Periodic Elements

GEORGE MASON UNIVERSITY

Where Innovation Is Tradition

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A Magazine from the College of Science

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Fragmented Forests: Decades of Data

Crash Test Geniuses

Spit Take, No Laughing Matter

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Join us for the College of Science Convocation

Wednesday, May 14, 2014, 2 p.m., at the Patriot Center

Christine H. Fox, acting deputy secretary of defense, U.S. Department of Defense, will deliver the keynote address. She has spent three decades in the defense industry as an analyst and research manager, with a special emphasis on operations. Fox is a two-time Mason alumna, holding a master's degree in applied mathematics and a bachelor's degree in mathematics.

George Mason University — Where Innovation Is Tradition

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On the Cover

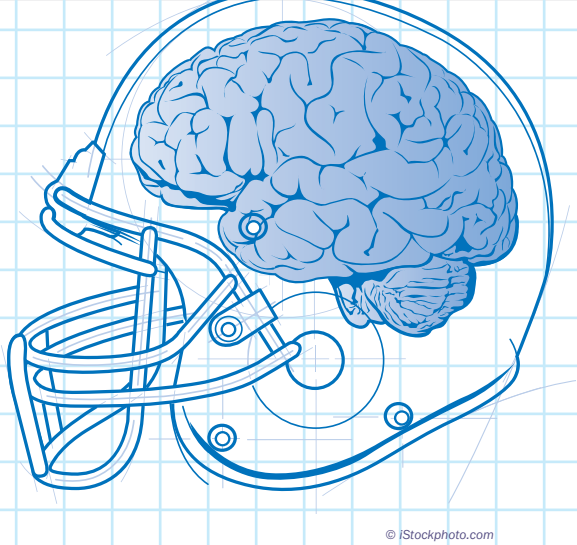
Photo: Beth Cabrera

Lily pads in the Amazon rainforest

Story page 8

Using Their Heads:

Research into Traumatic Brain Injury



Recent high-profile illnesses and suicides of NFL players and other professional athletes who have suffered concussions have brought the seriousness of traumatic brain injury (TBI) to the public's attention.

A concussion occurs when the head is hit so hard and so suddenly that the brain slams up against the skull and is injured. And while the trauma to the brain can be severe, it can go unnoticed. A person suffering a head injury may have cuts and bruises and may lose consciousness, but not always. In our *get out there and play, shake it off* sports culture, coaches, athletes, and their families have misunderstood the severe impact of a concussion on long-term health. TBI can lead to depression, suicide, Alzheimer's disease, Parkinson's disease, and chronic traumatic encephalopathy (CTE), a degenerative brain disease.

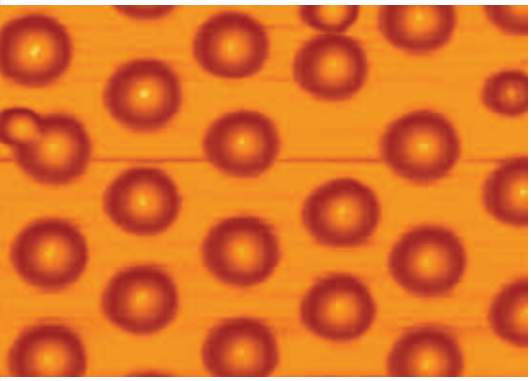


Photo: Courtesy of CAPMM

An atomic force microscope image of nanoparticles used to analyze biomarkers found in saliva.

"When a patient comes into an emergency room with a head injury, there is no objective clinical test to diagnosis a concussion. And there is no way to objectively determine when someone has sufficiently healed," says Shane Caswell, associate professor in the College of Education and Human Development and executive director of its Sports Medicine Assessment, Research & Testing (SMART) Laboratory.

Caswell is working to change all that. He has partnered with Emanuel (Chip) Petricoin III, codirector of the Center for Applied Proteomics and Molecular Medicine in the College of Science. Caswell and Petricoin are developing the first ever salivary biobank to test for unique brain proteins that show up after a head injury. "We know that there are specific markers, tau protein, S100B, and GFAP, that if you find them in a patient's blood are not good and indicate a brain trauma. One of the questions we want to investigate is whether these markers also show up in saliva," says Petricoin. The short answer is yes, but that is just the beginning.

Caswell has developed a study to track Mason athletes as well as a local youth football team throughout their entire ten-week playing season. The players' helmets are fitted with sensors that determine when a player has been hit. But more important to the study is the player's spit. Each week, Mason researchers collect the players' saliva and transport it to the lab, where it is analyzed for biomarkers using nanoparticles developed in Petricoin's lab. The sample collection is easy, painless, and noninvasive.

A nanoparticle is an engineered polymer, a microscopic substance that is synthesized in a beaker and acts like a sponge, explains Petricoin. "The particles are simple to make and can be tuned for specific uses, such as our salivary research."

Petricoin and his codirector, Lance Liotta, are using nanoparticles in research projects, such as breast cancer research, and are excited about the applications. "We can use them in vivo—on living material—to collect information. For instance, you can put them on a patch to collect biomarkers from your skin or on a tumor when it's removed," says Liotta.

For the concussion project, Petricoin says, "We have documented sixty concussive events and have samples from half of those athletes. We now have enough data to perform a biomarker discovery analysis."

Caswell and Petricoin realize that they have years of research ahead. Many factors have to be examined, including age and gender differences. The long-term hope is that a mouth guard can be developed that reacts, possibly with a change in color, if a player were to suffer a concussion. The work has applications for players returning safely to play, soldiers returning safely to combat, as well as the general population who suffer concussive events every day.

"Shane's dedication and detail to this study are tremendous," says Petricoin. "We couldn't do this type of research without such a well-thought-out collection method."

"We're bringing our labs out to the community," says Caswell. "We are providing direct care to athletes and helping students conduct research and see how clinically meaningful diagnostics are created."

This interdisciplinary research may help develop a new therapeutic approach to preventing and treating traumatic brain injuries.

Crash Test Geniuses

Spend some time with Cing-Dao (Steve) Kan, director of the new Center for Collision Safety and Analysis (CCSA) in the College of Science (COS), and you'll never look at a car crash, road, or car the same way again.

Kan and his staff of ten vehicle research experts and two students run computer simulations to crash cars and trucks into each other, walls, guardrails, and other stationary objects, such as trees. Kan admits it's fun but also serious work in an effort to improve transportation safety. Although the National Highway Traffic Safety Administration reports that traffic fatalities dropped by 4.2 percent for the first half of 2013, Kan is concerned this may change as the economy improves. More people will be buying new cars and getting on the road, and there will be an unpredictable mix of newer, fuel-efficient cars, like the tiny Fiat 500 and the Smart Car, and older, legacy model cars and trucks.

CCSA partners with the National Center for Manufacturing Sciences (NCMS), a nonprofit member-based group that has helped small manufacturers safety test and perfect their products before releasing them to the market for more than thirty years. Kan explains that automobile companies such as General Motors and Ford require their suppliers to test and certify that the parts they sell pass safety and quality standards. Many of these companies are small, without in-house testing expertise or resources. The small companies turn to NCMS, who partners with CCSA, to help.

