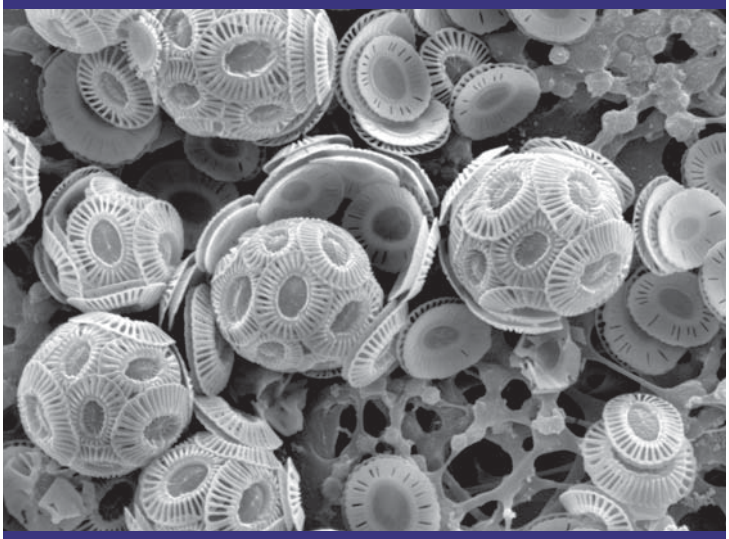
ROMBERG TIBURON CENTER

bayside

San Francisco State University's Field Station on the Bay • Romberg Tiburon Center for Environmental Studies • Fall 2009



Above: Scanning electron micrograph of the coccolithophore Emiliania huxleyi *and its calcareous shell.* E. huxleyi, *an important member of the marine phytoplankton community, forms plates of calcium carbonate, the so-called "coccoliths" to cover its cell.*

The RTC Mission

To advance understanding of the world's complex marine and estuarine environments through research, education, and outreach, with a focus on San Francisco Bay.

Ocean Acidification - RTC scientists work together to investigate the environmental consequences

The environmental issue of ocean acidification has recently been the focus of much attention in the media and the scientific world. The ocean has absorbed about one-third of the carbon dioxide (CO_2) produced by human activities since the beginning of the industrial age. The increase in CO_2 concentration in seawater leads to ocean acidification, which involves an overall decrease in seawater pH. Normal pH of seawater is about 8.2 on a scale of 0 to 14, slightly basic or alkaline. Seawater pH is expected to decrease to 7.8 by 2100. While this may not seem like a significant change, pH is on a logarithmic scale, so a 0.4 change is actually four times more acidic. Ocean acidification is also decreasing the carbonate ion (CO_3^{-2}) concentration of seawater through chemical reactions. Many organisms use carbonate to form shells or shell-like structures. These are known as calcifying organisms. Calcifying organisms such as coral, shellfish and other ocean life are sensitive to changes in carbonate chemistry. However, neither the extent of this sensitivity, nor its physiological basis is well understood.

Here at Romberg Tiburon Center, several scientists in three of our diverse laboratories are investigating how organisms that form shell-like structures might be affected by ocean acidification. Drs. Carpenter, Stillman, and Komada and their colleagues are engaged in a $1.2 million NSF-funded collaborative study of how such calcifying organisms, in particular the phytoplankton species *Emiliania huxleyi,* acclimate and adapt to changing ocean conditions.

The coccolithophore *E. huxleyi* was chosen as a study subject for many reasons. It is the most abundant calcifying phytoplankton species in the ocean. It is capable of growth at a wide range of salinities and temperatures. Its cells divide once or twice a day, allowing for constant regeneration of the experimental culture and potentially producing up to

continued on page 4...

SAN FRANCISCO STATE UNIVERSITY

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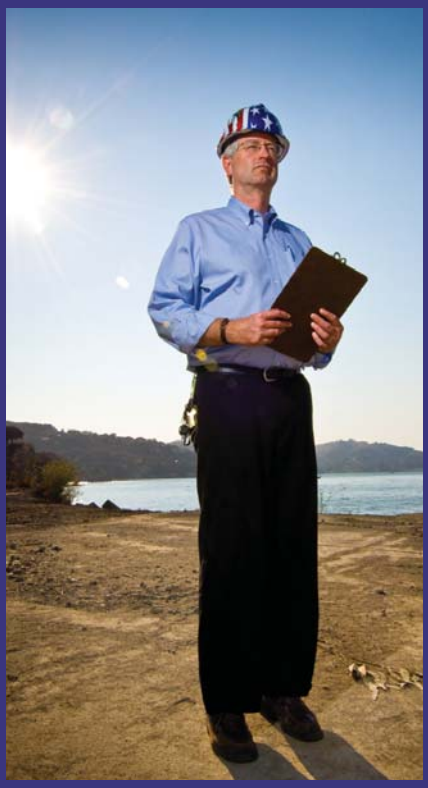

