territories, and U.S. federal waters where coral reefs are found. In the U.S. Pacific region, this includes American Samoa, the Commonwealth of the Northern Mariana Islands, Guam and Hawaii, and includes Florida, Puerto Rico and the U.S. Virgin Islands in the U.S. Atlantic/Caribbean region. The CRCP also supports coral reef conservation activities internationally, including the Pacific Freely Associated States.



FOR MORE INFORMATION...

For the latest news on NOAA's coral reef activities, information on funding opportunities, as well as background information on coral reefs and tips on things you can do to help protect reefs, visit the CRCP website at <http://coralreef.noaa.gov>.

Public access to NOAA's coral reef data, products, and publications is available through the NOAA Coral Reef Information System (CoRIS) at <http://coris.noaa.gov>. CoRIS is a single point of access to NOAA coral reef information and data products, and provides access to resources like informational essays, aerial photos, coral bleaching reports, management guides, scientific reports, an extensive illustrated glossary, professional exchanges and additional information on NOAA's efforts to understand, manage and protect coral reef ecosystems.

U.S. DEPARTMENT OF COMMERCE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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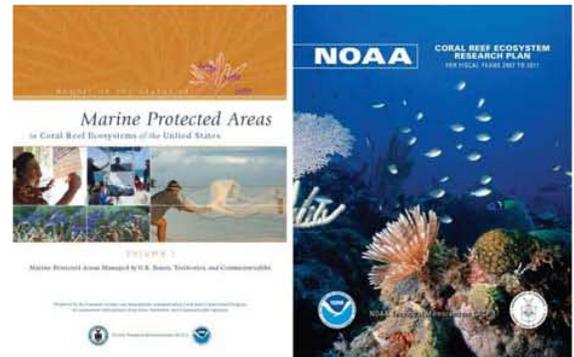




NOAA Coral Reef Conservation Program Fiscal Year 2007 Accomplishments

In fiscal year (FY) 2007, the National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program (CRCP) received just over \$27 million to support activities to conserve, manage, and understand coral reef ecosystems in the U.S. and around the world. The funding allowed NOAA to implement over 150 projects within the agency, fund three coral reef research institutes, and provide just over \$6.4 million in grants for additional projects. Below are just a few of the many accomplishments of the NOAA CRCP and its partners in FY2007.

NOAA CRCP Convenes an Expert Panel to Conduct a Five-Year External Program Review. As the culmination of months of planning by NOAA's CRCP, a seven-member panel of distinguished experts came together in September. The panel meeting included presentations from the CRCP and input from a variety of CRCP customers and stakeholders. The panel is charged with assessing CRCP effectiveness over a five-year period (FY2002-2006). The CRCP provided the panel with a comprehensive "self-assessment" of activities, outputs, impacts and challenges during FY2002-2006. The panel will provide its findings and recommendations in a final report in November; the report will be used to help guide CRCP planning for FY2009-2013.



The CRCP released the first two documents in its new technical memorandum series.

Administration Releases Proposal for Reauthorization of the Coral Reef Conservation Act. On May 8, the Department of Commerce transmitted to Congress an Administration proposal, the Coral Reef Ecosystem Conservation Amendments Act of 2007 (CRECAA), which strengthens the protection and restoration of our nation's coral reefs by providing expanded authorities to the Secretaries of Commerce and the Interior. The proposed legislation, which reauthorizes the Coral Reef Conservation Act of 2000, directs NOAA's CRCP to address emerging issues such as coral bleaching, disease, and climate change. The proposal also provides the authority to seek damages from those responsible for physical damage to coral reefs from such causes as vessel groundings, anchors, towlines, and lost cargo. The proposal mandates that the recovered damages be used to fund coral reef restoration. As of late October 2007, the House of Representatives passed HR 1205 and the Senate Commerce Committee is working to refer S 1580 to the Senate floor for a vote. Both incorporate some features of the CRECAA.

NOAA Releases First Agency-wide Coral Reef Ecosystem Research Plan. NOAA's first agency-wide coral reef ecosystem research plan was released on March 1 by NOAA's CRCP. The document, entitled *NOAA Coral Reef Ecosystem Research Plan for Fiscal Years 2007 to 2011* is designed to guide priority-setting for coral reef ecosystem research through FY2011. The Coral Reef Research Plan provides coastal and ocean managers, scientists, and policy makers with an up-to-date scientific assessment of the threats facing coral reef ecosystems, and identifies priority research needed to advance management action. Covering all coral reef ecosystems under the jurisdiction of the U.S. and Pacific Freely Associated States, the plan provides a national perspective on the research needed to address the range of stresses affecting the health of coral reef ecosystems, summarizes the management and other issues that will drive research at the regional level, and focuses on the use of research to guide effective implementation of ecosystem-based management strategies.

First Status Report Issued on U.S. Coral Reef Protected Areas. On March 1, the first-ever inventory and assessment of U.S. marine protected areas (MPAs) managed by State and Territory governments was released by NOAA's CRCP, as called for by the National Action Plan of the U.S. Coral Reef Task Force. The publication, *Report on the Status of Marine Protected Areas in Coral Reef Ecosystems of the United States Volume 1: Marine Protected Areas Managed by U.S.*

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States, Territories, and Commonwealths, was funded by the CRCP and coordinated by the Coastal Programs Division, both housed in NOAA's Office of Ocean and Coastal Resource Management. The report utilizes data collected in the National Marine Managed Inventory as well as the expertise of NOAA and state and territory co-authors to explore the management status of 207 MPAs located across the seven U.S. jurisdictions containing coral reefs. The report also identifies major challenges to effective MPA management and offers a series of recommendations both at the national and local levels to improve MPA success.

NOAA and USDA Pilot New Partnership to Address Land-Based Impacts to Coral Reefs. The U.S. Department of Agriculture (USDA) and NOAA's CRCP partnered to launch a new Conservation Effects Assessment Project (CEAP), located in the Jobos Bay Watershed in Puerto Rico. CEAP is an effort by the USDA to quantify environmental effects and benefits of conservation practices, highlighting interactions between upland and coastal ecosystems. This project established a CEAP Special Emphasis Watershed (SEW) co-located at the Jobos Bay National Estuarine Research Reserve in Puerto Rico. SEWs are strategically located watersheds with ongoing research and demonstration activities addressing specific resource concerns such as water quality. The Jobos Bay project will be the first SEW in the tropics, and initiates a collaborative partnership between USDA and NOAA to address natural resource issues in the coastal environments of U.S. coral reef areas.



A bleaching tools workshop participant conducts a resilience survey of an American Samoan reef. Credit: NOAA Coral Reef Watch

NOAA and GBRMPA Develop Training Program to Help Managers Address Coral Bleaching. NOAA's CRCP and Australia's Great Barrier Reef Marine Park Authority (GBRMPA) have developed a four-day "Bleaching Tools Workshop" for an intensive hands-on training on the recently published *Reef Manager's Guide to Coral Bleaching* (Guide). The workshop is designed for marine park managers, reserve managers, coral scientists, and other interested stakeholders involved in coral reef monitoring and bleaching response. The training includes formal instruction on the Guide, hands-on experience with satellite tools, practice in the field, and informal discussion to exchange ideas and foster collaborations that help increase managerial capacity to manage coastal resources. The first two workshops were conducted this summer: the first in Australia with participants from five nations, and the second in American Samoa with participants from the U.S. Pacific Islands and Fiji.

NOAA Awards \$9 Million in Coral Reef Conservation Grants. In FY2007, NOAA's CRCP awarded almost \$9 million in grants to external partners in support of coral reef research, education, management, and conservation. Representing over 34 percent of the CRCP budget for FY2007, these awards reflect NOAA's strong support for cooperative partnerships and conservation efforts outside the agency. Funds supported a range of activities, from community conservation projects to large-scale coral reef observation systems, and included support for three coral reef research institutes – one each in Hawai'i, Florida and Puerto Rico. Grants were awarded through both NOAA's six category Coral Reef Conservation Grants Program and the jointly managed NOAA-National Fish and Wildlife Foundation Coral Reef Conservation Fund. To date, this fund has awarded \$19 million in federal and non-federal matching funds to support over 190 on-the-ground coral reef conservation projects in 35 countries.

NOAA Assumes Coordination of the Global Socioeconomic Monitoring Initiative. The Global Socioeconomic Monitoring Initiative (SocMon) facilitates community-based monitoring of coastal areas, increasing coastal managers' capacity to assess and manage the human communities that use and depend on coastal resources. In FY2007, NOAA's CRCP began coordinating the program, which is currently active in six global regions with over 30 active sites. NOAA's leadership facilitated the first two domestic applications of the SocMon protocols through trainings held in the U.S. Virgin Islands (USVI) and Puerto Rico. The workshop for the USVI Coastal Zone Management Program, held in cooperation with The Ocean Conservancy, The Nature Conservancy, and USVI government, trained local resource managers in socioeconomic monitoring methodologies. A similar workshop was held in Puerto Rico, where 30 protected area managers were trained in the SocMon methodology. On the international front, SocMon continued to expand its geographic scope and depth of coverage, training regional trainers and monitors from nine countries. All of these efforts further the goal of improving and expanding socioeconomic monitoring of coral reef areas in terms of site coverage, use of standardized comparative methods, and developing a global picture of the social health of coral reef areas.

