

Gulf Stream newsletter



FALL 2005

A publication of **GOMMEA**

PRESIDENT'S MESSAGE:



Invaders? Do we have alien species from distant planets arriving to our shores and taking over our Gulf? Who are these creatures? Why do they like our Gulf? How will we defend ourselves and our native creatures? In this edition of Gulf Stream we will explore this world of Invasive Species.

Actually, an invasive species is native to its home waters. It is just when it gets into the Gulf of Maine, or other non native waters, that it can become a dreaded nuisance. Usually, this is because it is so successful that it is replacing species that are native to the Gulf of Maine. As we become more and more globally interconnected, species are being transferred from one environment to another with much greater frequency. This creates both habitat health impacts and, in some instances, economic impacts for our coastal resources. An impact such as an invasive species often needs creative approaches for management. I hope you enjoy

our exploration of this current topic.

I hope that you were able to join us for our annual meeting on Thursday, November 10th, where we explored the "Stars of the Sea" in the beautiful Gulf of Maine Research Institute. Those who attended received a one year membership to GOMMEA and a pewter seastar lapel pin. There was a very exciting presentation by Bill Curtsinger, National Geographic photographer, on the Art of Extreme Science. In addition, we learned about current echinoderm research in the GOM and met the winning class from Winnacunnet High School who won the contest to name the newest naval research vessel.

In July 2007 GOMMEA will be hosting the National Marine Educators Annual Conference in Portland Maine. We are working on this very exciting opportunity and would love to get more of our members and friends involved. Find more information on this opportunity in this newsletter. If you would like to become part of the planning team please contact Justine Glynn at Justine@gmri.org.

Theresa Torrent-Ellis

Issue Focus:

Invasive Species



Announcements: *Katrina Destroys National Headquarters*

As many of you are probably aware, the national headquarters for NMEA was destroyed in Hurricane Katrina's aftermath. They've put together a list of things they could use in a wish list: <http://www.usm.edu/aquarium/help.php>.
<http://www.usm.edu/aquarium>

The 2005 conference netted 287 new and renewing members. If you're a member of GOMMEA but not NMEA, this is a perfect time to join! Next year's conference will be in New York City, and the conference in 2007 will be in Portland, Maine!

NMEA will once again run a Sharathon at the NSTA conference in April, to be held in Anaheim, California. Learn more about this and more local conferences at: <http://www.nsta.org/conventions>.



A regular column from Mr. Fish

(AKA Jeff Sandler)

Ever try to catch a cat that doesn't want to be caught? That is an evasive species. What? This article is about invasive species? Oops. Let's start again.

What is green, has zebra-like striped legs and doesn't belong in a Maine tide-pool? No, it is not my brother-in-law. It is an Asian Shore Crab. Ok, it does have one thing in common with my brother-in-law. They are both invasive species.

An invasive species is an intruder. It is an organism that doesn't belong to the habitat in which it presently resides. It usually moves in by displacing a previous resident. Often the displaced is a native to that habitat.

Usually the invader is a pest, a big step down from the displaced native.

Here in South Portland, our ocean day camp students, better known as "Fish Campers," discovered the first Asian Shore Crab ever found in Maine.

It happened one summer morning in 2001. Deb Sandler, known as "Mrs. Fish," read an article in the Portland Press Herald newspaper which explained that an invader, an Asian based crab named the Asian Shore Crab (*Hemigrapsus sanguineus*), was expected to infiltrate Maine waters soon. Its home habitat was the western shores of the North Pacific Ocean, but its larvae had likely been taken aboard oil tankers in the sea water used as ballast. When the oil tankers arrived on the East coast of the USA they discharged the extra water and if the conditions were right, the crab larvae survived.

In 1988, the first Asian Shore crabs were discovered off of Cape May, N.J. Since that time they have been moving towards Maine in the north and the Chesapeake Bay in the south.

Mrs. Fish shared the article that late June morning with the Fish Campers. She pointed out that the Asian Shore Crab was about the size of a half dollar coin, mottled greenish in color (although it could also be purple or orange-brown), had three spines on each side of the carapace, and had distinct zebra-like striped legs.

Although it was smaller than the presently dominant tide-pool crab, the Green Crab (*Carcinus maenas*), the Asian Shore Crab was much more aggressive and had a bigger appetite than the Green Crab. That meant it would likely take over from the Green Crab as they are both in competi-

tion for the same habitat and food. Both crabs love to eat seaweed, barnacles, mussels, scallops, snails, and soft shell clams.

Mrs. Fish pointed out to the campers that there would likely not be a lot of sadness over losing the dominant Green Crab. The Green Crab is also an invasive species, having originated in Europe. Years ago, it invaded our coastline and out competed the native Rock Crab (*Cancer irroratus*). This was unfortunate, as we humans considered the Rock Crab good eating, while the Green Crab is not good eating. Also, the voracious Green Crab eats soft-shell clams. People also love to eat soft-shell clams. The Green Crab was an unwanted pest.

Now the Green Crab had better watch out, the newspaper said. The Asian Shore Crab was coming to Maine!

The campers listened carefully to Mrs. Fish and then went out exploring in the tide-pools.

It wasn't long before a Fish Camper excitedly brought to Mrs. Fish the first Asian Shore crab found in Maine. Soon, two more were discovered by other Fish Campers. They were here. The Fish Campers were excited to have found them but bummed they were here.

That was in 2001. Since then the Green Crab has seemingly held its ground. The Asian Shore Crab has not had the immediate impact that was expected. Scientists are presently studying the situation to find out why.

Probably the biggest fear scientists had was that the Asian Shore crab might eat the young lobsters. Lobsters are Maine's most valued seafood resource. Fortunately that has not been a problem either.



