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UMASS MARINE
The University of Massachusetts Graduate School of Marine Sciences and Technology

The marine graduate school moves forward in year two

– a message from the Dean

Welcome to the premier issue of *UMass Marine*, the newsletter of the University of Massachusetts Intercampus Graduate School of Marine Sciences and Technology. Those readers who have in the past received the publications *Currents* and *Fisheries and Oceanography Dispatch* will recognize a continuity of mission in *UMass Marine*: to keep our constituents informed of the marine research, education, and outreach being conducted by our state university. But with the establishment of the new multi-campus graduate school, our coverage now expands to encompass the entire University of Massachusetts system.

I use the word 'constituents' deliberately. As a public institution, we are charged with serving the state and its citizens. And each campus has its own particular areas of marine expertise to contribute, such as natural resources and remote sensing at Amherst; harbors and biogeochemistry at Boston; engineering and meteorology at Lowell; fisheries and modeling at Dartmouth. And the Medical School at Worcester offers new potential in the areas of marine pharmacology and genomics. The new graduate school integrates the respective marine strengths of the individual campuses; only by doing so could we have launched such a robust program.

Dean Rothschild (left) receives the American Institute of Fisheries Research Biologists (AIFRB) Outstanding Achievement Award from AIFRB President, Richard H. Schaefer.

Having completed our first year, Associate Dean Bob Gamache and I have a chance to catch our breath and look back at what has been accomplished as well as ahead to where the graduate school is going. We now have twenty graduate students enrolled in five option areas. The "virtual togetherness" of distance learning technology has become a routine part of our program, permitting students and professors scattered among the campuses to sit "together" in the same class and interact freely. We are part of the new Massachusetts Marine Fisheries Institute, which will engage our faculty and students in research alongside the applied scientists of the Division of Marine Fisheries.

With crises seemingly at every hand – from declining fisheries to estuarine degradation to global climate change – there has never been a greater need for attracting talent to the marine fields and nurturing that talent with the best training possible. There has never been a greater need to apply innovative and rigorous scientific research to the questions that underlie those crises, and to extend the results of that research to the broader community. These are the missions that the IGSMST has set for itself.

UMass Marine will report to you on the progress of these missions. In the pages of this first issue, you'll find a sampling of the kinds of marine research that are going on around the UMass system and the graduate students involved in every phase of that research.

The production values of *UMass Marine* are quite consciously modest, but with greater frequency of publication and the support of a host of informative websites, we intend to do a better job than ever of telling our story. Let us know how we're doing.

Brian J. Rothschild

Amherst lab joins nearshore experiment

AMHERST — Researchers from UMass Amherst's Microwave Remote Sensing Laboratory (MIRSL) are helping oceanographers understand the complex forces that motivate water movements close to shore.

Last fall, MIRSL Director Steve Frasier and a group of graduate students took two radar instruments to San Diego to participate in the biggest nearshore oceanography experiment of the decade. NCEX, or Nearshore Canyon Experiment, is a multi-institutional attempt to bring the understanding of nearshore physics to a new level.

Graduate student Gordon Farquharson prepares radar instrument for NCEX field experiment.

"We're hoping to use radar techniques to measure nearshore circulation within and beyond the surf zone," says Frasier. "This is an area that the radar community hasn't put much focus on to date."

"We're pretty good at the one-dimensional case," says Steve Elgar, a Professor at Woods Hole Oceanographic Institution and lead investigator for NCEX. Elgar is referring to sites like Duck, North Carolina, where nearshore oceanographers conducted their major experiment of the 1990s. The beaches at Duck, with regularly sloping bottoms and nearly uniform waves, provided a manageable

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Amherst lab

test of the models which scientists had developed to that point. Now they're ready for a site that raises the bar, and the Black's Beach area near San Diego is such a place.

"It's a washing machine out there," says Elgar. Underwater canyons, riptides, and cross-currents make for a patchwork of regimes at the Black's Beach site. Riptides reverse direction; interacting currents combine forces or cancel each other out; surfers are tossed about by powerful breakers in one spot, while 500 meters away young children are learning to swim in glassy water. Sorting out all these forces will depend on high-resolution, quality observations.

"Steve Frasier's radars image the surface in exquisite detail," says Elgar. "We have sensors about 100 meters apart, and if a 10-meter riptide is shooting by, we can miss it, but Steve will pick it up."

The X-band radar instruments were adapted by MIRSL professors, staff, and students from a Raytheon high-seas radar. The instruments send out beams that reflect off surface wavelets and return, in effect, instantaneously, carrying with them information about the velocity of the wavelets. Taken together, the returns yield a "map" of surface motion over some 50,000 square meters of ocean.

Read more about the Nearshore Canyon Experiment at:
http://science.whoi.edu/users/elgar/NCEX/ncex.html
and the Microwave Remote Sensing Lab at:
http://www.umass.edu/mirsl

With the field work essentially complete, the next few years will be dedicated to data analysis and model development. An accident which occurred during the NCEX field work provided a convenient example of the models' potential applications.