www.coralreef.noaa.gov

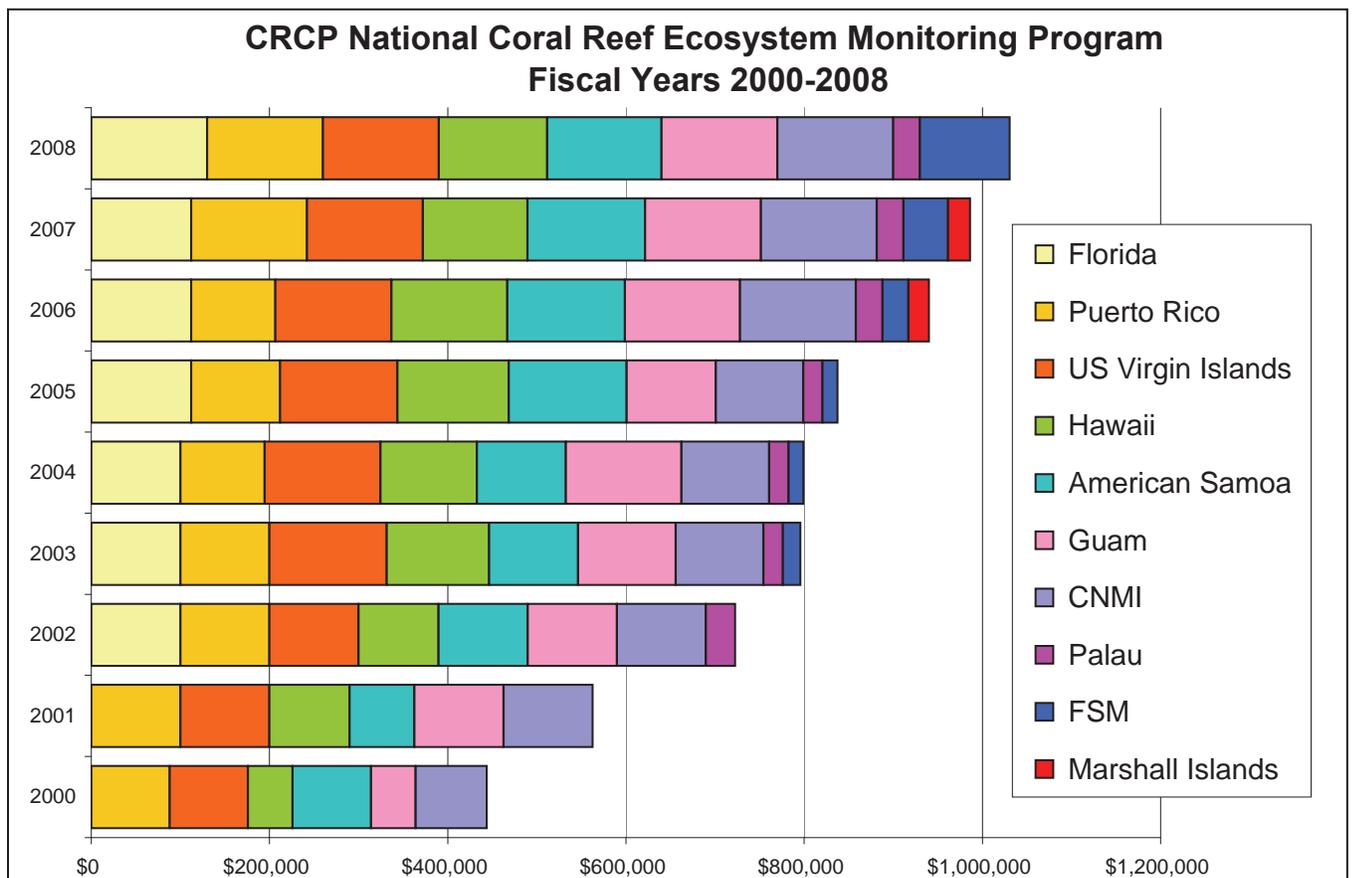


National Coral Reef Ecosystem Monitoring Program

Overview of Grant-Funded Activities in U.S. Pacific Jurisdictions, 2000-2008

Since 2000, NOAA's Coral Reef Conservation Program (CRCP) has provided annual funding to U.S. jurisdictions to support coral reef ecosystem monitoring activities that are conducted by state, territorial and commonwealth agencies. Currently, U.S. jurisdictions are eligible to apply for \$130,000 annually through the National Coral Reef Ecosystem Monitoring Program (NCREMP), which is administered by the Center for Coastal Monitoring and Assessment. The island nations in the western Pacific Ocean that maintain a compact of free association with the U.S., the Republic of the Marshall Islands, the Federated States of Micronesia, and the Republic of Palau, are also eligible to apply for \$30,000 annually. Together these ten grants, which are structured as cooperative agreements that provide for the substantial involvement on the part of the Federal government, are intended to enable the jurisdictions to obtain information to meet local management needs via collection of coral reef ecosystem monitoring data within three broad categories of inquiry: water/substrate quality, benthic (seafloor) habitats, and associated biological communities such as fish and invertebrates. To accomplish this objective, funds are provided to cover the real costs associated with *in situ* field work, including expenditures related to salaries of trained personnel, boat rental and fuel costs, scuba equipment, underwater cameras, supplies, etc. In certain instances, when requested by the applicant and agreed upon by NOAA, NOAA may also hold back a portion of any awarded funds in order to provide specific technical assistance in the form of contractual or other services.

Summaries and examples of coral reef monitoring activities undertaken in U.S. Pacific jurisdictions (American Samoa, CNMI, Guam, and Hawaii) as part of NCREMP are provided on the reverse.



American Samoa

Between 2000 and 2007, \$894,488.00 was provided to the American Samoa Department of Marine and Wildlife Resources (DMWR) under NCREMP. A 3-year agreement initiated in FY08 will provide an additional \$384,843.00 to DMWR by 2010.

Monitoring activities occur annually, primarily on Tutuila, with only recent expansion to sites in the Manua islands of Ofu, Olosega and Tau. No monitoring of Swain's or Rose Atoll has been undertaken by DMWR. Primary monitoring activities included surveys of lobster population and catch, coral disease and bleaching, and invasive species. Since 2005, a more consistent suite of activities has been implemented as part of the Territorial Monitoring Program. Most of the funding under this program has been devoted toward covering the costs for personnel, including one or two full-time monitoring positions (salary, benefits, and housing) as well as a boat driver and technician(s). Coral expert Doug Fenner has been working in American Samoa under this program since 2003. Ben Carroll has led the fish monitoring portion since 2006. Outboard engines were purchased to support the work in 2000 at the program's inception, but since then, most of the equipment and supplies purchased were fairly minimal and included reference books, temperature loggers, GPS units, and monitoring equipment such as underwater paper and transect tapes.

CNMI

Between 2000 and 2008, \$964,855 was provided to CNMI through this program. Funds are transferred to the Coastal Resource Management Office (CRMO) to support the work of an interagency Marine Monitoring Team. In an effort to build local capacity, the MMT has involved volunteers, students and interns in monitoring activities in the past few years. Only one multi-year award is currently in effect for CNMI, which provided \$129,944 in FY06, FY07, and FY08. A new 3-year proposal is expected in November 2008 for FY09 funding.

CNMI has maintained a relatively stable and comprehensive coral reef monitoring program since 2000. The program has been led by John Starmer since early 2001. Monitoring work is carried out by the Marine Monitoring Team, which is composed of staff from the CRMO, CNMI's Division of Environmental Quality (essentially Peter Houk), and to a lesser extent, CNMI's Division of Fish and Wildlife. In addition to these experts, surveys are also carried out by volunteers using a Reef Check protocol. The program focuses on annual monitoring of sites on the inhabited islands of Saipan, Tinian, Rota, and Aguijan; limited monitoring work has been conducted at some of the uninhabited northern islands. Additional surveys of reef flats (semi-annual) and deeper sites were added in 2002. A power analysis was completed in 2006 to verify that the approach provided the desired level of change detection and sufficient statistical rigor.

Guam

Between 2000 and 2006, \$749,092.00 was provided to Guam through this program. From 2000 to 2004, the Guam Dept. of Agriculture administered the awards, but since 2005, the monitoring grant has been awarded to and administered by the Guam Bureau of Statistics and Plans. A 3-year agreement initiated in 2007 under NCREMP will provide an additional \$390,000 to Guam by 2009. A new proposal is expected from Guam in November of 2009 for FY10 funding.

Much of the funding provided under this program was used to fund staff and graduate students and to purchase dive gear, cameras, tagging supplies, chemicals, computers and other equipment that was used for the various projects. Funded projects included water quality sampling in Tumon and Agana Bays, coordination of volunteer Reef Check surveys, compilation of historical monitoring data, monitoring studies to determine MPA efficacy and potential spillover effects, an economic assessment, curatorial activities, seagrass monitoring, dump leachate monitoring, and a biomarker study. In 2003 and 2004, Guam requested that NOAA hold back a portion of their award to hire a monitoring coordinator for the island. The monitoring coordinator, Valerie Brown, was central to the effort to develop a comprehensive inter-agency monitoring program for Guam, which was implemented beginning in 2005 with baseline surveys of disease, bleaching, predators and invasive species. Long-term monitoring continues at existing sites and new sites are being established for various purposes/projects.

Hawaii

Between 2000 and 2008, \$947,049 was provided to the State of Hawaii's Department of Land Use and Natural Resources, Division of Aquatic Resources (DAR) through this program. Matching funds in the amount of \$1,041,405 were contributed to this effort by DAR, primarily in the form of salaries and boat support. Only one multi-year award is currently in effect for Hawaii; it provided \$129,999 in FY06, \$117,584 in FY07, and \$121,706 in FY08. A new 3-year proposal is expected in November 2008 for FY09 funding.

Hawaii DAR has supported a variety of monitoring projects in Hawaii through this program. Initially, monitoring data was obtained in partnership with the University of Hawaii's CRAMP program, led by Dr. Paul Jokiel. In 2002, some funding was also channeled toward the West Hawaii Aquarium Project (WHAP, led by Bill Walsh at DAR) to assess the efficacy of the MPA network put into place on the west coast of the island of Hawaii. In 2005, in addition to the ongoing monitoring work, some funding was devoted to a study of offshore islands and initiation of monitoring work in Kauai by Dave Gulko at DAR. Since 2006, DAR has been implementing a fairly comprehensive and integrated long-term monitoring strategy that collects comparable data and information at a large number of sites on the islands of Hawaii, Maui, Lanai and Oahu using either the CRAMP or WHAP protocols. The frequency of monitoring varies depending on the type of site and target data, but ranges from quarterly (fully integrated sites) to once every 3 years (coral disease assessments).



CENTER FOR COASTAL MONITORING & ASSESSMENT

Science to Support Ecosystem Management

MISSION: TO ASSESS AND FORECAST COASTAL AND MARINE ECOSYSTEM CONDITIONS THROUGH RESEARCH AND MONITORING.

WATER



CCMA is home to one of NOAA's premier coastal and ocean Remote Sensing Programs whose efforts focus on monitoring and forecasting estuarine and coastal environmental stressors. The Center has developed the Nation's first operational *Harmful Algal Bloom* detection and forecasting system in partnership with NOAA's Center for Operational Products and Service. CCMA is also responsible for updating the "National Estuarine *Eutrophication Assessment*" to highlight changes in nutrient related water quality, sources of nutrients and expected future conditions.

 <http://ccma.nos.noaa.gov/stressors/pollution/EutroUpdate.html>

HABITAT



CCMA is a recognized leader in *Mapping Shallow & Mid-water Benthic Habitats*. Well versed in a wide range of technologies – from shipboard multibeam sonar to multi-spectral & satellite imagery – CCMA develops map products to delineate and classify the extent, nature, and condition of critical coastal and marine habitats. CCMA is also home to NOAA's *National Status and Trends Program (NS&T)*, the nation's longest running coastal and Great Lakes contaminant monitoring effort, measuring chemical, toxicological, and associated biological effects of contaminated waters throughout the U.S. coastal zone.

 <http://ccma.nos.noaa.gov/publications/MWTwoDecades.pdf>

LIVING RESOURCES



CCMA has delivered a number of "*Biogeographic Assessment*" products that have characterized the distribution of living resources throughout sanctuary waters, thereby providing a scientifically-based and objective framework for coastal decision making. Products have informed internal *Sanctuary Zoning*, as well as boundary delineation processes. The Center has also produced and implemented a range of *Monitoring Protocols* designed to quantify resource status, to establish baseline conditions, and detect change resulting from management action.

 <http://ccma.nos.noaa.gov/products/biogeography/cinms/>

 Visit our Website to Learn More About the Center for Coastal Monitoring & Assessment <http://ccma.nos.noaa.gov/>

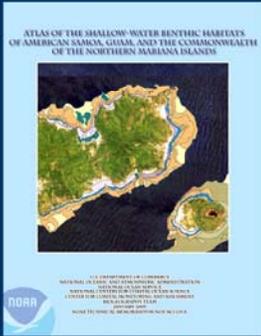
 Mark.Monaco@noaa.gov (Chief, Biogeography Branch) or John.Christensen@noaa.gov (Chief, COAST Branch)



CENTER FOR COASTAL MONITORING & ASSESSMENT

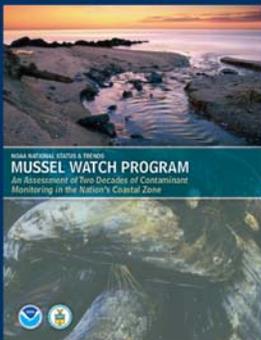
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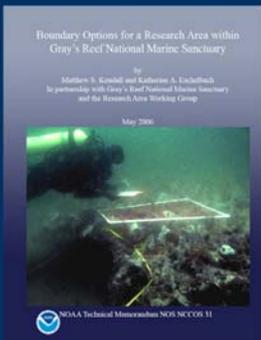
MAPPING

- http://ccma.nos.noaa.gov/ecosystems/coralreef/fl_mapping.html
- http://ccma.nos.noaa.gov/ecosystems/coralreef/main8hi_mapping.html
- http://ccma.nos.noaa.gov/ecosystems/coralreef/nwhi_mapping.html
- http://ccma.nos.noaa.gov/products/biogeography/usvi_nps/overview.html
- http://ccma.nos.noaa.gov/ecosystems/coralreef/us_pac_mapping.html



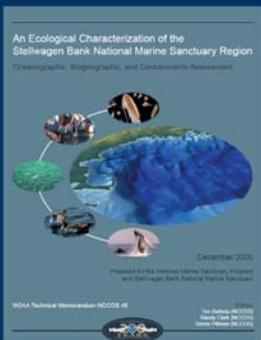
MONITORING

- <http://ccma.nos.noaa.gov/about/coast/nsandt/welcome.html>
- http://ccma.nos.noaa.gov/ecosystems/sanctuaries/grays_nms.html
- <http://tidesandcurrents.noaa.gov/hab/>
- http://ccma.nos.noaa.gov/ecosystems/coralreef/coral_grant.html
- http://ccma.nos.noaa.gov/ecosystems/coralreef/reef_fish.html



RESEARCH

- <http://ccma.nos.noaa.gov/stressors/extremeevents/hab/HABResearch.html>
- http://ccma.nos.noaa.gov/ecosystems/sanctuaries/grays_boundary.html
- http://ccma.nos.noaa.gov/ecosystems/sanctuaries/fgb_nms.html
- <http://ccma.nos.noaa.gov/ecosystems/coralreef/CEAP.html>
- http://ccma.nos.noaa.gov/stressors/pollution/nsandt/kbay_bioeffects/