CCSA also works directly with car and parts manufacturers, research universities across the globe, and government agencies, including the Federal Highway Administration, the National Highway Traffic Safety Administration, and the U.S. Department of Defense. After 9/11, CCSA worked with the U.S. State Department to design protective anti-ram bollards, those ubiquitous posts that surround government buildings and gate systems for U.S. buildings and embassies overseas.

Highway and road safety is a national and an international concern, and CCSA has research collaboration projects with schools across the country and as far away as Australia, Japan, and China. The center also works directly with car manufacturers such as Ford, Toyota, Hyundai, and Honda, as well as parts manufacturers such as Johnson Controls.

The CCSA facility is housed near the Fairfax Campus in a former administration building. The ground-floor garage lab is full of sophisticated testing equipment and a new car donated by Volkswagen that researchers are scanning inch-by-inch to reverse engineer into a complete simulated computer model. It's a meticulous and time-consuming process but necessary to have this type of vehicle in the simulation library.

The upstairs office area includes a conference room, NCMS office space, and space for the researchers. As you walk through CCSA, posters of real and simulated vehicle crashes and data line the walls. It's more video game-esque than roadside macabre. Kan admits that the space is quiet now, but it is just what he had hoped for—room to grow. Plans are already underway to bring in more student researchers. CCSA is also working with Mason to raise money to build an outdoor test track where they can run real collisions to augment the computer simulations.

Simulation Investigation

CCSA's simulation data is eerily accurate when compared to actual collision images and videos. One of the most important tools the group developed was a series of computer simulations of more than twenty standard cars, vans, crossovers, and light and heavy trucks, all now in the database. These virtual vehicles represent standard models found in most car inventories. The vehicles can run on any road surface and in any weather, contain virtual people of different sizes and weights, run at different speeds, and carry different loads.

Kan explains that the government wants to see trucks with increased fuel efficiency by March 2016. Currently, cars and trucks have different safety and fuel efficiency standards. However, one of the only ways to increase fuel efficiency is to decrease the weight of a vehicle. Trucks are designed to carry materials, so it is difficult to assess whether a lighter truck with a heavy load is actually meeting fuel standards. Also, a lighter truck may not be as safe on the road. These are all questions that can be investigated by changing the weight and running hundreds of simulations in almost unlimited scenarios.

Kan and many of his staff members worked together for more than twenty years at the National Crash Analysis Center (NCAC) at The George Washington University. He credits NCAC's work for many of our current vehicle and safety standards.

Driving the Data

Understanding and interpreting data is at the heart of CCSA's work. While it may be interesting to see virtual cars navigate icy roads or what happens in a side impact collision from the safety of a computer screen, this is just the beginning.

For instance, Kan explains that ten percent of car accidents involve a car rolling over. And while that indicates that ninety percent are from other types of collisions, the fatality rate for rollovers is thirty percent. Additionally, rollovers are inherently a problem in the United States "because we have more open roads," says Kan.

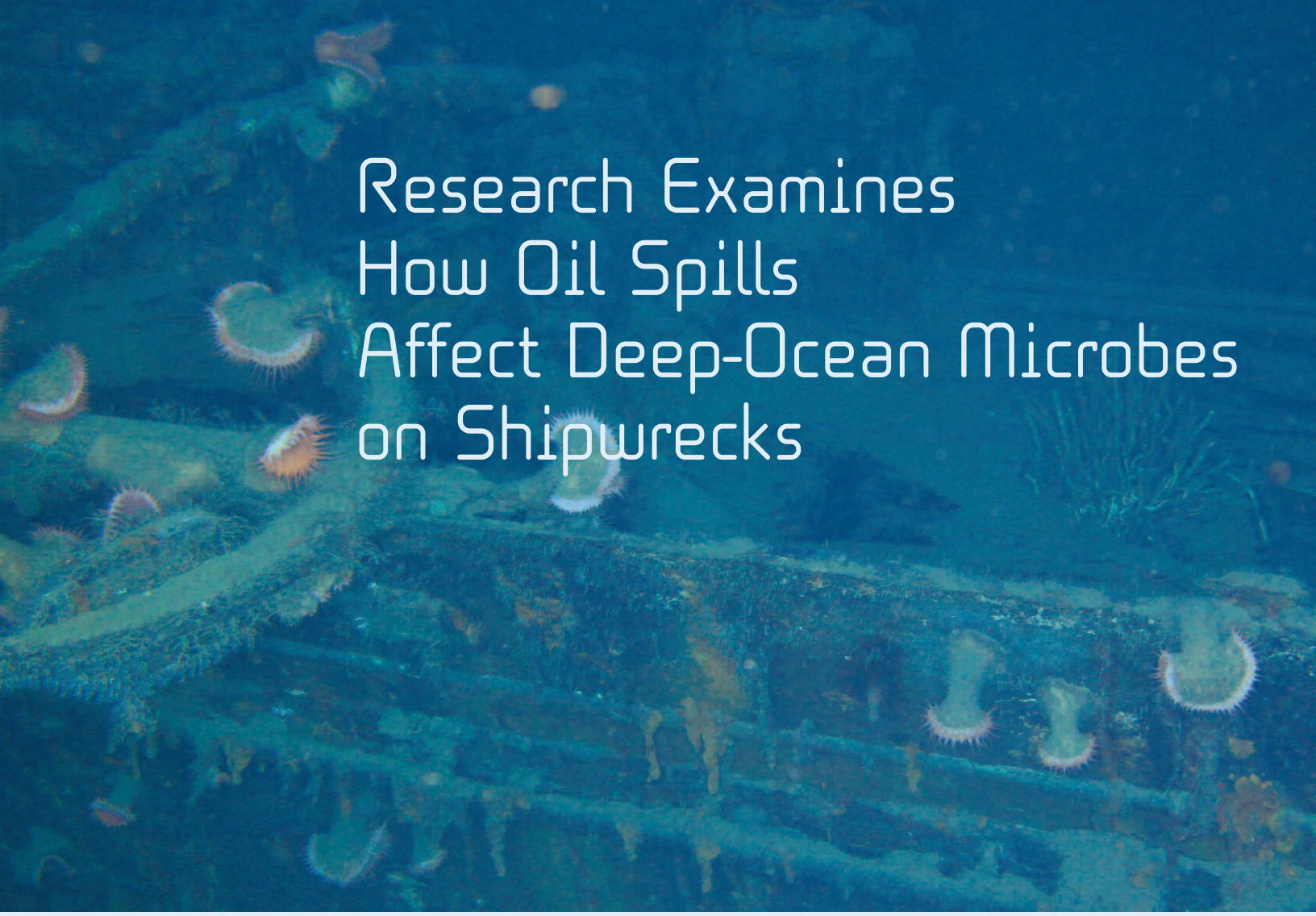
> "One of the most important tools the group developed was a series of computer simulations of more than twenty standard cars, vans, crossovers, and light and heavy trucks, all now in the database. The vehicles can run on any road surface and in any weather, contain virtual people of different sizes and weights, run at different speeds, and carry different loads."