To learn what scientists think as well as to learn more about this invader, here are some interesting web-sites to crab on to:

www.sgnis.org/kids

www.biology.mcgill.ca/faculty/leung/invasivetracers/

www.invasivetracers.com

University of New Hampshire
COOA Coastal Ocean Observation and Analysis
CoMPoSe Cruise Report October 24, 2003

At Sea – Part Four of Six

By Amy Holt-Cline



The CTD Package

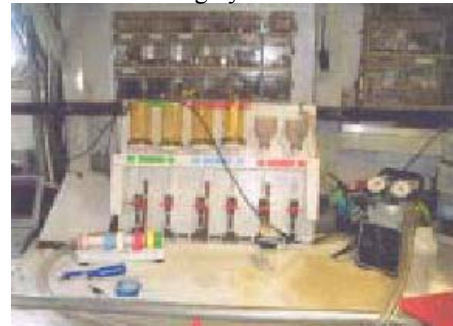


At each station, the cage is lowered to a depth ranging from 18 to 50 meters depending on the areas bathymetry. At every half meter, the various sensors on “the CTD package” data are logged. The data

later is downloaded and processed. Water is collected at the surface using a bucket and at a designated depth using a Niskin bottle. Palavi and Tim bring in the Niskin Bottle, which will then be transferred to a gallon jug simply because it’s easier to pour.

Both of the water jugs will then be handed off to the person downstairs stationed at the filter machine.

Filtering System



While the water is being filtered, a plankton net is deployed off the side of the ship.

Here you can see Tim Moore, Doctoral student and CoMPOSE technician, carefully fishing for plankton by keeping the plankton net open so enough water is passed through the net hoping to collect a decent sample. Behind Tim, GoMOOS Buoy B can be seen. This is about half way through the day 8 stations.



Gulfstream Editor’s Note:

In the next three issues of Gulfstream, we will be publishing the final parts of the serial article titled “At Sea,” in which Amy Cline describes a research cruise on the Gulf of Maine. This virtual cruise can also be found at the COOA website page: <http://www.cooa.unh.edu/pdf/At%20Sea.pdf>.

Citizen Science as a Solution to Invasive Species?

by David G. Delaney and Anna Solecki

Invasive species can be found in every type of habitat around the world. It is an important global problem; species are being transported to new areas every day at an alarmingly increasing rate. Scientists who are dealing with this environmental problem are not provided with adequate resources to effectively monitor and manage invasive species. Because of this challenge, they have been forced to resort to creative solutions to attempt to manage invasive species. Volunteer based monitoring has been highlighted as a potential solution to the ever-decreasing funding availability, since it maximizes the effectiveness of vital monitoring for scientists and at the same time creates a learning experience for interested people who have always wanted to be marine biologists. This article provides a brief background on the issue of invasive species, as well as an overview of one monitoring network: 'Citizen Science Initiative: Marine Invasive Species Monitoring Organization' (CSI MISMO).

Invasion biology

Invasion biology combines elements from multiple fields of study (e.g. community ecology, population biology, biogeography, evolution, genetics, conservation biology) to look at the causes and consequences of biological invasions and to examine factors that influence the establishment, spread, and impact of invasive species. But what exactly is an invasive species?

An invasive species is a species that has spread beyond its natural historical range and has established a self-sustaining (reproducing) population that expands rapidly and can cause damage. Ordinarily, a species stays in one general area because of barrier(s). The barrier can take on many forms such as geographical (e.g. a mountain or deep ocean), physiological (e.g. temperature) or biotic (competitive exclusion). Dispersal can occur when that obstacle is overcome. This can happen with or without the help of humans and therefore it can be a natural or unnatural (anthropogenic) process. Human influence is usually greater. Although it is possible for a bird to spread an exotic seed to a new region while it is migrating, this is usually facilitated by the intentional or unintentional introduc-

tions by humans and their activities (e.g. gardening, shipping, pets released in the wild).

Invasive species represent a great threat to our ecosystems because of the economic and ecological damage they can cause. Economic damage is defined as injury or harm that can be assessed in monetary terms, for example, an invasive species (invader) eating a commercially viable crop (e.g. wheat, clams). This type of damage is especially devastating to the people whose livelihoods are affected by these invaders. Ecological damage, on the other hand, is defined as injury or harm to the environment that has a less tangible economic cost. There are many types of ecological damage such as extinction, extirpation (small scale extinction), and has been noted as one of the leading causes of loss of biodiversity, second only to habitat destruction. Although these events do not have a known market value, it does not mean their impact is unimportant; quite the opposite even, since some ecological damage, such as extinction, is irreversible.

The European green crab (*Carcinus maenas*) is a perfect example of an invasive species causing both ecological and economical damage. This crab has been implicated in the decline and collapse of commercially viable shellfish in the state of Maine during the mid 1900s, and has been responsible for displacing native crabs and dominating the rocky intertidal zone of the Gulf of Maine. Once an invasion occurs and the invader has become well established, eradication and control of the invader becomes hard or impossible, thus prevention is critical. Studying species such as the European green crab, one of the most successful marine invaders, will hopefully allow scientists to understand the important biological characteristics of a "good" marine invader. This approach could help in identifying strategies that will potentially allow us to recognize future marine invaders as well as pinpointing the marine environments which are prone to future invasions. This would lead to better-informed policies and would allow us to prioritize monetary resources for the monumental problem of marine invasive species.

Citizen Science as a Solution to Invasive Species?

