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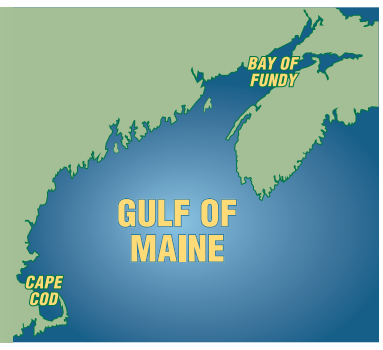

Promoting Cooperation to Maintain and Enhance Environmental Quality in the Gulf of Maine

Lost "ghost" fishing gear just keeps fishing. ***Story Page 9***

INSIDE

PHOTO: SHAWN P. CAREY (MIGRATION PRODUCTIONS)

The Semipalmated Sandpiper likes the mudflats of the Bay of Fundy. The species is sensitive to changes in its foraging areas.

Climate change and the Gulf of Maine

By Anne Hayden

The question is no longer if, or even when, climate change will affect the Gulf of Maine. The question is how—and how much? What will climate change mean for the ecosystem and the fishermen, coastal communities, and other stakeholders to whom it is so important?

One leading scientist warned at a recent conference that "there will be surprises."

Understanding the potential impact of climate change on the Gulf, from a scientific perspective, is not a simple exercise. First, much of what we know about climate change is averaged over a global scale. Understanding what an average increase of 2-4 degrees C over the next 100 years, as predicted by the Intergovernmental Panel on Climate Change (IPCC), means for the Gulf is complicated by the fact that the polar regions are warming faster than the equator.

Furthermore, the transfer of heat from the atmosphere to the ocean varies considerably depending on currents, tides, and winds. In the Gulf of Maine, climate scientists believe that warming due to increasing air temperatures will be somewhat offset by increased flow of cold Labrador Current water into the Gulf as the rate of Arctic sea ice melting increases.

The Union of Concerned Scientists has estimated that the Gulf of Maine will warm as much as 1-2 degrees C over the next 70 years. However, much work remains to be done before models can reliably predict what a warming atmosphere will mean for the Gulf of Maine.

Daniel Schrag, professor of Earth and Planetary Sciences at Harvard, speaking at a symposium in Boston February 5 on climate change and the marine environment, emphasized that "No one knows exactly what is going to happen" as marine waters warm. "I want to make it clear that there will be surprises."

> ***"Seabirds are exquisitely vulnerable to climate change."***
>
> *— Hector Galbraith*

Setting aside predictions of future change, do we see any evidence of recent warming in the Gulf, now that we know that climate change has been underway for years, if not decades? Until recently the data has been conflicting. Some studies have shown that the Gulf has actually been cooling over the past few years.

Heather Deese, graduate student in physical oceanography at the University of Maine, has been analyzing temperature records in the Gulf for long-term trends. She is quick to point out that "any warming due to climate change over the past century has been gradual—and very small relative to changes

*See **Climate Change** Pages 6-7*

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The Gulf of Maine Council on the Marine Environment was established in 1989 by the governments of Nova Scotia, New Brunswick, Maine, New Hampshire and Massachusetts to foster cooperative actions within the Gulf watershed. Its mission is to maintain and enhance environmental quality in the Gulf of Maine to allow for sustainable resource use by existing and future generations.

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Editor's Notes

The times and the *Times*, all changing

As clearly shown in our major story, the climate is changing and the changes are having an effect on the Gulf of Maine, as they are throughout the world. Fortunately, we can also see that efforts are taking place all around the Gulf to mitigate or prevent the worst effects of the changes.

Changes are coming to the *Gulf of Maine Times*, as well. In the Winter/Spring 2007 edition of the *Times*, editor Lori Villagra informed the readership that the paper copy of the *Times* would be reduced from four issues to three per year, and encouraged readers to subscribe on line.

This publication year, the *Times* was reduced from three to two paper issues as grant money dried up. Certainly, the *Times* is not alone. Newspapers around the country are closing down because costs are up and advertising dollars are down. The predicament of newspapers has been worsening for some time as more, especially younger, readers sought their news on the Web, not on paper, but the financial worldwide free-fall has accelerated the problem.

Now, the *Times* is facing a similar problem. Since the Times does not accept advertising, the paper has no source of revenue except the shrinking grant money or the generous donations of its readers and friends.

Unless an unexpected solution to the financial problem is found soon, this may be the last issue of the *Gulf of Maine Times*, at least on paper. Friends and readers who have not contributed to the support of the *Times* are urged to do so while there is time left to save it. We may be able to continue to publish the *Times*, at least on the Web, if there's enough support.

Meanwhile, we hope you will enjoy this issue of the *Times*. We wanted to provide readers with a snapshot of the challenges climate change poses to the Gulf and some of the programs designed to meet and overcome those challenges. Thanks to Anne Hayden, we have an overview of the situation. Anne was a policy development specialist at the Maine State Planning Office who co-wrote the seminal work, *The Gulf of Maine: Sustaining Our Common Heritage* in 1989 at the outset of the Gulf of Maine program.

In the last issue, the main story on alternative energy was written by Melissa Waterman, who was staff to the Gulf of Maine program at the State Planning Office from the program's start in 1989 through 1994. She contributed this issue's story on the novel and effective efforts to control solid waste in Annapolis, Nova Scotia.

Of course, the work of two other fine reporters represented here are familiar to readers by now. Assistant editor Catherine Colletti and Rebecca Zeiber, both of New Hampshire, have contributed many fine pieces to the *Times* and have done so again for this issue with stories on fluvial erosion, derelict fishing gear and tracking small lobsters

Book reviewer Lee Bumsted from South Portland, Maine, is another valued and long-time contributor whose critique of *The Unnatural History of the Sea* in this issue illuminates another perspective on environmental changes.

So please enjoy the paper, please consider supporting the *Times* financially, and if you don't see us on paper again, we hope you will see us on the web.

— Nancy Griffin

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Promoting Cooperation to Maintain and Enhance Environmental Quality in the Gulf of Maine

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UNH researchers track tiny lobsters

By Rebecca Zeiber

Icy air hits Jason Goldstein's face around his sunglasses and knitted hat as he drives a small boat in New Hampshire's Great Bay Estuary. He motors towards Fox Point, the site of a lobster trap he checks regularly.

Lobsters in the trap are not sold at market. Instead, they are fitted with transmitters to reveal their movements. And because lobsters are not stationary creatures, Goldstein is out tracking their migrations at least once a week, regardless of the season.

"At least it's not sleeting today," he says with a wry smile.

Goldstein, a Ph.D. candidate in zoology at the University of New Hampshire (UNH), has tracked lobsters along the New Hampshire coastline and into Great Bay throughout the past two years.

This research, funded by N.H. Sea Grant, will provide more accurate information about the sources of juvenile lobsters and interactions between the population stocks in New England.

The information could improve the management of this economically valuable fishery, thus allowing lobster to remain front and center among New England menu choices.

Goldstein and UNH professor of zoology Win Watson are particularly interested in the movements of "berried" females, those carrying eggs. Where the berried females go, so go their eggs, and those movements likely have implications for New England lobster populations.

"They are very mobile animals and move around to avoid bad weather conditions," Watson says. He notes that the average lobster can walk from the Isles of Shoals to the New Hampshire shore — up to 10 miles — in just a few days.

Along with other students and technicians, Goldstein has spent countless hours tracking the lobsters using ultrasonic and handheld hydrophone tracking equipment to locate them and determine their movements.

In addition to studying the migrations of the adult lobsters, Watson and Goldstein are learning how the movements of berried females could impact egg development and location of larvae upon hatching out.

"Just because you find a lobster with eggs in one location doesn't mean that's where the eggs will drop," Watson says. "This is a really important issue. It speaks to the source of recruits to the fishery, where they come from and where they are going.

"If New Hampshire berried female lobsters move 10 miles offshore and release their larvae next spring, where will those larvae go? Will they stay in New Hampshire or move south to Massachusetts? Will they survive at all?"

Watson and Goldstein began using oceanic drifters this year to learn more about larval movements. The drifters are submerged box-like structures that mimic the movements of lobster larvae, which typically float within two meters of the surface. The larvae are strongly influenced by the ocean currents until they settle to the bottom, about three weeks after hatch.

The drifters were deployed in locations where the berried females that were tracked had resided, and at the times of the year when the larvae were known to hatch. Every 30 minutes, a satellite transmitter fitted to the drifter reports its location and the coordinates are recorded and displayed on a web site.

Watson originally thought the drifters released about three miles offshore would be carried south with currents parallel to the shore. Instead, several of them crashed into the coast at Hampton Beach and the mouth of the Portsmouth Harbor near New Castle within one week of deployment.

"I found that very surprising," Watson said. "It makes you wonder if larvae would survive if they were carried so close to shore within a week of hatch before they were ready to settle on their own."

In contrast, the drifters released near or beyond the Isles of Shoals ended up near Cape Cod and Georges Bank, and those placed in the Great Bay Estuary stayed there, with some going up the Swampscott River toward Exeter.

"To me, that illustrated that if lobster eggs were hatched out in Great Bay, they would probably be retained in the systems, which might not be optimal," Watson said. "The estuary is not the best place for lobster larvae because of the warmer temperatures, higher turbulence and lower salinity."

This finding fits well with the hypothesis that mature female lobsters migrate out of the estuary, leaving the sex ratio skewed toward males.

Putting all these data into perspective will be Watson's next step. He hopes to apply what he has learned to improving management practices for the species. In particular, Watson wants to know if New Hampshire lobsters can be managed in isolation or if the management unit needs to be larger.

"If New Hampshire lobsters are recruiting to Massachusetts or elsewhere, then we need to work together to better manage the population," Watson says.

"If New Hampshire lobsters are recruiting to Massachusetts or elsewhere, then we need to work together to better manage the population."

PHOTO: WIN WATSON, UNH PROFESSOR OF ZOOLOGY
An oceanic drifter is deployed by Ph.D. candidate Jason Goldstein. The drifters look like underwater box kites with a GPS unit attached to the top, and they simulate the movements of larval lobsters drifting in the ocean for the first few weeks of their life.

Lobster industry challenged

Maine restaurants, retail outlets and towns rallied to push lobster sales this winter when prices to harvesters dropped to around $2 a pound.

In Stonington, a special event was held at which 5,000 pounds of lobster were sold at $3.50 a pound. In Georgetown, 3,400 lobsters were sold at $4 a pound and in Boothbay Harbor, nearly 7,000 lobsters were sold at $4 each.

"It's humanitarian to say we're doing it to help the lobstermen," said Brian Ross, a Bangor chef who started a nonprofit website with lobster recipes to help boost sales. "But you know what? Lobster tastes good."

Hannaford Supermarkets promoted lobster heavily and sold unprecedented amounts of the crustaceans to Maine residents in November and December.

Whether these efforts will pay off long-term to help the embattled industry remains to be seen because some lobster harvesters are predicting many will drop out of the fishery if prices don't rise by spring.

High fuel and bait prices, coincided with low lobster prices last season at the same time demand plummeted.

