Coastal Studies Center

Annual Report Number 10 • September 2010-August 2011

Michael Kolster, Coastal Studies Center Advisory Committee Chair

Bowdoin College and the Coastal Studies Center was very fortunate to have Ted Ames become the 2010-2011 Coastal Studies Scholar. Rather than teach a single course, mentor students and give a presentation, as is typical for this position, Mr. Ames' residency took a different tack. He gave visiting lectures to more than 200 students in classes across campus- from Introduction to Environmental Studies, and Natural Resource Economics and Policy to Biomathematics, in addition to working individually with students on analysis of historical fisheries data, and giving more than 12 presentations on and off campus.

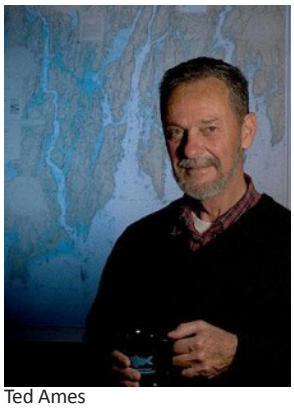
More important, the collaboration between Mr. Ames and Bowdoin faculty and students will continue beyond this residency, through participation in a collaborative multi-year research project funded by Sustainability Solutions Partners.

Coastal Studies hosted a National Ocean Symposium in October, bringing over 100 stakeholders and experts to campus to discuss final recommendations form the Interagency Policy Task Force on changes to national ocean policy. In the Spring Coastal Studies partnered with faculty from Earth and Oceanographic Science to bring experts from around the world to campus to discuss cyanobacteria and human health, a workshop that explored linkages of this toxin to human and animal neurological disorders, including Parkinsons, and Lou Gehrig's Disease (ALS).

The summer research season was robust- if you have the time and interest, visit the Coastal Studies Center student research page to view the student's Pecha Kucha Presentations at: http:bowdoin.edu/coastal-studies-center
Thank you for your interest in Bowdoin's Coastal Studies Center. We welcome you to visit the property and see for yourself what a special place it is.

Coastal Studies Scholar

Ted Ames, a founding board member of Penobscot East Resource Center and senior advisor became the 2010-2011 Coastal Studies Scholar.


Ted Ames

Penobscot East Resource Center is a non-profit organization on the dock in Stonington, ME with a mission of building marine stewardship at a local community level. The Center serves fifty fishing communities from the islands of Penobscot Bay to the Canadian border. Captain Ames fished commercially for 28 years. He was formerly Vice-Chair of the Maine Department of Marine Resources Hatchery Technology Committee, Executive Director of the Maine Gillnetters Association and director of Alden-Ames Lab, an environmental and water quality laboratory. He received his Bachelors and Masters Degrees in Biochemistry from the University of Maine and was an instructor/teacher of chemistry, biochemistry, and environmental science for ten years. He has authored several peer-reviewed articles on historical fisheries ecology, fishermen's ecological knowledge, and related subjects. Ames is the recipient of a 2005 MacArthur Award, and the 2007 Geddes W. Simpson Distinguished Lecturer at the University of Maine.

IN THIS EDITION:

A Publication of the Bowdoin College Coastal Studies Center.

For more information contact :
Bowdoin College
Coastal Studies Center
6700 College Station
Brunswick, Maine
Phone: 207-725-3396
Web: bowdoin.edu/coastal-studies-center

Bowdoin

Ted has been a member of a multi-year collaborative project with scientists and students from Bowdoin, Bates, the University of Southern Maine and the University of Maine, and with stakeholders throughout Maine's Kennebec and Androscoggin watersheds. The project is examining the ecological recovery of the Androscoggin and Kennebec rivers, their common estuary and nearshore marine environment. The group is working to identify and model the ecological and socioeconomic constraints hindering more complete ecosystem recovery, and to predict the economic benefits of further recovery under different scenarios of habitat restoration and dam removal. This collaborative endevor is a Sustainability Solutions Initiative EPSCor project. More information on this project can be found on the website: https://research.bowdoin.edu/rivers-estuaries-and-coastal-fisheries/

Five Bowdoin students completed independent study projects related to the ESPCoR iniative with Ted Ames this year. Sarah Ebel '10 researched the role of community based fisheries, examining in particular the role of women in community based initiatives. Sarah is the recent recipient of a Watson Fellowship that will enable her to continue her research during 2010-2011, looking at case studies of community based fisheries in New Zealand, Belize, Argentina, and Tanzania.

Andy Bell '10 and Elsie Thomson '11 worked with Ted in the fall using his data on historic fish abundances. Ted has mapped 1920's fishing grounds throughout the Gulf of Maine based on an analysis drawing on interviews he conducted with fishermen. Using this historic fish population data, Bell and Thomson investigated how spatial characteristics such as substrate and depth impact the distribution of different fish species (current fish populations in the Gulf of Maine are a fraction of historical stocks). This work will help identify critical habitat characteristics for different fish species as well as continue to add to understanding of fish movement (and life history). These advances will support future management and recovery plans for the Gulf of Maine. In the spring, Catherine Johnston '11 and Cory Elowe '10 completed independent study projects that built upon this earlier work.


Corey Elowe, Catherine Johnston and Ted Ames

Ted guest-lectured throughout the year at Bowdoin in courses ranging from biology, environmental studies, economics, English and mathematics and also met with high school students from Deer Isle in Stonington, ME who were touring the college and meeting with students at Bowdoin. Ted's role with the high school students was to inspire them to consider attending college, which he could speak to with relevance having grown up on nearby Vinalhaven Island.

