ROMBERG TIBURON CENTER

bayside

San Francisco State University's Field Station on the Bay • Romberg Tiburon Center for Environmental Studies • Fall 2010

Senior Research Scientist William Cochlan (middle) and oceanographic colleagues (left: graduate students Liza Barney (UWO) and Maureen Auro (RTC-SF State) Dr. Mark Wells, Univ. Maine, and Right: Dr. Charles Trick, Univ. Western Ontario) conduct iron-enrichment experiments with toxigenic phytoplankton using deckboard incubators aboard the R/V Thomas G. Thompson in the subarctic northeast Pacific Ocean. Photo: Julian Herndon

Phytoplankton:
From Fisheries to Fuel

Magnified by a microscope's power, phytoplankton can be stunningly beautiful. Phytoplankton are more than just pretty, though. These single-celled algae are an integral part of the oceanic food web, produce approximately half of the oxygen we breathe, and capture carbon dioxide from the atmosphere through photosynthesis. Recent research by Romberg Tiburon Center senior scientist Dr. William Cochlan and an international team of colleagues confirm that under the right environmental conditions, some species of phytoplankton produce deadly neurotoxins that sicken (or even kill) top predators like birds and mammals, while others have the potential to become the ultimate green producers of clean energy.

Phytoplankton is a broad term that includes a diverse array of single-celled algae that live in fresh and salt water. Many float in the top layers of the ocean while other species of phytoplankton coat the underside of polar sea ice and the mudflats that line the shore of the estuary. When ocean temperature, light and nutrient levels are just right, some species of phytoplankton reproduce rapidly, creating massive "blooms" seemingly overnight. Depending on the conditions and the species of phytoplankton, these blooms can either be a bountiful, nutritious buffet for ocean animals or a deadly toxic soup for consumers further up the food chain including marine mammals, birds and humans.

During Harmful Algal Blooms, referred to as HABs, toxins accumulate in small animals that eat the phytoplankton, and then accumulate to an even greater extent in the larger animals as they feast on the smaller animals. Through this biomagnification, top predators can then become ill, even though they didn't actually eat any of the toxic phytoplankton themselves. Unfortunately, this scenario occurs throughout the world many times each year, sometimes sickening or even killing humans

continued on page 4 . . . . . .

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.

SAN FRANCISCO STATE UNIVERSITY

W.G. SNEAD

Message from the Director

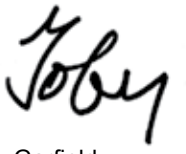
As I write this column, British Petroleum has stopped the blowout from the Deepwater Horizon accident through the top kill and is closing in on completing the relief well to seal the base of the well. But stopping the leak only marks the end of the first stage of dealing with the disaster. It will take years, if not decades, for the impacts of over 200 million gallons of released oil and the heavy use of dispersants to be neutralized. There are many messages in this environmental disaster; each citizen needs to examine their dependence on extractive, non-renewable fuels and we need to develop stronger regulations to protect the environment and to respond to such tragic events. A former RTC Research Associate, Samantha Joye (1989-1994), a Professor of Marine Sciences, is one of the leading voices of the environmental response to the disaster. Development of stronger environmental protection of the ocean requires understanding complex marine ecosystems. Research at RTC is focused on increasing awareness and knowledge of this diverse and fascinating ecosystem.

Dr. Katharyn Boyer and her laboratory are engaged in long-term monitoring of seagrass beds in San Francisco Bay. One of their objectives is documenting the impact on and recovery of the sea grasses from the 2006 M/V Cosco Busan oil spill. Valerie Greene, subject of this issue's student profile, worked in Dr. Wim Kimmerer's laboratory where they are investigating the reasons for the decline of pelagic fishes in the low salinity regions of the Delta. Their work is crucial for developing water use strategies. Dr. William Cochlan's laboratory specializes in the ecophysiology of marine phytoplankton. Their work strives to understand factors leading to phytoplankton blooms, how phytoplankton may be used as alternate fuel sources and ensure the safety of seafood in developing countries. All of these are examples of the important research that goes on at our Center.

Important research, education and outreach is regularly conducted on site, and we are busy planning for the future. The Center hired Flad Architects to assist with the creation of a site development plan. Stevens Williams and Sylvia Darr, architects at Flad, have spent the year meeting with the RTC community and working with me to craft a plan for strategic renovation of the site. Four important elements of the research campus have been identified for site development. These are renovation of the back third of the main research building, construction of a research and education greenhouse, repair and rebuilding of the wharf, and staged renovation of four other former Navy buildings that would complete the research quadrangle. The design plans also recognize the importance of the site to serve the SF Bay Area during emergency response. This plan leaves most of the land available for other usage which could include building renovations for other activities or a coastal ecological research reserve. The final site development plan will be released this Fall.

The research laboratories are vibrating with activity. Ten new graduate students join us this Fall semester, new curricula to strengthen graduate courses was proposed to the University, and faculty members Tomoko Komada (Chemistry and Biochemistry) and Jonathon Stillman (Biology) each start the new academic year with a promotion to Associate Professor. We anticipate an exciting academic year and hope you will attend this year's Discovery Day on October 10 from 11:00 am to 4:00 pm, our annual open house that showcases the research and science in your backyard.