He explains that analyzing car crashes and driving trends also involves a bit of psychology. "Americans are casual drivers," says Kan. "An American-made car is full of cup holders, entertainment systems, and gadgets. Drivers in Europe are more serious about their cars, and driving in parts of Asia is like driving in Disneyland with few rules or regulations."

CCSA's simulations are different from government crash tests. In those, a car is crashed head-on into a wall. Kan explains that this is the same force as if the car were crashed into itself. However, most crashes—and the most dangerous ones—are side-impact collisions and head-on impacts that skew to one side of the front wheelbase. Government crash testing also doesn't test how a car will survive if hit by a heavy car or truck, or if it strikes a guardrail or building. Additionally, crash test dummies are all one size and sit in one standard position. With the simulation, anything can be programmed to mirror real life.

Kan explains all these details with intense interest, and he wants to grow CCSA and expose it to more students. His personal collision knowledge is encyclopedic; by training, Kan is a mechanical engineer. He says that in the beginning, CCSA's research was more computer science-based because there was a need to build the simulations. But now that technology is readily available, the focus is interdisciplinary. He jokes that because crash testing involves physics, geography, biology, and psychology, CCSA's home in the College of Science is a good fit and a great resource for students and researchers.

In addition to settling into their new home, deconstructing a Volkswagen, working to finance a test track, and bringing in new researchers, the CCSA team is also studying jet engine containment scenarios to see how engine safety can be improved using new materials and designs. Vehicles are always evolving, and government standards are always changing: CCSA has no shortage of research opportunities.



Research Examines How Oil Spills Affect Deep-Ocean Microbes on Shipwrecks

Photo: Courtesy of Leila Hamdan

The 2010 Deepwater Horizon oil spill in the Gulf of Mexico affected marine mammals, fish, waterfowl—and the tiniest of marine life, microbes. Leila Hamdan, associate director of the Microbiome Analysis Center (MBAC) in the College of Science (COS) and assistant professor of molecular microbial ecology in the Department of Environmental Science and Policy (ESP), is working to understand the effects of this oil spill on microbial life on shipwrecks in the northern Gulf of Mexico. "When a shipwreck happens," Hamdan explains, "the first organisms on the scene are microbes. They help transform…human structures into a hotspot for life in the deep ocean."

Hamdan is leading researchers in exploring the ecological role that shipwrecks play in the deep ocean (deeper than 200 meters). Funded by the Bureau of Ocean Energy Management (BOEM), this is the first study to assess how this oil spill affected deep-ocean microbial communities on shipwrecks.

Hamdan and her team, including ESP professor and MBAC director Patrick Gillevet, selected six shipwrecks at varying distances from the Macondo wellhead, the epicenter of the Deepwater Horizon spill. Each area has one wooden-hulled and one steel-hulled shipwreck so that researchers can compare their findings on different hull materials.

The first expedition occurred in March of this year. Hamdan, Gillevet, and their team worked from the research vessel *Pelican*, operated by the Louisiana Universities Marine Consortium, outfitted for oceanographic study in coastal areas. Because the shipwrecks are at depths too extreme for diving, researchers use a remotely operated vehicle (ROV) to collect samples from the ocean bottom.

Hamdan explains, "A shipwreck is a hard surface, rarely found in the deep ocean, and it creates a perfect environment for organisms large and small to attach to." The study has implications for

(Left) Life in the deep – the wreckage of the steamship Anona *provides a foundation for micro and macro marine life in the deep, dark biosphere.*

recovery from the environmental damage caused by the Deepwater Horizon spill. "To understand how these environments exist naturally and how they'll be affected," explains Hamdan, "we have to get our brains around the microbial communities that are present…and how resilient [they are] to change."

"Decades of study of aquatic microorganisms show us that when a chemical insult to the local environment happens, in this case, an oil spill, the first organisms to respond are microorganisms," Hamdan says. "That response could have been quite detrimental. We need to understand what's happened to the base of this food web so that we can evaluate how it has affected these artificial reefs."

Hamdan and her colleagues are seeking to learn whether the spill contamination had a specific, different effect on wood-degrading organisms than on metal-degrading organisms. The answer could mean that preservation of one or the other type of ship hull may be affected differently, which could then affect BOEM's work of evaluating how these shipwrecks hold up over time.

Another goal is to examine the effects of the chemical dispersants (COREXIT 9500) that were used to mitigate the oil spill's effects, for example, on microbe growth which could be harmful to the biota of an ecosystem.

As far as implications for science, government, and the private sector, Hamdan says, "Because of where these ecosystems are and their high biodiversity compared to the surrounding ocean floor, they can serve as ecological monitoring platforms for contaminants in the deep ocean. I think we'll be able to contribute quite a bit of knowledge about how oil interacts at the ecosystem level there."

Leila Hamdan

During summers at the Jersey Shore, Leila Hamdan saw a place that was entirely transformed by blue water. "The landscape is shaped by water, and the attitudes of everyone there were moved by oceans," Hamdan says. "And the oceans moved me, too."

She planned to study aquatic systems in graduate school but wasn't sure exactly what discipline. She found her calling when she came to Mason and learned about aquatic microorganisms. "My microbial ecology professor talked about how integral microbes are to ecosystems but how little we know about them," Hamdan explains. "Studying microbes takes a lot of imagination and creativity because you never see what you're studying with the naked eye. It hit me like a thunderbolt, and I just had to study that. It's been my passion ever since."

Hamdan earned two degrees from COS: a master's in biology and a doctoral degree in environmental science and public policy. In her previous work as a research microbiologist at the U.S. Naval Research Laboratory, she researched bacterioplankton in major U.S. estuaries and studied microorganisms in hydrocarbon-rich environments on continental margins around the world.

For Hamdan, Mason provides collaboration among the people in her department. She says, "I'm part of a team that's trying to understand the environment in innovative and evolving ways."

Now a molecular microbial ecologist, she has expanded her research interests to include coastal, continental shelf, and deep ocean studies. To prospective students, Hamdan recommends, "Find something you're passionate about and stop at nothing to understand it."

Photo: Courtesy of Leila Hamdan

Hamdan standing on the stern of the Pelican *with the remotely operated vehicle (ROV) used for this study.*

NanoNotes

Elements of Distinction about the College of Science, its Faculty, Staff, Students, and Alumni

Emanuel F. Petricoin III, Center for Applied Proteomics and Molecular Medicine, was appointed to the board of directors and the scientific advisory committee of Egenix, Inc., a New York-based biotechnology company focused on the development of innovative cancer therapeutics.

Paul A. Dirmeyer, Department of Atmospheric, Oceanic, and Earth Sciences, was named a 2014 Fellow of the American Meteorological Society, the leading professional organization for atmospheric and related oceanic and hydrological sciences.