In October, Ted gave a presentation to the National Ocean Symposium at Bowdoin, speaking on "Maine Spatial Planning and Commercial Fishing in the Gulf of Maine." In November Ted was featured in the Kennebec Estuary Land Trust speaker series, and presented a seminar to Bowdoin faculty and staff. He also guest lectured in an Ecology and Policy of Maine's Rivers class at the University of Southern Maine, and in February, presented at Maine Audubon Society. Ted and John Lichter gave a joint presentation at the Harvard Forest in Petersham MA in late spring.

Research and Teaching

Many students taking courses in biology, earth and oceanographic science, and environmental studies, routinely visit the Coastal Studies Center (CSC) to conduct field and lab work. For example, students in Behavioral Ecology and Population Biology, taught by Professor Nat Wheelwright (Biology) and Lab Instructor Nancy Olmstead, learn to identify common trees and shrubs, and to collect insects, and fungi. Students in Biology of Marine Organisms, taught by Professor Amy Johnson and Lab Instructor Janet Gannon, explore the adjacent mudflats every fall and bring back worms and clams to study in the marine lab. Students in Biology of Marine Mammals, taught by Professor and Bowdoin Scientific Station Director Damon Gannon, conduct sound transmission experiments off the Bowdoin dock to investigate differences in how low- and high-frequency sounds propagate in shallow water; they also conduct experiments to investigate how background noise affects the detectability of a specific signal. The goal of these measurements is to understand the constraints on communication and echolocation imposed by the environment.

Students in Perspectives in Environmental Science use the CSC to study forest plots and collect data on tree growth. These data are used to examine the rate of carbon sequestration occurring on the property (using growth as a proxy). Scientists have wondered whether rising atmospheric CO_2 concentrations will lead to rising uptake of CO_2 by plants, since CO_2 is required for, and perhaps limits the rate of, photosynthesis. This "fertilization affect" hypothesis predicts that as the concentration of CO_2 rises, plant growth (and thus carbon sequestration) will also increase. The data collected by this year's students joins a long-term dataset started by Professor John Lichter.

The Coastal Studies Center participated in a cooperative study between Acadia University (Nova Scotia), Bird Studies Canada (Ontario, ON), the University of Guelph (ON), and the Maine Coastal Islands National Wildlife Refuge (ME) tracking migratory songbirds in the Gulf of Maine. The study monitored the migration of radio-tagged passerines across the Gulf of Maine, Bay of Fundy and in Southwestern Nova Scotia. Automated telemetry towers were deployed along the coast of Maine, including the Bowdoin's Kent Island Station and Coastal Studies Center, in an attempt to detect broad-scale movements made by migrants traversing the Gulf of Maine from Nova Scotia and migrants moving down the coast of Maine from Bowdoin's Kent Island.

Geology boat

Students in a course on Marine Geology use the 'Seaway" at the Coastal Studies Center for chirp sonar surveys, bottom sediment grab sampling, and hydrographic profiling, while those studying coastal oceanography use the boat to conduct eelgrass surveys, time series sampling of water properties and hydrographic profiling.

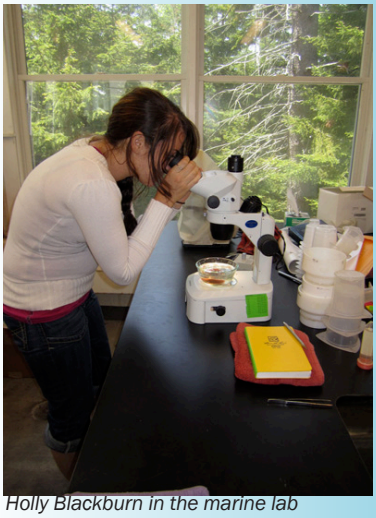
Summer at the Lab

During his last year as the Doherty Marine Biology Postdoctoral Scholar (2009-2011), Dan Thornhill, completed his work on the effects of ocean warming and acidification on coral calcification with Professor Johnson and Bowdoin Senior Honor students Roger Brothers and Laura Newcomb. Both Laura and Roger (class of 2011) were accepted into prestigious Ph.D. programs. Roger is at the University of North Carolina at Chapel Hill working on turtle migration, and Laura is studying the effects of ocean acidification on intertidal molluscs at the University of Washington's Friday Harbor Laboratory. Last year Dan also worked with two other honors students: Will Hatleberg ("The diversity and phylogenetics of marine siboglinid worms") and Lisa Walsh ("Distribution of Symbiodinium on a Florida Keys reef"). In January, Dan moved on to a position as Coral Reef Marine Scientist at the Defenders for Wildlife in Washington D.C. There he is involved in combining research and science-based advising for policy makers, especially with respect to issues involving coral reefs.

This summer Trevor Rivers joined the Bowdoin faculty as the new Doherty Marine Biology Postdoctoral Scholar. Trevor arrived in June and immediately began working at the Bowdoin marine lab with Tamara Perreault ('12) studying bioluminescent-based predator avoidance in a marine worm. Trevor did his Ph.D. at Cornell University studying vision-based behavior in marine systems, with a particular focus on bioluminescence. Trevor is also interested in the role of anthropogenic light (light pollution) on the behavior of marine animals, from the individual to the community level, and is concurrently working on a project studying the effects of light pollution on fouling community structure.

Seven other Bowdoin students worked as a team at the marine lab, in the surrounding ecosystems and back at the Bowdoin campus on a variety of projects with Professor Johnson. Six of the projects continued to explore aspects of the long-term study on the effects of climate change – temperature and ocean acidification - on sea urchin growth and metabolism. In addition, pairs of students focused particularly on their own aspects of the broader project: Alex Fahey ('12) and Sara Davenport ('13) looked for temperature and pH (ocean acidification) cues in skeletons of urchins that were grown under controlled conditions of pH and temperature over the last two years by Alex Brasili ('10) and Roger Brothers ('11); Katie Guttenplan ('12) and Anna Chase ('13) collected, measured and randomly sorted several hundred urchins (ranging in size from <0.1 mm to nearly 80 mm) into six aquaculture tanks – each at a different temperature - to study size-specific effects of temperature on sea urchin growth; Maren Askins ('12) and Gina Lonati ('12) took this research into the field – doing the first ever growth studies that matched growth of urchins outplanted into six tidepools at Cedar Beach, Maine with simultaneous growth of matched urchins in the marine lab. Jake Shorty ('12) worked on understanding the physical factors that determine the distribution of rock gunnels in intertidal tidepools.

