Sea Grant Delaware

University of Delaware | College of Earth, Ocean, & Environment

# Cannon Lab Exhibit Training Manual

July 2013

The primary objective of the Cannon Lab exhibit is to increase the public's awareness about the global environment and the research being done at the College of Earth, Ocean and the Environment and the School of Marine Science and Policy, and Delaware Sea Grant. There's an expectation to attract more visitors to this location, including K-12 school groups and provide visitors of all ages with a comprehensive exhibit experience.

The exhibit will be hosted by campus tour guides. This formal planned tour will deliver a consistent message about the college to visitors. To keep the content up-to-date, plexiglass panels will be used to display current information. They will be exchanged over time and as needed.

# Background:

**Questions and prescribed responses:**

Q. Can we come back to view the exhibits on our own?

A. The University of Delaware has an open campus policy. However, because our facilities are primarily used and designed for research and teaching, we strongly suggest that you schedule a private tour (with a group of 5 or more) through Lisa Dorey dorey@udel.edu. Labs are not open to the public due to safety reasons.

**QR codes:**
Inform people on the tour that cell reception can be variable in Cannon and it may take a long time to access the QR codes. If they wish to utilize them, perhaps they could do so after the tour OR they can scan the codes now and view the content later. In order to access the codes they must have a QR code reader on their smart phone; there are many QR code reader apps available through the app store on your phone. iPhone users might want to try QRReader.

# CEOE Mission:

University of Delaware College of Earth, Ocean, and Environment is involved in the study of the land, sea, and air. Its campuses in Newark and Lewes put it within a 200 mile radius of 15-20% of the U.S. population, with many environmental challenges. We have research projects around the world, as you'll see from the exhibits today.

The exhibit was installed to highlight the current research of our professors and students in the context of the impact, locally, nationally, and globally. Our research changes as environmental needs shift.

Our three areas of primary focus in the college are environmental observing and forecasting; marine renewable energy and sustainability; and ecosystem health and society. We have projects that may fall outside of those areas when specific research needs are necessary to answer topics that we are called upon to address, or when our response to environmental challenges must be faster than planning to do so.

1. Environmental observing and forecasting: remote sensing and satellite receiving stations, underwater gliders (AUVs, ROVs-sturgeons, sharks, penguins, oil spills, and more), underwater acoustics, Delaware Environmental Observing System (real-time weather data)

2. Marine, renewable energy and sustainability: wind energy, vehicle to grid technology (electric cars), marine biofuels, coastal agriculture

3. Ecosystem health and society: ocean acidification, water quality, sea level rise, biological shifts, global carbon cycle, climate, policy and governance issues, natural resource economics, demographic shifts, environmental justice

## News and research updates:

UDaily and other articles on homepage of DE Sea Grant and CEOE homepages include the latest updates.

http://www.udel.edu/udaily/

http://www.ceoe.udel.edu

http://www.deseagrant.org

**CEOE and Delaware Sea Grant Social Media:**

Delaware Sea Grant

www.facebook.com/deseagrant

https://twitter.com/DESeaGrant

http://www.youtube.com/deseagrant

CEOE

https://www.facebook.com/UDCEOE

https://twitter.com/udceoe

http://www.youtube.com/udceoe

## Contacts:

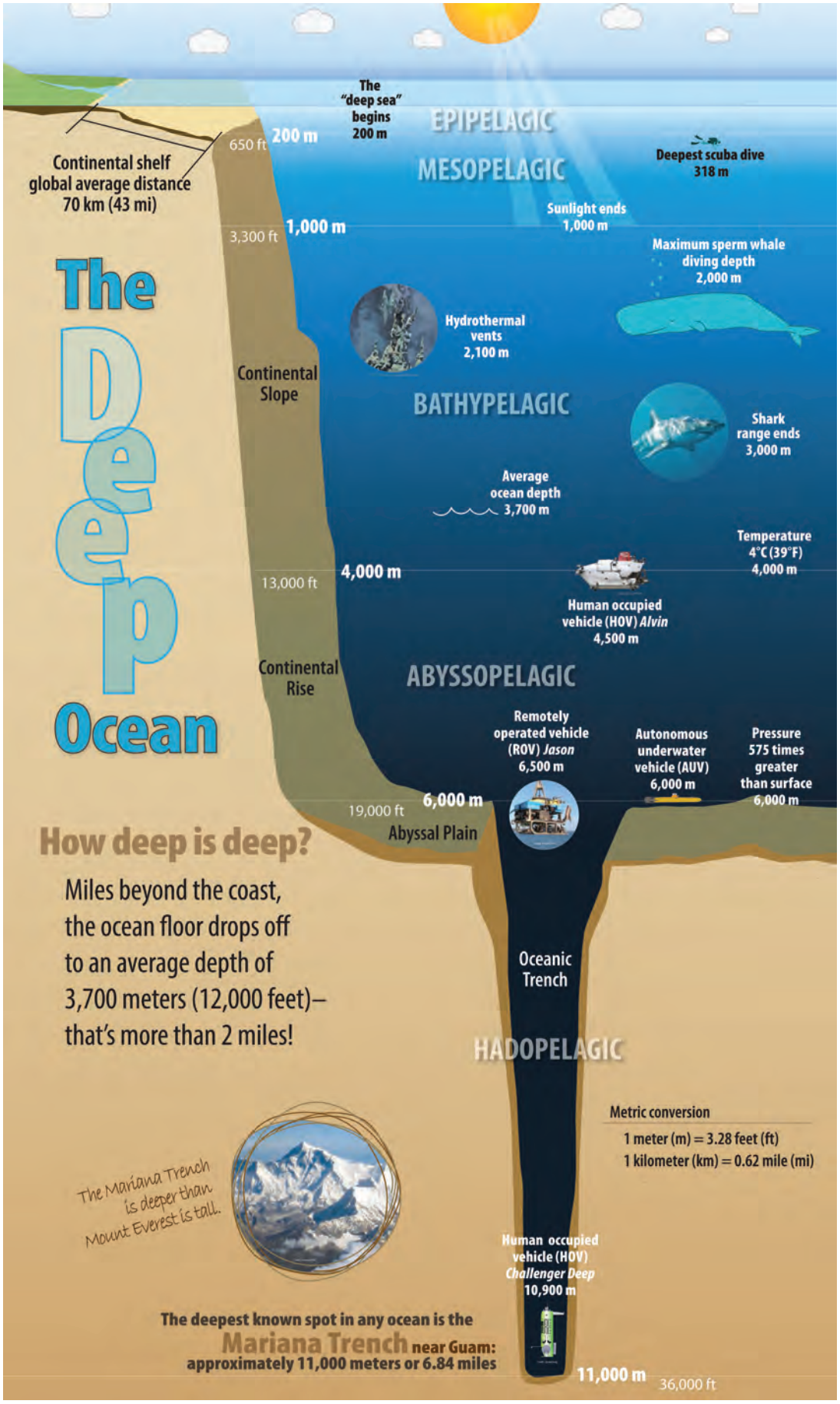
Chris Petrone - Docent Program Liaison - petrone@udel.edu 302-645-4308

Lisa Dorey - Tour Scheduling – dorey@udel.edu 302-645-4234

Environmental Public Education Office, mural content and exhibit resources – Katy O'Connell - kvo@udel.edu 302-831-0566

**We strongly encourage docents to route concerns/questions through the docent leader, Norma Morrison (nmorrison4@verizon.net). Norma can best route those items to the most appropriate individual in CEOE.

# Contents


The Deep Ocean
Continental shelf
global average distance
70 km (43 mi)
650 ft
200 m
The "deep sea" begins 200 m
EPIPELAGIC
MESOPELAGIC
Deepest scuba dive
318 m
Sunlight ends
1,000 m
3,300 ft
1,000 m
Maximum sperm whale diving depth
2,000 m
Hydrothermal vents
2,100 m
Continental Slope
BATHYPELAGIC
Shark range ends
3,000 m
Average ocean depth
3,700 m
Temperature
4°C (39°F)
4,000 m
13,000 ft
4,000 m
Human occupied vehicle (HOV) Alvin
4,500 m
Continental Rise
ABYSSOPELAGIC
Remotely operated vehicle (ROV) Jason
6,500 m
Autonomous underwater vehicle (AUV)
6,000 m
Pressure
575 times greater than surface
6,000 m
19,000 ft
6,000 m
Abyssal Plain
How deep is deep?
Miles beyond the coast, the ocean floor drops off to an average depth of 3,700 meters (12,000 feet)– that's more than 2 miles!
Oceanic Trench
HADOPELAGIC
Metric conversion
1 meter (m) = 3.28 feet (ft)
1 kilometer (km) = 0.62 mile (mi)
The Mariana Trench is deeper than Mount Everest is tall.
Human occupied vehicle (HOV) Challenger Deep
10,900 m
The deepest known spot in any ocean is the Mariana Trench near Guam: approximately 11,000 meters or 6.84 miles
11,000 m
36,000 ft

# The Deep Ocean

**Extreme — Deep Ocean:**
http://www.ceoe.udel.edu/extreme2003/geology/deepocean/

# Adapting to Life in the Deep Ocean

Most ocean life resides near the surface, where light enters the water and food sources are plentiful. In the darker depths, however, animals rely on special traits to survive.


## Large Mouths


Food is scarce in the deep sea, so many fish have characteristics to fit as much food into their bodies as possible when they get the chance. Big mouths, unhinged jaws, and expandable stomachs help these fish capture prey larger than themselves or eat as much debris falling from the surface as possible. The ferocious-looking fangtooth has a big mouth, long, sharp teeth, and a stretchy stomach to catch prey in the dark and swallow it whole.

## Unusual Eyes


Animals have developed various mechanisms for dealing with diminishing sunlight in the deep ocean. Some are blind and use other enhanced senses to find prey. Others have very large eyes (up to 100 times more sensitive to light than a human's) to detect light in the dim abyss.

The colossal squid, for example, has eyes that measure about 25 cm in diameter—the largest in the animal kingdom. The *Histioteuthis* squid has one eye much larger than the other and points upward to detect sunlight, while the other looks down to perhaps detect bioluminescent light. Other organisms, like the amphipod *Scina sp.*, have small red eyes that work very slowly to capture as much light as possible in dim environments, like a camera with a slow shutter speed.

## Camouflage


Camouflage is important in the deep and can mean the difference between getting a fresh meal and becoming a fresh meal. Most fish in the dark depths are black, red, or transparent to avoid being noticed. Red makes for good camouflage because many fish are born blind to the color red since red lightwaves do not reach that far down. One fish, the tasseled anglerfish, blends in with the seafloor and uses a bioluminescent lure to attract unsuspecting prey.


## Gigantism

Some animals in the deep grow to a much larger size than their shallow water equivalents. Oarfish, colossal squids, giant squids, and Japanese spider crabs are examples of these massive marine organisms. The ocean floor is also littered with giant amphipod and isopod crustaceans. Lower metabolisms allow for their large size, and scientists are investigating whether cold temperatures play a role in metabolism and gigantism.

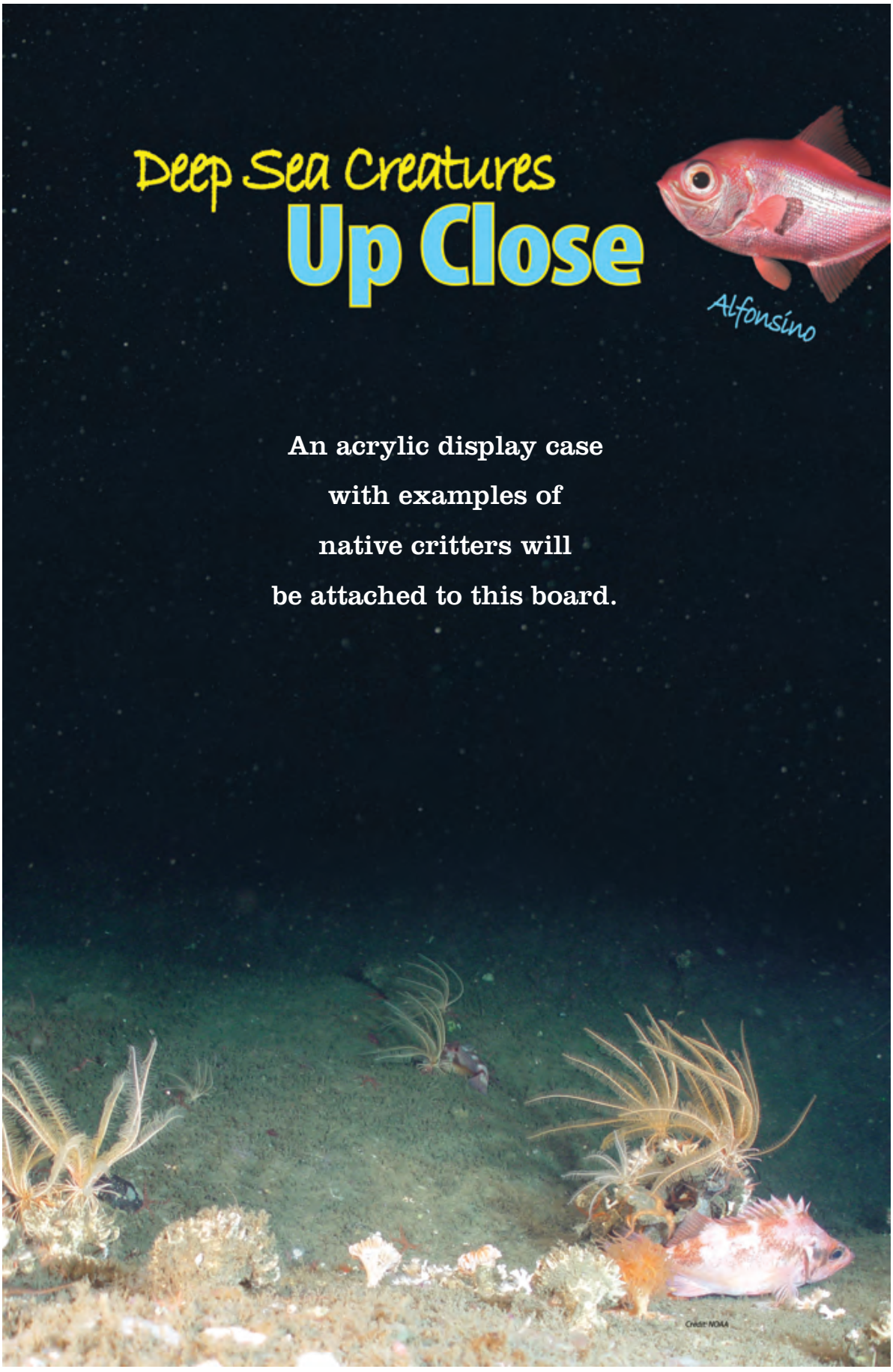
## Bioluminescence

With little or no sunlight in the deep ocean, many organisms that live there produce their own illumination. Special organs give off blue, green, or violet light—called bioluminescence. Some creatures living in the deep ocean get their bioluminescence by producing a chemical in their bodies, while others light up from glowing microbes that dwell inside them. For example, the anglerfish has bacteria residing in its photophores (light-producing blue circles). This symbiotic relationship helps both the bacteria, by providing them a home, and the fish—by providing them with an effective predatory tool.


