

Pre-Proposal on:

ASSESSMENT, INVENTORY AND MONITORING OF CORAL REEFS

Proposal to:

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Regional Manager, Research and Modeling
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P.O. Box 279
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Pre-Proposal Title:

**An Analysis of Pre- and Post-Hurricane Coral Reef Community Dynamics in the
Biscayne National Park: A "Before" and "After" Study in which the
"Before" is Really Known**

Pre-Proposal from:

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**An Analysis of Pre- and Post-Hurricane Coral Reef Community Dynamics in the
Biscayne National Park: A "Before" and "After" Study in which the
"Before" is Really Known**

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I. Introduction

Hurricane Andrew was only the tip of the iceberg of coral reef problems in South Florida. Prior to Hurricane Andrew, five of six coral reefs studied photogrammetrically since 1984 declined precipitously in percent live-coral cover and coral species diversity (Porter and Meier, 1992; see attached reprint). The loss varies between 4% and 10% per year for coral cover and between 13% and 33% for coral species diversity. All the reefs studied are in protected areas (either in National Marine Sanctuaries or National Parks). The only pattern that emerges is an odd inverse correlation between reef decline and reef latitude: reefs in the Lower Keys are losing coral faster than reefs in the Upper Keys. In fact, the only reef that grew during the survey was Ball Buoy Reef in the Biscayne National Park.

We call our best (and at present only) testable hypothesis to explain this pattern of decline **The Florida Bay Water Hypothesis**. Briefly stated, it is as follows:

Due to the diversion of freshwater from its historical flow patterns in South Florida, water in Florida Bay is of increasingly poor quality with respect to salinity, temperature, oxygen content, nutrient content, and turbidity. Based on hydrography, this water moves between the Florida Keys, under Hawk Channel (due to its hyper-salinity induced density), and out onto coral reefs on the Florida Reef Tract. Based on its suboptimal quality, this water causes increased coral mortality and decreased coral recruitment to reefs in its path. The correlation between coral mortality and latitude is therefore spurious, the causal link is not between mortality and latitude, but between coral mortality and the frequency and duration of contact with Florida Bay Water.

If this hypothesis is correct, then it bodes very well for Biscayne National Park coral reefs damaged by Hurricane Andrew. Specifically, we predict:

- H° 1) Due to their relative isolation from Florida Bay Water, coral reefs of the Biscayne National Park will recover quickly from damage caused by Hurricane Andrew.

Further hypotheses can be advanced:

- H° 2) We have shown that Biscayne National Park acroporid coral reefs are capable of increases in coral cover by as much as 15% per year (Porter and Meier, 1992). We therefore predict recovery rates as high as this after Hurricane Andrew.

- H° 3) The rate of reef recovery in the Biscayne National Park will be proportional to the proportion of the fast-growing coral *Acropora palmata* on the reef. Reefs dominated by this species will recover quickly; reefs dominated by other species will recover more slowly.

Despite the fact that many coral species spawned only three days before Hurricane Andrew struck, we have measured only low rates of larval recruitment to settlement plates in the park and predict that:

- H° 4) Due to low rates of coral larval recruitment, most of the coral recovery on Biscayne National Park coral reefs will be due to asexual vegetative growth, and not by sexual recruitment.

Based on previous work in Jamaica (Knowlton *et al.*, 1981) we predict a protracted period of coral fragment mortality in which:

- H° 5) Post-Hurricane coral fragment mortality will be proportional to the fragment size: small fragments will die at rates higher than large fragments.
- H° 6) The probability of tissue recovery after scour will be proportional to the area of the scar: small scars will heal quickly; large scars will heal slowly or not at all.

Using our base line data from photostations established in 1989 and monitored annually thereafter, we can also test the following questions:

- H° 7) How do patterns of pre- and post hurricane mortality and growth correlate with:
- a) species
 - b) abundance
 - c) morphology

As after Hurricane Allen in Jamaica in 1980, we predict that patterns of coral mortality will closely mimic coral morphology: branching corals will prove more susceptible to the mechanical damage of wave stress than boulder corals (Porter *et al.*, 1981), and that these patterns will be highly dependent on the position of the reef with respect to the most powerful breaking or internal waves (Kjerfve *et al.*, 1986) and depth (Porter *et al.*, 1982).

After Hurricane Allen struck Discovery Bay, Jamaica in 1980, the coralivorous gastropod mollusk, *Coralliophila abbreviata* decimated the few remnant coral colonies on the reef (Knowlton, *et al.*, 1990). Therefore:

- H° 8) How do population densities and predation patterns of *Coralliophila* differ between pre- and post-hurricane conditions on the reef? What of other predators such as *Diadema antillarum*?

Figure Legends

- Figure 1** Reef study sites. Biscayne National Park:
Ball Buoy Reef: (BP01), 3.1 m depth
Position: 25° 18.3'N; 80° 11.2'W
Triumph Reef: (BP02), 6.0 m depth
Position: 25° 28.7'N; 80° 06.7'W
Additional video transects will be located at reefs such as Elkhorn Reef, Rubicon Reef, Pacific Reef, and Alina's.
- Figure 2** Ball Buoy Reef, Biscayne National Park
Three video transects (Video Transects 1, 3, and 5) are located between the paired Video Transect Stakes 1 - 6. Each Video Transect is 25 m long and approximately 1 m wide (scale ping-pong balls on the sea floor in view of the camera could be used to set the exact magnification of each frame). The camera rolls between these start and stop points on an "underwater clothes-line" (see enclosed video), and views the same region censused by Chain Transect Lines 1, 3, and 5. The presence of these chain transects, which have been counted every year since 1989, directly under the video path will add considerable ground truth information to the video transect analysis in these locations. Note the location of Frame 34 from the Video Photostation 1. This frame is depicted in Figure 4a, "before" Hurricane Andrew (1991), and in Figure 4b, two weeks "after" the hurricane (1992).
- Figure 3** Triumph Reef, Biscayne National Park
Three video transects (Video Transects 7, 9, and 10) are located between the paired Video Transect Stakes 8 -13. Each Video Transect is 25 m long and approximately 1 m wide (scale ping-pong balls on the sea floor in view of the camera could be used to set the exact magnification of each frame). The camera rolls between these start and stop points on an "underwater clothes-line" (see enclosed video), and views the same region censused by Chain Transect Lines 8, 9, and 10. The presence of these chain transects, which have been counted every year since 1989, directly under the video path will add considerable ground truth information to the video transect analysis in these locations.