Gavin Sampey, a doctoral student in the Biosciences program, received a two-year funding award in the amount of $66,500 from the National Institute of Neurological Disorders and Stroke, part of the National Institutes of Health. His application for the Ruth L. Kirschstein National Research Service Award Individual Pre-doctoral Fellowship, "Effects of Exosomes Derived from HIV-1 Infected Cells on Viral Spread," earned an outstanding score of one percent, placing it at the top of all similar applications evaluated in that study section. Sampey's research will be performed under the mentorship of Fatah Kashanchi, director of research, at the National Center for Biodefense and Infectious Diseases in the College of Science.

Abul Hussam and **Timothy Born**, Department of Chemistry and Biochemistry, received a U.S. patent for their application titled "Removing Viruses from Drinking Water."

Dann Sklarew, Department of Environmental Science and Policy, served a one-year term as the Potomac River Goodwill Ambassador to the Potomac's sister river, the Arakawa River in Tokyo, Japan. He shared his expertise about the Potomac River watershed, its ecological challenges, stewardship, and sustainable development at an international green infrastructure workshop, a Kantō Plain rivers workshop, and seminars at Hosei University and Tokyo University of Agriculture.

Thomas Lovejoy, Department of Environmental Science and Policy, received the International Award of Excellence in Conservation from the Botanical Research Institute of Texas for his lifelong work to protect biodiversity.

Iliriana Mushkolaj, PhD Environmental Science and Public Policy '13, has been named the climate change planning advisor in the Senior Climate Change Unit of the Ministry of Foreign Affairs and International Cooperation for the Republic of Fiji.

Luis Nieves, PhD Environmental Science and Public Policy '99, has been appointed chancellor of the University of Puerto Rico at Humacao. He oversees more than 4,000 students and approximately 300 faculty members at the university's third-largest campus.

Carla Milagros Mere Roncal, a graduate student in the Department of Environmental Science and Policy, was selected to receive a Sidney Byers Scholarship for Wildlife Conservation from the Wildlife Conservation Network.

Ryan Valdez, a doctoral student in the Department of Environmental Science and Policy, was awarded a dissertation scholarship from the Society of Hispanic Professional Engineers Foundation.

Christine H. Fox, MS Applied Mathematics '80 and BS Mathematics '76, was appointed acting deputy secretary of defense by President Barack Obama. She is the highest-ranking female official in history to serve in the U.S. Department of Defense.

Dieter Bilitza, School of Physics, Astronomy, and Computational Sciences, was honored with the 2013 International Kristian Birkeland Medal for Space Weather and Space Climate, awarded by the Norwegian Academy of Science and Letters. He was recognized for his work on the International Reference Ionosphere, a widely used standard for Earth's ionosphere.

Kirk Borne, School of Physics, Astronomy, and Computational Sciences, was one of twenty-nine researchers selected from across the United States to participate in a National Science Foundation-sponsored Ideas Lab at Emory University. The program focused on big data in education, specifically, intensive research to improve teaching and learning.

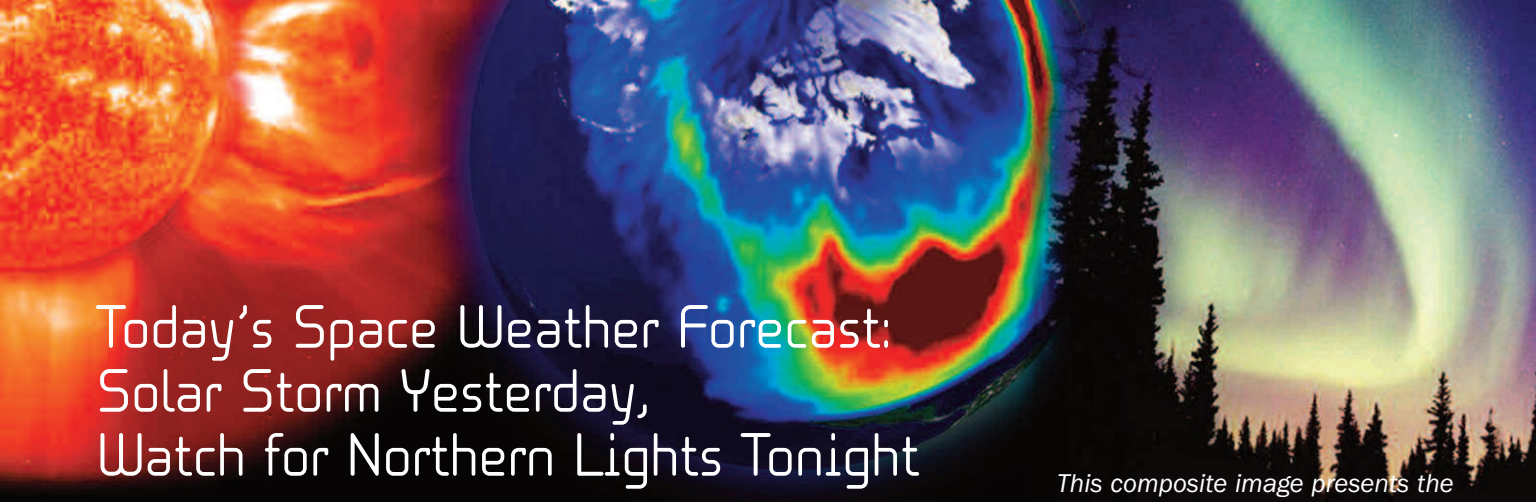
Faculty, staff, students, and alumni are encouraged to send their NanoNotes *to cosnews@gmu.edu.*

COS Alumni Chapter Established

The College of Science (COS) Alumni Chapter was recently accepted into the George Mason University Alumni Association. Walter McLeod, MS Chemistry '94, serves as president of the new chapter, which represents alumni who graduated in or prior to 2006 with a science degree from the former College of Arts and Sciences or the former School of Computational Sciences.

McLeod says the purpose of the chapter is to enhance the sense of community and connection between the university and COS alumni. "One of the goals," he adds, "is to strengthen the professional link between alumni and graduate and undergraduate students."

For more information, contact McLeod at mcleodwl@gmail.com.



Today's Space Weather Forecast: Solar Storm Yesterday, Watch for Northern Lights Tonight

This composite image presents the three most visible elements of space weather: a storm from the Sun, aurora as seen from space, and aurora as seen from the Earth.

Recently, the astronomical community was in a bit of a buzz as the Sun flipped its polarity. "Rotating plasma in the Sun generates a magnetic field" says associate professor Bob Weigel, director of the Space Weather Lab in the College of Science (COS). "Because the Sun rotates faster at the equator than at the poles, the magnetic field is constantly migrating from the pole to the equator." Weigel explains that this somehow causes the Sun to flip its polarity about every eleven years. This latest turn also marks the Sun's halfway point in its twenty-fourth solar cycle.

"The Sun has been quiet in recent years," says Weigel. This cycle has been the weakest in 170 years. An active cycle is characterized by increased sunspots and solar flares—events that contribute to space weather—literally out-of-this-world conditions caused by changes coming from the Sun.