"The question I find most fascinating is 'why do animals luminesce?' Although much is known about the physiology and chemistry of luminescence in many systems, much less is known about how it is used in nature. I use low-light videography, night vision, and other technologies to explore the ways organisms utilize light for various purposes such as courtship and predation defense." Trevor Rivers, Doherty Marine Postdoctoral Scholar



Holly Blackburn in the marine lab

Visiting Research

Jonathan Allen is Assistant Professor of Biology at William and Mary College in Willliamsburg, VA. From 2005-2008 Jon was the Doherty Marine Biology Postdoctoral Scholar at Bowdoin, and has returned each summer since 2008 with students to conduct summer research at the Bowdoin marine lab at the Coastal Studies Center. Jon and his students focus their research on the life histories of marine invertebrate animals. They study the ecology and evolution of larval forms in diverse organisms including sea urchins, sea stars, snails, crabs and other invertebrates. They are particularly interested in how changes in maternal investment affect larval and juvenile development.

Holly Blackburn's project was 'Tricking the embryo: Blastomere separation in deuterostome'. Holly examined whether cell fates are specified by the number of cleavages embryos undergo or by the information received from neighboring cells during development. A central paradigm of developmental biology is that deuterostome phyla (Echinoderms, Chordates etc.) exhibit radial and indeterminate cleavage during early development, which results in the production of equivalent cells within an embryo. Despite more than 100 years of experimental embryology though, basic mechanisms of cell specification remain unclear.

Graduate student **Kelly Hoolihan**, researched developmental plasticity in mudsnails (*Ilyanassa obsoleta*) and compared developmental responses to both native predators, such as hermit crabs and rock crabs, and invasive species, such as the green crab and Asian shore crab.

Jordan Salyers worked on 'Estimating predation rates in juvenile sea urchins'. Three decades ago, the urchin population in the Northern Atlantic experienced a dramatic decrease due to overfishing. In the subsequent decades, reestablishment of a successful urchin population has been difficult. Jordan's project sought to determine the causes of poor reestablishment. As research continues, these data will be used to determine the predators of juvenile urchins, the effects of different juvenile backgrounds on predation, and, consequently, the possible cause of slow urchin population reestablishment.

Daniel Schwab researched 'The effect of maternal size on reproduction and larval development in the mud snail *Ilyanasa obsoleta*'. Maternal effects occur when the phenotype of an individual is influenced by the phenotype of it's mother. This experiment demonstrated how maternal size effects can mediate adaptive responses to predators, as well as how these effects influence growth and development across generations.

Student Fellowships

Eighteen Bowdoin students were awarded fellowships for coastal or marine faculty mentored research this summer. Four of these students received summer fellowships to join a collaborative EPSCor project with scientists and economists from Bowdoin, Bates and the University of Southern Maine focused on the ecological and economic recovery of the Kennebec and Androscoggin watersheds.

All the students, including those from William & Marry College gave Pecha Kucha presentations (20 slides/ 20 seconds per slide) on their research, or art projects over two days in late July.
Watch the presentations posted on the Coastal Studies Center webpage: bowdoin.edu/coastal-studies-center


Coastal Studies Summer Research Fellows


Pecha Kucha student presentations

Amy Anderson, '12 was awarded a **Doherty Fellowship** to work with **Collin Roesler** (Earth and Oceanographic Science). Her project was titled: 'Modeling nutrient dynamics at the Harpswell Sound Buoy: Nitrate and nitrate and how they relate to *Alexandrium fundense*

Amy gathered and analyzed data collected from the oceanographic buoy in Harpswell Sound to determine the role inorganic nitrogen plays in occurrences of Alexandrium fundense, the harmful algal phytoplankton species that causes paralytic shellfish poisoning (PSP), colloquially known as red tide, in coastal Maine.

Harpswell Sound is a sentinel site for A. fundyense appearance and early closure for PSP toxicity in shellfish. With Dr. Roesler's assistance, Amy measured the concentration of nitrate hourly using ultraviolet absorption spectrum so that the nitrogen concentrations could be temporally compared to the phytoplankton observations to shed light on the role nutrient dynamics play in red tide occurrences.

Anne Hayden (Environmental Studies) and **DeWitt John** (Government & Environmental Studies) advised **Bess Carter** '13, a recipient of a **Rusack Fellowship** for her project: 'Analyzing the role of Non-Governmental Organizations (NGOs) in creating fisheries policies that protect the socio-economic interests of coastal communities while stabilizing fish populations'.

Interested in the turbulent history of overfishing and ineffective regulations governing New England fisheries, Bess researched the role played by local, regional and national NGO's in fisheries management. Bess examined the evolution of NGO involvement since the 1990's, interviewing representatives from the lobstering and groundfishing industries to analyze the effectiveness of NGO strategies to influence fisheries management and policy.

Anirudh Sreekrishnan '12 was awarded a **Doherty Fellowship** to work in **Patsy Dickinson**'s lab (Chemistry) researching 'The effects of molt hormone (20-hydroxyecdysone) on the modulation by histamine in the cardiac ganglion of the Homarus americanus'.