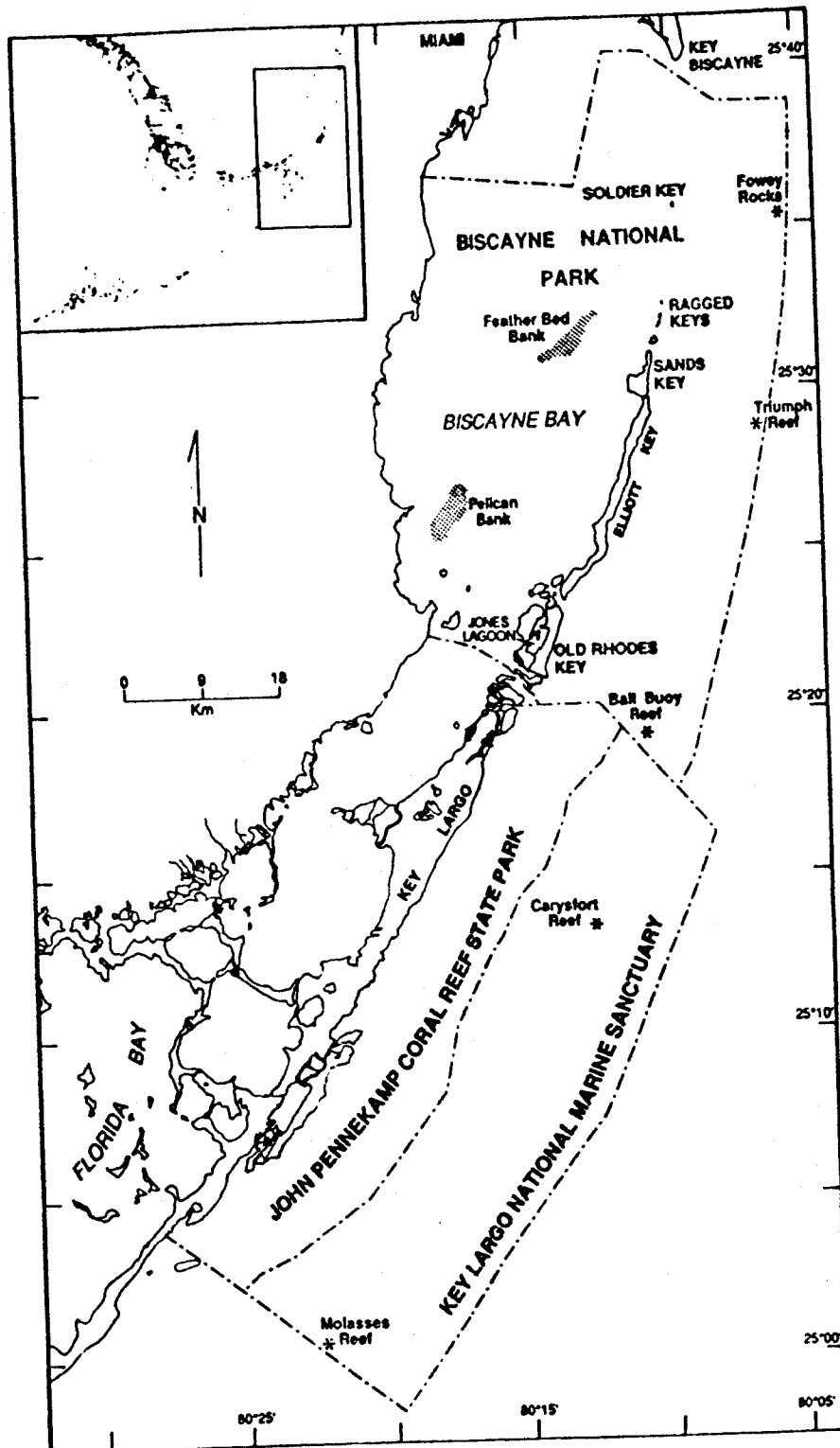


Figure 1

Biscayne National Park Ball Buoy Reef

Photostation 1 Line Transects 1-5

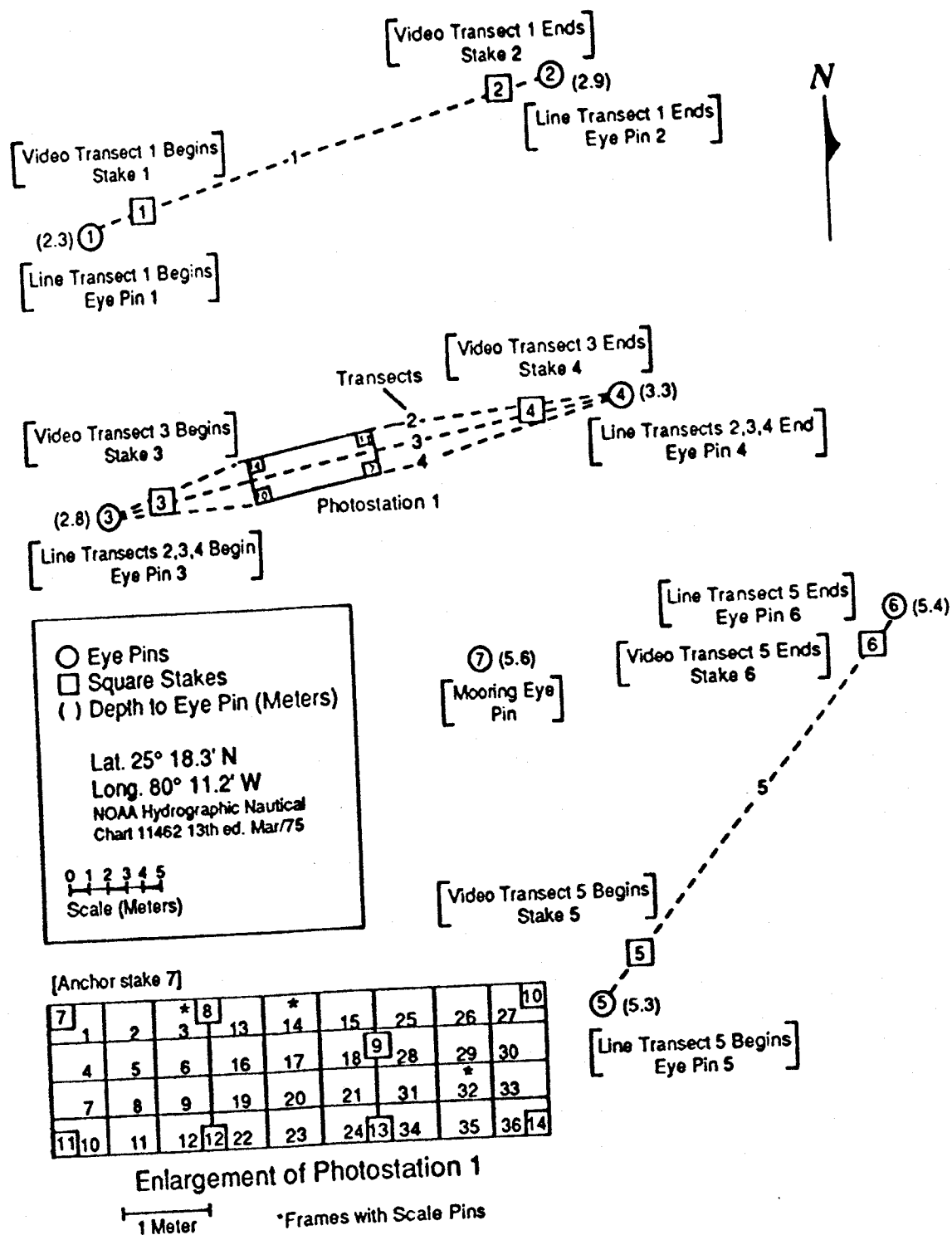
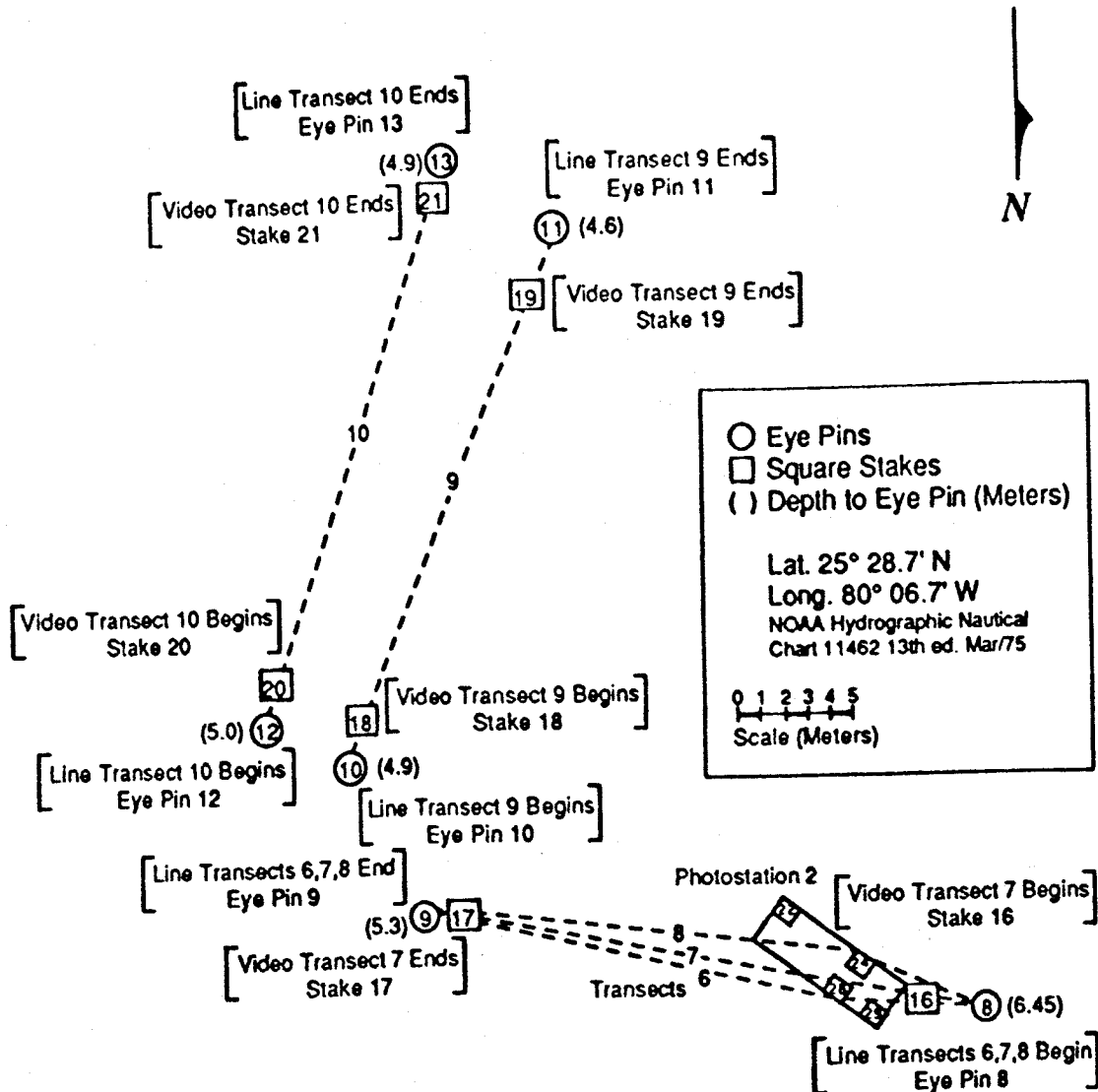


Figure 2

Biscayne National Park Triumph Reef

Photostation 2 Line Transects 6-10



[Anchor stake 22]

22	1	*	2	3	23	13	14	15	24	25	*	26	27	25
	4	5	6			16	17	18		28	29	30		
	7	8	9		*	19	20	21		31	32	33		
26	10	11	12	27	22	23	24	28	34	35	36	29		

Enlargement of Photostation 2

1 Meter

*Frames with Scale Pins

Figure 3

As part of Dr. Caroline Roger's Long-Term Coral Reef Assessment Program, Ouida Meier, my Ph.D. student, and I established two long-term monitoring sites in the Biscayne National Park in 1989 (Figures 1-3). All these areas are marked by stainless steel stakes; all of the stakes survived the storm. Our studies have used a nested sampling design to quantify rates of change among the major reef biota, focusing on the scleractinian corals. The survey consists of the following survey elements, all of which have been repeated annually since their inception in 1989. These were also repeated in early September, 1992, two weeks after Hurricane Andrew.

- 1) Fixed locations (2 fore-reef sites; Figs. 2 & 3) with
 - a) Fixed photographic quadrats for:
 - i) B&W prints, traced and digitized by hand, and
 - ii) Frame by frame statistical comparisons (N=36 frames)
 - b) Fixed line transects (each 25 m long; 5 on each reef; each counted annually three times)
- 2) Whole reef survey with:
 - a) Species counts (10,000 m²)
 - b) Random photographic quadrats (100 m²)

In 1990, we used the National Park Service funds to leverage MacArthur Foundation support to the Florida Institute of Oceanography and the SEAKEYS Program. These additional funds purchased video equipment and allowed us to modify the above NPS survey to include:

- 1) Fixed locations (2 fore-reef sites) with
 - a) Fixed video quadrats for:
 - i) Color video image analysis (Figs. 4a & 4b) and
 - ii) Frame by frame statistical comparison (N = 36)
 - b) Moving video transects (25 m each) directly above three of the line transects (Figs. 4c & 4d).

We wish to emphasize the overlapping nature and cross-comparison possibilities contained in our sampling scheme (Figures 2 & 3).

In addition to this sampling design, we wish to increase our reef sample size further by establishing more video transects (but not more fixed photostations) on reefs damaged by Hurricane Andrew. To do this, we will adopt and modify the Australian video image analysis system for the analysis of reefs in the Biscayne National Park. The key characteristics of the Australian system are as follows:

- 1) Fixed locations on 12 reefs per region (each "region" of the Great Barrier Reef Marine Park is the size of the Biscayne National Park)
 - a) 3 fixed "Primary" video transects lines, each 100 m long, each visited annually
 - b) 9 fixed "Cycle" video transects lines, each 100 m long, each one visited only once every 3 years
 - c) Analysis of random points from the fixed transect counted either as:
 - i) 5 randomly positioned points on 100 regularly grabbed frames
 - ii) 1 fixed point on 500 randomly grabbed frames

II. Objectives

We have two objectives. First, we will continue to monitor coral reef growth in the Biscayne National Park, begun prior to Hurricane Andrew using our existing **benthic photographic monitoring system** (see attached reprint: Porter and Meier, 1992). We will use these data to test the hypotheses listed above.