Hope to see you there,



Toby Garfield

bayside

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Envisioning RTC's future

Wharf reconstruction may include the research support facility shown here. A multi-purpose building could exclusively support research vessels when heavily trafficked, or serve related research and educational functions. Image: Flad Architects

The Seawater Research Center building will house both a Research Greenhouse and the Visitor Center/Classroom shown here in the foreground. A Coastal Wetland planted area will replace part of a large expanse of asphalt paving currently on the site. Image: Flad Architects

In this issue

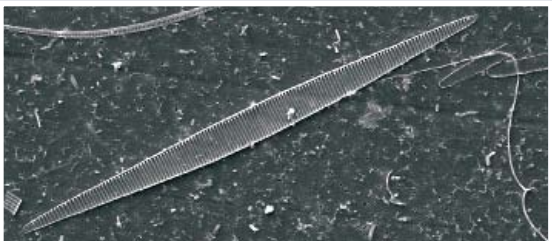
RTC summer undergraduate student researcher, Julia Betts (far right), assists University of Maine personnel aboard the R/V Melville of the Scripps Institution of Oceanography. The team retrieves a trace-metal clean water sampling device from the waters of the Pacific Northwest during a 2005 ECOHAB-PNW cruise. Betts conducted five multi-week research cruises while an undergraduate with the Cochlan Lab, and following graduation secured employment as a research associate in algal biofuels at Cellana LLC. Photo: William Cochlan

continued from cover . . .who consume shellfish that feed on the toxic algae. Dr. Cochlan and his colleagues study the precise mix of ocean conditions, such as the quantity and quality of certain nutrients, water temperature, light levels, and weather conditions that enable these blooms to begin and thrive. This research has taken Dr. Cochlan and his students around the world, including the equatorial and subarctic waters of the Pacific Ocean, Antarctica, the Pacific Northwest and most recently Hawaii.

Earlier this decade, Dr. Cochlan and his colleagues began to study a type of diatom belonging to the genus *Pseudo-nitzschia.* The diatoms can create a deadly neurotoxin (domoic acid) that causes brain damage and leads to seizures and both short- and long-term memory loss in mammals. The diatoms appear to be blooming more frequently and massively off the west coast of North America, including right off the Golden Gate. Fortunately for Dr. Cochlan and his team, they are routinely found in retentive physical features such as the large circulating Juan de Fuca Eddy between British Columbia and Washington. This eddy forms a perfect natural laboratory to study these toxigenic organisms.

biofuels - fuels from biological material derived from living, or recently living organisms

biomagnification - the process whereby the tissue concentrations of a contaminant increase as it passes up the food chain



Pseudo-nitzschia *sp., the diatom responsible for the production of domoic acid. Photo: Brian Bill*

To better study these microscopic algae, Dr. Cochlan and his research team of technicians and students grow, or "culture," diatoms. They grow large quantities of *Psuedo-nitzschia* spp. in the lab under a variety of precisely controlled conditions. Through years of experimentation and careful culturing, they learned that the environmental conditions which allow the diatoms to bloom are not always the same factors which will trigger production of domoic acid. Not only is there considerable variability among the small- and large-celled species with respect to these conditions, but even the kind of nutrients the diatoms use can make a massive difference in the amount of toxin per cell – or the hotness factor! This is particularly relevant since it appears that some of the species which bloom in Monterey Bay and off Washington will become more toxic if supplied with nutrients generally associated with agricultural runoff and urban sewage systems. However, this is not necessarily a man-made problem. Together with colleagues from the University of Western Ontario, NOAA Northwest Fisheries Center and the University of Maine, they found that even in the pristine waters of the subarctic Pacific, the resident *Pseudo-nitzschia* species is toxic in the absence of any pollution.

Dr. Cochlan's lab collaborates with a number of different laboratories, including the California Department of Health and the NOAA Northwest Fisheries Scientific Center in Seattle in the development of a database record of shellfish toxins on the West Coast of North America (USA and Canada). Their research led to the creation of an early warning system to alert people of an impending bloom. The early warnings allow commercial and recreational fishermen to avoid crabbing or clamming in the affected region, reducing the potential risk to human health. This work is being continued throughout the Pacific

Rim as part of an initiative though the North Pacific Marine Science Organization [PICES; see related article “Field Notes” on pages 8-9.]

Building from this previous research and earlier work conducted in SF Bay, the Cochlan Lab is about to embark on a new three year study to identify the primary toxic component and the specific environmental factors that stimulate growth and toxicity of another species of phytoplankton - the fish killer, *Heterosigma akashiwo*. *H. akashiwo* forms blooms in the Puget Sound region of Washington State and the inland waters of British Columbia, as well as in other areas along the West Coast including San Francisco Bay – where it was first discovered as a bloom-forming species by then graduate student Julian Herndon.

In Puget Sound, where there are large-scale salmon farms, *H. akashiwo* is particularly devastating because it often blooms where aquaculture pens hold dense congregations of fish destined for dinner tables. Recurring threats have caused extensive damage ($2 - 6 million per bloom) to both wild and net-penned fish of Puget Sound. The new research will help the fish farmers, as well as managers of adjacent wild fisheries, reduce the frequency and toxicity of the blooms, saving them millions of dollars in losses per episode.

