COL/SE/01

**Near Real-Time Wireless Video Monitoring of Coral Reef Events**
FY 2003 Proposal to the NOAA HPCC Program

August 19, 2002

| Title Page | Proposed Project | Budget Page |


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| Proposal Theme: | **Techniques for Collaboration, Visualization, or Analysis** |
| Funding Summary: | FY 2003 $ 64,800 |


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# NOAA Coral Camera for The World-Wide Web

FY 2003 Proposal to the NOAA HPCC Program

Proposal for FY 2003 HPCC Funding

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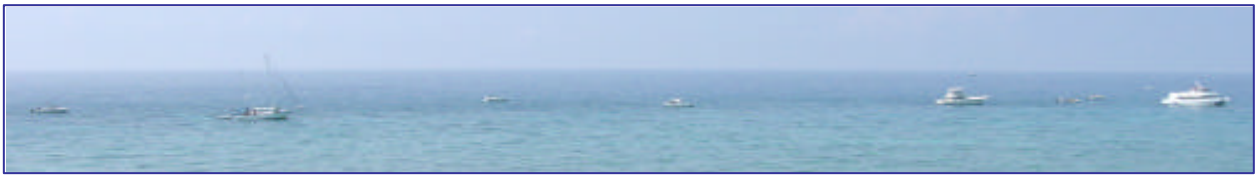

## Executive Summary:

Under the SEAKEYS program (in cooperation with the Florida Institute of Oceanography) and the Coral Reef Watch program, NOAA is the only organization in the U.S. that maintains, and is in the process of constructing, an automated near real-time meteorological and oceanographic network of instrumented array stations at U.S. coral reef areas. These stations are being implemented and maintained to, a) compile long-term databases for the purpose of understanding coral reef dynamics and for providing decision support to Marine Park Area (e.g., the Florida Keys National Marine Sanctuary: FKNMS) managers; b) to provide near real-time feedback on conditions thought conducive to coral bleaching and other biological events on the reefs; and, c) to surface-truth satellite sea temperature sensing algorithms, which are also used in coral bleaching predictions and alerts. What is missing in this effort is a means of near real-time feedback on the bleaching or other phenomena that are predicted and otherwise researched from remote sensing. Because these stations are remote and not always readily accessible, either because of inclemency, or other logistical concerns, it is difficult to understand adquately the cause and effect between environmental stress and observed bleaching or other biological events, which are modelled and monitored from afar. We propose to install an underwater camera to fulfill our requirement for immediate feedback on the condition of coral reefs and their inhabitants. We also propose to install an above water camera for the purpose of providing immediate feedback on MPA usage of coral reef resources. We propose to install these cameras at a very popular coral reef in the FKNMS, Molasses Reef, near Key Largo, Florida. This project leverages heavily on existing NOAA funding for the SEAKEYS and CREWS programs.

## Problem Statement:

***Brief Background***

NOAA's Coral Reef Watch (CRW) program utilizes remote sensing, computational algorithms and artificial intelligence tools to monitor, model, predict and report physical environmental conditions which adversely influence coral reef ecosystems. NOAA's Coral Reef Early Warning System (CREWS) network of meteorological and oceanographic monitoring stations, currently being deployed at all major U.S. coral reef ecosystems (e.g., Hawaii, American Samoa, U.S. Virgin Islands, etc.) is maintained by the Atlantic Oceanographic and

Meteorological Laboratory (AOML), a laboratory of NOAA Research. Satellite remote sensing products for the CRW program come under the purvue of NESDIS (Dr. Al Strong, co-CRW Principal Investigator with JH). The SEAKEYS meteorological and oceanographic monitoring nework (Ogden et al, 1994), originated and maintained by the Florida Institute of Oceanography, for which the CREWS artificial intelligence software was originally developed (e.g., Hendee et al 2001), and the CREWS network approach modelled, concentrates solely upon the Florida Keys and Florida Bay, serves as a test-bed for some of the CRW instruments and operational concepts, and is also considered a part of the CRW/CREWS network for purposes of data management, information synthesis and satellite surface-truthing of sea temperatures (Hendee et al 2002). Most CREWS and all of the SEAKEYS stations are or will be in the Florida Keys National Marine Sanctuary (FKNMS) or marine protected areas (MPAs).