The European green crab is a successful marine invasive species because it is a generalist and an omnivore. This organism illustrates important characteristics that can enable an invader to be carried to new locations and to thrive in new habitats. Firstly, its planktonic larval stage allows it to be transported by the vector of a ship's ballast water. Secondly, it is an omnivorous crab, so food is usually not a limitation. Lastly, being a generalist, the European green crab is able to endure a wide range of environmental conditions, such as it has an ability to control its body's salt levels. It can also withstand wide temperature ranges, allowing this crab to inhabit a diverse range of marine ecosystems and various locations. This explains why the species has obtained its extensive global invasive range; it has moved from its native range of the Atlantic coast of Europe to an extensive introduced range that includes both coasts of North America, South Africa, and Australia. Another invasive crustacean is now following the path of the European green crab. This invasive species is known as the Asian shore crab (*Hemigrapsus sanguineus*). It was first detected by a student in New Jersey, in 1988. Since then it has spread north as far as the coast of Schoodic Peninsula, Maine. The current northern range was found by Zach Itzkowitz and Corinne Sperling, "CSI detectives" of the CSI MISMO, on July 20th, 2005.

Citizen science

The US Government has found that early detection increases chances of eradication of invasive species. Monitoring is therefore crucial for early detection of invaders in new locations as well as determining the best strategy for finding and removing the largest number of invasive individuals in the most relevant areas. To be useful, monitoring approaches need to be implemented for real world conditions, given real logistical limitations such as insufficient funding to monitor extensively. Because of these limitations, the contributions of citizens are truly beneficial to scientists. They can compile a wealth of information, for example, about population structures, distributions, behaviors and mechanisms for conservation of various organ-

isms when scientists don't have enough time or resources to do so.

In the past, citizen science initiatives have been shown to be quite useful. Terrestrial and aquatic resource managers have taken advantage of volunteer networks for ornithology, stream and water quality monitoring. Audubon and the well-known Christmas Bird Counts have been ongoing for over 100 years and demonstrate the feasibility of citizen science initiatives and applicability of it within large-scale monitoring. Other such enterprises include weed monitoring in the Appalachians, organized by the Nature Conservancy, as well as the Washington Department of Fish and Wildlife's effort to monitor marine systems with the help of volunteers. Also the creation and proliferation of "bio-blitzes", where regular people gather species or samples to be identified by scientists, are gaining in popularity and show the interests and importance of citizen science activities. These events are advantageous for both the scientists who have at their disposal more personnel, allowing them to collect more samples than they could by themselves and for the public who benefits from a hands-on learning experience. Bio-blitzes have been successfully executed by many people such as the National Park Services that surveyed the beetle diversity of Acadia and monitored invasive crabs in the Boston Harbor Islands.

Our new citizen science monitoring network, CSI MISMO (www.InvasiveTracers.com), has already conducted systematic surveys May through August 2005 at 61 locations from Sandy Hook, New Jersey to Machias, Maine. A total of 52 rocky intertidal locations were sampled by the Delaney-led research team, and, additionally, nine sites were sampled by collaborators from Salem Sound Coast Watch. Each sampling location was positioned using GPS. Approximately 1,000 volunteers assisted the research team in collecting and identifying crabs in the intertidal zone. The volunteers, spanning all ages, backgrounds and seven northeastern coastal states worked in conjunction with our research team. Sampling groups came from the Darling Marine Center, the Cornell Exten-

Citizen Science as a Solution to Invasive Species?

sion program of Suffolk County, the New England Aquarium, the New York Biology Teachers Association, the Acadian Institute of Oceanography, the National Park Service staff, various NGOs, K-12 classes and communities (from those seven states).

With these supervisory structures in place, hopefully, there will be momentum for this monitoring to continue and expand via new interested individuals and organizations. The citizen science initiatives developed for invasive crabs could be extended to other marine invaders, such as echinoderms, tunicates, bryozoans. Crabs are easier to identify than most other marine species. However, given the success of our monitoring program, it is reasonable to assume that citizens would be capable to recognize more challenging species such as tunicates and bryozoans. Furthermore, there are tools already in place to raise awareness, increase efforts, and ensure proper training of potential citizen scientists. If interested, please see the links below and help with this important problem by becoming a citizen scientist. It only takes two days at the beach each year; I hope to see you there!

Deer Isle, MA



If the crabs can do it, so can we!



LINKS:

To join CSI MISMO:

<http://massbay.mit.edu/exoticspecies/crabs/http://www.InvasiveTracers.com>

Salem Sound Coastwatch <http://www.salemsound.org/chimp.htm>

MIT Sea Grant Center for Coastal Resources

<http://massbay.mit.edu/exoticspecies/index.html>

Washington Department of Fish and Wildlife

<http://www.wdfw.wa.gov/fish/ans/greencrab.htm>

The Nature Conservancy Volunteer Opportunities:

For kids: Sea Grant Super Sleuth - Nab the Aquatic Invader! <http://www.sgnis.org/kids>

Students Kick Off Interactive Marine Science Learning Program at the Gulf of Maine Research Institute

By Ben Slayton, GMRI

Portland, Maine —On October 18, the Gulf of Maine Research Institute (GMRI) hosted twenty-four 5th grade students from Dora L. Small Elementary School in South Portland, Maine to launch a unique marine science education program, delivered through an interactive learning platform within GMRI's new facility in Portland, ME. GMRI is a marine research and education institution that develops knowledge and public understanding of the Gulf of Maine ecosystem.



The Sam L. Cohen Center for Interactive Learning is a multi-media, digital learning platform. Through this platform, the students became engaged in a self-directed, inquiry-based learning program that is designed to connect Maine students with locally relevant marine science. During their 2 ½ hour learning experience, students assembled into teams of three and used computing and communications technologies to guide their way through the principles of the scientific method as they explored and solved The Mystery of the X-Fish.

