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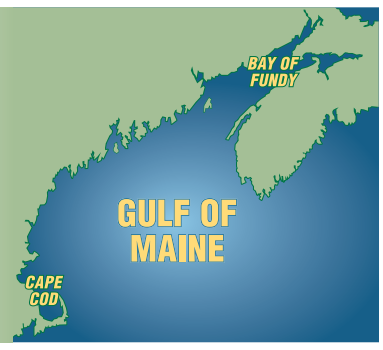
Gulf of Maine Times



Seeing nature's poetry.
Story Pages 6-7

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

INSIDE

...and more

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COURTESY: ACADIAN SEAPLANTS

Harvesting seaweed with rakes leaves a considerable portion of the shoots, which rapidly regenerate the plants.

Growing seaweed sustainably

By Susan Llewelyn Leach

THE CLEAR CHILLY WATERS of the Gulf of Maine, as uninviting as they might seem to land-huddled humans, are perfect for seaweed. High tides, little heavy industry and thousands of miles of craggy coastline make it one of the best spots in the world for seaweeds. So much so that 250 varieties thrive there.

When you add to that the rapidly growing market for seaweed around the world, you have a small industry bursting to expand in a region hungry for jobs.

The catch here is that only a certain amount of wild, hand-harvested seaweed can be pulled from the Gulf's waters without affecting the sustainability, or rejuvenation of the crop. And the limits of some of those harvests are already approaching, said Shep Erhart, owner of Maine Coast Sea Vegetables in Franklin, Maine, and an early pioneer of seaweed farming in the Gulf. "We're reaching the upper limit of the sustainable harvest for at least three of our species." Meanwhile, demand for their products is growing at 10 to 15 percent a year, he said.

"Sustainable" is a key word in commercial seaweed farming. It is a fundamental element in producing an organic crop, Erhart explained. He claimed his company was the first in the world to have its seaweed handling and harvesting procedures certified organic by the Organic Crop Improvement Association, or OCIA. Although the definition of organic is still up for debate, most agree sustainability is a key.

The importance of sustainability has spread far beyond proponents of organic food, however. Growing public awareness of the environment, along with the devastating consequences of overfishing in the North Atlantic over past decades, has further sensitized the industry.

PHOTO: SHEP ERHART

Drying alaria seaweed outdoors on the edge of Pigeon Hill Bay, Steuben, Maine.

Until recently, with the exception of a few experimental cultured seaweed sites, all the seaweed grown in the Gulf's waters has been wild and hand-harvested. Commercial

*See **Seaweed** Page 8*

Herring: A small fish that is a big deal

By Kirsten Weir

"The bean of coffee, the leaves of tea, the spices of the tropics, the worms that make silk, are of smaller influence on the nations (sic) richness than the herring of the Atlantic Ocean."

So wrote the French naturalist Bernard Germain de Lacépède more than two centuries ago. Times have changed since early American settlers first plucked the small silver fish from the waters of the Gulf of Maine. The herring's importance, however, hasn't diminished. "For a small fish," noted Peter Baker, project manager of the Pew Environment Group's Herring Alliance, "herring are a really big deal."

COURTESY: MBL LIBRARY

Atlantic herring

The Gulf of Maine herring fishery is coming under scrutiny this year. Last fall, the Herring Alliance—a coalition of environmental groups and some fishermen—ran a campaign urging New England residents to voice their concerns about the fishery, such as fishing practices, to bolster support for making it a priority fish to protect. As a result, the New England Fisheries Management Council (NEFMC) received some 8,000 public comments by email. In November 2007, the NEFMC voted to reexamine herring regulation, adding the species to its 2008 management priority list. "The council made an important decision today to fix the Atlantic herring fishery," Baker said in a statement issued immediately after the NEFMC vote. Yet not everyone agrees the fishery is broken.

Atlantic herring are small, streamlined fish reaching up to 10-14 inches (25-35 centimeters) in length that form enormous schools in the open waters and offshore banks of the Gulf of Maine. Herring hold a key spot in the middle of the food chain. They filter plankton from the water and are an important food source for large predators such as tuna, whales and sharks. "They eat really small things and are eaten by really big things," Baker said. "They are some of the most nutritious foods available for the

*See **Herring** Page 11*

A marsh in winter...

PHOTO: CATHERINE COLETTI

... looks deceptively lifeless.
Story Page 9

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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

Enjoying the spring melt

PHOTO: ANN FLEWELLING

"March Tracks" taken near Deer Isle, Maine.

It's between seasons, the *melt*, when the awkward silence encapsulating nature in ice is orchestrated into a crescendo of buds overgrowing brown stick plants and lush green shoots carpeting mudflats. Birds return like clockwork every year, and animals come out of their slumber to seek food and mates.

It's a time of year when warming air and longer daylight lure humans to the outdoors as well.

This Winter/Spring issue of the *Gulf of Maine Times* celebrates the melt in two stories. Assistant editor Catherine Coletti takes us to a marsh in winter, and tells us of the impending changes. "During winter, most of the perennial plants—the plants that will come back each spring—use energy and nutrients absorbed by their rhizomes, or underground plant stems, to stay alive under the ice," she writes.

"This spring, increasing light and warmth will tell the marsh to wake up... the melting away may reveal a weathered face, as ice, tides and waves have chipped away at its fragile outer edges."

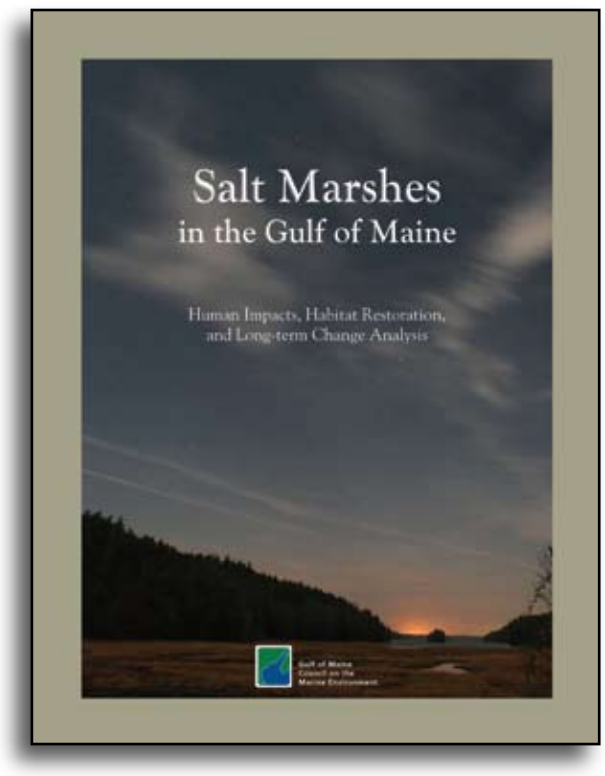
Another story profiles poet and conservationist Marnie Reed Crowell, a resident of Deer Isle, Maine. Nothing tickles Crowell's imagination like the spring melt. At the first signs of cracking ice, images flood her mind and poetry runs through her fingertips onto paper. The biologist-poet and environment conservationist says every season has its charms, but she loves melt. "I like to watch new sprouts come up and the old, dirty snow melt away … increasing day(light) is a metaphor for optimism," says Crowell.

She describes the energy of the melt we're all about to experience beautifully in "*Eider Envy,*" her poem about the Eider duck spring congregations that she calls "one of the wonders of the natural world."

"Was it yesterday the frozen cove
was locked-down desert? Today
the shore is ringed with rotting
blocky slabs.
In a languid band of Prussian blue
the rockweeds
wave and the silver sheen is alive
with thousands of eiders. It's galactic,
this black-and-white sprinkle."

The melt is a time of year that calls amateur and expert naturalists alike to observe the rebirth of the world around them—the lichens rimming the bottom of tree trunks in the city and country, the bird song returned after a long winter, buds spiraling around tree branches. Whether you experience these awakenings on your own or as part of a group outing, enjoy.

Lori Valigra



Salt marshes in the Gulf of Maine

A new 42-page booklet on salt marshes in the Gulf of Maine offers a reader-friendly look at the ecology of these vital coastal wetlands and ways to bring them back to health. Salt marshes remove pollution from the water, provide food and shelter for fish and birds, protect the shoreline from erosion and perform other valuable roles in the ecosystem. However, 75 percent of salt marshes in New Brunswick and Nova Scotia and 37 percent in New England states have been destroyed, according to the booklet. Many remaining salt marshes are in poor health because of road crossings, development of surrounding land and other human impacts. The rising sea, due to climate change, looms as a major threat. The booklet presents an overview of scientific findings about ecological functions of salt marshes, their connections with fisheries and the larger Gulf of Maine ecosystem, efforts to restore damaged marshes and the need for regional monitoring of salt marsh health. The booklet—*Salt Marshes in the Gulf of Maine: Human Impacts, Habitat Restoration, and Long-term Change Analysis*—was published in February 2008 by the Habitat Restoration Subcommittee, Habitat Monitoring Subcommittee, and Science Translation Project of the Gulf of Maine Council on the Marine Environment. It is an element of the Council's five-year Action Plan to enhance the health of the Gulf of Maine ecosystem. To download the booklet or request a hard copy, go to http://www.gulfofmaine.org/saltmarsh. The Web page also contains links to other publications and online resources related to salt marshes.

Gulf of Maine Council invites nominations for leadership and volunteer awards

Do you know a *group or individual* who has worked professionally or selflessly volunteered to improve the Gulf of Maine? A *volunteer* who has devoted his or her life to natural resource and environmental issues in the Gulf? A special *coastal management professional* who works in the Gulf of Maine? The Gulf of Maine Council on the Marine Environment is calling for nominations for its annual Visionary and Longard Awards. To nominate a group or individual please visit: http://www.gulfofmaine.org/news/index.php#2008nominations.

Nomination applications are due by April 25, 2008.

PHOTO: LORRAINE LESSARD

Kathleen Leyden won the first Susan Snow-Cotter Award.

Maine coastal manager wins Susan Snow-Cotter Award

Kathleen Leyden, coastal planning manager in the Maine State Planning Office, was awarded the first Susan Snow-Cotter Award for Excellence in Coastal & Marine Resource Management by the National Oceanographic and Atmospheric Administration (NOAA). She received the award at a ceremony in late February in Washington, DC. NOAA will present the annual award to honor people for outstanding contributions in helping the nation maintain healthy coastal and ocean resources. Susan Snow-Cotter, former director of the Massachusetts Coastal Zone Management and a tireless environmental advocate, died in late 2006 (see *Gulf of Maine Times*, Winter/Spring 2007, Page 2).

SCIENCE INSIGHTS

Sewage Solutions

By Peter H. Taylor

"What's that big mound in your yard with the pipe sticking out of it?" Often that was the first question people asked as they arrived at my house in a semi-rural town on the mid-coast of Maine.

"It's the leach field for my septic system," I'd say. Sometimes that was enough of an explanation.

Other times, my guest would pause and say, "What's a leach field?"

I had roughly the same level of knowledge—or should I say ignorance—about septic systems when I bought the house. A quarter of U.S. residents use septic systems instead of sewers, but I was a newbie.

I grasped the basic concept that water I flushed down the toilet or drained from the sink, shower and washing machine would go into the septic system. Then a series of pipes buried in the "big mound," or leach field, would release it into the soil, where microorganisms would clean up the water. The "pipe sticking out" of the mound provided ventilation to help the whole system to work as it should. Beyond that, I didn't have much of a clue. It turns out there's more to it than I ever would have guessed.

I grew up in a town in suburban Massachusetts where everybody's house was hooked up to the town's sewer system. The moment we flushed the toilet or drained the sink, the water and its load of dirt, soap, human waste and food scraps became somebody else's problem. That was true everywhere I'd lived as an adult, too.

Not the case at my new home. I became responsible for making sure the bad stuff in my wastewater would not seep into groundwater—and eventually into the ocean inlet by my house. Naïvely, I figured that since my septic system complied with local regulations and was well maintained, my wastewater and I were not a source of pollution.

I actually really liked having a septic system for the same reason I liked getting water from my well instead of a town water supply, and burning wood instead of oil to keep warm. It made me feel self-sufficient and connected to the land, unlike when I've lived in suburban or urban homes. To me, a septic system seemed more environmentally friendly than a town sewer system.