Bill Adler, president of the Massachusetts Lobstermen's Association, said he's heard from harvesters that many are considering getting out of the business completely.

The *Gulf of Maine Times* is made possible in part by a grant from:

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Taking charge of solid waste in Annapolis Royal

By Melissa Waterman

Annapolis Royal, Nova Scotia, the site of North America's first tidal power station, is leading the way in solid waste recovery among the Maritime provinces. Under the town's Zero Waste program, recycling and composting have become commonplace among Annapolis residents.

"Our motto isn't 'not in my backyard'," said Amory Boyer, Annapolis' chief administrative officer. "It's 'in everyone's backyard.'"

She noted that with each additional town-initiated waste recovery program, the recycling rate has gone up, now reaching 73 percent.

"We started the clear bag program in April [2008]. That brought it up 11 percent," Boyer said. Residents are required to use clear bags for all their household garbage which makes it very apparent when someone is not bothering to recycle plastics, glass and other materials.

In addition, the town has now begun a car battery drop-off and a fluorescent bulb return program, at no charge to the participants.

The Zero Waste program was introduced to the town council in 2000 by a group of residents concerned about the growing cost and environmental inefficiency of the town's waste disposal.

"Our town council thought it was a good idea and adopted the program," explained Boyer. In the intervening eight years, the recycling rate in Annapolis has risen to an impressive 73 percent, she said.

"We had to do some education and get the property owners involved," Boyer explained. "But there's been no backlash, none whatsoever."

The Zero Waste program uses many different means to make it as easy as possible to compost or recycle. Backyard composters are sold at a discount in local hardware stores. These units compost leaves and grass clippings as well as food items.

> ***"Our motto isn't 'not in my backyard. It's 'in everyone's backyard.'"***

Annapolis residents use them to digest food items, including meat, dairy and egg products that are unsuitable for the backyard composters. While they do not produce compost, they hasten decomposition of food items, allowing nutrients to leach into the soil below.

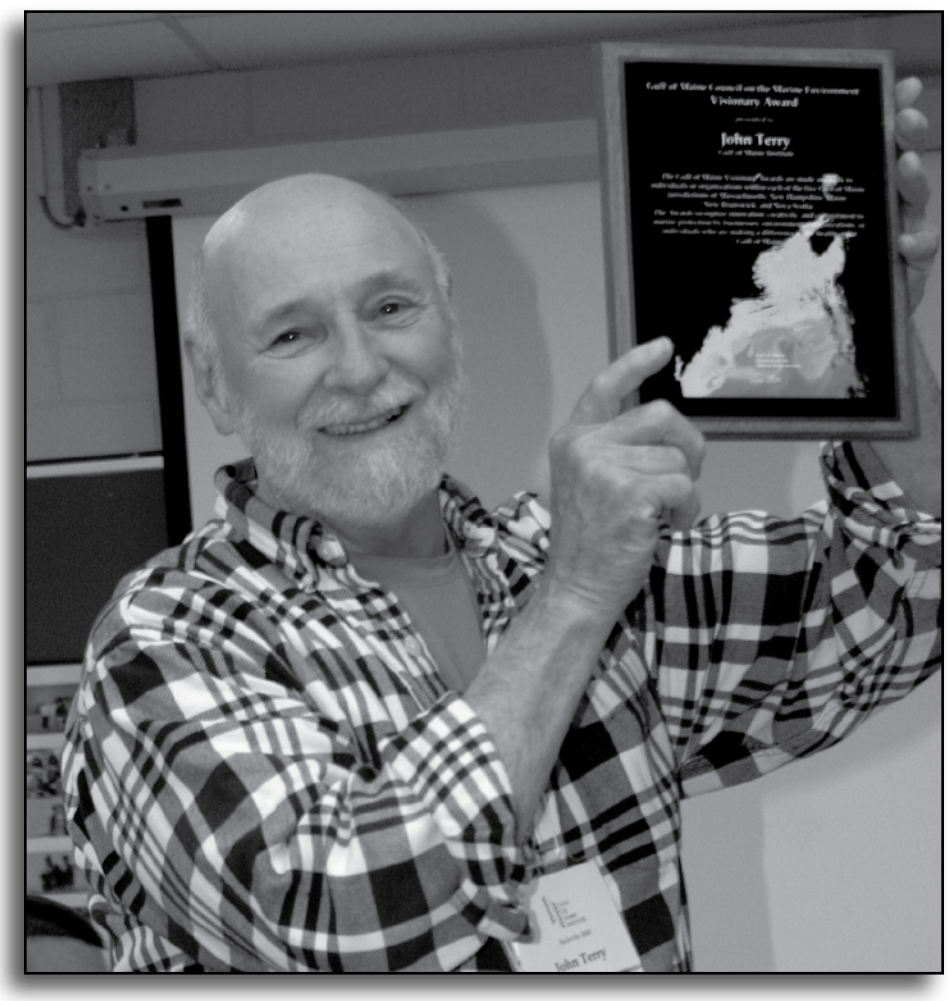
Neighborhood composters are large green plastic bins that are built and maintained by the town. Some town residents, including renters, are not able to participate in backyard composting. The six neighborhood bins allow them to bring their material to be composted.

Finally, Earth Tub composters are commercial-size composters located in the town's public works yard. These units are for commercial and institutional businesses, such as restaurants, which produce large amounts of organic material.

"The town pays 50 percent of the cost of the green cones and residents pay the other half," Boyer said. "We take charge of the neighborhood composters. There's a bin next to each full of wood chips to cover whatever is put in. People are very good about doing that."

"Composting is cheap," said Boyer. "Solid waste disposal costs money to truck the stuff away. This is working."

Correction



John Terry was identified incorrectly in the last issue. The John pictured was actually John Halloran, while the real John Terry, a member of the Gulf of Maine Institute's Guide Team is pictured above, with his Gulf of Maine Visionary award.

Dennis wetlands restoration project wins award

The Massachusetts Office of Coastal Zone Management was among several state, local and federal environmental officials recently honored by the federal government for a project that restored 65 acres of coastal wetlands in Dennis.

Coastal America, a collective of federal agencies that support wetlands and aquatic habitat restoration, awarded leaders of the Sesuit Creek Salt Marsh project the 2008 Coastal America Partnership Award for outstanding efforts to restore and protect the coastal environment. Coastal America comprises 16 federal agencies, including the Executive Office of the President, the Environmental Protection Agency and the Department of Energy.

Welcome new members of the Gulf of Maine Council:

Deerin Babb-Brott, Executive Secretary Massachusetts Executive Office of Energy and Environmental Affairs; and Director, MA Office of Coastal Zone Management

Douglas Grout, Chief, Marine Fisheries Division, NH Fish and Game Department

Peter Lamb, Senior Philanthropic Advisor, New Hampshire Charitable Foundation (Private Sector Councilor for New Hampshire)

David Morse, Minister, NS Department of Environment

Jack Wiggin, Executive Director, Urban Harbors Institute (Private Sector Councilor for Massachusetts)

Calendar

March 12

Gulf of Maine Reseach Institute lecture series. The Secrets of Fishbones: Marine Archaeologists Dig up the Past by Dr. Nathan Hamilton of the University of Southern Maine. The presentation will begin at 7 pm. Gulf of Maine Reseach Institute, 350 Commercial Street, Portland, ME 04101 For more information, contact Patty Collins at (207) 228-1625 or pcollins@gmri.org.

March 25-26

Gulf of Maine Council on the Marine Environment Working Group Meeting will be held at the New Hampshire Department of Environmental Services Coastal Program Office, Pease International Tradeport, Portsmouth, NH Wednesday, March 25, 1 – 5 p.m. and Thursday, March 26, 8:30 a.m. – 4 p.m.

April 3

15th Annual Secretary's Awards for Excellence in Energy and Environmental Education All Massachusetts schools (K-12) that offer energy and environmental education programs are eligible to apply for the awards that Massachusetts Secretary of Energy and Environmental Affairs (EEA) Ian Bowles will bestow on Massachusetts teachers and students who are involved in school-based programs that promote environment and energy education. Awards cover topics such as topics ranging from renewable energy, recycling, energy conservation, water testing, climate change, conservation ecology, or Atlantic salmon egg-rearing and more.

Application deadline is Friday, April 3. Apply online at http://www.mass.gov or contact Meg Colclough at 617-626-1110 or meg.colclough@state.ma.us.

April 24

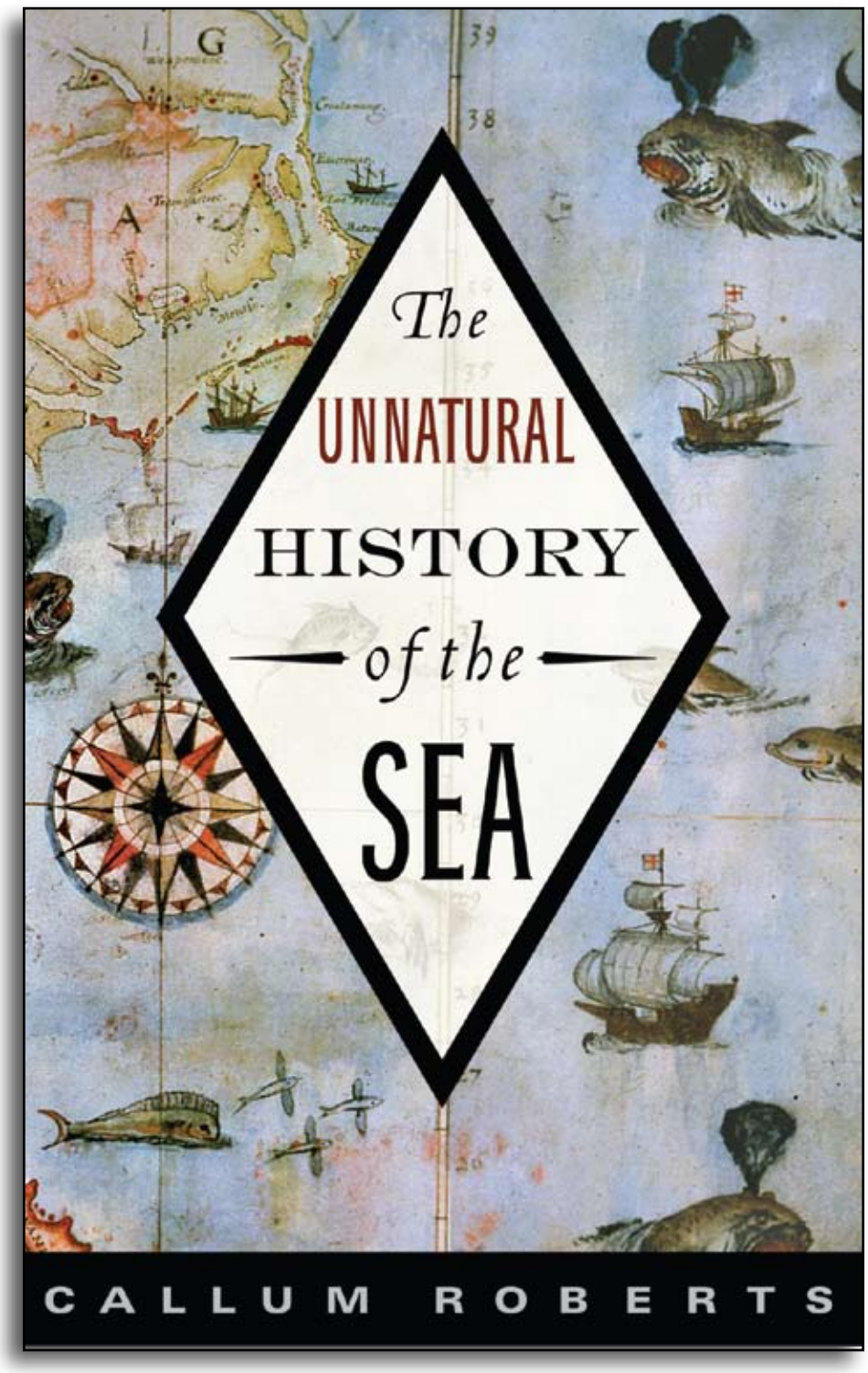
The Gulf of Maine Council on the Marine Environment is calling for nominations for its annual Visionary, Longard, and Susan Snow-Cotter Leadership Awards and the first Industry Award. One group and one individual—paid professionals or volunteers are eligible—in each province and state, will be selected to receive a Visionary Award. One Longard Award will be selected to honor a lifetime of achievement in his or her volunteer work. One individual will be selected for the first Susan Snow-Cotter award to recognize a coastal management professional who exemplifies outstanding leadership or exceptional mentoring in the Gulf of Maine watershed. One industry will be selected to receive the new award. To nominate a group or individual, please complete and return forms by April 24, for a Visionary, Longard, Susan Snow-Cotter, and Industry Award. These forms are posted at http://www.gulfofmaine.org/council/opportunities/#awards. For your reference, further information on the awards as well as a list of past award recipients is posted. Articles about them published in the Gulf of Maine Times are also included. For more information, contact Michele Tremblay, naturesource communications. Call 603/796.2615, or fax, 796.2600. http://www.naturesource.net

