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Volume 6, Number 1

Ba Watch

Arctic Worlds,
Old and New

As Africa
Goes Green

Catalyst

Spring 2011 Volume 6, Number 1

is published twice earl b the Of ce of Communications at the Marine Biological Laborator (MBL) in Woods Hole, Massachusetts. The MBL is dedicated to scienti c discover and improving the human condition through research and education in biolog , biomedicine, and environmental science. Founded in 1888, the MBL is an independent, nonpro t corporation.

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Dear Friends,

We live in an age when environmental issues—from oil spills to toxic algal blooms to global warming—are regularly headline news. Ecosystems science is extremely important in separating fact from fiction in many of these issues. But it is also clear that ecosystems science must be broadly interactive, if those facts are to be put to practical use. As this issue of *MBL Cata t* highlights, our Ecosystems Center scientists collaborate with many kinds of people in diverse ways that extend the ultimate impact of their research on society. From volunteering for a local environmental group, to advising national and international policymakers on global climate change, Ecosystems Center scientists are making sure their research makes a difference.

When I look at the outstanding body of research that our Ecosystems Center is producing, two important themes stand out. One is long-term polar research. The Arctic and Antarctic are changing faster in response to climate warming than all other regions on earth. Shrinking glaciers, loss of sea ice, and thawing permafrost are visibly apparent to our scientists who have been working for decades at the National Science Foundation's Long Term Ecological Research (LTER) sites at the two poles. Given their combined expertise in Arctic and Antarctic ecosystems, they are currently considering the merits of a "bi-polar" research approach to identify common patterns and critical "tipping points" in polar environmental change.

Another important theme at our Center is the cycling of nitrogen through the Earth's soil, water, and atmosphere. Why should we care about nitrogen? One reason is global warming. More than a third of the nitrous oxide—a powerful greenhouse gas—being emitted to the atmosphere is due to human activities, mainly the use of nitrogen-based fertilizer. A second reason we must care is the runoff from fertilizer, combined with inadequate sewage treatment, means our coastal waters are being overloaded with nitrogen, which debilitates marine habitats and threatens their survival. Nitrogen loading has become a major economic issue facing all coastal communities, including Woods Hole. The Ecosystems Center has world-recognized expertise on the nitrogen cycle and its role in critical environmental issues.

I'd like to extend a warm thank you to Hugh Ducklow, director of our Ecosystems Center, who not only ably guides the Center but found time to serve as guest editor for this issue of *MBL Cata t*. Hugh directs the Antarctic LTER, which complements the Arctic LTER originally directed by John Hobbie and now led by Gaius Shaver, both of the Center.

The stresses and challenges our planet faces are not small. But the dedicated scientists at the MBL Ecosystems Center are providing valuable information that helps build a firm foundation as society finds ways to turn the tide.