“GMRI has always been committed to finding unique and engaging ways to break down the barriers that often surround scientific understanding,” said Alan Lishness, Chief Innovation Officer at GMRI. “Our staff, including educators and scientists, is dedicated to developing learning activities that encourage students to use the scientific inquiry process to answer real scientific questions. And the Cohen Center was specifically designed to deliver these activities in an interactive way. Today was the culmination of years of prototyping, testing, iterating...and a lot of hard work.”



Doug Caldwell, 5th grade teacher at Small Elementary School, was on hand to observe his students as they followed the principles of the scientific method to unravel The Mystery of the X-Fish. “Over the past three years, my students and I have played a role in helping develop a unique education facility for Maine students to discover and interact with marine science,” said Mr. Caldwell. “The Cohen Center will become a valuable educational tool for science teachers throughout the state. There is no better way to stimulate learning than to give children the power to investigate and draw conclusions on their own.”

Now that the first class has been through the Cohen Center for the interactive marine science experience, GMRI will gradually increase the number of classroom sessions through the end of the year. Commencing in January 2006, GMRI plans to provide every community in Maine with the opportunity to send either its fifth or sixth grade classroom to the Cohen Center, free of charge, to conduct a personalized exploration of locally relevant marine science.



Mystery of the X-Fish Program Summary

Immerse your students in the world of marine science with the *Mystery of the X-Fish*.



At the Gulf of Maine Research Institute in Portland, Maine, your 5th or 6th grade students will conduct marine research as they explore and discover the importance of the X-Fish in the Gulf of Maine.

Students will work in teams at 4 multimedia, digital kiosks to carry out hands-on scientific investigations:

- *What Does the X-Fish Eat?* - identifying what the X-Fish eats through a stomach content microscope activity.
- *Where Are the X-Fish?* - going to sea on a virtual research cruise and fishing trip to discover how and where the X-Fish is found.
- *What Does the X-Fish Do?* - hypothesizing about how the X-Fish behaves by observing fish swimming in a live schooling tank.
- *What Is the X-Fish?* - discovering the true identity of the X-Fish.

All students will leave the program with their own personal websites that allow them to view the photo and video evidence that they recorded during their visit. Educators can also supplement the *Mystery of the X-Fish* program with engaging pre- and post-visit lesson plans and activities from our website. All activities at the Lab and on the website are aligned with the Maine Learning Results and the National Science Education Standards.

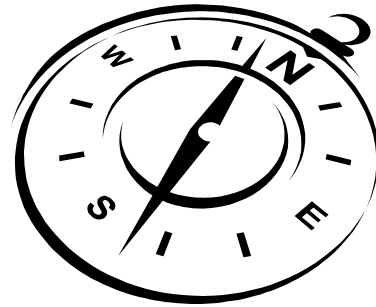
The Gulf of Maine Research Institute is committed to bringing in every 5th or 6th grade class in Maine; the program is **free of charge**.

Please contact scheduler@mystery.gmri.org or call (207) 772-2321 ext. 1647 for more information or to schedule a visit with your class.

Come discover the *Mystery of the X-Fish*!

Navigate the Web Invasive Species

by Justine Glynn



There was a surprising wealth of material available online in this timely and important topic.

If you read only one article online, make it this one from the Census of Marine Life Gulf of Maine Area Program: <http://www.usm.maine.edu/gulfofmaine-census/Docs/About/Organisms/Invasive.htm> (If you don't want to type in that whole URL, go to google.com and type in "census of marine life" maine "invasive species." The article will be your first result!

For a superbly comprehensive list of resources and experts, as well as good key questions and facts, visit: <http://www.fundyforum.com/tdarchive/td10.html> This is from an online forum that is no longer active, but could give you some ideas for starting a classroom forum on the subject of 'bio-invasiders.'

Here's a state-by-state listing of nuisance species from the Northeast Aquatic Nuisance Species Panel: <http://www.northeastans.org/rr/priorityspecieslists.htm>. This thorough site includes links to details on each species, with photographs and drawings galore!

Finally, another comprehensive site is from the National Biological Information Infrastructure: <http://invasivespecies.nbi.gov/>

Click on "Current biological issues" on the left, then Invasive Species. Here you'll find a wealth of resources. Be sure to click on the Education link to find more classroom resources than you could ever use! Also be sure to check out the content under Data. Here you can access state-by-state lists, with resources within each state.

Join NMEA!

STUDENT: Any full-time student. 1 year—\$20.

ACTIVE: Any person who supports the goals of NMEA.

1 year—\$40; 2 years—\$78; 3 years—\$118.

CHAPTER AFFILIATE: Any person who belongs to a regional chapter. 1 year—\$35; 2 years—\$68; 3 years—\$103.

FAMILY: Active members receiving only one set of mailings per household. 1 year—\$65.

ASSOCIATE: Any person providing additional support to NMEA. 1 year—\$55.

SUSTAINING: Any person providing substantial additional support to NMEA. 1 year—\$100 or more.

LIFE: any person who wishes to join as an active member for life. \$500 or more.

INSTITUTIONAL: Any active nonprofit organization with goals similar to NMEA. 1 year—\$40.

CORPORATE: Any company or organization involved with the marine education market. \$250 or more.

Name _____

Title/Occupation _____

Address _____

City/State/Zip _____

Please make check payable to NMEA and mail with this form to: NMEA, PO Box 1470, Ocean Springs, MS 39566-1470, (228)374-7557, website: <http://marine-ed.org>

Foreign memberships: please add \$5.00 U.S. currency only, drawn on a bank with U.S. branch.