ASSESSMENT

- http://ccma.nos.noaa.gov/ecosystems/sanctuaries/stellwagen_nms.html
- http://ccma.nos.noaa.gov/ecosystems/sanctuaries/chanis1_nms.html
- http://www8.nos.noaa.gov/cit/nsandt/download/bi_monitoring.aspx
- <http://ccma.nos.noaa.gov/ecosystems/coralreef/coral2008/welcome.html>
- <http://ccma.nos.noaa.gov/publications/eutrouupdate/>

Integrated Mapping, Monitoring, and Assessment throughout the Nation's Coral Reef Ecosystems

In Cooperation with NOAA's Coral Reef Conservation Program

Background

Worldwide, long-term monitoring efforts have identified a complex array of factors, from coastal development and pollution to fishing activities, that have substantial negative impacts on coral reef ecosystem health. The resulting decline in the ability of these ecosystems to provide services, such as sustenance and coastal protection as well as economic benefits, has become a serious concern for US jurisdictions. In response, NOAA's Coral Reef Conservation Program (CRCP) has targeted key thematic areas to help ameliorate these impacts and preserve these ecosystems. Working in partnership with CRCP, NOAA's Center for Coastal Monitoring and Assessment (CCMA) is providing scientific and technological expertise to conduct integrated mapping, monitoring and assessment activities addressing four major thematic areas:

Coral Reef Conservation Management Needs

CCMA has successfully implemented a tiered approach that emphasizes developing strong collaborative partnerships, identifying local conservation and research priorities, and implementing targeted place-based management activities to assist jurisdictional efforts in reversing the degradation of US coral reef ecosystems. Integrated CCMA activities include: 1) targeted seafloor mapping in high priority conservation areas; 2) mapping and monitoring the condition of benthic and fishery resources at territorial, regional, and national scales; 3) evaluating the efficacy of marine protected areas; 4) characterizing the effects of coral bleaching events on coral ecosystems; 5) supporting research on human dimensions; and 6) characterizing chemical contaminants and their effects. CCMA's strong collaborative partnerships with jurisdictions have resulted in the development of strategic local long-term monitoring programs and resource assessment tools, such as geographic information system (GIS) maps.



Example Products:

- State of Coral Reef Ecosystems Report
http://ccma.nos.noaa.gov/ecosystems/coralreef/coral_report_2005/
- Tortugas Integrated Biogeographic Assessment
<http://ccma.nos.noaa.gov/ecosystems/coralreef/tortugas.html>
- Main Hawaiian Island Marine Protected Area Assessments
http://ccma.nos.noaa.gov/ecosystems/coralreef/hi_rfh.html
- National Coral Reef Ecosystem Monitoring Program
http://ccma.nos.noaa.gov/ecosystems/coralreef/coral_grant.html

Land-Based Pollution and Water Quality

Land-based sources of pollution affecting coral reef resources have been identified as a focus area for priority action in the Local Action Strategies of many US jurisdictions. To address this issue, CCMA partnered with local and federal government agencies and academic institutions to develop an assessment framework to link the presence and distribution of land based pollutants with the condition of coral reef ecosystems. The framework integrates: 1) chemical contamination in sediments and coral tissues; 2) systemwide nutrient flux; and 3) coral cover to assess the impacts of land-based pollution on coral reef ecosystems. In addition, CCMA has partnered with the US Department of Agriculture (USDA) to quantify effects of agrochemicals (nutrients and pesticides) on the Jobos Bay National Estuarine Research Reserve System (NERRS) community structure. The assessment of chemical contaminants and their effects in coral reefs is an extension of CCMA's National Status and Trends (NS&T) Program, which has monitored contaminants in the Nation's coastal waters (including Puerto Rico, southern Florida and Hawaii) for over 20 years.

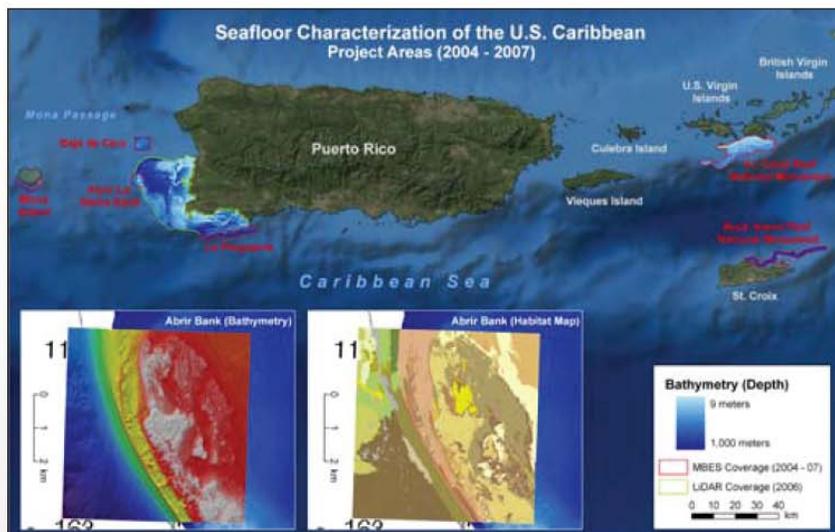
Example Products:

- Mussel Watch Database
http://www8.nos.noaa.gov/cit/nsandt/download/mw_monitoring.aspx
- "An Assessment of Chemical Contaminants in the Marine Sediments of Southwest Puerto Rico"
<http://ccma.nos.noaa.gov/publications/southwestpuertorico.pdf>
- Summit to Sea Assessment to Characterize Land-Based Sources of Pollution
http://ccma.nos.noaa.gov/ecosystems/coralreef/summit_sea.html



Fishing Impacts

CRCP has identified the need to understand and address the threat of fishing pressures on the condition of US coral reef ecosystems. In response, CCMA has partnered with academic institutions and government agencies to develop novel approaches for designating and evaluating the effectiveness of fishery closures such as Marine Protected Areas (MPAs). CCMA has mapped benthic habitats and monitored biological resources in regions with declining fisheries; conducted initial characterizations of fishery closure areas such as Bajo de Cico, Tourmaline Bank and Abrir la Sierra; and helped implement a fishery closure at Grammanik Bank in the US Virgin Islands. The Center has also led the development of reef fish sampling designs and monitoring protocols, which are being used to evaluate MPA efficacy, delineate MPA boundaries, and assess reef fish assemblages in the US Caribbean, Gulf of Mexico and Hawaii. CCMA scientists are also tracking fish movements using acoustic technologies to determine habitat preferences, ontogenetic movements, residence times and movements across MPA boundaries.



Example Products:

- Seafloor Characterization in the US Caribbean
http://ccma.nos.noaa.gov/products/biogeography/usvi_nps/overview.html
- Reef Fish Monitoring Guide
http://ccma.nos.noaa.gov/ecosystems/coralreef/fish_protocol.html
- Comparison of Reef Fish Habitat Utilization Patterns Within and Outside Hawaii Marine Protected Areas
http://ccma.nos.noaa.gov/ecosystems/coralreef/hi_rfh.html

Education and Outreach

Education and outreach activities are integral components of CCMA's program to map, monitor, and assess coral reef ecosystems and are tailored to meet specific needs identified by individual jurisdictions. CCMA's education and outreach efforts include: 1) developing strong partnerships with state, territorial, federal, non-governmental organization and academic constituents; 2) identifying and developing products, computer-based tools, and materials that are customized to the needs and capabilities of jurisdictional partners; 3) actively engaging and educating the public and media in addition to the management and scientific communities about important coral conservation, management and scientific findings; and 4) developing innovative web-based products that educate and provide access to monitoring data collected by CCMA.



Example Products and Activities:

- Reef Fish Database
http://www8.nos.noaa.gov/biogeog_public/query_main.aspx
- Benthic Habitat Viewer Database
<http://www8.nos.noaa.gov/bhv/bhvMapBrowser.aspx>
- Workshop: St. Croix, USVI 2006-Transfer of Methodology for Monitoring Purposes
- Workshops: 6 jurisdictions 2000-2007 Methods for conducting and applying shallow-water habitat mapping
- Video: NOAA and NPS-Partners for Protection and Resource Management
- Habitat Digitizer
<http://ccma.nos.noaa.gov/products/biogeography/digitizer/welcome.html>



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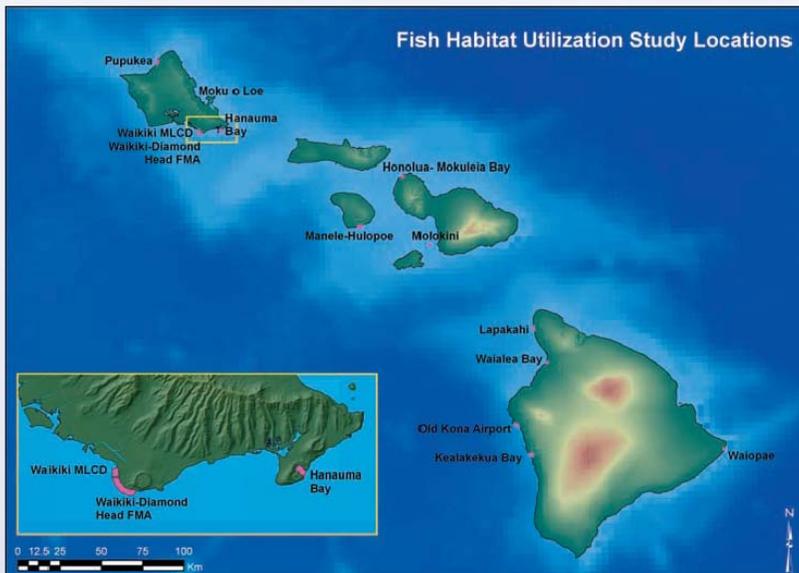




FISH HABITAT UTILIZATION PATTERNS AND THE EFFICACY OF MARINE PROTECTED AREAS IN THE MAIN HAWAIIAN ISLANDS



Over the past four decades, Hawaii has developed a network of 11 Marine Life Conservation Districts (MLCDs) to conserve and replenish marine resources around the state. Initially established to provide opportunities for public interaction with the marine environment, MLCDs vary in size, habitat quality, and management regimes. The evolution of MLCDs into a spatial management tool used to protect marine ecosystems presents an excellent opportunity to test hypotheses concerning marine protected area (MPA) design and function. Digital nearshore habitat maps developed by NOAA's Center for Coastal Monitoring and Assessment, Biogeography Team were used to structure field investigations and identify patterns of habitat use for various fish species. Habitat utilization patterns are useful in defining essential fish habitat and biologically relevant boundaries for MPAs.



Study sites were located within and around the eleven MLCDs and the Moku o Loe Reserve.

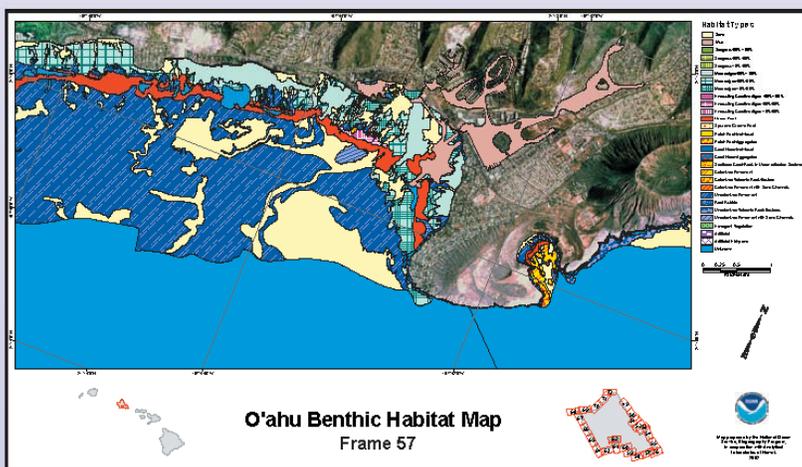
Results of the study, which was undertaken cooperatively between Hawaii's Department of Land and Natural Resources, Division of Aquatic Resources and NOAA's Biogeography Team, show that the abundance and distribution of species and assemblages was strongly tied to habitat type. Management also played an important role, as MLCDs had higher values for most fish assemblage characteristics (e.g. biomass, size, diversity) than adjacent control areas. In addition, apex predators and other target species were more abundant and larger in MLCDs, illustrating the effectiveness of these closures in conserving fish populations. Habitat complexity, quality, size and level of protection from fishing were important determinates of MLCD effectiveness. Other major findings include:

Benthic assemblage characteristics

- The most abundant substrate type was turf algae (48% cover) followed by sand (23%), coral (16%), macroalgae (7%), coralline algae (5%), macroinvertebrates (1%), and seagrasses (<1%).
- Oahu sites had less coral and more macroalgae than Hawaii, Lanai, and Maui sites.
- Coral cover was higher in MLCDs than in open access areas or FMAs. In contrast, macroalgae cover was lowest in MLCDs and highest in the open access areas.