Since histamine has been implicated in human cardiovascular functions and possibly linked to the molt cycle of lobsters, it is a good candidate to study in the cardiac ganglion. The hormone responsible for molting is 20-hydroxyecdysone (20-HE), has a connection to changes in behavior in the cardiac system. This research project sought to examine whether the effect of histamine on the whole heart depends on the lobster's molt stage. Anurudh expected to find that the effects of histamine vary depending on the lobster's molt stage. This research can be taken a step further, by looking at only the isolated cardiac ganglion in order to get a sense of the mechanism of this process.

LaShaye Ervin '12 and **Colin Oglivie** '12 received **Rusack Fellowships** to study the 'Proliferation of Eastern Dwarf Mistletoe (*Arceuthobium pusillum*) infection in red spruce (*Picea rubens*) and white spruce (*Picea glauca*) with professor **Barry Logan** (Biology).


La'Shaye and Colin

Eastern dwarf mistletoe is a plant that is completely dependent on the red or white spruce tree for survival. Mistletoe manipulates the morphology of its host by altering the tree's contents of abscisic acid and creating vigorous and chaotic branch growth, known as witches' brooms. Red and white spruce have different tolerances to infection with white spruce usually dying as a result of infection, and red spruce tolerating infection, often with few obvious indications of whole-tree stress. The mechanism underlying the difference in dwarf mistletoe tolerance of the two species is not known, however this project will provide information on the extent to which both species are endophyticaly penetrated by the parasite. LaShaye and Colin note that mistletoe appears to be capable of greater manipulation of host white spruce development and physiology, which benefits the parasite but hampers tree survival. They propose that greater manipulation requires more intimate contact between the parasite and its host. They hypothesize that they will find parasitic penetration to be greater in white spruce than red spruce.

Community Service & Outreach

Spindleworks is a non-profit art center for adults with disabilities in Brunswick Maine. This is the second year Spindleworks artists have visited the Coastal Studies Center.

The Spindleworks program strives to immerse the artists in their community and the local environment as often as possible. Field trips are a regular part of each month throughout the year. As often as the weather allows, outings include trips to local natural spaces to sketch and paint on site. The Coastal Studies Center provided a perfect launching off point for the artists to explore and find inspiration.


Artists at the Ccoastal Studies Center

On two different days this summer, Spindleworks staff and artists piled into the van with sneakers and sketchbooks for a visit to the Coastal Studies Center. Welcomed by Coral, and starting from the Coastal Studies lab building the group packed up supplies for their field work and plein air painting. Six artists and two staff then chose to hike the mile long path down to Brewer Cove.

With perfect summer weather, the artists observed and documented the natural setting using a variety of media including photography, watercolor and graphite. Enjoying lunch back at the lab, the group got very excited to look out the window to see three deer grazing.

Catherine Johnston '12, **Riker Wikoff** '12, **Michelle Kaufman** '11, and **Daniel Lowinger** '11 were awarded summer research fellowships through **Sustainability Solutions Partners** to work on the 'Ecological and economic recovery of the Kennebec and Androscoggin rivers, estuary and nearshore marine environments' with **Phil Camill** (Earth & Oceanographic Science/Environmental Studies), **John Lichter** (Biology/Environmental Studies), and **Guillermo Herrera** (Economics).

Merrymeeting Bay is a freshwater tidal ecosystem in Midcoast Maine that supports a diverse and complex food web. Historically, migratory waterfowl and anadromous fish thrived in the bay. Human activities led to a collapse of the ecosystem in the second half of the twentieth century. Water quality of the bay was able to rebound much faster than the biotic components of the bay. Populations of submerged aquatic vegetation, macroinvertebrates, and fish are improving slowly. Research this summer focused on mapping vegetation and surveying anadromous fish populations in the bay. The mapping data will be added to a time series describing vegetation change over the past 50 years in the bay. In addition, social research focused on exploring perceptions of change on the Androscoggin and Kennebec Rivers through conducting interviews with stakeholders. By interviewing a wide range of people, we can analyze the differences in the health and action on the two rivers. Economics research examined the scholarship of methods for valuing river restoration, examining hedonic pricing theory, travel cost method, and benefits transfer. The economics research culminated in running focus groups comprised of Maine residents in order to develop a contingent valuation survey to value different scenarios of river restoration.

Mary Lou Zeeman, (Mathematics) advised two students working at the Coastal Studies Center this summer. **Emma Cutler** '13 received a **Clare Booth Luce Fellowship** for her project: 'Climate modeling: Interactions between volcanism, weathering, ice albedo, energy balance, and temperature'. **Keith Heyde** '11 received a **Hughes Family Summer Research Gran**t for his project: 'Modeling population dynamics in linked carbon sequestration and hydrogen production systems'.

Emma worked on developing mathematical models of climate dynamics to learn more about the causes of abrupt changes observed in the paleoclimate record. These models consider ice albedo feedback, changes in the earth's orbit, the carbon cycle, and greenhouse gases. She focused on the relationship between volcanism, silicate weathering, and atmospheric carbon dioxide.

Keith researched algae based carbon sequestration and energy producing systems. Specifically, he looked at algae population dynamics and how this algae population can be used as a potential energy source. Keith was interested in learning if it might be worthwhile to establish an algae filtration system atop Bowdoin's heating plant. He tested three different algal species (botryococcus braunii, dunaliella tertiolecta, nannochloropsis oculata) and measured how their population dynamics were affected by numerous constraints such as light, gas residence time and nutrient loadings, to see how effective these species are at absorbing carbon. All three algae are potential biofuel candidates as well as being potential feedstocks for hydrogen producing bacterium. The end results will give a cursory analysis and suggestion as to whether or not developing a linked, algae based, filtering and energy producing system is a worthwhile venture for Bowdoin College.