July 24-29, 2010

Coastal Zone Canada 2010 The international conference, Coastal Zone Canada 2010, is scheduled for July 24-29, 2010 in Charlottetown, Prince Edward Island. The theme is 'Healthy Oceans - Strong Coastal Communities'. The first call for papers will be issued in May.

Book documents tremendous, little-known loss of marine life

Taking a look back at bountiful times



The Unnatural History of the Sea

By Callum Roberts

Island Press, Washington, D.C. $19.95, paperback, 454 pages, ISBN 978-1-59726-577-5 (2008 for paperback, 2007 for cloth).

Book Review

The Unnatural History of the Sea

Reviewed by Lee Bumsted

If we could travel back in time, we would return to 2009 with a much better understanding of the degradation of our oceans. Since time travel isn't in the cards, having Callum Roberts act as our guide is the next best thing.

In *The Unnatural History of the Sea*, the professor of marine conservation at the University of York in England clearly describes how we have lost much more marine life than we realize.

> ***"... it is easy for us to view the diminished productivity of today's seas as normal,"***

Roberts states that when we attempt to restore fisheries, we may only be trying to arrest recent declines. "Where human impacts on the sea's populations extend far back in time, it is easy for us to view the diminished productivity of today's seas as normal," he writes. "We have known nothing different."

He argues that we need the perspective of the past to inspire more aggressive action. Only then can we bring back the sea's productivity and health.

Early explorers along the European and North American coasts wrote detailed accounts of the sea life they encountered. These reports were so glowing that they might seem suspect to readers today. Yet as Roberts reviews these accounts, he provides evidence that the seas really were teeming with an amazing array of fish and marine mammals.

Roberts couples these reports of initial abundance with a history of fishing over the last several hundred years. Fishers took the fish closest to their homes first, then moved further and further offshore as they depleted local stocks. New technologies, such as bottom trawling nets in the 14th century, steam trawlers in the 19th century, and advanced electronics in the 20th century, helped them chase fish more effectively. It is now nearly impossible for the fish to hide.

He decries how destructive and wasteful some fishing methods are. Bottom trawling affects not just the sea-floor habitat needed by the fish harvested there, but the health of the entire ecosystem. Bycatch results in much dead or dying fish being tossed overboard. Bykill consists of fish and invertebrates that don't reach the surface but that are killed by fishing gear nevertheless.

The figures Roberts provides on species declines are startling. The cod population on the Grand Banks off the coast of Newfoundland is estimated to be less than 1 percent of what it was prior to harvesting. Oyster yields in Chesapeake Bay have dropped to 80,000 bushels per year from a peak of 15 million in the 19th century. He estimates that the total mass of fish in European seas today is 5 percent of what it was before industrial fishing began.

After all this, Roberts turns out to be optimistic about the future of the sea.

"The creation of national and international networks of marine protected areas, together with some simple reforms in the way we fish, could reverse this run of misfortune," he states. "We cannot return the oceans to some primordial condition absent of human influence. But it is in everyone's interest to recover some of the lost abundance of creatures in the sea."

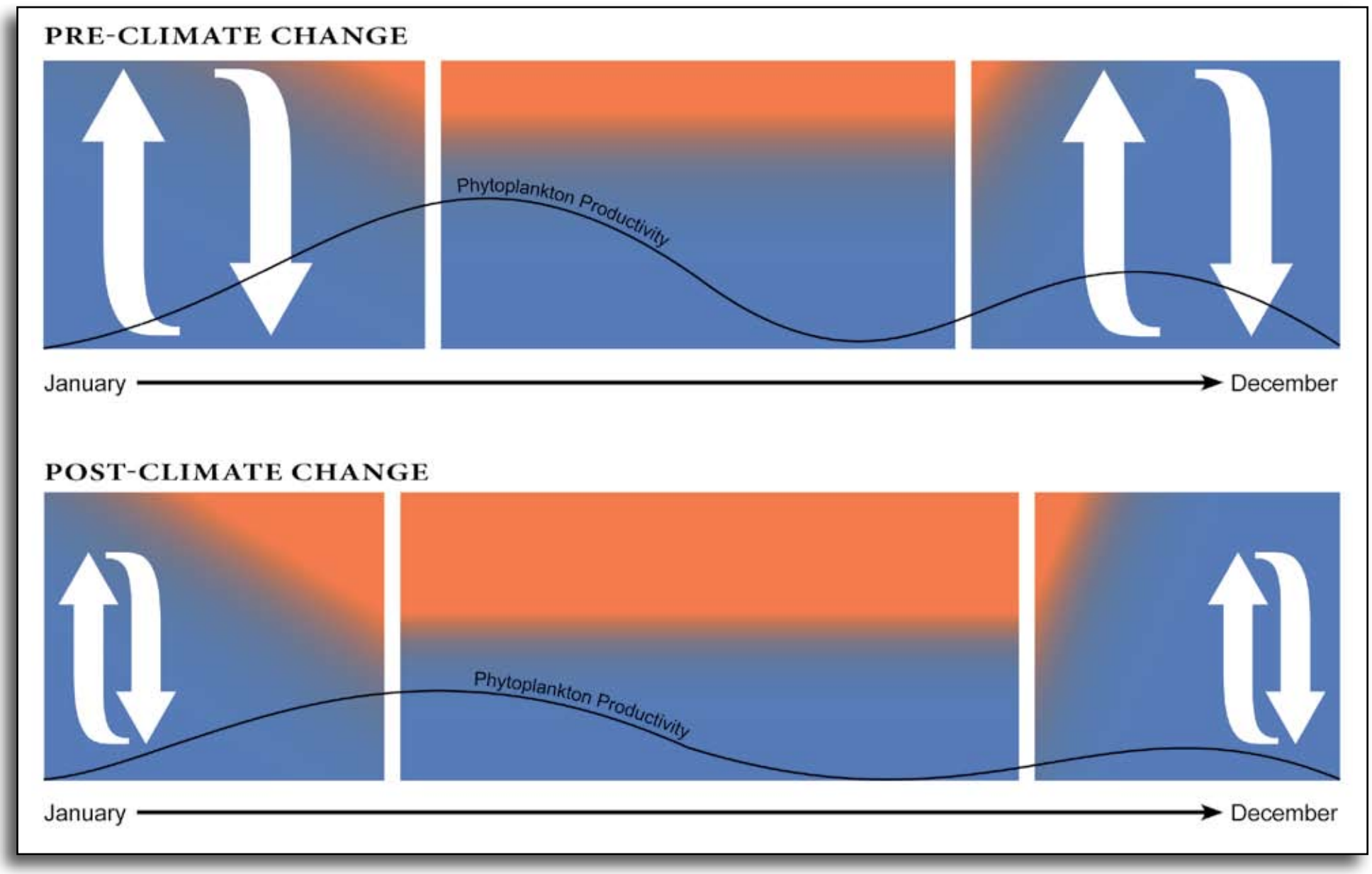
In stark contrast to terrestrial preserves, which make up 12 percent of the total landmass, only 0.6 percent of the sea is at least partially protected from fishing, according to Roberts. He makes a strong case for designating far greater sections of the sea as preserves. This would allow fish habitat to recover and let fish live longer, reaching ages favoring greater reproductive success.

Roberts writes that spillover fish from protected areas would resupply fishing grounds, so there would actually be more fish available to harvest, not less. He also offers recommendations on management policies to make fisheries more sustainable.

Callum Roberts's writing is quite engaging and his proposals are compelling. With *The Unnatural History of the Sea* newly available in paperback, his call to action can deservedly reach a larger audience.

As he says: "...if people forget what the seas were once like, and consider today's waters as something approaching natural, then we could end up trying to maintain marine ecosystems in their present degraded states. We have to do better than that."

> ***"...if people forget what the seas were once like, and consider today's waters as something approaching natural, then we could end up trying to maintain marine ecosystems in their present degraded states. We have to do better than that."***



Climate change may result in the formation of a warm surface layer that begins earlier in the summer, lasts longer into the fall, is deeper and more distinct. Such changes would limit the mixing of nutrients into surface waters and might result in a decline in phytoplankton productivity.

Climate Change *continued from Page 1*

in weather and circulation patterns that occur on the scale of years and decades. As a result, it has been difficult to pick up a climate change signal in the noise of weather-induced temperature changes in the Gulf."

The problem is compounded by the fact that comprehensive data on water temperature, from satellites and buoy-based sensors, are relatively recent. Only a handful of data sets go back far enough to allow for analysis of long-term trends.

Deese looked at data from a monitoring site in the southwestern Bay of Fundy that has been monitored by the Canadian Department of Fisheries and Oceans since 1924.

"My latest results indicate that water temperatures have warmed over the past nearly 100 years, a trend that is likely the result of climate change," said Deese.