ROB O'DEA

RTC Director Garfield envisions the future of the North Dock, one of the waterfront areas on the 35-acre site. Guided by the master plan feasibility study, he will be raising funds to make site improvements a reality.

bayside

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Message from the Director

Greetings from the Director's Office. As I write, I can watch the hustle and bustle of the research activity at our bayside waterfront. Students working at the greenhouse and seawater tanks. RTC seawater technician, Chanh Rattana, checking the pumps, ensuring that there is a proper sea water supply flowing to the dozens of research projects. The Research Experience for Undergraduates (REU) students arrive to begin another day of lab and fieldwork. Beyond the bulkhead, the San Francisco Bay provides an ever changing backdrop – fog, fishing pelicans and sea lions, the occasional whale, fishing and sailing boats, high speed ferries and mammoth commercial ships – all superimposed on the spectacular landscape.

Each day the interaction of nature and man underscores the importance of the Center's research. Ocean acidification is one of the most damaging, but least discussed, consequences of increased carbon dioxide (CO_2) in the atmosphere and ocean. One of our NSF-funded projects, called EnGen, is looking at the response of one of the major ocean calcifying phytoplankton, coccolithophores, in lowering oceanic pH. Leading this program are Professors Carpenter, Komada and Stillman. [See the cover article to learn more about ocean acidification.]

RTC reached a milestone this spring; the 100th graduate student to conduct research at the Center obtained a SF State masters degree. Our graduate students are extremely talented, as demonstrated by their impressive record of scholarships and awards. Stephanie Kiriakopolos is finishing her Achievement Rewards for College Scientists (ARCS) scholarship. Tricia Goulding and Gavin Archbald have also been awarded this prestigious scholarship for the 2009 academic year. SF State is the only non-PhD granting institution in the ARCS program, and only six scholarships are available to SF State. The fact that two of the six scholarships were awarded to RTC students is an indication of the high caliber of our students. This spring we also celebrated the achievements of three of our undergraduate students. We are very proud that RTC has increased the number of undergraduate students conducting senior research at the Center.

Faculty and staff achievements likewise show the strength of RTC. Kathy Boyer and Sarah Cohen were both promoted to Associate Professor of Biology with tenure. Raman Paul moved from his Administrative Coordinator position to be our Grants Administrator, and Jennifer Viale is the new Administrative Coordinator. Linda Mayo joined the RTC staff as the Operations Director. And, Brita Larsson won the College of Science and Engineering Eden Staff Award for outstanding service to students and faculty. The RTC community was unanimous in nominating Brita for this award, and we extend well-deserved congratulations!

RTC hasn't been immune to the State's financial woes. In December, the stop-work order on all bond-funded research impacted many of our programs including seagrass restoration, Delta environmental studies, and deployment of instruments to measure surface currents. Despite these major setbacks, RTC continues as a thriving creative hub of SF State.

With this edition of the *bayside* we have changed our look and welcome your comments and suggestions. To share your thoughts in person, or to experience RTC and the sounds and beauty of the Bay firsthand, be sure to join us at our Discovery Day Open House on October 4.

Hope to see you there,

Toby Garfield

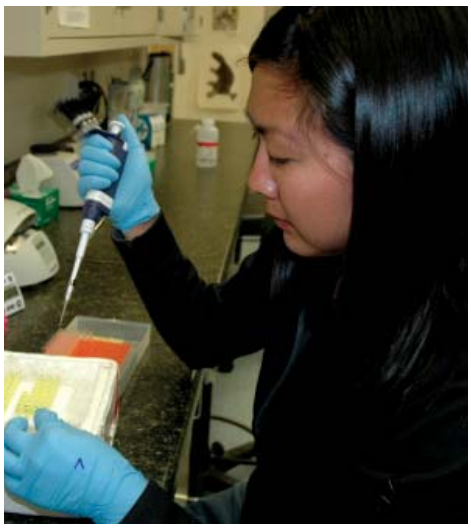
Graduate Student Profile: *Verena Wang*

Verena Wang will soon earn her MS in Marine Biology after three years of research at RTC. In addition to being president of the RTC Student Association, Verena also took part in outreach activities for the Center, and was the recipient of numerous awards, including the Sea Grant Traineeship, RTC Bay Scholarship, and the Tyee Club Scholarship. *bayside* recently conducted an email interview with Verena who was travelling in China.