I didn't know that even a legally designed, well-maintained septic system is scarcely better than a sieve for dealing with some pollutants. Nitrogen is the worst offender. Eighty percent or more of nitrogen typically escapes untreated through a conventional septic system. That can add up to 10 pounds (4.5 kilograms) of nitrogen per year for each person using the system. Once the nitrogen gets into a lake or bay, it fuels out-of-control growth of algae, which can foul the water body and compete for nutrients.

The problem is that conventional septic systems lack oxygen. The persistent scarcity of oxygen prevents the combination of nitrogen and oxygen atoms into nitrate molecules, which then can change into nitrogen gas. In its gaseous form, nitrogen is harmless and does not fuel growth of algae.

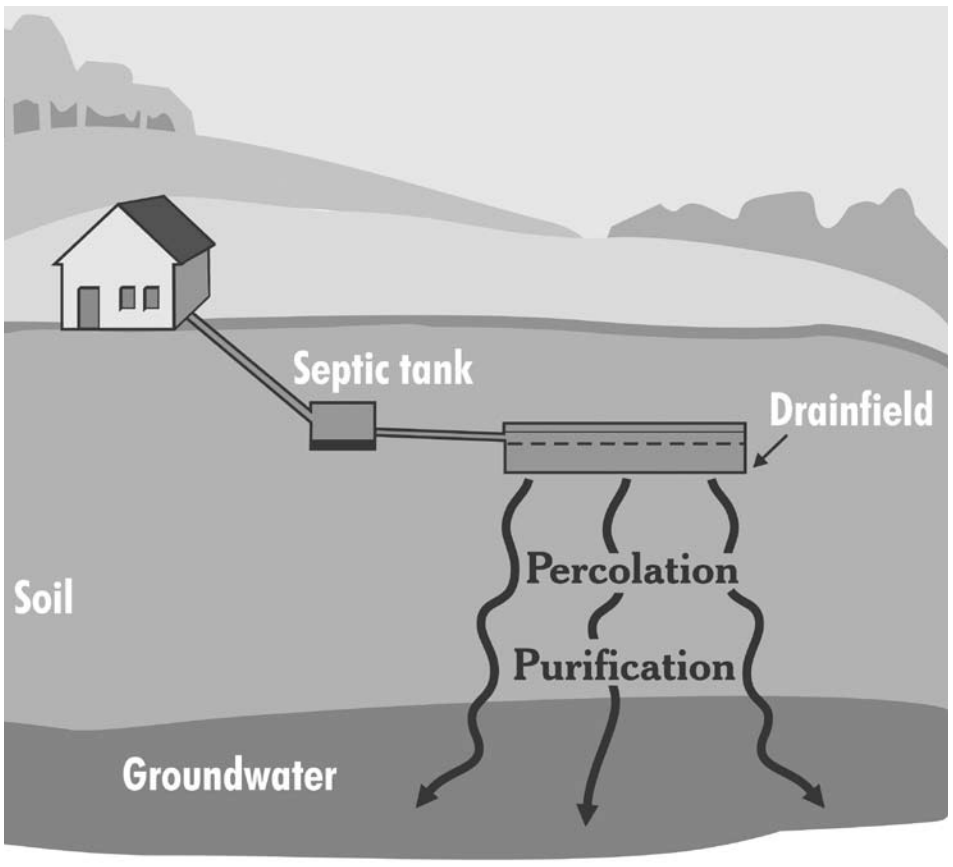
It really surprised me that—even in peak operating condition—my trusty septic system might have contributed to pollution in the ocean that I enjoyed seeing from my sofa. Most people remotely familiar with septic systems know that an inadequate or broken system causes pollution, but the serious shortcomings of "good" septic systems aren't as widely known among homeowners and other regular folk.

Consequently, I was glad to discover recently that scientists and engineers are conducting research to overcome the technical shortcomings of conventional septic systems. Already, there are many options available, such as fixed media (in which the liquid is pumped over a filter filled with waste-eating microorganisms, allowing fast treatment in a relatively small space) and suspended-growth systems (in which a blower injects air into the system to increase the dissolved oxygen and enable faster growth of bacteria). The main drawback is that the new technologies tend to cost far more than a conventional system.

An approach called periodic aeration might emerge as a cheaper but effective solution. José Amador of the University of Rhode Island and David Potts of Geomatrix LLC are testing the approach using a simple, low-cost device that blows air into the septic system at regular intervals. By injecting oxygen, the device allows the formation of nitrate. Funded in part by the Cooperative Institute for Coastal and Estuarine Environmental Technology (http://ciceet.unh.edu), the laboratory experiments and field trials show that periodic aeration can enable a conventional system to remove up to 75 percent of the nitrogen in wastewater. That's a dramatic improvement.

I'm encouraged to know that research is revealing new ways to make septic systems pollute less. I don't know yet if periodic aeration is the best solution for my septic system, but I'm going to look into it and other promising, new technologies. Then I'll really be able to wow my guests with tales about that "big mound with the pipe sticking out of it."

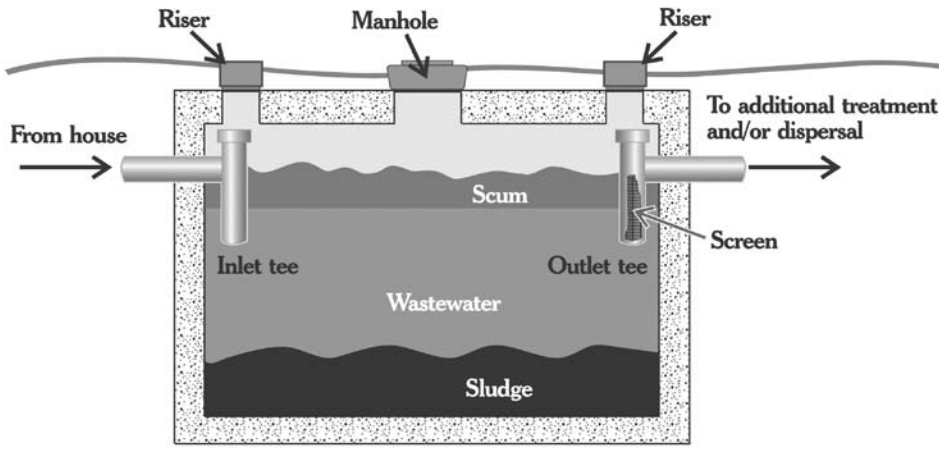
Peter H. Taylor (peter@waterviewconsulting.com) is a consultant for the Gulf of Maine Science Translation Project. He specializes in communication of coastal and marine science.



COURTESY: ENVIRONMENTAL PROTECTION AGENCY

Scientists are developing better technologies for treating wastewater. Added to a standard septic system (both diagrams), the new equipment can enhance performance. Some of the technologies pump wastewater over a filter filled with waste-eating microorganisms. Others inject air into the septic system to enable faster growth of bacteria.

Typical single-compartment septic tank with ground-level inspection risers and screen



COURTESY: ENVIRONMENTAL PROTECTION AGENCY

Resources for sewage solutions

Brief about the CICEET-funded study by José Amador and David Potts
http://ciceet.unh.edu/briefs/amador_brief

Scientific papers by Amador and Potts in the Journal of Environmental Quality
http://jeq.scijournals.org/cgi/content/full/35/4/1160
http://jeq.scijournals.org/cgi/content/full/33/5/1828

Gulf of Maine KnowledgeBase: Sewage and Wastewater
http://www.gulfofmaine.org/knowledgebase/sewage

Sewage Management in the Gulf of Maine: Workshop Proceedings
http://www.gulfofmaine.org/knowledgebase/sewage/docs/SewageReport.pdf

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A Good Thing Gone Awry: The Environmental Disruption Caused by an Overload of Nitrogen is Emerging as a New Concern for the Gulf of Maine
the Gulf of Maine Times, Summer 2002
http://www.gulfofmaine.org/times/summer2002/nitrogen.html

Workshop Report 2001: Managing Nitrogen Impacts in the Gulf of Maine
http://www.gulfofmaine.org/knowledgebase/nitrogen/docs/NitrogenWorkshopReport.pdf

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Septic Systems for Coastal Homes
http://www.coastalcontractor.net/pdf/2005/0510/0510sept.pdf

Fact Sheet: Septic Systems
http://www.stormwatercenter.net/Assorted%20Fact%20Sheets/Tool7-Non_Stormwater/SepticSystems.htm

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Septic Systems: How They Work and How to Keep them Working
http://maine.gov/dep/blwq/docgw/septic_systems.pdf

Maintaining Your Septic System: Special Considerations for Shoreline Property Owners
http://www.umext.maine.edu/waterquality/Publications/7082.htm

Where eagles fly

By Dave Kellam

On a bright winter afternoon an Air National Guard KC-135 Stratotanker lifts off from Pease International Airport in Portsmouth, New Hampshire. The 161 ton (146,000 kilograms, fully loaded) aircraft seems to defy gravity as it takes to the clear blue skies over the Piscataqua River and Great Bay. But this impressive flying gas station shares the air with an even more awe-inspiring flying colossus of the natural world: the bald eagle.

Weighing in at about 12 pounds (5.4 kilograms) and with a wing span of seven feet (2.1 meters), the bald eagle is a majestic predator that lives around water bodies with abundant fish to hunt and large trees or cliffs along the shoreline for roosting and nesting.

Bald eagle nests are impressive structures built with branches collected by a single breeding pair that maintains the nest year after year. During the winter, bald eagles leave their nesting territories and congregate around open water with readily-available food sources. In New Hampshire, this is along major rivers and estuaries.

Resource managers must be able to recognize critical riparian habitats and work with landowners to protect these areas from future development.

The state's largest estuary, Great Bay, is the winter home for many eagles that summered throughout the Piscataqua River watershed in southeastern New Hampshire. During the statewide 2007 Christmas Bird Count, coordinated annually by New Hampshire Audubon, excited birdwatchers on the Seacoast Team counted 15 eagles in the coastal region, which smashed the old record of six.

One of the reasons eagles congregate around Great Bay is the availability of prime roosting habitat at the Great Bay National Wildlife Refuge. Six miles (9.6 kilometers) of rugged intertidal shoreline includes large white pine trees and other natural features that allow the eagles to roost in peace. Most importantly, development is limited. In addition to the federally-protected habitat of the refuge, the area enjoys large tracts of development-free shoreland, thanks to the protection efforts

New Hampshire Audubon has embarked on a three-year project in 2008 to determine habitat use of wintering eagles along the Merrimack River corridor.

of the Great Bay Resource Protection Partnership and management by the Great Bay National Estuarine Research Reserve. However, other eagle habitat in the state is not as secure.

By the 1970s, historic bald eagle populations in the lower 48 states plummeted to the brink of extinction as a result of loss of habitat, shooting and the pesticide DDT, which severely disrupted the eagles' reproduction. After DDT was banned in the United States and eagles received endangered status under the federal Endangered Species Act (ESA) in 1978, eagles began to make a comeback. They were reclassified under the ESA from endangered to threatened in 1995, and in June 2007, were removed entirely from the list. The species remains on the state of New Hampshire's list of threatened and endangered species, but as populations increase, they may be delisted in New Hampshire as well.

In southern New Hampshire, development has dramatically diminished winter eagle habitat along the Connecticut and Merrimack Rivers. In addition to historic mill buildings, new structures built in the areas adjacent to rivers, also called riparian areas, remove roosting trees and disturb the birds, forcing them to expend valuable energy to fly to quieter places, potentially away from vital food sources.

Resource managers must be able to recognize critical riparian habitats and work with landowners to protect these areas from future development. In addition to benefiting wildlife, undisturbed, well-vegetated riparian areas protect water quality and reduce impacts of flooding.

Resource managers face a challenging task because of a lack of information about how wildlife uses riparian habitats along long stretches of a river. To address this need for information, New Hampshire Audubon has embarked on a three-year project in 2008 to determine habitat use of wintering eagles along the Merrimack River corridor. Senior biologist Chris Martin of New Hampshire Audubon is leading this project that is funded by a $50,000 grant from the Merrimack River Bald Eagle Habitat Fund administered by the National Fish and Wildlife Foundation.

