Winter 1989

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NSU Oceanographic Center

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Currents

Winter 1989 Volume III Number 1

ADJUSTMENTS MADE IN MARINE GEODESY

Dr. Georges Blaha, a marine geodesist, has been a Research Scientist with the Oceanographic Center since late 1977. He has been funded by the Air Force Geophysics Laboratory, which is interested in the determination of the geoid and the earth's gravity field. Knowledge of the gravity field, and especially of the marine geoid, is of prime importance to oceanographers as well, according to Blaha, "for example in the task of precise calculation of an ocean current." In general, the geoid determination is done by the adjustment of various geophysical quantities in linear or nonlinear models.

During the first eight years at Nova, Blaha used satellite altimetry in this task. For the uninitiated, the marine geoid is "essentially the idealized surface of the ocean," Blaha explains. "Idealized" in this case means that there are no effects such as waves, swells, or currents. "On land," he continues, "it would be an imaginary surface of ocean extending underneath the surface of the terrain."

Blaha is no longer using satellite data. During the past three years, he has been involved in the theoretical analyses of the least-squares method, beginning with linear models and continuing with nonlinear models of the quantities to be adjusted.

"In general," Blaha says, "various geophysical phenomena are modeled by chosen parameters, such as coordinates of points on the earth's surface, earth's potential coefficients, tidal parameters, etc. These parameters can be deduced from many kinds of measurements (for example, satellite altimeter data, angles measured on the earth's surface, elevations above sea level).

"However, measurements always contain errors and therefore need to be adjusted. The most widely accepted form of adjustment is what is called in the physical sciences the least-squares method. This kind of adjustment has the best properties in that it attributes the smallest corrections, in a certain sense, to the observations.

"The adjustment model that links the parameters to the observations may be linear or nonlinear," Blaha continues. "Both of these types can be represented geometrically by a surface embedded in a space. In the linear case, this surface is flat, i.e., a plane. In the nonlinear case, the surface is curved.

"In pursuing this research, generalizations must be made to a u-dimensional surface embedded in an n-dimensional space, where u represents the number of parameters and n represents the number of observations. There must be fewer parameters than observations (u smaller than n) for an adjustment to take place. This situation reflects the fact that a surface has fewer dimensions than the surrounding space. The geometric analogies (spaces, surfaces) can lead to formulas that have better properties than those derived by purely algebraic means."

Blaha's recent paper to *Bulletin Geodesique* features an example of a nonlinear model in which "four parameters were adjusted using six simulated observations (accordingly, u=4, n=6). The adjustment model expressed each observation as a third-order polynomial in the four parameters. In this example, initially errorless observations were at-

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Dr. Georges Blaha relaxes at the Center's boat basin.

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were attributed chosen errors. When the simulated errors reached a certain magnitude, the 'standard' solution (an algebraic formula) gave the correct result in four iterations, i.e., after four consecutive applications of the adjustment formula.

"On the other hand, the geometric formula recovered these same results in two iterations. When the attached errors were made much larger, the standard formula diverged (the results were unobtainable). For the same errors, the geometric formula still converged in two iterations. This indicates that the geometric insight offers avenues whereby a problem which is unsolvable using standard adjustment methods can be solved rapidly using geometric methods. This type of problem takes milliseconds of computer runtime on a PC, half a minute by the time it is printed."

Blaha emphasizes that the least-squares adjustment is the tool not only of oceanographers or geodesists, but of most physical scientists as well. In fact, last year the International Union of Geodesy and Geophysics (IUGG) adopted the study of nonlinear adjustment as one of its tasks, and has established a special study group to that end. Blaha is one of 16 scientists in this group, which was selected from a field representing seven different countries.

PEOPLE ON THE MOVE

Our lab was well represented at the annual Fall American Geophysical Union (AGU) meeting in San Francisco, December 5-9. **Dr. Julian McCreary**, Director, presented a poster entitled "A Numerical Investigation of Squirts and Eddies in the California Current System." **Dr. Gary Hitchcock** chaired three sessions on ocean optics and physics. **Dr. Gary Kleppel** presented a paper entitled "Zooplankton Diets in and around a Cool Water Filament off Central California." Dr. Kleppel also presented a poster, with graduate student **Carol Reese**, entitled "Pigments as Indicators of a Response to Environmental Changes in an Animal/Algal Symbiotic Relationship." Ph.D. student **Denis Frazel** also attended the meetings.