This light is used to attract prey or mates, and in some cases, distract and confuse predators. The most common deep-sea fish, the lanternfish, has photophores near its eyes and uses them like a car uses headlights. There are even some fish, like the dragonfish, that produce a red light that other fish can't see and do not know when they are being spied on. Krill have photophores dotted all over their bodies to blend in with sunlight to hide from creatures below.


## Enhanced Senses

Not all deep-sea fishes have special light-catching eyes or glow-in-the-dark features. Many have well-developed lateral lines, which are sensory organs that help detect vibrations and movement in the water. Some fish, like the tripod fish, have extra-long fins they use like antennae or hands. They perch on objects and use their fins to feel around until they find prey. Some deep-sea octopi have hair-like projections called cirri that line their webbed arms, possibly helping to sense food in the darkness.


Deep Sea Creatures
Up Close
Alfonsino
An acrylic display case
with examples of
native critters will
be attached to this board.

# Adapting to Life in the Deep Ocean

**NOAA Bioluminescence website:**
http://oceanservice.noaa.gov/facts/biolum.html

**Excerpt from site:**

***Bioluminescence is the production and emission of light by a living organism.***

The light emitted by a bioluminescent organism is produced by energy released from chemical reactions occurring inside (or ejected by) the organism.

If you've ever seen a firefly, you have encountered a bioluminescent organism. In the ocean, bioluminescence is not as rare as you might think. In fact, most types of animals, from bacteria to sharks, include some bioluminescent members. Also, bioluminescent are found throughout marine habitats, from the ocean surface to the deep sea floor.

While the functions of bioluminescence are not known for all animals, typically bioluminescence is used to warn or evade predators), to lure or detect prey, for communication between members of the same species.

**TED Talk Video: Edith Widder — The weird, wonderful world of bioluminescence**
http://www.ted.com/talks/edith_widder_the_weird_and_wonderful_world_of_bioluminescence.html

**Deep Sea Creatures Up Close:**
Each of the organisms on display can be matched to a description like below.

# Observing from Afar

Hundreds of miles above Earth, satellites in space are constantly collecting information about the planet's changing landscape, weather, and other conditions. Our scientists use data beamed back down to study ocean changes and the coastal zone.

Campus real-time satellite receiving station at Willard Hall in Newark, Del.

Our scientists are developing techniques to track oil spills, monitor coastal flooding, and better understand fluctuations in ocean circulation that could be related to climate change. The satellite data also are useful for emergency management agencies in following significant weather and other possible disaster events.

Thanks to two satellite receiving stations installed in Newark in 2010, the University of Delaware is among just a few East Coast institutions that can access real-time, high-resolution satellite data as it streams in from space. The benefit is faster, more up-to-date weather and environmental monitoring.

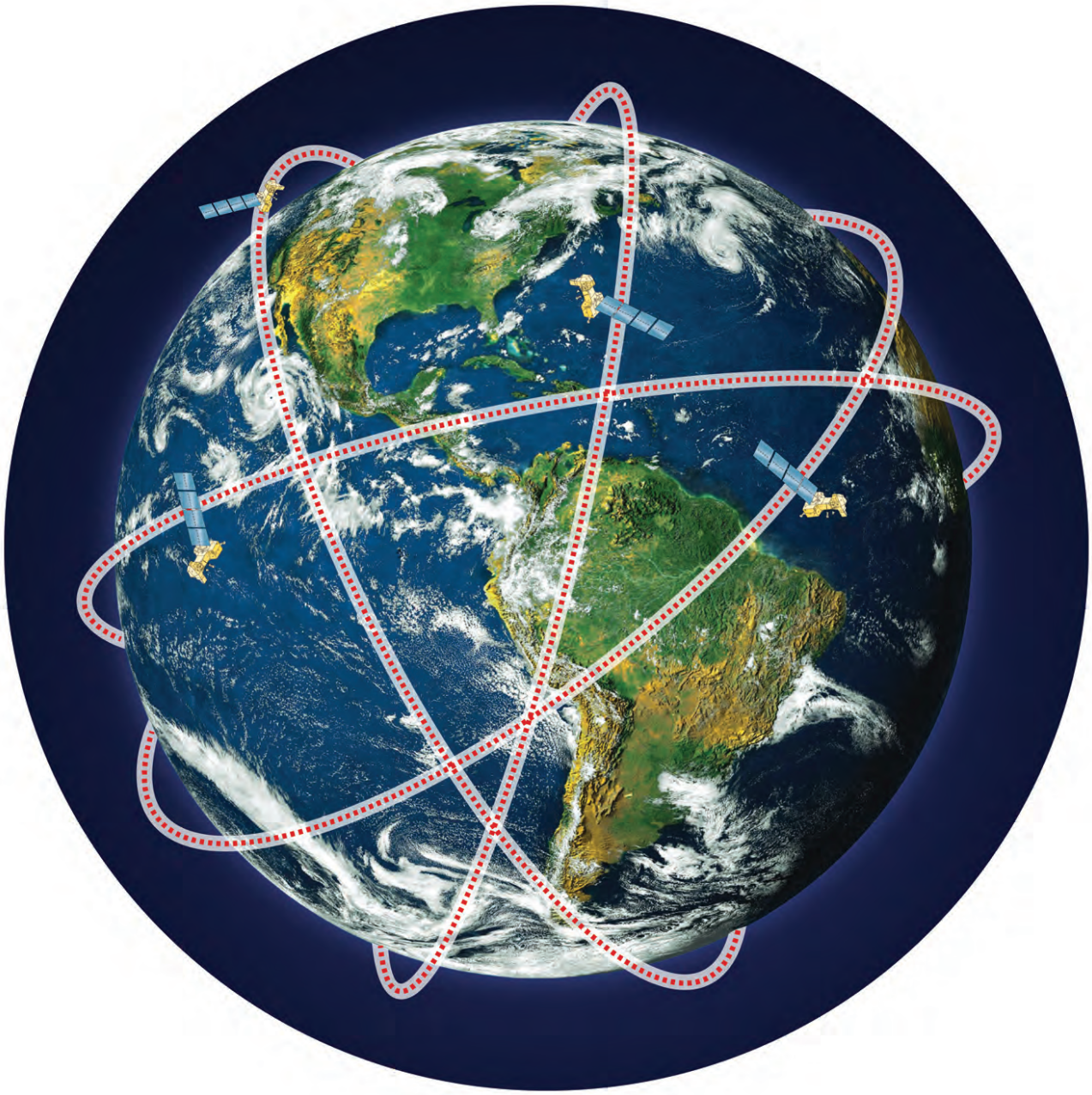
Research vessels, aircraft, and satellites equipped with multispectral, infrared, and microwave sensors are used for gathering data. Advanced computer systems analyze and enhance the satellite imagery. Temperature, salinity, currents, and wind speed are just some of the oceanographic measures that can be determined using remote sensing.

State-of-the-art labs in Newark and Lewes house equipment that produce detailed maps combining large amounts of ocean information. Remote sensing refers to scientific observations made from a distance, typically with specialized sensors on satellites. Aerial photography, radar, and sonar are also considered remote sensing techniques.

***Learn more about our Center for Remote Sensing***

WEB EXTRA

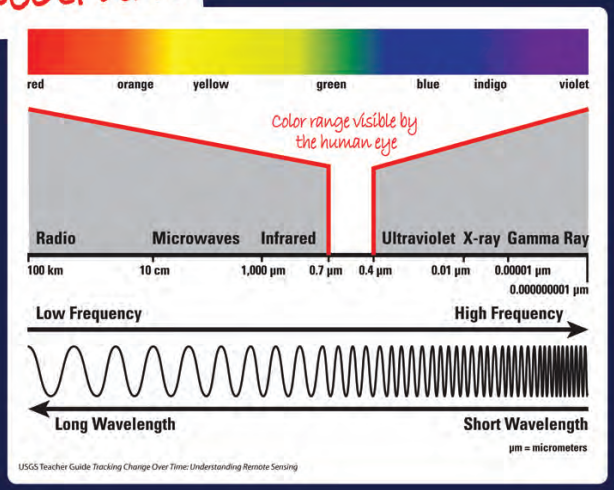
Throughout this exhibit, you'll see QR codes like the one above. Scan them with your mobile device, and you'll be taken to online extras. QR reader app must be installed on your device.



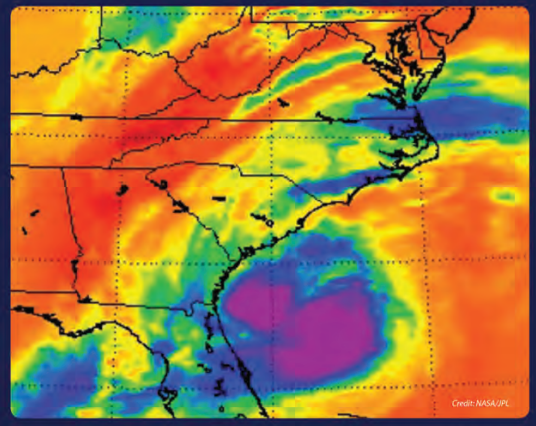
B – Satellite in Space

# The electromagnetic spectrum

The electromagnetic spectrum represents the range of energy frequencies. Long wavelength radio waves are at the low end, while gamma rays are at the high end with the shortest wavelengths. While humans can only see one section of the spectrum, the colors of the rainbow, satellites can detect a broader range that includes ultraviolet and infrared. These invisible frequencies are often assigned visible colors to represent them on satellite maps.




USGS Teacher Guide *Tracking Change Over Time: Understanding Remote Sensing*




Here, a satellite measured various wavelengths that were mathematically converted to determine the temperatures of Tropical Storm Hanna's cloud tops in September 2008.

# Observing from Afar

**UD's Satellite Receiving Station main website:**
http://udsrs.udel.edu/

**Excerpt from SRS site:**

The University of Delaware College of Earth Ocean and Environment's satellite receiving station (UD SRS) was installed on the roof of Willard Hall Education Building in July 2010. The equipment benefits faculty and others who study changes in the mid-Atlantic environment. It has supported a wide range of research projects, including those that monitor coastal flooding; observe coastal waters for harmful algal blooms, which can deprive waters of oxygen; and track changes in ocean circulation that could be related to climate change, and assisting local fisheries. The data produced from this equipment has also been utilized with Google Earth to aid in teaching and educational events.

The UD SRS was purchased with a grant from the National Oceanic and Atmospheric Administration (NOAA), obtained by CEOE Dean Nancy Targett.

The station consists of an X-Band receiver for reception of the MODIS family of satellites which allows for the study of sea-surface temperature, chlorophyll concentrations, land surface temperatures, and vegetation patterns. An L-band receiver allows for the reception of NOAA, MetOP, and Fung-yen satellites to study atmospheric conditions, land surface temperatures, and sea surface temperatures.

**Related UDaily article:**
http://www.udel.edu/udaily/2011/aug/satellite081710.html

**New satellite receiving stations provide real-time environmental data**

12:48 p.m., Aug. 17, 2010 — It's a process that begins 22,000 miles above our heads — satellites collect information about our planet and transmit it back to Earth.

Thanks to two satellite receiving stations installed last month on the Newark campus, University of Delaware researchers will be among the few who can access that data as it streams in from space.

The equipment, located on the roof of the Willard Hall Education Building, benefits faculty and others who study changes in the mid-Atlantic environment. It will support a wide range of research projects, including ones that monitor coastal flooding; observe coastal waters for harmful algal blooms, which can deprive waters of oxygen; and track changes in ocean circulation that could be related to climate change.

One of the receivers provides information on land and ocean surface conditions such as sea-surface temperature, chlorophyll concentration, and currents, while the other focuses on atmospheric and weather changes such as tropical storm activity and temperatures.

"The two stations really complement each other because to understand what's happening in the atmosphere you need to know about what's happening at the surface of the earth and vice versa," said Dan Leathers, professor of geography and deputy dean in the College of Earth, Ocean, and Environment (CEOE). "We have a lot of people in the college who are interested in interactions between the atmosphere and the land and ocean surface."