Martin developed a plan to capture five eagles in early 2008 and attach satellite transmitters to the birds to track their movements. The information gathered will reveal the daily habits of the eagles and show what specific habitats are used along the Merrimack River and throughout the region. "Because eagles can travel up to 100 miles (161 kilometers) per day, we have never been able to follow an individual eagle across New Hampshire," noted Martin. "With this project, we will be able to see how a bird uses different habitats on a daily basis. From my desktop computer, I can see if a bird tagged in Manchester has flown north to [Lake] Winnipesauke or is utilizing habitat on Plum Island at the mouth of the Merrimack."

Martin looks forward to overlaying the eagle location data with geographic information system (GIS) maps of intact riparian areas and other natural resource features. "The work we are doing with the eagles is designed to help people understand why river habitat is important," said Martin. "Too often, resource managers lack the tools they need to demonstrate to others the extent of good habitat. Information from this project will allow everyone to draw their own conclusions on what habitat needs to be protected."

New Hampshire Audubon plans to announce when the eagles have been successfully tagged and how the public can follow the movements of project birds on the Internet. Until then, eagle watchers can likely get a glimpse of the colossal predator at the Great Bay Discovery Center on Depot Road in Greenland, New Hampshire, or Adam's Point in Durham, New Hampshire.

Dave Kellam is project coordinator for the New Hampshire Estuaries Project.

PHOTO: U.S. FISH & WILDLIFE SERVICE DIGITAL LIBRARY

Bald eagle in flight.

Calendar

March 3 – 6

Atlantic Climate Change 2008 is scheduled for March 3-6 in Halifax, Nova Scotia. The theme is *Risks, Responses and Tools for Action*. Topics will include: science of climate change, impact on renewable natural resources, natural resource management, infrastructure decision-making, energy choices, mitigation options, adaptation tools and others. For information visit: http://www.esans.ca/events.html#climate.

April 30 – May 3

The 2008 National Science Meeting of the Ecological Monitoring and Assessment Network (EMAN) is scheduled for April 30 – May 3 in Gatineau, Québec. Topics include: gaps in biodiversity and climate change research, biodiversity monitoring, and planning and management tools. For information visit: http://www.eman-rese.ca/eman/reports/meetings/national2008/.

May 11 – 14

Aquaculture Canada 2008, the 25th Annual Meeting of the Aquaculture Association of Canada, is scheduled for May 11-14 in Saint John, New Brunswick. The theme is *Growing Quality Seafood through Innovation*. For more information visit: http://www.aquacultureassociation.ca/ac08/index.html.

May 25 – 29

Coastal Zone Canada 2008 is scheduled for May 25-29 in Vancouver, British Columbia. The conference will be preceded by a Youth Forum on May 23-25. The agenda will look at the advances and the setbacks in our understanding and management of coastal and ocean systems, both in Canada and globally. The conference will also establish recommendations and actions for the immediate future and for the next 30 years. For more information visit: http://www.czca-azcc.org/html/conferences/czc08_papers.html.

Outside the Gulf

Fish think fast to catch prey: German researchers have modeled the compact neural circuitry that allows archerfish to make accurate and flexible decisions about its insect prey in a flash. The researchers chose the archerfish because it is known for its unique way of shooting its insect prey with water and making rapid-fire decisions about where it will land. The fish pinpoints its prey in a four-dimensional space and maps it precisely onto a fine-tuned, two-dimensional motor space. In another set of experiments, the simple archerfish network also had to choose the most rewarding target out of two and decide when a response is likely to succeed, the researchers reported. The circuitry must be tuned on the basis of what the fish have learned previously.

"Small Circuits for Large Tasks: High-Speed Decision-Making in Archerfish," by T. Schlegel; S. Schuster at Universitat Erlangen-Nurnberg Institut fur Zoologie II in Erlangen, Germany. *Science*, January 4, 2008, 1149265, 104-106.

Migratory birds can compensate for longitude. Eurasian reed warblers captured during their spring migrations and released after being flown 1,000 kilometers (621 miles) to the east can correct their travel routes and head for their original destinations, researchers reported in the online version of *Current Biology* on Jan. 31. The new evidence suggests that the birds have true navigation, meaning that they can identify at least two coordinates that roughly correspond to geographic latitude and longitude. The findings challenge the notion held by some that birds might be limited to navigation in the north-south direction. But scientists still don't know how they do it.

Chernetsov et al.: "A Long-Distance Avian Migrant Compensates for Longitudinal Displacement during Spring Migration," Chernetsoy, et. al., *Current Biology* 18, 1–3, February 12, 2008.

Travelogue

Meeting whales on their terms in the Bay of Fundy

By Karen Finogle

The breaths come suddenly. Short bursts of moist air blown urgently into the night sky. A mammalian geyser trades carbon dioxide for oxygen before it slips beneath the surface. It's over in seconds. Perched on the edge of a cliff, at a campsite 50 feet (15 meters) above the ocean, I crane my head forward to scan the murky darkness below. I wait…for a shimmering back or barnacled head to break the surface. Nothing.

And then another blowhole sounds off. Twice this time. Another follows minutes later. The whales surface in the shadows, avoiding the single moonbeam that casts a carpet of light across the Bay of Fundy. My chance to see these baleen feeders evaporates with their invisible breaths.

Hearing them is its own magic. In a silence interrupted only by the waves lapping against the rocks, these creatures surface and exhale with voracity—as if they are on the verge of drowning. In response, I quiet my own breathing and listen. My whole being is tuned to their frequency, awaiting their missives.

My blubbery companions could be humpback or endangered North Atlantic right whales, but they are likely finback or minke whales, which are most often spotted from the shoreline. Members of all four species spend the summer and fall months near Grand Manan, a Canadian island in the Bay of Fundy that is 15 miles (24 kilometers) long by almost seven miles (11 kilometers) wide.

Like much of the land that touches the Bay, Grand Manan has some of the highest tides in the world, 27 to 30 feet high (8 to 9 meters), and they change every six hours. That's the secret behind what makes these waters such a four-star destination for whales.

PHOTO: LAURIE MURISON, GRAND MANAN WHALE AND SEABIRD RESEARCH STATION

A right whale breaching off of Grand Manan.

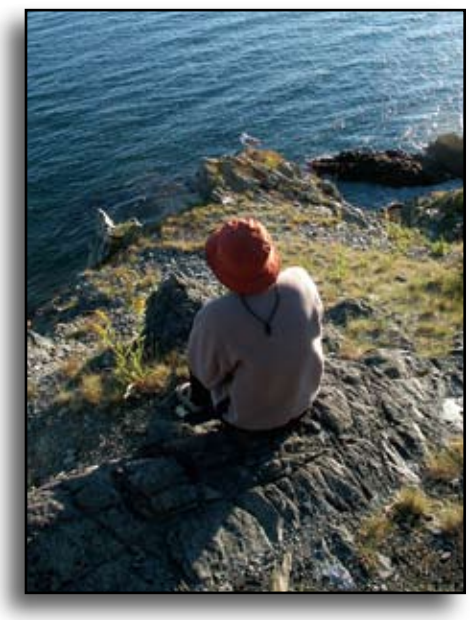


PHOTO: PETE INGRAHAM

Karen Finogle contemplates communicating with whales.

Approximately 100 billion tons of water is pushed in and out of the Bay twice a day. This kinetic energy acts as a giant biological mixer, churning up nutrients and bringing them to the surface where phytoplankton—round, single-celled organisms that are algae, bacteria or fungi—grow through photosynthesis. Phytoplankton is the diet of zooplankton, tiny ocean animals that float at the whim of ocean currents. And zooplankton is the food staple of our baleen friends.

I had begun my whale watch on the 90-minute ferry crossing the Bay of Fundy from Blacks Harbour, New Brunswick, outside on the deck until the stiff wind and pitch and roll of the ship sent me inside to one of the vinyl, padded benches.

In the Bay, the endangered right whales, of which there are only 300 to 350 left in the world, have the right of way. In 2003, an international collaboration between shipping and oil companies, scientists and the Canadian and U.S. governments led to the shifting of shipping lanes four nautical miles east of established routes in hopes of reducing collisions, which nearly always kill whales if the vessel is large enough. Right whales, in particular, cannot afford to lose even one animal if the species is to survive. The shift diverts ships away from the primary feeding areas in the Grand Manan Basin, an area of deep water between the island and Nova Scotia, and has significantly reduced the number of whales in direct exposure to vessels.

This year, that right-of-way will be extended, sort of. In June, the Roseway Basin, an area 1,780 square nautical kilometers southwest of Nova Scotia, will be designated as an area to be avoided by container ships. Another example of international collaboration, the new designation was adopted by the International Maritime Organization last fall and will be in effect from June through September each year. Unlike the Fundy regulation, this act is voluntary, but shipping companies have historically been quick to respond to such measures, and this particular act requires only a minor route diversion.

The 50-degree Fahrenheit (10-degree Celsius) night air chills me, and I must abandon my moonlit listening post on the northeastern side of the island for the warmth of my sleeping bag. The tent sits a mere 15 feet (4.5 meters) from the cliff edge, one of the reasons I chose to come to the island and the Hole-in-the-Wall Campground. I had never seen or heard a whale before, but the intelligence visible in their eyes, the grace and curiosity so often depicted on televised nature programs drew me in. I wanted to meet them, but on their terms.

With the advent of daylight, I am back scanning the ocean water, waiting for the whales to move by, on their way to floating banquets of zooplankton. Every wave that rises and breaks offshore tricks me into looking closer, but Gray seals are my closest companions. They are Neptune's Labrador Retrievers, spinning and twirling in the water, mimicking the joy their terrestrial cousins find in rolling in the grass. They dive and surface in the fishing weir that stands near the cliff walls–a primitive-looking, kidney-shaped herring trap used by bands of Passamaquody and Mik'maq.

Seals seem adept at navigating the entrance to the stake and twine net structures that stand like sentries around Grand Manan; the tall, thin poles driven in the ocean floor jut out of the water, visible even at high tide. I watch as a seal's head bobs on the outside of the net, ducks, and then resurfaces inside only minutes later.

'If only I could shout down to them, my voice penetrating the water and riding the currents until it reached their ears. What would I say?'

Once herring enters a weir, they follow the path of the netting, the curved shape of which continuously directs the fish away from the entrance. It can also confuse harbor porpoises, and even whales. In one year, there were more than 300 porpoises caught in the weirs around Grand Manan. Most years, about 15 to 30 get trapped. Occasionally, minke whales, and sometimes humpback and right whales, swim through the opening and then become confused; they have known no such confinement in the ocean and cannot negotiate an exit. Luckily, the Grand Manan Whale and Seabird Research Station, a research organization established in 1981, has been working with weir fishermen for several years to develop successful techniques that free both porpoises and whales safely.

It's a more difficult scenario in other parts of the ocean where other types of fixed fishing gear provide invisible barriers. Through photographic documentation, 75 percent of right whale and humpback whale populations have scars from entanglements. Some whales break free but carry fishing line wrapped around their fins, tails or baleens. If tight enough, the lines can saw through flesh and expose the whales to infection and possible death.

Entanglement and collision are the two biggest risks to right whales currently, and the Grand Manan Whale and Seabird Research Station, as well as several other organizations, is continuously working to find new avenues of communication and collaboration with government agencies and private industry to identify ways to reduce these threats.

My last night on Grand Manan, I again scramble to the cliff as the moon begins to rise on the eastern edge of the Bay of Fundy. It is quiet except for the white noise of water against rock and the occasional laughter from nearby campers. I wait for the whales to return, for the final breaths or calls that will include me in their community, if only for a moment. I sit patiently as my muscles grow stiff. Nothing but the sound of surf reaches my ears.

Underwater, somewhere else, they are probably calling to each other. They are social creatures that rely heavily upon communication, and hearing is perhaps their most important sense. The Bay, the entire ocean really, has been getting louder. Increased shipping traffic, blasting, harbor dredging, fishing, and even whale watch tours all add noise to the ocean. And the Bay of Fundy is already a naturally noisy area, where the tides alone can cause a whale to raise its voice.