Dr. Kleppel attended a meeting in Halifax, Nova Scotia, later in December to plan a cruise to the Irish Sea at the end of April. The NSF-sponsored cruise will be in collaboration with the fisheries lab at Lowestoft, Wales. The science to be pursued will include fishes, zooplankton, and the physical properties of the regional waters.

Dr. Richard Dodge was in Washington, DC, November 27-30 to attend a Scientific Review Board meeting at the offices of the Minerals Management Service (MMS). Dr. Dodge is on the Advisory Board for a contract between the Smithsonian Tropical Research Institute and MMS.

Dr. Dodge maintained his MMS connection January 23-27 in Panama City, Panama, at a meeting of the Scientific Review Board. Under discussion were long-term effects of a recent oil spill on coral reefs, sea grasses, and mangroves. MMS is particularly interested in this spill because it occurred in the immediate vicinity of its research facility in Panama.

Dr. Russell Snyder spent two weeks in early December in Holland and West Germany, consulting with coworkers **Drs. Willem DeVoogt, Hermann Gerritsen**, and **Charles Calkoen** of Delft Hydraulics Laboratory (DHL), and with **Prof. Klaus Hasselmann** of the Max-Planck Institute for Meteorology (MPI). He gave talks at DHL, MPI, and the Dutch Meteorological Institute (KNMI), outlining plans for the coming wave experiments in the Bight of Abaco and reporting on recent computations of nonlinear wave interactions.

Dr. Gary Hitchcock presented two talks in January. On the 13th he spoke on "Export of Biogenic Carbon from Coastal Waters to the Deep Sea," at NOAA's Great Lakes Environmental Research Labs on the Ann Arbor campus of the University of Michigan. On the 18th he traveled to San Francisco, where he attended a symposium on physical/biological interactions and presented a paper on "Phytoplankton Dynamics in Relation to Mesoscale Physical Processes." The symposium was held in conjunction with the annual meeting of the American Association for the Advancement of Science (AAAS).

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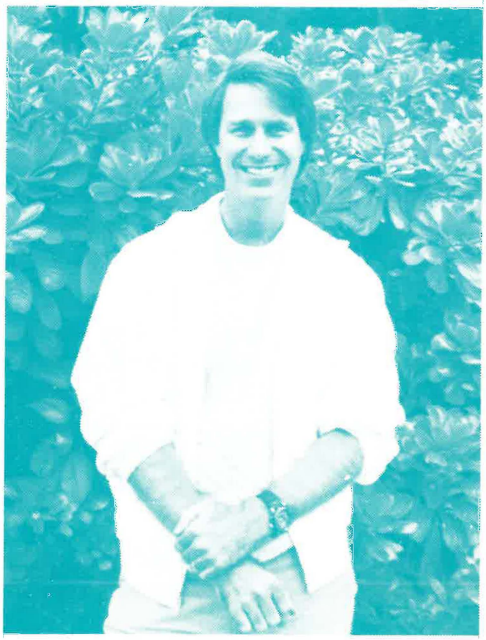
Holiday Gala Draws Crowd

As usual, the Oceanographic Center's annual holiday party was a hands-down success. Shown here are Nova President **Dr. Abraham S. Fischler** and his wife **Shirley**; **Mr. James Guerdon**, Vice President for Administration and Finance; and **Mr. John Santulli**, Director of Business Services.

SPOTLIGHT

A MOVEABLE FEAST UNDER STUDY



Dennis Landmeier takes a time out from reef work.

Ph.D. student **Dennis Landmeier** is actively researching a basic question that pertains to artificial reefs -- why are fish attracted to them? To help fill in the blanks, he has constructed and set in place a rather complex artificial reef array off Key Largo. Landmeier states that his structures are "of a proven design to attract primarily the species we're interested in -- specifically grunts and snappers."

Each of the 20 structures now in place is constructed of PVC pipe, measures 6 feet square by 3 feet high, has 4 central legs, and is underlain by concrete blocks. Twenty separate, identical concrete block reefs without the PVC members also are in place. Landmeier feels that the structure containing the PVC piping probably will attract a larger and more diverse community of fishes.