Zebra Mussels



Zebra mussels are a huge pest accidentally brought into the Great Lakes, possibly on the hulls or in the ballast water of vessels from Europe,

which has been plagued by zebra mussels for centuries. A temperate, freshwater species, zebra mussels have spread to many other lakes and rivers in the US and Canada. Prodigious eaters, they filter out nearly all the phytoplankton (and small zooplankton) in the 15-40 micrometer size. By removing most of the food for microscopic zooplankton and filter feeders, which in turn support larval and juvenile fishes and other animals, zebra mussels can effectively starve the native populations of infested lakes and rivers. Lakes that were full of phytoplankton before zebra mussel infestation are devoid of the algae afterwards.

Zebra mussels were first discovered in 1988 in Lake St. Clair, a small lake between Lake Erie and Lake Huron. Their free-swimming, nearly invisible larvae, called veligers, may have been discharged from the ballast water of one or more transoceanic ships in 1985 or 1986. Since then, they have spread almost to New England, and states are working feverishly to educate boaters so the mussels don't spread farther.

Within two to three weeks, the veligers "settle" and attach by strong byssus threads to hard surfaces such as rock, wood, glass, rubber, fiberglass, metal, gravel, and native mussels. They grow best in areas of free-flowing water where they can filter out large quantities of plankton. Colonies of zebra mussels may accumulate and clog water-intake pipes and screens of drinking water facilities, industrial facilities, power generating plants, golf course irrigation pipes, cooling systems of boat engines, and boat hulls. Zebra mussels grow rapidly to about thumbnail size, mature within a year, and reproduce prolifically. An adult female can produce 30,000-100,000 eggs each year!

Zebra mussels (*Dreissena polymorpha*) are native to eastern Europe, having existed there long before industrialization. There, people building factories and other facilities just take them into account and design ways to work around them. For example, a designer may build facilities with two sets of pipes so one set can be closed off when it becomes fouled. The clean one takes over while the other is de-musselled. In western Europe, where zebra mussels have been around for 200 years, diving ducks have made them an important part of their diet.

Besides clogging pipes and devouring most of the available microscopic food supply, zebra mussels may present a health hazard by increasing human and wildlife exposure to organic pollutants such as PCBs and PAHs. Studies have shown that zebra mussels can accumulate the pollutants in their tissues in concentrations 300,000 times greater than in the environment. They deposit these pollutants as pseudofeces, loose pellets of mucous mixed with particulate matter that they filter from the water. Scavenging animals that eat the pseudofeces may pass these pollutants up the food chain. When the zebra mussels coat bathing beaches, the sharp-edged mussels cut the tender feet of swimmers.

Zebra Mussels (continued)

Trace the invasion of zebra mussels in the U.S., and predict their next attack!

1. Discuss the history of zebra mussels and their impact on humans and the food chain.
2. Trace by satellite the route by which zebra mussels came into the Great Lakes on the hulls of commercial vessels.
3. The Zebra Mussel Range Map is prepared by the New York Sea Grant Program. It is updated about every 3-4 months to report new sightings. Using the map from May, 1995, connect the round dots and bold lines which indicate the locations of zebra mussel sightings.

Shade in the infested areas.

How far South have zebra mussels spread? How far North? East? West?

Have they reached New England? What infested body of water is closest to Maine?

Once they are introduced into a body of water on boat hulls or in ballast water, how can they spread? (by floating downstream, free-swimming veligers, by attaching to something else and being carried)

4. Find the small lake called Lake St. Clair between Lake Erie and Lake Huron, where zebra mussels were first sighted in the US.

Using an atlas to determine scale, calculate how far zebra mussels have spread in a decade.

5. The spread of the zebra mussels may be limited by water temperature. Zebra mussels don't do well where average summer temperatures are above 81oF (27oC) and where average summer temperatures are below 54oF(12oC). Females spawn when water temperatures get above 54oF.

Using an infrared satellite image showing water temperatures in late summer (at their peak), predict which areas might manage to evade zebra mussel infestation.

Tracking phytoplankton decline

Lake Erie was one of the first places infested by zebra mussels. Adult zebra mussels were discovered there in 1988, so they may have been present since 1986. Examine CZCS images of the Great Lakes to determine the amount of phytoplankton in 1985. Examine a SeaWiFS image of the area today and discuss the change over the last ten years.

Trying to control zebra mussels

Find out more about the techniques that are being used to get rid of these animals. Chlorine has worked effectively to kill zebra mussels, but it also harms everything else, so alternatives more benign to the ecosystem are being explored. See the bibliography for places to contact for more information.

Duck migration on the Great Lakes may be changing as a result of the increase in food supply. How could you research whether or not this is happening?

Mussel observations

For obvious reasons, it is illegal to transport zebra mussels over state lines, so you can't study them directly (except their empty shells), but you can examine blue mussels which have a similar physiology. Blue mussels are not the pests their cousins are.

Examine live blue mussels to get an idea of what zebra mussels look like. Zebra mussels are smaller, and as their name suggests, variegated in color. Discuss why you can not buy live zebra mussels in Maine.

Zebra Mussels (continued)

Aliens in the environment

According to a 1993 study, at least 4,500 non-indigenous species have set up residence in the United States. Fifteen percent of these cause severe harm, ranging from the displacement of native species to the destruction of habitat to an estimated \$97 billion economic impact in market losses and pest control costs between 1906 and 1991.

Research other creatures (plants and animals) that have been introduced accidentally into New England habitats and how they have affected the environment (for example, feather grass *Phragmites*, the gypsy moth, a seaweed known as “deadman’s fingers” *Codium fragile tomentosoides*, the common periwinkle *Littorina littorea*, etc.)

Discuss means by which this problem could be averted or reduced (including more stringent national laws, better regulatory coordination among states, and environmental education about the potential dangers of importing non-native species).