Leathers, who led efforts to acquire the equipment, received support from a committee of CEOE faculty that included Xiao-Hai Yan, Mary A.S. Lighthipe Professor of Marine Studies; Matt Oliver, assistant professor of oceanography; Tracy DeLiberty, associate professor of geography, and Young-Heon Jo, assistant research professor of oceanography.

Supplied and installed by California-based SeaSpace Corp., the stations cost about $500,000. A National Oceanic and Atmospheric Administration (NOAA) grant obtained by CEOE Dean Nancy Targett funded them.

From their perch atop the Willard Hall Education Building — chosen because it allows a 360-degree view of the horizon with no electromagnetic interference — the receivers collect information on a large swath of the globe. They capture data on the middle of the Atlantic to the center of North America and from Cuba to Newfoundland.

The beauty of having such technology right on campus, said the scientists involved, is that it gives them access to real-time data. There are only a handful of the receiving stations on the east coast, and UD researchers previously had to depend on other organizations to obtain data.

“That meant a delay of hours or even days,” said Yan, who also directs UD's Center for Remote Sensing. “Now we can monitor our coast so we will know right away if there is anything we need to respond to, a significant weather event for example.”

UD researchers also plan to provide that information to others who can use it, including other university and government researchers as well as state government emergency response and monitoring agencies.

Educators at the K-12 level are also expected to make use of the information. The Delaware Geographic Alliance plans to work with teachers to create teaching models that rely on such data for lessons on topics like meteorology or ocean currents.

Another benefit of the technology is that it provides raw data directly from the satellites. The data that come from the satellites give the intensity of electromagnetic radiation at different frequencies or wavelengths, Leathers explained.

“What the researchers really will be doing is developing algorithms or formulas to pull a bunch of those different frequencies and put them together in a way that tells you something,” he said. “They want that raw data so they can come up with algorithms to figure out better ways to look at what’s happening on the earth’s surface.”

Helping facilitate the huge amount of data will be a new technician to be hired this summer. That position, also funded by the NOAA grant, is designed for someone who will be responsible for data storage and dissemination to users.

Article by Elizabeth Boyle

# Hydrothermal Vents: Hot Stuff

You may be familiar with "Old Faithful" in Yellowstone National Park. This famous geyser spouts a column of water heated by volcanic rock deep within Earth's crust. Hydrothermal vents are geysers on the seafloor.

## Where are they?

Most hydrothermal vents occur at an average depth of about 2,600 meters (8,530 feet) along the Mid-Ocean Ridge system—the underwater mountain chain that winds around the globe.

## How do they form?

In some areas along the Mid-Ocean Ridge, the huge plates that form Earth's crust move apart and cause deep cracks in the ocean floor. Seawater seeps into these openings and is heated by the melted rock, or magma, beneath the crust. As the water heats up, it rises. When this "hot spring" gushes out into the ocean, its temperature may be as high as 360°C (680°F).

Above some vents, chimneys are made from dissolved metals that form into particles when the super-hot vent water meets cold seawater. Vent chimneys can grow taller than an 18-story building!

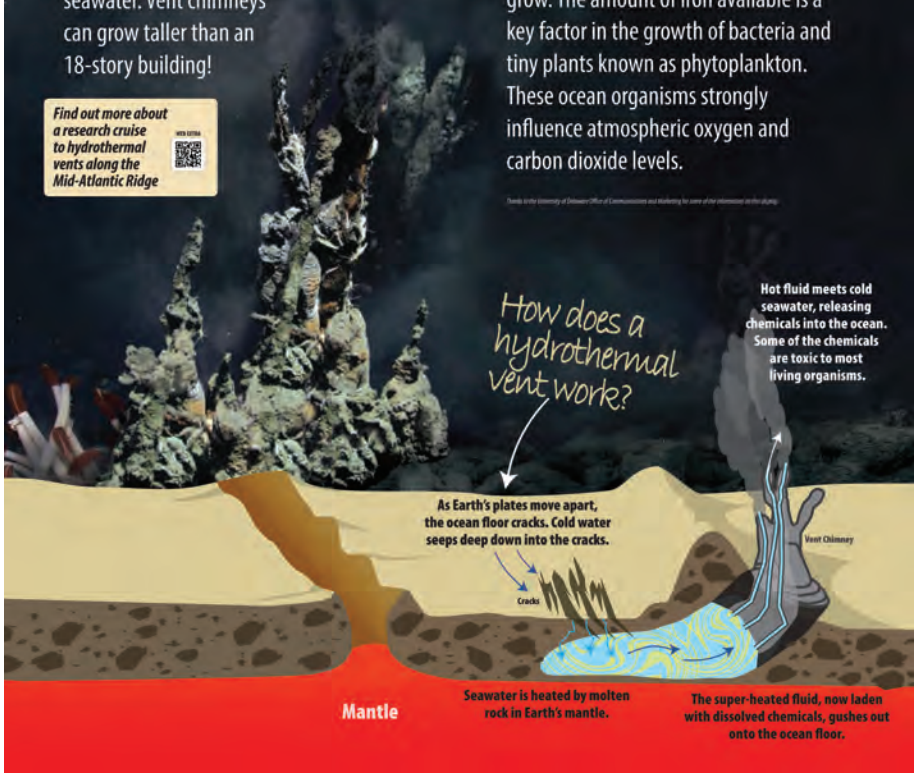
*Find out more about a research cruise to hydrothermal vents along the Mid-Atlantic Ridge*

## Why study them?

There are many reasons why our scientists want to learn more about hydrothermal vents. Some vent bacteria, for example, convert harmful chemicals to safer forms that can be used by other vent creatures. This feature makes the bacteria potential candidates for cleaning up hazardous waste.

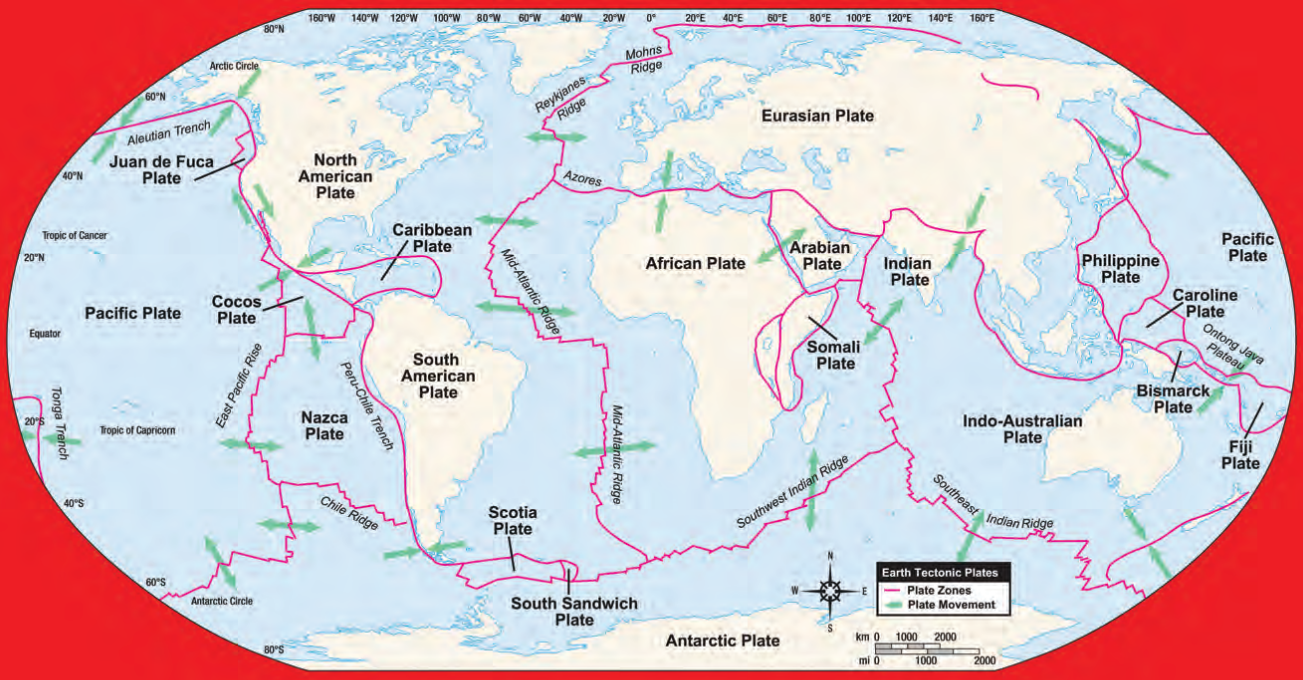
Besides providing habitat for exotic shrimp, giant tubeworms, ghost-white crabs, pinkish eel-like fish, and other mysterious organisms, hydrothermal vents are believed to play an important role in the ocean's temperature, chemistry, and circulation patterns.

For example, scientists believe that hydrothermal vents spew large amounts of pyrite and other iron-rich compounds into the ocean. As pyrite travels from the vents, it gradually releases iron, which organisms use to grow. The amount of iron available is a key factor in the growth of bacteria and tiny plants known as phytoplankton. These ocean organisms strongly influence atmospheric oxygen and carbon dioxide levels.



# Did you know?

Earth's longest mountain range is underwater! The Mid-Ocean Ridge system is more than 65,000 kilometers (40,400 miles) long and snakes between the continents. It marks the areas where Earth's crustal plates are moving apart. This is where most hydrothermal vents are located.



# Hydrothermal Vents — Hot Stuff

**Related UDaily story:**
http://www.udel.edu/udaily/2013/oct/luther-pyrite-vents-102312.html

**Oceanographer leading expedition to hydrothermal vents for pyrite research**

9:06 a.m., Oct. 23, 2012 — that tiny pieces of pyrite, also known as fool's gold, from hydrothermal vents travel long distances deep within the Pacific Ocean. Now, they want to know if that is also true in the Atlantic.

College of Earth, Ocean, and Environment researchers are currently at sea — smack in the middle of the Atlantic Ocean — to find out. Led by George W. Luther, III, Maxwell P. and Mildred H. Harrington Professor of Oceanography, the team is investigating elements gushing from the vents and the implications for surrounding environments.

"Between the Pacific and the Atlantic, we'll have a really good idea of the different kinds of sulfur and iron concentrations coming out of the vents," Luther said.

The crew departed on Oct. 16 from São Miguel, Azores, a small island about 900 miles west of Portugal, for the Mid-Atlantic Ridge, an underwater mountain range that winds longitudinally from near Greenland to south of Africa. They plan to sample vents from three sites — named Rainbow, TAG and Snake Pit — located far off the coast of Morocco and Western Sahara. An expedition blog features updates from the field as the scientific team, which includes several undergraduates, carries out its research.

Hydrothermal vents are formed by cracks in the seafloor that release superheated water and minerals from within Earth's crust. The formations support tubeworms, mussels, crabs and other intriguing life forms that would otherwise have difficulty surviving at such great depths.

Aboard the research vessel Knorr, the scientists are sending the Remotely Operated Vehicle Jason/Medea to the bottom of the ocean to collect samples from vent plumes. The vehicle has titanium major samplers that can withstand very hot temperatures and extend down into the vents to suck water out. The scientists then analyze the water from the samplers for elements including iron, manganese and sulfide.

Luther has developed needle-like electrodes, encased in protective polymers, that take instantaneous readings of the different chemicals in cooler waters near the plumes. He utilized the approach on previous excursions in the South Pacific, helping determine the precise composition of the chemistry near animals living there.

On those trips, his team found that nanoscale pieces of pyrite, 1,000 times smaller than the diameter of a human hair, make up to 10 percent of the iron coming out of hydrothermal vents. Pyrite, which consists of iron and sulfur as iron disulfide, may travel up to 4,000 kilometers away through the ocean at that extremely small size. Given the substance's slow oxidation rate, pyrite-generated iron can get released in remote parts of the deep sea and provide trace nutrients to bacteria, plankton, fish and other sea life.

Luther recently published a paper in the Proceedings of the National Academy of Sciences based on this earlier research. Along with colleagues from Harvard University and other institutions, co-author Luther and graduate student Amy Gartman found that deep-sea hydrothermal vent geochemistry can affect the distribution of bacteria that live in snails. Snails form symbiotic relationships with different types of bacteria depending on the temperature and composition of vent fluids.

On this trip, the researchers will compare even more vents. The Rainbow vent is known to have higher concentrations of iron than sulfides, while Snake Pit and TAG have more sulfides than iron. The scientists hope to determine whether the pyrite nanoparticles are an iron source in the Atlantic as well as the Pacific, suggesting they are ubiquitous for all vents.

"So we can get a real range," Luther said.

Studying the geology, chemistry and biology of hydrothermal vents highlight the intersection of various disciplines in the field of marine science — something the crew hopes to interest future scientists about. Bill Geppert, a marine science and robotics teacher at Cape Henlopen High School in Lewes, Del., joined the journey to communicate with students while in the field. Classes can follow the project by checking the blog and utilizing educational resources available there.

The cruise is scheduled to end on Nov. 8 in Charleston, S.C.

Article by Teresa Messmore

**Related "Extreme" Sites:**
http://www.ceoe.udel.edu/extreme2001/geology/vents.html

**Fun Facts:**

– Hydrothermal vents were discovered in 1977 in the Pacific Ocean.
– Geologist are intrigued by how rapidly vent chimneys grow — up to 9 meters in 18 months.

http://www.ceoe.udel.edu/deepsea/level-2/chemistry/chemo.html

**Excerpt from web page:**

They can withstand a broad range of temperatures - some close to the boiling point, eat toxic chemicals for breakfast, bear the weight of the ocean on their shoulders, and never see the light of day. Such is the life of the organisms that inhabit deep-sea hydrothermal vent sites!

These creatures, from microscopic bacteria to towering tubeworms, thrive under some of the most demanding conditions on the planet. And what further distinguishes them from other life on Earth is their energy source. They are the only complex ecosystem known to live on energy from chemicals rather than energy from the sun.