Tell us about your research at RTC. My thesis research is a bit of a spin-off of the big tunicate (sea squirts) project that Dr. Sarah Cohen is conducting in her lab. The colonial tunicates of the genera *Botryllus* and *Botrylloides* (botryllids) are worldwide invaders, and Dr. Cohen and Dr. Greg Ruiz of the Smithsonian Environmental Research Center (SERC) have been collaborating on monitoring the arrival of invaders, collecting botryllids from as many places as possible, and genotyping specimens to get an idea of global spread and diversity. I did a lot of work collecting and genotyping samples for Sarah's project, and had the opportunity to go to Alaska in the Fall of 2007 to help out with the retrieval of SERC fouling panels that were put in the water to monitor for new invaders as part of a citizen-science network.

Why Alaska? Alaska is the most recent and northernmost site of botryllid invasions on the West Coast, and is generally a very pristine site, unlike SF Bay, which is loaded with invasive species. The Alaska invasion is a unique opportunity to study a population of invaders fairly close to their initial arrival, so I collected tunicates (*Botryllus schlosseri*) for my project while I was there. The general idea is to use genetics to compare the newly invaded site in Alaska to sites in SF Bay, where *Botryllus schlosseri* has been around for a long time.

Why should we care about invasive species? Invasive species are a huge problem in the marine realm. With global shipping, it's just so easy for marine species to hitch a ride to places they would normally never be found, and potentially cause huge problems for the natives in their new environment. Invasive species can grow rapidly and spread easily, and frequently out-compete native species for resources such as space and food. Often they cause economic harm as well (such as affecting local fisheries). Studying invasive species and learning as much about them as we can is one way of reducing future invasions. The more we know about the problems caused and patterns of invasion, the more we can focus on prevention.



W.G. SNEAD

Verena performs bench-work in the "Gene Lab."

Which came first, your interest in marine science, or your interest in genetics? I was actually really against working on genetics for a long time because it looked incredibly boring, and I had my heart set on doing a field ecology project. I just love the idea of going out in the field, setting up experiments, and getting grubby. The molecular stuff seemed too sterile for me. But once I started working on tunicate genotyping for Dr. Cohen, I found out that I really like bench work, and you can get really great results from genetics. Plus the science and technology is all incredibly cool, as nerdy as that may sound. So my interest is in marine ecology, but I got sucked into the world of genetics, and I really like it!

What will you do when you return from your travels in China? Find a job! For now, it woould be really great to work in an academic lab because it would allow me to stay right in the middle of the most current research. Eventually it'd be nice to get involved with an agency, where I'd be able to link some of my research experience to policy. ■

Ocean Acidification *continued from page 1...*

700 generations over the two-year study period. This allows the scientists to observe evolutionary adaptation in a very short period of time. Due to its abundance and broad range, formation of new and sinking of old calcium carbonate coccoliths (shells) plays a significant role in the ocean's carbonate cycle. Also, its genome has been sequenced, so the activity of individual genes can be identified in response to different conditions over time.

W.G. SNEAD

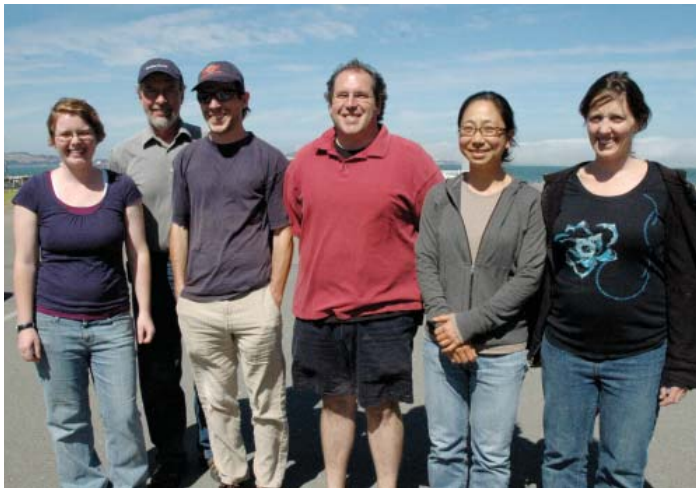
Post-doctoral researcher Dr. Ina Benner at work in the temperature controlled culture room. The chemostats of E. huxleyi *are bubbled with CO2 and continuously mixed. Cells will be sampled every three months of the two year experiment to measure differences in photosynthesis, calcification, and gene expression.*