"But even in an active solar cycle, most of us wouldn't realize the change," says Art Poland, a former NASA researcher and one of the scientists responsible for establishing the Space Weather Lab in 2003. The best known effect of space weather is the aurora borealis, the northern lights, usually only visible toward the North Pole. The light show is a result of the Sun's magnetic storm interacting with the Earth's magnetic field; explosions on the Sun shoot charged particles into space and to the Earth. The Earth's magnetic field captures the particles and pushes them to the poles. When the particles collide with gas molecules in the Earth's atmosphere, the energy produces the light show. Poland says that both the Earth's magnetic field and its atmosphere protect us from the constant wind that comes from the Sun. Although most people aren't looking up the daily space weather forecast (you can at the National Weather Service Space Weather Prediction Center, www.swpc.noaa.gov), space weather is becoming increasingly important.

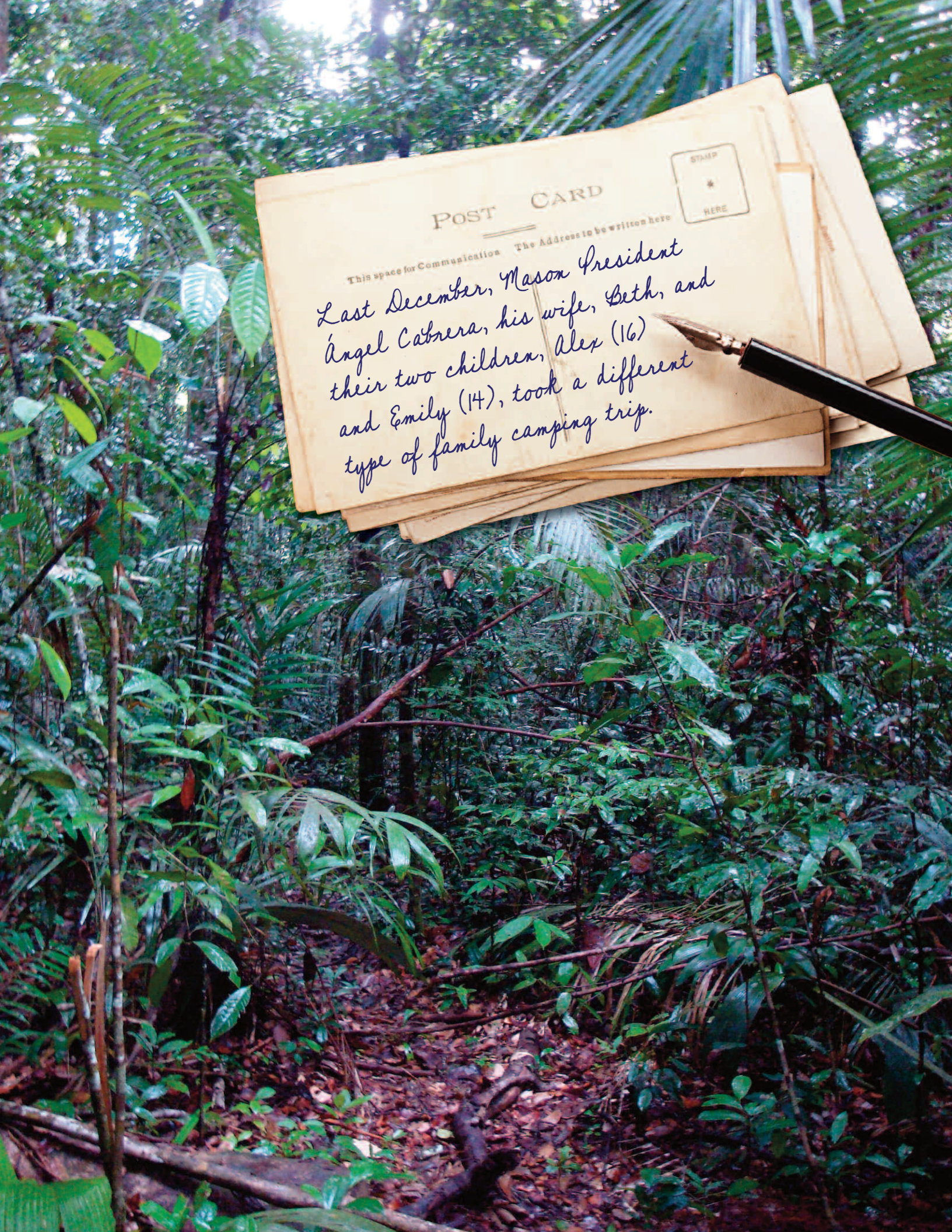
Poland explains, "Our current understanding of space weather is the same as our understanding of the Earth's weather was back in the 1950s." Advances in technology enable us to understand more. And it's precisely because of technology that we care about space weather forecasts. For instance, it is both cheaper and faster for airlines to fly planes over the poles when traveling between continents. However, increased solar activity brings large amounts of radiation that can disrupt communication systems and GPS, and increase radiation exposure to the flight crew and passengers. Space weather forecasts allow carriers to decide when to reroute flights to lower latitudes.

Utilities are concerned too. In March 1989, a powerful geomagnetic storm hit Earth, causing circuit breakers in Canada's Hydro-Quebec's power grid to trip, causing a blackout. With space weather forecasts, power grids can now be decoupled to prevent extensive blackouts. NASA and the military monitor space weather, too. Solar storms can affect the accuracy of missiles during warfare, disrupt satellites, and delay space walks or launches.

The Space Weather Lab is affiliated with the School of Physics, Astronomy, and Computational Sciences in COS. The lab, like its history, is unique. Poland says that in the early 2000s, he and several fellow space researchers working at NASA and the U.S. Naval Research Laboratory (NRL) were ready to retire from their government jobs but not from their research or work. The scientists had substantial government grants that they were able to bring to Mason with the hope that the university would see a need for their work and could support a program with several younger tenured faculty members. With additional funding from the National Science Foundation (NSF), the lab was established. Today, the lab attracts researchers from all over the country, including NASA, NASA Goddard, and NRL. While there is no space weather academic degree currently offered by COS, the lab is a place where students develop an understanding of the Sun, the heliosphere, geospace, and how they interact.

The Space Weather Lab has a variety of projects including the Solar Eruptive Event Detection System (SEEDS), which automatically detects and classifies solar events, and the space weather forecasting contest, in which participants can test their forecasting skills against models, algorithms, and other space weather forecasters from around the world.

Photo composite: Courtesy of NASA


POST CARD
STAMP
HERE
This space for Communication
The Address to be written here
Last December, Mason President
Ángel Cabrera, his wife, Beth, and
their two children, Alex (16)
and Emily (14), took a different
type of family camping trip.

Postcards from Camp 41

"I told Beth and the kids that I was taking them on an exotic vacation, but it wasn't going to be to a fancy resort," says Cabrera. "They were going to be sleeping in a hammock in the middle of the Amazon rainforest. They were game for it."

The Cabreras were not alone. They were traveling with famed conservation biologist Thomas Lovejoy to Camp 41, a unique and remote research facility that serves as the permanent home base for one of the oldest and largest conservation projects in Brazil.