***Problems***

1) The only current method for verifying CRW predictions of coral bleaching (and other intended CREWS information early warning products, such as fish and/or invertebrate spawnings or migrations, red tides, etc.) is by direct verification by traveling to the remote sites, diving in the water, and checking to see whether the predictions are correct or not. This is of course very expensive for traveling and time-consuming for personnel, especially since home base may be thousands of miles away from the coral reef in question. Also, a visit may not closely coincide with the monitored and/or predicted event.

2) The FKNMS requires timely feedback on fishing and diving use at selected areas, and also on illegal activities at these sites. Most of the time, there are not enough personnel to visit or protect key sites.

3) The majority of American citizens will never see and appreciate a coral reef in their lifetime. This leads to a misunderstanding of the importance of coral reefs and reduces NOAA's effectiveness at preservation of these intrinsically beautiful and economically important resources.

***Relevance to HPCC Objectives***

These problems can be met with solutions under the HPCC mandated objectives which "…require the cooperation of multiple sites and, perhaps the introduction of advanced communications protocols." The solutions proposed below "…demonstrate new techniques for working with NOAA data and information." The solution proposed herein relies upon the Internet-2 infrastructure for those who are able to access it (although the solution is also available for those who are not).

## Proposed Solution:

We propose to install an underwater color video camera (the same used on the USS *Monitor* recovery) with live streaming video at the Molasses Reef SEAKEYS station, near Key Largo. The real-time video will be accessible during daylight hours via the Web.

***Millepora alcicornis***

Outland Technologies' Mini camera, model UWC-325/P, will be positioned at the base of the Molassess Reef station so that the view will

encomplass a stand of coral species (fire coral: *Millepora alcicornis*) known to bleach first in mass coral bleaching episodes (Cook et al 1990; Marshall & Baird 2000; and personal observations). Above the water, and facing mooring buoys where divers are required to tie their boats, a sony CVC-6800EX-H.E.A.T Color Bullet Camera with EXview technology and built-in 4 mm lens will be attached atop the instrument case at the Molassess Reef SEAKEYS station, and will be powered by solar panels and marine grade batteries already present on the SEAKEYS stations for powering the meteorological and oceanographic stations. The cameras will have a solid-state relay which will automatically turn power to the camera off and on with daylight and dusk. The digital signals obtained during the day from the two cameras will be sent via coaxial cable to a MicroTek Electonics two-channel wireless video transmission microwave dish. From there, the signal will be sent to a receiving dish (manufactured by the same vendor) at NOAA's National Undersea Research Center (NURC) laboratory close by at Key Largo and from there to a Viewcast Niagra 4222RW model rackmount video encoder. The encoder will encode the video data stream into a Windows Media compatible data stream. (Microsoft does not require royalty for Windows Media usage, whereas RealPlayer media does.) At the NURC lab, wireless service is through TerraNovaNet, using two systems: the standard system runs at 3 Mbs but has capability to 20 Mbs for special events; the backup system runs at 1.5 Mbs. (There are also ISDN lines for point-to-point connections at 384 Kb.) At AOML, the encoded data will be collected on a ViewCast Niagra 3200W server. The server software will be configured, in cooperation with University of Miami's Rosenstiel School for Marine and Atmospheric Sciences: RSMAS) to identify whether the client requesting the video stream is an Internet or Internet-2 client, then serve the data appropriately. The server software will also be configured to only allow Internet transmission during non-peak usage if client requests become burdensome to the AOML/RSMAS Internet traffic. Internet-2 traffic is anticipated to be unaffected by high volume usage; however, it too can be configured in the same fashion if necessary.