On land, our food chain is based on photosynthesis, the process by which green plants use the energy from the sun to make food. However, in the deep sea, where the sun's rays never reach, organisms make food from chemicals - a process called chemosynthesis.

**Tiny Bacteria Play Mighty Role**

The hydrogen sulfide and other chemicals that rocket out of hydrothermal vents would be poisonous to most organisms. But tubeworms and other animals flourish here thanks to special adaptations and the relationship they have with the tiniest life at the vents: bacteria.

Bacteria hold the key to life at the vents because these microscopic organisms can convert the toxic chemicals released by the vents into food and energy. So in order to survive, vent-dwelling animals, such as clams and tubeworms, must either consume bacteria or harbor bacteria in their bodies so that the microbes can make food for them.

For example, tubeworms have no mouth, eyes, or stomach ("gut"). Their survival depends on a symbiotic relationship with the billions of bacteria that live inside of them. These bacteria convert the chemicals that shoot out of the hydrothermal vents into food for the worm.

Since a tubeworm has no mouth, how do bacteria enter the worm? Scientists have found that, during its earliest stages, the tubeworm does have a mouth and gut for bacteria to enter. But as the worm grows, these features disappear!

**New Scientific Discoveries**

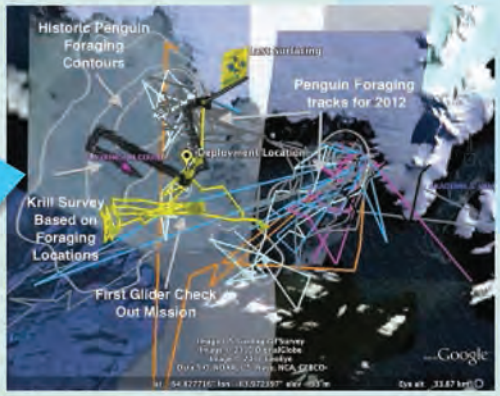
Scientists are particularly interested in bacteria from hydrothermal vents because these microscopic organisms possess enzymes that can withstand high temperature and pressure, giving them many valuable uses in industry. For example, some bacteria can convert harmful chemicals to safer forms, making them ideal for cleaning up oil spills and hazardous waste.

Scientists are also curious about the deep sea's tiniest life because these organisms are among the oldest on Earth. In fact, Archaea (pronounced "ark-ee-uh"), an ancient life form, recently was found at vent sites. Previously, these microscopic organisms had been discovered in another “extreme environment” — hot springs in Yellowstone Park. Like bacteria, Archaea consist of cells without a nucleus, yet more than half of their genes are unlike anything else on the planet!

# Penguins Provide Window into a Changing Environment

What's the best way to study the Antarctic's ecosystem?

**FOLLOW THE PENGUINS**




At our Global Visualization Lab here on the Hugh R. Sharp Campus, scientists can follow the movements of individual penguins. Correlating penguin travels with other environmental information, the scientists hope to gain a better understanding of changes occurring in the far-flung Antarctic ecosystem.

Looking a bit like a child carrying a backpack, this penguin is outfitted with a device that reports the animal's movements.

Our scientists track penguins on land, under the sea, and even from space to unravel the environmental dynamics in the West Antarctic Peninsula as the region experiences climate change.

Rising annual temperatures have had a trickle-down effect around the peninsula, which extends northward from Antarctica toward South America. Warmer conditions have reduced the amount of sea ice and potentially the numbers of shrimp-like krill found in the ocean. Fewer krill means less food for Adélie penguins, whose population has declined 70 to 80 percent in recent decades.

To better understand what is happening, researchers attach harmless tracking devices to several penguins, which then leave their rookeries to swim out to sea and catch krill.

The tracking devices transmit information via satellite about where they have traveled. Here in Delaware, scientists process that data and overlay the individual penguins' routes in colorful, zigzagged lines on a specialized map.

Back in Antarctica, underwater robots called gliders are launched into the ocean to collect temperature, salinity, chlorophyll, and other data along the birds' routes. By analyzing these measurements, the team is trying to figure out which factors influence the penguins' feeding patterns.

Overall the area is becoming less hospitable to Adélie penguins, which are either dying or moving further south where there is more ice.

***Read the latest about this research***

WEB EXTRA

# Penguins Provide Window into a Changing Environment

**Related UDaily article:**
http://www.udel.edu/udaily/2012/jan/oliver-penguins-011812.html

**Penguins provide window into shifting Antarctic ecosystem**

10:33 a.m., Jan. 18, 2012 — What's the best way to study the Antarctic's ecosystem? Follow the penguins.

Scientists are tracking penguins on land, under the sea, and even from space to unravel the environmental dynamics in the West Antarctic Peninsula as the region experiences climate change.

"We're not just down there bird watching," said Matthew Oliver, assistant professor of oceanography in UD's College of Earth, Ocean, and Environment. "This is a concerted effort to put the whole ecosystem together."

Rising annual temperatures have had a trickle-down effect around the peninsula, which extends northward from Antarctica toward South America. Warmer conditions have decreased the amount of sea ice present there, as well as potentially the numbers of krill that feed on phytoplankton nearby. Fewer krill means less food for Adélie penguins, and both populations have declined 70 to 80 percent in recent decades.

To better understand what is happening, researchers are studying this food web in relation to physical properties of the ocean. A team from the Polar Oceans Research Group is currently in Antarctica attaching tracking devices to several penguins simultaneously. The penguins then go about their foraging routines, leaving their rookeries to swim out to sea and catch krill.

Each evening their pre-programmed tracking devices transmit information via satellite about where they have traveled during the previous 24 hours. Computers at UD receive emails from these penguins that describe their locations, and then they process that data and overlay the individual penguins' routes in colorful, zig-zagged lines on a specialized map based on Google Earth.

Next the researchers predict where the penguins' future scavenging patterns will be, taking into account additional information from NASA satellites.

Back in Antarctica, underwater robots called gliders are programmed and sent into the ocean to measure temperature, salinity, chlorophyll and other indicators along the birds' routes. By analyzing these different factors, the team is trying to figure out which elements influence the penguins' behavior.

"As we understand where these penguins are foraging, we want to know what that ocean substructure looks likes," Oliver said.

The goal is to decipher what exactly the penguins are responding to in the water that leads them to forage in some areas but not others. Early results suggest that tides may be a key factor. Oliver hypothesizes that as the tidal phase shifts from one big tide per day to two, the flow of water changes in such a way that it impacts the krill distribution and penguin behavior.

Other hypotheses involve ocean temperature and visual cues. The team will be examining at which depths the temperature is changing a lot, and whether there are certain optical parameters that are important because penguins are visual predators.

Penguins are a good indicator species for environmental change, Oliver said, because they integrate both large- and small-scale physics that affect ecosystem health. Overall the area is

becoming less hospitable to Adélie penguins, which are either dying or need to move further south where there is more ice. Meanwhile other species of penguins, the land-loving Gentoos and Chinstraps, are moving in.

"If you look where the animals are going, they are going there for a reason," said Travis Miles of Rutgers University via videoconference from Antarctica.

Rutgers is partnering with UD on the project by handling glider logistics in the field, and Kim Bernard from the Virginia Institute of Marine Science is contributing by sampling krill populations by boat. The study is funded by NASA in partnership with the National Science Foundation's Long Term Ecological Research (LTER) Network site in Antarctica.

The experiments combine computer science, engineering, oceanography and biology, with researchers and graduate students constantly troubleshooting how to write code and analyze data in meaningful ways.

"We've got animals, robots, people, satellites," Oliver said. "It's been a really neat confluence of technology."

Article by Teresa Messmore

**Sea Talk Penguins:**
http://deseagrant.org/seatalk/sea-talk-video-penguins

**Blog post about penguin research:**
http://www.oceanbytes.org/2011/01/21/penguins-auvs-satellites-together-at-last/

**Excerpt from blog:**

The "Birders", headed by Bill and Donna Fraser, head out to local rookeries to identify good penguins to tag with satellite transmitters. Finding the right breeding pair is key. The pair should have two chicks with both parents still around. Some chicks only have one parent, probably because one parent was killed by a Leopard Seal. We want to choose one of the parents, because we are pretty certain they will return to their chicks to feed them. This also helps in recovering the transmitter. If the bird does not return, the transmitter comes off during their natural annual molt cycle. Once a penguin is selected, it is gently fitted with a satellite transmitter. Special waterproof tape is used to connect the transmitter to the thick feathers on the back of the penguin. The penguins are remarkably calm during the process. Once the tag is attached, the penguin is released back to its nest. The next part of the sequence is for the birds. The penguins head out to feed on krill and small fish in the area. Their tags relay their position information to ARGOS satellites and we get nightly updates.

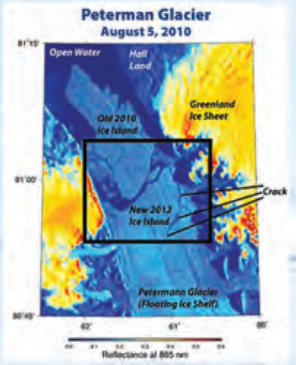
# Polar Research

## A barometer for global climate change

Our scientists conduct research at the far reaches of the globe, including the polar areas of the Antarctic and the Arctic. Studying these remote regions improves our knowledge of organisms that live in the bitter cold and ocean dynamics worldwide.

Sea ice in the Arctic region has declined dramatically in recent decades. Researchers are investigating the role and consequences of rising atmospheric and oceanic temperatures on sea ice loss.

Since 2003, we have been part of an international team that maintains ocean observing equipment in the Nares Strait, a deep waterway between northern Greenland and Canada. Analyzing satellite images and field data, scientists have found that the Arctic has been losing sea ice since these satellite records began in 1979 and the process appears to be accelerating.

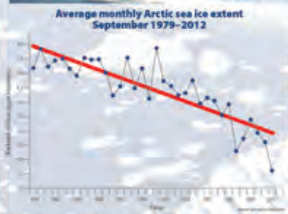


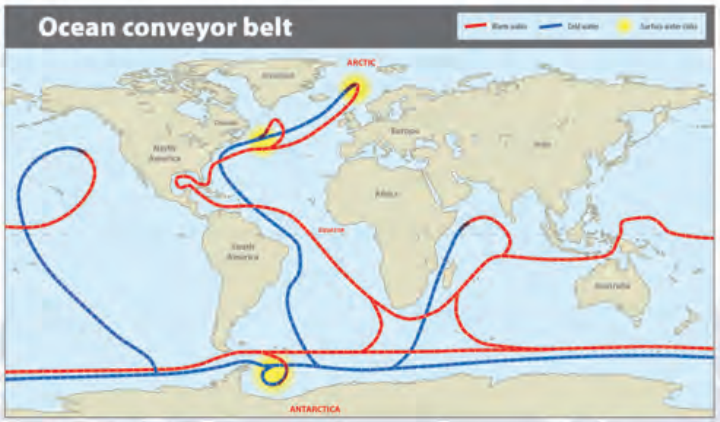

As sea ice melts, large amounts of freshwater are added into the Arctic Ocean. In this region, the delicate balance between freshwater and salt water is changing and affecting circulation patterns.

Variation in wind, temperature, and salinity drive circulation throughout the world's oceans. As currents move from the equator to the poles, they cool, release freshwater in the form of surface sea ice, then sink while emitting heat into the atmosphere. The cold, dense water then returns toward the equator. This cycle is known as the "conveyor belt" which impacts the climate on a global scale. The poles serve as pumps driving this conveyor, which completes a cycle every 1,000 to 4,000 years. Changes at the poles further impact our climate and could increase warming in some parts of the world while cooling others.

**Watch a video of Arctic ice loss firsthand**

WEB EXTRA


**The Arctic**

Defined at the area north of 66° latitude, the Arctic Ocean is nearly covered in ice year-round. In this region, our researchers study sea ice, shipping routes, marine bacteria, and crustacean survival tactics, among other topics, to get a better picture of the roles they play in the global environment.

**The Antarctic**

Our scientists travel to the Antarctic to investigate shifting penguin habitats, genetics of marine worms, and how wildlife is affected by climate change.

**More on Arctic crustaceans**

WEB EXTRA

# Coping with the cold

**Our scientists can face harsh and unpredictable conditions when conducting their polar research.**

**While traveling in icy waters, they wear immersion suits to prevent hypothermia in an emergency. Our scientists typically depart for Antarctica during the winter, which is summer in the southern hemisphere.**

**Fun fact:**
An immersion suit can weigh more than 10 lbs!

**Related UDaily articles:**
http://www.udel.edu/udaily/2013/jul/glacier-071612.html

### Greenland glacier loses ice island twice the size of Manhattan

7:51 p.m., July 16, 2012 — An ice island twice the size of Manhattan has broken off from Greenland's Petermann Glacier, according to researchers at the University of Delaware and the Canadian Ice Service. The Petermann Glacier is one of the two largest glaciers left in Greenland connecting the great Greenland ice sheet with the ocean via a floating ice shelf.

Andreas Muenchow, associate professor of physical ocean science and engineering in UD's College of Earth, Ocean, and Environment, reports the calving on July 16, 2012, in his "Icy Seas" blog. Muenchow credits Trudy Wohleben of the Canadian Ice Service for first noticing the fracture.

The discovery was confirmed by reprocessing data taken by MODIS, the Moderate Resolution Imaging Spectroradiometer aboard NASA's Terra and Aqua satellites.

At 46 square miles (120 square km), this latest ice island is about half the size of the mega-calving that occurred from the same glacier two years ago. The 2010 chunk, also reported by Muenchow, was four times the size of Manhattan.

"While the size is not as spectacular as it was in 2010, the fact that it follows so closely to the 2010 event brings the glacier's terminus to a location where it has not been for at least 150 years," Muenchow says.