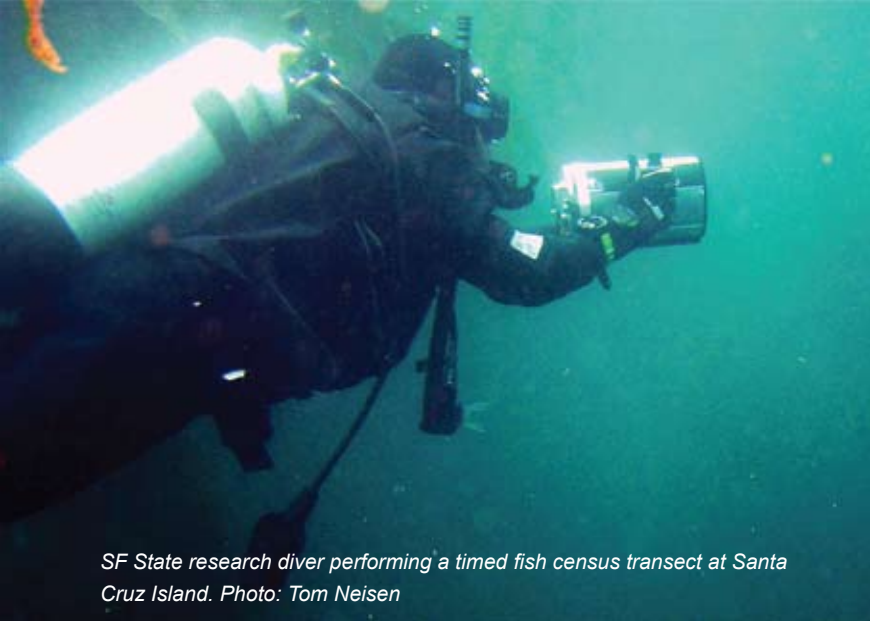
Not all phytoplankton are killers. While in Kailua-Kona Hawaii, Dr. Cochlan’s laboratory participated in a unique collaboration between university researchers and the private sector (Cellana LLC of Royal Dutch Shell and HR Biopetroleum) to develop the world’s most advanced research facility for algae-based biofuels. Under Dr. Cochlan’s direction as Head of Cultivation, the facility reached the potential to be zero-waste for aquatic emissions, which is extremely rare in energy production. The facility continues to lead this green energy industry.

If successfully mass produced and processed, biofuels derived from algae could provide a sustainable, renewable, and much cleaner alternative to fossil fuels. The entire RTC community is proud of the ground-breaking role Dr. Cochlan and his RTC-SF State students are playing in this emerging field. Dr. Cochlan is a member of the Science Leadership Team of this organization and continues to conduct research funded by Cellana and the U.S. Department of Energy in support of this effort.

With so much of his research affecting important global issues, from fisheries to fuel, Dr. Cochlan and his students have the opportunity to present their results and participate in oceanographic efforts world-wide and their research is often in the headlines of not just the *bayside*, but newspapers and websites around the world.

For more information about Dr. Cochlan’s research, please visit: http://rtc.sfsu.edu/in_cochlan.htm.

In memoriam
Gary Ingerson
April 13, 1957 - October 6, 2009
RTC Facilities Project Supervisor
(2001 - 2009)



SF State research diver performing a timed fish census transect at Santa Cruz Island. Photo: Tom Neisen

Scientific Diving - Another day at the 'office'

When is a dive just another day at the office? When you're a scientist who needs to know how many red abalone occur along a transect line 25 feet under the sea, or how many rockfish live in a kelp forest. Researching underwater species comes with extra challenges for marine scientists studying them in their habitats. For many, SCUBA (Sustained Under Water Breathing Apparatus) is a fundamental tool, allowing them to work underwater.

RTC is home to the San Francisco State University (SF State) Scientific Diving Program, led by Dive Safety Officer David Bell. The program provides everything from training and logistical support to dive vessels. Students wishing to dive under the auspices of the university must have current SF State Scientific Diving status or Scientific Diver-In-Training status. Since SF State does not currently offer a Scientific Diving Certification course, students must obtain advanced dive training through sister institutions such as Moss Landing Marine Laboratories and University of California at Santa Cruz. Once students have the proper status, Bell is ready to take them diving.

"My goal," says Bell, "is to make every research dive just another day at the 'office.'" Getting students comfortable in the water is not an insignificant task. To study an organism in its native environment, you have to be able to operate in that environment. That means being able to swim through a kelp forest without getting entangled, especially challenging when you are carrying a clipboard, bulky video camera or underwater collection gear such as nets and bags. A scientific diver's equipment and safety procedures must be second nature. Bell wants the students to have the same comfort level in the water as they do in the research lab. To accomplish this, students perform practice dives in many different environments, from deep water dives off the coast of Monterey, to kelp forest and surge zone dives in the waters off Catalina Island.

During training, Bell requires his divers to close their eyes and know instinctivley where each piece of equipment is. This allows divers to optimize the short time they are in the water, and also aids divers that conduct research in low visibility conditions, such as diving at night or in SF Bay, where normal visibility is a foot or less. Divers who have been through the Scientific Diving Program are well-equipped to conduct research dives anywhere in the world, from the Sonoma Coast to South Africa, Polynesia and Japan.

While the physical environment is a challenge, so too can be the long list of forms, medical evaluations and gear checks that are prerequisite for "getting in the water" to do field work. The SF State Scientific Diving Program helps with the paperwork, and also supports students and faculty in field logistics by providing research vessels specifically outfitted for diving. Presently, RTC Marine Operations maintain four small vessels from 15-21 feet long that are fully equipped for research at remote sites. Students and faculty can be certified to operate these vessels themselves, providing an equipment resource singularly unique among Bay Area four-year universities.

Over the next decade, Bell's goal is to grow the program from its current size of about 12 active divers to about 30. One exciting path to the program's growth is the re-opening of the new California Academy of Sciences. There is tremendous interest by both students and faculty to partner in research projects or volunteer as aquarium divers. With a ready audience and unmatched resources, the only limitation to the program's growth is funding to put those resources to use.

An organizational member of the American Academy of Underwater Scientists since 2000, the SF State Scientific Diving Program has created a safe and reliable program, the result of which is a 100% safety record for more than 1,000 research dives! ■

China rockfish, Carmel Pinnacles State Marine Reserve. Photo: Tom Neisen

Graduate Student Profile - Valerie Greene

ROB O'DEA

Recent RTC Master's graduate Valerie Greene is about as far from the stereotype of "stuffy scientist in a lab coat" as you can get. She is a former assistant options trader, bartender, Marine Mammal Center volunteer, aspiring trapeze artist, and wears beautiful tattoos (marine-themed, of course). She epitomizes the bygone ideal of the Renaissance person—field and laboratory scientist, artist, and creative thinker. We stole a few minutes of her time to learn about her background, research at RTC, and future plans.