What sets this artificial reef apart from others is that not only can the reef be picked up and moved from place to place, but entire communities of varying species of coral will be transplanted beneath the reefs on the underlying concrete blocks. The moveable experiment will allow Landmeier to study the special trophodynamic (feeding) relationship that apparently exists between the corals and the fishes.

Landmeier became interested in this relationship while working with **Dr. Richard Dodge** on a coral growth study. In previous examinations of fishes that tend to reside among corals, it was always believed that the fishes derived the major benefits - food, shelter, and a place to reproduce. Then came the exciting idea, explains Landmeier, that "fishes actually could be contributing to corals by supplying nutrients." That idea then was expanded beyond what had been done in previous studies.

"If we take the corals and actually transplant them under the reefs, it allows us better experimental control," he continues. "If we want to move the corals away from the fish, we can. As a matter of fact, we can literally pick up the reef and move it away. This gives us the control over the fish community that other experimenters have not had." The reef design has proven successful in attracting a large number of fishes, "and we know that we can precisely quantify their populations on the reefs."

While studying fish behavior, Landmeier can look at coral activities as well. He is considering the possibility that both hard and soft coral growth can be stimulated naturally in an artificial environment. He uses a recent tanker accident in which extensive coral damage occurred over a reef in the Keys as an example of a practical application of this sort of "management tool." "Some coral transplantation actually has taken place on the reef," he explains. "But I look toward the possibility of coordinating coral transplantation with the reintroduction of fishes and invertebrates into an area. It is sort of like renourishing an area where there has been a forest fire. Nothing is being accomplished while a damaged reef is just sitting there, except extension of that damage into adjacent habitats."

Through this innovative experiment, Landmeier hopes to gain a better understanding of the interdependence between the benthic community and the diverse fish community. He especially wants to know how this relationship affects a natural reef. By manipulating the benthic structure of an artificial reef, he can study fish recruitment to his heart's content. He can transplant different kinds of corals to see just how the recruitment is affected. He can also control such factors as the height of surface areas by introducing huge brain corals, or by moving in a family of fragile sea fans. His method of transplantation can show "not only how different species affect fish populations, but also the effects of structure and size."

Landmeier hopes to be finished with his project by this summer. His wife Carol recently became an apprentice in training dolphins at a small marine park in the Keys, and since he aspires to being a behavioral ecologist, his research conceivably could be pursued in a marine park atmosphere. "Some happy combination would be nice," he concludes.

SOFT CORALS SEE RED

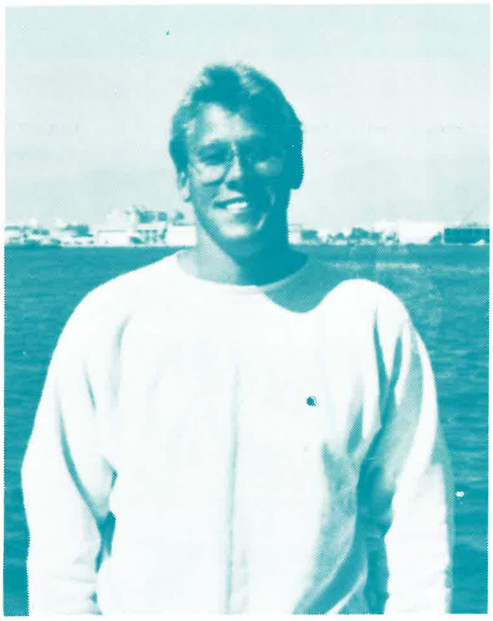
Kevin Kuta, an M.S. student working with **Dennis Landmeier**, is studying the effects of fishes on the growth of gorgonians, especially sea fans and bent sea rods. In particular, he is interested in finding out whether some of the fish under study, grunts and snapper as well as pelagic fish such as jack, actually cause these soft corals to grow faster simply by being associated with them.

Kuta is using at least two methods of measuring coral growth that have not been used in previous studies. One is a photographic technique that requires a specially designed framing device. Photos are taken at a predetermined distance from the subject gorgonian during each measured time period. The photos are studied and then compared with photos taken previously. Using a digitizer, Kuta is able to determine the amount of change in growth over time by measuring the change in area of the gorgonians.