"The Greenland ice sheet as a whole is shrinking, melting and reducing in size as the result of globally changing air and ocean temperatures and associated changes in circulation patterns in both the ocean and atmosphere," he notes.

Muenchow points out that the air around northern Greenland and Ellesmere Island has warmed by about 0.11 +/- 0.025 degrees Celsius per year since 1987.

"Northwest Greenland and northeast Canada are warming more than five times faster than the rest of the world," Muenchow says, "but the observed warming is not proof that the diminishing ice shelf is caused by this, because air temperatures have little effect on this glacier; ocean temperatures do, and our ocean temperature time series are only five to eight years long — too short to establish a robust warming signal."

The ocean and sea ice observing array that Muenchow and his research team installed in 2003 with U.S. National Science Foundation support in Nares Strait, the deep channel between Greenland and Canada, has recorded data from 2003 to 2009.

The Canadian Coast Guard Ship Henry Larsen is scheduled to travel to Nares Strait and Petermann Fjord later this summer to recover moorings placed by UD in 2009. These mooring data, if recovered, will provide scientists with ocean current, temperature, salinity and ice thickness data at better than hourly intervals from 2009 through 2012. The period includes the passage of the 2010 ice island directly over the instruments.

According to Muenchow, this newest ice island will follow the path of the 2010 ice island, providing a slow-moving floating taxi for polar bears, seals and other marine life until it enters Nares Strait, the deep channel between northern Greenland and Canada, where it likely will get broken up.

"This is definitely déjà vu," Muenchow says. "The first large pieces of the 2010 calving arrived last summer on the shores of Newfoundland, but there are still many large pieces scattered all along eastern Canada from Lancaster Sound in the high Arctic to Labrador to the south."

Prior to 2010, the last time such a sizable ice island was born in the region was 50 years ago. In 1962, the Ward Hunt Ice Shelf, on the northern coast of Ellesmere Island in Nunavut, Canada, calved a 230-square-mile island.

Article by Tracey Bryant

**UD researchers, students partner with Naval Academy in Arctic training exercises**

http://www.udel.edu/udaily/2013/feb/arctic-sea-ice-022813.html

2:57 p.m., Feb. 28, 2013 — University of Delaware scientists are embarking to a remote research destination, braving freezing temperatures and high winds to study changes in Arctic sea ice. Their field site is a frozen expanse of the Arctic Ocean along the northernmost shoreline of Alaska.

"We will walk out onto the water," explained Cathleen Geiger, research associate professor of geography in the College of Earth, Ocean, and Environment. "It's not often you get to stand on the ocean."

Geiger and her research team will be measuring sea ice using cutting-edge technology to quantify shifts in this dynamic environment, where seawater freezes in the winter and melts in warmer months. At the same time, they will be training undergraduates from the U.S. Naval Academy in techniques that include 3-D mapping of ice contours and cross-referencing locations into geographic information systems (GIS).

The 15-day program is led by the Naval Academy's Oceanography Department to expand its curriculum on polar regions, with the UD portion sponsored by the National Science Foundation under a grant led by Geiger.

Warmer annual temperatures are increasing the amount of sea ice melt each year, opening previously ice-blocked areas to travel through the Arctic Circle — which government officials have raised as a national security concern.

Geiger has been studying sea ice since the 1980s, when the tail end of the Cold War fueled funding for scientists to examine this natural barrier with Russia. Today the subject has relevance in the context of global warming, with long-term satellite records showing sea ice shrinking over the past 35 years. The amount of sea ice that forms annually is effective for monitoring climate change.

"Sea ice works like a genuine bellwether," Geiger said. "It will recover very quickly if the planet starts to cool down again."

While scientists have good data on the two-dimensional footprint of sea ice, calculating the thickness and total volume is more difficult. The ice is floating, for one, and constantly moving and being reshaped by wind and ocean currents.

UD researchers are combining measurements taken underwater, in the air and from space to monitor sea ice changes. In their field experiment March 4-16, one approach will be to simply drill holes in the ice and measure the depth in select locations.

They can't drill too many holes, or they will destroy the very thing they seek to measure. So they use the drill holes to calibrate a new 3-D ground method and measure ice thickness with electromagnetic induction (EM). This tool involves a transmitter, similar to conventional radar, and a receiver that is sensitive to electrical currents that the transmitter induces in ice and seawater. Traditionally, such devices measure points and profile lines; this work seeks to expand mapping abilities into 3-D.

From the relative strength of the induced currents compared to the transmitter output, the system can determine the distance to the underlying seawater — and hence the ice thickness.

College of Engineering doctoral student Jesse Samluk will assess the usefulness of the 3-D electromagnetic model, enhance its capabilities and validate the results with direct measurements in the field. In particular, he is exploring methods to improve the accuracy of ice thickness measurements near deformed ice features, where measurement errors are highest.

"This project is expected to increase our fundamental knowledge about how radar signals interact with the environment and to enable more accurate predictions of ice thickness distribution as a

global climate variable," explained James Kolodzey, Charles Black Evans Professor of Electrical Engineering and Samluk's co-adviser with Geiger.

Computer vision doctoral student Scott Sorensen is also participating in the project. No stranger to the Arctic, last summer he participated in a 2012 Arctic expedition aboard the research vessel Polarstern to continuously capture images of the sea ice using a camera system he and fellow doctoral student Rohith Kumar designed in UD's Video/Imaging Modeling and Synthesis Laboratory (VIMS). He is advised at UD by Chandra Kambhamettu, professor of computer and information sciences and director of VIMS.

For this project, Sorensen will continue working with 3-D imaging of sea ice, specifically comparing various imaging techniques with the georeferencing techniques used in geography.

Geography graduate student Renato Kane and Department of Geography Chair Tracy DeLiberty will round out the UD team, using imagery collected by satellites that are downlinked directly to the National Ice Center. Through this collaboration, they will create multi-scale maps to evaluate changes in the ice.

These mapping methods will be integrated with results from Naval Research Lab (NRL) aircraft flights to map the top half of the ice. The field measurements serve to experimentally verify new algorithms between ice above the water and ice below the water.

The total picture compiled has various practical applications, from mapping walrus habitat to improving ship navigation and aiding in search-and-rescue operations.

As an educational experience for the Naval Academy students, Geiger hopes the field project prepares the next generation of leaders to understand future changes in the environment.

"Students will stand on a world of ice that is changing directly beneath their feet," Geiger said. "Together with views of the Aurora Borealis, such an experience completely solidifies a person's understanding of Earth as a moving, changing planet."

**About UD's College of Earth, Ocean, and Environment**

Founded in 1970, the UD College of Earth, Ocean, and Environment brings the latest advances in technology to bear on both teaching and conducting ocean, earth and atmospheric research. The college comprises the School of Marine Science and Policy, the Department of Geological Sciences and the Department of Geography, offering both undergraduate and graduate degrees using an interdisciplinary approach to environmental science.

**About UD's College of Engineering**

The UD College of Engineering is home to six academic departments and three degree programs devoted to building a community of problem-solvers focused on challenges associated with sustainability, energy, health care and the environment. World-renowned initiatives led by faculty include 14 college-based research centers and six university-based research centers, all of which provide a fertile training ground for future engineers. Article by Teresa Messmore and Karen Roberts

**NOAA Arctic Theme Page:**
http://www.arctic.noaa.gov/

**Arctic Report Card: Update for 1012:**
http://www.arctic.noaa.gov/reportcard/

**Fact from site:**
What's new in 2012?
New records set for low snow extent and sea ice extent, and for widespread ice sheet melting.

# Cruising in the Name of Research

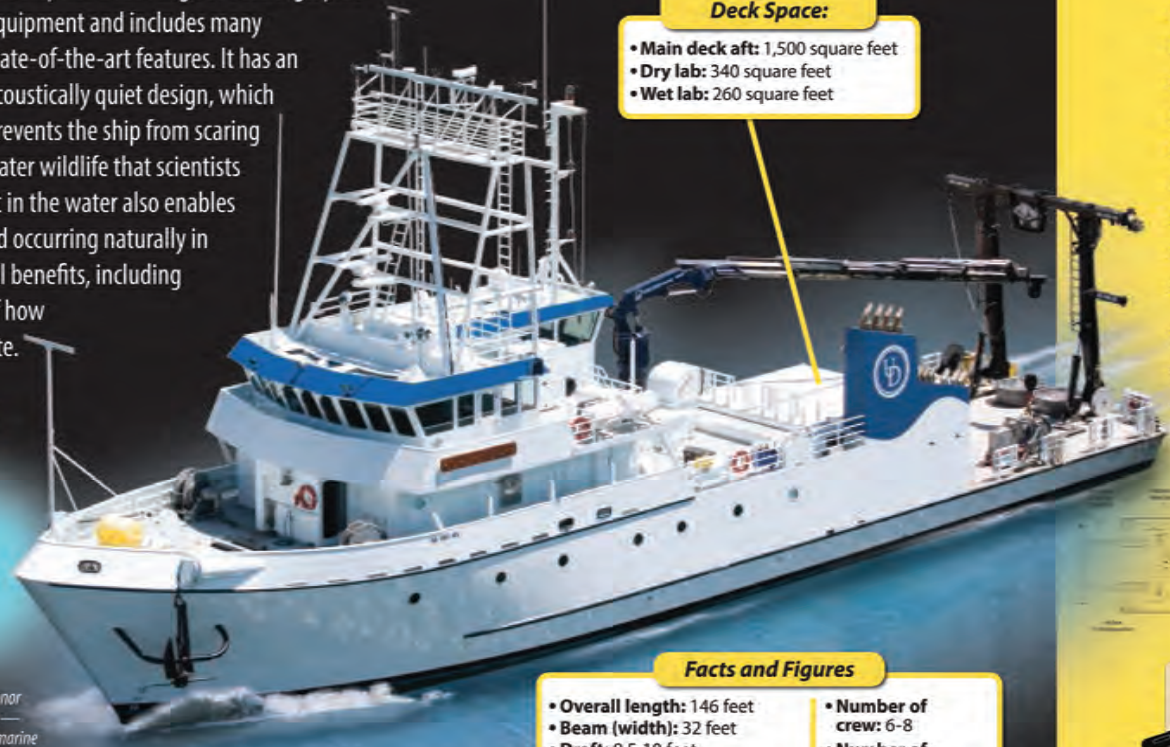
Taking to the water is a necessary part of the job for many of our scientists. Our coastal research vessel, the *Hugh R. Sharp*, is our floating laboratory.

The *Hugh R. Sharp* is one of the most advanced research ships in the United States. It can spend up to 18 days at sea and is versatile enough to support a wide range of marine disciplines.

The ship has a full range of oceanographic equipment and includes many state-of-the-art features. It has an acoustically quiet design, which prevents the ship from scaring off fish and other underwater wildlife that scientists wish to study. Being quiet in the water also enables researchers to study sound occurring naturally in the ocean. This has several benefits, including a better understanding of how sea creatures communicate.

**Working Lab and Deck Space:**

- **Main deck aft:** 1,500 square feet
- **Dry lab:** 340 square feet
- **Wet lab:** 260 square feet



**Research Range**


*The vessel is named in honor of the late Hugh R. Sharp—a longtime supporter of marine research who served for many years on the University of Delaware's Board of Trustees. Although docked at the college's Lewes campus, the ship is a regional asset and serves scientists from many institutions.*

**Facts and Figures**

- **Overall length:** 146 feet
- **Beam (width):** 32 feet
- **Draft:** 9.5-10 feet
- **Max. antenna height:** 75 feet
- **Cruising speed:** 10-11 knots
- **Number of crew:** 6-8
- **Number of researchers:** 14-16

## There's a van for that!

The *Hugh R. Sharp* is a multipurpose research vessel. Its deck can be modified to accommodate scientists' different needs. Portable laboratories—known as "vans"—can be easily removed or added prior to leaving for sea. The vans are designed with different purposes in mind. One van holds refrigerator units. Another has a special air filtration system. A third is designed to allow seawater to flow in and out of it.

With only the equipment needed for that particular research cruise, the vans help conserve valuable space on the ship.

***Watch a time-lapse video of the R/V Sharp getting ready for a cruise***

# Cruising in the Name of Research

**Main Website:**
http://www.ceoe.udel.edu/marine/rvSharp.shtml

**Sea Talk: Surveying Scallops on the R/V Sharp**
http://deseagrant.org/seatalk/video-story-surveying-scallops-rv-sharp

**Related UDaily articles:**

**Sharp Family**
http://www.udel.edu/udmessenger/vol21no1/stories/otg-sharp.html

**Spring Break at Sea**
http://www.udel.edu/udaily/2013/apr/sharp-spring-break-041713.html

**UD researchers studying 'fingerprint' left on seafloor by Hurricane Sandy**
http://www.udel.edu/udaily/2013/nov/seafloor-hurricane-111512.html

11:05 a.m., Nov. 15, 2012 — Beneath the 20-foot waves that crested off Delaware's coast during Hurricane Sandy, thrashing waters reshaped the floor of the ocean, churning up fine sand and digging deep ripples into the seabed. Fish, crustaceans and other marine life were blasted with sand as the storm sculpted new surfaces underwater.

UD scientists cued up their instruments to document the offshore conditions before, during and after Sandy's arrival to scrutinize the differences and better predict the environmental impact of future storms.

"Out here, we're trying to get the fingerprint of the storm," said Arthur Trembanis, associate professor of geological sciences and oceanography, aboard the research vessel Hugh R. Sharp.

Trembanis and his colleagues focused in on Redbird Reef, an artificial reef about 16 miles off the coast of the Indian River Inlet. The site contains old subway cars, boats and truck tires sunk over the past decade to provide habitat for sea creatures. The scientists have been studying the reef in recent years, among other "hard bottom" sites in this otherwise barren, sandy region, to examine the ecosystem found there and create detailed maps of the seafloor.