If only I could shout down to them, my voice penetrating the water and riding the currents until it reached their ears. What would I say? Would I apologize for all the other noise, for the clutter we've added to their saltwater home? Would I stutter and stumble, the awkward visitor at a family gathering?

I think I would simply start with a "hello" and listen to what they had to say; the sound of their breathing has already taught me so much.

Karen Finogle, a free-lance writer and senior editor at AMC Outdoors, lives in Durham, New Hampshire.

Profile: Marnie Reed Crowell

Waxing poetic on the spring melt, lichens and all things natural

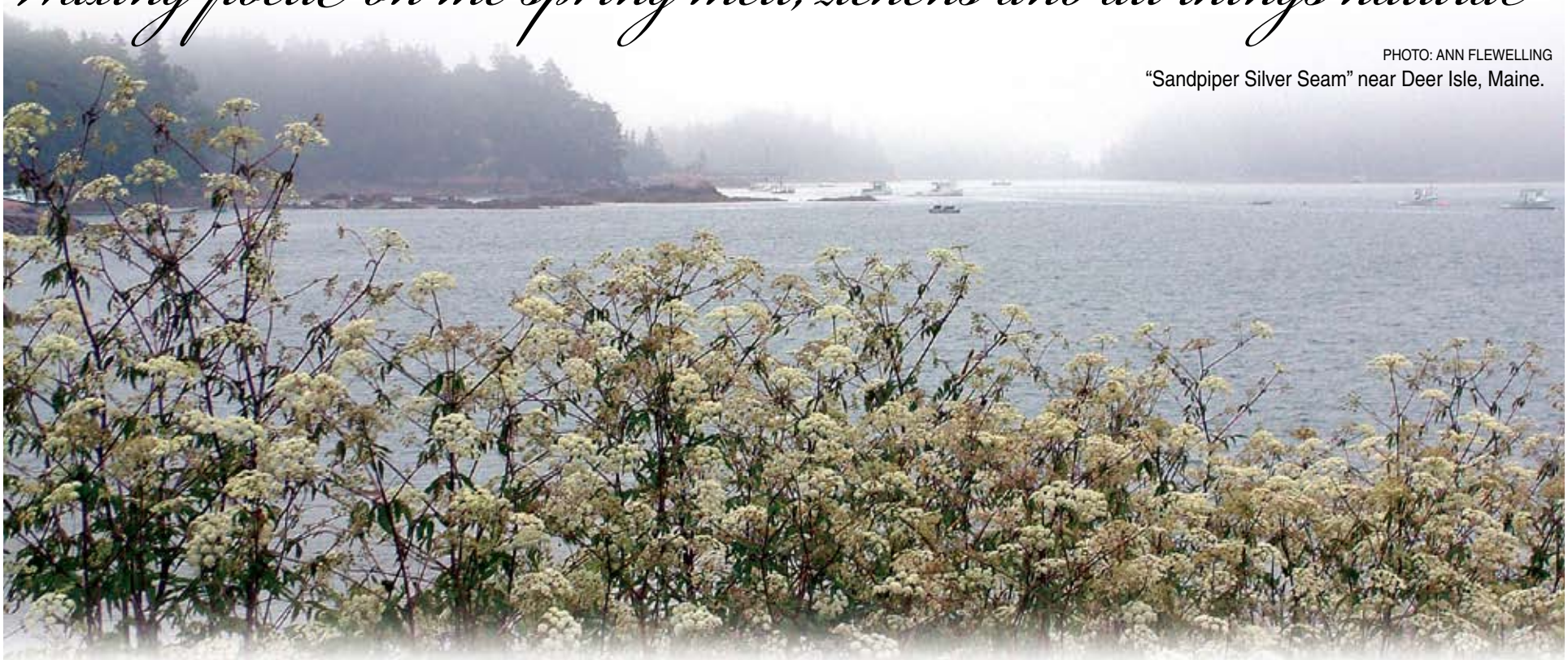


PHOTO: ANN FLEWELLING
"Sandpiper Silver Seam" near Deer Isle, Maine.

By Lori Valigra

Nothing tickles Marnie Reed Crowell's imagination like the spring melt. At the first signs of cracking ice, birds returning from their winter retreats and buds clustering on branches, images flood her mind and poetry runs through her fingertips onto paper. The biologist-cum-poet and environment conservationist says every season has its charms, but she loves melt. "I like to watch new sprouts come up and the old, dirty snow melt away," she said excitedly. "And then I like to see which things are on time. It's a bit of detective work." Some birds always return on time, triggered by daylight. "Increasing day is a metaphor for optimism," said Crowell.

Crowell, a Deer Isle, Maine, resident originally from New Jersey, doesn't see the line often drawn between science and artistic expression. The daughter of an entomologist, she grew up fascinated with the natural world. She fell in love with both words and science, and to this day still hasn't chosen between them. And like her father, she possesses a natural curiosity about the things she doesn't know in nature, and an unstoppable willingness to share what she does know with anyone within earshot. "I grew up explaining how

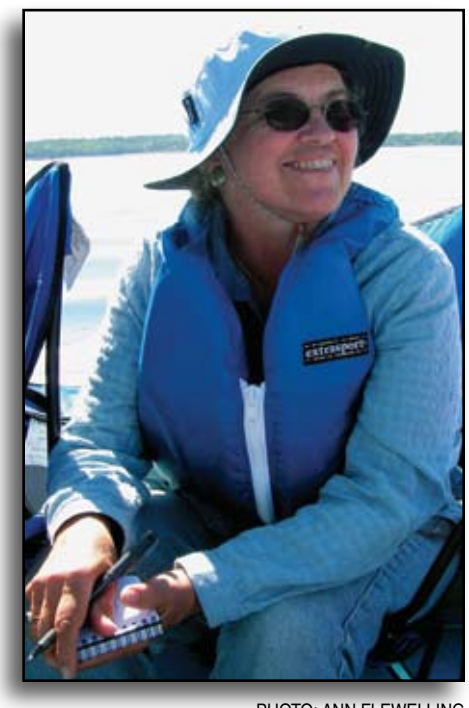


PHOTO: ANN FLEWELLING
Marnie Reed Crowell

an *entomologist* was insects and an *etymologist* was words," she said. "My father taught me the scientific and the common name for everything we saw. I had a hard time choosing between arts and science." Ultimately, she didn't choose, but wove the two together, teaching high school biology and Latin. Crowell has since published a number of books on natural history as well as poetry. "I called my first book *Greener Pastures* because I thought any pasture is worth greening," she said. Perhaps some of the inspiration for that book came from teaching biology to inner-city sophomores in Camden, New Jersey, who didn't spend much time getting to know the natural world around them. "As far as they were concerned, a little brown bird was a kind of bird. That was a bird species."

Wild times in the city

Crowell believes anyone can sensitize themselves to nature, starting with small steps. For example, city dwellers could notice the subtler signs of spring's onset by seeing the discoloration at the bottom of a tree. If they're inquisitive, they might look beyond what most would call "scum" and consult a guide book at their local library. In the book they'd discover they had seen one of the two or so lichens that can survive city air pollution. Country dwellers may be able to identify 30 species of lichens on trees where the air is purer, she said. But merely noticing that there is something growing on the tree is a step closer to nature. "You may not be able to name them [the lichens], but you're a step ahead of yesterday when you didn't know they were there," she effused. "So the world just keeps getting richer and richer."

Nowadays, Crowell, keen-eyed and energetic at 69, explores Deer Isle, where she puts her astute and sensitive observations and interactions with nature into verse that even the most science-challenged can understand. Working at her side much of the time is photographer Ann Flewelling, who brings the dimension of physical imagery to the stanzas of her poems. The two call their verbal/visual collaboration "threehalf press," because the combination of one plus one person can be more than two. Their most recent book, *Beads & String: A Maine Island Pilgrimage*, is a collaboration that highlights Deer Isle's preserves. New chapters focused on months of the year appear each month on the Web site of Island Heritage Trust http://www.islandheritagetrust.org/, a conservation land

Spotted Sandpiper

Just at the silver seam
between the sea and shore
the spotted sandpiper
teeters, speaks softly to itself
a poem it has by heart.
—Marnie Reed Crowell

PHOTO: ANN FLEWELLING
"Icicles on the Lee Eaves" taken near Deer Isle, Maine.

Icicles on the Lee Eaves

Crystal cool carrots
like dragon's teeth drip.
The rain chain hangs frozen
stiff and stout as a club,
but hear the ocean snarl
as out of the south
come the jaws of Spring.
—Marnie Reed Crowell

trust for Deer Isle, Stonington and the surrounding islands. Proceeds for the book, to be published in full in the spring, will go to the Trust.

A trust emerges

The volunteer-run Island Heritage Trust is another of Crowell's loves. She and her husband, Ken, an ecologist, were instrumental in its origins in 1987. It was Ken's work studying the mouse populations on different islands surrounding Deer Isle that helped enlarge the circle of people interested in donating land or easements to maintain the pristine character of Deer Isle. Crowell said it's not necessary to be a Rockefeller to donate land or services, such as the proceeds of a book, to a land trust. "No one was a millionaire on Deer Isle," she said. She and Ken met many islanders through Ken's work. They also volunteered to give nature walks and talks, which inspired other islanders who attended to donate land or easements to the Trust.

Their interest in conservation began in New Jersey, where both are from, and where they got involved in The Nature Conservancy, which later led to their work in the land trust. Of Deer Isle's 24,000 acres (9,712 hectares), so far 2-3 percent are preserved.

Crowell, her husband and their Deer Isle friends started the land trust. What is amazing about Deer Isle, Crowell said, is that almost all of the preserves in the early years were gifts from people. "Nobody was wealthy. Emily Muir had to sell some of her land so she could afford to give away that other land," said Crowell of local builder, architect and artist Muir, who decided to give the backland where she was building a line of houses along a cove as a nature preserve.

Crowell admitted those were good years, but now people considering making donations have a tougher decision with the rapid escalation of land prices. "Land preservation is entering a new phase," she said. "How do you deal when you're now talking millions of dollars? The last couple of years the preserves have been purchased, not given. People may be generous, but they're not going to give away a million-dollar nest egg."

But there are smaller, still important contributions that can be made. "Most of my contribution has been I donated my talent," she said. "It happens we came to Deer Isle early on, so we were able to acquire 30 acres (12 hectares) of land that's right next to a preserve. We gave the conservation easement on it."

But Crowell feels her more significant contribution to the land trust has been reaching the local people through nature walks and books, work that inspired the people who owned properties to find a good mechanism to donate. "That's totally satisfying," she said.

Artists as educators

So what is the artist's role in preserving the environment? "An editor at *Reader's Digest* told me the key to success is that people want to know what it's like to be inside someone else's skin. So I'll tell you what it's like to be me and go mackerel fishing." Crowell doesn't think artists are obligated to have an environmental cause or bend to their work, but she does suggest to her artist friends that making an artist's statement could be useful. Crowell said most of the local artists do make such a statement, for example, Carolyn Caldwell http://www.carolyncaldwell.com. "Why do I paint?" she says in her artist's statement on her Web site. "Vanishing beauty. The world is changing rapidly. Development is overtaking the natural world….My hope is that artists can slow the rush."

Said Crowell, "She could have painted ugly stuff, but she chose to paint beautiful stuff and serenity and say, 'look, if we don't take care of it, this is what we're going to lose.'"

It's not just professional painters, photographers or writers who can speak for the environment. Crowell admits she wasn't trained to write. She felt compelled to do so. She also hails the advent of new technologies like digital cameras, which make it easy for people to capture and share images via home-made newsletters, the Internet and other ways.

"If you're a city person looking at ants and then go to the museum and look at the display, how do you share that? Do you share it in your local co-op newsletter? Do you share it in your school newspaper? You probably can find someplace to share it, and it probably will mean something to other people," she said. "Part of what I do, by the way *Dowsing* and other poems, is for people who spend their life's energy in a city working hard. They need their battery recharged," she added. "So by reading *Dowsing* they'll feel better, like holding hands with wind on the bay."