Lovejoy, who holds a joint appointment as University Professor in the College of Science and the College of Humanities and Social Sciences and is a Senior Fellow at the United Nations Foundation, has led scores of trips to Camp 41 to show people the dramatic and real effects of deforestation. For nearly four decades, he has been overseeing this ecological experiment in the heart of the Amazon rainforest.

"I'll take anybody down I can," says Lovejoy. "These are my jungle seminars. I want as many people as possible to see what is happening. I'd like more Brazilians to see it, too. Our hope is to get the board of the World Wildlife Fund-Brazil there soon." His tours have included celebrities, politicians, and researchers, anyone interested in sustainability. The more people who experience the Amazon and see how deforestation is causing the loss of so many of the world's species, the better the chance to save it. It also teaches about biodiversity and the living planet.

In the 1970s, Brazil had a Forest Code requiring farmers and ranchers to maintain a fifty-percent legal preserve of their property (today's version is eighty percent). However, it was not known how large or what shape these artificial environments (habitat islands) needed to be to support the same type of healthy ecological environment found in natural forests. This set-aside gave Lovejoy an idea: What if the preserved areas could be arranged together to form a number of islands of different sizes that could be measured for changes in biodiversity?

Prior to this idea, starting in the 1970s, there was a major controversy called the SLOSS Debate (single large or several small reserves). Not all scientists trusted the theory because it hadn't been tested. Many ecologists began running studies on already existing fragmented ecosystems, but the original conditions of the fragments were undocumented and unknown.

Lovejoy designed the first and, still to this day, the largest fragmentation experiment, specifically in this case, to measure the effects of habitat fragmentation on the Amazon tropical rainforest. Originally named the Minimum Critical Size of Ecosystems Project, it began in 1978 and was endorsed in 1979 by the National Institute of Amazonian Research (INPA) and a small monthly grant from the World Wildlife Fund (WWF). Today, the project, now called the Biological Dynamics of Forest Fragments Project (BDFFP), is a collaborative project between INPA and the Smithsonian Institution. Mason will soon be a partner.

"I'll take anybody down I can," says Lovejoy. "These are my jungle seminars. I want as many people as possible to see what is happening."

The original fragmented land was cleared, and the study was based on one- and ten-hectare fragments. Researchers started collecting data, but the ranchers had not cleared the rest of the land so the experiment was not fully developed. Two years later in 1983, Lovejoy received new funding from WWF to create two new fragments.

continued on page 10

(Left) Exploring the Amazon jungle. (Above right) Houses along the Amazon River.

All photos for this article: Courtesy of Beth Cabrera

Fragmented jungle. The edge effect, where vegetation and species exposed to hot drying air and sunlight die.

Postcards, *from page 9*

The Edge Effect

It did not take long to document significant changes, specifically along the edges of the fragmented forest. Big trees and other plants, now exposed to strong sunlight and winds blowing down from the Andes Mountains, died. This edge effect extends at least one hundred meters into the fragmented area. Additionally, Lovejoy explains, "Anything that has a large home range, such as spider monkeys and jungle cats, does not stay. Birds that prefer darkness and shade and avoid open areas disappear. A one hundred-hectare fragment loses about half its bird species, about fifty types of birds."

The task of counting and documenting different animals and plants is immense, but what is often noticed is what is lacking. For instance, it's not uncommon to find colonies of army ants covering the jungle floor. A typical colony could contain one million or more of the insects. Birds often follow the ants as the insects turn up the area and act as beaters, helping the birds find food. However, a one-hectare area is too small to sustain the immense ant colony, and the insects die. The birds die or leave, as there is no food. Army ants need at least thirty hectares to survive.

Another significant problem is water. Lovejoy says, "The Amazon makes half its own rainfall. When trees die, the water runs off and threatens the entire rain cycle. The deforestation can lead to severe drought."

A Multi-Jungle View

Lovejoy likes visitors to experience the Amazon from different levels, so the Cabreras began their tour on the river. The trip to Camp 41 begins in Manaus, the capital city of the state of Amazonas in northern Brazil, where the Rio Negro and the Amazon River come together at a famous place called the Meeting of the Waters. "These rivers are bigger than any river you've seen," says Cabrera. "So large that you can't see across them at times."

The meeting is remarkable for its size but, also, for a unique phenomenon. The Rio Negro is black, and the Amazon is a light brown. Where the two come together, the waters do not mix because of different densities and temperatures. The two massive waterways flow separately side-by-side for many miles. "This is an incredible sight to see," says Lovejoy, "and we were also lucky to see pink dolphins that are native to the area. I also like people to experience traveling on the river because this is how people got around before planes." Not that transportation is still easy. There is only one main road in Manaus that travels through the jungle and eventually north to Venezuela.

To get to Camp 41, you travel by Jeep until you reach the jungle and a smaller dirt road. That eventually ends. "You grab your things and hike the rest of the way into camp," says Cabrera.

After touring the Meeting of the Waters, Lovejoy took the group to an early-morning visit to a tower that extends above the level of the jungle canopy. "From there you see the jungle wake up. You see things that you have trouble seeing from the ground," says Lovejoy.

Johan Rockström and his family also joined the Cabreras. Rockström is the executive director of the Stockholm Resilience Centre and an international expert in global sustainability. "The party was half children and half adults," says Lovejoy. He likes it when family members come on the trips. The adults become parents and see the research and the jungle through their children's eyes.

"Tom is a teacher and hangs back, letting his students guide visitors through the site," says Cabrera. "You can tell as you are walking through the jungle that he has dozens of stories to share, but he doesn't interrupt. His researchers are experts, and each walk into the jungle exposes you to plants and animals you would never notice."

Learn more about the Biological Dynamics of Forest Fragments Project at amazonbiodiversitycenter.org. The website features photos of the research and an eye-opening deforestation video created from satellite imagery.

Lovejoy explains that one of the top researchers, Mario Cohn-Haft, is an ornithologist who could easily have become a musician. He has the ability to hear the bird song and identify the species. This is particularly useful because birds hide in the jungle.

With these experts, it is all too easy to see the differences in the fragmented area compared to the undistributed control areas and Camp 41, which is in the heart of the jungle and not in the fragmented sites.

Cabrera and Lovejoy agree that it is depressing to see the loss of species and the dramatic death of the forest and understand that if it continues, countless species will go extinct and the entire weather system and ecology of Brazil and the world may be affected. Cabrera adds that he does feel a bit of hope because Lovejoy is working so hard to bring attention to this problem with credible research and outreach.

"Optimism is the only option," Lovejoy says. If you are pessimistic, you won't do anything. The challenge is much greater than it was forty-nine years ago. But this country has the biggest level of public awareness about biodiversity in the world. Half of the Amazon is now under protection. It's not enough to protect the hydrological cycle. The forest is at a tipping point, it's not an experiment we want to see."