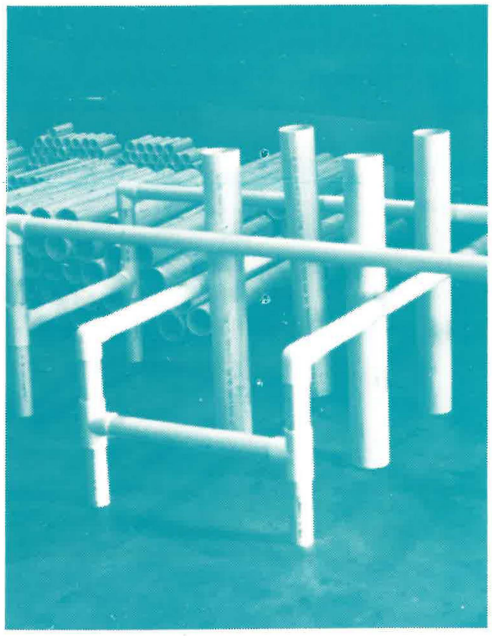
A second method uses an alizarin staining technique, by which the gorgonian skeleton is subjected to a red stain band essentially from stem to stern. At the end of a predetermined time period, the coral is cross-sectioned, and the extent of growth during that period can be easily determined.

Kuta's next objective - hopefully as a Ph.D. student - is to try to determine the mechanism of this increased coral growth, if indeed it does occur. "We know that it occurs in hard corals," Kuta says, "but no one has published any findings on soft coral growth studies such as this one."

Kuta feels that this is innovative research that definitely should be pursued. Apparently the directors of the Coastal Studies Institute agree. Both Kuta and Landmeier have received funds for this research from the Center's Karlan Conservation Fund.



Kevin Kuta, with Port Everglades as a backdrop.



Assemble artificial reef structure.

SPRING TERM SCHEDULE ANNOUNCED

The spring term will start on April 3. Each course is conducted during the evening from 6:30 to 9:30. Courses may be of interest to the layman as well as teachers interested in recertification. For additional information call (305) 920-1909.

Marine Geology (OC-5604). Topics range from fossil reefs to mid-ocean ridge basalts. Southeast Florida geology will be included in the lectures. Instructor: **Dr. Pat Blackwelder** (Center faculty). Starts Mon. April 3.

Tropical Marine Fish Ecology (OC-6120). Presents aspects of tropical fish ecology, including estuarine, mangrove, reef, and pelagic environments. A mandatory 4-day field trip to the Keys for fish population assessment is scheduled. Instructor: **Dennis Landmeier** (Center Ph.D. candidate). Starts Tues. April 4.

Marine Microbiology (OC-6055). Topics include the nature, activities, interactions, and ecological roles of marine bacteria and their heterotrophic microbial consumers in coastal and offshore environments. Instructor: **Dr. Curtis Burney** (Center faculty). Starts Wed. April 5.

Wetlands Ecology (CZM-TBA). Basic ecology of coastal (salt and fresh) wetlands, followed by intensive field work in the identification, delineation, and evaluation of young wetlands. Students will visit area wetlands to learn agency delineation techniques. At least 4 Saturday field trips will replace some evening classes. Instructor: **Dr. Bart Baca** (adjunct faculty). Starts Thurs. April 13.

M.S. STUDENTS SUCCESSFULLY DEFEND

On December 2, M.S. student **Peter Roopnarine** defended his thesis before his professors and peers as part of the Friday Seminar Series. His thesis title was "Geometric Analysis of Shell Morphology in the *nodi littorina ziczac* Species Complex."

Translated, this means that he evaluated the shell shape of a certain species of snail, the *ziczac*. Roopnarine has been determined to see whether shell shape is a good way to distinguish between the species and to learn how the shape of a snail is influenced by genetics and environment.

And what was his major finding? It was that shell shape is *not* a good way to distinguish between species, because it turns out that the shape is highly variable. It is, however, a very good indicator of environmental variables, such as wave action, temperature, and, most importantly, water productivity. The latter variable tells us how rich the water is in nutrients.

According to Roopnarine, one can compare shells from the same species but from different areas, and can sometimes tell whether there is a component of growth. "For example," he explains, "snails in Florida grow faster than in the East Caribbean, in the region of St. Croix." The reason is elusive.