Downtime at the Coastal Studies Center

Bowdoin's Women's Basketball team spent an overnight at the Coastal Studies for a well-deserved mini-retreat.

Bowdoin's Circle, a group that provides students with a safe place to discuss thoughts on spirituality and ways to slow down and create meaning in everyday life visited the Coastal Studies Center last December. They stayed in the

farmhouse from Friday afternoon through Saturday morning. They spent a cozy night inside sharing and playing games. In the morning a few ventured out on a sunrise hike and sang songs along the way. It was a very special weekend for all involved.

Doherty Fellowship recipient **Matthew Ramos** '12 worked with **Phil Camill** (Earth & Oceanographic Science/Environmental Studies) on the 'Dynamics of carbon export from Maine watersheds to the Gulf of Maine'.

Coastal ecosystems are highly influenced by the presence of organic matter in the form of carbon, nitrogen, and phosphorus. Dissolved and particulate organic carbon (DOC/POC respectively) are produced in terrestrial ecosystems and transported to the coast by rivers and streams through runoff processes. Carbon mobilization and transport is expected to change drastically in the near future due to changes in land use, temperature, and precipitation. The changing flux of carbon to the coast will alter the biogeochemistry of coastal ecosystems and affect many respects of their functionality, including the severity and frequency of harmful algal blooms and the productivity of local fisheries. To better understand how the changing flux of carbon will alter coastal ecosystems in Maine, this project investigated the processes that factor into carbon mobilization and transport across three major river systems in Maine (Androscoggin/Kennebec, Penobscot, and St. John) to the coastal ocean.

Jacob Shorty '12 was awarded a **Doherty Fellowship** to work with **Damon Gannon, and Amy Johnson** (Biology), to explore the 'Microhabitat selection and intertidal range of the rock gunnel'.

The rock gunnel (*Pholis gunnellus*) is a small, eel-like fish found in the intertidal zone on both coasts of the North Atlantic found from early spring to late fall, The fish moves to deeper waters only when sea temperatures are at their coolest. The rock gunnel plays an ecologically significant role as a primary food source for a variety of larger organisms, including fish, birds (such as the double-crested cormorant), and mammals (such as the river otter). Additionally, it has been identified as an effective environmental sentinel for monitoring contaminant impacts in the coastal environment. Increasing global air and sea surface temperatures associated with climate change are well documented. If water temperature is a limiting factor regarding the rock gunnel's southern range along the US east coast, an increase could significantly decrease availability of suitable habitat. This project will investigate the hypothesis that increasing seawater temperatures are causing a northward shift in the geographic range of the rock gunnel.

Three students received **Doherty Fellowship** awards, to work under the direction of **Amy Johnson** (Biology) in the marine lab.

Anna Chase '13 investigated the 'Effects of temperature on growth rate of the green sea urchin *Strongylcentrotus drobachiensis*'

Increased atmospheric concentrations of CO_2 result in decreased ocean pH as dissolved CO_2 reacts with seawater to form carbonic acid. Ocean acidification has the potential to dramatically impact the ecology of marine calcifiers such as echinoderms. Accumulation of CO_2 in the atmosphere is also associated with increasing ocean temperatures. The interacting effects of increased temperature and decreased pH will result in species-, size-, and temperature-specific alterations in calcification rates in response to climate change. The green sea urchin is also an ecologically and economically important species in the Gulf of Maine. Studying sea urchin growth rates in conditions of differing temperatures will increase our ability to understand how future climate changes may impact this species of urchin. More accurate models of green sea urchin growth could potentially allow for the implementation of more successful management programs in the Gulf of Maine.

Marine Lab Crew

Marine lab student and faculty researchers, and a few friends and family members collected specimens at Giant Steps in Harpswell at the outset of the research season.

Mid-season the group travelled to the Rockland jetty to collect sea urchins. The Bowdoin outing club lent wetsuits for the venture.

The final trip was capped by a call from Margaret Pizer, Jon Allen's wife announcing the imminent arrival of Eliot Jonathan Allen.

Welcome Eliot!
Baby brother to Simon

Katherine Guttenplan '12 researched 'The effects of climate change on the growth of the sea urchin *Stronglycentrotus drobachiensis'*.

As global carbon dioxide levels rise, many marine organisms can tolerate the increase in acidity, but calcifiers, creatures who produce calcium carbonate skeletons, may be more or less able to sequester calcium and carbonate ions into their skeletons. Katherine's goals included: (1) resolving the peak of the urchin growth curve, (2) identifying the temperature optimal for growth, and (3) characterizing metabolic rates of non-reproductive urchins.

Gina Lonati '12 studied 'the green sea urchin *Stronglycentrotus drobachiensis* as an environmental indicator in its response to global climate change'.

The metabolism of marine ectotherms, such as sea urchins, depends on the temperature of the seawater. Thus, increases in ocean temperatures associated with global climate change will alter ectotherms' metabolism, growth, reproduction, dispersal, and longevity. Determining the consequences of climate change on the growth of this sea urchin will contribute to the understanding of the consequences to marine calcifiers in general as well as to the sea urchin fishery specifically. Gina sought to establish the techniques to recapture and identify urchins released into the field, to quantify their growth, and to compare their growth to that of urchins grown under laboratory conditions of controlled temperature and pH.

Maren Askins '12 also reeived a Howard Hughes Medical Institute Fellowship for her project 'Marking and recapturing the Green Sea Urchin, *Strongylocentrotus droebachiensis*, to measure growth rates in the field'.

With help from other summer researchers Maren planted urchins treated into six tidepools at Cedar Beach. She monitored tidepool oxygen, temperature, pH and salinity and recaptured urchins at intervals to quantify field growth rates. Concurrently she treated and grew urchins as a control group in marine lab tanks at ambient temperature to calibrate a growth curve for the field urchins.