Lovejoy travels to Brazil about four times a year. Many times he stays only in Manaus to oversee administrative work. A team of full-time researchers, both Brazilian and American, work to document the project and maintain the barrier that creates the jungle fragment. Lovejoy says, "The jungle keeps encroaching on the fragmented area, and it changes depending on how the land is cleared." He explains that if the area is cleared for cattle pasture, more natural forest will regrow. One of the first trees to return is the Cecropia, a tree with distinct paddle-like leaves that can reach heights of thirty feet. If the area is cleared by fire, what happens is that only a single species comes back usually through sending out suckers. What you end up with is a "thicket of toxic plants."

Though the camp is remote, it can only be reached on foot, and there are no amenities or comforts, Lovejoy loves the rhythm of the jungle. "I love the sounds of the Amazon, it's almost like home to me," he says. "You never know all the sounds you are hearing, but there is one sound that you hear every single morning, you can set your watch to it." He recalls having the actor Tom Cruise at camp, and early one morning, Cruise asked him what time it was. Minutes earlier the familiar animal call broke through the jungle cacophony, and he said, "Oh, it's 5:30."

The Meeting of the Waters, the Rio Negro and Amazon River.

Researcher to Researcher

Cabrera's interest in Lovejoy's work is more than mere curiosity. The two educators met in the summer of 2012 while they were both in Rio de Janeiro. Cabrera, a recognized international expert in global leadership, higher education, and corporate citizenship, was chairing a set of sessions at the Rio+20 United Nations Conference on Sustainable Development; Lovejoy was announced as winner of the prestigious Blue Planet Prize, considered the most important international environmental award. A fast friendship based on mutual interests and goals was forged.

Since that first meeting and this Amazon trip, the two are working together through the university to effect positive global environmental change. Cabrera says, "The type of work Tom does is an example of the type of research we want to see across the university. His work shows how science can inform action and can contribute to solving problems that matter." Cabrera also is working with other science leaders at Mason, such as Jagadish Shukla, University Professor of Atmospheric, Oceanic, and Earth Sciences, president of the Institute of Global Environment and Society, and a member of the 2007 Nobel Prize–winning Intergovernmental Panel on Climate Change, on developing a sustainability research initiative.

Lovejoy adds that Mason, along with colleagues at the University of Brasília and King's College, Cambridge the United Kingdom, are developing a reforestation project. "The Brazilians are upbeat and warm people. If you go halfway, they will meet you. My heart beats according to the Samba."

Computing Against Alzheimer's Disease

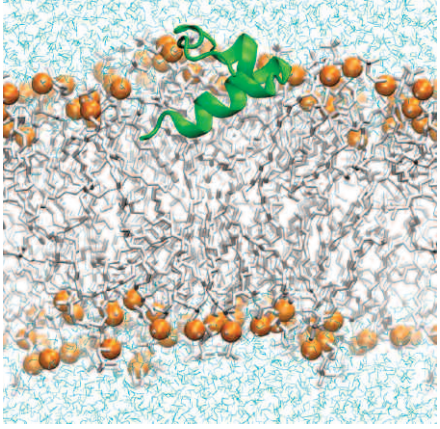


Image: Courtesy of Dmitri Klimov

Computer simulations showing Aβ peptide penetrating a cellular membrane.

Alzheimer's disease is the most common form of dementia, accounting for up to eighty percent of reported cases. Disease risk sharply increases with age, and it is estimated that more than half of individuals over eighty-five suffer from some form of Alzheimer's. Despite urgency and decades of research, Alzheimer's disease currently has no cure.

To develop a therapeutic approach against Alzheimer's, it becomes increasingly evident that concerted efforts of doctors, molecular biologists, and computational modelers are needed. Dmitri Klimov, an associate professor in the School of Systems Biology, represents this new category of researchers who attempt to address this challenge through computational means.

"Computer simulations—numerical experiments that are important research tools—are constructed on some known theoretical model," explains Klimov. "The power of the simulation comes from its ability to analyze hundreds, if not thousands, of options for how molecules interact and behave." Computational biology is an interdisciplinary science pulling from chemistry, computer science, and biology to build and understand models.

Klimov and his graduate student, Chris Lockhart, are seeking the molecular origin of Alzheimer's disease with the hope that a therapeutic solution or a biomarker-based diagnostic tool can be developed. They are looking to tackle two specific problems. The first is research on the small Abeta peptide, an agent that kills neuron cells in Alzheimer's patients. They hope to explore why the Abeta peptide, when it joins with others, becomes toxic to cells. The second study is to see if a biomarker can be identified for the disease. Currently, the disease is diagnosed using behavioral tests. These tests are unreliable and unable to quantify the occurrence and progression of the disease.

Solving these problems through molecular modeling requires an extraordinary amount of computing resources, which are not readily available. Klimov believes he has found an opportunity that may offer the level of computations he needs by partnering with a local software company.

PARABON®

"We all have power plants sitting on our desks," says Steven Armentrout, founder and CEO of Reston, Virginia-based Parabon Computation, as he describes the untapped potential of modern computers. "About ninety to ninety-five percent of computing capacity goes to waste."

Parabon Computation is a software company specializing in distributed computing solutions. The company's flagship program, Frontier, is used by organizations to transform existing IT infrastructures into a single, centrally managed computing network, pooling resources to work on specific problems.

Scientists and researchers who are seeking answers to computationally challenging questions use the Frontier platform to distribute calculations across potentially thousands of computers to dramatically reduce the time required to produce answers. Parabon has previously used Frontier for its Compute Against Cancer program and is now partnering with Klimov on a new research project, Compute Against Alzheimer's Disease.

Any computer, even the one you may be using to read this article, can be connected to the Frontier platform via the Internet. When the computer sits idle, say in the middle of the night or during the user's lunch break, it can be used to crunch datasets. If you can string together several hundred computers or even thousands, the potential to analyze the data increases proportionally. "Volunteering computing" was popularized by the University of California, Berkeley, and its SETI@home project. People around the world volunteer to connect their computers through the Internet to tackle many types of research problems.

Klimov and Parabon are now seeking volunteers who will connect their computers to seek a cure for Alzheimer's disease. The research is partially funded through a Small Business Technology Transfer (STTR) grant from the National Institutes of Health (NIH), a special program that requires a small business to partner with an academic research institution. The program goal is to transform scientific studies and results into

continued on page 13

Interested in joining the fight against Alzheimer's disease?

Visit ComputeAgainstAlzheimers.org to learn how you can connect your computer to the Frontier platform. It's safe, secure, noninvasive, and meaningful.

Alzheimers, *from page 12*

innovative commercial products. "I've known Parabon for many years," says Klimov. "When I had the idea to apply for the NIH funding, it was a natural fit to partner with them."

Klimov will serve as the primary investigator on the project but says, "Without this software company, we can't do this research. They provide the infrastructure." The Alzheimer's research is a good fit for Parabon, too. In addition to using the distributed computing grid for Klimov's research, Parabon researcher Ellen McRae will be looking at the genetic underpinnings of the disease.

This project is currently in its first phase. Parabon has set up a website, ComputeAgainstAlzheimers.org, and the goal now is to solicit volunteers who are willing to connect their computers through Frontier to be used to perform these extensive calculations.