Two genetically distinct types of *E. huxleyi* cells will be cultured under constant environmental conditions across three levels of CO_2: "present day" (380 parts per million CO_2) and projected "year 2100" (750 and 1000 ppm CO_2) ocean conditions. Each set of conditions will determine the amount of available carbonate. Short and long-term experiments will be conducted to see how the phytoplankton adapt to different levels of light and nutrients under the three CO_2 regimes. Short-term (two week) experiments will be conducted for adaptive responses and long-term (two year) for selective responses. Physiological performance (how well the cells photosynthesize under different conditions) will be correlated with gene expression using state of the art genetic analysis tools. The ability to monitor gene expression allows scientists to uncover more information about how an organism may be stressed by environmental change, even if it appears to be doing well.

At RTC, an elaborate experimental design takes up a small room and adjacent wall. Four thousand gallons of filtered, sterile seawater with low nutrient levels is housed nearby, to be used in the steady-state chambers (chemostats) that house the cell cultures. Research technician Joëlle Tirindelli and post-doctoral researchers Ina Benner and Stephane Lefebvre regularly cart bottles of this water back to the experiment room. On the wall outside, an intricate maze of tubes supply the different levels of CO_2 to the chemostats. Gases with appropriate CO_2 concentrations are created by blending small amounts of pure CO_2 into a stream of ambient air that is pumped in from outdoors.

Collaboration is key in scientific research. RTC scientists collaborate on a number of research projects, and this ocean acidification study is a perfect example. Between Dr. Carpenter's expertise in microbial ecology and nutrients, Dr. Stillman's expertise in environmental genetics, and Dr. Komada's expertise in carbon cycling, the perfect team was assembled. Their innovative proposal was funded, and with the addition of the talented and hard working postdoctoral researchers and research technician, the complex study began. All three lead scientists agree that this work cannot be done alone. Dr. Carpenter said, "We wouldn't have been successful (in receiving the NSF grant) without all three of us." Dr. Komada agrees, "Each one of us fills a distinct niche, and we need each other to be successful." Dr. Stillman added, "None of us could have done it on our own. We are combining our expertise."

Even with this combined expertise, getting the experiment started was not without challenges. From setting up the special electrical system, to having the chemostats custom made, to getting the gas mixtures just right, the study took a year to get started. With these challenges tackled, the study is well under way. We look forward to sharing the results of this important work with the scientific community and the public over the next few years. ■



W.G. SNEAD

The ocean acidification research team pictured from left to right: Post-doctoral researcher Dr. Ina Benner, Prof. Ed Carpenter, postdoctoral researcher Dr. Stephane Lefebvre, Prof. Jonathon Stillman, Prof. Tomoko Komada and research technician Joëlle Tirindelli.

RTC Science at the South Pole: a report from research tech Joëlle Tirindelli

During the month that I spent on our earth's southernmost continent, I felt like I had been put in the shoes of a great naturalist explorer, the likes of Charles Darwin and John Muir. Every new wind-shaped rock formation or patch of moss that I saw sparked my interest in this frozen desert environment. Dr. Edward Carpenter, my supervisor here at RTC, provided me the opportunity to go to the South Pole to be part of a team of researchers studying blue-green algae in the Dry Valley region of Antarctica. These plant-like algae, *Nostoc commune*, fix carbon and nitrogen. Our research hypothesis is that *Nostoc* supports nearby soil bacterial communities by providing necessary carbon and nitrogen that it converts from the atmosphere into biologically accessible C and N. The focus of our research is to estimate the carbon and nitrogen fixed by the *Nostoc* and the potential of this carbon and nitrogen to support surrounding bacterial communities. We also aim to characterize the blue-green algae and bacterial communities by counting and identifying samples under a microscope and by using genetic tools.