Amy Johnson also mentioned two students whose research was primarily conducted on the main Bowdoin campus, with occaisional collaboration with the the Coastal Studies marine lab researchers.

Alexandra (Alex) Fahey '12 and **Sara Davenport** '13 both received **Howard Hughes Medical Institute Summer Fellowships** to continue research on the effects of climate change on sea urchins. Global warming has led to an increase in both ocean temperatures and acidity as oceans absorb atmospheric carbon dioxide. These environmental changes can impact the formation of skeletons by marine calcifiers, such as corals and urchins. Urchins, a type of echinoderm, use the available calcium carbonate in the ocean when constructing their skeletons and are important global contributors to the marine carbon cycle. An increase in carbon dioxide decreases the calcium carbonate available for the sea urchins to use.

Alex and Sara performed skeletal analysis on green sea urchins grown by Alex Brasili '10 which were grown in three different temperature conditions. Alex B. had measured the urchins' growth rates and found that larger urchins (>20 mm in diameter) grew fastest at 7°C and the most slowly at 17 ° while the smallest urchins grew fastest at 14°C. Sara and Alex continued Alex B.'s research by detemtermining skeletal weight. Their preliminary data analysis suggests

In August the Coastal Studies Center (CSC) hosted 30 first-year students who arrived a week ahead of their peers to participate in Bowdoin Science Experience (BSE), a program open to all students interested in science and math, especially thoese under-represented in these fields. BSE students and faculty spent an afternoon exploring the CSC, playing frisbie in the fields, checking out the animals in the marine lab, and learning about what the CSC has to offer for field work and research opportunities. Students and faculty also enjoyed a relaxing dinner at the farmhouse.

Common Good Day brought ten hearty souls out to the CSC for an afternoon of hauling brush and gathering trash and other debris from the intertidal zone. The coastal debris was tabulated for Coastal Cleanup Day, a statewide initiative of Maine's Coastal Program. Participating were neighbers Winnie and James Chen, staffperson Rosie Armstrong, and students, Chrissy Hayes '14, Nora Biette-Timmons '14, Sam Shapiro '12, Kaitlynn Miller '14, Christine Rholl '14, Adrienne Hanson '14, Chester Eng '11, and Elise Thomsen '11.

This Fall we had the great fortune of revitalizing the shuttle out to the Coastal Studies Center from 2-5:30 most Friday afternoons, thanks to Coastal Studies Program Assistant, and driver Coral Sandler. Many students who had not yet visited the property were encouraged to do so. Students studied in the farmhouse, or enjoyed the fields, dock and trails.

"It is my hope that other students will come to love this piece of land as I have".
Coral Sandler '12, Coastal Studies Program Assistant

that skeletal thickness and fraction of body that was skeleton was unaffected by differences in perature, even though growth rate of urchins did differ with temperature. Alex and Sara will apply the same skeletal analyses to urchins grown by Roger Brothers '11 that were exposed to different pH and temperature scenarios. They expect to find that pH will alter size-dependent morphology.

Rachel McDonald '12 received a **Rusack Fellowship** for her project 'Light and Water as Both Subject and Medium in Portraying Maine's Coast'. **Meggan Gould** (Art) advised Rachel on her project.

Two of the most significant forces at play on the coast, that frame and enliven the environment, are light and water. They are constantly shifting, affecting their surroundings and interacting with each other in various ways based on the time of day, the weather, and the time of year. In this project, Rachel worked to observe, discover, and depict how these key but ever-changing elements shape the coastal environment as well as the people interacting with it. She did so by exploring light and water as both the subjects of her art and as parts of the artistic process of portraying them by combining the photographic process of "cyanotyping" with watercolor painting.

Trevor Rivers (Biology) mentored **Tamara Perrault** '12 who received a **Doherty Fellowship** to conduct research on 'Luminescence as a response to predators in the scale worm *Harmothoe imbricate'*.

Bioluminescence has evolved from more than one common ancestor in over 30 taxonomic groups. Their study focused on the luminescent scale worm *Harmothoe imbricata*. Although many studies have analyzed how light is produced by *Harmothoe*, none have specifically considered why it is produced. Their hypothesis was that scale worms use luminescence as a defense against predators. Data was collected from crab species that live in the same intertidal region as the worms: *Carcinus*, *Cancer* and *Hemigrapsus*. Tanks in lab were regulated on a 12-hour light cycle so that it was dark during our day. For data collection, a worm and crab were placed in a 4" x 4" tank separated by a divider. After an adjustment period, the divider was removed and their interaction was filmed using low light cameras and a night vision device (with an infra-red light source). Light levels were measured by a photomultiplier and recorded to disk. Preliminary observations revealed two different luminescent responses. The first was a flashing response from an intact worm that is possibly meant to warn or surprise predators. The second was a bright display from the back half of an autotomized worm, allowing the front half to escape and eventually regenerate.

Coastal Studies Assistant

This Summer I had the great fortune of serving as the Coastal Studies Center Student Assistant. I couldn't have dreamed of a better way to spend the summer before my senior year at Bowdoin. Much of my time was spent getting to know the property users: dog walkers (and their dogs), visitors from as far away as China, Dennis Luescher, our alternate caretaker, the local Sheriff, the Bowdoin housekeepers, marine lab researchers, and many prospective students and their families.

My time was split between tasks at the farmhouse, the marine lab, and the land. In the farmhouse basement, I sorted and boxed shell fragments from an archaeology project researching shell middens left by Native Americans on the property centuries ago. By the end of the summer boxes of shell fragments were relocated to the

Community Service & Outreach

This fall, eleven students, and Lorraine Washburn from Coastal Studies for Girls, (a high school semester program) met Laura Newcomb '11 at the marine lab. Laura explained her research on ocean acidification and its potential impacts on corals and urchins to the group. Students were generally amazed to learn that corals a) were animals; b) that there were corals in New England and; c) that those pieces of coral they were familiar with were covered by something alive. The students learned about experimental set-up, acidification of the oceans, and got a sense of what research is like for undergraduates.