Gary Borisy

Gary Borisy
P ta D t

FEATURE

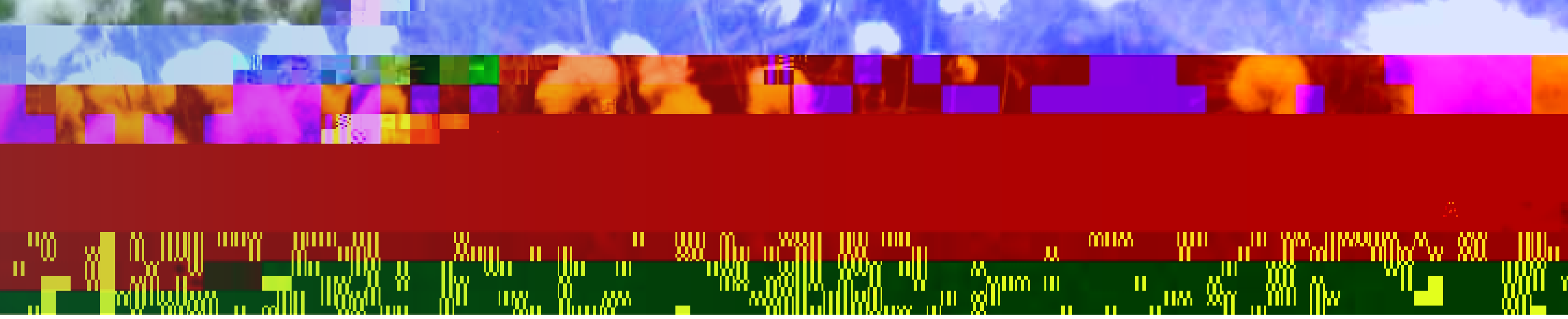
DEPARTMENTS

MBL

Earth in the Balance

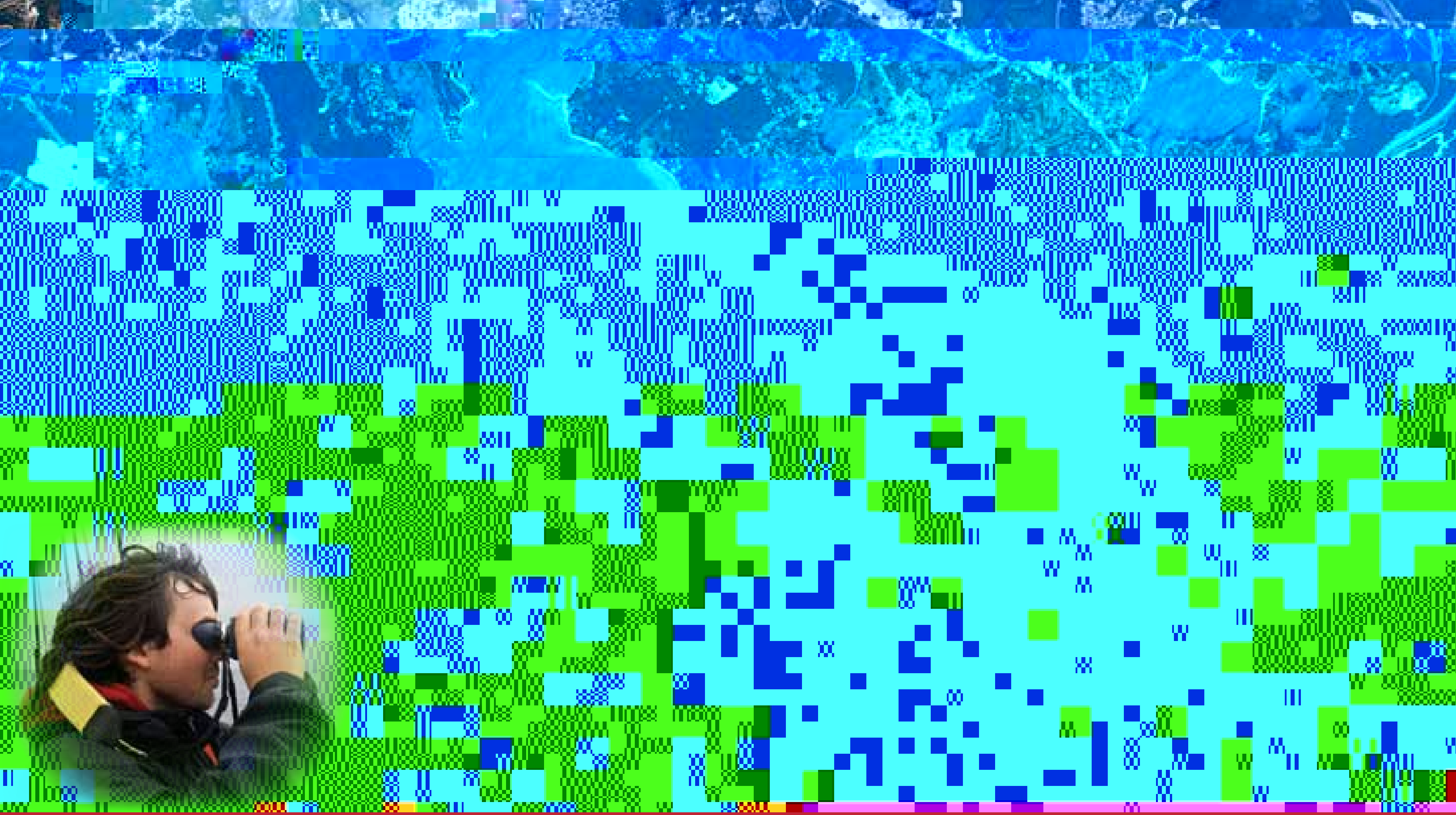
Restoring our planet to health

The web of people who are concerned about how we are changing our planet just keeps widening. In the Arctic, native people tell scientists what the polar landscape was like generations ago, before the ice started to melt. In Africa, farmers stop to consider how to best apply crop fertilizer in a way that does minimal harm to the environment. On the Massachusetts coast, citizens band together to find workable solutions to the nitrogen pollution that threatens the harbors and bays.



Inside this intricate web is where MBL Ecosystems Center research translates into action. It is where the years of patient scientific observation of environmental change become a firm foundation for citizen and political action at all levels, from towns to regions to nations. It is where fishermen, schoolchildren, retirees, global leaders, policymakers, artists, all types of people converge with scientists in the strong desire to bequeath our planet in a healthy state to future generations.

This issue of *MBL Cata t* explores the connections between Ecosystems Center scientists and some of the environmentally aware people they encounter in their daily work. Together, they are delivering a powerful message: We need a better understanding of how ecosystems operate in the face of climate change and pollution, and we need to act now to create a sustainable future for our planet and its people.



he conversation started, as man do, at a social event on a summer evening. Hugh Ducklow had just arrived as the new director of the MBL Ecos stems Center in 2007 when, at a part , he met Mark Rasmussen, president of the Coalition for Bu ards Ba . This citi ens group is devoted to protecting the ba and its watershed, which includes more than a do en towns in southeastern Massachusetts. Its central program is Ba watchers, a team of 135 volunteers who regularl collect samples from the ba 's coves and harbors to monitor them for changes in water qualit .