Besides improving scientists' understanding of the natural environment, the work has potential military applications: Shifting underwater sands and sediment can bury — or uncover — dangerous mines used to explode enemy vessels in conflict zones. Understanding how weather conditions can affect such objects on the bottom of the ocean could help the Navy, which funded this scientific cruise, identify and avoid the weapons.

In the peacetime waters off Mid-Atlantic shores, however, the manmade structures at the reef serve as research substitutes for mines. Two days before Hurricane Sandy hit, Trembanis' group set up a specialized buoy at the reef with three different types of equipment attached that rested on the seafloor to measure waves, currents and sand formations on the seafloor.

The researchers also used a multibeam sonar on the ship to generate images of the seafloor, complemented by side-scan sonar for a finer resolution images taken by an autonomous underwater vehicle (AUV) — an unmanned, torpedo-shaped machine that darts through the ocean to collect data.

"We really can build a pretty complete picture of what happened on site," said oceanography graduate student Carter DuVal, who is basing his master's thesis in part on the information gathered.

The team repeated the sonar runs on Nov. 10, finding newly formed sand ripples, reshaped surfaces and exposed areas, with significant patches of “scouring” where erosion occurred due to rapidly flowing water. Currents raced at more than 3 knots during the Sandy’s peak, capable of moving large stones and rotating the researchers’ underwater equipment almost 50 degrees during the storm.

In analyzing the data collected, the scientists will link the geological markings on the seafloor to wave conditions and currents. Then they can develop models of how sediments move and predict whether areas might experience extensive scouring.

In addition to Navy use, the research could inform engineering decisions for offshore wind turbines, which have been considered in the vicinity of Redbird Reef.

The study is just one of several ways Trembanis tracked Sandy’s geological imprint. He also took photographs and video during an airplane flyover of the coasts of Delaware, New Jersey, Maryland and Virginia just days after the storm, recording what happened right at the land’s edge for the Program for the Study of Developed Shoreline. He and his team also surveyed Broadkill Beach with high-resolution GPS to map its shape after the storm, finding it to be much more flat than usual for this time of year. They also used sonar to generate an image of a shipwreck near Cape Henlopen, which revealed a lot of sand had been swept off the wreck site.

Collecting pre- and post-storm metrics through a variety of means creates a valuable dataset, Trembanis said, though it was not easy to compile. Aboard the Sharp last weekend, the team was unsure whether the buoy survived the storm, eagerly anticipating its presence as the ship headed to the site.

While it remained in place to clearly indicate where the equipment was, not all data that they hoped to collect was there: a rotary sonar scheduled to record ripples at regular time intervals malfunctioned. That information would have helped separate conditions specific to Sandy from those of the northeaster that arrived a few days later. Instead, they will have to settle for a composite of the two.

Other signs pointed to how rough the conditions were, though. As the ship’s crew raised the scientific equipment that rested on seafloor during the storm, a large piece of twisted metal arose that had been entangled in the rope — possibly a window frame from a subway car.

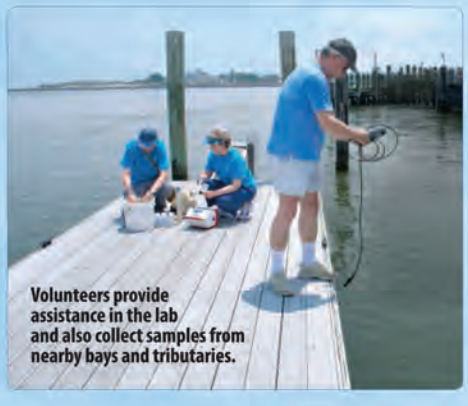
Doug Miller, associate professor of oceanography in the College of Earth, Ocean, and Environment on board to collect biological samples, worried that the sharp debris would cut the line and sink the equipment. Thankfully, it did not.

“But that was a tense moment,” Miller said.

Article by Teresa Messmore

# Water Watchdogs

The coast is a major economic driver in southern Delaware, attracting millions of visitors and generating almost $7 billion each year. We work on many fronts to ensure that our coast remains a desirable place to live and visit.



Volunteers provide assistance in the lab and also collect samples from nearby bays and tributaries.

## Community involvement for clean water

The Natural Resources Defense Council recently ranked Delaware first nationally for beach water quality. The organization rates hundreds of popular beaches around the country, awarding up to five stars to sites with clean water and strong testing and safety practices. Delaware's Dewey Beach and Rehoboth Beach are consistently among a handful of beaches nationwide that receive 5-star ratings.

## Why are Delaware beaches so highly regarded?

Monitoring frequency is one of the factors in the rankings, and this is where the UD Citizen Water Quality Monitoring Program plays a role. Run by Delaware Sea Grant with assistance from trained citizen volunteers, the program analyzes water samples collected by the state.

Program staff process water samples multiple times per week here at the Hugh R. Sharp Campus in Lewes. The location is much closer to the beaches than the state's labs in Dover, helping resource managers from the Department of Natural Resources and Environmental Control meet collection time standards.

## Interested in the UD Citizen Water Quality Monitoring Program?

**To learn more, visit citizen-monitoring.udel.edu**

*Watch a video of our Water Watchdogs in action!*

Sea Grant Delaware

Healthy Coastal Ecosystems

Resilient Communities and Economies

Sustainable Fisheries and Aquaculture

Environmental Literacy and Workforce Development

*Check out what's happening at Delaware Sea Grant*

## About Delaware Sea Grant

Based at the University of Delaware's College of Earth, Ocean, and Environment, the Delaware Sea Grant College Program is one of 33 university-based programs throughout the United States. Sea Grant conducts scientific research, education, and training that help people wisely use, manage, and conserve our valuable coastal resources. Visit deseagrant.org to learn more about the program.

*Science Serving the Delaware Coast*

# Water Watchdogs

**Citizen Monitoring Program – Learn how to volunteer:**
http://citizen-monitoring.udel.edu/

Details on how to become a volunteer:

Anyone can be a good volunteer monitor! No special background or experience is required. Our volunteers come from all walks of life – from teenagers to senior citizens. The common characteristic they have is their interest in helping protect their watershed.

Volunteers devote less than one hour per week from April to October to water testing at their assigned site, usually at or near their home. During the remainder of the year, testing is done at less frequent intervals.

For more information about becoming a volunteer, jfarrell@cms.udel.edu or call 302.645.4250.

**Current Water Quality Reports available at:**
http://citizen-monitoring.udel.edu/reports.shtml

**Video about Citizen Monitoring Program:**
http://deseagrant.org/seatalk/video-story-water-watchdogs

# How Healthy is Delaware Bay?

While passengers aboard the Cape May-Lewes Ferry enjoy the sights of Delaware Bay...

Although historically Delaware Bay did not experience the extreme pollution of the urban Delaware River, it does suffer from pollution, habitat destruction, and overfishing. By installing equipment on the ferry, our scientists have established a regular program to track the lower bay's health.

Despite continual monitoring of the full length of the bay for more than 40 years, additional information is needed to help us fully understand the complicated environment created where Delaware Bay meets the Atlantic Ocean. With funding support from the Delaware Sea Grant College Program, our scientists are changing this situation. The ferry makes up to eight crossings a day, providing many opportunities to collect and analyze water samples.


As the ferry crosses between Delaware and New Jersey, water is pumped from the bay into scientific instruments located on the ship. The instruments inform scientists about the flow of water in and out of the bay, the amount of microscopic plant material in the water, and the amount of oxygen available to aquatic life.

Thanks to this approach, they are learning even more about the complex environment of the lower bay. In fact, the ferry's monitoring equipment provided more information about this part of the bay in just a few months than had been collected over the past several decades!

This wealth of data not only gives scientists an indication of Delaware Bay's health and vitality, but also informs natural resource agencies responsible for managing valuable coastal and marine resources.

...scientific instruments on the vessel are gathering data about the water below.

# How Healthy is Delaware Bay?

**Sea Talk videos:**
http://deseagrant.org/seatalk/sea-talk-video-cruising-data

http://deseagrant.org/seatalk/seatalk-video-cleaner-delaware-river

**Related UDaily article:**
http://www.udel.edu/udaily/2010/mar/estuary033110.html

**Delaware Estuary research tells massive clean-up story**

10:13 a.m., March 31, 2010 — The Delaware Estuary was so unhealthy in the 1940s that in some areas it completely lacked oxygen and was largely void of aquatic life in the summer. Its low oxygen levels and the production of hydrogen sulfide turned white ships grey, and its severe rotten egg odor even threatened its use as a port.

The estuary today, by comparison, is a much healthier place. In fact, new research published by Jonathan Sharp, University of Delaware professor of oceanography, in the March issue of the journal Limnology and Oceanography documents that the Delaware Estuary has seen one of the most dramatic improvements of water quality of any river worldwide.

The research, based on about 100 years of data on oxygen levels, also paints one of the most complete pictures of an estuary's demise and recovery available. Not only did Sharp analyze data from his own research sampling, which he's done multiple times each year since 1978, he also looked at Delaware River Basin Commission's water monitoring stations going back to 1967. Less consistent data from other sources such as the Philadelphia Water Department and anecdotal sources such as newspaper articles provided perspective on the earlier years.

Together this information shows an estuary that for decades was pumped with municipal and industrial wastes, including raw sewage put directly into the river. The sewage caused outbreaks of disease such as typhoid fever. In addition, oxygen-consuming bacteria in the water, fed by copious organic matter in sewage and other human-created contaminants, caused large declines in the amount of oxygen in the estuary.

In one of the paper's anecdotal examples, Sharp explains that the estuary used to support the largest shad spawning area of the whole east coast. The numbers plummeted in the early 1900s, however.

“The waters were so depleted of oxygen that the shad couldn’t hold their breath long enough to swim up stream,” said Sharp, a faculty member in UD's College of Earth, Ocean, and Environment.

By World War II, the estuary was so unhealthy that certain areas completely lacked oxygen in the summer.

The tide began to turn in 1970 when the Environmental Protection Agency was formed and major grants financed upgrades to sewage treatment plants.

“That's when the real change took place,” Sharp said. “because so much of that oxygen depletion in the Philadelphia area was due to sewage that was inadequately treated.”

As regulations for sewage treatment plants and industrial discharges have resulted in water quality improvements, Sharp said, natural resource managers have tended to turn their attention to other areas.

“There has been a lot of interest recently that nutrients coming into the water are stimulating excess algal production,” he said.

Increased nutrient concentrations fuel overgrowths of oxygen-robbing algae.

“One of the things I was trying to do here is to point it out that it's not quite so simple as a lot of people are treating it,” he said.

In his paper, Sharp suggests that while addressing nutrient loading is important, resource managers should not make that their only focus. Many other factors, such as habitat alteration and destruction, and other contaminants, directly and indirectly influence oxygen concentrations in the Delaware estuary.

Sharp explained further that today the estuary experiences no lack of oxygen in the summer. The recovery, he said, is reason to fully consider any changes that could affect the estuary.

“With the tremendous improvement in water quality, this is more reason to be cautious about anything that could impair the water quality such as the dredging to deepen the channel,” he said.

For more details on this research, read the full article on the *Limnology and Oceanography* March issue Web page.

Article by Elizabeth Boyle

# Underwater Robots



Sand tiger shark migration tracking

Underwater robots help scientists explore the ocean, collecting valuable images and data along the way. These unmanned, torpedo-shaped devices dart through the water with cameras, thermometers, GPS units, and other equipment on board. Some require people to operate them from the surface, while others are programmed to accomplish missions all by themselves.

**Remotely operated vehicles (ROVs)** have a tether attached to a boat that transmits power and sends information back and forth. These are relatively easy for scientists to maneuver to view, survey, and sample specific objects.

ROV

**Autonomous underwater vehicles (AUVs)** operate independently once launched and run on battery-powered motors. Without a tether, they can cover a broad range when gathering ocean data and can travel to shallow water where ships cannot.

AUV

Scallop count

See underwater footage of CEOE's new ROV

Our scientists use these robots to track sharks, map the bottom of Delaware Bay, count scallop populations, investigate shipwrecks, and more!

**Gliders** are slower types of AUVs that move by adjusting their buoyancy (ability to float) and require less battery power, making them good for long-distance trips.

GLIDER

Shipwreck W.R. Grace

# Underwater Robots

**Related site The ORB LAB:**
http://orb.ceoe.udel.edu/

**Excerpts from ORB LAB site:**

**Modeling Sturgeon Habitats In Delaware Bay**

Atlantic sturgeon have recently been listed under the Endangered Species Act and populations have been struggling to rebuild since the late 19th century. The utilization of acoustic biotelemetry along with the Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS) will allow us to link the movements and habitats of Atlantic sturgeon with oceanographic conditions to better understand their seasonal migrations and distributions in the Delaware Bay, as well as the coastal Atlantic Ocean. This project is funded by the National Marine Fisheries Service and is part of a collaborative effort between the University of Delaware, Delaware State University, and Delaware Department of Natural Resources and Environmental Control.

**Modeling Shark Movements and Habitat Selection In The Atlantic Ocean**

Many shark species in the Atlantic Ocean are experiencing drastic population declines. In order to better manage these populations, we need to understand where sharks migrate, and what oceanographic conditions constrain their movements. Working with researchers from the University of Rhode Island and Delaware State University, we are modeling tiger shark movements and habitat selection based on electronic satellite tag and satellite measured surface ocean data. We are also researching sand tiger shark presence and habitat selection in the Delaware Bay using acoustic telemetry. In addition, we are employing the use of pop-off satellite archival tags, and mobile transceivers in order to research the species assemblages encountered by sand tiger sharks while they are migrating along the Eastern Seaboard.