Factors influencing fish assemblages

- Habitat complexity explained most of the variability in fish biomass, species richness, and diversity. Habitat complexity was higher in MLCDs than in adjacent open areas, as many MLCDs were established specifically to protect high quality habitat. When controlling for habitat complexity, MLCDs still had significantly greater fish biomass than open areas of similar habitat complexity.
- Fish biomass was 2.6 times greater in MLCDs and the Moku o Loe reserve than in open areas.
- Depth range explained most of the variability in species richness and diversity among protected areas; MLCDs with wider depth ranges had more species and higher diversity than protected areas with a more narrow range of depths.
- Size spectra analysis indicated that adult fish were larger and that larger fish were more abundant in protected areas.



A benthic habitat map depicting the diversity of nearshore habitats in Hanauma Bay MLCD and adjacent areas of south Oahu near Hawaii Kai.



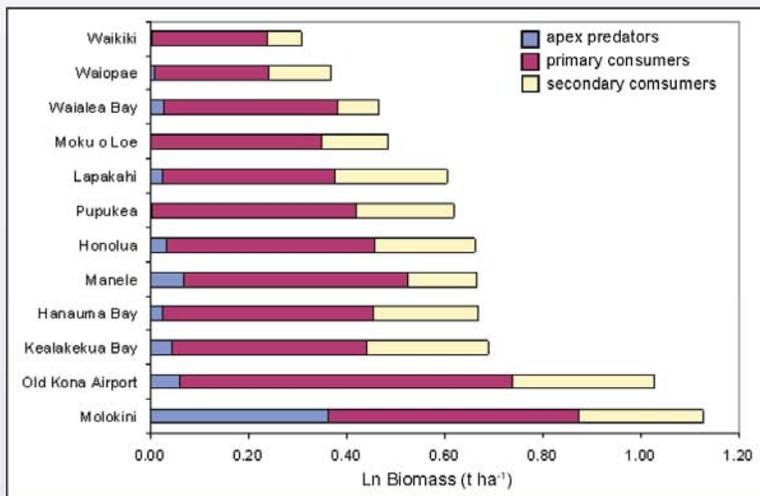
Center for Coastal Monitoring and Assessment
science serving coastal communities

Trophic composition observations

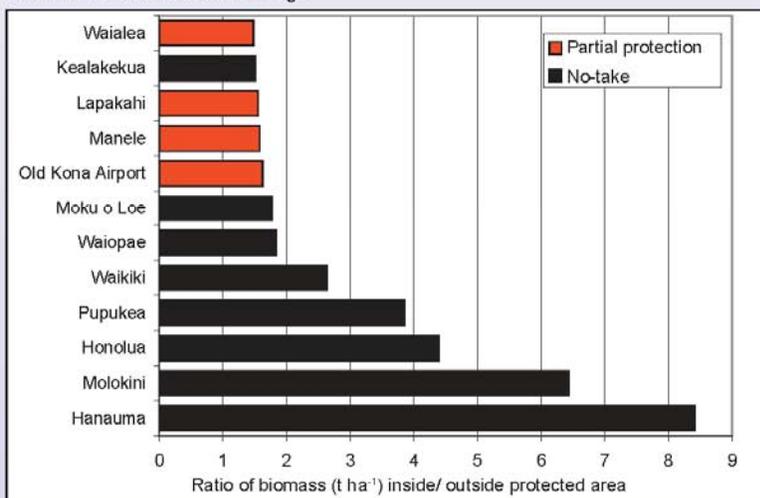
- Primary consumers (herbivores) were the most abundant (numerical and biomass) trophic group among major habitat types.
- Although overall biomass was low in sand habitats, apex predators accounted for 60% of the biomass there, highlighting the importance of sand habitats and the need to incorporate them into reserve design.
- The mean ratio of apex predator biomass was more than 17 times higher in MPAs than in adjacent areas open to fishing.
- Herbivore biomass in protected and open areas showed a negative relationship with macroalgal cover.

Comparisons among Hawaiian MPAs

- Molokini Shoals MLCD had the highest fish biomass observed in all MLCDs, followed by Old Kona Airport, Kealakekua Bay, and Hanauma Bay. Molokini also had the highest biomass of apex predators (primarily sharks and jacks).
- Fish biomass in Hanauma Bay MLCD was more than 8 times higher than in an adjacent open area. This is likely due to poor habitat quality (sedimentation, invasive seaweeds) and high fishing pressure outside the MLCD.
- Waialea, Kealakekua, Lapakahi, Manele, and Old Kona Airport all had relatively small differences in the ratio of fish biomass inside the MLCD and in adjacent open areas. Lower fishing pressure and high habitat quality outside the MLCDs may explain these relatively small differences.
- Species richness, biomass, and diversity were low at Waikiki, Moku o Loe, Waiopae, and Waialea. The small size and shallow depth range of these MPAs limit their effectiveness for biodiversity conservation and fisheries replenishment.



Mean biomass (tons per hectare) by trophic guild on hardbottom habitat only among all MLCDs and the Moku o Loe refuge.



Ratio of biomass (tons per hectare) in hardbottom habitats inside MLCDs and the Moku o Loe refuge vs. outside areas open to fishing.

Future protected area design in the main Hawaiian Islands needs to incorporate a mosaic of habitats to support viable reef fish populations. Complex habitats harbor higher biomass and greater species richness. Shallow nearshore habitats are necessary for recruit settlement and juvenile survival, while deeper habitats are important foraging, sheltering, and spawning sites for large adults. In addition to these hardbottom habitats, sandy areas are important corridors for the movement of species between hardbottom habitats. Adjacent non-reef habitats provide coral reefs with a net gain in energy through feeding guilds that shelter on the reef by day and forage in surrounding habitats at night.

MLCDs in Hawaii were established to support the State of Hawaii's conservation and education objectives, not to enhance fish stocks. As a consequence, most MLCDs are currently too small and encompass too few habitat types to provide substantial benefits to coastal reef fisheries. MLCDs currently encompass less than 1% of the total reef area of the main Hawaiian Islands. Reserves of sufficient size can be self-sustaining over time through retention of larvae. Alternately, a well-designed network of reserves, established at distances that enable transfer of larvae between reserves, can also protect existing populations and enhance non-protected populations through larval dispersal.

For more information, please contact

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 Mark Monaco at (301) 713-3028 x174 or Mark.Monaco@noaa.gov
 Athline Clark at (808) 587-0099 or Athline.M.Clark@Hawaii.gov
 Additional information may also be found at: <http://biogeo.nos.noaa.gov>.

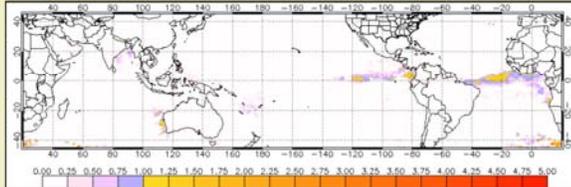


NOAA Coral Reef Watch

Satellite monitoring for coral reefs

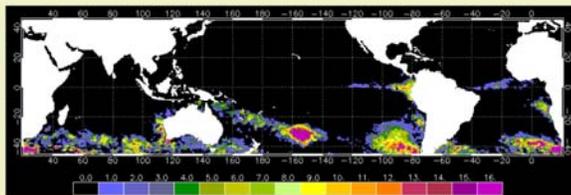


Near-Real-Time Monitoring Products



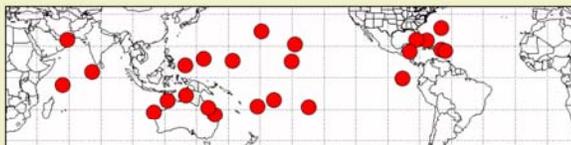
HotSpot Charts

Areas of thermal stress (anomalously high sea surface temperatures) conducive to coral bleaching. The scale shows the intensity of the stress; areas at risk for bleaching are shown in orange and red colorations.



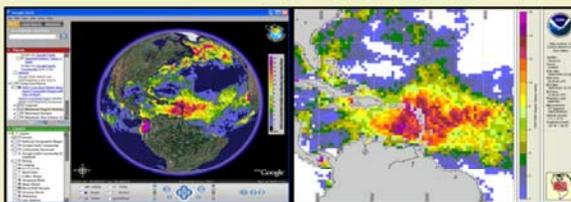
Degree Heating Weeks (DHW) Charts

Cumulative thermal stress experienced by an area over the last 12 weeks. Orange to purple indicates persistently high temperatures, if there are reefs in these areas corals may be experiencing severe bleaching.



Satellite Bleaching Alert System

Automated email alerts monitor thermal stress at selected reef sites. Satellites monitor the water temperature and wind speed at 24 "Virtual Stations" remotely, without the cost and difficulty of deploying buoys. Reef conditions are assessed twice-weekly.



Coral Reef Conservation & Satellite Technology

NOAA has many satellites orbiting the Earth. Coral Reef Watch uses sea surface temperature data from Polar-orbiting Operational Environmental Satellites (POES) that provide daily coverage of the earth's surface. Continuous monitoring of sea surface temperature (SST) at global scales provides researchers and stakeholders with tools to understand and better manage the complex interactions leading to coral bleaching. When bleaching conditions occur, these tools can be used to trigger bleaching response plans and support appropriate management decisions.

Future Directions

Currently we are working on a number of experimental products to enhance the current suite of temperature-based products. These include; increased resolution of current products, additional "Virtual Stations," expansion into bleaching forecasts, a doldrums product identifying low wind regions, a light stress product, and modeling the response of ocean chemistry to ocean acidification.

Google Earth and HDF Available

The entire suite of Coral Reef Watch data products is available in these formats: Google Earth, Hierarchical Data Format (HDF), ASCII text, graphs, and images.

Latest global data and images freely available at <http://coralreefwatch.noaa.gov/>
 For more information, contact Mark Eakin (Coordinator) at coralreefwatch@noaa.gov

NOAA Coral Reef Watch

Satellite monitoring for coral reefs



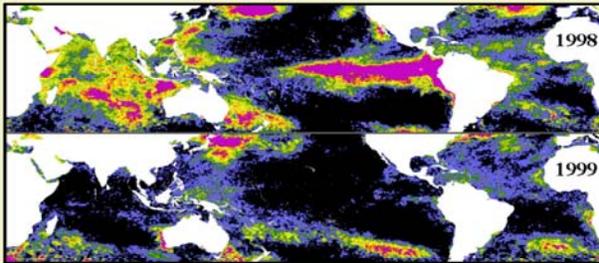
Coral Reef Watch uses satellite data to provide current reef environmental conditions to quickly identify areas at risk for coral bleaching. Coral reefs are one of the most diverse ecosystems in the world. Reefs support essential coastal fisheries, protect coasts from erosion, support local tourism and are sources of pharmaceuticals. Sustained high water temperatures, in conjunction with other natural and human-based stressors, could cause coral bleaching to become an annual event in most oceans. This could lead to a rapid decline in the health of coral ecosystems worldwide.



Coral Reefs and Climate Change

Coral Reefs are very sensitive to stress caused by elevated water temperatures, bright sunny days, and calm water. Corals respond to stressful temperatures by expelling the symbiotic algae that live within their tissues and provide most of their food and their characteristic color. While corals can recover from short term, minor stress, they can starve and die if the stressful conditions continue for weeks or months. Coral bleaching has become much more severe in recent decades as sea temperatures have

risen. Along with near-real-time data products, Coral Reef Watch produces retrospective data, such as multi-year time series graphs and annual DHW maximum maps. These climate monitoring products can be used to assess the inter-annual variation of thermal stress and provide early warnings by comparing current conditions with the development of the thermal stress during prior extreme years.



These composite charts show maximum DHW values for 1998 and 1999. Clear differences can be seen between global temperature patterns.

Partnerships

Australia: Coral Reef Watch collaborates with some of Australia's leading coral reef scientists and managers through partnerships with The Australian Institute of Marine Science, The University of Queensland, The Great Barrier Reef Marine Park Authority, James Cook University, other Universities and Government Agencies.