Crowell recommends carrying around a small notebook, or jotting creative thoughts, phrases and inspirations on them. "I had to learn to trust my own flash of emotion or inspiration," she said. "What I see in the natural world is usually a metaphor that has a deeper meaning to me. It is a highly spiritual experience, like *Dowsing* or *Mackerel*. Both of those poems are pretty humbling. Like *Dowsing*. I literally was walking around the Isle with a stick in my hand and Ann looked at me and said you're doing a poem aren't you? And I said I suppose I am. What is the poem about? It's about holding these sticks in your hand. Formerly bayberry, these are ordinary twigs, but I like the way they feel in my hand. I'm half expecting them to pull down toward the center of the earth like a dowser. And then I realize this is so interesting it must be the way a lobster feels in communion with something bigger and since it's sea you'd call it Neptune or Poseidon."

She added, "What I would encourage everybody to do is when you get those thoughts, work on them, play with them, make them more exact and meaningful. Words have an abstract melody. Listen to that. You don't need to go to a poetry class. Allow yourself to listen to it as an abstract sound. And the pattern of words that most fit, play with that for a week or so and look at it again. A better way of arranging it will occur to you. That tinkering is what's making poems."

Lori Valigra is editor of the Gulf of Maine Times.

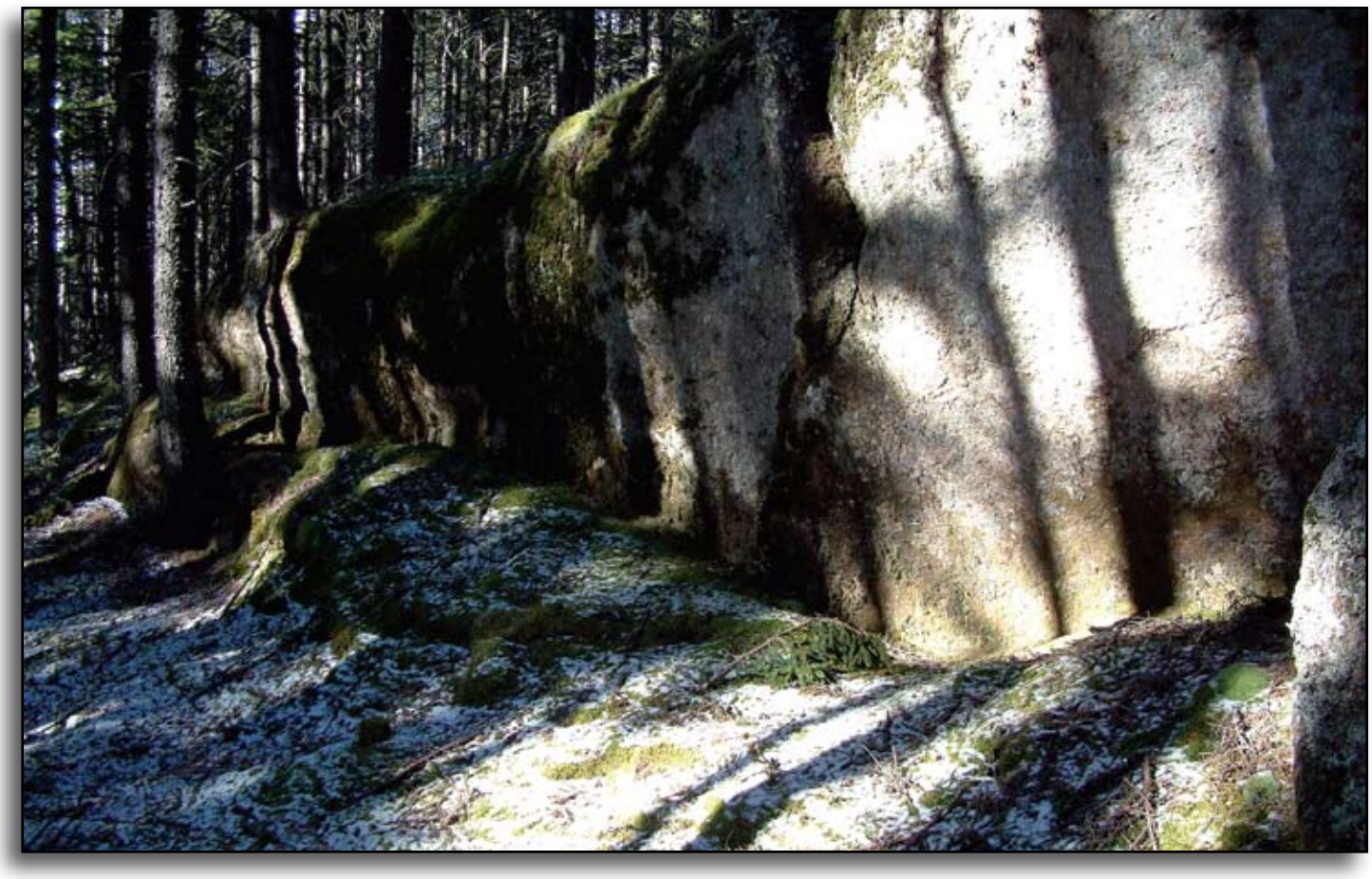


PHOTO: ANN FLEWELLING
"Cloud of Being" taken at Crockett Cove Woods, a preserve on Deer Isle, Maine.

Dowsing

These two bare twigs,
formerly bayberry,
too scant to be driftwood
but nicely branched and silvered,
they fit my hand so well
I carry them full circuit
around the island
with no vain intention
of taking either home with me–
but I like the feeling
of winnowing the sea breeze,
of holding hands with the sky,
of sensing how a lobster feels
waving its claws in communication
with Poseidon and the sea.

—Marnie Reed Crowell

Hear Marnie Reed Crowell read her poetry on the *Times* online at: http://www.gulfofmaine.org/times.

PHOTO: ANN FLEWELLING
"Dowsing" was inspired by one of Crowell's walks around Deer Isle, Maine.

For more of Marnie Reed Crowell's and Ann Flewelling's work visit: http://www.threehalfpress.com.

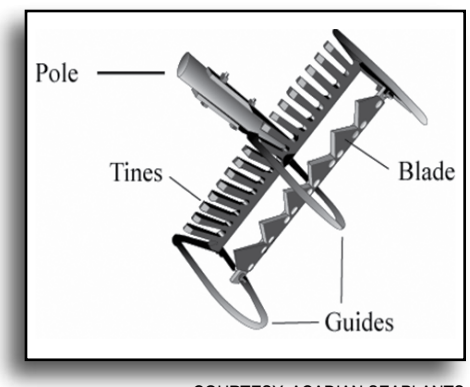
Seaweed *continued from Page 1*

seaweed companies have taken pains to protect their crop. Take Acadian Seaplants of Dartmouth, Nova Scotia, which claims to be the world's largest independent manufacturer of seaweed-based specialty products. The company has a sophisticated, internationally-recognized sustainable harvesting and monitoring program. Each seaweed bed is photographed from the air and assessed on the ground—with the data recorded in a computer file—to ensure the crop is managed sustainably.

Alan Critchley, the company's vice president of research, said Acadian Seaplants harvests 17 to 25 percent of the standing stock of rockweed—well below the annual growth rate. The seaweed's biomass is also monitored before, during and after each harvest, Critchley said.

To avoid the possibility of overharvesting a wild crop, Erhart plans to add cultured seaweed next year—growing deep burgundy-colored dulce seaweed on nets and selling it under a "local and sustainable" label rather than "organic."

At the same time, a new twist to the cultured seaweed story is developing as a number of commercial seaweed operations along the Gulf coast, including Erhart's, collaborate with scientists and researchers. They are experimenting with an integrated aquaculture idea that is producing some surprising and encouraging results.



COURTESY: ACADIAN SEAPLANTS

A cutter rake for sustainable seaweed harvesting.

Aquaculture is a staple of the fishing industry, but has traditionally been a monoculture—growing one type of finfish, or shellfish, in isolation. With integrated aquaculture it is possible to create mini-ecosystems in the sea whereby the waste of one species, salmon for example, becomes the food or fertilizer for other species such as shellfish and seaweed. The setup, first proposed six years ago, turns out to be a more efficient, economic and ecologically sensitive way to operate aquaculture.

Thierry Chopin, a researcher at the University of New Brunswick, is at the forefront of this integrated idea, known more scientifically as Integrated Multi-Trophic Aquaculture, or IMTA. When rafts of blue mussels are placed in close proximity to Atlantic salmon cages (within 20 meters or 60 feet), and ropes of kelp (a large brown seaweed) dangle from a raft 100 meters (300 feet) away, the three species complement and increase each other's growth, Chopin discovered.

High tides, little heavy industry and thousands of miles of craggy coastline make the Gulf of Maine one of the best spots in the world for seaweeds.

Fish farms produce an excess of nutrients in the surrounding waters. When kelp is grown near the fish cages, Chopin said, it absorbs much of the excess dissolved inorganic nutrients, such as nitrogen and phosphorus, and increases its biomass 46 percent faster than when grown 1.2 kilometers (0.7 miles) away at a reference site. Meanwhile, the mussels feed on the organic particulates and grow 50 percent faster. This acceleration speeds up the harvesting cycle and turns the natural recycling into an economic benefit.

Shawn Robinson, a government researcher at the St. Andrews Biological Station in New Brunswick, is collaborating with Chopin on the IMTA idea with the help of a local company, Cooke Aquaculture. He said they're at the commercial scale already. Four salmon sites each have four rafts of kelp and four of mussels placed at carefully chosen distances. And the result: enormously plump mussels and fast-growing seaweed. His only concern, Robinson said dryly, is that people might develop a taste for these unusually stout mussels and forget what the wild ones look like.

On the cusp of larger commercial use, IMTA appears to be a win-win formula with a further bonus. Despite early concerns that the shellfish and seaweeds might be "reservoirs" for diseases that would affect the fish, the reverse has been the case, Chopin said. "Our team, and also another one in Norway, have observed that mussels seem to be able to destroy the virus responsible for ISA (infectious salmon anemia)," Chopin said. This means the mussels have the potential to act as a biofilter for disease reduction or prevention, he added.

COURTESY: ACADIAN SEAPLANTS

Surveying rockweed seaweed biomass.

'Sustainable' is a key word in commercial seaweed farming. It is a fundamental element in producing an organic crop.

One other concern had been that seaweed's function as a natural water filter might turn it into a repository for pollutants. Over six consecutive years, Chopin said, the Canadian Food Inspection Agency (CFIA) monitored the seaweed for residues of heavy metals, PCBs and a host of other contaminants, but no accumulation of chemicals was ever found. The results were always below the regulatory limits.

One other concern had been that seaweed's function as a natural water filter might turn it into a repository for pollutants.

Acadian Seaplants has been working closely with Chopin on the IMTA experiment and markets the kelp produced. When asked about the "organic" status of Acadian Seaplants products, Critchley said the term is loose. All seaweeds enjoy the status of being an "organic input" for agricultural purposes, he said. The company's site at Pennfield, New Brunswick, is also certified for the production of organic products from seaweeds.

Erhart of Maine Coast Sea Vegetables said his whole crop is certified organic by the Organic Crop Improvement Association. When harvesting in the ocean, he acknowledged, there is little control of the environment. But where one harvests—far from industry and flood drains, for example—how, when and how much are all part of the OCIA assessment. That includes how the plants are transported, dried, stored and packaged.

While most of us might first think of the dark green or black crinkly strip wrapped around sushi rice when seaweed is mentioned, the sea plants' uses are far and wide. Rich in nutrients absorbed from the rushing tides, various types of seaweed are used in products ranging from fertilizers to cosmetics, animal and human food to vitamin supplements, and pharmaceuticals to textiles to biotechnology.

The next time you eat ice cream or drink beer, chances are some rock-clinging seaweed was integral to its production.

Susan Llewelyn Leach is a free-lance writer based in Cambridge, Massachusetts.

From the Scientific Literature

The ocean's uneven heat gain: While overall temperature in the North Atlantic Ocean has risen over the past half century, it has not been consistent across the area, researchers reported in the journal *Science*. This example fits with the general pattern of global warming, but before scientists can accurately predict what the impacts of warming will be, they need to understand the spatial pattern of temperature change. The researchers found that in the North Atlantic, the tropics and subtropics have warmed, but the subpolar ocean has cooled over the last 50 years. Using an ocean general circulation model, they interpret the change as mostly the result of wind and buoyancy forcing associated with the North Atlantic Oscillation, which is a climate phenomenon caused by differences in sea-level pressures.