In the ensuing years, we plan to refine the technology and install cameras at other SEAKEYS and CREWS sites, which are located in the FKNMS and other MPAs. Also, we anticipate that, with success, we would like to string cable to deeper sites where a broader range of coral assemblages, important to other researchers, can be viewed. We also hope to transfer this technology to other non-U.S. coral reef sites where we plan on installing CREWS stations for other governments.

***Activities***

* Purchase equipment

* Field test all hardware and software at AOML first, debug the system

* Install encoder hardware and software, and microwave receiving dish at NURC lab and change configuration of server hardware and sofware at AOML appropriately.

**Molasses Reef SEAKEYS Station**

* Install cameras, cables and microwave transmission dish at Molasses Reef SEAKEYS station. Verify data signal acquisition and tranmission, and power budget at station.

* Aim transmitting dish to receiving dish. Technicians at NURC and Molasses Reef verify solid data link via communication via cell phone. Positions and attitudes of both dishes will be fixed and recorded.

* Reconfigure software component at NURC site, as necessary.

* Configure server and Web at AOML to allow traffic at only certain times of the day.

*Chaetodon ocellatus* and *Thalassoma bifasciatum*, common inhabitants of Molasses Reef.

* Test system and obtain feedback from Michael Anderson (RSMAS) on possible glitches in system.

* Announce to coral-list (1,800 coral researcher subscribership) that camera is up and running.

* Monitor usage and possible adverse affects on Internet connections at RSMAS and AOML. Modify configuration as appropriate.

* Maintain (clean, service) cameras through regular trips by FIO Field Team to the station throughout the year.

***Literature Cited and References:***


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Ogden, J.; J. Porter; N. Smith; A. Szmant; W. Jaap; & D. Forcucci. (1994). A long-term interdisciplinary study of the Florida Keys seascape. *Bulletin of Marine Science 54(3)*, 1059-1071.


## Analysis:

***Rationale and Benefits***

Large amounts of NOAA funding are now being spent for the SEAKEYS and Coral Reef Watch programs for the purpose of predicting and monitoring conditions conducive to coral bleaching and other biological events on the reefs. The CREWS station sites are being located at critical areas, as are the SEAKEYS stations, but those same areas are usually not easily reachable

within two or three days time, or even greater during periods of inclemency. The use of cameras gives those who watch the data immediate feedback on what effects variations in measured parameters have on corals and coral reef inhabitants. The cameras are of obvious benefit to an understaffed MPA manager who needs to monitor use and abuse of often large protected tracts of reefs. And finally, millions of citizens of all nations can enjoy the beauty of American coral reefs and begin to understand the complex interactions of coral reef organisms through viewing them online at their leisure over the Web, without having to travel to the sea to observe them in person.

***Alternatives***

The only other alternative to viewing in person or use of the herewith proposed cameras is to log the visual images on underwater cameras and retrieve the images at a later date. The main problem with this is that if the camera malfunctions, you won't know it until you retrieve the system and attempt to view it. Also, this requires an extensive underwater video storage device for extremely large files; such a solution would be troublesome to maintain, expensive to build or purchase, and very large. And of course, this "solution" does not provide near real-time feedback.

## Performance Measures:

This project will be deemed fully successful when live video images of Molasses Reef above and below water are broadcast over the World-Wide Web.

**Inside the Molasses Reef Instrument Closet**

**Milestones** (in months after funding received)

Month 1 -- purchase and test all required equipment

Month 2 -- Meet with NURC and SEAKEYS personnel in Key Largo and discuss logistics

Months 3 -- Install equipment, verify communications connections, beta test system

Months 4-5 -- Go live with presentation on the Web

**Deliverables**

- Images every day on the Web
- Archived, recorded images (as mpg and jpg files) of corals bleaching, obtained from the cameras.
- Comments from Web users on recommendations, uses, compliments and/or complaints.
- Counts of boats visiting Molasses Reef, obtained through the Web camera.