**3-D Mapping of Ocean Water Masses and Biomes**

Satellite oceanographic products provide an unequaled view of the global ocean surface allowing us the opportunity to map important biogeochemical processes in the ocean such as primary production and carbon export to the deep ocean. However, despite the wealth of data satellites provide, their continuing criticism is that they “see” only a fraction of the water column in most ocean conditions.

**Fun online volunteer opportunity! Help assess the health and abundance of the Mid-Atlantic scallop fishery by learning how to analyze seafloor images and count scallops.**
http://subseaobservers.com/

**Redbird Reef Monitoring**
http://coastalcare.org/2013/06/an-ancient-beach-with-modern-subway-cars-16-fathoms-down-to-take-this-train/

**Related UDaily articles:**
http://www.udel.edu/udaily/2013/aug/trembanis-shipwreck-080812.html

**Lewes wreck found to be W.R. Grace, ship destroyed in 1889 hurricane**

1:10 p.m., Aug. 8, 2012 — University of Delaware researchers have discovered that a shipwreck near the coast of Cape Henlopen is a 215-footlong sailing vessel destroyed by a hurricane more than a century ago.

Scientific surveys and historical records indicate that the wreck is the *W.R. Grace,* a three-masted ship that ran aground during a hurricane on Sept. 12, 1889.

“It was not something we expected to be as old as it was,” said Arthur Trembanis, associate professor of oceanography and geological sciences in the College of Earth, Ocean, and Environment.

Trembanis' research group came upon the shipwreck two years ago while training undergraduates to use remotely operated vehicles (ROVs) and other ocean surveying equipment along the coast of Cape Henlopen State Park near Lewes, Del. They were surprised to find that the wreck was not included in a public federal database of known shipwrecks and other potential navigation hazards.

Delaware’s coast has been the site of hundreds of shipwrecks over nearly four centuries, making identification a challenge – particularly with older wooden ships disintegrating over time. State archaeologists initially suspected that this unknown wreck was made of iron or steel since it was readily picked up on sonar, possibly a military or freight vessel dating to World War I or later.

Trembanis partnered with Jeff Snyder, president of SeaVision Underwater Solutions, a commercial marine surveyor, to revisit the site in June and obtain better images with side-scan sonar and video technology. They were able to pinpoint the exact location, orientation and size of the wreck, which sits about seven meters below the surface.

Oceanography graduate student Carter DuVal then consulted a book about shipwrecks in the Mid-Atlantic and other sources to begin cross-referencing their field findings with historical clues. Maritime records revealed that the dimensions of the *W.R. Grace,* built in 1873, matched that of the wreck, and the ship had a metal sheath around the hull to prevent marine growth.

DuVal also researched newspaper accounts about the ship’s fate when a strong hurricane struck the coast in 1889. Apparently the massive ship had difficulty navigating the shallow waters around Cape Henlopen, and after dropping anchor to ride out the storm, the ship drifted and lodged into the sand below.

The vessel was carrying 7,000 empty petroleum barrels from France to refill in Philadelphia and ship to Japan. With the *W.R. Grace* a loss, operator Flynn and Company sold the barrels at auction.

“When we found the wreck itself, we noticed that there doesn’t appear to be any cargo in the hold,” DuVal said. “So that is also something that points to our wreck being the *W.R. Grace*.”

Today the ship is covered in dense clusters of blue mussels and frilled anemones, forming an artificial reef similar to others built around Delaware Bay. The invertebrates need hard surfaces o latch onto and form colonies, which are not easy to find along the sandy coastal zone.

“If they encounter something, they colonize pretty quickly,” Doug Miller, associate professor of oceanography, said, adding that a significant population can manifest in just a few years. “It’s indicative that our coastal shallow waters are very, very productive.”

The sandy coastal features seem to have prevented life from taking hold on the wreck until relatively recently: The ship appears to have been previously buried. Swift currents help move the ocean floor in this area into a series of ripples, with conditions so turbulent that the sandy tip of Cape Henlopen extends about nine meters each year.

A 1995 study of the area did not reveal the wreck, yet the ship’s outline did appear on a 2007 National Ocean and Atmospheric Administration survey (the results were not included in the public database). So either the wreck was uncovered sometime between 1995 and 2007, Trembanis said, or it has undergone periods of burial and exposure.

State archaeologist Craig Lukezic said he has frequently encountered those kinds of changes while studying shipwrecks. He said a scuba dive investigation could reveal more information about the wreck, such as the architecture of the boat, but there are probably no artifacts left on the ship since the contents were salvaged before it submerged.

Such a dive would need to be conducted in cooperation with the state, as the wreck is protected by law under the Abandoned Shipwrecks Act, and the currents make diving in the area treacherous.

“It makes it very difficult and very dangerous,” Lukezic said.

For now, the ROV and sonar findings can be used to better understand the ocean dynamics that impact wrecks, compare the site to other reefs and study how the ocean floor changes over time. “We’re in an exciting time for this kind of exploration,” Trembanis said. “In our own backyard are some exciting new discoveries.”

Article and video by Teresa Messmore

http://www.udel.edu/udaily/2013/feb/rov-marine-research-022213.html

**New remotely operated vehicle to aid UD marine research efforts**

12:41 p.m., Feb. 22, 2013 — An underwater robot made a splash at a University of Delaware swimming pool recently in a test of the new equipment, which will soon be used in field research by College of Earth, Ocean and Environment (CEOE) scientists.

The device, called a remotely operated vehicle (ROV), can dive deep below the ocean surface to record video, create sonar images and retrieve objects.

“It has just about everything you could want,” said Douglas Miller, associate professor of oceanography.

Miller and Arthur Trembanis, associate professor of oceanography and geological sciences, tested the ROV’s maneuverability and imaging features at the Carpenter Sports Building’s swimming pool. The machine successfully darted around the pool, churning up a plume of water before plunging underwater with two bright headlamps lighting its way.

About the size of a laundry basket, the robot has a yellow plastic and metal frame that contains four waterproof video cameras: three in the front — one of which is high-definition — and one in the back. A sonar system uses sound to make detailed pictures of seafloor contours, and a three-pronged arm opens and closes to grip rocks, clams and other marine samples.

Powered by a long tether attached to a control station, the ROV is operated by a joystick and a set of buttons — like a video game. Researchers could easily watch it move around in the pool, but at sea they will have to rely solely on the compass and navigation system.

“Usually you’re not able to see it,” Trembanis said, adding that his lab has a simulator for student practice. “You have to remember that the orientation is relative to where it is.”

CEOE researchers have used ROVs to examine shipwrecks and geological formations off Delaware’s coast, but they had to work with contractors because the college lacked its own equipment. The new machine will increase access to the technology and give students the opportunity for hands-on training.

Mark Moline, director of the School of Marine Science and Policy, joined the researchers for the pool test, wearing his scuba gear to swim with the ROV and check that it functioned properly. He will take it on an upcoming research expedition to Palau in the western Pacific, working with the Navy to study how water flows around the islands there. He will also document the vertical walls of coral reefs.

“People are trying to figure out and map the true distribution of organisms,” Moline said.

Off the coast of Delaware, Miller plans to use the ROV to take video of sea life inhabiting the Redbird artificial reef and count the number of mussels, for example, that are present. The robot's arm could potentially pluck off samples for further examination.

The ROV was custom-built by Outland Technology Inc. in Louisiana, where the devices are commonly used by the energy industry to inspect gas lines and oil rigs. The cameras can switch to black-and-white if visibility is poor to get a better picture, and sensors on the ROV record depth, date and time with each video stream.

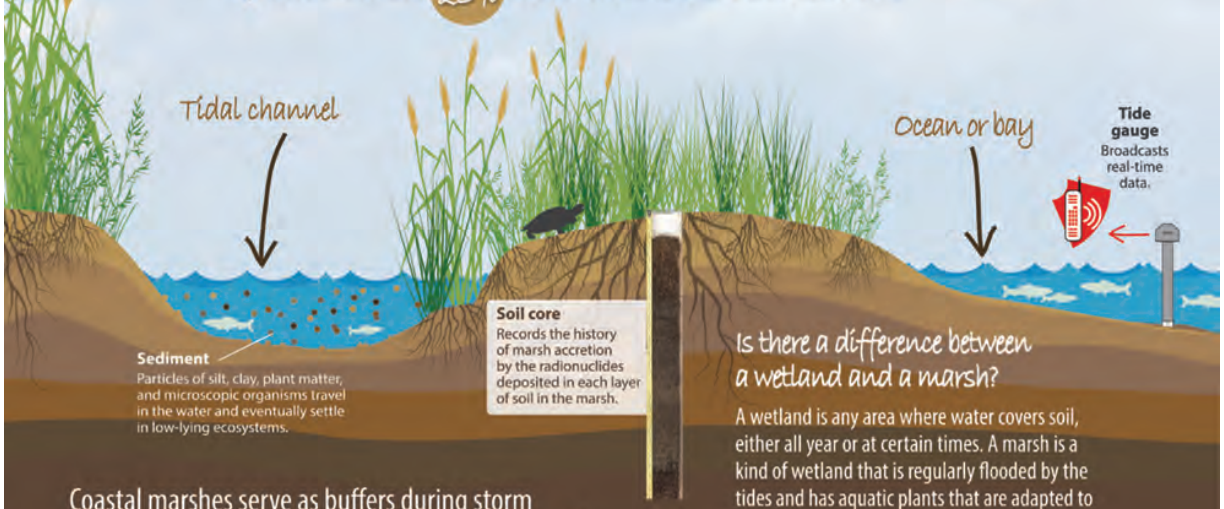
At the initial testing, all systems were in working order and ready for use in the ocean.

"This is fantastic," Trembanis said.

Article by Teresa Messmore

# Measuring Coastal Marshes

**Approximately 25% of the state of Delaware is covered by wetlands and 23% of our wetlands are tidal marshes.**




## Is there a difference between a wetland and a marsh?

A wetland is any area where water covers soil, either all year or at certain times. A marsh is a kind of wetland that is regularly flooded by the tides and has aquatic plants that are adapted to living in waterlogged soils.

Coastal marshes serve as buffers during storm flooding, remove pollutants from water, and provide important habitats for wildlife. Scientists are studying how the mud carried by rivers, tides, and storm surges gets trapped in these low-lying ecosystems.

**Why?** Marshes build upwards through a combination of plant growth and sedimentation, a process known as accretion. If coastal marshes cannot accrete at the same pace as rising sea levels, they can disappear. An increase in the rate of sea level rise can speed erosion of marsh edges, leaving open water or unvegetated mud flats behind. Accelerated erosion has already been observed in Delaware, resulting in tidal wetland loss.

Marsh accretion can be measured using radioactive elements, whose decay rates provide "clocks" for timing sediment burial. Naturally occurring and manmade radioactive elements enter Delaware Bay from rain and other sources, attach to particles suspended in the water, and eventually settle in marshes.

Our researchers measure samples from marshes in the Mid-Atlantic region to determine if sites are accreting fast enough to keep up with sea level rise. Their results can be used to inform land use management decisions.

On the landward edge, marshes often abut farms and developed properties. On the ocean or bay side, they face increasingly higher sea levels—creating a "coastal squeeze" for space.

To assess the status of coastal marshlands, scientists compare rates of marsh accretion to rates of local sea level rise measured by tide gauges.

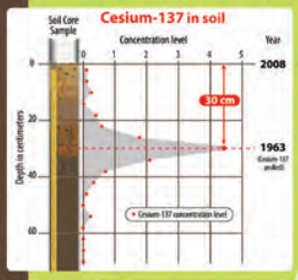
## Back at the lab:

### Measuring soil age with Cesium-137

One of the radioactive elements used to date sediment is man-made. Cesium-137 ($^{137}Cs$) was introduced to the environment by atomic weapons testing starting in the early 1950s. It is present worldwide in soils, ocean water, and marine sediments at harmless levels.

Atmospheric fallout of Cesium-137 peaked with weapons testing in 1963. After the Nuclear Test Ban Treaty in 1963, fallout decreased rapidly and was negligible by the mid-1980s.

The amount of Cesium-137 in soils and aquatic sediments can be measured in a laboratory using sensitive radiation detectors. Researchers scan soil cores to determine the soil layer with the highest radiation reading and equate it to 1963. The distance from the top of the core to the depth of 1963 indicates the amount of soil that has accreted. Dividing this length by the number of years since 1963 provides the rate of soil buildup through time for the sample site from which the core was obtained. The soil accretion rate is then compared with tide gauge data to determine if marsh growth is keeping pace with recent sea level rise at each site.




**The soil accretion rate formula**

2008 − 1963 = 44 years
(year core was obtained − year cesium-137 peaked)

1963 yr = 30 cm deep

Soil accretion rate:
30 cm ÷ 44 years = 0.7 cm per year

For this sample, the soil buildup is 0.7 cm a year, which is approximately the height of this brown line.


# Soil Core

## TIME MEASURED IN CENTIMETERS

At left is a soil core collected from a salt marsh in Barnegat Bay, N.J., in 2009. The soil changes from living roots at the core top to peat and mud at the bottom. The accretion rate, based on radionuclide age dating, is 0.25 cm per year.

# Measuring Coastal Marshes

**Related article in UD Research magazine:**
http://www.udel.edu/researchmagazine/issue/vol4_no1/slr_intro.html

# Digging Deep for Drinking Water in Southern Delaware

Researchers drilling a well during field research.

**65%** of the Delaware population obtains its drinking water from groundwater

Groundwater is a valuable natural resource in Delaware, serving as the main source of drinking water for people living south of the Chesapeake and Delaware Canal. Without the option of getting drinking water from rivers, communities rely on this water drawn from underground.