What lobstermen observe

Is the ecosystem responding to temperature change that has already occurred? Researchers at the Island Institute, a non-profit based in Rockland, Maine, tackled this issue by tapping into the extensive ecological knowledge accumulated by fishermen. They asked lobster fishermen if they had observed any changes in the fishery or marine environment that might be attributable to climate change.

Like the climate change signal itself, the ecological effects of climate change can be difficult to discern from those of other factors such as fishing pressure, habitat loss, and pollution. The results of the interviews were surprising: fishermen identified distinct changes in lobster behavior that may be related to climate change.

The timing of the shed, that moment in early summer when masses of soft-shelled lobsters recruit into the fishery after molting, has changed. Fishermen report that the shed used to be very predictable. In mid-coast Maine, for example, they could count on the shedders arriving just in time to meet Fourth of July holiday demand. But for the last eight to 10 years, the shed has become much less predictable. Shedders arrive earlier than expected—or occasionally later.

> ***"The rate of change we are experiencing is 100 to 1000 times faster than geologic change and threatens to outstrip evolution."***
>
> *— Scott Doney*

"Why are we catching shedders in March, April, May and June?" asked Gerry Cushman, fisherman from Port Clyde, Maine.

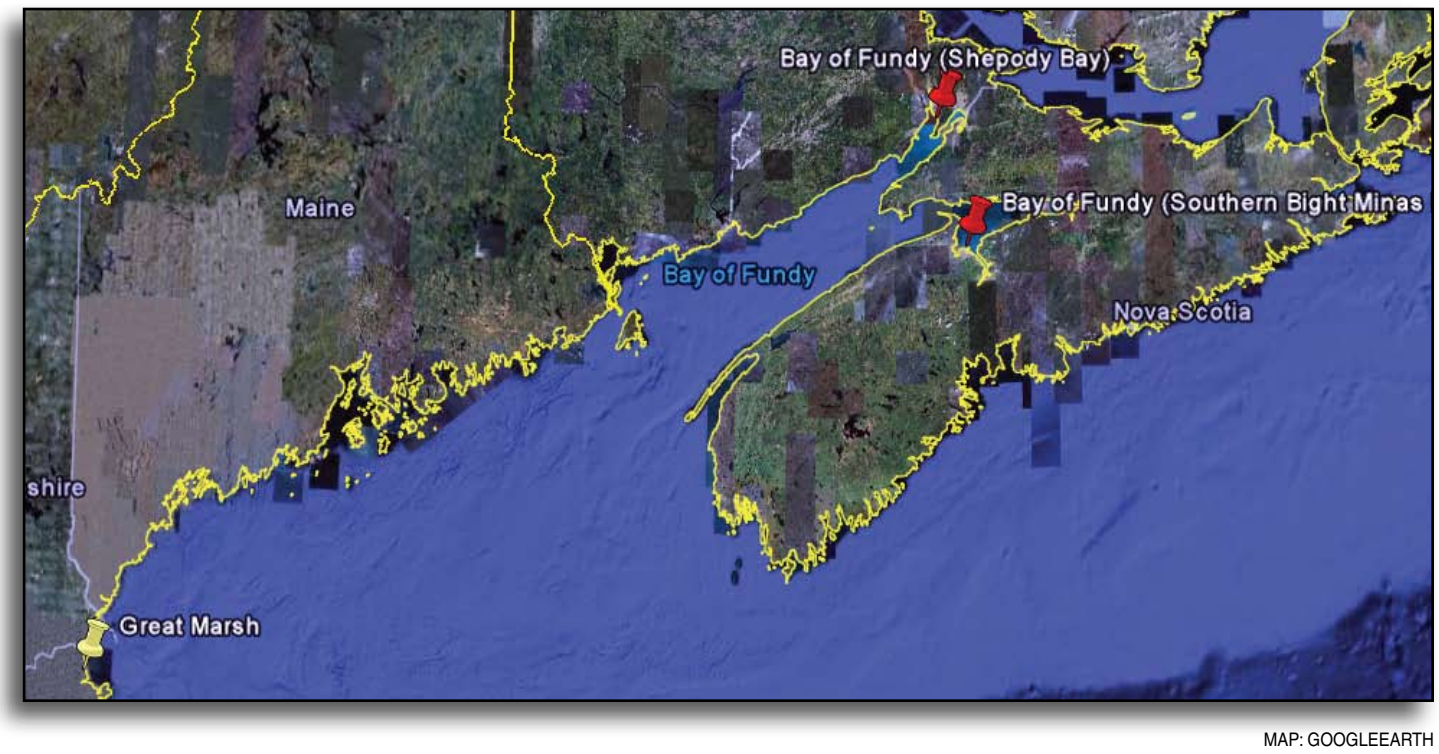
Variability in the shed may reflect the increased variability in annual weather patterns that climate scientists tell us are one consequence of climate change. Increased rainfall and a shift in snow melt to earlier in the spring may also be resulting in changes in freshwater inputs to the Gulf of Maine, altering salinity.

Changes in the shed might be a result as lobsters are sensitive to changes in salinity. Sometimes the shed is less of a "spurt," the term fishermen use for a sudden wave of increased catches, with the shedders instead trickling in over a several week period. Later in the season, fishermen are finding that lobsters are moving into deeper water, part of their annual migration inshore and off again, much earlier than usual.

"The places I fish in August are the places we used to fish in October," said Jim Wotton of Friendship, Maine.

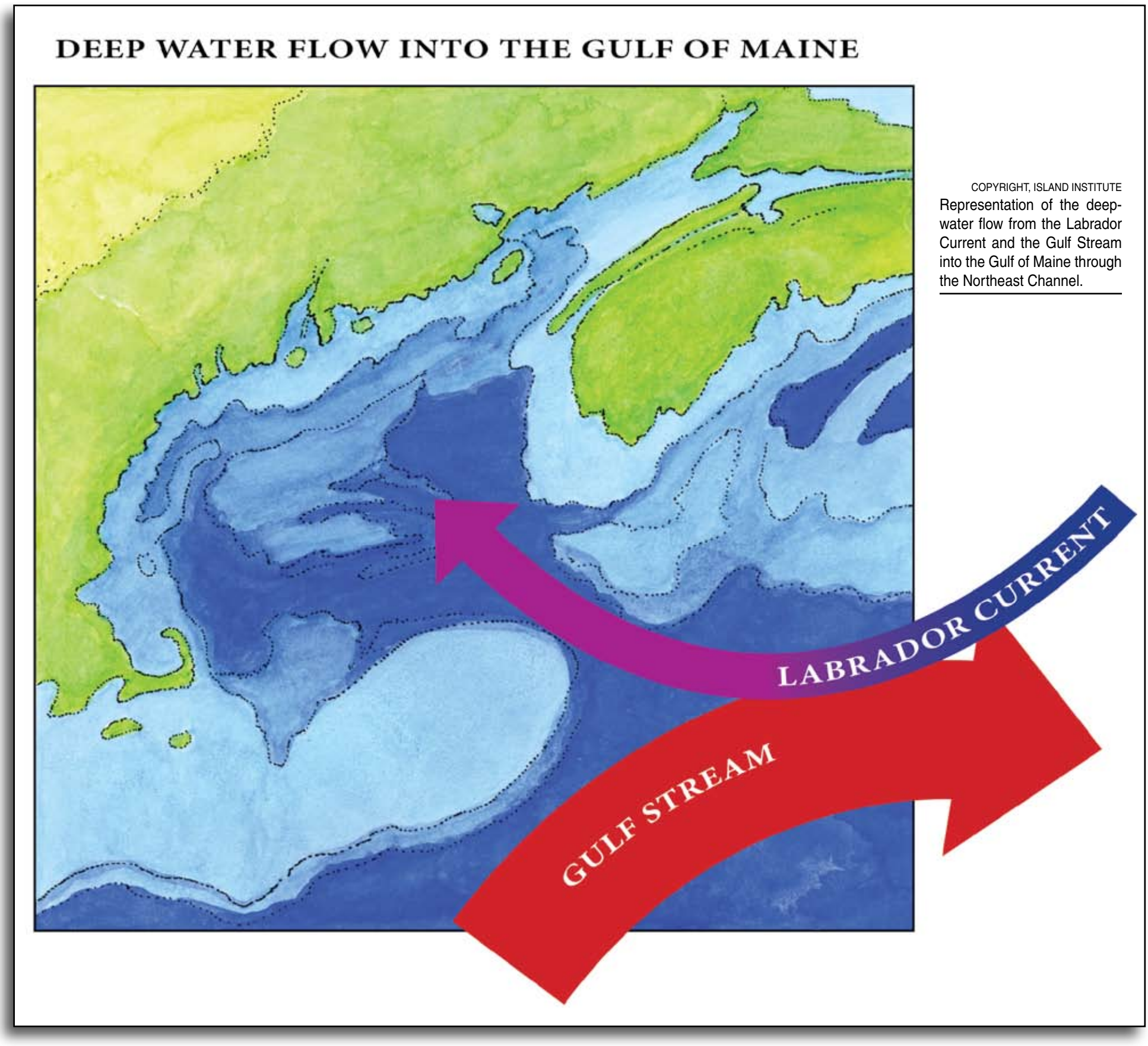
Gillian Garratt-Reed, marine program manager at the Island Institute, said her project will next consider unusual organisms the fishermen report finding in their traps.

"Fishermen have always noted the odd sea horse or black sea bass in



MAP: GOOGLEEARTH

Seabird reserves in the Gulf of Maine that are part of the Western Hemisphere Seabird Reserve Network.



Representation of the deep-water flow from the Labrador Current and the Gulf Stream into the Gulf of Maine through the Northeast Channel.

their traps, now we want to pay attention to how many fishermen are observing new or unusual species and how often," she said. "Climate scientists predict that species may shift north as water temperature warms; fishermen, on the water daily, are likely to be the first to see such changes as they occur."

Canary in the mine shaft

Shorebirds may be like the canary in the mine shaft when it comes to the ecological consequences of climate change. The semipalmated sandpiper, a tiny shorebird that passes through the Gulf of Maine by the thousands on its fall migration from the Arctic to South America, is highly sensitive to changes in its foraging areas.

"Seventy percent of the world's population of this species visits the mudflats of the Bay of Fundy, stocking up on tiny amphipods that live in intertidal sediments," explained Charles Duncan, director of the Shorebird Recovery Project for the Manomet Center for Conservation Sciences, based in Manomet, Massachusetts.

This source of food is critical to the survival of the sandpipers because, as Duncan pointed out, "Once they leave the Bay of Fundy, they fly non-stop to Suriname, an amazing feat."

> ***"There will be surprises."***
>
> *— Daniel Schrag*

Duncan manages the Western Hemisphere Shorebird Reserve Network, a system of more than 70 sites designed to protect the far-flung habitat of these peripatetic creatures. Three sites in the Gulf of Maine are part of the network: Shepody Bay in New Brunswick, Minas Basin in Nova Scotia and Great Marsh in Massachusetts.

These sites could be affected by climate change in three ways, said Duncan. First, rising sea level may outpace the ability of the mud flats to migrate inland – if development on land allows them any room to move at all.