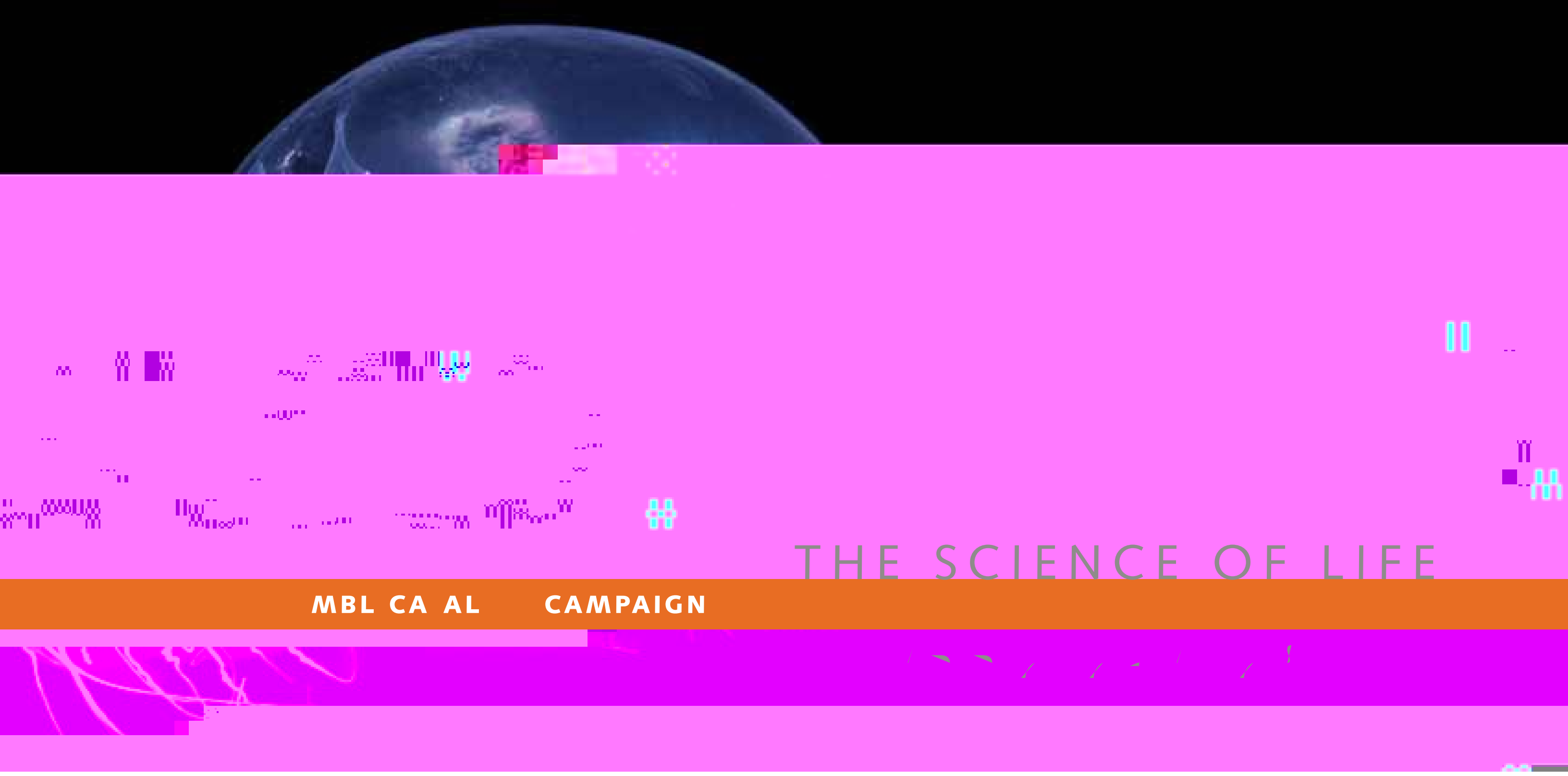
I thought, I can do that. I live right near the ba , sa s Ducklow. So he signed up to be a Ba watcher. Two mornings a week during the summer, Ducklow leaves for work a little earl and stops b his sampling station in Fiddler's Cove in North Falmouth. It takes about a half hour, he sa s, to record several weather and water conditions, including dissolved o gen which, if low, can indicate deterioration in water qualit .

It's fun, Ducklow sa s. The onl time I get to do sampling for m own work is once a ear, when I go on a [research] cruise to Antarctica. More to the point, he sa s, Environmentall , this is an important issue and organi ation.

Since then, the ties between MBL and the citi ens group have onl strengthened. Two ears ago, the Ecos stems Center signed a contract to perform ongoing anal sis of some of the Ba watchers samples. More importantl , some of its scientists are increasingl active as coalition advisors.

The MBL is not just running sample anal ses and sending us the data on a disk, sa s Rasmussen. The relationship is more like science advisors and collaborators. MBL scientists such as Anne Giblin, Chris Neill, and Hugh Ducklow are guiding how we conduct the Ba watchers program: what are the right stations to monitor; what aspects of our data are beginning to tell a stor that leads to new questions we want to answer. The reall are a guiding

River and stream networks are the source of 10 percent of the nitrous o ide emissions that are due to human activities, report MBL Senior Scientist Bruce J. Peterson and collaborators in a global-scale stud . Nitrous o ide (N_2O) is a potent greenhouse gas that contributes to climate warming and destruction of o one in the stratosphere. Over the past 50 ears, humans have doubled the load of nitrogen to the biosphere primaril through appl ing nitrogen fertili er to crops and burning fossil fuels, Peterson sa s. One consequence is more nitrogen gets into streams, lakes, and estuaries, which can lead to low-o gen conditions harmful to aquatic life. But this stud shows another consequence is a u of N_2O from the rivers and streams to the atmosphere, he sa s. While carbon dio ide is the most abundant greenhouse gas in the atmosphere, N_2O is 300 times more potent, molecule per molecule. This calculation of nitrous o ide u from river networks, which the scientists derived from research on 72 streams across the United States, is three times the amount previousl estimated b the Intergovernmental Panel on Climate