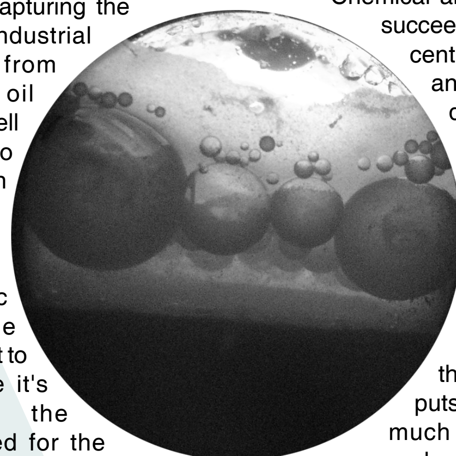
Some 130,000 gallons of sewage spilled near the field site, and environmental managers were stymied. "They had no idea where [the spill] would go," says Elgar, "so they simply shut down all the area beaches," an expensive proposition in itself, not to mention the negative ripple effects on the local tourist industry.

It is such costly – both economically and environmentally – repercussions that oceanographers hope to minimize with the next generation of nearshore models. Everything from water transport to fisheries to environmental management stands to benefit from their success. §

Deep-sea storage of anthropogenic carbon dioxide

LOWELL — If there is one thing we've got too much of, it's carbon dioxide: global emissions are estimated to exceed 25 billion tons annually. And CO_2 is well known as the mother of all greenhouse gases, leading the list of contributors to global warming.

Technologies for capturing the carbon dioxide from industrial discharges, such as from power plants and oil refineries, are "fairly well established," according to Professor Emeritus Dan Golomb of the UMass Lowell Department of Environmental, Earth and Atmospheric Sciences. But the question remains of what to do with the CO_2 once it's captured. Among the repositories considered for the storage, or sequestration, of carbon dioxide has been the world ocean. The capacity of the deep ocean to absorb CO_2 is enormous, and if discharged at sufficient depth (thought to be 1000 meters), the CO_2 would not re-emerge into the atmosphere for centuries.



Globules of liquid CO_2 coated with a sheath of limestone particles, viewed through window of the high-pressure cell which produces the emulsion.

However, the obstacles to deep-ocean discharge of CO_2 are manifold: (a) significant volumes around the discharge point would become acidified, harming marine organisms; (b) the deeper the discharge, the more expensive the transport costs; and (c) acceptable discharge sites are not accessible to many coastal sites of industrial continents.

Golomb and his co-investigators at UMass Lowell are pursuing a scheme that would address these problems. Funded for two years by the Department of Energy, their research involves creating an emulsion of liquid CO_2, water, and finely ground limestone ($CaCO_3$). Investigators estimate that the emulsion, which is much denser than seawater, would sink from a discharge point at about 500 meters to greater depths, most likely to the ocean bottom. Since carbon dioxide reacts with $CaCO_3$ to form calcium bicarbonate, which is soluble in water, the dissolved calcium would be available to be used by aquatic organisms, and the bicarbonate would remain sequestered in the ocean indefinitely. Finally, the emulsion plume has a higher pH than a pure liquid CO_2 droplet plume, which addresses the problem of acidity.

In the first year of work, Golomb and his team - Profs. Eugene Barry and David Ryan, both from the Department of Chemistry, and Prof. Carl Lawton and Research Assistants Peter Swett and John Hannon, all from Chemical and Nuclear Engineering - succeeded in demonstrating their central hypothesis: that such an emulsion released in the deep ocean would sink to the ocean bottom without acidifying the surrounding water.

In the second year, the investigators will be refining the work in two respects. First, they want to quantify the yield of their emulsion. As Golomb puts it, "In other words, how much $CaCO_3$ do we need to make a stable emulsion?" Their other objective is to determine the optimum size for the $CaCO_3$ particles. "If the particles are too big, they won't stick to the droplets; if they're too small, they won't make the CO_2 droplets heavy enough to sink, and they'll fizz up to the surface like champagne or Coca-Cola." Both questions must be answered before the emulsion scheme moves to operational development.

Golomb points out one additional objective. "Marine biologists expressed serious reservations about the idea of discharging pure liquid carbon dioxide into the ocean," he notes. "We'd like to demonstrate to the biologists' satisfaction that ocean discharge and storage of CO_2 with our emulsion is harmless." §

Visit the Center for Complex Environmental Systems web site at:
http://www.uml.edu/centers/ces

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Researchers assess "fallout" from 9/11

BOSTON — In 1985, Curtis Olsen, then a researcher at the Oak Ridge National Laboratory, travelled to Pearl Harbor as part of a team assessing the environmental impact of a half-century of U.S. Navy operations there. To take measure of that impact over time, the investigators turned to the sediments.

Sediments are natural record-keepers. Suspended particles scavenge substances from the water column and carry them to the bottom, where they may be buried and preserved until disturbed–in this case, by curious scientists. By taking core samples of the bottom sediments at selected sites, and determining the age and composition of the sediments–section by section–down the length of the cores, Olsen's team sought to document a modern history of the harbor.

Much of the history revealed by the sediments was unexceptional. But in a core from an undisturbed part of the harbor, concentrations of a number of species were abnormally high in a 4-centimeter section set between 1930 and 1950. This was the trace left by the December 7, 1941, Japanese attack

and its aftermath.