A typical sampling day in the Miers Valley, our field site in Antarctica, began when my three colleagues and I headed out of the heated lab tent after breakfast in our National Science Foundation issued red parkas. We carried backpacks filled with beakers, pumps, soil corers, notebooks, lunch, water, and the un-glamorous pee bottles (marked well with a "P" so that we didn't mistake them for water bottles). Our mission was to sample the *Nostoc* mats that form around glacial melt water streams and rivers, and also around snow melt water ponds in the Miers Valley, the southernmost valley in the Dry Valleys. In this pristine environment, we had to also do our sampling with the most minimal impact possible on the natural environment (hence the "P" bottles). During the day, we were in contact by hand held radios with our collaborators and camp mates from the New Zealand Antarctic program.

All in all, there were 10 to 12 people who stayed at the field camp and trekked out in pairs or groups in different directions on different sampling missions. A few people would hike or be flown into our camp by helicopter from other camps set up in adjacent valleys for a few days. An Adelie penguin was waddling around and squawking just yards away from where the helicopter landed the day we arrived in the Miers Valley. The life forms found in the Dry Valleys are very different from those found on the ice shelves near the sea. Penguins and seals do not belong in the Dry Valleys, although they do end up there in cases when the animals appear to have been disoriented.

When I say camp, I really mean it – I was staying in a tent in Antarctica! You might picture the half-frozen penguins huddled together for warmth in March of the Penguins when you imagine a tent camp in Antarctica, but really, it wasn't that cold. I was there in January which is summer in the southern hemisphere. Temperatures stayed a few degrees above or below freezing, much like a mild winter week in the Sierra Nevadas.

The helicopters, cold weather clothing, and other field camp supplies and logistical support were all provided by the National Science Foundation's Antarctic program. I was issued a mountain tent (which I shared with a woman colleague), a very warm sleeping bag, an insulating pad, a sleeping pad, and warm thermal underwear and socks to sleep in. I also had a hat and neck garter to keep me warm and a sleeping mask to block out the continuous daylight. I was surprised how normal the 24 hours of sunlight became; although it amazes me to think I didn't see the sun set for an entire month.

It was nice, though, to get back from the field camp to the comforts of the American research base, McMurdo, with its heated dorms and hot showers. It was even nicer to have a stopover in the summer heat of New Zealand on my way back. The biggest environmental shock I experienced was on my return to San Francisco when the sun set at 5:30 pm. That, and the realization that I had to begin analysis on the hundreds of samples we brought back from Antarctica! ■

Joëlle Tirindelli is an SF State alumnus who completed her MS in Marine Biology at RTC in 2006. Below left: Joëlle dressed in her NSF issued parka in front of Miers Lake, Antarctica. Bottom right: Little Buddha Lake, Antartica where Joëlle and her colleagues sampled Nostoc *mats. Photos: Dr. Jill Sohm, Joëlle Tirindelli*

Open for Learning! New Interpretive Exhibits Educate Visitors to the Reserve and Beyond

Maynance Ferner gets up-close with the marsh mural at the new Rush Ranch Nature Center. Photo: Sarah Ferner

Until recently visitors to the San Francisco Bay National Estuarine Research Reserve (NERR) had limited opportunities to learn about the exceptional tidal wetlands or research happening within the Reserve. Now visitors can learn from interactive educational exhibits at both of the reserve sites, China Camp State Park in Marin County and Rush Ranch in Solano County, as well as at the Aquarium of the Bay at PIER 39 in San Francisco.

Birders, picnickers, and other visitors to Rush Ranch can now compare the size of their hand to the size of a great egret's footprint, get an up-close look at an alkali tiger beetle, and make many other discoveries. Two of the most striking features of the new exhibits are the beautiful murals painted by Benicia-based artist Lee Wilder Snider. The larger of the two murals features a cross section of the marsh and slough, so visitors can explore what animals lurk in the marsh and in the slough's muddy waters. Tactile tiles with imprints of animal tracks, interesting plants, and artifacts line the bottom of the mural and are ready to engage even the youngest of visitors with life in the estuary. Rush Ranch is also featured in a new exhibit at the Aquarium of the Bay at PIER 39. The Aquarium's exhibit includes a floor-to-ceiling map of the estuary, with digital screens that introduce visitors to life at Rush Ranch and China Camp. The digital screens, as well as four other changeable exhibits located at Rush Ranch and China Camp, offer a great opportunity for scientists working within the Reserve to share results of their research with the public.

All of these exhibits were funded by a grant from the National Oceanic and Atmospheric Administration to SF State, which is the lead partner of the San Francisco Bay NERR. ■

The National Estuarine Research Reserve System is a network of protected areas established for long-term research, education and stewardship of the nation's estuaries. Each NERR is a partnership between the federal and state government. The San Francisco Bay NERR is a partnership among National Oceanic and Atmospheric Administration, San Francisco State University, California State Parks, Solano Land Trust and the Bay Conservation and Development Commission.