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CAMPAIGN PRIORITIES

Ecos stems	$15 million
Microbes	$15 million
Biodiversit	$10 million
Transformative Laborator Courses	$20 million
Brown/MBL Partnership	$ 5 million
Whitman Center Research Catal st	$10 million
Regenerative Biolog & Medicine	$10 million
Marine Resources	$ 5 million
Cellular D namics	

IN THE Arctic,

nature balances on the freezing point of water

In this cold, circumpolar landscape, climate change is not a vague concept. It's not something to think about another day. People in the eight countries above the Arctic Circle are watching as one world slips away, and a new one forms.

The rise in planetary surface temperature of about 1˚F since 1900 may not yet be noticeable in the "Lower 48." But in the Arctic, an entire ecosystem is thawing, melting, and reshaping.

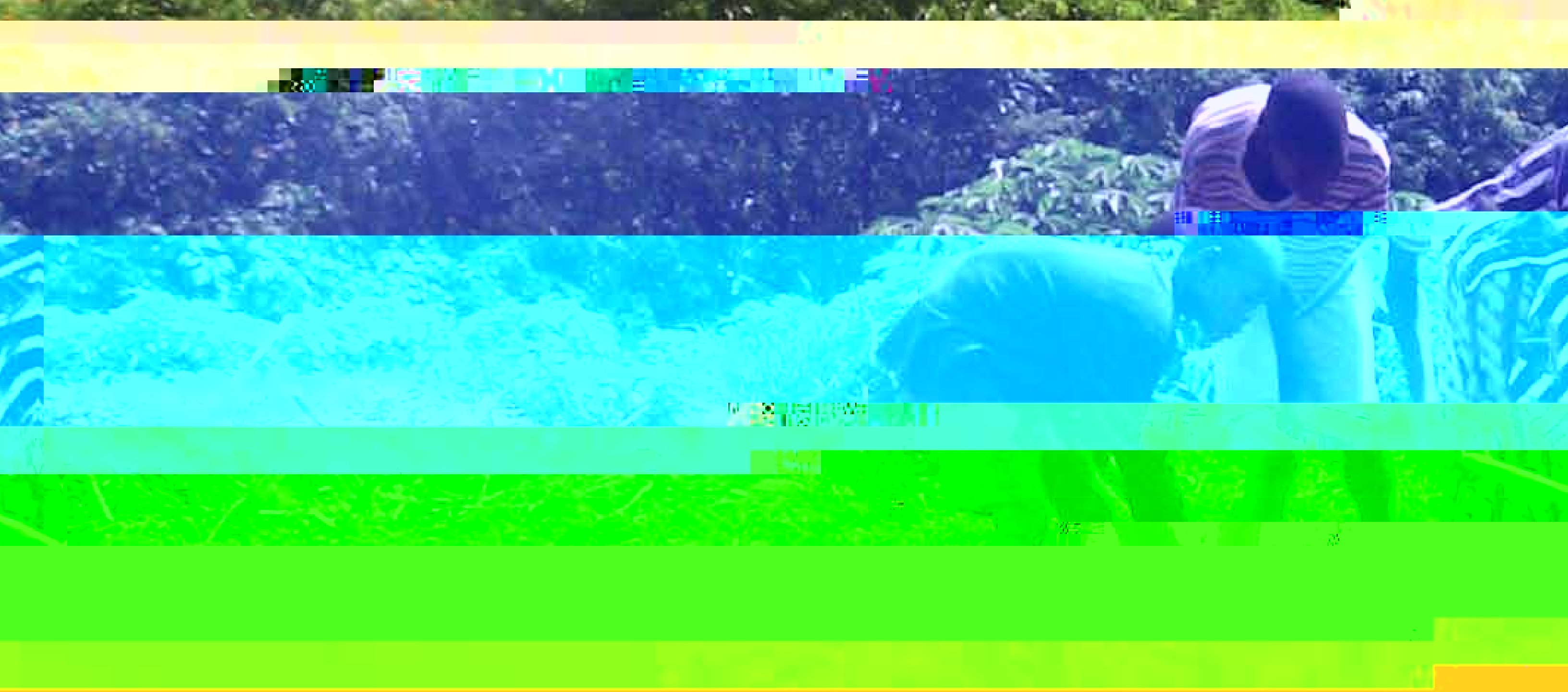
"Everything is changing," says Senior Scientist Bruce Peterson of the MBL Ecosystems Center, who has studied river ecology at Toolik Field Station on Alaska's North Slope since 1975. "The glaciers at Toolik have shrunk; you can see it from the camp. In some places, the ground ice is melting out. It's not being replaced; it's just disappearing. There is a major transformation taking place as the cryosphere [frozen layer] is going away. "