What inspired your interest in marine science? I was working as an assistant options trader on the stock market floor, and I soon realized that it wasn't a good fit for me. I wanted to live a more relaxed lifestyle, and do something that really mattered. I had always loved the ocean, so I decided to pursue a degree in marine biology at SF State. I was interested in marine mammals, so for two years I volunteered at The Marine Mammal Center, the rehabilitation center located in Sausalito.

What changed your mind about studying marine mammals? As an undergraduate student at SF State, I took the Biology of the Algae class from Dr. Frances Wilkerson. It was this class that made me realize that smaller organisms are also interesting, and offer many more research opportunities. I graduated with a Bachelor's of Science in 2006 and continued my studies at RTC as a graduate student.

What did you work on as a graduate student at RTC? In Dr. Wim Kimmerer's laboratory, I studied the grazing impact of invasive clams on the microzooplankton in the northern San Francisco Estuary. The overbite clam, *Corbula amurensis*, was introduced into the Bay in the 1980s. Since then, both phytoplankton and native fish, including the threatened Delta Smelt, have declined. This clam is an impressive filter feeder, tolerant of a wide range of salinities, and large beds of these tiny (two centimeter) clams can filter large volumes of plankton each day. I was interested in predator-prey interactions between different trophic levels. It was known that clams eat bacteria and phytoplankton, but I was the first to look at links between clams and ciliates. I found that grazing by clams could cause substantial mortality in the ciliates. In 2009, I won first prize in the Biology Division of the SF State Student Research Competition for my work. My research was part of a collaboration with the U.S. Geological Survey (USGS) in Menlo Park, where I interned during my graduate studies. My internship in the Benthic Ecology Laboratory sent me to Klamath Lake, Oregon to examine benthic nutrients, and the Clark Fork River in Missoula, Montana to study bioaccumulation of trace metals.

What did you do when you weren't doing research? When not in the field, I worked part-time as a bartender in San Francisco and took up the trapeze!

What are you working on now? I defended my thesis in May and expect to officially graduate in August. I am working full time at the USGS in the Water Quality and Phytoplankton Ecology Lab, analyzing a remarkable San Francisco Bay data set that spans more than 25 years. Such a long time series of data provides a thorough baseline to compare to long-term and short-term changes in the ecosystem. This is critical in evaluating the impact of catastrophic events such as oil spills, and longer-term events such as climate change.

benthic - relating to or happening on the bottom under a body of water

ciliates - a group of protozoans characterized by the presence of hair-like organelles called cilia

trophic level - an organism's position in the food chain

What did you enjoy most about being at RTC? The nurturing sense of community, and having lots of people as resources for my education. I have also given back to the community as an active member of the RTC Student Association and outreach volunteer.

We wish Valerie the best of luck in her future endeavors which may include pursuing a Ph.D., and look forward to upcoming trapeze performances. Here's to a true Renaissance woman!

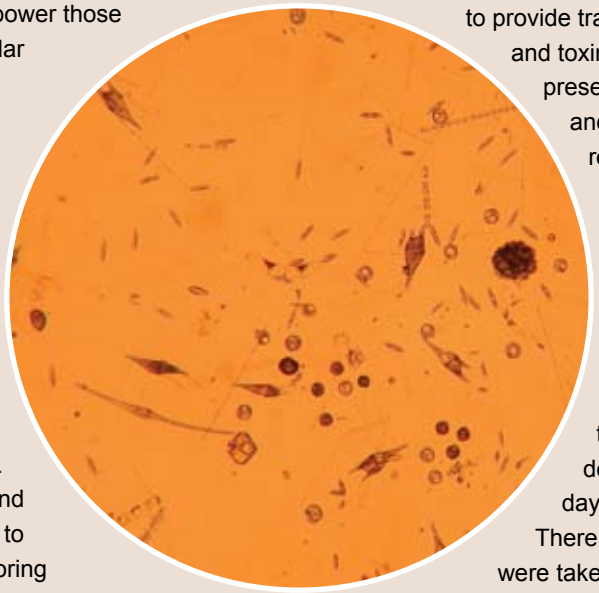
Field Notes :

In Guatemala with Julian Herndon and Brian Bill

Someone always asks: What do you do? This usually entails explaining to them what a Harmful Algal Bloom (HAB) is and results in glazed-over-eyes and yawns. Toxigenic phytoplankton are not usually on peoples' radar and it's not until the HAB, popularly known as a "Red Tide," affects people personally that killer algae hits the newspaper headlines. Unfortunately, this happened in Guatemala in 1987 when a toxic bloom of *Pyrodinium bahamense* sickened 187 people who consumed contaminated shellfish, eventually killing 26, half of them children under the age of six.

Brian Bill and I traveled to Guatemala as part of The North Pacific Marine Science Organization's International Seafood Safety Project (PICES-ISSP). PICES is a intergovernmental organization with members from the United States, Russia, Korea, Japan, Canada and China. In this project, we had the opportunity to take our research endeavors and experience outside of traditional laboratory settings and help save lives in a country that not only has limited funding and motivation for HAB monitoring, but has also been devastated by decades of military conflict and severe poverty. Working with highly motivated researchers and students at the University of San Carlos, officials from the Guatemalan Fisheries and Health Department and the Guatemalan Navy, and local aquaculture businesses and fishers, the PICES team was able to help train, educate and empower those already working to prevent another similar tragedy in their country.