Materials

<http://www.invasivespeciesinfo.gov/profiles/zebramussel.shtml> Zebra mussel database information for your state, atlas, bag of blue mussels purchased at a seafood store, satellite imagery

Invasives Resources

Maine intruders fact sheet

Maine’s Marine Invasion is a full-color, six-page fact sheet on Maine’s marine invasive species highlighting some of the state’s most abundant or problematic invaders. How do species from other areas get into Maine’s coastal waters? What happens when they get here? What is being done in Maine to address the issue of marine invasive species? The fact sheet covers these topics and also outlines actions that can be taken by citizens to minimize the risk of introducing new species into Maine’s coastal waters. Developed by Maine Sea Grant, in collaboration with the Casco Bay Estuary Project and Maine Marine Invasive Species Working Group. To obtain copies of this publication, please call (207) 581-1435 or visit the Maine Sea Grant Web site at www.seagrant.umaine.edu

Exotic species in coastal New England

The Massachusetts Institute of Technology Sea Grant Program has produced the *Hitchhikers Guide to Exotic Species*. The guide contains color photographs and information on several introduced species that can be found along the New England coast, as well as some native species for comparison purposes, and is printed on waterproof paper. To request a copy, please

contact hitchhikers@mit.edu. To download an electronic copy, go to <http://massbay.mit.edu/images/HHall.pdf>

Alien invaders in Canada

The global impact of alien species across Canadian landscapes is recognized as a major threat to biodiversity. The problems are exacerbated by the globalization of trade and the inability of current inspection and quarantine regimes to cope with an increasing demand. *Alien Invaders in Canada’s Waters, Wetlands, and Forests* is a collection of papers from experts in several disciplines that discuss and analyze invasive species from a variety of perspectives: invasion pathways, affected sectors, management and control and national and international collaborations. The publication was compiled and edited by Renata Claudi, an expert on macrofouling and aquatic nuisance species, Patrick Nantel, a Canadian Forest Service science advisor and plant ecologist, and Elizabeth Muckle-Jeffs, a communications expert. The book can be ordered through the Government of Canada Publications Web site at <http://publications.gc.ca>.

NOAA Vessel "Henry B. Bigelow" Named by New Hampshire School in Ship-Naming Contest; Teacher named NMEA Teacher of the Year

The Henry B. Bigelow ship is the first vessel to be named by students through a NOAA educational outreach contest. A team of five students and their marine biology teacher from Winnacunnet High School in Hampton, N.H., won the "Name NOAA's New Ship" contest, which ran from October 2003 through January 2004. The contest, created to encourage interest in scientific studies, was opened to students in kindergarten through 12th grade in the six New England states. The winning team produced an innovative project that encourages learning and also supported their selection of a ship name honoring a distinguished oceanographer from New England. The students and their teacher attended the keel laying ceremony as guests of NOAA. *(Continued on next page)*



Kathleen Gregg (on right), wife of Sen. Judd Gregg (R-N.H.), who is the ship's sponsor, presenting a framed poster of the NOAA ship naming contest to the teacher of the winning team, Catherine (Cathy) Silver of Winnacunnet High School in Hampton, N.H.

Cathy Silver, the teacher whose class won the naming award, was named NMEA Teacher of the Year. She was presented the award at the final ceremony at the NMEA conference in Maui, Hawaii.

Cathy Silver displays her NMEA teacher of the year award in Maui.



***ARMADA Project:
Research and Mentoring
Experiences for Teachers***

The University of Rhode Island's Office of Marine Programs is now accepting applications for the ARMADA Project- Research and Mentoring Experiences for Teachers. The ARMADA Project provides K-12 teachers an opportunity to actively participate in ocean, polar, and environmental science research and peer mentoring.

Selected Master Teachers (with five or more teaching experience) are paired with leading scientists and participate in shipboard, field, or laboratory research with all expenses paid. Research experiences will take place during the summer, although there may be opportunities during the school year. Upon completion of their research experience, Master Teachers develop ways to bring the fruits of their research experiences, including scientific data, methodologies, and technology into their classrooms. They share their experiences by mentoring new teachers in their school district and by presenting their results at the National Science Teachers Association National Conventions.

The ARMADA Project has involved teachers in research experiences all over the world. Past experiences include taking part in the largest North Pacific humpback whale study in the waters off the coast of Alaska, investigating the impacts of global change in the Arctic Ocean, monitoring and assessing tidal creeks in South Carolina, studying the impact of human activity on dusky dolphins in New Zealand, exploring the seafloor off the coast of Sumatra to better understand the forces that lead to the 2004 Asian tsunami, water circulation studies in the Norwegian Sea, and a variety of ecosystem monitoring projects in the Bay of Fundy, Narragansett Bay, Gulf of Maine, Stellwagen Bank, Western Shelf of Florida, Sargasso Sea, Bahamas, Alaska, and Block Island Sound. See www.armadaproject.org for more information on past research experiences.

Application deadline is February 6, 2006

For more information about teacher qualifications, responsibilities, and to download an application see the ARMADA Project website www.armadaproject.org or contact Andrea Kecskes at 401-874-6211 or armada@gso.uri.edu.

NOAA Vessel "Henry B. Bigelow"

(continued from previous page)

The ship is named after Henry Bryant Bigelow, a renowned oceanographer, who worked as a researcher, instructor and professor of zoology at Harvard from 1906 to 1962, and founder of Woods Hole Oceanographic Institution in 1931. He transformed the Gulf of Maine from a scientific unknown to one of the most thoroughly studied large bodies of water in the world, and in doing so, developed the interdisciplinary, ecosystem-oriented approach that characterizes modern oceanography.



NOAA ship keel laying ceremony in Gulf Port, Miss., as Sen. Trent Lott (R-Miss.) addressed the assembled audience.