What was dramatic about the "geochemical fingerprint" of the attack was its scale. For example, Olsen points out, "That one bombing event introduced more lead into the harbor than did the following 50 years of naval operations and sewage disposal."

Nearly 20 years later, now a professor at UMass Boston, Olsen was called to the site of the World Trade Center attack. Once again he found himself at the scene of a great catastrophe, leading a team charged with characterizing its impact on the local harbor.

But the two situations had striking differences. In the case of the World Trade Center, Olsen was on the scene weeks, rather than decades, after the attack. Second, unlike the Pearl Harbor case, the terrestrial component of the 9/11 fingerprint was scattered for blocks around "ground zero." So the team sampled the ash and debris, characterized it chemically and then attempted to document its presence in the sediments of the harbor.

Recalling his Pearl Harbor experience, Olsen added another dimension to the investigation. He remembered that the sediments deposited following the December 1941 attack had a distinct oily and gritty texture. Could a textural signature also be identified for the WTC event?

Read more at:
http://www.es.umb.edu/

It turns out that it could. Says grad student Joseph Smith, who took part in the study, "The WTC ash and debris had a distinct fibrous texture contributed by high concentrations of such elements as calcium (from gypsum) and silicon (from fiberglass). Fibers from the WTC parent material were readily identifiable in New York Harbor sediments that were deposited shortly after the attack, providing a second line of evidence to cross-check with our chemical analyses."

Naturally occurring radioactive isotopes were used to corroborate that sediment sections containing the fingerprint were deposited on, or shortly after, September 11, 2001. The fission-produced radioisotope iodine-131 was also detected in the surface sediments. Iodine-131 is used in medicine, notably with thyroid patients, and was likely introduced to the harbor via the municipal wastewater system from local hospitals and clinics. Its very short half-life (~8 days) makes iodine-131 potentially a very precise (week-to-month) tool for documenting the effects of very recent episodic events such as the WTC attack.

Although motivated by a catastrophe, the WTC investigation is advancing the methodologies of sediment textural analysis and the use of novel tracers such as iodine-131 in estuarine work. §

Continued from back cover

Scallop survey dividends

"Over the same area, we saw significant densities of sea stars, almost like a mat covering the sea floor. Could sea star predation be part of the explanation for the 'missing' 40 million pounds?"

"Mike was preparing his research on the basis of data from previous cruises," says Stokesbury, "but this new data are so good that he's trying to incorporate them into his work."

Student Jake Nogueira is studying the stock-recruitment relationship in the scallop fishery. "On the one hand," he points out, "it's understood that if there are too few scallops, they can't reproduce. On the other, high densities can have negative effects on recruitment." Using the video stock from the survey, Nogueira is examining the density of juvenile versus adult scallops. "One of the interesting observations that we made this summer was to witness a 'recruiting event'. In a particular part of the mid-Atlantic we found as many as 100 juvenile scallops per video scan, an area of less than 3 square meters. This could be a scallop 'nursery'."

"The focus of my lab is on integrating biological science and fisheries science," says Stokesbury, "and Jake's research is a combination of the two. It will benefit his work that we have a broader range of scallop densities than anyone's ever had before. But we also have actual images of the sea floor that he can measure on a scale of centimeters."

Research experience such as this is "one leg of the tripod" for IGSMST graduate students. Quality courses are equally important. "For example," says Marino, "I'm taking a fish population dynamics course that is team-taught by scientists from the National Marine Fisheries Service. Classes like that at UMass—which you don't find on many campuses—should attract a lot of students." The third leg is interaction with present and future colleagues, so students in Stokesbury's lab are expected to participate in professional meetings—both scientific and regulatory. Says Nogueira, "The experience I'm getting here—between the classes, the field work, and professional meetings—is an ideal setup for me." Echoes Marino, "I wouldn't give it up for anything. It's a really good balance." §

Visit the scallop research web site at:
http://www.smast.umassd.edu/Fisheries/Scallops/

Graduate students Mike Marino and Brad Harris tagging scallops.

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Scallop survey pays educational dividends

DARTMOUTH — Last summer, fisheries scientists from the University of Massachusetts Dartmouth, along with research partners from the commercial fishing industry, conducted the most comprehensive survey of the Atlantic sea scallop resource ever undertaken. The unprecedented extent of the survey, the innovative video sampling system used, and the unique collaboration among commercial industry members, the University, and the state made the survey national news. Perhaps owing to the survey's repercussions for scientists and fishermen, a third group of beneficiaries were nudged off the front page: students.

"There were graduate students on every survey cruise last summer," says Prof. Kevin Stokesbury, head of the Fisheries Science Lab at SMAST and director of the scallop surveys. "We also train undergraduates in the lab, two or three every year. We even sometimes have high school students working with us—there were three on last summer's cruises."

Mike Marino is one of the IGSMST graduate students who participated in the scallop survey. He has a grant through UMass Amherst to investigate the predator/prey relationship between sea stars and scallops. "In one area, which had been estimated to have nearly 100 million pounds of scallops, we actually found only about 60 million," he recalls.

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