Above: Julian Herndon (right) provides shipboard instructions to a Guatemalan Naval Academy cadet in Puerto Quetzal on the use of newly donated equipment. Below: mixed phytoplankton. Photos: William Cochlan & Brian Bill



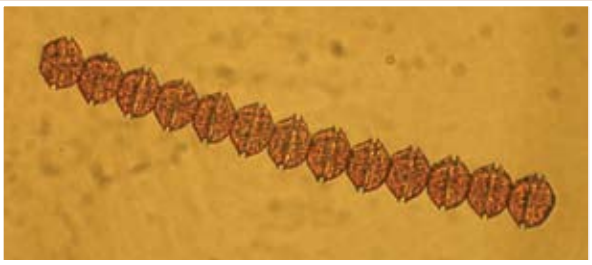
Working with Dr. William Cochlan at the Romberg Tiburon Center and his colleagues from around the world had prepared us well. We felt knowledgeable and confident in our abilities to lecture and provide hands-on training to people who spoke a different language and live in a reality shaped by forces that we seldom experience in the United States. Everywhere we went we felt welcome and sensed genuine gratitude for our efforts to help them improve their scientific monitoring methods and the safety of their seafood. Foreign aid projects in Latin America involve well-intentioned people, but as we discovered, overly complicated and unrealistic goals tend to fail over the long term as the projects are challenged by technical and political obstacles that are not anticipated. The PICES-ISSP project endeavors to work within the constraints of the knowledge, ability and, most importantly, the resources of the country in question. With this in mind, we first traveled to Guatemala in September of 2009 to listen and learn about the situation from the local experts and together decide how we could help. When we returned to Guatemala in February of 2010 we were able to provide training in HAB monitoring, identification, and toxin analysis techniques as well as presentations on basic oceanography and present donations of some basic research equipment. This will help the Guatemalans to improve their existing capabilities, knowledge and skills.

During one of the training sessions at the Pacific Naval Command, the class participants learned simple toxin tests and microscopic identification techniques that allowed them to readily determine that oysters harvested the day before could have made people sick. There was a bloom occurring at the time we were taken out on a Guatemalan naval vessel to collect samples. These samples, collected and analyzed by the students, revealed that another HAB species, this time *Alexandrium* sp. (a paralytic shellfish poisoning or PSP-producing organism), was blooming. Shellfish tissue samples analyzed by the students indicated that the oysters were indeed contaminated by this microscopic alga and bioaccumulating saxitoxin in their tissues, the same type of toxin that had led to the

1987 deaths. It was incredibly rewarding to see firsthand how a little bit of knowledge and ability could so dramatically improve the health and livelihood of the people.

The participants in the three training courses were very motivated to learn. The students, including the Commander of the Guatemalan Coast Guard, spent their break time refining their microscopy skills and asking questions. They were mesmerized by the abundance and variety of life present in their waters. One of the Naval Cadets conveyed to us a story about his hometown on an inland lake that experiences water color changes, which are followed by death of fish and illness of children who swim in and drink the water, including one recent death. While we could not answer his questions about whether the illnesses and death were related to a HAB in the lake, he was able to glimpse the links between an aquatic ecosystem and human health. Guatemala needs more help than our initial visits provided, and the project continues to provide support by email and conference calling. Bill had traveled to the Philippines in 2008 and 2009 for a similar course. Both of us are looking forward to the next country and maintaining professional contact with our new colleagues in Guatemala. ■

Julian Herndon is a Research Associate in Dr. Cochlan's Laborarory and a SF State alumnus who completed his M.A. in Marine Biology at RTC in 2003. Fluent in Spanish, Herndon served as the official translator for the training mission. Having finished his dissertation research work in Cochlan's Lab, Brian Bill is currently working in the Marine Biotoxins Program at NOAA's Northwest Fisheries Science Center, Seattle having fished his dissertation research work in Cochlan's Lab. He will defend his masters thesis in Fall, 2010.



Above: Brian Bill demonstrating pipetting technique to Bureau of Fisheries and Aquatic Resources (BFAR) personnel in Manila, Republic of the Philippines. Photo: Vera Trainer. Below: The dinoflagellate Alexandrium *sp. a paralytic shellfish poisoning or PSP-producing organism. Photo: Brian Bill*

Congrats, Grads!

Andrea Cayenne, 2010. Identification of protein interactions with lactate dehydrogenase in the Porcelain Crab *Petrolisthes cinctipes*. Jonathon Stillman, Advisor.

James Fuller, 2010. Phytoplankton growth under varying conditions of atmospheric CO_2. Frances Wilkerson, Advisor.

Valerie Green, 2010. Grazing impact of the overbite clam on the microzooplankton assemblage of the Northern San Francisco Estuary. Wim Kimmerer, Advisor.

Maxwell Hubbard, 2010. Verification and harmonic analysis of San Francisco Bay surface currents utilizing HF Radar. Newell Garfield, Advisor.

Amelia Ryan, 2009. Salinity and nitrogen interactions in *Sarcocornia pacifica* dominated salt marshes. Katharyn Boyer, Advisor.

Out & About: Another busy year of community outreach for RTC

It's been a busy, exciting academic year for the outreach program at Romberg Tiburon Center. Last September, members of the RTC community had the opportunity of coordinating the annual California Coastal Cleanup effort at Blackie's Pasture in Tiburon. Several graduate students and scores of families collected 483 pounds of debris and recyclable materials while educating the community about reducing waste. Join us this year for the 2010 Cleanup on Saturday, September 25 from 9:00 am to 12:00 pm at Blackie's Pasture.

RTC graduate students Tricia Goulding and Sarah Blaser at the 25th Annual Coastal Cleanup Day, September 19, 2009.

San Lorenzo High School student Brandon Jones Mooney prepares to filter phytoplankton from a bay water sample.

Local high school students learn about eelgrass at Romberg Tiburon Center's William Atchley Nursery Tank. Photos: Erin Blackwood

In October we had a very successful and rewarding Discovery Day Open House with our nine active laboratories collaborating on interactive research displays. Also at the event were touch tanks with live marine animals, SF State Ceramics, arts and crafts for kids, several guest exhibitors, and the annual live salmon release by the Tyee Club and Tiburon Salmon Institute. RTC and Discovery Day were also featured in a short film entitled "Students Saving the Ocean," which is now available on YouTube. Join us this year on October 10 from 11:00 am to 4:00 pm for our 21st open house. Our theme is "Science in Your Backyard and Beyond."