The researchers suggest that while the spatial pattern of temperature change in the North Atlantic does not directly reflect global warming, it may be the indirect result of warming as transmitted through large-scale changes in atmospheric circulation.

"The Spatial Pattern and Mechanisms of Heat Content Change in the North Atlantic," by M.S. Lozier; M.S.C. Reed; N.J. Moore at Duke University in Durham, NC; S. Leadbetter; R.G. Williams; V. Roussenov at Liverpool University in Liverpool, UK; and N.J. Moore at Michigan State University in East Lansing, MI, *Science*, January 3, 2008, 1146436v1.

How diatoms build their shells: Diatoms, some of which are so tiny that 30 can fit across the width of a human hair, are so numerous that they are among the key organisms taking the greenhouse gas carbon dioxide out of the Earth's atmosphere. The shells of diatoms are so heavy that when they die in the oceans they typically sink to watery graves on the seafloor, taking carbon out of the surface waters and locking it into sediments below. Scientists reported in the online edition of the *Proceedings of the National Academy of Sciences* their discovery of whole subsets of genes and proteins that govern how one species of diatom builds its shell. For oceanographers, the work might one day help them understand how thousands of different kinds of diatoms—and their ability to remove carbon dioxide from the atmosphere—might be affected by something like global climate change. The new work took advantage of the genomic map of the diatom *Thalassiosira pseudonana* published in 2004 by a team led by University of Washington oceanography Professor Virginia Armbrust, who is a corresponding author of this paper.

"Whole-genome expression profiling of the marine diatom *Thalassiosira pseudonana* identifies genes involved in silicon bioprocesses," Mock et. al. *Proceedings of the National Academy of Sciences*, 2008; 0: 0707946105v1-0.

GULF voices

Awakening the marsh

By Catherine Coletti

The sun glares off the snow, which blankets most of the ground on the salt marsh. I can see my breath in the air.

We squint in search of the Canada geese and ducks that come to spend the winter here. Species such as American black ducks, mallards and American widgeon will forage for seeds, stems, leaves and even snails and small clams on the exposed mud flats of the low salt marsh when the tide is out. Today we spot the silhouettes of crows, adept scavengers in many surroundings, including this one.

My tour guide is Steve Miller from the Great Bay Discovery Center in Greenland, New Hampshire. He said, "There's still some deep holes, so watch your step." I forgot to wear gloves, left my hat in the car and can feel my ears turning red with cold, but I don't mind because I feel like I've stepped into a scenic painting. On the horizon, the water looks blue in the sunshine, but when a cloud passes overhead, it becomes a muted gray.

Above our heads, the dead stems of common reed (*Phragmites australis*)—this particular bunch is a native stand (we can tell because it has lost its leaves)—line the outer edge of the marsh and rustle dryly in the wind, inviting us to enter.

Once we pass the taller growth, the marsh reminds me of a sort of winter Wild West, wide open and the wind now whipping around my hair. The leaves and stems of the smooth cordgrass (*Spartina alterniflora*) and salt hay (*Spartina patens*) are half buried in the snow in ankle-high clusters. Steve and I weave around their dead brown tops.

During winter, most of the perennial plants—the plants that will come back each spring—use energy and nutrients absorbed by their rhizomes, or underground plant stems, to stay alive under the ice. The cordgrass has an additional winter survival strategy: tiny purple-tinged shoots at the base of last year's dead growth connect the roots and rhizomes to the oxygen in the air above. In the spring, the purple shoots do not grow bigger, their job having been completed.

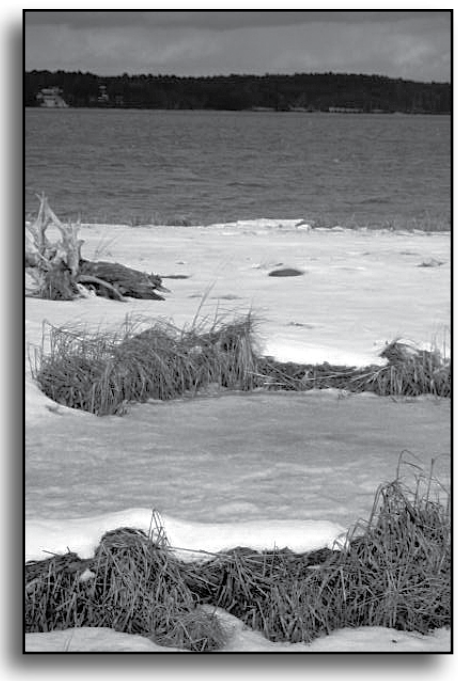


PHOTO: CATHERINE COLETTI

Salt marsh pool (foreground) covered by a thin sheet of ice. Mummichog fish, crabs and shrimp bury themselves in the mud at the bottom of pools like these throughout the winter.

Steve and I come across a pool covered with a thin sheet of ice. Most likely there are mummichog fish, crabs and shrimp buried in the mud at the bottom of the pool, where they will stay until the sun's warmth and light sends them the memo to come out. Snow acts as an insulator, keeping the creatures underneath protected. Burrowed in their winter homes, they are oblivious to the influx of the tides, which bring seawater in and out twice a day. The velocity and depth of the tides fluctuate with the position of the moon in an ancient dance.

During low tides, thin layers of ice form across the marsh and freeze to the plants and peat, or soil filled with organic matter. If freezing temperatures remain in an area sheltered from wave action, the ice deepens, reaching thicknesses of 1 to 2 feet (30-60 centimeters). In an amazing process called ice rafting, the ice chunks get sucked away by the outgoing tide, taking hunks of peat and plants with them. The plants hitchhike to new locales, sometimes deposited in marsh areas to take up residence, and sometimes doomed to sub-tidal habitats where they can't survive. Steve said he has seen ice chunks the size of bathtubs with plants sticking out of them floating out of Little Harbor, when he worked at the Seacoast Science Center along the Atlantic shoreline in New Hampshire.

Ice rafting also happens in rocky areas, where it rips away the fucoid, or brown algae that grows there, including knobbed wrack (*Ascophyllum nodosumm*), which is commonly recognizable as seaweed. However, if deposited in a marsh, the fucoid algae ultimately form free-living plants that appear quite different than their original sources. Plants or animals produced in response to habitat factors such as ice rafting are called ecads. Typically the fucoid ecads grow entangled within the cordgrass and form extensive biomass, particularly during the spring, prior to the extensive growth of the cordgrass. Both the cordgrass and the fucoid algae are important sources of detritus, or dead plant and animal matter, within salt marshes, providing energy to the marsh system.

Avoiding all of that above-ground winter upheaval, the horseshoe crab—whose name is a bit of a misnomer as it is not a crab species but is related to spiders and scorpions—moves to deeper and warmer waters and waits for spring burrowed in the mud, sometimes with only its tail sticking out. Many resident New Hampshire horseshoe crabs overwinter in Great Bay and Little Bay, and will migrate to the shallower waters near the marsh when the water hits about 10 degrees Celsius (50 degrees Fahrenheit).

This spring, increasing light and warmth will tell the marsh to wake up, melting the snow and splattering green across it like a modernist painter. The melting away may reveal a weathered face, as ice, tides and waves have chipped away at its fragile outer edges.

Due to the cold ocean water brought in by the tides, salt marsh plants grow a bit later than inland ones, and most make their spring debut around mid May. Also around that time, the horseshoe crabs will be spawning at the high tide line, their eggs providing food for many bird species, some of which rely on the additional energy to migrate.

This spring, the animals and plants and land and water will continue their inter-relationships into summer, fall, and then return to another winter, where dark and cold will tell them to die back, slow down and once again wait to emerge into life.

Catherine Coletti is assistant editor of the Gulf of Maine Times.

The Presumpscot: A river in recovery

By Matt Craig

For decades, locals turned their backs to the Presumpscot River, the largest freshwater source to Casco Bay in Maine. One of the earliest industrialized rivers in New England, the Presumpscot was notorious for emitting noxious fumes, some might say, strong enough to peel the paint off of those houses unfortunate enough to be built near its shores.

Despite its polluted past, or perhaps because of it, the river also has known many allies, including former Senator George Mitchell (Dem., former Senate Majority Leader), who once declared, "It's not often we're given a second chance with something as fragile as a river. Let's keep working on it. After all, the Presumpscot River has worked hard in the service of mankind for hundreds of years. It's time we returned that favor."

Recently, concerned stakeholders have joined with municipalities, non-governmental organizations, industry, and state and federal agencies to do just that. In 1999, pulp mills ceased discharges to the Presumpscot, dramatically improving water quality. In 2002, the Smelt Hill Dam, the lowest of the nine dams on the river, was removed so the lower seven miles (11 kilometers) of the Presumpscot and 100 miles (160 kilometers) of tributaries now flow freely to Casco Bay, allowing unrestricted access for anadromous (sea-run) fish. In 2005, a project to enhance fish passage at the Highland Lake dam enabled the return of alewives to spawning grounds. In 2007, citizen, industry and agency stakeholders reached a preliminary agreement to restore fish passage at existing dams on the Presumpscot main stem (see the *Gulf of Maine Times*, Fall 2007).

Even the historical pollution has served as an unlikely ally to keep the land undeveloped. That land along the river corridor today presents unique opportunities for land protection adjacent to urban areas.

To address the need for further water quality improvements that promote the return of native fish species, the Casco Bay Estuary Partnership, in collaboration with the Presumpscot River Watershed Coalition, was awarded a $740,000 U.S. Environmental Protection Agency Targeted Watershed grant in 2005.

COURTESY: ANDY COLVIN

Presumpscot River Watch staff Forrest Bell (on shore) and Tim Bennett anchor a data sonde, or instrument package, in the Pleasant River, a tributary to the Presumpscot River.

As part of the Presumpscot Watershed Initiative, farmers have volunteered to steer livestock away from tributaries toward alternate watering systems to prevent fecal contamination. Youth conservation corps have restored riparian buffers and mitigated decades of erosion while fostering stewardship in their communities. Watershed golf courses have agreed to strive for Audubon International Sanctuary certification to improve habitat, reduce water quality impacts and appeal to the green-minded golfer.

Municipalities continue to commit substantial amounts of staff time, equipment and materials to stabilize degraded stream crossings and replace undersized culverts, while promoting yardscaping programs that encourage residents to embrace low-impact lawn care. Students are learning about the history and ecology of the river through place-based experiential lessons. All the while, dedicated volunteers are sampling water quality, complementing thousands of data points and building a baseline of data for the future.

Despite centuries of intensive industrial use and pollution, the citizens of the Presumpscot watershed are showing that it is never too late to turn back to the river. The Presumpscot is now a river in recovery.

Matt Craig is the technical program coordinator with the Casco Bay Estuary Partnership in Portland, Maine.

For more information visit: http://presumpscotcoalition.org

Book Review

Atlantic Coast Beaches

Reviewed by Lee Bumsted

Many of us return year after year to a particular coastal beach. This special stretch of sand or stones could be near our home or our summer vacation spot, or perhaps it is a day-trip destination. If we're lucky, we get to visit it not just in the summer, but in all seasons. For me, that beach is found at Popham Beach State Park in Phippsburg, Maine.

Our favorite beach is different every time we see it. We may wonder why it has a new contour, or notice that its surface has beautiful ripple patterns. It could be covered by interesting wrack or foam of unknown origin. Dunes may have shifted or new salt-tolerant plants taken root. The sand may even sing to us.

In *Atlantic Coast Beaches: A Guide to Ripples, Dunes, and Other Natural Features of the Seashore*, William Neal, Orrin Pilkey and Joseph Kelley write: "We love the beach, the critters it holds and nurtures, and the complex mechanisms that make it work. We're intrigued by the physical processes that one can observe and understand if one learns how to read the beach." In this engaging book, they help us appreciate our own beach and give us tools to be more attentive observers of the forces at work on it.