Second, rising water temperatures may affect the sandpipers' prey. Particularly troubling to Duncan is the possible "uncoupling of the chronology of migration and the appearance of the birds' food supplies." This could happen if the many elements of the food web do not respond to climate change in lockstep and he believes it is unlikely that they will.

Finally, invasive species and new diseases may create new challenges for the sandpipers. Other shorebirds are also at risk. Piping plovers and least terns, which nest on the beaches of the Gulf of Maine, have been fighting an ongoing battle against increasing recreational activity and development along the coast. Sea level rise adds a new degree of difficulty to the protection of these species.

The Gulf of Maine may be the only New World wintering ground for the purple sandpiper. Ominously, the red-necked phalarope, which once fed by the thousands on the flats of the Bay of Fundy, disappeared from the area 20 years ago in a mystery still unsolved by ornithologists.

"Seabirds are exquisitely vulnerable to climate change," noted Hector Galbraith, who oversees Manomet's Climate Change Initiative.

Galbraith is working with Duncan to develop a tool that can be used to assess the risk of climate change to shorebirds, explaining that "Manomet is mounting a major effort to work with reserve managers to develop methods to assess the vulnerability of shorebird sites to climate change."

Mitigate, adapt

As scientists work to grasp the meaning of climate change for the Gulf of Maine, decision-makers in the states and provinces are identifying effective policy responses. Some responses tackle mitigation: how can we reduce greenhouse gas emissions to slow and eventually reverse climate change?

Nova Scotia released its 2009 Energy and Climate Change Action Plan earlier this year. The plan, similar to others in the region, calls for a cap on emissions, increased renewable energy and improvements in energy efficiency.

In New Brunswick, the province's Climate Change Action Plan explains that New Brunswick-led initiatives will reduce greenhouse gas emissions by 2012.

Other proposed policies address adaptation. Due to the delayed effect of greenhouse gases on climate change, the planet will be subject to several decades of warming—and would be even if all greenhouse gas emissions were eliminated today.

Natural Resources Canada is stressing the importance of adaptation to climate change in Atlantic Canada. Among its efforts is the identification of shoreside trails and

Continued on Page 12

Climate change here and there it's all connected, everywhere

Book Review

2009 State of the World: Into a Warming World

Reviewed by Nancy Griffin

This book begins with a timeline from 2007 through 2008 that traces natural and man-made environmental disasters, chronicles changes in oceans and the efforts to protect endangered species, while illustrating the connection between earth's inhabitants and the changes that affect them.

The 2009 State of the World by the Worldwatch Institute is a collaborative work, the 26th consecutive book in a series by the organization, building on and crediting the groundbreaking climate change work by Goddard Institute scientist James Hansen more than 20 years ago.

With dozens of contributors from around the globe, the book covers everything from the role of cities in climate change, through India's fledgling efforts to stem the progress of climate change and building resistance to drought in Sudan.

"The science of climate change has come a long way" say the three project directors - Robert Engelman, Janet L. Sawin and Michael Renner - at the book's start.

"This volume offers a range of informed perspectives on pathways for adapting to a warming world while avoiding catastrophic consequences," they add. "The politics is still lagging behind, but the urgency of constructive climate action is now clearer than ever."

From farming to the security challenges climate change will present as populations grow hungrier and poorer, the data in the book is diverse, but most of the authors point out the worldwide connections.

Despite the book's far-flung perspectives, it provides useful information for everyone concerned about the effects of global warming.

Thomas Lovejoy, president of the H. John Heinz III Center for Science, Economics and the Environment in Washington, D.C., writes a chapter on Climate Change's Pressures on Biodiversity. He shows changes in the behavior of species, for example, eel grass and the yearly northward movement of its southern limit in Chesapeake Bay.

"An even more devastating system change is already taking place: the acidification of the ocean" due to concentrations of carbon dioxide, writes Lovejoy. It "is a matter of great consequence because tens of thousands of marine species build shells and skeletons from calcium carbonate."

These species need an "equilibrium... The colder and more acid the water is, the harder it is for organisms to mobilize calcium carbonate," including coral and giant clams.

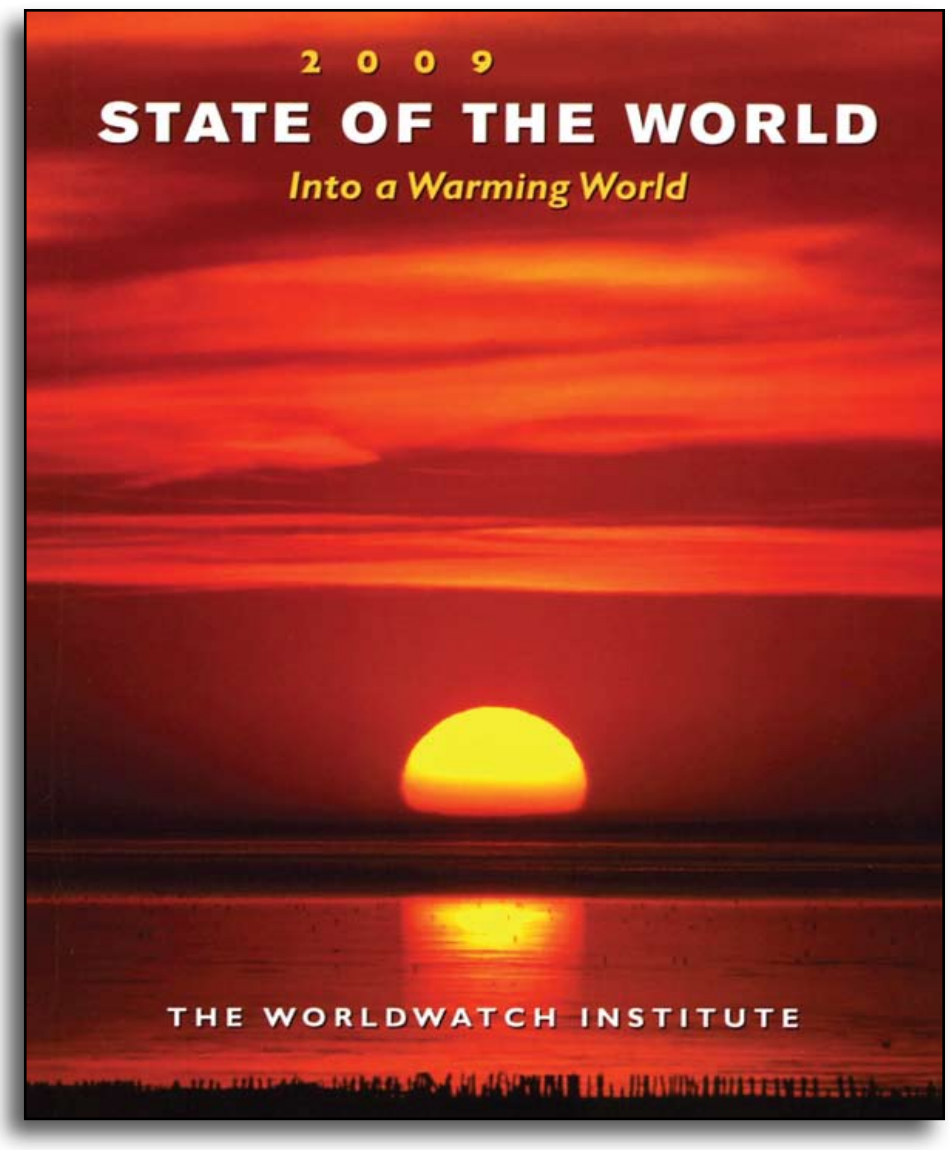
Lovejoy and other authors, despite documenting negative effects on the world and its people, also offer hope for progress, mitigation and adaptation, if not total respite.

For instance: "Natural connections urgently need to be reestablished in landscapes to facilitate the dispersal of individual species as they follow the conditions they need to survive," writes Lovejoy. "... the opposite of the current situation of patches of nature in human-dominated landscapes."

Minimize stresses on ecosystems to avoid reinforcing warming changes, he adds, "by reducing siltation, for instance, on coral reefs."

To lower stresses, Lovejoy recommends reducing areas of concern to smaller, manageable sizes because adaptive measures "are hard to design using the extremely coarse scale of global climate models."

He suggests "downscaling," working cheaper and faster by using laptops instead of supercomputers, saying, "Managers need a much more precise idea of what kind of change is likely to take place within a square kilometer and over the next few years."



2009 State of the World: Into a Warming World

A Worldwatch Institute Report on Progress Toward a Sustainable Society

Linda Starke, editor

W.W. Norton & Co., New York $19.95, paperback, 262 pages, 2009

ISBN 978-0-393-33418-0

In the first chapter, The Perfect Storm, authors Christopher Flavin and Robert Engelman identify 10 key challenges, while later in the book, author Betsy Taylor writes a chapter called "Not Too Late to Act."

There's optimism along with the dire news, but authors agree optimism will last only if there's action, because urgency is needed.

"Though rarely recalled today (in the late '80s) the Montreal Protocol offers lessons for the climate negotiations of 2009" when the U.S. government and chemical manufacturers supported the phaseout of ozone-depleting gases.

"We cannot afford to have the Copenhagen climate conference (planned for November) fail," write Flavin and Engelman. "The outcome of this meeting will be written in the world's history books — and in the lasting composition of our common atmosphere."

Resources

Energy and climate change in Nova Scotia

The province of Nova Scotia has released its 2009 Climate Change Action Plan and Energy Strategy. The Climate Change Action Plan has two main goals: reducing greenhouse gas (GHG) emissions and preparing for changes to climate - http://climatechange.gov.ns.ca. The Energy Strategy focuses on more renewable energy and greater energy efficiency. It also encourages growth in offshore and onshore activity - http://www.gov.ns.ca/energy/energy-strategy. Both are available for download.

Coastal Hazards Resilience

The presentations and proceedings from the Coastal Hazards Resilience Workshop are available. The workshop, organized by the US Northeast Regional Ocean Council, was held November 19-20, 2008 in New London, Connecticut. The purpose of the workshop was to better understand how the region might work collaboratively to improve its ability to withstand both severe coastal hazard events and more gradual impacts from climate change. Presentations and proceedings are available at http://community.csc.noaa.gov/nroc/index.php?option=com_docman&task=cat_view&gid=38&Itemid=55.

Report upgrades coastal waters

The recently released National Coastal Condition Report III (NCCRIII) indicates the overall condition of the nation's coastal waters has improved slightly, and is now upgraded to 'fair.' The report is the third in a series of environmental assessments of U.S. coastal and Great Lakes waters. It is a collaboration of the U.S. Environmental Protection Agency (EPA), the National Oceanic and Atmospheric Administration (NOAA), the U.S. Geological Survey (USGS), the U.S. Fish and Wildlife Service, coastal states and the National Estuary Program. The participants assessed America's coastal conditions using five indicators of condition: water quality, sediment quality, benthic community condition (the health of the water's bottom-dwelling invertebrate species), coastal habitat loss as indicated by changes in wetland areas, and fish tissue contaminants.