**ATTENTION long-time members
of GOMMEA and NMEA:**

NMEA's History Committee is beginning to plan for next year's 30th NMEA Anniversary, and is collecting names of people who have been ongoing members since 1980 or before. Please let us know, via email to Justine@gmri.org, how long you've been a national or local member. If you're not sure, but remember the first national conference you attended, check out this site: <http://www.susanleachsnyder.com/NMEAConferenceSites.html>, which lists past conferences by year and theme.

Non-Native Species: They could invade your classroom!

by Sarah Kirn and Sarah Morrisseau, Gulf of Maine Research Institute

Teachers who draw on current issues to bring depth and relevance to their curriculum may find the topic of invasive species useful. Non-native species and invasive species are increasingly in Maine's local popular press. Articles highlight invasive species' growing threat to our native species, natural resources, recreational areas, and property. The headlines include:

In War on Weed, Beetle Winning, Portland Press Herald, 8/28/03

State Plans to Head Off New Species, Morning Sentinel, 8/06/02

Marine Life Gone Bad: Scientists Inventory Invaders, Portland Press Herald,
8/05/03

Sea Squirts Put Squeeze on 40 Square Miles, Portland Press Herald, 11/24/04
Milfoilers!, Kennebec Journal, 8/04/05



How can teachers – science teachers and others – effectively use invasive species to enhance their curriculum? The answers are nearly limitless! Invasive species can be used as a window into any number of disciplines in both the sciences and humanities. Here are just a few ideas, organized under the categories used in the Maine Learning Results:

English Language Arts

- ***Process of Reading, Literature and Culture*** - While not invasive, apple trees are not native to New England. There are numerous books about Johnny Appleseed, the popular folk hero who planted apple seeds and trees in the 1800s.
- ***Stylistic and Rhetorical Aspects of Writing and Speaking*** - Persuasive writing skills can be sharpened using real or contrived scenarios involving non-native and invasive species. Ask students to persuade a town counselor why she should care about hydrilla in a local pond, why a neighbor should not plant purple loosestrife in his flower garden, why a little sister should not bring an Asian shore crab home to Maine with her from a Massachusetts beach, or why a teacher should not bring flower seeds home with her after vacationing in Europe during February break. There are many sides to this issue and few answers.
- ***Research-Related Writing and Speaking*** - Coupling popular newspaper articles with scientific journal articles about invasive species can build reading skills and extend students' research capabilities for self-directed projects and papers. Students can also practice writing a popular news article from a scientific abstract, or vice versa.

Health and Physical Education

- ***Physical Fitness, Motor Skills, Personal and Social Interactions*** - Focused nature walks are a great way to connect students with their local environment and to apply science learned in the classroom to the natural world. An invasive species walk could help students hone their observation skills and practice species identification.
- ***Physical Fitness, Motor Skills, Personal and Social Interactions*** - Communities currently managing a species invasion may offer students an opportunity to help with eradication efforts. Eliminating a species from an area is often physically challenging and provides students opportunity for service learning and environmental stewardship.
- ***Physical Fitness, Motor Skills, Personal and Social Interactions*** - Popular food chain simulation games that involve running and tagging get students moving and help kinesthetic learners grasp concepts. Adding an invasive species to the game will help students think about how a non-

Non-Native Species: They could invade your classroom!

native species introduction may disrupt the balance of a native ecosystem.

- **Motor Skills, Personal and Social Interactions** - For those teachers with flower or vegetable gardens at school, have students plan and plant a garden containing only native species, an invasive species-free garden, or have students label all existing flowers and crops with their native country and how they were introduced to Maine.

Mathematics

- **Algebra Concepts, Measurement** - Mathematical opportunities abound in monitoring the presence, absence, and changes through time of non-native and invasive species populations:

- A quadrat analysis is a common protocol for assessing the size of a population (e.g. crabs on a beach, loosestrife in a marsh, bittersweet on a roadside). Students practice measurement and counting/tallying skills as they collect data in the field. In the classroom, students can work with the data to determine the average population per quadrat, scale-up to estimate a total population for the area, determine ratios of native to non-native or invasive species, etc. In doing a long-term or seasonal study, students can graph how the populations change over time.



- **Probability** - If field work is being done in a coastal/tidal area, ask students to help schedule field trips based on tide charts and weather forecasts.

Modern and Classical Languages

- **Oral and Written Presentations** – have students research known invasive species and present what they found to their classmates

Science and Technology

- **Ecology** - When a non-native species is added to a community, it is essentially a classic science experiment of causing change in a community and watching how that change cascades through the food web, nutrient cycles, etc. Controlled versions of this experiment are performed by researchers who want to learn about the natural community – what species are competing with others, which predator is the top predator, what are the preferred food sources, etc.
- **Continuity and Change** – There are numerous “naturalized” species in New England that most people think have been here always (apple trees, night crawlers, sugar maples, honeybees, to name a few). How might New England have looked before these species arrived here?
- **The Earth (Climatology)** - Non-native species may have come from almost anywhere in the world. Many, especially those from climates very dissimilar to ours (e.g., deserts, the tropics), will not survive in Maine or New England let alone pose any threat to our native communities. Others, especially those from climates similar to ours (e.g., temperate forests areas of Japan or Europe) will find the climate close enough to their native one that they will flourish. Additionally, they may have left behind the species that competed or preyed on them. These are the species that pose the greatest threat. The non-native species that succeed, become established, and potentially become invasive are those that come from climates similar to ours (climatology).
- **Continuity and Change, Scientific Reasoning** - Animals and plants have an enormous range of adaptations that help them survive in their environments. What are some of the adaptations that

Non-Native Species: They could invade your classroom!

help species become invasive? Reproduction strategy, growth habit and rate, water capture and storage, nutrient capture and use, etc.