"We don't know which environmental factor influenced the different shapes, only that different environments do lead to different shell shapes. Therefore," he concludes, "several species of closely related snails living on the same shore in the same environment will have similar shell shape, while two populations of the same species living under different environmental conditions will have different shell shapes." Having dispensed with shell morphology as a good species indicator, Roopnarine concludes that anatomical and biochemical means are the best ones to use.

Roopnarine has been accepted into the Ph.D. program in Paleogeology at the University of California at Davis, where he plans to use his newly acquired knowledge about shell morphology to interpret more accurately fossil material of snails and bivalves. He started small, he says, with a broad smile, and now he will be branching out.

Peter Roopnarine is all smiles at the completion of his thesis defense. He is flanked by members of his committee, Drs. Gary Kleppel and Nat Apter.

Kim Driver and guide dog Jessie, following a Friday seminar

M.S. student **Kim Driver** successfully defended her non-thesis option paper at a Friday Seminar, on December 30. Her work is entitled "Evidence of Electromagnetic Detection in Cetacea."

Cetacea is an order of aquatic mammals that includes whales, dolphins, and porpoises. Driver's literature survey indicates that cetacea use electromagnetic sensing for navigation and orientation. "According to theory," she explains, "it is presumed that there is some sort of magneto receptor in dolphins' and whales' brains that causes them to be able to sense the earth's magnetic field."

The mechanism is thought to use magnetite, which in most animals is a biogenically precipitated chemical. When found in rocks, magnetite is termed a mineral; in cetacea it is found in the dura of the brain - the part that separates the hemispheres - and is called a

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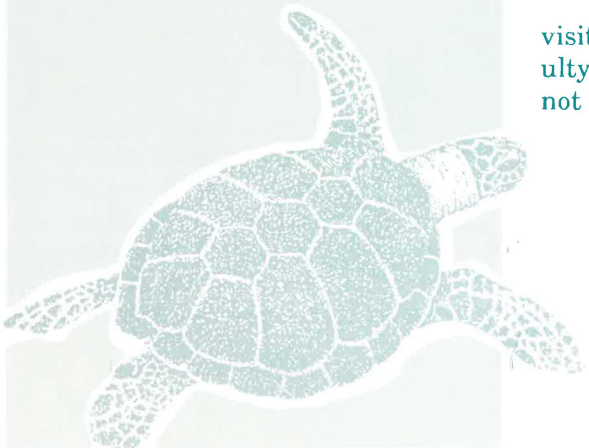
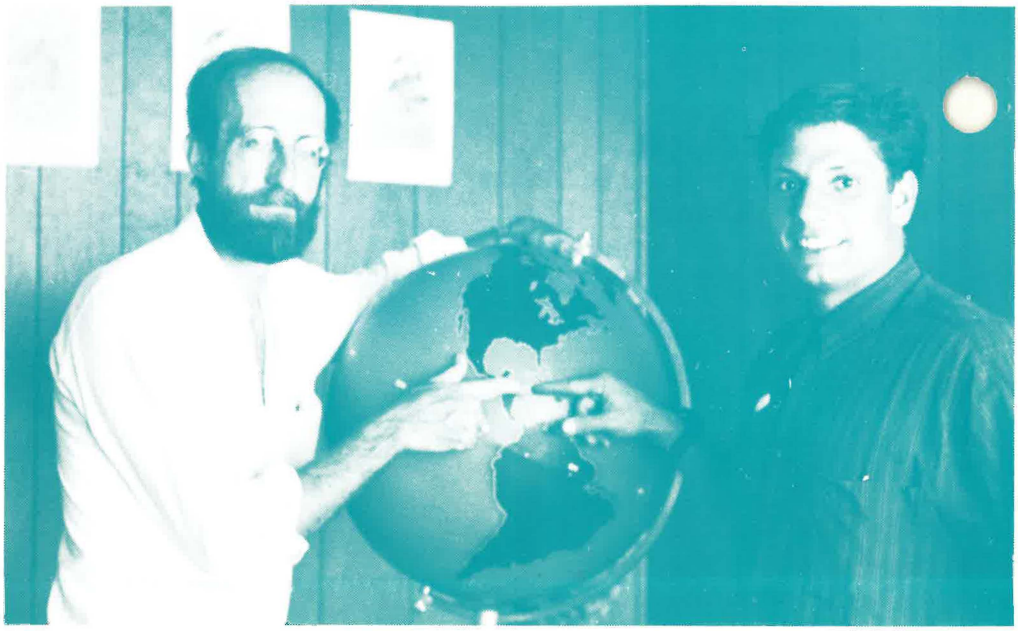
navigational aid. Driver says that this mechanism, which can provide a "map" or a "compass" for the cetacea, may be an instinctive, not a conscious, process.