Second, we will refine and implement the rapid quantitative video transect methods developed by the Australian Great Barrier Reef Marine Park Authority to produce a **user-friendly video image analysis system** for quantifying change in benthic communities in the Biscayne National Park.

III. Methodology

Our photographic monitoring system is well described in the attached reprint. The enclosed video tape will show you the additional kinds of data routinely collected since 1990 by our video system. Although 100% of the still-life photographic data are analyzed, very little of the video tapes have been.

The Australian video image analysis system relies on fixed belt transects (100 m long and approximately 1 m wide, for a total coverage of 100 m²) and, from within these areas, the analysis of one fixed point on 500 randomly grabbed frames or five randomly positioned points on 100 regularly grabbed frames. We have made an initial attempt to test this system on our Biscayne National Park video tapes. Table 1 lists twenty randomly chosen x,y intercept coordinates which were counted on ten randomly grabbed frames (Table 2). The video was rolled forward to the randomly chosen transect meter number, and the identity of the biota in view (Table 3) under twenty randomly chosen points were counted. Percent change (loss -, or gain +) is listed in Table 3, and plotted in Figure 5. Although we used our system to identify individual species of corals (which we could do easily since we had the "ground truth" line transect counts over exactly the same belt transect, the Australians have emphasized only broad categories of biota, such as soft corals, hard corals, and algae (Done, 1992).

The use of point counts overcomes the fact that the camera does not always include the same area. To determine the area surveyed, the Australians put a fixed monopod under their video camera to help correct for camera distance from the reef (although three-dimensionality on their reefs still poses an interpretation problem). Our camera system "flies" on guy wires at a fixed distance above the reef. We address this scaling problem by putting a ping-pong sphere of known diameter on the sea floor in view of the camera to set the scale.

We propose to acquire and adapt the Australian image analysis system for use by the National Park Service for rapid, quantitative assessment of coral reef change in its underwater parks. I have seen this system demonstrated at the Seventh International Coral Reef Conference in Guam last June, and although there are many problems and bugs in their system, we feel that we can build on their initial effort to produce a highly effective, user-friendly system to detect coral reef community change.

We propose to establish three additional 25 m video transects on at least six more reefs such as Pacific, Elkhorn, Rubicon, Bache Shoals, and Alina's Reef to bring the total to four outer reefs and four inner patch reefs.

IV. Institutional and Staff Capabilities

The principles in this study are Dr. James W. Porter, Mr. Robert Cheney, and Ms. Sarah Lewis (C.V. attached). As you can see by the C.V. of Mr. Robert Cheney, we have, in our group, an extraordinarily well qualified individual to undertake the computer programming and video image analysis. We already have three years of video tape, of both the video transects and the photostations (1990 and 1991 before Hurricane Andrew, and 1992 after Andrew). These data are available to begin analysis immediately here at the University of Georgia. We will need BNP support for all boat work in the park (July-October, 1993, and July-October, 1994), plus Park divers and diving support for the use of the hydraulic drill, establishment of the new video stations, and re-survey of the existing video transects and photostations.

V. References

- Done, T.J. 1992. Constancy and change in some Great Barrier Reef coral communities: 1980-1990. *Amer. Zool.* 32:655-662.
- Kjerfve, B., K.E. Magill, J.W. Porter, and J.D. Woodley. 1986. Hindcasting of hurricane characteristics and observed storm damage on a fringing reef, Jamaica, West Indies. *Jour. Mar. Res.* 44:119-148.
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- Porter, J.W., J.F. Battey, and G.J. Smith. 1982. Perturbation and change in coral reef communities. *Proc. Natl. Acad. Sci. USA* 79:1678-1681.
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VI. Schedule of Project Milestones

Milestones	Completion Date
Establishment of Contract at UGa	June, 1993
Build <i>in situ</i> video system	June-July, 1993
Design , implement, and debug computer image analysis software	June, 1993 to July, 1994
Survey BNP for location of new video transects	July-August, 1993
Design , implement, and debug computer image analysis software	June, 1993 to July, 1994
Drill, set up, and photograph new video transects	August-October, 1993
Analyze Pre-Hurricane (1990 & 1991) and Post-Hurricane (1992, 1993) video transects	January-June, 1994
Resurvey video transects	August, 1994
Resurvey existing photostations (B&W, Color Slides, & Video	September, 1994
Analyze 1994 photographs and video	November, 1994 to June, 1995

VII. Budget

We propose a two year budget because we can complete the video image analysis system within that period. After this, the Park Service will be able to operate this system without assistance.

Our budget contains relatively few equipment purchases. This is because we already have much of the hardware needed, provided by a successful MacArthur grant through the SEAKEYS Consortium. Within two months of the start of the project, we will provide the Park Service with a list of equipment (video cameras, computers, TV monitors, frame-grabber boards, *etc.*) needed to run the system. We can then set these up for the Park Service as our computer software system comes on line in the project.

The budget is predicated on BNP providing boats and diving logistics while the investigators are in the park during the summers of 1993 and 1994. The budget is not predicated on the provision of housing in the park, however, the final budget will have to be determined only after a careful review of our housing options in South Florida.

Submitted To: NPS
Principal Investigator: James W. Porter
Budget Dates: 06/01/93 to 06/31/95
Budget Duration: 2 years

A. Salaries				
Senior Personnel (Monthly)	\$/mo	# mo		
a. J.W. Porter (1993-1994)	\$5,500.00	3	\$16,500.00	
b.			\$0.00	
Salaried Biweekly				
c. Res. Tech. I	\$1,800.00	24	\$43,200.00	
d.			\$0.00	
Graduate Students (RC/SL)	\$1,000.00	36	\$36,000.00	
Undergraduate Student (Hourly)			\$0.00	
SALARY SUBTOTAL			\$95,700.00	
B. Fringe Benefits				
Senior Personnel	Rate	Amount		
a. (>37K)	0.260	\$16,500.00	\$4,290.00	
b. (<37K)	0.270	\$0.00		
Salaried Biweekly				
c. (>15K)	0.330	\$43,200.00	\$14,256.00	
d. (<15K)	0.330	\$0.00		
Graduate Student	0.000	\$36,000.00	\$0.00	
Undergraduate Student (Hourly)	0.000	\$0.00	\$0.00	
BENEFIT SUBTOTAL			\$18,546.00	
C. Permanent Equipment				
1. Frame-grabber card system		\$2,800.00		
2. Hi-8 Time code corrector		\$2,500.00		
3.				
EQUIPMENT SUBTOTAL			\$5,300.00	
D. Travel				
1. FL Field work		\$18,000.00		
2. (2 trips, 1993 & 1994, 4 per., 3 mo.)				
TRAVEL SUBTOTAL			\$18,000.00	
E. Other Direct Costs				
1. Photo Processing / Video supplies		\$6,000.00		
2. Annual NPS diving physicals		\$3,000.00		
3. Camera/Computer Maintenance		\$7,500.00		
4. Australia Video Mapping Software		\$10,000.00		
SUPPLIES SUBTOTAL			\$26,500.00	
F. Total Direct Costs (A - E)			\$164,046.00	
G. Indirect Costs				
MTDC	NPS CPSU 10%	0.100	\$158,746.00	\$15,875.00
H. TOTAL COSTS			\$179,921.00	

Figure 4 Video imagery from Ball Buoy Reef (1991-92), BNP.