Others who take watchful notice are the residents, including members of the Yukon River Intertribal Watershed Council in Arctic Alaska and Canada. This coalition of First Nations and Tribes formed to preserve and protect the 1,980-mile river that not only gives them sustenance and livelihood, including a commercial salmon fishery, but is a sacred waterway in their culture. The council's long-range goal is "To be able to drink water directly from the Yukon River."

In a convergence of common interests, Woods Hole scientists and the Yukon River Council are intersecting in a long-term research effort called the Arctic Great Rivers Observatory (GRO).

"We have learned a lot by talking to the indigenous people in the Arctic," says Senior Scientist Max Holmes of the Woods Hole Research Center, who along with Peterson is one of the principal investigators of the Arctic-GRO. "The indigenous people have a long-term perspective. They know when the ice used to break up [seasonally] at the mouth of a river, for instance, and they know when it happens now. They can offer qualitative information that may indicate patterns we already suspect, and we can try to confirm with satellite data. Their anecdotes can even point us in new directions."

Beyond the sharing of traditional ecological knowledge, the Yukon River Council is woven into the fabric of the Arctic-GRO through another route: river sampling. The council, with help from the U.S. Geological Survey, has set up a water quality observation program along the Yukon that involves regular sampling at



assionate social revolutions and long-range planning don't alwa s go hand in hand, but sometimes the opportunities arise to make wise choices in the midst of great change.

Such is the case with the African Green Revolution, which is the new wave of the agricultural revolution that swept Asia and Latin America in the 1940s to 1960s.

African farmers, having missed the Green Revolution of the 20th centur , are now beginning to add substantial amounts of fertili er to their crops, sa s Distinguished Scientist Jerr Melillo of the MBL Ecos stems Center. The short-range bene ts are tremendous: Farmers are suddenl tripling their harvest ields in a nation where nearl a third of the people live in e treme povert , and the soil and climate for agriculture are poor.

Yet as the rst Green Revolution has shown, the intensi cation of agriculture, with its high inputs of fertili ers, pesticides, herbicides, and water to obtain ma imum crop ields, can have comple consequences for the land and its sustainabilit .

Intensive agriculture often drives farmers to speciali e. It can also make them mone , sa s Chris Neill, senior scientist in the MBL Ecos stems Center and director of the Brown-MBL Partnership. Some people argue that that is a good thing. If the U.S. Midwest is good at producing corn, for e ample, then it should focus on producing corn ver ef cientl and sell it to the rest of the world. Other people think that is a nutt s stem. We should be focused on feeding people, producing a wide variet of crops, using less inputs to the land, transporting produce shorter distances.

What path the farmers in Africa will take as their own Green Revolution unfolds is of great interest to Neill, Melillo, and a group of their colleagues at the MBL, Brown