In the literature and through talking with people in the field, Driver has found geological, physiological, and evolutionary evidence for her conclusions. For example, she has learned that most live strandings of cetacea occur in areas where there are major gradient changes in the earth's magnetic field. In other words, the magnetic field is at either a maximum or a minimum intensity, not at an average.

From an evolutionary standpoint, animals ranging from bacteria through higher species possess magnetite and show behavioral and physiological responses to the earth's magnetic field. "Humans have magnetite too, but we have come to rely on other resources to get around," Driver reasons. "But cetacea have fewer resources to rely on during migration. It would appear that any migratory creature, from monarch butterflies to Canada geese and green sea turtles, responds to changes in the earth's magnetic field." Alligators, Driver found, are the only species studied so far that do not possess magnetite, yet respond to magnetic field changes.

Driver, who navigates with the aid of her guide dog, **Jessie**, hopes to continue her studies at U.C. Davis in animal medicine. Armed with a B.S. in Psychology from Nova, a minor in zoology, and the pending M.S. in marine biology, becoming a veterinarian is the logical next step.





Dr. Richard Dodge and Peter Barlas pinpoint Grand Cayman's location.

STUDENT UPDATE

M.S. student **Peter Barlas**, a recent M.S. graduate specializing in coastal zone management, has secured a very promising position on Grand Cayman Island. He has been named Assistant Coastal Planner for the islands.

Barlas's attempts to get the job were fraught with anxiety. He had to wait several days while Hurricane Gilbert wreaked its considerable havoc across the Caribbean before he could get to Grand Cayman for an interview. As for his duties, Barlas explains that "the main goal of a Coastal Planner is to achieve a balance between preservation and sound development. I hope to create a more effective plan in the Cayman Islands through a reevaluation of their present plan and by incorporating the modern coastal zone management techniques that I've learned here at Nova."

Barlas has been promised many visitors to his island paradise -- by faculty, staff and fellow students who do not want him to feel island-bound.

WHERE ARE YOU?

We would like to hear from our alumni and from former faculty and staff members who have scattered to the four corners since leaving the lab. Please take a moment to fill us in on your whereabouts and recent activities. Also let us know whether or not you are on the *Currents* mailing list.

NAME_____

ADDRESS_____

_____

OCCUPATION/
ACTIVITIES_____

_____

_____

_____

_____

ALUMNUS?_____
YEARS_____

FACULTY/STAFF?_____
YEARS_____

ON *CURRENTS* LIST?_____

DIRECTOR ACCEPTS GIFT

Dr. Julian McCreary, Director, recently accepted a gift to the Center from **Dr. Nat Apter**, resident adjunct, and his wife **Valerie**, upon their return from the north. It is (was), we were told, a lobster claw.

The accompanying inscription reads: "This decorative piece, generated on the continental shelf of northern New England, was purchased for the Oceanographic Center in a restaurant in Rockport, MA, in honor of the Director's birthday. We trust that its huge eyes will watch over all of you, gently and aggressively." They do.

NEW GRANT AWARDS KEEP THE WHEELS GREASED

Several new grants and contracts have been awarded to Center researchers since last summer's listing. Many additional proposals are pending, and some are just sea dreams.

G. Blaha: "Non-iterative Least Squares Adjustment of Nonlinear Parametric Models in Geodesy," Air Force Geophysics Laboratory (2 years).