National Coastal Condition Report III - NCCR III (2008) - reports on progress since the 2005 report.

Factsheet: National Coastal Condition Report III (2008)

Accessing the Maine coast

Along the Maine coast, conflicts over access to and from the water are becoming more common. Now, people on the coast have a new resource to help them understand the legal background and tools available to address access concerns. Based on research conducted by the Center for Law and Innovation at the University of Maine Law School and funded by the National Sea Grant Law Center, a new website was launched by Maine Sea Grant, in partnership with University of Maine Cooperative Extension, Maine Coastal Program, and the Island Institute. It is an information resource for coastal property owners, beach and waterfront users, public and environmental interest groups, and municipal, state, and federal governments. The site offers legal tools to address the specific coastal access questions and needs of these stakeholder groups. http://www.seagrant.umaine.edu/accesslaw

The Coastal Update newsletter

The Coastal Update newsletter, currently distributed to over 5300 people worldwide, has been published by the **Atlantic Coastal Zone Information Steering Committee (ACZISC)** since 1997. This and previous issues of the e-newsletter are available at http://aczisc.dal.ca/update.htm. Feedback is appreciated - see http://aczisc.dal.ca/update-feedback.htm. Please feel free to circulate the Update among your own networks. Note that the inclusion of items does not imply endorsement by the ACZISC or its member agencies.

Entanglements: Lost "ghost" fishing gear just keeps fishing

PHOTO: DOUG COSTA

Cod are trapped in a ghost gill net. Nets are lost at sea but they do not stop trapping marine life.

By Catherine Coletti and Jen Kennedy

What lies beneath your favorite ocean view may surprise you. Lost, abandoned, and discarded derelict fishing gear, such as nets, lines, lobster/crab/shrimp traps, buoys and other recreational and commercial fishing equipment finds its final resting place in the marine environment worldwide, including the Gulf of Maine.

Derelict gear out in the ocean is called "ghost gear" because it continues to catch marine life even though no human is actively using the gear. The gear continues fishing for years and catches marine mammals, seabirds, fish and invertebrates, and also catches healthy predators that come to feed on the decaying organisms that have been caught.

Gear can also smother habitat if it drifts to the ocean bottom. Additionally, derelict fishing gear poses a big problem for fishermen, who can get entangled in it while navigating their boats. Fishermen can also spend hours in a season untangling their gear from ghost gear, amounting to many hours of lost fishing time.

In Puget Sound, Washington, U.S., a hot spot of activity in the U.S. for recording and removing ghost gear, the Northwest Straits Initiative (http://www.nwstraits.org) removed 939 gillnets, in which they found 35,930 live and dead animals including 22 dead marine mammals, 378 dead birds, 1,022 live and dead fish, and 29,517 live and dead invertebrates.

Without hard statistics like those available in Puget Sound, it's hard to know exactly how much of this kind of debris is in the Gulf of Maine and how much damage it's doing. The nonprofit group Stellwagen Alive (http://stellwagenalive.org/) would like to find out.

This organization is coordinating groups in the Gulf of Maine working on addressing the ghost gear issue, with a focus on collecting scoping and assessment information, such as the amount, type and location.

A challenge added to this lack of regional information is the complicated set of legal issues that surrounds the retrieval and disposal of derelict fishing gear. Laws regard the gear as private property, and as such it cannot be removed by anyone but the owner without special permits.

Stellwagen Alive Director Jennifer Bender Ferre is casting a wide net to build the strongest networks and partnerships possible to create solutions to derelict fishing gear issues. More than 30 organizations were represented at a regional derelict fishing gear workshop hosted by Stellwagen Alive in November at the New England Aquarium. Attendees were from academia and research institutions, the commercial fishing industry, nonprofits and federal and state agencies.

Objectives of the workshop included disseminating information about the implications of ghost gear, bringing to light the regulatory barriers surrounding its retrieval and removal, and forming a regional effort to work together on solutions.

Three working groups that emerged from the meeting are looking at how solutions can come to fruition in the Gulf of Maine. A commercial fishing liaison with the Stellwagen Bank National Marine Sanctuary further helps provide a link to the fishermen in the planning and scoping efforts to find these solutions.

In partnership with the Provincetown Center for Coastal Studies (http://www.coastalstudies.org/), Stellwagen Alive is collecting information on ghost gear for a mapping initiative. To report debris, visit Stellwagen Alive's web based reporting form at http://www.stellwagenalive.org/seadebris/

In addition, if you have conducted scoping studies or know of existing studies in the Gulf of Maine, please get in touch with Stellwagen Alive at (617) 522-1838 or jennifer@stellwagenalive.org.

For more information about marine debris and removal projects in the United States, visit NOAA's marine debris page (http://marinedebris.noaa.gov/welcome.html).

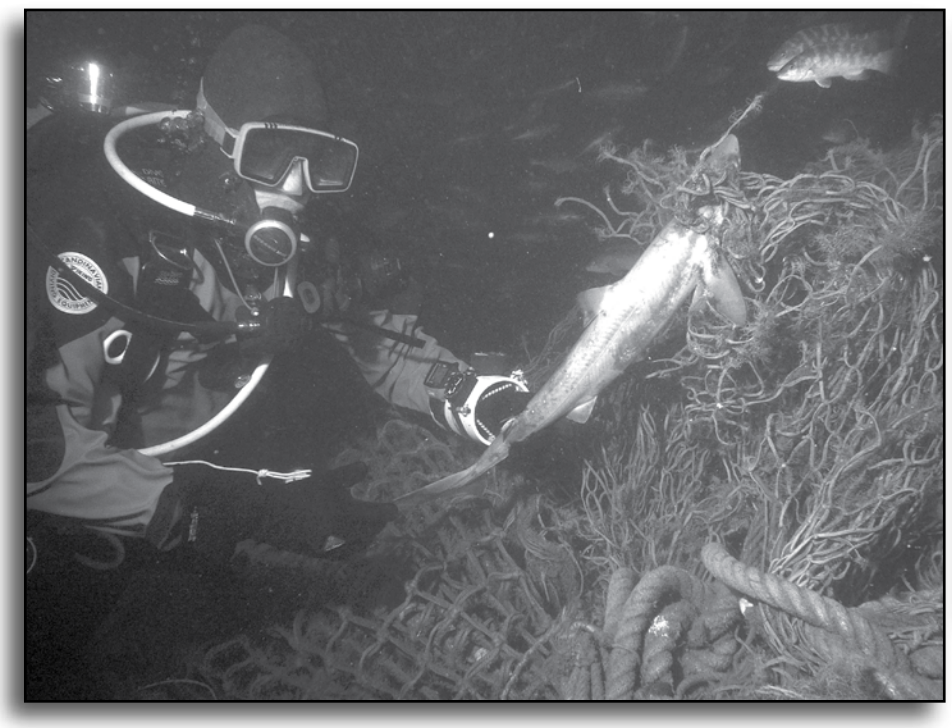


PHOTO: DOUG COSTA

Fish caught in a derelict trawl net in the Stellwagen Bank National Marine Sanctuary, Mass.

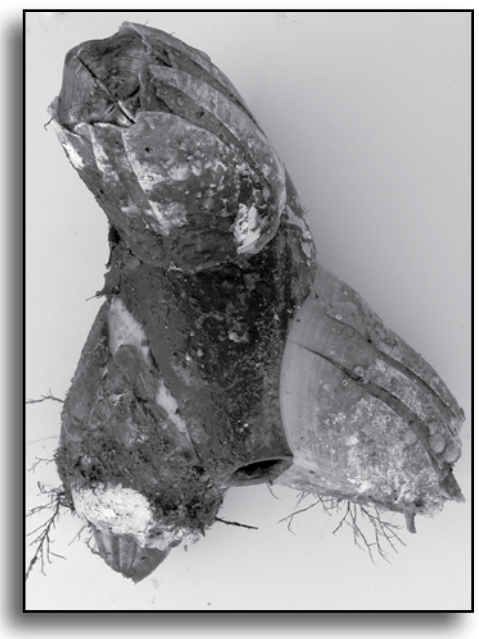


PHOTO: COURTESY OF STELLWAGEN BANK NATIONAL MARINE SANCTUARY

This barnacle was found in a derelict gill net that had been left on the dock in Scituate, Mass.

Analysis

Changing Course – the lesser known flooding hazard

By Catherine C. Coletti

PHOTO: DAVE KELLAM, PISCATAQUA REGION ESTUARIES PARTNERSHIP

Damage to a road caused by fluvial erosion in Newmarket, New Hampshire. Effects of fluvial erosion range from gradual changes in a stream bank to catastrophic changes in river channel location and size during flood events.

Fluvial erosion, or the removal and transport of silt, sand, gravel and other stream bank materials by rivers, happens when development near rivers and streams meet natural processes.

This kind of flooding hazard is less well known than flooding inundation - when land is simply overwhelmed with too much water. It takes into account the movement of water and soil in rivers and, even more important, that rivers must constantly adapt to changes in their paths. Similar to other kinds of hazards, being proactive is the best way to avoid the future damage posed by fluvial erosion.

Effects of fluvial erosion range from gradual changes in a stream bank to catastrophic changes in river channel location and size during flood events.

Community residents in Raymond, located in New Hampshire's coastal watershed, experienced this firsthand during the floods in April 2007, when a stream changed course to blast through a culvert and run over Old Bye Road, shutting down the road for days.

As in the case with the town of Raymond, people usually become aware of the fluvial erosion hazard (FEH) when they encounter it on the stream bank. Some areas are geologically prone to river channel instability, putting development located there at risk. Floodplains, or flat areas of land next to the river, containing material easily moved by water, such as gravel and sand, are particularly susceptible.

Traditional development patterns often put homes and buildings right along river corridors, unknowingly placing them in the path of FEH. And as land becomes more and more urbanized, seemingly small land use changes can result in problems later.

During pre-settlement times, rivers meandered across floodplains and had the room to spread out, keeping erosive forces low. However, as river beds have been manuiplated into narrower channels by humans, they have the ability to gather much more force.

Factor in a high rain event, some undersized culverts, and a stream that has been manipulated by humans, and you have a recipe for fluvial erosion at its worst. The river now has high potential to alter course and flood properties as it adapts to the conditions thrown in its path.

Keeping out of the path of fluvial erosion is the most cost-effective approach to avoiding potential damage from the hazard. Riparian buffers and floodplain mapping, such as those maps provided by the National Flood Insurance Program, do not plan for protection against FEH because they are based on the river at its most stable condition.

A tool used by planners to help avoid FEH is the "fluvial hazard overlay district," a planning unit based on a scientific assessment of river channel size and location, as well as land uses in a particular area.

"An FEH ordinance helps towns minimize flood losses and increase public safety by reducing encroachment in sensi-

In the News

First-in-the-nation "green" pellet burner unveiled at College of the Atlantic

College of the Atlantic (COA) in Bar Harbor, Maine, just fired up its first-in-the-nation, carbon-neutral wood pellet boiler that provides clean heat to four buildings, or one-fifth of the campus.