Figures 4a (1991) and 4b (1992) are from the Ball Buoy Reef Photostation pre- and post- Hurricane Andrew. Figures 4a & b show Frame 34 of the Video Photostation (see exact location of Frame 34 on Figure 2, insert). This video image is "grabbed" by a Data Translation Card, and printed through the Optimas Image Analysis System as demonstrated in the accompanying video. Note the abrasion and loss of tissue from the lower middle branch of *Acropora palmata*.

Figure 4 c & d are grabbed from the Video Transect and imaged in the same way as Figures 4 a & b. Figures 4c and 4d are from the rolling video transect (see enclosed 2-minute video clip), again "before" (1991) and two weeks "after" (1992) Hurricane Andrew.

The arrow in each frame (4c & 4d) denotes the reference point. The lower right area shows loss of coral.

Figure 5 Percent change (loss -, or gain +) in reef biota is plotted "before" and "after" Hurricane Andrew. Twenty randomly chosen x,y coordinates (Table 1) were counted on eight randomly chosen transect meter marks (Table 2) for the biota under the coordinate points (Table 3). The loss of *Acropora palmata* during the storm, and increase in fleshy algae after the storm, was easily detected with statistical confidence for this random counting process. Note the loss of *Acropora palmata*, and its replacement by fleshy algae.



Fig. 4a. Ball Buoy Reef-1991 Pre-Hurricane Andrew



Fig. 4b. Ball Buoy Reef - 1992 Post-Hurricane Andrew



Fig. 4c.
Acropora Reef - Video Transect Pre-Hurricane



Percent Difference of Each Group

1992 % Cover Value - 1991 % Cover Value

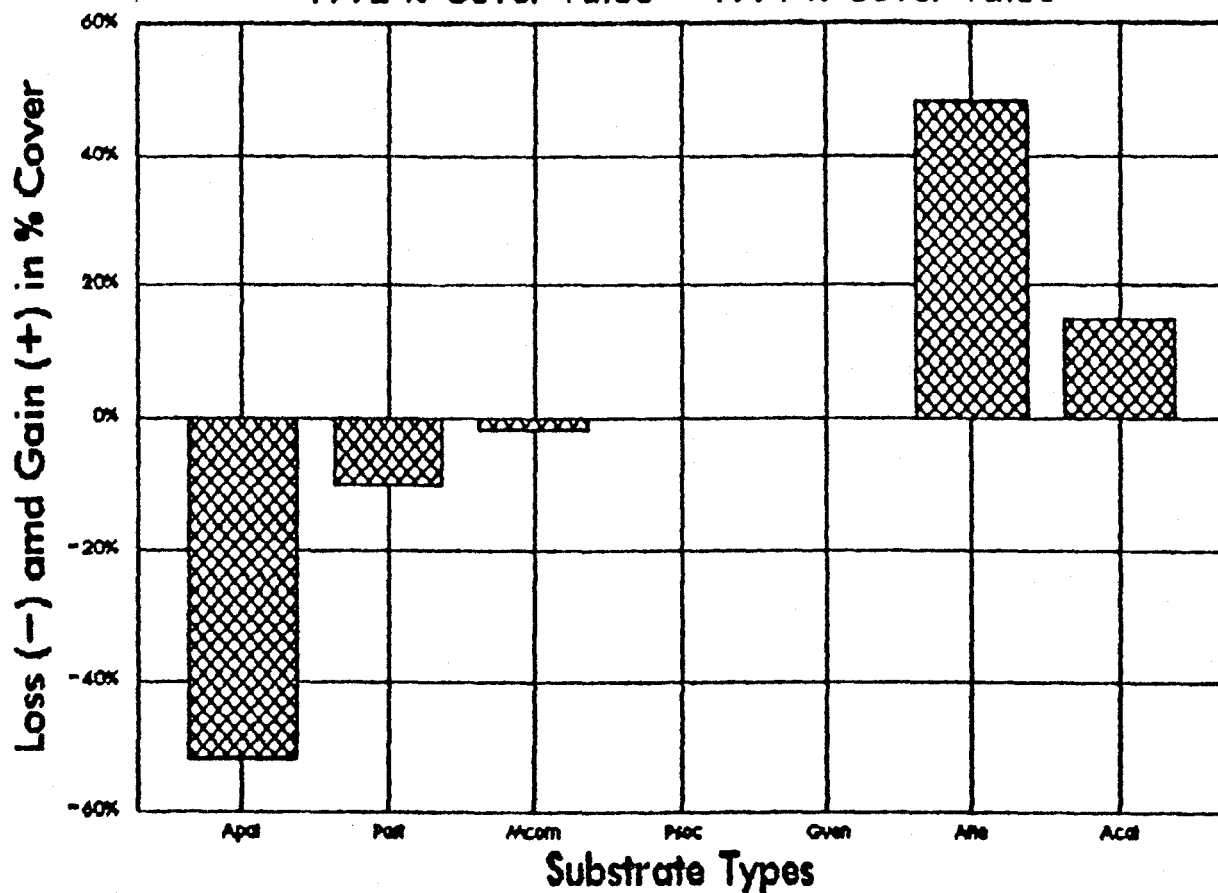


Figure 8. 5 Reef, Frame 12: Percent gained or lost after Hurricane Andrew.

Table 1. Random coordinates (1-10) for the point intercept survey of the Reef Video Transect

Random Coordinates: 20 pairs
Random Frames: 8 frames

Random X coordinates (1-10)

9 5 10 6 8 10 7 4 2 1 10 10 2 10 1 6 8 3 9 5

Random Y coordinates (1-10)

8 9 5 5 7 10 4 10 1 10 8 1 9 3 8 10 1 3 9 8

Table 2. Random frames (1-25) for the point-intercept analysis of the Reef Video Transect

Random Frames (1-25)

6 9 11 12 13 14 15 20

Table 3 Replicate counts (N=3), Reef Transect
Frame 12
1991 (Before) and 1992 (After) Hurricane Andrew

#	Cat.	1991			Avg.	Std.	1992			Avg.	Std.	Diff. (92-91)	Sig.
		Ct1	Ct2	Ct3			Ct1	Ct2	Ct3				
1	Apal	12	13	13	63.3%	2.4%	3	2	2	11.7%	2.4%	-51.7%	*
2	Past	3	2	2	11.7%	2.4%	1	0	0	1.7%	2.4%	-10.0%	*
3	Mcom	1	0	0	1.7%	2.4%	0	0	0	0.0%	0.0%	-1.7%	
4	Psoc	0	0	0	0.0%	0.0%	0	0	0	0.0%	0.0%	0.0%	
5	Gven	0	0	0	0.0%	0.0%	0	0	0	0.0%	0.0%	0.0%	
6	Afle	0	0	0	0.0%	0.0%	9	10	10	48.3%	2.4%	48.3%	*
7	Acal	4	5	5	23.3%	2.4%	7	8	8	38.3%	2.4%	15.0%	*
Tot:		20	20	20	100.0%		20	20	20	100.0%			