World Bank: Coral Reef Watch is part of the Coral Reef Targeted Research (CRTR) Program, a partnership between the Global Environment Facility, the World Bank, The University of Queensland, NOAA, and approximately 40 research institutes & other parties around the world. The goal is to shed light on key unknowns and fill gaps in existing scientific knowledge through coordinated research and to transfer this knowledge to reef managers in developing countries.



Photo credits: C.M. Eakin

NOAA Coral Reef Watch

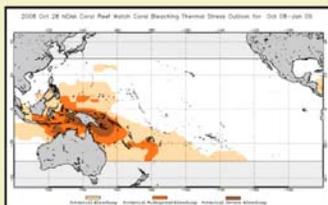
Research and Development



Experimental Products

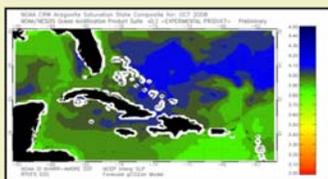
http://coralreefwatch.noaa.gov/satellite/current/experimental_products.html

Seasonal Bleaching Outlook



This coral bleaching forecast system uses NOAA sea surface temperature (SST) forecasts (Linear inverse Modeling) to develop maps of potential coral bleaching severity during the upcoming weeks to months. The outlook is based on a composite of up to 16 weeks during the bleaching season. Their purpose is not to provide exact predictions at any particular reef locations, but to provide general patterns of bleaching potential.

Ocean Acidification Product Suite

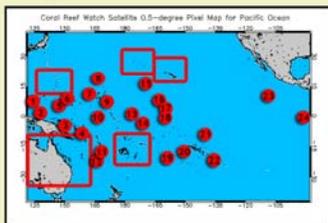


A synthesis of satellite and model datasets provides a synoptic estimate of sea surface carbonate chemistry in the Greater Caribbean Region. This tool compliments on-going geochemical surveys by providing estimates of changing ocean chemistry on a broader scale than shipboard observations can permit. Near-real-time estimates are modeled from daily fields of SST, salinity, sea-level pressure, and atmospheric CO₂ (derived from *in situ* data). The suite currently includes:

Aragonite Saturation State, $p\text{CO}_{2,sw}$, Total Alkalinity, Carbonate Ion, and Bicarbonate Ion.

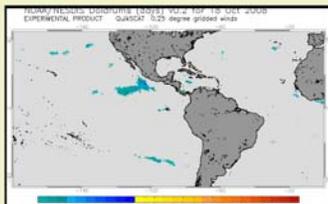
190 Virtual Stations

Along with the worldwide data, we also focus in on representative coral reef locations around the world.



We call these "Virtual Stations": it is like having a temperature sensor in the water next to a reef, but it is completely based on satellite remote sensing measurements. Users can access time-series graphs and data for each of the Stations. Users can also sign up for free automated e-mail alerts, which will warn them if corals in those areas are at risk for bleaching. The new experimental sites complement the existing 24 operational Virtual Station sites that have been running consistently since 2000.

Doldrums



Local weather patterns may greatly influence bleaching: as wind speed falls there is reduced mixing, cooling and heat transfer, increasing the likelihood of abnormally high temperatures. Using NASA QuikSCAT satellite data, we identify regions of low wind conditions (4-day mean of < 3 m/s) as doldrums. The duration of these doldrums events is then tracked by accumulating the number of days over which this condition is met (doldrums days).

All experimental products freely available at <http://coralreefwatch.noaa.gov/>
For more information, contact Mark Eakin (Coordinator) at coralreefwatch@noaa.gov

NOAA Coral Reef Watch

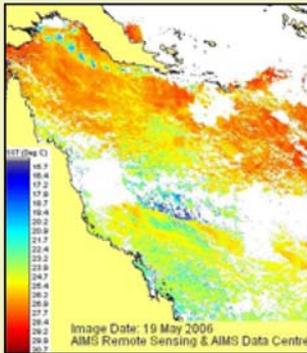
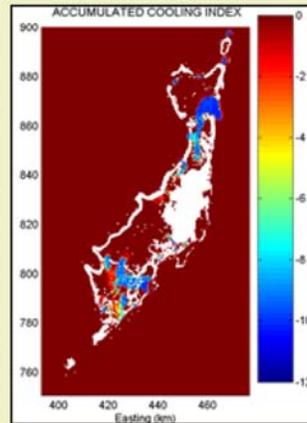
Research and Development



Research Activities

Hydrodynamic Modeling

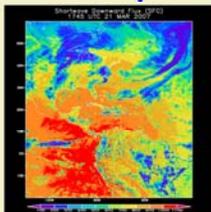
A pilot project developed a heat stress model for Palau that identifies areas where surface water stays relatively constant due to mixing. These areas are expected to have less risk of coral bleaching. The model captures the water flow around Palau using a bathymetric map with 250-meter resolution, derived from high-resolution satellite imagery, and includes the influence of seasonal currents and tidal currents. The model was validated against *in situ* oceanographic data. The result is a two-dimensional hydrodynamic model of Palau, plus a model for the temperature profile. The results are summarized into a measure of "thermal capacitance"-- *i.e.* how much the mixing cooled the surface water temperature during the one-month study period. The resulting map provides a tool that has been considered by designers of a protected-area network to build in resilience against potential future climate change regardless of the direction of that change.



High-Resolution SST

We will improve the spatial scale of our bleaching monitoring with experimental products at resolutions as fine as 1-km. Our partners in Australia are providing experimental daily high-resolution (2-km) sea surface temperatures and bleaching risk for the Great Barrier Reef region, off the northeastern coast of Australia. Collaboration on products like this helps Coral Reef Watch prepare for the next generation of NOAA's operational Sea Surface Temperature product, which blends data from several polar-orbiting and geostationary satellites, and will include improved climatologies and better coverage along the coast.

Light & Temperature



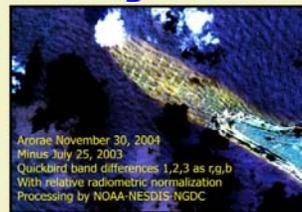
Incorporating satellite based ocean temperature and insolation to develop improved nowcasts of bleaching and mortality.

Disease Risk



Examining the relationship between SST and coral disease prevalence in Australia, the Caribbean, and Hawaii.

Bleaching Assessment



Analysis of Quickbird and IKONOS satellite imagery to confirm bleaching events in remote areas.

CoRIS

NOAA'S CORAL REEF INFORMATION SYSTEM

<http://coris.noaa.gov>

NOAA'S CORAL REEF INFORMATION SYSTEM (CoRIS) IS A SINGLE POINT OF ACCESS TO NOAA'S CORAL REEF INFORMATION AND DATA, PARTICULARLY THOSE DERIVED FROM NOAA'S CORAL REEF CONSERVATION PROGRAM.

WHAT CoRIS OFFERS...

Discover NOAA's Data

CoRIS data discovery tools provide access to metadata, data, and information from the NOAA Coral Reef Conservation Program and other coral reef projects. CoRIS includes coral reef mapping and monitoring data and products, coral bleaching nowcasts, environmental sensitivity index maps, aerial photography, and much more. Users can search for data and information in three different ways: an interactive map that allows users to locate available data by region, a text-based keyword search, and a series of browsable lists of data arranged by keywords.

About Coral Reefs

CoRIS offers original essays that describe coral biology and physiology, reef structure, and types of reefs. Other essays in the 'About Coral Reefs' section discuss natural and human threats to corals and coral diseases, as well as characterizing regional coral reef ecosystems and deep-water coral communities.

Professional Exchanges

CoRIS Professional Exchanges capture the lively debates of experts on contemporary coral reef issues. Exchanges are derived from discussions on NOAA's Coral Health and Monitoring Program (CHAMP) "Coral-list" listserv, which includes hundreds of participants worldwide.

The Library

The CoRIS Library enables searching and browsing through a growing collection of NOAA's coral ecosystems-related publications, reports, Web sites, educational materials, and digital images.

NOAA's Coral Reef Activities

Over thirty-five offices across NOAA carry out the work of NOAA's Coral Reef Conservation Program. This section summarizes NOAA's coral reef activities and the work of participating offices and provides direct access to major reports produced by the Coral Reef Conservation Program and its NOAA partners.

The Glossary

Can you define dactylozoid? One of the most popular features of CoRIS, the Glossary, defines thousands of technical and scientific terms used in coral reef science and management. Many definitions are accompanied by colorful illustrations. The Glossary is regularly updated and continually expanding.

CoRIS and METADATA

CoRIS search engines rely on *metadata* that describe and document NOAA's coral reef data sets and data products. Metadata include the 'who, what, when, where, why, and how' of each data set or product. The CoRIS Web site offers helpful guidance for creating good descriptive metadata, informative tools such as an acronym list, a taxonomic list of species, and much more.



CoRIS provides access to the wealth of coral reef data and information collected by NOAA worldwide, with emphasis on the U.S. states, territories, and remote island areas. These include Hawai'i, American Samoa, Guam, the Commonwealth of the Northern Mariana Islands, and the Freely Associated States in the Pacific Ocean and Florida, Texas, Puerto Rico, and the U.S. Virgin Islands in the Atlantic Ocean. NOAA's Coral Reef Conservation Program supports effective management and sound science to preserve, sustain, and restore valuable coral reef ecosystems.

CoRIS

NOAA'S CORAL REEF INFORMATION SYSTEM

Regional Portal

<http://coris.noaa.gov/data/portals/welcome.html>

The Regional Portal is an enhancement to the CoRIS web site, providing CoRIS users with regionally-focused access to CoRIS metadata, data, and information about coral reefs in a clear, concise, and integrated way. While the focus of the information is specifically NOAA Coral data, activities, information, and products, non-CRCP activities that fall under the US Coral Reef Task Force umbrella will be included as appropriate.



Regional Overview

The purpose of the CoRIS Regional Data Portal is to better describe the structure and organization of the data, metadata, and information available in the CoRIS system. The portal is designed to provide a clear and concise overview of the data and information available in the CoRIS system. The portal is organized into several sections: Home, About, Data, and Information. The Home section provides an overview of the CoRIS system and the Regional Data Portal. The About section provides information about the CoRIS system and the Regional Data Portal. The Data section provides information about the data available in the CoRIS system. The Information section provides information about the information available in the CoRIS system.



Atlantic and Caribbean
 - Florida
 - Navassa Island
 - Puerto Rico
 - Flower Garden Banks
 - U.S. Virgin Islands

Interactive Maps Provide Regional Access to the Following Categories of Data and Information ...

- ★ Regional Chapters from the State of the Reefs Reports
- ★ Links to CoRIS Metadata, Data and Publications for a Specific Region
- ★ Available Real-Time and Near-Real-Time Data
- ★ Regional Key Documents
- ★ Education and Outreach Items
- ★ Information for Marine Protected Areas and Marine Managed Areas
- ★ Other Data
- ★ USCRTF Partner Activities
- ★ AND More!

The regions have been defined according to the regions within the "State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2005" report, and are as follows: Florida, Navassa Island, Puerto Rico, the Flower Garden Banks, the U.S. Virgin Islands, American Samoa, the Commonwealth of the Northern Mariana Islands, the Federated States of Micronesia, Guam, the Main Hawaiian Islands, the Republic of the Marshall Islands, the Northwestern Hawaiian Islands, the Republic of Palau, and the Pacific Remote Island Areas.



NOAA's Integrated Coral Observing Network (ICON)

The U.S. National Oceanic and Atmospheric Administration's (NOAA) Integrated Coral Observing Network (ICON) (formerly known as CREWS) is a project of the Atlantic Oceanographic and Meteorological Laboratory's (AOML) Coral Health and Monitoring Program in Miami, Florida. The ICON Program is funded through NOAA's Coral Reef Conservation Program (CRCP) and High Performance Computing and Communication's Office.

The ICON Vision--The ICON vision is to serve as a model for all of NOAA in establishing a high quality *in situ* coral reef monitoring network, and for the integration of near real-time *in situ*, satellite, radar and other data for ecological forecasting in coral reef ecosystems

Goals--For the next few years, the ICON Program will be focusing upon:

- Integrating data from diverse independent sources, especially for developing Ecological Forecasting models for use by MPA managers and researchers
- Ensuring consistency with NOAA's Integrated Ocean Observing System.
- Forging international partnerships
- Facilitating development and transition to operations of promising relevant *in situ* instrumentation

An International Network of Meteorological and Oceanographic Monitoring Stations

The growing ICON Network is currently comprised of stations in St. Croix, US Virgin Islands; La Parguera, Puerto Rico; and Discovery Bay, Jamaica. Stations are also under construction, or being planned, for deployment in Little Cayman Island (Central Caribbean Marine Institute); St. Thomas, USVI; Saipan (CNMI); Taiwan; and Antigua (Antigua and Barbados Government). The stations are designed to deliver hourly measurements of important meteorological and oceanographic variables and will eventually serve to establish long-term databases at the world's most threatened and important coral reef areas.