The KOB wood pellet boiler, built by Veissmann of Austria, is controlled by a highly sensitive computer system. More than a dozen sensors and motors continually monitor temperatures, as well as the level of oxygen and pellets in the mix, said school officials.

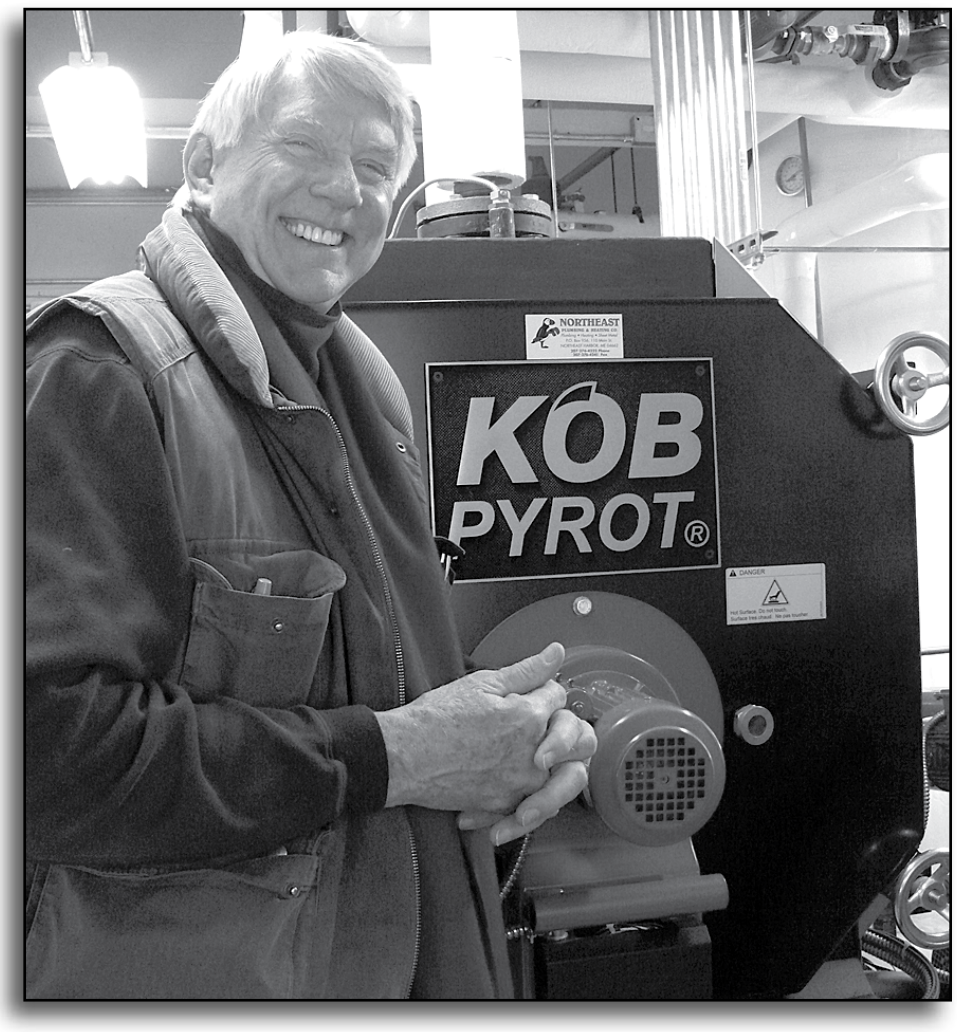
"The combustion technology is very advanced, the fuel/air mixture is the perfect mixture. There's constant monitoring, so it is high-efficiency and clean burning," said Burkhard Fink, who installed the half-million BtU boiler. Emissions are kept to a minimum and the white substance spiralling from the chimney is steam, not smoke, he added.

In Europe, where the technology evolved, such clean-burning systems are required by law, said Fink. "The quality of emissions can compare to the cleanest of gas boilers." The boiler's renewable fuel is compressed sawdust pellets, a byproduct of an Aroostook County sawmill.

The boiler is one element of a sustainable complex of student housing completed on COA's campus last summer, the college's first major building project since it became carbon neutral in 2007 and pledged to move to total reliance on renewable energy sources by 2015.

The three new student residences and a converted campus center that make up the Kathryn W. Davis Student Residence Village also feature a foot of cellulose insulation created from shredded newspapers, the use of gray water from showers to preheat hot water, an energy recovery central ventilation unit preheating fresh air in the buildings and composting toilets.

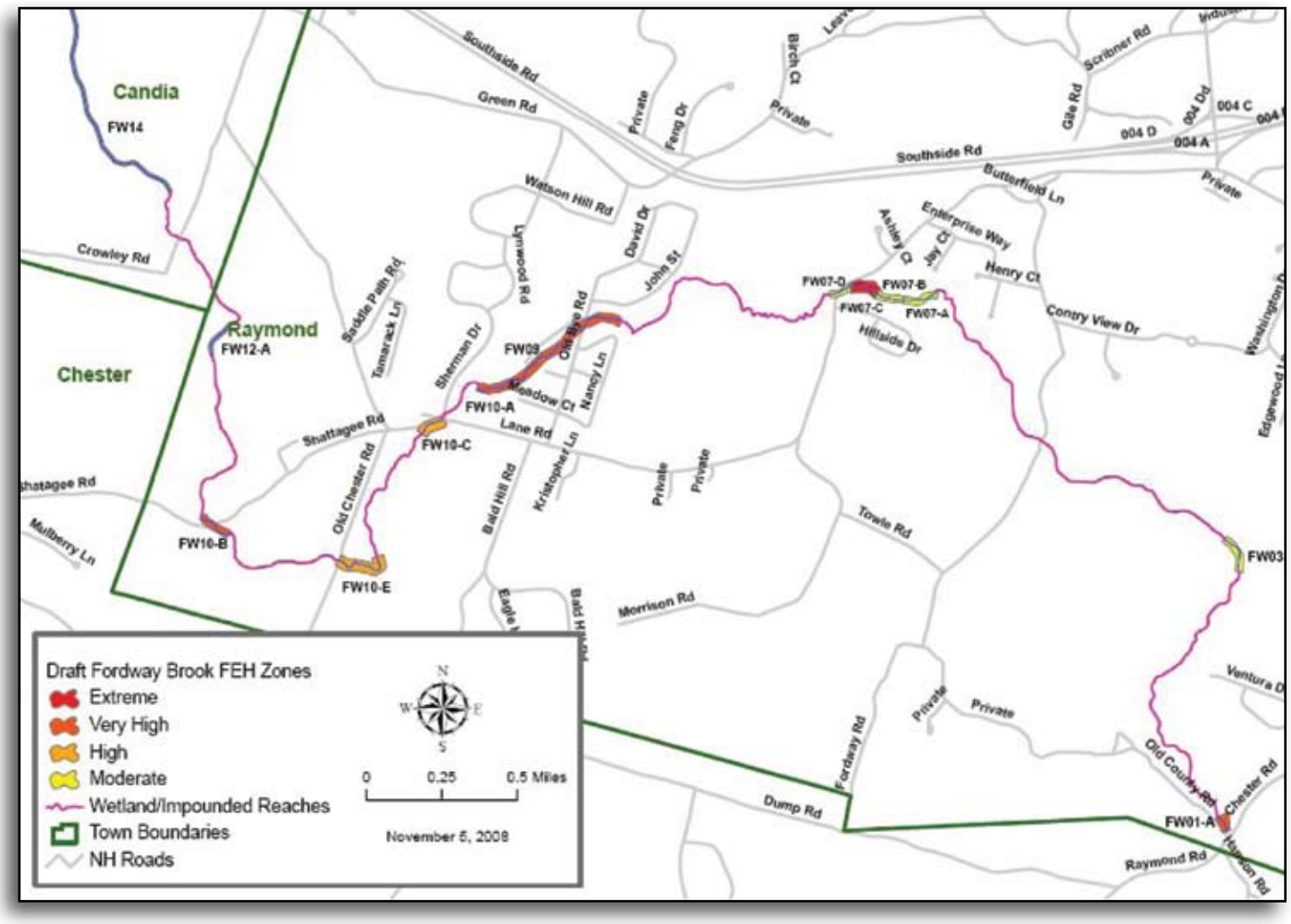
All electricity at COA comes from renewable hydropower and all new buildings have recycling containers on every floor, all kitchens have composting bins. Light-emitting diodes and compact fluorescent bulbs are used for lighting All appliances are energy-efficient, paints are non-toxic, "green" cleaning materials are preferred, and furniture is made of sustainably harvested regional wood.



David Hales, president of College of the Atlantic, displays the new, clean-burning pellet burner that's part of the school's commitment to sustainability.

Analysis

During pre-settlement times, rivers meandered across floodplains and had room to spread out, keeping erosive forces low. However, as rivers have been channelized, they have the ability to gather much more force.



Draft fluvial erosion hazard (FEH) zones map for Fordway Brook, Raymond, New Hampshire. To develop an overlay district, fluvial erosion corridors are given a sensitivity rating according to their vulnerability to FEH, giving town planners information on where this hazard is most likely to occur.

tive areas of the river corridor. When the ordinance is implemented, the river will have more room to adjust which in turn will minimize conflicts between the river and adjacent land uses," said Sally Soule, coastal watershed assistance supervisor at the New Hampshire Department of Environmental Services (DES).

To develop an overlay district, FEH corridors are given a sensitivity rating according to their vulnerability to FEH, giving town planners information on where this hazard is most likely to occur. For example, it could be used to place restrictions on development and land uses in the FEH corridors.

Building a new structure on an eroding bank, for instance, can be avoided using the information. Geomorphic data used to predict water and sediment flow include width and depth of the river channels and the location of human and natural barriers, such as existing development and beaver dams.

Other uses of the data include stream and floodplain restoration projects, bridge and culvert replacement priorities and river corridor protection opportunities.

In Raymond, townspeople decided to explore the adaptation of an FEH overlay district. A model FEH ordinance, including an overlay district, was created using data collected from a fluvial geomorphology study conducted last summer in the Exeter River Watershed, which includes the town of Raymond, by the N.H. DES Watershed Assistance and Geologic Survey with funding assistance from the NH Coastal Program. The project was also supported by the Federal Emergency Management Agency (FEMA) and the N.H. Department of Safety, Division of Homeland Security and Emergency Management.

The model ordinance is not mandatory, but available for consideration on a town-by-town basis. Although too late for this year's town meeting, when voters gather to make local decisions, Raymond may become the first New Hampshire community to adopt an FEH ordinance in 2010.

The issue of FEH is of great concern in Vermont, where geologic conditions coupled with land use development patterns put fluvial erosion at the forefront of flooding damage. New Hampshire piloted its FEH program after Vermont's work.