In November, we held a successful teacher workshop for 20 Northern California teachers on the hot topic of ocean acidification taught by Drs. Jonathon Stillman, Tomoko Komada, and Ina Benner, in partnership with the SF Bay NERR. Our next teacher workshop on water quality monitoring will be on Saturday, November 6 at RTC. Classroom teachers, especially middle and high school, and informal educators are welcome. Also on the teaching front, every November we participate in "Expanding Your Horizons," an event at SF State for girls aged 9-14 designed to encourage their interest in science and math.

The winter was full of preparations for the Sea Lion Bowl, the Northern California Regional competition of the National Ocean Sciences Bowl hosted by RTC and SF State's College of Science and Engineering. Four new teams of five high school students joined us this year, including one all the way from Nevada! Teams from San Lorenzo and Oakland High Schools were supported by a grant from the Miranda Lux Foundation. Volunteers and teams alike tried out the new electronic version of competition questions, saving about 16 reams of paper! Mission San Jose High School of Fremont again won the 2010 Sea Lion Bowl, with a surprise third Place finish for Sierra High School. Mission San Jose went on to the National Finals in Florida to win third Place. The 2011 Sea Lion Bowl is Saturday February 26 at SF State. Volunteers and teams are needed to participate. Please visit http://rtc.sfsu.edu/sealionbowl/ to learn more.

All year long, RTC provided expertise on San Francisco Bay ecology. Outreach Coordinator Erin Blackwood and RTC Master's students were called upon by SF State faculty, Richardson Bay Audubon Center's annual Bay Shore Studies docent training class, The Marine Mammal Center, Lawrence Hall of Science's MARE Bay Explorers program, Marin Country Day School, the Bay Institute's Bay Estuary Education Program, and Environmental Traveling Companions to offer educational programs for middle school to college students and adults.

Even in the summer, outreach at RTC does not slow down. This past summer, we offered a College of Extended Learning course specifically for underserved high school students planning to participate in the 2011 Sea Lion Bowl. The course was supported by funds from the Miranda Lux Foundation and the California Coastal Commission's Whale Tail license plate program.

We look forward to another year of exciting opportunities to educate students, teachers, and the community about the important research being conducted "in your backyard and beyond!" ■

RTC goes GREEN!

RTC is going GREEN thanks to the leadership of three Romberg Tiburon Center staff members: NERR Coastal Training Program Coordinator Marina Psaros, Research Technician Chris Raleigh and Operations Director, Linda Mayo. With a groundswell of enthusiasm and volunteer support from students, scientists and staff who share the goal of "greening RTC," the three spearheaded a new effort to promote sustainability by reducing RTC's environmental footprint.

What is the mission of the new Sustainability Program; how can the RTC community get involved; and how can RTC share its insights and successes with the public? Those are the questions that a group of 25 faculty, post-docs, staff and students came together to address in the summer of 2009 at a kick-off meeting hosted by Mayo and Raleigh. The meeting produced the program's mission statement: to integrate the values and principles of sustainability into daily operations.

A year after the kick-off meeting the program is flourishing. "Green action teams" were formed to tackle projects ranging from recycling and composting, fundraising, energy reduction, green transportation, and creation of a website to help people get involved. The teams have achieved results. One team led by graduate student Verena Wang organized buckets and signs to collect food scraps, coffee grinds and tea bags that previously went into the trash, and built three bins using recycled wooden pallets to compost what they collected. In the futre, the compost will fertilize a community garden outside the main research building organized by Postdoctoral Fellow Dr. Ina Benner.

sustainability - the potential for long-term maintenance of the natural world and the responsible use of natural resources

Another green action team has promoted reduced-carbon commuting by holding a raffle with prizes for people who bike or carpool to work, with a bonus given for first time green commuters. Led by Dr. Benner, the group also organized bike commuters to participate in a regional Team Bike Challenge in which teams competed to bike the most to work during May. Two RTC teams competed and cycled a combined total of 2,559 miles, earning one team third place in the San Francisco County category.

A third action team, led by graduate student Stephanie Kiriakopolos, arranged an energy audit. A PG&E representative came to RTC and recommended specific ways to reduce energy use, such as replacing outdoor lighting with energy efficient LED lights. Team members such as RTC volunteer Jan Davidson-

Graduate student Verena Wang adds to the compost that will eventually become fertilizer for the RTC community garden. Photo: Anne Slaughter

Drexel are applying for funding to make this goal a reality. In the meantime, older light fixtures have been replaced with energy efficient ones, weather stripping has been added to doors, and covers placed on thermostats to reduce wasteful heating.

Recycling and re-use efforts have also been stepped up, thanks to Lab Technician, Anne Slaughter. Recyclable bottles and cans are collected and cashed in to support sustainability related projects. Clean plastic research supplies and containers no longer needed by our labs collected and donated to middle and high schools. Slaughter acted on a tip that campus had excess recycling bins available, and contacted Caitlin Steele, SF State sustainability programs manager. She provided RTC with numerous containers that were distributed throughout our site. SF State has made huge strides to incorporate sustainability in to campus life. Their efforts provide direction and inspiration to our program.

At a recent "Green" meeting Mayo said, "sustainability is in everyone's interest and now is the perfect time to begin in earnest." The RTC community has demonstrated that sharing an interest in greening RTC and collaborating to develop sustainable practices indeed makes for a great beginning. ■

Hidden Habitats: San Francisco Bay's Rocky Shore

China Camp State Park is well known for its marshes and mudflats (and awesome mountain biking trails), but lately scientists have been flocking to a less well known habitat within the Reserve – the rocky parts of the shoreline. San Francisco Bay is a muddy place. There is mud on the bottom, mud in the water, and usually mud on the shoreline, but China Camp and surrounding waters protect several areas of rocky shoreline, including rocky intertidal areas, cobblestone beaches, and even a small rock island. Although it is terrific habitat for eye-catching birds, like oyster catchers, as well as barnacles and mussels, the island has an unsavory name, Rat Rock.