Neal, Pilkey, and Kelley explain beach influences as large as geologic setting, tides, and storms and as small as the microscopic organisms that live between grains of sand. They describe processes that occur over long periods of time and others whose evidence is erased with the incoming tide. The chance to see short-lived seasonal features, such as frozen wave swash (the water and materials carried onto the shore when a wave breaks) or an ice foot (a narrow strip of ice formed on the shore by the gradual freezing of wave spray) is a good reason to visit the shore in the winter months; Popham Beach and other beaches along the Gulf of Maine are ideal places to find such formations.

The chapter "Can You Read a Beach?" contains some great tips on being a beach detective: how to observe naturally occurring foam, wind structures in sand, sand layers, foot-sucking "bubbly sand," and patterns left by invertebrates and plants. The authors "recommend that you put down your beer, binoculars, fishing pole, or the novel you brought to the beach and make some close-up beach observations." In another chapter they discuss the variety of minerals and shells that make up sand, and how a handful of sand can tell much about the beach's origins.

Because one intention of this book is to take people beyond looking for seashells, shells are described primarily in the context of how they came to be on a given beach. Fossil shells are more common than might be expected. They originate in ancient rock on the sea floor. As an interesting aside, the mechanism that causes 80 to 90 percent of shells to rest on the beach concave side down is revealed.

The authors are able guides to this beach-reading. All three have written books on environmental problems facing East Coast beaches but have teamed up here to focus on natural processes. William Neal is professor emeritus and past chairman of the Department of Geology at Grand Valley State University in Michigan. Orrin Pilkey is professor emeritus in the Nicholas School of the Environment and Earth Science at Duke University in North Carolina. Joseph Kelley is a Maine native who is chairman of the Department of Earth Science at the University of Maine.

While the authors' primary focus is natural processes, they do write that "beaches are indestructible, *except* when humans get involved." They describe the negative consequences of trying to maintain beaches in fixed locations in front of buildings sited too close to the waterfront. Shore-hardening structures such as seawalls cut beaches off from replenishing sand. Beach nourishment programs are also temporary solutions, as factors that led to the original sand loss are still present. For instance, the beach at Camp Ellis, Maine, has been artificially replenished eight times since 1969. Importing beach material has the further ill effect of smothering native invertebrates and plants.

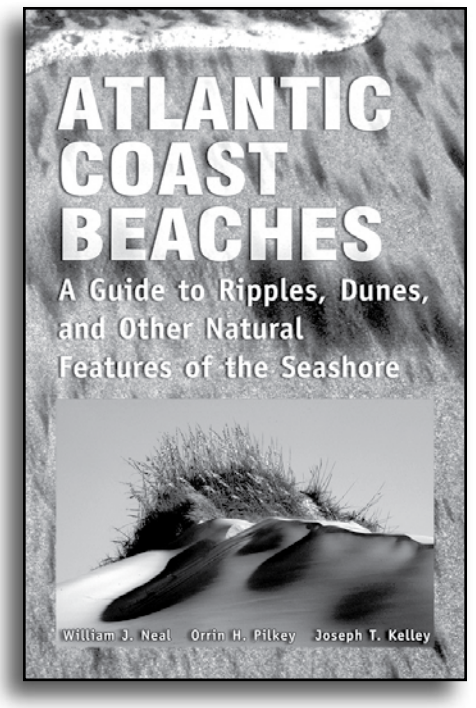
Many photographs and diagrams complement the text and a helpful glossary is included. Canadian readers should note that the beaches used as examples are limited to those found between Maine and Florida.

Oh, about those singing beaches. It's a sound sometimes made when dry sand grains of similar size slide against each other, as when children or playful adults shuffle along. It's just one of the many things readers will know to look and listen for on their next walk along their favorite beach.

Lee Bumsted writes on conservation and outdoor recreation topics from South Portland, Maine.

PHOTO: NEAL, PILKEY, KELLEY

Toadstool-shaped pedestal structures form as the wind removes the surrounding and underlying dry sand from a cohesive biscuit-shaped mass of sand.



Atlantic Coast Beaches: A Guide to Ripples, Dunes, and Other Natural Features of the Seashore

By William J. Neal, Orrin H. Pilkey and Joseph T. Kelley

Mountain Press Publishing Company

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Resources

...for and about the Gulf of Maine

Stream Barrier Removal Monitoring Guide

The *Stream Barrier Removal Monitoring Guide* provides a framework of critical monitoring parameters for use at dam and culvert removal sites in the Gulf of Maine watershed. Eight parameters presented in the guide will allow restoration practitioners to document the physical, chemical and biological effects of stream barrier removal. The parameters are monumented cross sections, longitudinal profile, grain size distribution, photo stations, water quality, riparian plant community structure, macroinvertebrates and fish passage. The guide presents the scientific context for barrier removal and gives detailed methods and data sheets for six parameters. It is based on input from more than 70 scientists, natural resource managers, engineers, consultants and staff from non-governmental organizations in Massachusetts, Maine, New Hampshire, New Brunswick and Nova Scotia. Published in December 2007, the Monitoring Guide was produced by the River Restoration Monitoring Steering Committee of the Gulf of Maine Council on the Marine Environment. View the guide at: http://gulfofmaine.org/streambarrierremoval.

More Resources...

The Gulf of Maine Biodiversity Discovery Corridor is a swath of ocean and underlying seafloor extending from shore to deep sea that is the focus of regional biodiversity investigations. A compilation of historic research in Discovery Corridor waters, prepared to guide future research, is available at: http://www.marinebiodiversity.ca/cmb/Members/lou-van-guelpen/discovery-corridor/index.htm.... The December 2007/January 2008 issue of *MPA News* (Vol. 9, No. 6) includes the **results of a poll on what should be done when Marine Protected Areas do not meet their goals**. Visit: http://depts.washington.edu/mpanews/issues.html...The Food and Agriculture Organization of the United Nations' Fisheries and Aquaculture Department has launched a Web site to **increase knowledge on the contribution of Marine Protected Areas to fisheries management**. See: http://www.fao.org/fishery/mpas... The **first newsletter on** "*GISFish*," the Global Gateway to Geographic Information Systems, Remote Sensing and Mapping for Aquaculture and Inland Fisheries, is available at: http://www.fao.org/fi/gisfish/newsletter/en/november_2007.html... ***The Canadian Aquaculture R&D Review*** includes information on recent and completed research projects related to salmon, trout, charr, oysters, mussels and other species. Visit: http://www.aquacultureassociation.ca.

Herring *continued from Page 1*

animals that feed on them."

Herring have long been important for humans as well. Traditionally, they were harvested from fixed-gear traps called weirs, or caught in purse-seine nets drawn around their schools as they surfaced at night to feed on plankton. In parts of Canada, such as the Bay of Fundy, herring harvest methods are still fairly traditional, said Gary Melvin, a herring scientist at the Canadian Department of Fisheries and Oceans Biological Station in St. Andrews, New Brunswick. In U.S. waters, on the other hand, the face of the herring fishery has changed. In the last decade or so, large boats known as midwater trawlers have become the norm—and the source of much of the current controversy over the fishery.

Midwater trawlers tow vast nets to round up herring, often working in pairs with one net stretched between them. "The nets can be as long and as wide as a football field, and six to eight stories tall," Baker said. "You've seen this shift in how herring are harvested. That's what concerns a lot of us."

Fast Facts: Lobster Snacks

Once upon a time, most of the herring netted in the Gulf of Maine ended up in sardine tins. Today, only one cannery remains in New England. Some 60 to 80 percent of herring landings return to the sea as lobster bait.

The fish are so popular as bait, in fact, that Gulf of Maine Research Institute scientists are now investigating whether all that herring bait has fueled the growth of the lobster population in the Gulf of Maine.

The question for the NEFMC is whether that concern should translate into new management measures. Because Gulf of Maine herring move between Canadian and U.S. waters, the countries assess the stock jointly. The last Transboundary Resource Assessment Committee report in 2006 found the Gulf of Maine stock was healthy. "The fishery is in pretty good shape," said Lori Steele, the Herring Fishery Management Plan Coordinator at the NEFMC. "The resource is not overfished and overfishing is not occurring."

COURTESY: CHOIR COALITION

A pod of pilot whales next to a long herring net being towed by a midwater trawler.

While herring remain abundant overall, they may be hard-hit in the inshore areas popular with trawlers. "When the trawl fleet moves in en masse, they can take so much herring so fast that the predators leave. As the midwater trawl fleet has exploded, tuna landings have plummeted," said Baker. "It's a recipe for disaster."

Bycatch is another concern. By the time trawlers haul in the nets, everything in them is typically dead. Bycatch stand little chance of being thrown back alive. "There are questions about what the fleet may be catching in terms of bycatch," Steele noted. "The concern voiced to the council is about the need for better monitoring and accounting of catch and bycatch."

Herring fishermen argue that they're abiding by management rules, and that no evidence of a bycatch problem exists. Herring swim high in the water column, they point out, and the trawl nets don't come anywhere near the seafloor, where groundfish such as cod and haddock spend most of their time.

Furthermore, they said, the NEFMC just implemented new regulations in the summer of 2007. Under the new amendments, only fixed-gear and purse-seine fishermen can harvest herring in the inshore area between June and September. Mary Beth Tooley, a spokesperson for the Small Pelagics Group, which represents fishing vessel owners, said it's too soon to know if the new amendment will have a positive effect—and it's unfair to saddle fishermen with additional regulations in the meantime. "They have no new information from the last go-around," she said.

The Herring Alliance is calling for the NEFMC to create a monitoring system that ups the number of observers on herring boats. But that's easier said than done. In 2005, observers were present on about 20 percent of herring fishing trips, Steele said. The last two years, that number has been much lower. Observers are funded by the National Marine Fisheries Service, she said, and NMFS has to prioritize the budget it's handed by Congress.

For the record, stressed Tooley, "we're not against increasing observer coverage." Rather, she said, the industry resists the idea put forward by some environmentalists that boat owners should pay upwards of $1,000 a day to fund observers themselves. "We don't think it's fair to single us out among all the fisheries and say you have to have your own observers," she said.

> ***'When the trawl fleet moves in en masse, they can take so much herring so fast that the predators leave.'***

Now that the NEFMC has voted to add herring to its 2008 priority list, there's nothing for either side to do except wait. It could be two years or more before any amendments are finalized and added to the management plan, Steele said. The council will take a hard look at the fishery, she said, and explore different programs for monitoring just what goes into the nets. "We need more information to better identify what specific problems there may be," Steele said, adding that questions about bycatch and inshore depletion, "certainly are valid concerns. And I think the council has responded to that."

Kirsten Weir is a free-lance writer in Saco, Maine, who focuses on science, health and the environment.

Genetics sorts local from alien seaweed

By Rebecca Zeiber

Beach combing on a frigid, blustery New England winter day might not be a very popular activity, but for researchers at the University of New Hampshire, or UNH, it's helping to solve a scientific puzzle in the seaweed world. The mystery involves a "who's who" in which two plant types may look the same but are vastly different. One type is native, while the other came from Japan, perhaps carried by shellfish or the hulls of ships or spread by growers of the seaweed in certain areas off the Northeast U.S. coast.

The first piece of the puzzle involves collecting samples. Jeremy Nettleton, a master's candidate in plant biology at the university, searches for red seaweed (genus *Porphyra*) along the intertidal zone. From December through May, Nettleton travels to sites along the New England coast to collect long blades of *Porphyra*. Conducting field research during the winter is a necessity, since that is when it is easiest to find the blades.

Back at the lab, Shelly Dare, also a master's candidate in plant biology, searches through seaweed specimens from regional herbariums to determine if previously collected samples were misidentified and to find out how long each species has been growing in a particular region. These two students, along with their advisors Art Mathieson and Chris Neefus, both UNH professors of plant biology, often work side by side in the field and the lab. They are investigating *Porphyra* in New England as part of a New Hampshire Sea Grant-funded project.