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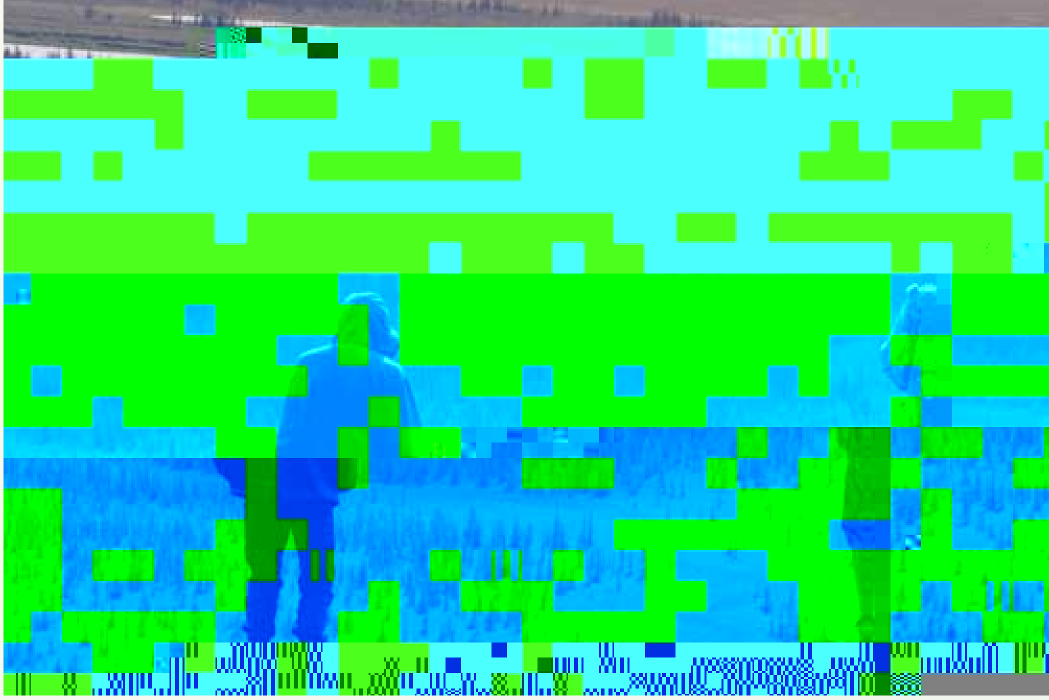

MBL:

JM: There is a growing recognition that we have to put adaptation measures in place because we are already experiencing climate changes, and we want to minimize adverse effects in the future. People at the local and regional levels are starting to incorporate climate change adaptation measures

structures in harm's way, and make them less vulnerable to damage from floods, intense winds, and other extreme events. A terrific example of climate change adaptation is the Deer Island sewage treatment plant in Boston Harbor (lower left), which was built about two feet higher to take into account projected sea level rise by 2050, the planned life of the facility.

Getting the world's nations to agree on mitigation actions to reduce emission of greenhouse gases, such as carbon dioxide, has been difficult. In the United States, communities, states, and regions are showing leadership on mitigation by looking for win-win situations that make good economic sense and at the same time reduce emissions of heat-trapping gases. Many of these win-win cases involve improving the efficiency of energy use. Beefing up insulation in our homes and businesses, switching to more energy-efficient lighting, and buying higher-efficiency cars are all steps in the right direction.

MBL:

JM: Helping the public understand what the climate change models can and cannot do is an important challenge for the scientific community. We have to do a better job of explaining the benefits and limitations of these models. They help us think more clearly about the complex interactions among the atmosphere, the ocean, and the land that influence the planet's climate. They also help us to quantify the uncertainties associated with the climate projections. The public needs to be reminded that all of us make many decisions in our daily lives that factor in uncertainty. The military, the business community, governments—all of them use "what if" exploration tools (models) to look into the future and to manage uncertainty.

MBL:

JM: That's why we have to work at linking model projections with our observations of climate trends. A focus on observations allows us to talk about facts. Last spring, for instance, I gave a presentation on climate change to a business group in Rhode Island. We discussed how our observations over the last 30 years show a 70 percent increase in heavy downpours in the Northeast, and our models project this will continue. So how we adapt is a very practical issue, and at the meeting we talked about options like rebuilding the storm drain infrastructure. Three weeks later, there were torrential downpours that led to extensive flooding in Rhode Island. After that, I got a number of calls from meeting participants who wanted a copy of my Power Point presentation. It's not that I was prescient. It's just that there have been these observations that tell us something, and if we are smart, we will pay attention.