Armentrout explains that connecting to the project is easy. Volunteers download an application that will run unobtrusively like a screen saver. When a user is active, typing or surfing, the program remains dormant. When user activity ceases for a period of time, the program communicates with the Frontier server and is put to use to run the simulations. The application is under complete control of the volunteer, and it can be turned off at any time. It's also secure. The Frontier system is used by government agencies such as the U.S. Department of Defense.

"We would like to have at least 1,000 computers to have a meaningful impact," says Armentrout. "Of course the more we have the better." The website will also publish updates about the project for anyone interested.

This Alzheimer's project is a non-invasive way to become involved in medical research to help solve one of the most devastating diseases of the twenty-first century.

Dean's Message

Photo: Creative Services

Peggy Agouris
Dean, College of Science

As the new permanent dean of the College of Science, I'm excited to be in a place that mirrors the diversity of our society, captures the amazing talent available in students, scientists, and educators, and becomes the place where they find their intellectual home. My new role also gives me a unique opportunity to continue to examine and learn about the countless opportunities to include science in the daily lives of people around us.

In this issue of *Periodic Elements*, we take you into the field and inside the lab to explore the spectrum of projects happening here every day. One such special journey was taken by Mason President Ángel Cabrera and his family when they visited the remote Amazon jungle with world-renowned conservation biologist Thomas Lovejoy, also a Mason professor. Their confluence of thoughts, ideas, and energy is as powerful as the confluence of the Rio Negro and the Amazon rivers that they toured. Cabrera says the work of science at Mason shows "how science can inform action and contribute to solving problems that matter to the world." I couldn't agree more.

Our new Center for Collision and Safety Analysis uses complex computer simulations to improve transportation safety, and researchers at the Prince William Campus are using nanoparticles to determine if an athlete has suffered a concussion. Our scientists are also investigating ecosystems that form around shipwrecks in the deep ocean, as well as the weather in space. We invite you to become involved, too, and donate your computer's downtime to help find a cure for Alzheimer's disease.

The university's ten-year strategic plan is committed to elevating research at the university and promoting research of consequence. The College of Science will be a crucial part of that plan.

Periodic Elements

Read past issues of Periodic Elements at cos.gmu.edu

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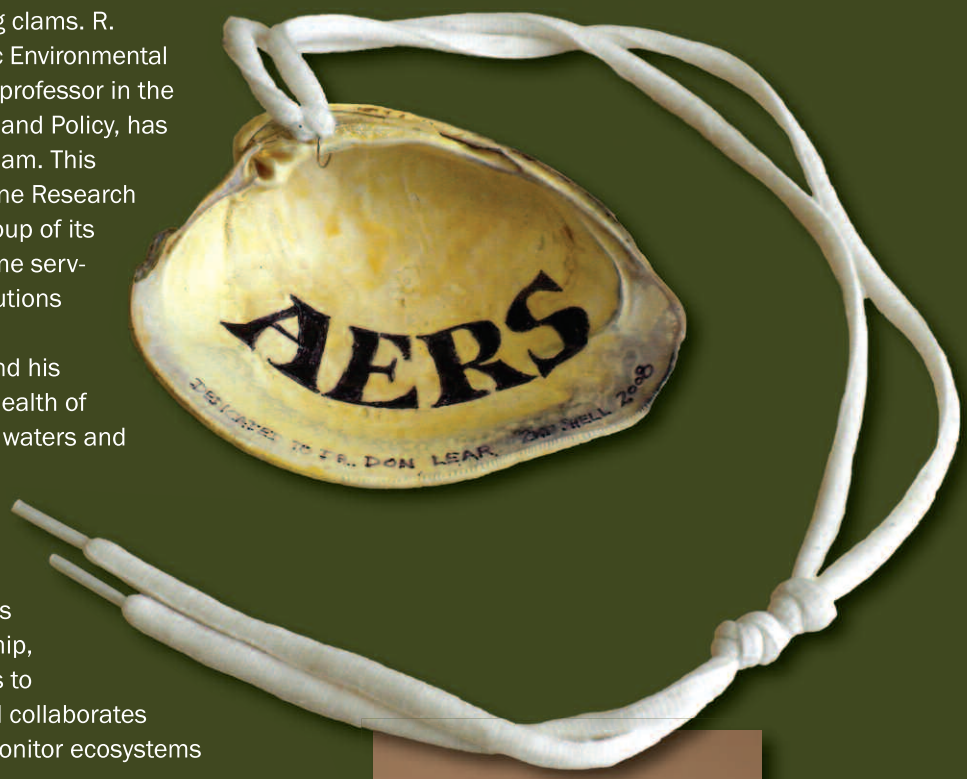
The Venerable Clam

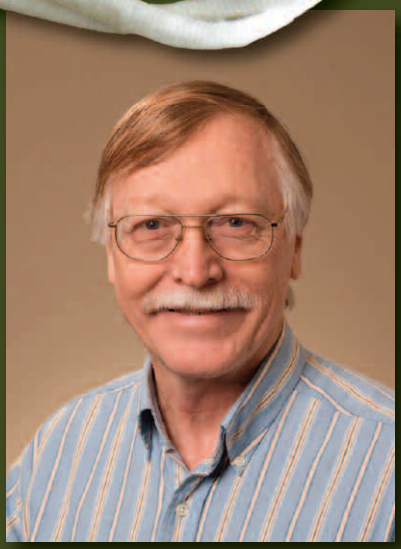
Career achievements are recognized in many ways: Actors vie for Oscars, musicians listen for the beat of Grammys, and environmentalists dig clams. R. Christian Jones, director of the Potomac Environmental Research and Education Center and a professor in the Department of Environmental Science and Policy, has earned his own clam—the Venerable Clam. This annual award from the Atlantic Estuarine Research Society (AERS), the oldest scientific group of its kind in the United States, honors lifetime service and achievement for major contributions to estuarine ecology and society.



For nearly three decades, Jones and his colleagues have been monitoring the health of the Potomac River and its surrounding waters and ecosystems in Northern Virginia. Committed to sharing his environmental passion beyond Mason, he works with K-12 students and teachers to identify field experiences that instill the importance of stewardship, partners with community organizations to promote environmental education, and collaborates with local governments to study and monitor ecosystems and water quality.

His work with the Fairfax County Department of Public Works and Environmental Services has resulted in partial restoration of the ecosystems in Gunston Cove, a bay of the tidal Potomac. For his long-time involvement with monitoring the water quality in the cove, Jones was recently honored by the county with a Champion Award, cited in the Partnering category for his leadership, community outreach, and support of county projects.

Jones also shares his passion through philanthropy to help make environmental education more accessible to students. Because of his generosity, AERS established the Ann C. Powel Fund, named in honor of Jones' deceased wife, to enhance the AERS Endowment and provide support for student travel and participation at AERS meetings. In addition, he is working with other organizations to create similar pathways to accessible environmental opportunities.



R. Christian Jones