TONI IGNOFFO

RTC welcomes first Operations Director

In January, RTC hired its first Operations Director, Linda Mayo. Linda comes to RTC with a wealth of experience as a nonprofit administrator. She has specialized in administration and organizational development for over 25 years. Says Director Toby Garfield, "Linda is a strong addition to our administrative team. The Operations Director position was identified years ago as a critical position. Linda's skill set and 'can do' approach make her a terrific person to take on the role."

Says Mayo about the position, "When people ask me what I do, I tell them I work hard to make RTC operate safely and efficiently. I assist the many talented experts at RTC to coordinate their complex project activities while maximizing precious resources. Resources at any academic research center are scarce – this is especially true today!"

Linda came to RTC after six years serving in two other SF State research institutes. From 1995 to 2002 she was an executive director of an HIV/AIDS organization and a management consultant in New York City. Prior to NYC, Linda developed her operations skills during her 14-year tenure at Easter Seals NJ. Linda holds undergraduate and graduate degrees from Rutgers University. In 1995 she completed a MS in health policy and nonprofit management from New York University.

When asked about her departure from social services, Mayo says, "I consider focusing on environmental science as part of the health and social services continuum. When I was 16, I worked at a camp for kids. Many of the urban kids had asthma and/or had suffered from lead poisoning from exposure to massive pollution and toxins. I understood then that without a healthy environment, people's quality of life eroded and the need for human services increased exponentially. Over thirty years later, I'm thrilled to contribute to RTC where the science and the mission are focused on the health of our marine and estuarine environments." ■

All Hands on Deck! Sign up for the 2010 Sea Lion Bowl at SF State!

RTC is now recruiting high school teams and volunteers for the March 6, 2010 Sea Lion Bowl – to be held at the College of Science and Engineering at SF State University's main campus. The Sea Lion Bowl is an academic competition where teams of high school students compete in a timed, "buzz-in" competition. It is one of 25 regional competitions that make up the National Ocean Sciences Bowl, which was started in 1998 to motivate students, teachers and parents to study and pursue careers in ocean sciences. Questions cover ocean science topics in the fields of biology, physics, geology and chemistry – as well as related geography, technology, history, and current events. Prizes are awarded for achievement, sportsmanship and spirit. The top team wins a trip to the National Finals to be held next April 23-25 in St. Petersburg, Florida.

RTC has hosted the Bowl for the last two years. Last February's competition was highly successful, with enthusiastic participation from dozens of SF State faculty, staff and students. For another successful competition in 2010, we need four to five teams from Northern California high schools, coaches, and scores of volunteers. If you would like to learn more about how you can get involved, please contact Erin Blackwood at erinb@rtc.sfsu.edu or 415-338-3757.

For more information about the "Sea Lion Bowl" and the NOSB, please visit: http://rtc.sfsu.edu/sealionbowl

ROB O'DEA

The 2009 Sea Lion Bowl volunteers.

ROB O'DEA

Students prepare their answer to a difficult question about oceanography.

MAKE A DIFFERENCE TODAY!

Please make a TAX-DEDUCTIBLE DONATION to RTC.

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For more information about donating and/or planned gift information, please contact: Wendy Abraham/Director of Development for the College of Science and Engineering of SF State at wra@sfsu.edu or 415-405-3826.

THANK YOU!

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In Celebration of:

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[Birth, Graduation, Wedding]

DISCOVERY DAY 2009!

Discovery Day is a free festival of educational fun that includes marine animal touch tanks, scientific exhibits, music, art, and more. An annual event, our open house offers the public a unique opportunity to spend the day behind the scenes learning about the scientific research activities that take place at the Center. Adults and kids alike are sure to enjoy the day.

Please join us ~
Sunday, October 4
11:00 a.m. to 4:00 p.m.

Free admission and parking!
See you there!

RTC CLASSES

FALL 2009

Biol 582
Biological Oceanography

Biol 586
Marine Ecology Laboratory

Chem 863
Ecosystem Ecology

Biol 865
Environmental Physiology

SPRING 2010

Biol 534
Wetland Ecology

Biol 556
Natural History of Marine Invertebrates

Biol 631/731
Animal Physiology Lab

Biol 863
Plankton Ecology

For more information visit http://rtc.sfsu.edu

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