"So again, a very positive experience for the students. For us to be able to have close access to organisms in tanks, even occasionally is also very valuable. Without this resource, we are more limited in the species with which we can interact."

Lorraine Washburn

first floor of Adams Hall. Many hours later, after minor repairs, and a lot of scrubbing the basement was ready for use by Pre-Orientation students who would camp in the field at the end of August.

Lunch breaks on the dock overlooking gorgeous Harpswell Sound were what brought me to the marine lab most days. At the lab I would feed the diversity animals, hose down the floor and clean out the drains. Cleaning and maintaining the most public parts of the property mostly consisted of clearing brush, brush, and more brush! With assistance from Stephanie Pashuti, we made great progress, and with help from the Bowdoin carpenters shop (making planks) and common good day volunteers (2011) we replanked a 42' wet section of the Long Cover Loop trail. Every moment of this summer was a gift. Thank you to all that make the Coastal Studies Center what it is and made my job possible! Coral Sandler '12

Coral Sandler

Coastal Studies Symposia

In October 2010 Coastal Studies hosted a **National Ocean Symposium** that brought over 120 researchers, academics, ocean policy experts, and representatives from federal and state agencies together with other stakeholders to campus to discuss final recommendations from the Interagency Policy Task Force on changes to national ocean policy. These recommendations could fundamentally change marine resource governance throughout the United States' Exclusive Economic Zone, and have significant implications for many stakeholders. Speakers included former Congressman, Tom Allen, Elliot Norse, President of the Marine Conservation Biology Institute, Ron Beck, U.S. Coast Guard, Jim Wilson, Professor of Marine Sciences at the University of Maine, Ted Ames, Coastal Studies Scholar, and co-founder of the Penobscot East Resource Center, and Philip Conkling, President of the Island Institute.

Undergraduate students from Bowdoin, Colby, and Bates Colleges, the University of Maine in Orono, and Augusta, along with graduate students from Maine, MIT, University of Massachusetts, Boston School of Law, the University of Maine School of Law, and Duke University attended the symposium and poster session.

With funding from the Coastal Studies Center, Bowdoin's Earth and Oceanographic Science department hosted a three-day workshop and short course:**'Cyanobacteria and Human Health: Merging Ecology, Epidemiology and Neurologic Disorders** in August. The workshop was focused on the linkages between marine and freshwater cyanobacterial blooms, toxicity, and human health impacts. Approximately 100 people from around the world participated; plenary speakers and invited panelist presented views from medical, environmental and policy perspectives; participants unanimously appreciated the interdisciplinary and trans-organizational approach.

While it would have been satisfying to have more conclusive findings on the range of topics, what the workshop did elucidate is the breadth and interconnectedness of this topic. It also made quite clear that the connection between cyanobacterial blooms and human health will be an increasingly important phenomenon in the future given the proven impacts of cyanobacterial toxins on human health, and the human and climate-change impacts on the environment and cyanobacterial blooms. There is clearly an intensification of use of natural aquatic systems, which are coming under increasing risk. Thus there is an urgency to this problem. The workshop also demonstrated specific gaps in our understanding and the need for focused interdisciplinary research. Our goals for future workshops should indeed focus on formulating white papers necessary to obtain vital funding. To learn more about this workshop, see the webpage: http://www.bowdoin.edu/earth-oceanographic-science/

Conference organizer and Associate Professor of Earth and Oceanographic Science Collin Roesler (left) with Dr. Hans Paerl of the Institute of Marine Sciences at the University of North Carolina at Chapel Hill.

"We're trying to piece together the puzzle," noted keynote speaker Dr. Paul Cox, a leading researcher on cyanobacteria and neurodegenerative illness.

"Our hypothesis requires a really interdisciplinary approach with neurologists, experts in oceanography, microbiology, microchemists." "One of the reasons the gathering at Bowdoin was so wonderful is that it brought all these different people together, many of them for the first time."

Cyanobateria Workshop in Searles Hall, Bowdoin College, August 2011

Honors Projects

***Connotes College of William & Mary student**

Francis Armstrong* (2011) Environmental Induction of Twinning in Echinoids

Andrew M. Bell (2011) Habitat Fragmentation in Estuarine Ecosystems: Food Web Implications

John Roger Brothers (2011) The Effects of Climate Change on the Growth and Calcification of the Green Sea Urchin, *Strongylocentrotus droebachiensis*

Rachel Katherine Eveleth (2011) Formation of elongated garnets in the Spring Point amphibolite, Harpswell, Maine

William Ludden Hatleberg (2011) The diversity and phylogenetics of marine siboglinid worms

Molly Anne Kwiatkowski (2011) The modulatory PS neurons use different neurotransmitters in different locations to coordinate motor patterns in the American lobster, *Homarus americanus*

Laura Anne Newcomb (2011) The effects of climate change on the symbiosis and physiology of the temperate coral *Astrangia poculata*

Lisa Lenoble Walsh (2011) Distribution of *Symbiodinium* on a Florida Keys reef

Connor White* (2011) "The Trait Mediated Indirect Influences of the Blue Crab, Callinectes sapidus on the Foraging Behavior of the Atlantic Oyster Drill, *Urosalpinx cinerea.*"

Members of the Class of 1961 spent the first afternoon of their 50th reunion weekend at the Coastal Studies Center in May (2011). Many ventured to the marine lab to view the diversity animals, and learn about research projects from student fellows and Bowdoin marine biologist Amy Johnson. The tour continued with a walk to the dock and floats for a discussion of the Bowdoin Oceanographic buoy and a view of Harpswell Sound.