When I asked Dr. Matt Ferner, SF Bay NERR Research Coordinator, what made the rocky intertidal habitat at China Camp so special, he answered quickly and emphatically: "the diversity of life there!" He then listed more species than I have room to name here, ranging from worms, snails, and algae to Dungeness crabs and oysters. It is the latter, the native Olympia oyster, that has been attracting researchers lately. Scientists don't know how common oysters were in San Francisco Bay before the Gold Rush, but we suspect that the sediment that filled the estuary during the Gold Rush, as well as the blasting of rock outcroppings that were hazardous to ships, and perhaps overfishing, likely reduced oyster populations to the point that they are very uncommon now.

In recent years, several government agencies, scientists, and community groups have been working together to restore oyster populations at select places in the estuary. China Camp is not one of these sites, but the oysters have started to come back anyway. Informal observations just four years ago suggested oysters were uncommon in the Reserve. And then, suddenly, there were little, almost delicate looking oysters attached to each cobblestone in the lower intertidal. Native oysters.

Because there was no regular monitoring program along the rocky shore, we have no way of knowing if this is a new population or a typical cyclical increase in the number of oysters. The oysters, though, have brought attention to this habitat. Graduate Research Fellows working with the Reserve are now conducting surveys to determine their density. In addition, one of these Fellows – Brian Cheng, a Ph.D. student from UC Davis – is studying the oysters' tolerance of salinity and temperature, so he can better predict the impact of climate change on shellfish and the species they interact with.

The Reserve staff and scientists are not alone in our fascination with the Bay's rocky shoreline. The State Coastal Conservancy recently published a draft "Subtidal Habitat Goals Report" that reviews the current state of knowledge of both intertidal and subtidal rocky habitats, as well as other hidden habitats within the Bay, like seagrass and macroalgal beds. The report outlines key research questions that need to be asked for each of these habitats, and suggests some management strategies to ensure these valuable habitats are protected. There are some things each of us can do to protect rocky shorelines, including enjoying and exploring the habitat from a safe distance. After all, you wouldn't want to step on a native oyster! ■

The rocky intertidal habitat at China Camp State Park. Photo: Matt Ferner

NERR Notes was written by Sarah (Davies) Ferner, SF Bay NERR Education Coordinator. 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.

RTC & SF Bay NERR
Fall 2010 Teacher Workshop
"Water Quality Monitoring"

Network with local educators and scientists as you collect and analyze real-time water quality data from around the bay, learn about the latest related research, and design and conduct a water quality experiment that can be taken back to the classroom.

Saturday, November 6
8:30 am to 5:00 pm

Breakfast and lunch are provided.
Register online: www.sfbaynerr.org

Wetland Science Series

In 2004 Dr. Trish Foschi, professor emeritus of Geography, proposed an exciting new educational concept for RTC: a series of professional development courses to be taught at the Center. She wanted to share her expertise of a mapping technique known as remote sensing with wetland researchers. When wetland ecology researcher Dr. Katharyn Boyer joined the RTC faculty that year, the idea grew. Foschi, Boyer and their colleagues knew that the Society of Wetland Scientists' had a Professional Wetlands Scientist Certification program (SWS-PWS). Realizing there was interest and demand, the group decided to create a RTC Professional Development Course Series serving the wetland scientist community. The courses they developed meet the training requirements for SWS Certification.

Since spring of 2005, a variety of short courses have been offered each year to provide training on a range of topics. The course offerings allow students to gain expertise in wetlands delineation (both basic and advanced), restoration ecology, policy, geographic information systems (GIS), plant identification, experimental design, ecology of invasive species, wetland restoration monitoring techniques, and statistical analysis. RTC also partners with the SF Bay National Estuarine Research Reserve to use local field sites such as China Camp and Rush Ranch whenever possible. Students gain useful hands-on experience from our excellent instructors and rate the courses highly.

Wetland Science Series courses are open to all levels, but a biology background is helpful.

Class participants learn how to use quadrats for determining percent coverage of wetland plants at China Camp State Park. Photo: Alicia Yballa

Upcoming Wetland Science Series courses:

Advanced Wetland Delineation
BIOL 9016 2 CEU Cost: $535
Dates: 2.5 day course, Thursday & Friday 8:30-5:00, Saturday 8:30 -12:00 pm, October 21-23
Class Format: 50% Lecture 50% field demonstration
Instructor: Tim DeGraff

Wetlands Restoration Ecology
BIOL 9395 1.6 CEU Cost: $430
Dates: 2 Days, Friday & Saturday, 8:30-5:00
November 5-6
Class format: 75% lecture and 25% field demonstration
Instructor: Gretchen Coffman

Spring, 2011: Dates TBA
Wetland Delineation
Wetland Restoration Monitoring Techniques
GIS for Wetlands

For more info: http://online.sfsu.edu/~wetlands
Email: wetlands@sfsu.edu
Phone: (415) 819-2073

2009/2010 Academic Round-Up

13 - Number of undergraduate and graduate classes held at RTC

151 - Number of undergraduate and graduate students attending classes

30 - Number of Master's students working on their degrees

49 - Number of undergraduate assistants, interns or volunteers

7 - Number of high school student volunteers

5 - Number of Master's degrees awarded

30 - Number of science seminars

25 - Number of outreach events and workshops

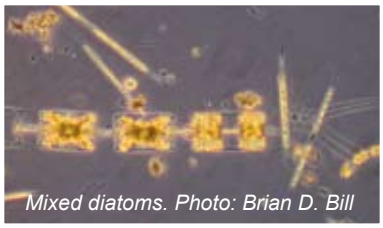
RTC Research Directions

Our faculty and research scientists continue to be awarded significant research projects. This new section in *bayside* will annually share information on some of the recent research grants funded at RTC.