- ***Inquiry and Problem Solving, Scientific Reasoning*** – review the components of a natural system (primary producers, herbivores, carnivores, decomposers, etc.). Have the class make hypotheses about what would happen if various species (e.g., a cactus, a lion, an orange tree, a palm tree, an elephant, a mole rat) were introduced to New England. Have students research the potential invaders (what they eat, what are their important adaptations, what climate do they typically inhabit, how much water do they need) to assess the risk they pose to New England's natural communities.



Social Studies

- ***Geography: Human Interactions with Environments*** - Non-native species are brought to Maine intentionally and accidentally via human vectors. Today and since colonization, humans have traveled species worldwide through international commerce, coastal shipping, historical and present day immigration, recreational boats, gardening, craft products, and pet releases, just to name a few.
- ***History: Chronology*** - Natural histories of New England's plants and animals will reveal that many are not native to the area. Researching how our non-native or naturalized species (apple trees, sugar maple trees, pigeons, night crawlers, honey bees, starlings, lupine, food crops, etc.) got to Maine opens windows into the natural and human history of New England.
- ***Geography: Human Interactions with Environments*** - Maine and other states have or are working to pass legislation to protect local waterways from species such as variable leaf milfoil, Eurasian water milfoil, and hydrilla. Students studying federal and state government may find interesting what the United States and Maine are currently doing to protect the environment from species introductions and to manage established invasive species populations.
- ***Economics: International Trade and Global Interdependence, Personal and Consumer Economics*** - Economics concepts and skills are easily applied to invasive species. The global distribution of goods and services has introduced hundreds of thousands of non-native species to countries worldwide, with a small percentage of those species becoming invasive. Students can investigate such topics as the economic advantages of species eradication versus management, the economic advantages of buying local produce (fossil fuel savings, reduced risk of introducing invasive species, etc.).

If you want to learn more about invasive species, the following websites are a good place to start:



-Invasive Species Knowledge Center: http://www2.nature.nps.gov/views/KCs/Invasives/HTML/03_Stories.htm#

-Global Invasive Species Database: <http://www.issg.org/database/welcome/>

-Maine Center for Invasive Aquatic Plants, Virtual Herbarium: <http://www.mciap.org/herbarium/>

-Environmental and Economic Costs Associated with Non-Indigenous Species in the United States: <http://www.hear.org/AlienSpeciesInHawaii/articles/pimentaletal1990612.pdf>

-Exotic Species Curriculum for Agricultural Problem-solving Ed. (ESCAPE): <http://www.unk.edu/acad/biology/hoback/escapecasesstudymain.html>



NMEA 2005 by Mark Wiley

The 30th NMEA Conference was held at Maui Community College in Kahului, Maui, Hawai'i from July 11-16, 2005. The theme was "Na'na' I Ke Kumu, Na'na' I Ke Kai" which translated means "Look to the Source, Look to the Sea." The weather was predictably glorious and many of the conferees took advantage of that weather during the two field days sponsored by the conference to sample marine activities throughout the island. Mark Wiley and Ann Reid dove with a white-tipped reef shark in the crystal clear water of Molokini Crater as part of one of the conference field day offerings.

After the field days the conference got down to the more typical plenary and concurrent sessions the conference is known for. The plenary sessions focused primarily on marine issues facing the Hawaiian Islands and included experts on everything from biodiversity to fish pond renovation. In the afternoons following the plenary sessions a slew of concurrent sessions were available for those who could resist the lure of the beaches. Networking opportunities were readily available including a brushfire delayed Luau and a dinner at the Maui Ocean Center aquarium.

***Gulf Stream* is published three times a school year. Deadlines are November 1, February 1 and April 1. Please email contributions to newsletter editor Susan Hayhurst at susan@gmri.org. (Alternatively, you can send a copy on CD or floppy disk to Susan Hayhurst, GMRI, PO Box 7549, Portland, ME 04112).**

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NMEA 2007 to be held in Portland!

GOMMEA has been selected to host the annual conference of the National Marine Educators Association in July 2007. NMEA's Conference Committee made the recommendation to the NMEA Board of Directors at this summer's conference on Maui. GOMMEA is one of 15 affiliated chapters of NMEA, and 2007 will be the third year that the important annual event will be hosted by our chapter. In fact, GOMMEA has been looking forward to this decision for more than a year, and plans are well underway for an exciting, stimulating and fun conference.

The Gulf of Maine provides an unparalleled opportunity to explore innovative research, teaching, and stewardship, and we look forward very much to introducing our corner of the planet to educators from across the country and the globe. The mission of NMEA is to make known the world of water. GOMMEA has always interpreted that mission broadly to include marine and aquatic systems – from the mountains to the sea. Our theme will be built on the three pillars of research, teaching, and stewardship for which this region is known so well. The Gulf of Maine experience is a wonderful thing to share, and we hope that you will join us in the planning and the leadership for NMEA 2007.

A core group of current and former GOMMEA board members have been working together for over a year on the plans, and we are seeking the help of any-

one interested in playing a key role in creating a very special, week-long conference for over 400 participants. We need people interested in assembling an impressive program and creating the vision for a suite of special events. Interested in field trips? Or, what about the nitty-gritty details of transportation? A vibrant auction has always been the anchor of a great conference, raising important funds to support financial aid for future conference participants.

Look to the pages of Gulfstream for regular updates on conference plans. The NMEA Annual Conference will be held in New York City in 2006, and we hope to have a strong contingent from GOMMEA in attendance. Then, onward to 2007!

--NMEA 2007 Co-chairs

Justine Glynn and Don Hudson

Special Announcement

Attention NMEA members: Please see the NMEA website www.marine-ed.org for NMEA News, Vol. 21, No. 3. This issue of NMEA News is the first issue to be posted electronically and not mailed in hard copy. Read about this year's conference and other news of interest from the national level.

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