Presentations & Exhibitions

* Connotes student, or alumni, ** connotes College of William & Mary Student

All the Bowdoin students presented their research findings at the Bowdoin College President's Science Symposium held on campus in October.

**Armstrong, Francis , '11 (College of William and Mary, summer 2010 researcher the Coastal Studies Center) "Best Student Poster Award" at the Society for Integrative and Comparative Biology meeting Salt Lake City, UT, 3-7 January, 2010.

Note: This is the third time in the last five years that undergraduate research at the Coastal Studies Center has been given this award (Francis has been preceded by: Ben Lake, Bowdoin '07 in 2007, Nick Alcorn, Bowdoin '08 in 2008). The other student researchers receiving this award in 2009 and 2010 were late-stage Ph.D. students.

*Chase, Alison P., Roesler, Collin S., *Hankinson, Samuel J., Teegarden, Gregory, Laine, Edward. The use of spectral reflectance to identify phytoplankton species succession in coastal Maine. Ocean Optics Conference, Anchorage, Alaska, 27 September-1 October, 2010.

*Eveleth, Rachel '11 (Rusack Fellow, summer 2010) presented her research at the Northeastern/Central Geophysical Society of America meeting, March 2011, Pittsburgh, PA.

*Hankinson, Samuel J., Teegarden, Gregory J., Roesler, Collin S., Laine, Edward, P.: Phytoplankton Dynamics in Harpswell Sound, Gulf of Maine. Abstracts with Programs, Joint Meeting of Northeastern and Southeastern Section of the Geological Society of America, 14-16, March 2010, Baltimore, MD. p. 34.

*McDonald, Rachel '12 Light and water as both subject and medium in portraying Maine's coast, Bowdoin's Visual Art Center Fishbowl, 2-14, September 2010.

Teegarden, Gregory J., Hankinson, Samuel, J.*, Laine, Edward, P., Ebel, N., Roesler, Collin S. Chaotic succession and atypical species composition of phytoplankton communities in a HAB-prone embayment in Casco Bay, Gulf of Maine. American Society of Limnology and Oceanography, 20-26, February, 2010, Portland, OR.

*Wolovick, Michael, J., Laine, Edward, P., Roesler, Collin, S., Teegarden, Gregory, J. Influence of Kennebec Discharge and Wind Forcing on Subtidal Circulation in Eastern Casco Bay, Gulf of Maine. American Society of Limnology and Oceanography, 20-26, February, 2010, Portland OR.

Publications

* Connotes student, or alumni

Allen JD, Pechnik JA (2010) Understanding the effects of low salinity on fertilization successes and early development in the sand dollar Echinarachnius parma. Biol. Bull 218: 189-199.

Thornhill D.J., Chilcoat G.C., Hernandez-Pech X., Iglesias-Prieto R., LaJeunesse T.C., Kemp D.W., McCabe-Reynolds J., Rotjan R.D., Schmidt G.W., Shannon T., Todd B.D., Warner M.E., Fitt W.K. (In review) Life and death of reef-building corals: seasonal monitoring in Florida, the Bahamas, and Mexico reveals a connection between host tissue biomass and colony mortality. Submitted to Ecology.

Hilário A., Capa M., Dahlgren T.G., Halanych K.M., Little C.T.S., Thornhill D.J., Verna C., Glover A.G. (2011) New perspectives on the ecology and evolution of siboglinid tubeworms. Submitted to PLoS One.

*Kemp D.W., Oakely C.A., Thornhill D.J., *Newcomb L.A., Schmidt G.W., Fitt W.K. (2011) Catastrophic mortality on inshore coral reefs of the Florida Keys due to severe low-temperature stress. Submitted to PLoS One.

Thornhill D.J., Struck T.H., Ebbe B., Mendoza G.F., Levin L.A., Halaynch K.M. (In prep.) Evolutionary history of cold methane seep Dorvilleidae (Annelida). In preparation for Proceedings of the National Academy of Sciences USA.

Thornhill D.J., Steury T.D., Santos S.R. (In prep.) The ecological and evolutionary implications for population genetic structure and clonality in symbiotic dinoflagellates. In preparation for American Naturalist.

*Hatleberg W., Hilário A., Halanych K.M., Thornhill D.J. (In prep.) Phylogenetics and evolution of symbiotic annelids in the deep-sea. In preparation for Molecular Phylogenetics and Evolution

Xiang Y., Thornhill D.J., Santos S.R. (In prep.) Host specificity and regional endemicity in Symbiodinium populations associated with sea anemones, Aiptasia spp. In preparation for Molecular Ecology

Dickinson, P.S., Wiwatpanit,T. *Gabranski, E.R.,*Ackerman,R.J. *Stevens, J.S.*Cashman, C.R., Stemmler, E.A. and Christie, A.E.. (2009) Identification of SYWKQCAFNAVSCFamide: a broadly conserved crustacean C-type allatostatin-like peptide with both neuromodulatory and cardioactive properties. Journal of Experimental Biology. 212:1140-52.

Coastal Studies Center Faculty & Staff

Faculty Advisory Committee

Michael Kolster (Chair)
Phil Camill
Connie Chiang
Damon Gannon
Anne C.J. Hayden
Guillermo Herrera
Amy Johnson
Susan Kaplan
Ed Laine
Peter Lea
Daniel Thornhill

Staff

Mark Murray (Caretaker)
Mike Chipman and Richard Johnston (Facilities Plumbing Shop)
Dennis Luescher (Alternate caretaker)
Coral Sander (Student Assistant)
Rosie Armstrong (Coordinator)

Photo credit: Marissa Perez