R. Dodge: "Broward County Beach Renourishment," Broward County (1.75 years).

G. Hitchcock: "Phytoplankton Abundance in Relation to Lagrangian Paths in the Gulf Stream," ONR (2 years).

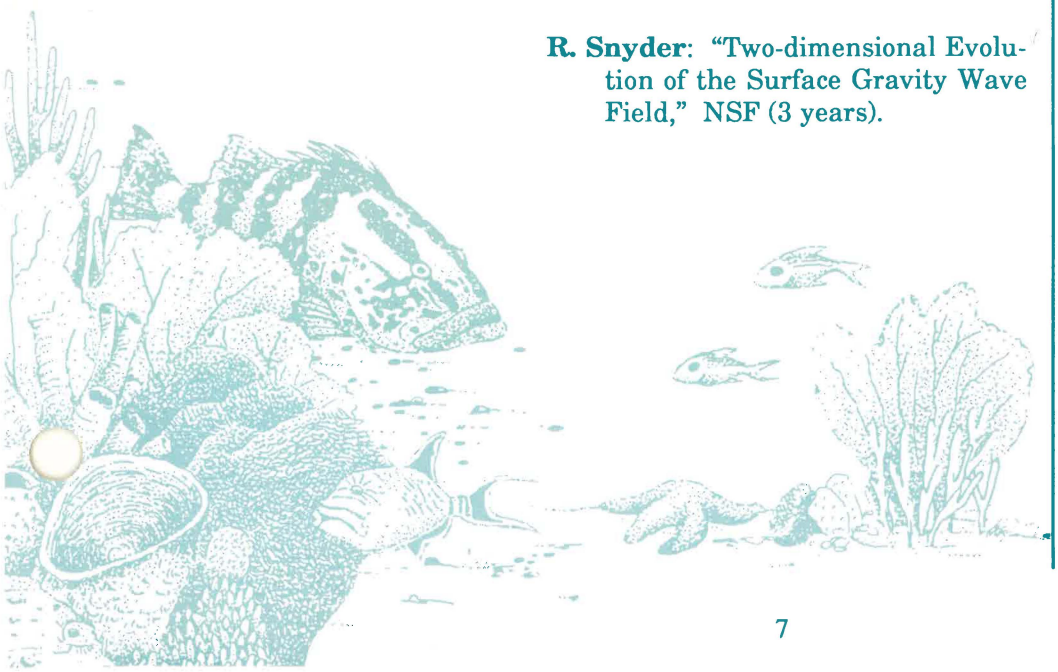
G. Kleppel: "Dynamics of Small-scale Distributions of Zooplankton," NSF (year 2).

G. Kleppel: "Fishery Recruitment in Florida Waters: Workshop," Florida Sea Grant (5 months).

J. McCreary: "Dynamics of the Instability of Equatorial and Coastal Currents," NSF (year 2).

J. McCreary/P. Kundu: "Modeling Tropical Western Boundary Circulation," NSF (3 years).

R. Snyder: "Two-dimensional Evolution of the Surface Gravity Wave Field," NSF (3 years).



FRIENDS STILL NEEDED

Many thanks to those who have responded to our request for new members of **Friends of the Oceanographic Center**. We must, however, expand our membership so that new donations will start to make a difference. We have revised the first **Friends** category to include individual contributors as well as students at the $25 level. If you would like to help us out by becoming a **Friend**, please return the form below to the Oceanographic Center. Thanks in advance.

FRIENDS MEMBERSHIP APPLICATION

YES! I would like to become a **Friend of the Oceanographic Center**. Enclosed is my check for $_____, payable to Nova University and marked "Friends."

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Dr. Julian McCreary presented an invited seminar at the University of Miami's Rosenstiel School on January 19. The title of his talk was "A Numerical Investigation of SST Variability in the Arabian Sea."

Dr. Gary Kleppel co-chaired a workshop at Live Oak, Florida, February 15-17. Sponsored by Florida Sea Grant College and the American Fisheries Society, the workshop's main focus was on predicting recruitment, or the survival of fishes to reproductive or fishable age.

During February 7-11, M.S. student **Catherine Mattison**, our "turtle lady," attended the Ninth Annual Sea Turtle Workshop at Jekyll Island, Georgia. U.S. and foreign researchers discussed the current status of sea turtle studies and plans for the continuation of ongoing projects.

In early March, **Jan Witte** coordinated a meeting of about 40 investigators in NOAA's Tropical Ocean Global Atmosphere (TOGA) program. The meeting was held in Honolulu and was hosted by former Center director **Dr. Dennis Moore**, of the University of Hawaii.

Honors

Dr. Russell Snyder has accepted an invitation to serve a three-year term as Associate Editor of the *Journal of Physical Oceanography,* published by the American Meteorological Society. The other Associate Editors are **Dr. Peter R. Gent** of NCAR in Boulder, Colorado, and **Dr. Eli Joel Katz**, of Lamont-Doherty Geological Observatory in Palisades, New York.

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