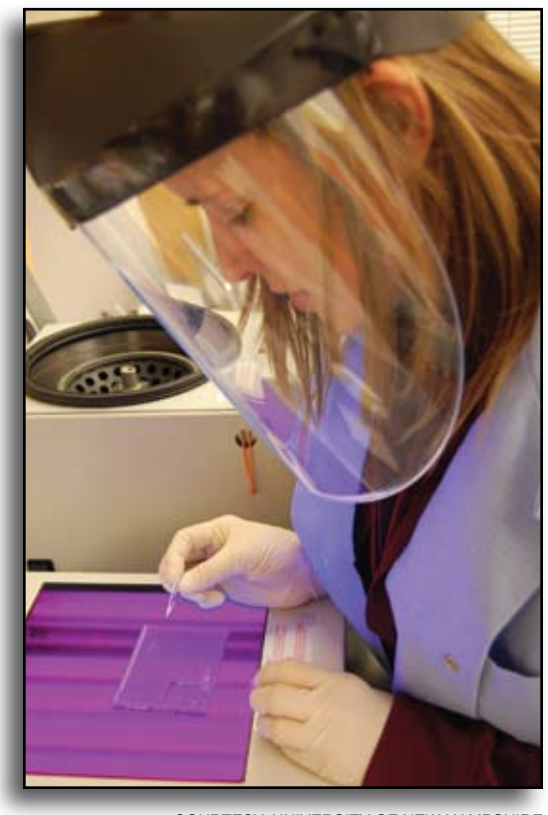
The puzzle involves sorting out red seaweed species. Researchers, resource managers and others are concerned over whether or not many of the *Porphyra* species found in New England are originally from the region or if they are instead a Japanese cultivar, a plant variety propagated for specific traits. This concern stems from the potential of non-native species to use the habitat and resources necessary for the survival of native plants.

Porphyra is commonly known by the Japanese name "nori" and is the seaweed used to make sushi, Neefus explained. It is grown on nets in Asia to supply the $1.2 billion per year nori industry, he said, but has escaped and become widely established in natural habitats.

"This cultivar is selected to grow more quickly and have larger blades, and it is more likely to outcompete native species if environmental conditions are favorable," Nettleton added. Therefore, it is important to determine their current and historical distribution in New England. This requires comparing both new samples and specimens collected years ago from the same region. Many of the old samples were misidentified, so seaweed thought to be native might actually have been the Japanese cultivar.

"I can't tell the difference between the native species and the Japanese cultivar by sight," Dare laughed, and she works with them every day. The morphological traits are too similar, she said, and thus genetic analyses are necessary to separate the two.

"My samples are pretty fresh, so it's easy to conduct molecular analyses on them," said Nettleton. However, the older herbarium samples that Dare works with are not always in as good a condition. This makes the task of sorting out native versus cultivar more difficult.



COURTESY: UNIVERSITY OF NEW HAMPSHIRE

Student Shelly Dare looks for genetic clues to identify non-native seaweed.

DNA sequencing of the species requires being able to compare present-day samples collected throughout the coastal regions of New England with species collected from the region in the past. This enables researchers to determine if new species have begun colonizing the region or if samples from the past were simply misidentified. It is possible that a species considered to be a newcomer to the area has actually been here for quite a long time, Mathieson said.

This research requires going back to historical collections of seaweeds held in herbariums where samples are kept from 200 years ago in some cases, rehydrating the samples, and then doing genetic analyses on a small piece of the old seaweed.

Once analyses are conducted on both the old and new samples, the genetics can be compared to see if a Japanese cultivar has been introduced recently and is spreading or if it was here hundreds of years ago without scientists knowing it. However, it can be extremely difficult to determine how a species came to be in a particular region. The Japanese cultivar tends to have narrower blades. The genetic analysis indicates there may be different chromosome counts for different *Porphyra* species, but more research is needed.

The goal is to determine the potential impacts the Japanese cultivar might have on native species. Once this puzzle is more complete, the information will be used to improve management along the coast of New England.

"We want to inform coastal managers about the threat that the Japanese cultivar may or may not pose to native plant species, and then help managers decide what actions they should or should not take as a result," Nettleton added.

Rebecca Zeiber writes for New Hampshire Sea Grant in Durham, New Hampshire.

Research Update

Undersea vehicles look deep to watch offshore aquaculture pens

By Rebecca Milne and Gerhard Pohle

As fish farms move farther offshore and into deeper waters, monitoring the environment around them poses bigger challenges. A multi-partner project led by the Huntsman Marine Science Centre (HMSC), St. Andrews, New Brunswick, is evaluating the use of remotely operated vehicles, or ROVs, for aquaculture in general and sediment analysis in particular. While the HMSC sees a number of potential uses for ROVs in research and education, this particular project focuses on environmental monitoring of aquaculture.

Aquaculture today involves the farming of diverse organisms including fish, molluscs, crustaceans and aquatic plants. It is the fastest growing food production sector in the world. Consumers, regulators and public interest groups concerned about the environmental impacts of fish culture operations are increasingly challenging fish farmers. As a result, regulatory agencies have developed monitoring programs to address the environmental concerns raised by the discharge of organic waste into the surrounding water body.

Effective and efficiently delivered environmental monitoring programs can help aquaculture grow in a socio-economically and environmentally sustainable manner. Monitoring the effect a fish farm has on its surroundings allows for regulation and modification of operations to keep impacts to an acceptable and manageable level. This is done by studying the ocean floor under and surrounding the cage, or net pen, to see how much waste is accumulating. Monitoring typically involves visual inspection and evaluating how much organic loading from fish feces and uneaten food has disturbed the natural ecology.

In most jurisdictions, field data currently are collected with sediment samples for geochemical or biological analysis, combined with a video survey of the sea floor. Currently, commercial divers collect this information. However, as the trend in aquaculture towards deeper sites offshore continues, it is becoming more difficult and dangerous to use divers. Recent innovations in aquaculture methods, the lack of suitable aquaculture sites near-shore and the requirements of species new to aquaculture all are contributing to the growing trend towards offshore aquaculture.

Because there are limitations in using divers for environmental monitoring, there is a need for reliable and consistent data collection at the deeper sites. HMSC's new division, the International Aquaculture Innovation Centre (IAIC), is a pre-commercial testing facility addressing the issue. IAIC investigates issues challenging sustainability and productivity of the aquaculture sector.

Gerhard Pohle, senior research scientist at HMSC, started the ROV project after hearing about a conversation between William Robertson, HMSC's new executive director, and Larry Ingalls, president of Ocean Horizons Ltd., a salmon-farming company. "Bill's experience in aquaculture operations and Larry's desire to adapt monitoring to the industry moving offshore led us to investigate ROVs as a possible alternative to scuba divers for work at deeper sites," said Pohle. ROVs are unmanned submersibles; they are not constrained by the depth limitations of divers, and they may be a safer and more efficient method of collecting data at deeper sites.

ROVs are seeing increasing applications ranging from oil platform and pipeline maintenance to underwater tree log recovery and deep-sea exploration. This project is pioneering ROV use in environmental monitoring for the aquaculture industry.

Realizing the large scope and cross-jurisdictional application of this project, institutions from both sides of the U.S.-Canada border cooperated and contributed in the undertaking. With the help of the New Brunswick Environmental Trust Fund, the Gulf of Maine Council on the Marine Environment, the Canadian Industrial Research Assistance Program of the National Research Council, Business New Brunswick and Ocean Horizons, the HMSC was able to purchase and deploy a Stealth 2 ROV from Shark Marine Technologies Inc., St. Catharines, Ontario. Fisheries and Oceans Canada also contributed training in geochemical sample analysis and advice on the design and specifications of the sediment sampler.

"While ROVs have been around for some time," Pohle noted, "it has only been in recent years that costs have become reasonable for smaller organizations such as ours. As in the computer industry, with costs coming down, capabilities of ROVs have actually gone up." Other than cost, size and weight are particularly important factors, he said, because transportability and ease of handling on board vessels are essential. This particular machine is relatively small, and with a weight of about 45 kilograms (100 pounds), does not require any special gear to get onto a boat or in and out of the water. "Basically, we can pack everything into a 1.2-by-0.9-meter (4-by-3-foot) container and head off to wherever we are needed," he said.

PHOTO: GERHARD POHLE

Pilot Rebecca Milne makes adjustments to the undersea vehicle.

COURTESY: HUNTSMAN MARINE

The diversity of organisms in the Gulf of Maine shown by underwater video survey for the Ocean Energy project in 2007.

The ROV is rated to a depth of 305 metres (1,000 feet), and so is capable of monitoring deep water sites where monitoring would have been impractical or incomplete in the past.

The ROV is operated with a computer topside that is connected to the vehicle by a 305-metre (1,000-foot) umbilical cable. The ROV pilot commands the ROV via a computer using a wireless controller device. For navigation, the pilot uses a live video feed, scanning sonar that works like radar to detect obstacles, and a tracking system that displays the ROV's precise position relative to the deployment vessel.

In addition to a standard grappling arm, the ROV is equipped with two video cameras, one color and the other a low-light, black-and-white camera, useful in deep water or when using the two floodlights is not helpful. "This is the case when light reflects back from suspended matter close by or when the lights attract so many organisms that they interfere with visibility," Pohle noted.

Cameras are principally used for navigation of the ROV and to run video for environmental monitoring. They are crucial for using the unique sediment sampler. Development of the sampler was key to the success of this project, as obtaining undisturbed sediment samples is necessary for proper analysis. "We needed to obtain at least the top two centimetres (0.8 inch) of sediment in an 'as-is' state to correctly determine surface conditions," Pohle said. It is important that the sediment sample is undisturbed because the required geochemical information is in the top 2.54 centimetres (1 inch) of the sediment.

In order to accomplish this with an ROV, the HMSC commissioned a sampling apparatus developed specifically for this purpose. The sediment sampler uses a pneumatic piston powered by a small air tank to push in and retract a triplicate set of sampling tubes from the sediment. Custom-made, one-way valves prevent the loss of material when the sample is retracted. A rotating carousel then moves the tubes out of the way and brings another set of triplicate tubes into deployment position to take the next set of samples. Watching this on screen, the operator can make adjustments in positioning the tubes. In this way, three triplicate samples can be taken per dive. Obtaining triplicate samples increases statistical confidence in the results and gives an indication of variability.

The usefulness of ROV technology in aquaculture monitoring can be seen in favourable costs and clear safety benefits, particularly at deep water sites. Other advantages to the fish farmer include real-time video feedback at the surface so that farm management can instantly adjust operations, such as changing feeding schedules. The ROV also can be more frequently deployed, allowing more feedback to the operator and the ability to mitigate environmental impacts as they occur.

The ROV presently is undergoing a factory refit to enhance it with a laser scaling system for determining the size of objects during visual surveying. Improvements are being made to the positioning system, and on-screen readouts of water temperature will be available. A clamshell sampler that can take larger volumes of material, such as for faunal analysis, also is being field-tested.

ROVs have the potential to make environmental monitoring safer, simpler and more efficient.

The HMSC hopes this new technology will be adopted by the aquaculture industry, particularly at offshore sites, to promote sustainability. It could provide uniform and efficient environmental monitoring of sites as well as broaden the information made available to farmers. The ROV has the potential to make environmental monitoring safer, simpler and more efficient. Beyond aquaculture, HMSC Director Robertson sees potential for a variety of uses of the ROV that include enhancing education and research programs "that we are only beginning to explore."

For example, since the fish farm project, the ROV has been used on a number of missions related to ocean energy extraction in the Bay of Fundy. A renewable resource that can meet the social standards of sustainability, tidal in-stream energy development is currently a major area of activity in both Canada and the United States. With its high ocean tidal cycles, the Bay of Fundy is of particular interest. The HMSC ROV has been used over the last six months to characterize physical and biological attributes of potential sites using videography. This included a number of successful fly-through dives at depths exceeding 100 metres (328 feet), at sites in Head Harbour Passage and Western Passage near the Canada/U.S. border that experience current speeds of up to 6 knots.

The ROV collected important evidence on substrate suitability and biological diversity that will help in the overall assessment in terms of impact and resource potential.

Rebecca Milne works at Huntsman Marine Science Centre in St. Andrews, New Brunswick, as an ROV and lab technician. Gerhard Pohle is senior research scientist at the Centre. *The aquaculture research in this story was funded by a grant from the Gulf of Maine Council on the Marine Environment, which also sponsors The Gulf of Maine Times.*