* (p > 0.05)

Categories

- 1 Acropora palmata
- 2 Porites astreoides
- 3 Millepora complanata
- 4 Palythoa sociatus
- 5 Gorgonia ventelina
- 6 Fleshy algae
- 7 Calcareous algae

ABRIDGED CURRICULUM VITAE

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PERSONAL INFORMATION:

Born: 5-October-1946

Wife: Karen G. Porter, Ph. D., Professor of Zoology, University of Georgia

RESEARCH AND SCIENTIFIC INTERESTS:

Population ecology, invertebrate zoology, marine biology, ecology of coral reefs, predator-prey dynamics, biological and historical origins of diversity, energy flow and food utilization in tropical marine ecosystems, biogeography of tropical marine organisms, sedimentation and pollution effects on coral reefs, systematics of the scleractinian corals, marine consequences of global climate change.

EDUCATIONAL EXPERIENCE:

B.S. (Biology) Yale College, New Haven, CT, 1965-1969

Ph.D. (Biology) Yale University, New Haven, CT, 1969-1973

EMPLOYMENT EXPERIENCE:

Graduate Coordinator, Ecology Degree Program, University of Georgia (1992 -)

Professor of Zoology (1985 - Present), University of Georgia, Athens, GA 30602

Curator of Invertebrates (1985 - Present), University of Georgia Museum of Natural History, Athens, GA 30602

Coordinator, University of Georgia Alumnae Foundation Fellows Program (1984 - 1987)

Biologist (1980), Environmental Protection Agency, Gulf Breeze, FL

Associate Professor of Zoology (1977 - 1984), University of Georgia, Athens, GA 30602

Assistant Professor of Natural Resources (1973 - 1977), School of Natural Resources, University of Michigan, Ann Arbor, MI 48109

Smithsonian Pre-Doctoral Fellow (1971-1972), Smithsonian Tropical Research Institute, Panama

Updated 12/93

FELLOWSHIPS, HONORS, AND SPECIAL AWARDS:

National Science Foundation Traineeship (1964)
National Science Foundation Undergraduate Research Participation Award (1968)
Honors in Biology (1969), Yale University
Smithsonian Pre-Doctoral Fellowship (1972-1973)
National Science Foundation Doctoral Dissertation Improvement Award (1972-1973)
John Spangler Nicolas Outstanding Doctoral Dissertation Award (1973), Yale University
University of Michigan Rackham Faculty Research Fellowship (1974)
Editor, Ecology and Ecological Monographs (1975-1980)
Woods Hole Marine Ecology Staff (Summers 1977 - 1979; 1986 - 1988)
Elected to the American Society of Naturalists (1978)
Elected as a Fellow of the American Association Advancement Science (1983)
Creative Research Award (1983), University of Georgia
Outstanding Educator Medal (1984), Gamma Beta Phi National Honor Society
Sandy Beaver Teaching Award (1988), University of Georgia

EDITORIAL BOARDS:

Editor, Ecology and Ecological Monographs (1975-1980)

SYMPOSIUM ORGANIZER:

Fifth International Coral Reef Congress, Papeete, Tahiti, 1985

MAJOR NSF OR NOAA FUNDED SCIENTIFIC EXPEDITIONS:

Chief Scientist, Johnson-Sea-Link Submarine Expedition, Tongue of the Ocean, Bahama Islands (1972)
Staff Scientist, Hydrolab Mission, Bahama Islands (1974)
Staff Scientist, R.V. Alpha Helix, Clarion Island Expedition, Eastern tropical Pacific (1974)
Staff Scientist, R.V. Alpha Helix, Visayan Sea Expedition, Philippines (1975)
Staff Scientist, R.V. Ackeron, Great Barrier Reef Expedition, Australia (1981)
Staff Scientist, Hydrolab Mission, St. Croix, U.S. Virgin Islands (1982)
Chief Scientist, R.V. Sea Hawk, Jamaica Fore-Reef Expedition, Discovery Bay, Jamaica (1983)
Staff Scientist, Hydrolab Mission, St. Croix, U.S. Virgin Islands (1985)
Chief Scientist, Aquarius Mission 88-3, St. Croix, U.S. Virgin Islands (1988)

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- 1982 Porter, J.W., J.F. Battey, and G.J. Smith. Perturbation and change in coral reef communities. *Proc. Natl. Acad. Sci., U.S.A.* 79:1678-1681.
- 1984 Porter, J.W., L. Muscatine, Z. Dubinsky, and P. Falkowski. Primary production and photoadaptation in light- and shade-adapted colonies of the symbiotic coral, *Stylophora pistillata*. *Proc. R. Soc. Lond., B* 222:161-180.
- 1985 White, M.W., and J.W. Porter. The establishment and monitoring of two permanent photograph transects in Looe Key and Key Largo National Marine Sanctuaries, Florida Keys. *Proc. Fifth Internat. Coral Reef Congress, Tahiti* 6:531-537.
- 1988 Porter, J.W., and N.G. Targett. Allelochemical interactions between sponges and corals. *Biol. Bull.* 175:230-239.
- 1989 Muscatine, L., J.W. Porter, and I.R. Kaplan. Resource partitioning by reef corals as determined from stable isotope composition: I. Delta 13C of zooxanthellae and animal tissue vs depth. *Mar. Biol.* 100:185-193.
- 1989 Porter, J.W., W.K. Fitt, H.J. Spero, C.S. Rogers, and M.W. White. Bleaching in reef corals: Physiological and stable isotopic responses. *Proc. Natl. Acad. Sci. USA* 86:9342-9346.
- 1992 Porter, J.W., and O.W. Meier. Quantification of loss and change in Floridian reef coral populations. *Amer. Zool.* 32:625-640.
- 1993 Porter, J.W., and C.S. Rogers. The metabolic cost of clearing sediments in three species of Caribbean corals. In Press. *Bull. Mar. Sci.*

RESEARCH GRANTS:

- NSF Grant, OCE-81-10918 (1981). Long term analysis of benthic population and community dynamics on a coral reef. J.W. Porter, PI/PD, 2 yrs., \$158,587.
- U.S.-Israel Binational Science Foundation Grant, 81-2390 (1981). Light intensity and nutrition of hermatypic corals. J.W. Porter, PI, Co-PI's: P. Falkowski, Z. Dubinsky, and L. Muscatine, 2 yrs., \$166,700.
- NSF Grant, OCE-83-00623 (1983). Temporary commensalism between benthic macroalgae and gorgonian corals. J.W. Porter, PI/PD, Co-PI: C. Slocum. 2 yrs., \$23,000.
- NOAA SURF Grant, SU-0583 (1983). Productivity of reef corals. J.W. Porter, PI/PD; Co-PI: L. Muscatine, 1 yr., \$85,000.
- NOAA Hydrolab (1984). Chemical interactions between corals and sponges. J.W. Porter, PI, Co-PI: N.M. Targett, 1 yr., \$8,625.
- EPA Grant, USVI-130 (1985). Analysis of the effects of pollution on Virgin Island coral reefs. J.W. Porter, PI/PD, 2 yrs. \$10,542.
- NSF Grant, OCE-87-18256 (1987). Nutrient sources and sufficiency for symbiotic zooxanthellae. J.W. Porter, PI/PD, 3 yrs., \$24,526.
- NPS Grant, USDI-NPS-25 (1988). Population biology of reef-building corals, Phase I. J.W. Porter, PI/PD, 1 yr., \$63,000.
- NSF Grant, OCE-88-05761 (1988). "Bleaching" in Caribbean reef corals. J.W. Porter, PI/PD, 1 yr., \$20,000.
- NPS Grant, USDI-NPS-00 (1989). Population biology of reef-building corals, Phase II. J.W. Porter, PI/PD, 2 yrs., \$43,000.
- MacArthur Foundation Grant, RR00207F (1989). Population biology of Floridian reef corals, Phase I. J.W. Porter, PI/PD, 2 yrs., \$98,000.
- MacArthur Foundation Grant, RR00207F (1991). Population biology of Floridian reef corals. Phase II J.W. Porter, PI/PD, 2 yrs., \$55,000.
- EPA Grant, X004931-91-0 (1991). The physiological effects of dredging on Charleston Harbor invertebrates. J.W. Porter, PI/PD, 1 yr., \$33,148.
- NSF Grant, OCE-93-18503 (1993). The physiology of sclerochronology: Mechanisms and variation in formation of the high density band in the massive coral *Montastrea annularis*. J.W. Porter, PI/PD, 3 yrs., \$120,000.

Resume for
ROBERT F. CHENEY
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Willow Springs, MO 65793
(417)469-3792

Job Goal: To gain further field work experience prior to obtaining an advanced degree in avian ecology.

Education

1983-1985 M.S. in Physics at the University of Missouri-Rolla
1980-1983 B.S. in Physics at the University of Missouri-Rolla
1983-1985 Physical Mechanics Instructor, University of Missouri-Rolla

Work Experience

Field Technician, The University of Rhode Island, Kingston, RI, March 1992 to October 1992

Research on the Black Rail including: bird capture, radio tracking, vegetation sampling, call-count surveys, data analysis, GIS, telemetry station construction

Riparian Restoration Project Manager, The Nature Conservancy, Stony Creek Preserve, CA, January 1991 to February 1992

Riparian forest restoration including: determination of mixture of dominants plants to be restored, determination of restoration techniques, vegetation monitoring, equipment operation, herbicide application, seedling propagation; Project management of riparian mitigation contract including: supervision of a crew of field biologists, budgeting, responsible for overseeing a one million dollar mitigation contract, equipment and materials purchasing, project reporting to both TNC and USFWS

Physicist, Naval Weapons Center, China Lake, CA, June 1985 to January 1991

Weapons system design and integration, construction and field testing of prototype weapon system components, computer modeling and simulation, management of a highly visible research and development project including: definition of work, supervision of multi-disciplinary team of scientists and engineers, timetables, funding requirements, project briefings to both the scientific community and Pentagon representatives

Volunteer Riparian Restorationist, The Nature Conservancy, Kern River Preserve, CA, June 1988 to January 1991

Tree growth measurement, data analysis, database management, field mapping and soil sampling, backhoe and tractor work
Surveys: Distribution of Mariposa Lily on the Kern River Preserve
Awards: 1989 Kern River Preserve Volunteer of the Year, The Nature Conservancy Special Achievement Award

Researcher, Wright Patterson Air Force Base, OH, May 1984 to August 1984

Solid-state physics research, two published papers at Gaseous Electronics Conference, Outstanding Researcher Award

Short-term Field Biology Experience

Bill Williams River, AZ, August 1990 - survey for nesting pairs of the Yellow-billed Cuckoo

Lake Isabella, CA, Spring and Fall of 1990 - twice yearly survey of migrating shorebirds for the Point Reyes Bird Observatory

Colorado River, CA, February 1990 - censusing of populations of winter-roosts of the California Leaf-nosed Bat

Kern River, CA, Summers of 1989 and 1990 - survey for nesting pairs of the Yellow-billed Cuckoo, vegetation plot sampling on restoration sites, census of breeding bird use of restoration sites

San Bernardino County, CA, Springs of 1989 and 1990 - Survey and behavioral observations of breeding birds in 3 mile by 3 mile plots

Desert Studies Research Center, CA, Spring, 1989 - Participant in mammal trapping techniques class

Skills

Bird identification by sight and sound, bird censusing, field data collection, vegetation monitoring, radio tracking, bird territory mapping, experimental design, data analysis by computer, computer modeling, report writing, supervision of field crews, project management, heavy/light equipment operation, vehicle maintenance,

Hobbies

Bird watching, recording of bird songs, volunteering at nature preserves

References

Mr. Ron Tiller
Project Manager
The Nature Conservancy
P.O. Box 1230
Hamilton City, CA 95951
(916)826-0847

Dr. William R. Eddleman
Dept. of Natural Resource Sciences
The University of Rhode Island
210B Woodward Hall
Kingston, RI 02881-0804
(401)792-5950

Dr. Steve Laymon
Director, Kern River Research Center
P.O. Box 990
Weldon, CA 93283
(619)378-3345

Mr. Courtney J. Conway
Dept. of Natural Resource Sciences
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(401)792-4558

Dr. David Burdick
Physicist, Naval Weapons Center
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SARAH K. LEWIS

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EDUCATION

Ph.D. program, September 1991-Present. University of Georgia, Athens, Georgia.
B.S., May 1989, Cornell University, Ithaca, New York
Undergraduate Grade Point Average: 3.4
Major: Ecology and Systematics
Honors: Dean's List, Regent's Scholarship at Cornell. Awarded highly competitive University-wide non-teaching graduate fellowship at University of Georgia.

ADDITIONAL EDUCATION

1992. Organization for Tropical Studies. Selected to participate in graduate level research-oriented field course in tropical biology and ecology in Costa Rica. Emphasis on developing, conducting and analyzing independent research projects.

1988. King's College, University of London, England. Obtained a six month Cornell Abroad study award in a competitive program to study biology.

1987. Shoals Marine Laboratory, Maine. Awarded scholarship for a summer field course in marine science to study organisms of New England rocky coastline. Culminated in research project to investigate the ecology of the vertical shoreline transition.

EXPERIENCE

Summer 1992. Florida Keys reef monitoring research with Dr. James Porter, University of Georgia. Photographed and videoed permanent quadrats for long-term monitoring survey on coral reefs in Looe Key and Key Largo National Marine Sanctuaries and Biscayne National Park. Also ran video along research transects. Surveyed Black Band Disease at Looe Reef. Assessed the impact of Hurricane Andrew on the Florida reefs.

Spring 1992. Discovery Bay Marine Laboratory, Jamaica. Research assistant for project on inducible defenses of gorgonians and differences associated with ontogeny.