For more information, visit...
http://www.vtwaterquality.org/rivers/docs/rv_municipalguide.pdf

Around the Gulf

NE fishermen sue to ban herring trawlers

The Midcoast Fishermen's Association, based in Port Clyde, Maine, filed suit against the federal government February 26, hoping to ban industrial herring trawlers from fishing areas identified as spawning grounds for groundfish.

Represented by the public interest law firm Earthjustice, papers filed in federal court by the fishermen's group charged that herring ships are catching haddock and other groundfish stocks in their nets, and that New England Fishery Management Council (NEFMC) has reneged on a promise to curtail their activites.

"More than a year ago the Midcoast Fishermen brought the ecologically damaging impacts of midwater trawl fishing in groundfish protected areas to the attention of fisheries regulators. Yet groundfishermen have nothing to show for it," said Earthjustice attorney Roger Fleming. "We have no choice but to proceed in the courts."

Fleming adds that in November 2007, the New England Fishery Management Council voted to make herring industry reform a priority and initiated a new amendment to the herring fishery management plan. In the next two years, NEFMC indicated a willingness to curtail midwater trawling in spawning areas. But at a recent meeting February 9, the council chose not to consider its herring subcommittee's recommendation.

Midwater trawlers were initially banned from groundfish-closed areas in 1994. But in 1998 federal regulators decided to re-open these areas to trawlers, based on an assumption that the herring ships would catch little or no groundfish in their nets.

In a 2004 enforcement sweep, personnel from the Maine Marine Patrol and Massachusetts Environmental Police caught midwater herring trawlers illegally trying to land thousands of pounds of juvenile haddock and hake mixed with their herring catch. In recent months, government monitors have documented other instances where thousands of pounds of haddock were caught and discarded by the trawlers.

Right whales' wintering ground found in Gulf

Whale researchers spotted 44 right whales in one area of the Gulf of Maine this winter, leading scientists to believe they have identified a wintering ground for the endangered whales, and possibly a breeding ground.

Scientists from the National Oceanic and Atmospheric Administration's Northeast Fisheries Science Center in Woods Hole, Massachusetts, spotted the whales during an aerial survey in the Jordan Basin area in late December, 70 miles south of Bar Harbor, Maine.

Wind project environmental review done

The United States Minerals Management Service (MMS) released the Final Environmental Impact Statement (FEIS) January 19 for the 130-turbine Cape Wind offshore wind energy project in Nantucket Sound. The FEIS concluded the project's environmental benefits would outweigh the potential negative impacts and established the requirements intended to minimize those impacts. The FEIS caps seven years of state and federal review. A final decision by the U.S. Secretary of Interior will end the permitting process.

Forests overlooked in regulating climate?

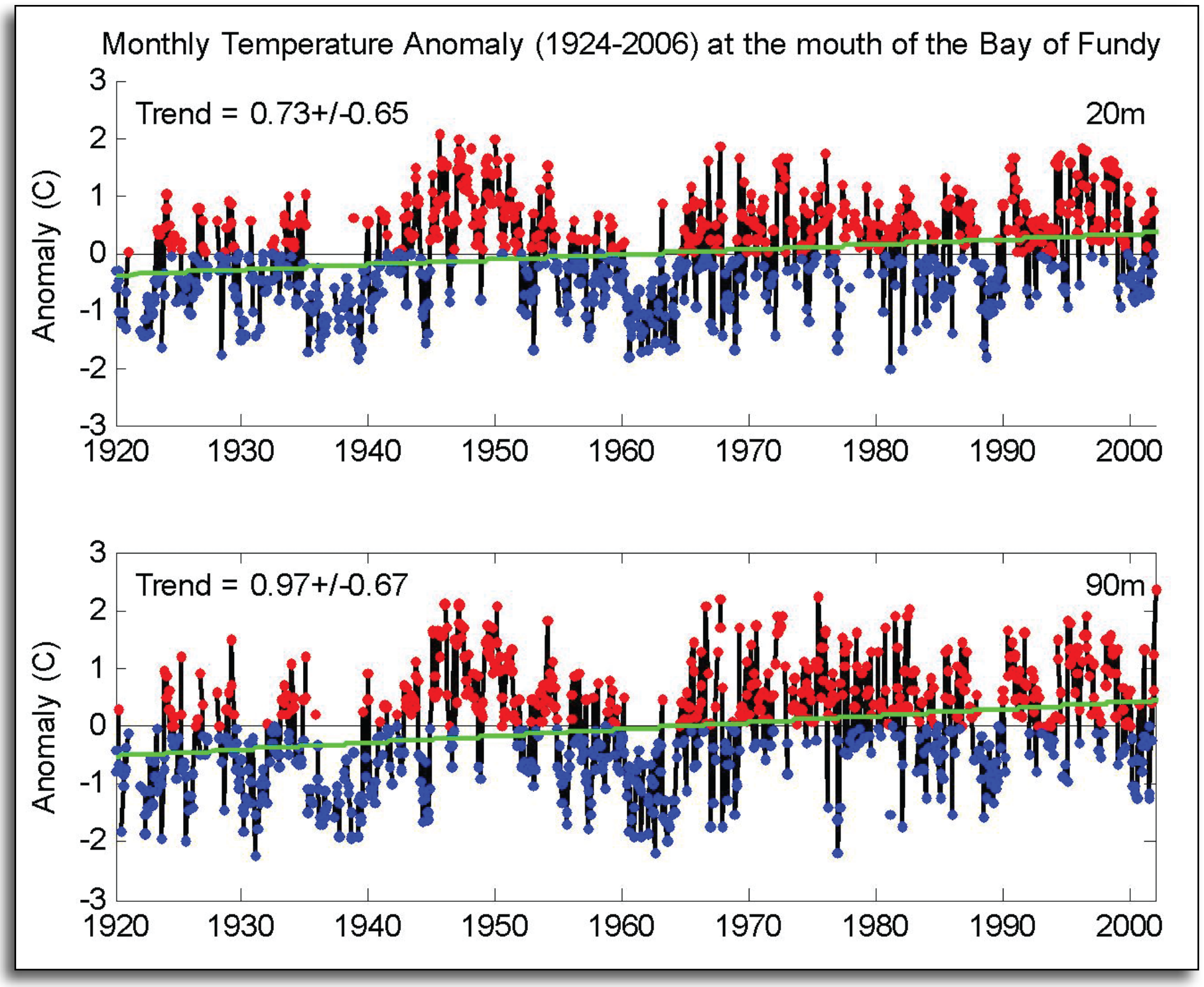
Researchers at the University of New Hampshire have released a study that shows forests may influence the earth's climate in more important ways than previously noted.

The study was published in the Proceedings of the National Academy of Sciences in November. Scientists led by a team at the UNH said they stumbled upon the importance of nitrogen in foliage while poring over six years' worth of data collected from research sites across North America.

Scott Ollinger, a professor at the UNH Institute for the Study of Earth, Oceans, and Space and the department of Natural Resources and the Environment, and his colleagues, discovered that, of the total amount of sunlight that falls on forests, the fraction that gets reflected back to space is directly related to levels of nitrogen in their foliage. When sunlight is reflected back to space, it doesn't influence the earth's temperature.

This new discovery suggests that nitrogen plays an important role in the earth's climate system never before considered. The team included Ollinger and UNH colleagues Andrew Richardson, Mary Martin, Dave Hollinger, Steve Frolking, and others.

Researchers say the newly discovered link adds an interesting new twist to understanding the climate system and raises intriguing questions about the underlying nature of ecosystem–climate interactions.



Trends in water temperature from 1924 to 2006 at two depths, 20 m and 90 m, at the mouth of the Bay of Fundy. The graph shows the difference in temperature between the average for each month in the time series and the temperature for that month averaged over the 80 years of the time series. The longterm monthly averages are represented by the midline on the graph. Monthly averages that are lower than the long-term average fall below the midline and are marked in blue; those that are higher are above the midline and are marked in red. The green line illiustrates the warming trend at both depths.

Climate Change *continued from Page 7*

boardwalks. These amenities are important for both tourism and recreation, and both are at risk from the potential impacts of climate change, including a projected increase in storm intensity and frequency as well as sea level rise.

The agency has identified strategies for protecting these points of access to the coast and has produced an attractive and user-friendly brochure to get the word out to coastal communities.

The focus was very much on adaptation at the climate change symposium in Boston. Speakers at the meeting, organized by the New England Aquarium and the Woods Hole Oceanographic Institution, stressed the need for action.

Ellen Douglas, Assistant Professor of Hydrology at the University of Massachusetts, Boston, insisted, "We need to begin mitigation and adaptation strategies now." By acting now, she believes, "We can have an impact on what occurs by mid-century."

Several speakers reiterated the need to move beyond a science-based analysis to a risk management approach. Schrag pointed out there is much uncertainty in understanding climate change.

"Uncertainty makes scientists conservative," he said, but "a conservative approach is bad for risk assessment."

The IPCC efforts have been conservative, but scientists now know the earth is warming faster than the previous conservative estimates.

Scott Doney, a marine chemist at Woods Hole and another speaker at the symposium, believes it is not change so much as the rate of change that threatens marine ecosystems.

"The rate of change we are experiencing is 100 to 1000 times faster than geologic change and threatens to outstrip evolution," nature's own means of adaptation.

Gary Yohe, Professor of Economics at Wesleyan University, agreed that it is time to shift from high-confidence scientific analysis to management of the risks of climate change.

"We need to provide information to people" who can use it to assess the probability of climate change impacts in relation to the consequences of such impacts, said Yohe. He explained that risk management represents a paradigm shift that will enable effective adaptation because it will allow individuals, communities and businesses to identify and address major vulnerabilities to climate change.

StormSmart Coasts, a program of the Massachusetts Office of Coastal Zone Management, is an example of this new approach. The program helps communities prepare for and protect themselves from coastal storms and flooding.

Overall, the theme of the symposium can be summarized as follows: Climate change is with us – and will be for some time. If we wait for scientists to prove that climate change is responsible for the flooding of low-lying roads, for the spread of invasive species, for the increase in river runoff - then we may have limited options for protecting our coastal waters from the threats represented by a warming world.

For further information on climate change:

Manomet's climate change initiative
http://www.manomet.org/programs/climate/

Western Hemisphere Shorebird Reserve Network
http://www.whsrn.org/index.html

Massachusetts' StormSmart Coasts program
http://www.mass.gov/czm/stormsmart/

Nova Scotia's Climate Action Plan
http://www.gov.ns.ca/energy/resources/spps/energy-strategy/Climate-Change-Action-Plan-2009.pdf

Changing Climate, Changing Coasts: A symposium hosted by the New England Aquarium and the Woods Hole Oceanographic Institution on February 5, 2009
http://www.neaq.org/about_us/symposium.php

Intergovernmental Panel on Climate Change
http://www.ipcc.ch/

Northeast Climate Impacts Assessment
http://www.northeastclimateimpacts.org/

Natural Resources Canada: Climate Change Impacts and Adaptation
http://adaptation.nrcan.gc.ca/index_e.php

Department of Fisheries and Oceans, Canada
http://www.mar.dfo-mpo.gc.ca/science/ocean/database/data_query.html