MBL:

JM: Yes, but I also find surprising levels of awareness in places you might not think about. For example, the Department of the Navy is very interested in the climate change issue, particularly sea level rise. They have hundreds of bases around the world and they are very concerned about that infrastructure being in harm's way. And they see that this situation will not go away, and that flooding and storm surge problems will likely increase over the century. Hopefully the new Congress will have a dialogue with some of the people in the military who have serious concerns about climate change, and think it could become an important national security issue.

MBL: 2

ACCOLADES

An Early Wake-Up Call

The gray, shingled house perched high on a dune at Great Sippewissett Marsh in Falmouth, Massachusetts, was an appealing retreat in the early 1970s. Unfortunately, the house has since slipped into Buzzards Bay, due to erosion exacerbated by sea-level rise. MBL scientists first began research in the Great Sippewissett Marsh in 1971, making it an early site for their long-term studies of salt marsh function. In that decade, MBL scientist Ivan Valiela and colleagues, including John Teal of Woods Hole Oceanographic Institution, discovered that nitrogen is a critical factor regulating the "metabolism" of salt marsh ecosystems. Teal and Valiela, who co-taught the MBL Summer Course on Marine Ecology for seven years, published the seminal paper on the subject, "The nitrogen budget of a salt marsh ecosystem," in 1979 in the journal *Natu* . After 40 years of concerted study, Valiela says, it is clear that salt marshes are providing a vital service to the environment by intercepting land-derived nitrogen before it reaches fragile coastal ecosystems. The years of observation also have revealed how salt marshes, and the houses near them, are vulnerable to global changes such as sea level rise.—DS

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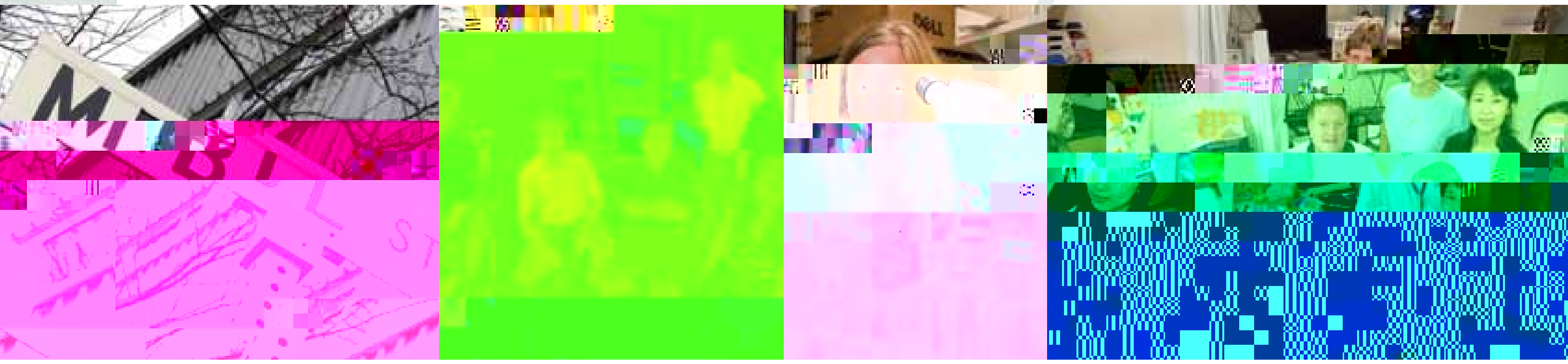

The Whitman Center for Research and Discovery

Hundreds of scientists from around the globe come to the MBL each year, eager to try out their best ideas for creative experiments that, often, can only be done in Woods Hole. They bring their top graduate students and post-docs, quickly set up shop in Rowe Laboratory or elsewhere on campus, meet up with their collaborators from other institutions, and dive into an intense period of scientific inspiration and discovery. The next issue of *MBL Catalyst* will explore the Whitman Center's illustrious history and ongoing mission of conducting important research with high-impact results.