Jan. 1991-Aug. 91. Section of Ecology and Sytematics, Cornell University. Tropical marine ecology research technician (Dr. Drew Harvell, supervisor). Morphological and chemical induction in the common Caribbean gorgonian *Briareum asbestinum*. Included transplant experiments, micro and macro habitat measurements, depth cline surveys, predator censuses and lab and field feeding trials. Field-equipment construction, lab and computer work and data analysis was performed in Ithaca and in San Salvador, Bahamas. Field work in the Bahamas using SCUBA and maintaining and running small boats. Underwater video filming of experiments.

1989-90. West Indies Laboratory, St. Croix, U.S.V.I. Marine biology research technician (Dr. E.H. Gladfelter, supervisor). Long-term coral reef monitoring project in conjunction with the National Park Service. Included monthly coral monitoring, quarterly fish censuses, underwater photography and resurveying cross-reef transects. Majority of field-work conducted using SCUBA and involved much small boat operation. Produced two field guides on the work conducted at Buck Island.

Summer 1989. West Indies Laboratory, St. Croix, U.S.V.I. Field assistant (for Dr. Robert Warner, UCSB). Behavioral studies on bicolor damselfish, involving dawn-diving and role of male parental care.

**TEACHING
EXPERIENCE**

1992-Present. Teaching assistant for medical and human anatomy at the University of Georgia.

1990. Conducted field-trips for grade-school children on ecology and marine biology of St. Croix.

1988-89. Competitively selected as a biology teaching assistant at Cornell University. Tutoring, teaching and testing students in introductory biology.

1987. Student advisor to incoming freshmen at Cornell.

LANGUAGE

Second language-French. Summer exchange student in Dieppe, France.

PERSONAL

Certified SCUBA diver. Circa 380 hrs. diving.
Karate, Horse-riding - Western and English. Cornell University Equestrian Team. King's College Women's Soccer Team.

PUBLICATIONS

Reference guide to long-term monitoring sites. Text by S. K. Lewis; photographs by K. French. - Mimeographed.

Coral monitoring conditions guide. Text by S. K. Lewis; photographs by K. French. - Mimeographed.

Jennifer Icy Tougas

Address: Department of Zoology
University of Georgia
Athens, GA 30605

Goals:

My lifetime goal is to responsibly and accurately bring science to the public through personal interactions and video. In the near future, I plan to finish a Masters degree in Zoology from the University of Georgia during Spring Quarter, 1994. I believe this will prepare me for my lifetime goal.

Education:

Formal Education

B.S. in Zoology from The University of Georgia, 1987-1991
M.S. in Zoology (2nd Year), 1991 to Present
Duke University Summer Course at DUML, 1990

Academic Honors

Dean's List Winter Quarter, 1991
Dean's List, Fall Quarter, 1990
Dean's List, Winter and Spring Quarters, 1989

Other Honors

Certificate of Appreciation, 1990. For contributions to Career Awareness Week
Certificate of Appreciation, 1990. For contributions to Brumby Residence Hall
Runner-up, Grace Thomas Award for Outstanding Undergraduate Zoology Students

Research Experience:

Research Assistant to Dr. James W. Porter.

Winter Quarter 1993. Responsibilities include analyzing settling tiles from Florida coral reefs, developing a video logging and editing system to be used next quarter, and partially supervising and directing the activities of a student worker.

Summer Quarter 1992. During this field season, we used SCUBA to photograph and video existing monitoring stations in the Florida Keys. Additionally, the settling tiles were collected and new tiles were established.

Spring through Fall Quarters, 1991. During the summer field season, we used SCUBA to re-establish photostations in Key Largo and Looe Key National Marine Sanctuaries. Line transect, video and photographic methods were employed to collect data. During Fall quarter, I printed black and white photographs, traced photographs, wrote computer manuals for the Biosis Superfile program and edited videos for use in the classroom and media.

Spring 1990. Work included establishing photostations and line transects, counting line transects, photograph photostations, video the videostations and video transects and record various underwater activities and life using the Hi8 video camera.

Student work program with Dr. James W. Porter

1990-91 Academic year. Work involved extensive computer work "crunching" data, digitizing photographs of coral reef monitoring stations, editing videos and designing equipment to be used with the underwater video housing.

Teaching Experience:

Athens YWCO Camp

Summer 1992. Environmental Adventures Activity Specialist. During the summer, I designed and implemented an active environmental education program for children ages 6 to 14.

Advanced Campcraft Activity Specialist. I taught advanced topics in camping to Counselors in Training and to senior campers ages 12 to 14.

Summer 1989 and 1990. Cabin Counselor. Principle responsibilities included supervising a cabin of campers ages 11 and 12 and teaching basic horse care and riding to campers of all ages.

Graduate Laboratory Assistant

Spring and Fall quarters, 1992. Introductory Biology for non-majors.

Responsibilities included conducting laboratories in introductory biology, leading summary discussions in the labs and creating and grading quizzes for the students.

Winter quarter, 1992. Responsibilities included preparing audio/visual equipment for lectures and conducting discussions and laboratory sections.

Publications:

James W. Porter, C.S. Rogers, O.W. Meier, R.C. Curry, Linda Chiang, J.I. Tougas and S.R. Smith. In Press. Quantification of coral reef change (Part 1): The establishment and computer analysis of permanent line transects in the Biscayne national Park, Florida. Seventh International Coral Reef Symposium (Sinajan, Guam). Abstract.

"Student studies in kelp beds, gains invaluable experience." The Red and Black. March 2, 1992.

"Audubon does more than watch birds." The Red and Black. May 5, 1992.

Video Productions:

Some of my coral reef video footage has been used by CNN and the BBC. This year, GPTV will also be using some of my footage.

"A Plant Culturing Technique". 1992. This is an instructional video used in the Biology 108 laboratories to demonstrate an aseptic technique to culture tobacco calluses.

"Underwater Jewel of the National Park Service." 1992. This video documents monitoring methods used on coral reefs in Biscayne National Park and addresses issues such as visitor impact and disease.

Extracurricular Activities:

Graduate School

President, Zoology Graduate Student Association, 1992-93 Academic Year
Zoology Representative to the campus wide Graduate Student Association, 1991-92 Academic Year
Video Coordinator, Zoology graduate Student Seminar Series, 1991-92 and 1992-93 Academic Years
Intramural Softball

Undergraduate

President, Seabrook Harbor, Brumby Residence Hall, 1989-90 Academic Year
Member of Presidential Council, Brumby residence Hall, 1989-90 Academic Year
Member of the Outreach and Publicity Committees for Career Awareness Week, Clark Howell Hall, Winter Quarter, 1990
Treasurer, Seabrook Harbor, Brumby Residence Hall, 1987-88 Academic Year
Intramural Softball and Flag Football

Hobbies and Interests:

SCUBA Diving, Photography, Pencil Drawing, Watercolor Painting, Horseback Riding, Softball

Grants:

NPS Grant, CA-5000-9-8020 (1993). Long-term Monitoring of the Coral Reef Organisms of Biscayne National Park: Larval Recruitment. J.W. Porter, PI, Co-PI: J.I. Tougas, 6 mo. \$6,000.