Drs. Edward Carpenter and Ina Benner have recently returned from a collaborative research cruise that took them to a unique part of the Atlantic Ocean where the Amazon River flows in. The Amazon is generally high in phosphate and low in nitrate, two nutrients that phytoplankton need to grow. Its outflow is so huge that the mixing zone where it meets the ocean has the same characteristics. Since nitrate is limited here, you would expect to see only a few phytoplankton present, but surprisingly scientists see large blooms of diatoms occurring. This curiosity has led scientists to discover a unique partnership: the diatoms are living in a symbiotic relationship with diazotrophs. The diazotrophs take up atmospheric nitrogen and fix it into a nitrogen form that the diatom can use. This promotes growth of the diatoms and results in the large blooms.

diatoms - aquatic, single celled algae that live inside a silica shell

diazotrophs - bacteria that fix atmospheric nitrogen gas into a more usable form



Mixed diatoms. Photo: Brian D. Bill

The large blooms add another part to this story. Diatoms use carbon dioxide (CO_2) for photosynthesis. With so many of them photosynthesizing there is a higher uptake of CO_2 occurring in this part of the Atlantic. The carbon of the CO_2 is used to build new parts of the cell and when the diatoms die and sink to the ocean floor, they take the carbon with them. Dr. Carpenter's research quantifies the size of the blooms and the percentage of diatoms that are symbiotic with the diazotrophs.

With funds from National Science Foundation (NSF), Drs. Wim Kimmerer and Sarah Cohen are investigating feeding and food limitation of the early life history stages of copepods. Copepods are abundant in aquatic environments and are an important food source for many organisms, including small fish. Even though they are one of the most common members of the plankton, research about their early life history is limited. The Kimmerer Laboratory is researching what copepods eat, how fast they eat and the impacts of limited prey on their feeding and growth. The Cohen Laboratory will use molecular techniques to identify prey items in the guts of copepods from their DNA. Information on what they eat and how they respond to their food environment is essential to understanding the population dynamics of copepods, and ultimately their roles in marine ecosystems.

Copepod. Photo:Toni Ignoffo

copepods - small crustaceans found in the ocean and nearly every freshwater habitat

pelagic - relating to or living in open water rather than waters adjacent to land or inland waters

A three-year study to investigate the decline of pelagic organisms, including fish, in the San Francisco Bay-Delta is also just getting underway. This collaborative study involves State and Federal agencies and RTC scientists Drs. Wim Kimmerer, Lindsay Sullivan, Jonathon Stillman, Richard Dugdale and Alex Parker. U.S. Department of the Interior funds will support this multi-task research to investigate delta smelt feeding and food web interactions, response of an invasive clam to various salinities, concentration and fate of ammonium, pri-

marily from waste water treatment in the Sacramento River and Delta, and the influence of elevated ammonium which may negatively affect phytoplankton growth.

Global climate change is predicted to increase the frequency and severity of extreme weather events, including heat waves. Intertidal zone organisms have evolved tolerance to elevated temperatures that occur when low tide coincides with hot days, but maintaining that tolerance requires energy. Just how much energy is needed, and how much more energy might be required in future climate is not known. Through research funded by a NSF Research In Undergraduate Institutions (RUI) grant, Dr. Jonathon Stillman and his laboratory are investigating the energy requirement by examining thermal tolerance and metabolism in different life history stages of multiple species of porcelain crabs adapted to different thermal environments. Adults of some porcelain crab species live high in the intertidal zone and maintain higher heat tolerance than other porcelain crab species that live low on the shore, whereas larvae of both species live in the ocean and experience the same temperatures. By comparing the cost of living in these two environments in each of the porcelain crab species, the Stillman Lab hopes to identify how much more energy it requires to be thermally tolerant. These findings will help us understand how intertidal zone organisms will respond to changes in habitat temperature that are associated with climate change. ■

Porcelain crab larvae. Photo: Jonathon Stillman

life history stages - the various forms an organism expresses, beginning with its reproductive cells and ending with its adult form

MAKE A DIFFERENCE TODAY!

Take time now to send your tax-deductible donation.

Your investment in marine and estuarine studies today is an investment in your family's tomorrow for cleaner and healthier oceans, bays and estuaries. Your donation will support student scholarships, scientific diving and small boat training, research equipment, educational trainings, community seminars and important greening projects at RTC!

Please use the attached envelope or clip out this form and mail today! Thank you!

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TELEPHONE* optional_____ DONATION AMOUNT _____

Make checks payable to: University Corporation, SF State (in the memo line please write: Romberg Tiburon Center)

Please mail to: Romberg Tiburon Center, 3152 Paradise Dr., Tiburon, CA 94920

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!*

bayside

San Francisco State University's Field Station on the Bay • Romberg Tiburon Center for Environmental Studies • Fall 2010

DISCOVERY DAY 2010

"Science in your backyard and beyond!"

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. It's all about educational fun that includes marine animal touch tanks, scientific exhibits, art, and more. Adults and kids alike are sure to enjoy the day.

Sunday, October 10
11:00 am to 4:00 pm

Free admission and parking!
See you there!

RTC Seminar Series

Want to learn more about Chinook salmon conservation, upwelling and marine larvae, Chinese mitten crabs or SF Bay conservation efforts? These topics and more are covered in our weekly seminar series. It's free and open to the public.

Join us Wednesdays at 3:30 during Spring and Fall semesters.

Visit rtc.sfsu.edu/seminar.htm for the schedule, titles and location.

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