What Do The Stations Measure?

The standard meteorological station measures air temperature, wind speed and gusts, wind direction, barometric pressure, precipitation, light (above and below water), sea temperature, salinity, and state of tide. Other instruments, such as the Pulse Amplitude Modulating Fluorometer, and a sensor for measuring partial pressure of carbon dioxide, have been deployed for research on coral stress and growth at the Bahamas and Puerto Rico stations.



The Integration of Data for Research

Integration of coral data is one of the recommendations by the U.S. Commission on Ocean Policy:

- **Recommendation 26-9:** Congress should fund the Integrated Ocean Observing System (IOOS)
- **Recommendation 15-4:** NOAA should ensure that water quality monitoring data are translated into timely and useful information products for the IOOS
- **Recommendation 21-4:** The U.S. Coral Reef Task Force should identify critical research and data needs for the IOOS.

The ICON Program is heavily engaged in integrating data, not only from our stations we deploy throughout the world, but also through matching data from our government agency and academic partners.



Partnerships Help Data Integration

- Satellite data for sea temperature and chlorophyll (courtesy of USF/IMaRS)
- Satellite data for winds (NESDIS)
- WERA ocean surface currents (RSMAS)
- Clouds (NCDC)
- In situ data from ICON and other partners:
 - SEAKEYS Network (Florida Keys)
 - AIMS Network (Australia)
 - NMFS Coral Reef Ecosystems Division Buoys (Pacific Ocean)
 - Aquarius Habitat (Florida Keys)

Ecological Forecasting

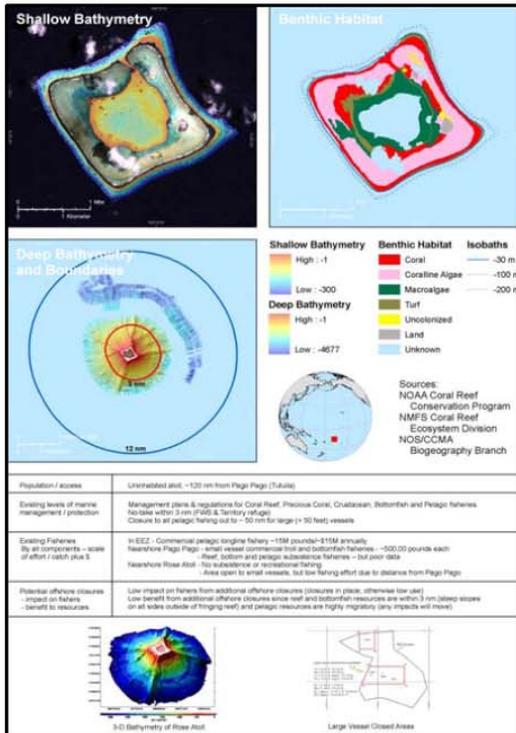
Ecological forecasts predict the impacts of physical, chemical, biological, and human-induced change on ecosystems and their components. The ICON program is taking advantage of the many data sources to produce forecasts such as those for coral bleaching, larval drift, spawning, migration, upwelling, and other marine behavioral events and phenomena for the benefit of Marine Protected Area (MPA) managers and researchers. These forecasts are very difficult to research and produce, due to the very complex nature of marine ecosystems, but with the help of our agency and academic partners, we have begun to produce some effective daily products which will eventually help the MPA managers better understand and help regulate their MPAs.

Want To Learn More?

To learn more, contact Dr. Jim Hendee (Jim.Hendee@noaa.gov,) or visit the ICON Web page at: <http://ecoforecast.coral.noaa.gov>



Coral Reef Ecosystem Integrated Observing System Pacific Benthic Habitat Mapping



This brochure using mapping data from Rose Atoll in America Samoa was generated for national management assessment of proposed Marine Conservation Areas.

Principal Goals

In support of NOAA's Coral Reef Conservation Program (CRCP), the Coral Reef Ecosystem Division of the Pacific Islands Fisheries Science Center and the Biogeography Branch of the National Centers for Coastal Ocean Science have jointly undertaken a nation-wide coral reef benthic habitat mapping program to provide a comprehensive suite of digital map products and define the spatial extent and habitat types of U.S. coral reef ecosystems.

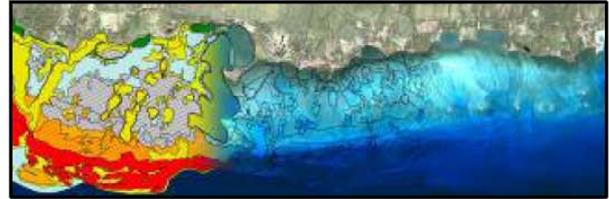
- This work supports management needs and objectives:
- Establish and evaluate marine protected areas (MPAs) and zoning efforts
 - Develop robust sampling designs for monitoring
 - Assess damage to natural and cultural resources
 - Plan coastal development and mitigation activities
 - Prioritize conservation efforts
 - Conduct change analysis to detect ecosystem shifts

It also helps to assess and develop technologies to more efficiently map coral habitats:

- Move from static to iterative map products
- Reduce cost and increase accuracy
- Increase thematic and spatial resolution
- Integrate shallow and moderate depth map products

Mapping Approaches

The primary approaches for coral reef habitat mapping that have been used to date have been interpretation of satellite



Shallow habitats are delineated from aerial/satellite images of nearshore, visible depths.

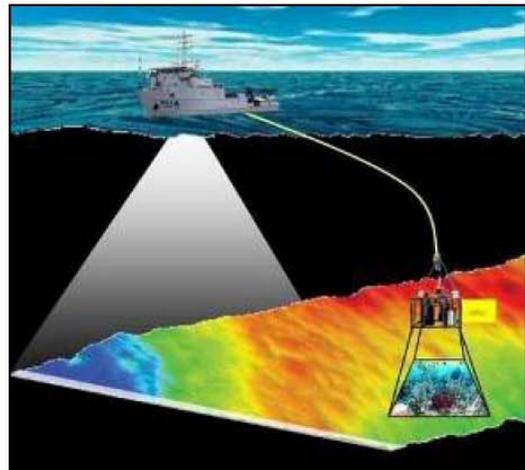
and aerial images in shallow water (< 30 m) and acoustic bathymetric mapping combined with collection of optical-imagery (video and still photographs) in depths from 15 m to greater than 500 m. In limited areas shallow bathymetric data from airborne light detection and ranging (LIDAR) sensors have also been used.

Shallow habitat mapping:

- Nearshore to visible depths
- Uses satellite imagery, aerial photos, etc.
- Humans set visible habitat boundaries, assign classes
- Maps: zone, structure, and biological cover
- Validate via accuracy assessment

Strengths and weaknesses of shallow habitat mapping:

- Limited to habitats that are *visible* in the imagery
- Process gives access to images as well as structure and cover mapping products
- Products meet national and local/regional needs
- One-acre minimum mapping unit provides balances spatial resolution and time/budget constraints
- Images, products available to all users, allowing for the creation of higher resolution products if needed



Bathymetric data from acoustic sensors are interpreted using optical data.

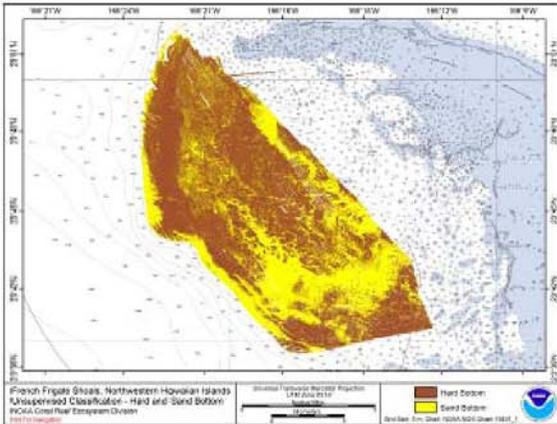
Acoustic bathymetric habitat mapping:

- Mid-water and deepwater habitats, from 15 m to greater than 500 m
- Uses multibeam acoustic technologies
- Maps: high-res bathymetry, backscatter, bathymetric derivatives (e.g., rugosity, bathymetric position index)

- Validated by observations from towed cameras, remotely operated vehicles, autonomous underwater vehicles, etc.

Strengths and weaknesses of acoustic bathymetric mapping:

- Process generates derived products in addition to bathymetric contours (e.g., slope, rugosity)
- Backscatter information is collected with the bathymetric data and aids in the determination of seafloor type and habitat maps (e.g. hard/soft maps)



Hard/soft maps of the Northwestern Hawaiian Islands was used to aid management in design of random-stratified sampling protocols.

- Bathymetry and backscatter are used to delineate conservation areas, including essential fish habitat (EFH) and habitat area of particular concern (HAPC), and identify biologically important seafloor features
- Defines boundaries delimited by particular isobath
- Can update nautical charts if data are collected to appropriate standards
- Acoustic mapping in very shallow water (< 15 m) is slow, expensive and can be dangerous. So, LIDAR, although expensive, may be more cost effective

Mapping Status and Products

Both shallow benthic habitat mapping (9,535 km²) and mid-depth bathymetric mapping (64,000+ km²) are well advanced across the Pacific. In contrast, shallow, nearshore bathymetric data still must be collected in most areas and additional development is needed to create moderate depth habitat maps and especially to *integrate data across all depths to create continuous habitat maps.*

JURISDICTION	BENTHIC HABITAT MAP PRODUCTS		BATHYMETRIC PRODUCTS	
	Shallow-Water (<30 m)	Moderate depth (30-1000 m)	Shallow-Water (<30 m)	Moderate depth (30-1000 m)
Main Hawaiian Islands	75-100%	0-25%	75-100%	75-100%
Northwestern Hawaiian Islands	50-75%	0-25%	25-50%	25-50%
American Samoa	75-100%	0-25%	25-50%	75-100%
PRIA	0-25%	0-25%	0-25%	75-100%
CNMI	75-100%	0-25%	50-75%	75-100%
Guam	75-100%	0-25%	75-100%	75-100%

A variety of digital mapping products are available at the fol-

lowing URLs:

- <http://www.soest.hawaii.edu/pibhmc>
- <http://ccma.nos.noaa.gov/about/biogeography>

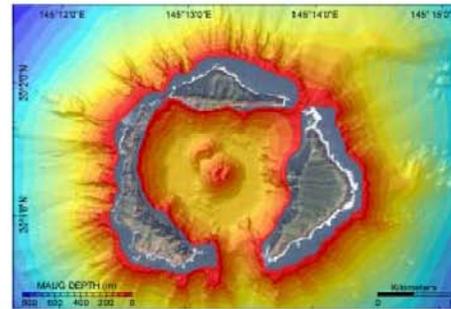
Management Applications

Federally managed areas

- Critical data for Pacific marine conservation areas in response to the needs of the Council on Environmental Quality (CEQ)
- Aids in delineating special conservation areas (e.g., EFH, HAPC, MPAs)
- Data are used by U.S. Fish and Wildlife Service, Environmental Protection Agency, and the Department of Defense (DOD)

CNMI/Guam

- Mapping and biological data have been used by the U.S. Naval Facilities Engineering Command, as well as national and local/regional management agencies, to determine environmental impacts of proposed DOD training and construction projects
- Saipan, Tinian, and Rota bathymetric surveys used to improve nautical charts; working to obtain DOD LIDAR data to share with management agencies
- Assessment of Garapan anchorage to minimize anchoring impacts on coral reef resources



A bathymetry map of the Maug Islands in the CNMI.