Our researchers are interested in how seawater along the coast mixes with groundwater. Using field and laboratory measurements and mathematical models, they study the forces that exchange water between underground channels, called aquifers, and the ocean.

Understanding those processes may be important as sea levels continue to rise. One prediction for Delaware is a rise of 1 meter (3.3 feet) between now and the year 2100. The rising ocean will cause brackish water—a mix of salt water and freshwater—to enter aquifers and may spoil the freshwater there.


Our scientists also study how groundwater movement affects coastal ecosystems. Groundwater flowing into coastal surface waters can carry nutrients from human land use, such as agriculture and septic systems. When nutrient levels are too high, they fuel an overgrowth of algae that robs bays and estuaries of oxygen and threatens marine life.


Ongoing development also puts increasing demands on water supplies, so the Delaware Geological Survey (DGS) in the College of Earth, Ocean, and Environment is helping to improve groundwater monitoring in southern Delaware. DGS recently drilled new wells to examine water regularly and monitor for potentially harmful substances like radon and arsenic.

The researchers also check for the levels of nutrients, pharmaceuticals, personal care products, and other possible pollutants. In addition, they gauge groundwater and streamflow to better predict changes related to withdrawal for human use—helping to avoid over-pumping aquifers, decreasing streamflow, or miscalculating water availability.

Sea level rise, saltwater seepage, agriculture, and development are among the potential threats to groundwater quality that researchers are examining in the environment.

# Digging Deep for Drinking Water in Southern Delaware

**Related website:**
http://www.geosci.udel.edu/geosci/hydrogeology

**Related article in UD Research magazine:**
http://www.udel.edu/researchmagazine/issue/vol4_no1/slr_drinking_water.html

**Excerpt from article:**

Seventy-five percent of the drinking water provided to New Castle County residents comes from surface water, primarily the various tributaries of the Christina River. Below the Chesapeake and Delaware Canal, though, all drinking water—as well as water for irrigation and most industrial uses—comes from groundwater. And while contaminated sites are sparser in southern Delaware, drawing water from wells beneath agricultural lands and coastal plains provides its own set of hazards.

**Sea Level Rise – information resources**

– UD Research magazine http://www.udel.edu/researchmagazine/issue/vol4_no1/slr_intro.html

– NOAA http://oceanservice.noaa.gov/facts/sealevel.html

**Excerpt from NOAA site:**

**Sea level is rising at an increasing rate**

There is strong evidence that global sea level is now rising at an increased rate and will continue to rise during this century.

While studies show that sea levels changed little from AD 0 until 1900, sea levels began to climb in the 20th century.

The two major causes of global sea-level rise are thermal expansion caused by the warming of the oceans (since water expands as it warms) and the loss of land-based ice (such as glaciers and polar ice caps) due to increased melting.

Records and research show that sea level has been steadily rising at a rate of 1 to 2.5 millimeters (0.04 to 0.1 inches) per year since 1900.

This rate may be increasing. Since 1992, new methods of satellite altimetry (the measurement of elevation or altitude) indicate a rate of rise of 3 millimeters (0.12 inches) per year.

This is a significantly larger rate than the sea-level rise averaged over the last several thousand years.

# Protecting Coastal Communities from Natural Hazards

A storm of unprecedented strength, Hurricane Sandy brought extreme tidal flooding, heavy precipitation, and strong winds to Delaware in October 2012.

When a storm like Sandy hits, Delaware's coastal communities know which areas are likely to flood and prepare accordingly. But what will happen in coming decades when predicted sea levels are higher and storms become more intense?

Preparing for more intense storms

Planning for sea level rise and flooding

Sea Grant Delaware

**We are helping residents and municipalities plan in advance of disaster:**

## Lewes

Delaware Sea Grant partnered with the City of Lewes to expand on plans to minimize damage from coastal storms and flooding. They assessed vulnerabilities related to natural hazards and climate change, such as temperature increases, rising sea levels, and more intense storms. They received input from the public, prioritized issues of concern, and developed action strategies.

The City of Lewes Hazard Mitigation and Climate Adaptation Action Plan was unanimously adopted by the Lewes City Council in 2011, one of the first such documents in the country. The city's Hazard Mitigation Team is working to implement the strategies, starting by educating people on hazards, emergency preparedness, water supply issues, and flood and wind insurance.

## Delaware City

Sea Grant is addressing climate change in relation to infrastructure challenges, land use, building standards, and ecosystem protection. Improving the stormwater system is a priority for the community, with flooding from the Delaware River potentially worsening drainage problems as sea level rises and storms become more severe.

Delaware Sea Grant worked with a Community Task Force and Advisory Committee to identify vulnerabilities, pinpoint trouble areas, and review best practices. Collaborating with other organizations, we are now helping to create a Delaware City action plan and extend climate adaptation efforts to local governments regionally.

Developing strategies to keep businesses and homes safe


Protect your family and your home with actions highlighted in the *Delaware Homeowners Handbook to Prepare for Natural Hazards*, available for free download under "Publications" at deseagrant.org.

# Protecting Coastal Communities from Natural Hazards

**Delaware Sea Grant Homeowners Handbook** — More than 80 major storms have threatened Delaware's coast over the past three decades, putting lives and property at risk. The resource guides residents on practical measures that can keep them safe and minimize damage to homes and property.
http://deseagrant.org/products/2012-homeowners-handbook

**City of Lewes Pilot Project:**
http://www.deseagrant.org/lewes_pilot_project

**Excerpt from page:**

**Pilot Project for The City of Lewes, Delaware: Mitigation and Adaptation to Natural Hazards and Climate Change — Planning and Building Resilient Coastal Communities**

Working with partners, the City of Lewes has made significant planning progress in mitigating natural hazards and adapting to climate change. Local officials and residents have been engaged throughout this process in developing a plan to improve community sustainability and resilience.

**Project Summary**

With its strong history of hazard mitigation planning and preparedness, the City of Lewes is perfectly poised to take advantage of an increasing understanding of climate change impacts. It is already known that temperatures are rising, glaciers are retreating, and sea levels are rising. These changes will exacerbate hazards that are known to threaten Lewes today. While these changes cannot be prevented, the effects of these events are dependent upon the choices and actions that Lewes makes today.

Given the increasing future threats that Lewes faces, the overall goal of the Hazard Mitigation and Climate Adaptation project has been to further the City's hazard mitigation work by incorporating climate adaptation. The project has developed an action plan that aims to improve community sustainability and resilience. Local officials and residents have been engaged through a series of workshops to determine the City's greatest existing and future vulnerabilities and to chart a course of action to reduce these vulnerabilities.

Vulnerability self-assessments were conducted during several workshops, and these assessments resulted in the identification of two key vulnerabilities. The first is Lewes' water system and the combined threats of saltwater intrusion into the aquifer and destruction of water conveyance systems that it faces from sea-level rise. The second vulnerability is the destructive impacts on homes and City infrastructure from increased flooding.

Based upon these two key vulnerabilities, six specific actions were identified as recommendations, and associated implementation guidance was provided. The recommended actions have significant overlap with the Lewes Mitigation Planning Team's current priorities. The City will continue to work with partners to apply the recommendations that will integrate hazard mitigation and climate adaptation efforts.

# Leading the Way in Wind Energy

Rising energy prices and concerns over climate change and air quality from burning fossil fuels have led to increased interest in offshore wind as an alternative source of power for coastal areas. Our scientists and policy experts are at the forefront of examining this technology.

*A select group of students get hands-on experience with the Lewes wind turbine. After completing a rigorous safety training program, they are certified to climb to the top of the turbine, where different scientific equipment collects information in support of corrosion, wildlife, and other research. The studies are helping to lay the foundation for offshore wind turbines in U.S. waters. For the students, the experience makes them well-qualified to work in the renewable energy field.*

These efforts are putting Delaware on the map as a pioneer in marine renewable energy, which could create price-stable electricity and a cleaner environment for future generations.

## Campus turbine generates power, boosts research

Inspired by several previous University of Delaware research studies on wind energy, UD partnered with Gamesa Technology Corp. to install a 2-megawatt wind turbine here on our Hugh R. Sharp Campus in 2010.

At times, the turbine spins out more than enough electricity to power our campus; the excess is fed to Lewes' electric grid. In addition, the turbine's proximity to Delaware Bay makes it a unique platform for scientific research in areas such as turbine corrosion and avian impacts.

**Visit UD's wind turbine website**

WEB EXTRA

Throughout this exhibit, you'll see QR codes like the one above. Scan them with your mobile device, and you'll be taken to online extras. QR reader app must be installed on your device.

## The future of wind

UD is also a leader in national efforts to advance offshore wind development. For example, our researchers recently completed a study that identified potential sites for future wind turbines off the Delaware coast.

Our researchers also are studying public opinions about offshore wind power issues, including how offshore turbines could affect beach tourism. In addition, they are investigating how to integrate large amounts of offshore wind power into the existing land-based generation and grid systems.

# Leading the Way in Wind Energy

**Related UDaily article:**
http://www.udel.edu/udaily/2013/aug/lewes-wind-turbine-080112.html

**UD's wind turbine in Lewes marks second year of energy generation, research**

1:55 p.m., Aug. 1, 2012 — This past June marked the second anniversary of the installation of the University of Delaware's wind turbine located in Lewes. Since it became operational in June 2010, the turbine has generated 9.5 million kilowatt hours (kWh), spinning out more than enough electricity to power the Hugh R. Sharp Campus.

"The turbine is a source of clean energy generation that powers our campus without polluting the air," said Nancy Targett, dean of the College of Earth, Ocean, and Environment. "Given its proximity to the ocean, it also serves as a unique platform for scientific research."

A joint committee that includes UD and wind turbine manufacturer Gamesa Technology Corp. has been actively driving multiple collaborative research and development projects.

"The project with the University of Delaware provides a unique opportunity to do collaborative research that has synergistic benefits for Gamesa and the University and yields results that can benefit the broader wind industry," said Miguel Angel Gonzalez-Posada, Gamesa's vice president of technology.

Since its commissioning in 2010 through May of this year, the Gamesa G90-2.0 MW model turbine generated more electricity than was needed to power the laboratories, offices and other buildings on the Sharp campus. The University sold 2.3 million kWh of the surplus electricity to the Lewes Board of Public Works.

"The electricity is bought at the same price they would pay for energy from conventional sources," said Willett Kempton, professor of marine policy. "The turbine is operating cost effectively, selling power at market rates, and it's also helping to reduce the amount of coal and natural gas that has to be burned, which means that there's a public health benefit through cleaner air."

The energy sale proceeds are used to operate and maintain the wind turbine and to fund the research projects.

So far, two UD employees and two graduate students have completed specialized training by Gamesa staff as part of the company's Global University training program in Bristol, Pa. The training qualifies them to climb the turbine, install research instruments and perform maintenance.

Research projects have been plentiful. Last year, as part of a study of corrosion in a marine environment, students of Stephen Dexter, professor of marine biosciences, installed steel sample plates on top of the 256-foot turbine. Dexter is comparing plates placed at the ocean's edge with those placed at the turbine site, about a quarter-mile inland, to evaluate atmospheric corrosion rates over time. Early results show rates in Lewes to be comparable with those in other areas studied on the East Coast. The results of the study could be a useful tool when conducting site assessments for coastal wind farms.

Validation of an enhanced ultrasonic wind speed/direction sensor and acoustic emission/ resonance-based health monitoring systems for blades and nacelle medium voltage transformer was successfully completed by Gamesa this past spring. Just recently, the company installed and began on-site validation testing for a new prototype generator, which is made specifically for production in the U.S. market.

"The collaboration with UD provides us with the opportunity to have a platform for testing systems, components and control software under live operating conditions," said Avinash Taware, electrical section manager at Gamesa. "The research team at the University has been an invaluable partner in the development and implementation of our projects."

An ocean engineering graduate student recently started an experiment measuring the vibration of the tower and examining how it responds to wind force against the rotor.

"While it's not visible, the turbine's tower does move slightly," Kempton said. "It's a moving, dynamic system and designed to be that way. This research will improve models to better predict and analyze tower movement."

In a separate study, researchers are looking into the turbine's effect on bird and bat populations. UD Department of Entomology and Wildlife Ecology researchers Jeffrey Buler and Gregory Shriver, along with Kevina Vulinec, professor at Delaware State University, are conducting a two-year study in collaboration with the states of Delaware and Maryland.

Final reports on the tower and wildlife studies are expected late next year.

Article by Teresa Messmore

**UD's Wind Turbine Site with current conditions:**
http://www.ceoe.udel.edu/lewesturbine/

**Excerpt from site:**

***How big is the wind turbine?***

The Statue of Liberty in New York stands at 305 feet high from the foundation to the top of the torch.

The size of wind turbines varies and is directly related to their designed electrical output. The University of Delaware turbine is a 2-megawatt (2-MW) machine, which stands approximately 400 feet high from its tower base to the apex of its blade at peak rotation. Each of the turbine's three blades is approximately 140 feet long.

***How much electricity does the wind turbine generate?***

The amount of electricity produced by one turbine depends on its size and quality of wind resource. A typical 2-megawatt turbine, when placed in an appropriate wind resource, can provide enough emissions-free electricity to power about 500 average homes for a full year.

***Why aren't the blades spinning right now?***

There are three reasons why the blades might not be spinning: 1) There is not enough wind. The turbine is programmed to begin generating electricity when the hub-height wind speed reaches 8 miles per hour. 2) The turbine is in need of or undergoing maintenance. Like your car, the wind turbine undergoes regularly scheduled maintenance; at other times, unscheduled events occur that require turbine maintenance. For safety purposes, the blades are stopped when technicians work on the turbine. 3) For some research projects, such as the avian and bat study currently under way, technicians must climb the tower to mount a device.

## Notes

## Notes