American Samoa

- Assessment of options for possible Ofu runway extension
- Identification of several coral-rich areas around Manu'a Islands in waters deeper than 30 m
- Identification of extensive, potentially coral-rich shelf areas surrounding Tutuila from bathymetric data and additional optical surveys of the outer Tutuila insular shelf to define ecologically significant areas for corals and fisheries

Hawaiian Archipelago

- Integrated data supports damage assessments
- Bathymetric contours defined the boundaries of the Papahānaumokuākea Marine National Monument
- Bathymetric/backscatter data used to define bottom-fish closure areas in the main Hawaiian Islands
- Bathymetric products have defined habitat use by monk seals and humpback whales
- Helped determine placement of replenishment areas for the aquarium trade



Coral Reef Ecosystem Integrated Observing System Pacific Reef Assessment and Monitoring Program

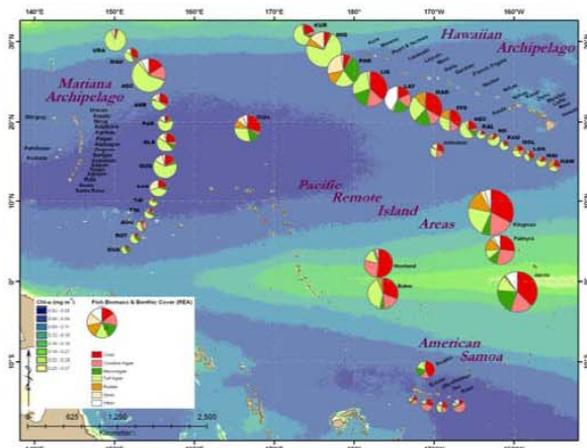


Overview

In support of NOAA's Coral Reef Conservation Program, the Coral Reef Ecosystem Division (CRED) of the Pacific Islands Fisheries Science Center leads the Pacific Reef Assessment and Monitoring Program (RAMP) in providing the scientific information needed to implement ecosystem approaches to management and long-term conservation of coral reefs across the vast and remote islands, atolls, and reefs of the U.S.-affiliated Pacific Islands. Every 2 years, Pacific RAMP conducts interdisciplinary integrated ecosystem assessments to document the spatial patterns and temporal trends of the fish, corals, other invertebrates, algae, and microbes in the context of their complex benthic habitats and dynamic oceanographic environments. Through the consistent use of comparable methodologies across diverse gradients of biogeography, environmental conditions, and human stressors, these broad-scale Pacific RAMP surveys support an unprecedented ability to understand ecosystem processes and provide local, regional, national, and international resource managers and policymakers with essential information to support effective management and conservation across this diverse range of scales.

Pacific RAMP surveys directly support management needs and objectives:

- Monitor ecosystem health, including corals, fish, algae, and macroinvertebrates
- Assess the ecological impacts of fishing, climate change, land-based sources of pollution, and other threats
- Establish and monitor the effectiveness of marine protected areas
- Plan coastal development and mitigation
- Prioritize and plan conservation efforts
- Conduct change analysis to detect ecosystem shifts



Biennial Pacific RAMP cruises provide broad-scale integrated ecosystem assessments of coral reefs across the U.S.-affiliated Pacific Islands. This figure shows reef fish biomass (size of pie charts) and benthic composition (percentages within pie charts) overlaid on satellite-derived chlorophyll-*a*.

Assessment and Monitoring Approaches

Biological resources are monitored using four complementary methods: site-specific Rapid Ecological Assessments (REA) of fish, corals, macroinvertebrates, and algae; broad-scale spatial towed-diver surveys of benthic composition and condition and of ecologically and economically important large fish and macroinvertebrates taxa; moored ecological acoustic recorders of biological and anthropogenic (vessels) sounds; and autonomous reef monitoring structures (ARMS) to monitor indices of cryptic invertebrate biodiversity.



Site-specific rapid ecological assessment (REA) surveys monitor the condition of corals, fish, algae, and macroinvertebrates.

REA surveys utilize belt transects (line-point intercept), photo quadrats, video transects, roving diver surveys, stationary point counts, and occasional sample collections of unidentified species. Metrics observed include distribution of species composition and diversity, abundance (density), size class, biomass, percent benthic cover, and disease prevalence.

Towed-diver surveys significantly expand the spatial coverage of biological surveys and document localized issues of concern, such as outbreaks of crown-of-thorn seastars or invasive species, extent of bleaching, or occurrences of rare or protected species.



Broad-scale towed-diver surveys document benthic composition and abundance of fish and macroinvertebrate taxa.

Pacific RAMP surveys were initiated in the Northwestern Hawaiian Islands (NWHI) and the Pacific Remote Island Areas (PRIA) in 2000 and extended to American Samoa in 2002, Guam and the Commonwealth of the Northern Mariana Islands (CNMI) in 2003, and the main Hawaiian Islands (MHI) in 2005. This ongoing time series of observations provides an essential baseline from which to monitor the ecological impacts of climate change, fishing, land-based sources of pollution, and other stressors.

Data from 8 years of Pacific RAMP surveys have been incorporated into databases and are being used to generate comprehensive reports such as the 2002, 2005, and 2008 *State of the Coral Reef Ecosystems of the United States and Pacific Freely Associated States* and the *Coral Reef Ecosystem Monitoring Report for American Samoa: 2002–2006*. In addition, these data have been used as the basis for over 60 papers in peer-reviewed scientific journals. Data are routinely shared with and provided to partner agencies.

Important Observations

- Contrary to expectations, mass coral bleaching was documented in the NWHI during Pacific RAMP surveys in both 2002 and 2004 at Kure, Midway, and Pearl and Hermes Atolls.
- 69% of the variance of large fish biomass across the Pacific is explained by proximity to human population centers.



Bleached *Montipora* spp. corals in the NWHI.

- Pacific RAMP has documented a significant decline of large fish at Rose Atoll and Swains Island.
- An invasive didemid tunicate was observed to be aggressively spreading over coral, macroalgae, coralline algae, and rubble around Swains Island.
- The uninhabited PRIA have exceptionally high fish biomass, high biological diversity, and the highest coral covers across the U.S.-affiliated Pacific Islands.
- Pacific RAMP has documented high abundance of two IUCN threatened species, bumphead parrotfish (*Bulbometopon muricatum*) and humphead wrasse (*Cheilinus undulatus*) at Wake.



Napoleon wrasse and bumphead parrotfish are common at Wake Atoll and rare elsewhere.

- Fifteen years after a 1993 shipwreck at Rose Atoll, ecological impacts, including increased turf algae, cyanobacteria, and herbivorous fish still dominate the wreck site.

Selected Management Applications

Federally managed areas

- Critical data for assessment of presidential proposal for increased Pacific marine conservation areas.
- Aids in delineating special conservation areas, such as essential fish habitats, habitat areas of particular concern, and marine protected areas.

CNMI/Guam

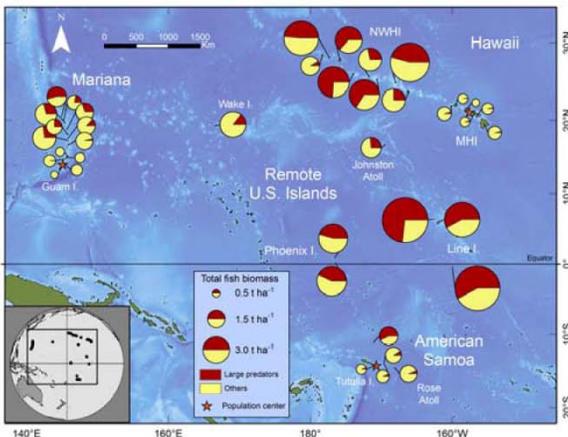
- Using data from Pacific RAMP cruises conducted in 2003, 2005, and 2007, an 800-page report of preliminary findings and key figures for Guam, Tinian, Aguijan, Saipan, and Pagan was provided to resource management agencies in September 2008. These data provide baseline information to assess the potential impacts of proposed military construction and training activities.

American Samoa

- Based on Pacific-wide fish observations, Governor Togiola Tulafono initiated efforts to protect large reef fish, including all species of shark, giant trevally, giant groupers, bumphead parrotfish and humphead wrasse, throughout American Samoa.

Hawaiian Archipelago

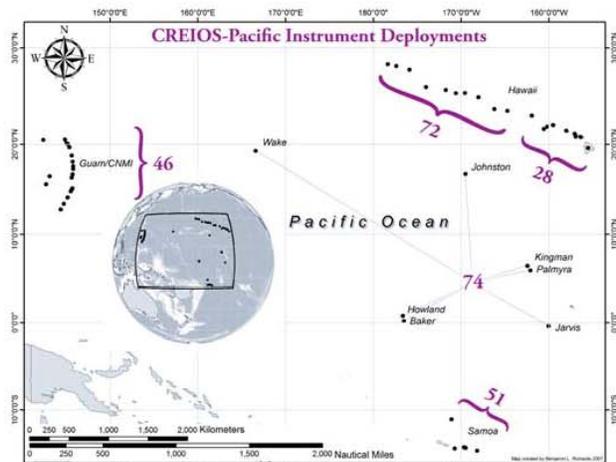
- Pacific RAMP observations show that fish biomass and abundance of apex predators is much greater in the NWHI than in the MHI.
- Pacific RAMP data were used as major inputs for designation of the NWHI as the Papahānaumokuākea Marine National Monument.



Distribution of fish biomass, predators and others, across the U.S.-affiliated Pacific Islands.



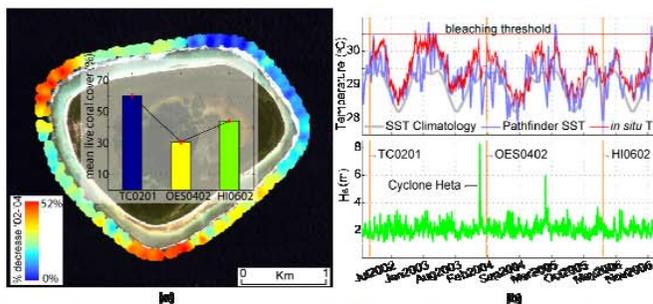
Coral Reef Ecosystem Integrated Observing System Pacific *in situ* Oceanographic Observations



CREIOS environmental and ecological observation study sites.

The CREIOS-Pacific Network

NOAA established the Coral Reef Ecosystem Integrated Observing System (CREIOS) to provide integrated and interdisciplinary environmental and ecological observations. The Pacific Islands Fisheries Science Center Coral Reef Ecosystem Division (CREED) leads the Pacific portion of the CREIOS, conducting biennial biological and hydrographic surveys of coral reefs in the U.S.-affiliated Pacific Islands and maintaining a diverse network of *in situ* instruments providing long-term time-series observation of ecosystem parameters. The CREIOS-Pacific network currently includes 54 islands, atolls, and reefs located among Guam; the Northern Mariana Islands; American Samoa; the main and Northwestern Hawaiian Islands; Howland, Baker, and Jarvis Islands; and Palmyra, Kingman, Wake, and Johnston Atolls. These sites range from some of the most remote and pristine reef systems on the planet to areas heavily impacted by local human activities.



Loss of coral cover associated with Cyclone Heta at Swains Island, American Samoa: (a) decrease in percent live coral cover in 2002 and 2004 with graph of island-wide mean coral cover during cruises in 2002, 2004, and 2006; (b) top, satellite and *in situ* SST; bottom, mean significant wave height showing storm event and cruise dates.

Principal Goals

- Characterize the long-term variability of oceanographic and meteorological conditions and processes influencing coral reefs, detect significant environmental change, and assess potential impacts of climate change, such as ocean warming and acidification on reef ecosystems.

- Quantify key physical and chemical forcing mechanisms, including currents, temperature, waves, and nutrient fluxes, that are pertinent to biological processes, such as distribution of organisms, biological productivity, dispersal and recruitment of larvae, localized and large-scale patterns of coral bleaching, and degree of disturbance due to episodic storms.
- Provide broad-scale ecosystem baselines and comparative analyses to assess impacts of land-based pollution.
- Generate synoptic morphological and benthic habitat maps.
- Assess and monitor anthropogenic activity, such as vessel traffic, in marine protected areas and other sites of special interest.

CREIOS-Pacific Instrument Types

	Sea Surface Temperature (SST) Buoy Moored buoy that provides high-resolution SST data. Subsets of data are transmitted, at least once per day, via satellite telemetry.
	Coral Reef Early Warning System (CREWS) Buoy Moored buoy providing near real-time, high-resolution SST and surface conductivity, air temperature, barometric pressure, and wind speed and direction. Enhanced buoys also measure photosynthetically active radiation and 3 bands of UV radiation above and below the surface. Subsets of these data are transmitted daily via satellite telemetry.
	Subsurface Temperature Recorder (STR) Deployed at depths ranging from 0.5 to 40 m, STRs are typically attached to a reef structure or positioned on the seafloor with added weights. They provide high-resolution temperature observations, internally recorded at 30-min intervals.
	Ocean Data Platform (ODP) Deployed on the seafloor, at depths typically ranging from 15 to 40 m, the ODP provides directional current profiles and wave spectra using a 3-beam 1000 kHz acoustic Doppler profiler and high-resolution temperature and conductivity time series observations.
	Aquadopp Profiler (AQD) Deployed on reef flats and shallow reef passes (channels) at depths of 2–10 m, the AQD provides full-depth, directional, current profiles and wave spectra using a 3-beam 2 MHz acoustic Doppler profiler.
	Wave-and-Tide Recorder (WTR) Deployed on the seafloor at depths typically ranging from 10 to 25 m, the WTR provides high-resolution wave, tide, and temperature records.
	Ecological Acoustic Recorder (EAR) Typically deployed at depths of 5–25 m, the EAR is a passive acoustic device developed specifically for monitoring marine mammals, fish, crustaceans, other sound-producing marine life, and human activity in marine habitats. A digital, low-power system that records ambient sounds up to 30 kHz on a programmable schedule, an EAR can respond to transient acoustic events that meet specific criteria, such as motorized vessels passing nearby or cetaceans.

Standard CREIOS instruments deployed at sites around the Pacific.

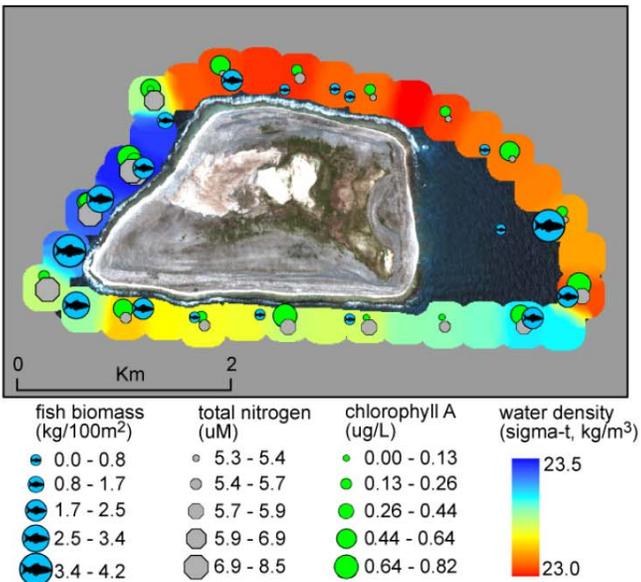
Instrumented platforms are deployed to record data between biennial Pacific Reef Assessment and Monitoring Program surveys and to complement and validate satellite observations and numerical model outputs. The 54 islands and atolls currently are instrumented with 24 telemetering surface buoys and 239 subsurface data recorders.

Hydrographic field surveys are performed during research cruises to provide a detailed spatial assessment of the oceanographic and water quality conditions in nearshore waters. Collected data include shipboard acoustic Doppler current profiler; conductivity, temperature, and depth; dissolved oxygen; turbidity (beam transmittance); chlorophyll-*a*; nutrients; seawater

carbonate chemistry, including dissolved inorganic carbon and total alkalinity; sea surface temperature and salinity; and ocean current drifter information. Both field surveys and moored instrument platforms are essential in understanding and interpreting environmental observations. The long-term time-series data sets from surface and subsurface instrument platforms provide context for the more detailed biennial spatial “snapshots” afforded by field observations.

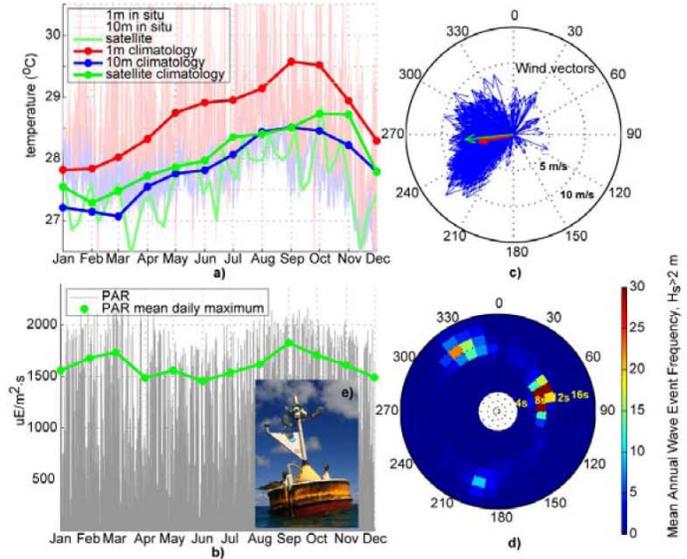
Monitoring the Environment

Numerous connections between CREIOS observations and ecological change have been identified at a variety of scales, including mass coral bleaching events from reef to archipelago levels, distribution of fish biomass around islands, and the impact of episodic storm wave events on coral cover. Such connections between ecological and physical/chemical phenomena would be difficult to make without a systematic and integrated ecosystem-based approach that concurrently collects biological and oceanographic information.



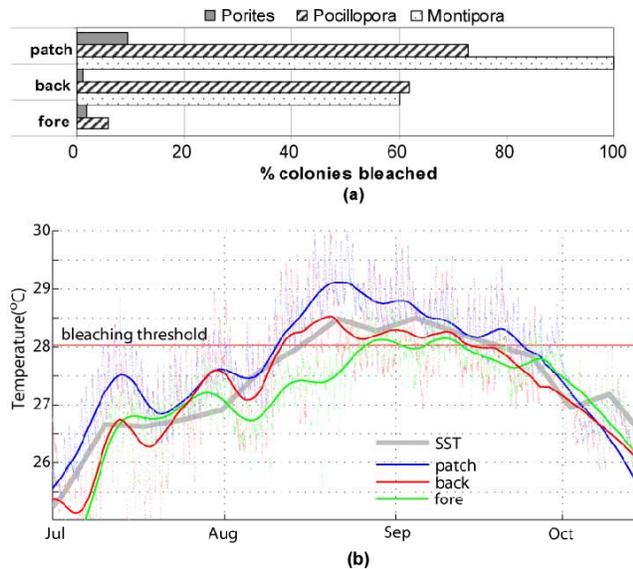
Upwelling at Jarvis Island: biomass of planktivorous fish from 2008 Rapid Ecological Assessment surveys with total nitrogen, chlorophyll-*a* concentrations, and sigma-t (density) at the 10-m depth level. Water upwelling caused by topographic interaction with the Equatorial Undercurrent is indicated by high nitrogen and density values. This upwelling is linked to exceptionally high biomass and distribution of reef fish, live coral cover, and other ecosystem components.

Using comprehensive standardized data sets, heavily impacted reef systems can be compared with relatively pristine reefs on multiple spatial scales. Further, CREIOS-Pacific researchers can rapidly improve their abilities to assess local ecological impacts, such as nutrient loading and sedimentation, extractive activities, such as fishing, and predicted global effects, such as ocean warming and acidification.



Typical CREIOS data streams showing *in situ*, satellite, and modeled climatology from Palmyra Atoll: (a) satellite and *in situ* temperatures, (b) photosynthetically active radiation (PAR), (c) daily mean wind vectors with overall mean, and (d) mean annual frequency of occurrence of significant wave heights over 2 m.

Near real-time data telemetry serves to alert resource managers and researchers of episodic events and emergent trends in the environment that could significantly affect the surrounding coral reef ecosystems, allowing for responsive action.



Mass coral bleaching event in 2004 at Pearl and Hermes Atoll, Northwestern Hawaiian Islands: (a) incidence of coral bleaching by habitat and genus (September–October), (b) weekly satellite SST and *in situ* sea temperatures for 3 habitats. Observed bleaching correlates well with *in situ* measurements, showing the magnitude and duration of temperatures elevated above the bleaching threshold.



Pacific Islands Fisheries Science Center Coral Reef Ecosystem Division Marine Debris Program



NWHI Marine Debris Removal

The marine debris team of the NOAA Pacific Islands Fisheries Science Center (PIFSC), Coral Reef Ecosystem Division (CRED), has successfully completed 12 seasons of marine debris removal from the coral reefs of the Northwestern Hawaiian Islands (NWHI). Derelict fishing gear (DFG), prevalent in coastal and marine habitats throughout the Hawaiian Islands, presents the hazard of lethal entanglement to numerous marine species, most notably the critically endangered Hawaiian monk seal, the threatened green sea turtle, and the endangered humpback whale. DFG also damages benthic reef habitats, acts as a vector for the introduction of alien and invasive species, and poses a hazard to navigation.



A green sea turtle is entangled in DFG at Pearl and Hermes Atoll.

Though the PIFSC Protected Species Division removed marine debris from the beaches surrounding the islands in the NWHI starting in 1982, the first efforts to assess the abundance of marine debris on the surrounding coral reefs were not initiated until 1996. Over the period from 1996-2000, a multi-agency NWHI marine debris partnership led by PIFSC initiated small-scale marine debris removal efforts in the NWHI to lessen the impacts to coral reef habitats and reduce entanglements and mortality of threatened and endangered species. From 2001 to 2005,



A diver works to free a net from the reef at French Frigate Shoals.

NOAA's Coral Reef Conservation Program, NWHI Coral Reef Ecosystem Reserve, and Marine Debris Program funded an intensive, large-scale debris removal effort that engaged federal, state academic, industry and nongovernmental organizations as partners. Led by PIFSC, this effort resulted in the removal of 511 metric tons of debris from the reefs of the NWHI.



Derelict fishing gear draped over a coral reef in the Northwestern Hawaiian Islands.

In 2006, the PIFSC marine debris team transitioned to a maintenance mode and removed over 19 metric tons of debris from the NWHI. However, a study—

published in the April 2007 issue (Vol. 54) of the *Marine Pollution Bulletin* and authored by CRED staff (Oliver Dameron, Michael Parke, Mark Albins, and Rusty Brainard) —determined that the annual accumulation rate for marine debris in the NWHI is at least 52 metric tons, based on the 2001-2005 debris surveys, oceanographic analyses, and benthic habitat characteristics of 85% of the islands and atolls.

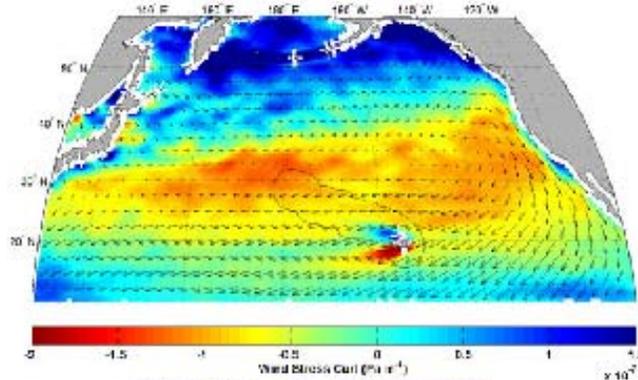
The PIFSC marine debris team, continuing in maintenance mode, has removed 59 metric tons of debris from the NWHI during the 2007-2008 field season, bringing the cumulative marine debris removal total to 599 metric tons.



Yearly and cumulative weights of marine debris removed from the NWHI

GhostNet Project

In addition to removal of derelict fishing gear from the reefs and beaches of the NWHI, CRED has been partnering with NOAA's Satellite Information Service (NESDIS) and Office of Oceanic and Atmospheric Research (OAR), and Airborne Technologies Inc. on the GhostNet project designed to develop cost-effective tools for locating and removing derelict fishing at sea, before it has done damage to the coral reef ecosystems of the NWHI. This work, which has been funded since the late 1990s by NASA, NOAA's Coral Reef Conservation Program, Marine Debris Program, and Papahānaumokuākea Marine National Monument has investigated uses of high-resolution satellite remote sensing imagery, aerial surveys, satellite-tracked drifters, and oceanographic modeling to develop maps of debris estimated likelihood indices (DELI) to locate DFG at sea. This work is based on known oceanic convergence patterns across the North Pacific Ocean.



North Pacific winds from QuikScat 1999-2006:
Lower wind stress curl (dark orange to red) means greater oceanic convergence and corresponding higher marine debris densities.

Over the past couple of years, the GhostNet project has been developing and testing the use of an unmanned aerial system (UAS), Malolo I, designed to be launched from a ship at sea to provide aerial reconnaissance for marine debris in the surrounding waters. Malolo 1 is designed with a imaging system and anomaly detection software to detect derelict fishing gear at the ocean surface. Once debris is detected, the UAS sends a GPS location to the ship to enable cost-effective removal. This system was first field tested in March 2008 in the NWHI with limited success, but designers have been working to correct issues and the system will be retested in December 2008.



An unmanned aerial system (UAS) is launched from a small boat during 2008 field testing

For more information, please visit our Web site:
<http://www.pifsc.noaa.gov/cred/mdr.php>