

The Sea

RICH *and* STRANGE



BY BILL O'LEARY — THE WASHINGTON POST

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An Integrated Curriculum For The Washington Post Newspaper In Education Program

A Word About The Sea — Rich and Strange

Nathaniel Hawthorne wrote “be it owned, after all my solitary joys, that this is the sweetest moment of the Day by the Sea” (“Footprints on the Sea-Shore”). The ancients told of a heroic Odyssey and Jonah’s giant fish, the Irish narrated tales of seals and people of the sea, and more modern writers have stories of open boats, perfect storms and pirates. The sea is a place of solitary joy and stormy waters, maker of mayhem and source of mystery, a haven and home to plants and animals. In this guide, sea changes are explored.

Washington Post writers take us to the Baltic Sea where scientists have discovered a new seaweed, a “super female clone” of the bladder wrack; to the Galapagos Islands where fishermen, tourists and conservationists confront sustainability and livelihood issues; and to the St. Lawrence Seaway where non-native aquatic species are hitching rides and invading new waters.

Science and art join when using the Herbarium Mount activity. Home economics and science mix in preparing a Seaweed Cake. *Post* editorial writers praise good news for oysters on the Great Wicomico River. *KidsPost* readers focus on one-of-a-kind iguanas on the Galapagos Islands and coral. Study questions, an etymology focus, sidebars with additional resources and lesson suggestions provide teachers with rich material to study the sea.



A reminder to *Post* INSIDE program teachers: If you plan to use articles in this guide in the e-Replica format more than three months after their publication date, remember to bookmark them. Two “Ocean of Information” activities in this guide give students practice in using the Search, Calendar and Contents features of the e-Replica *Post* to locate the Science page and science articles.

COVER PHOTO: Amazingly colorful fish populate the Coral Reef exhibit at the Smithsonian’s National Museum of Natural History. This is the only “living” exhibit in the new hall.

Lessons: Genetic variation, adaptations, environmental pressures, natural events and human activities influence ecosystems. Concerns about sustainability, environmental impact, scarcity, and supply and demand impact the debate between livelihood and protecting the natural environment.

Level: Low to High

Subjects: Biology, Economics

Related Activity: Art, Home Economics

NIE Online Guide

Editor — Carol Lange

Art Editor — Carol Porter

Contributing to This Guide

Lisa Wu, Oceanography/Geophysical Systems Lab Director at Thomas Jefferson High School for Science and Technology, Alexandria, Va., provided scientific background, contacted Dr. Abbott to get permission to share her recipe, and contributed “Bladder Wrack in the Baltic Sea,” study questions and answers; “Herbarium Mounts,” a science and art activity and illustrations; and the Seaweed PowerPoint found at www.washpost.com/nie.

The recipe for Seaweed Cake is used with permission of Dr. Isabella Abbott, the first native Hawaiian woman to earn a PhD in science at UC Berkeley.

Available Online

All *Washington Post* NIE guides may be downloaded at www.washpost.com/nie.

Send Comments About This Guide

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The Sea — Rich and Strange

Changes are taking place in the waters of Earth. A new species of seaweed has appeared in the Baltic Sea. Non-native aquatic species are invading the Great Lakes. Pollution, overfishing and sustainability are influencing the eating habits of humans. These and other marine-related topics are found in this guide.

Discover Marine Iguanas

“Cute? No. Cool? You Bet,” an April 2009 *KidsPost* article, introduces students to marine iguanas, the world’s only sea-going lizards. In preparation for reading the article, you might do the following:

- Ask students to share what they know about lizards and iguanas
- Have students locate the equator, South America, Ecuador and the Galapagos Islands on a globe or map
- Define vocabulary terms found in the article: algae, bask, cold-blooded, evolution, filtration, iguana, lizard, marine, naturalist, straddle
- Introduce students to Charles Darwin who was born Feb. 12, 1809, and sailed to the Galapagos Islands as part of an around the world science expedition in 1831 on the *H.M.S. Beagle*.
- Explain the concept of “adaptation.”

Give students the study sheet “Marine Iguanas — One of a Kind.” After they have completed the first three questions, give them the article to read and then answer the remaining questions. The tenth question could lead to an Internet or library search for the answer. Students could trade questions or each find the answer to her or his own question.

The activity sheet includes vocabulary words found in the article. Students may be asked to underline the words in the article, to define the words and to use the words in a 1- to 3-paragraph story.

Meet a New Animal — Coral

Play the animal, vegetable or mineral guessing game. Include “coral.” Discuss with students the properties that make coral an animal.

The *KidsPost* article “Corals Are Animals, Too” can be used with several science topics including global warming, threatened species and interdependency within habitats.

After reading the article, discussion or a quiz could include:

- Percentage of fish in the ocean that depend on coral,
- Benefits of coral to fish,
- Threats to coral, and
- Progression from single polyp to reef.

Teachers may also read the article to examine the writing process. Students may find examples of

- Quotations from an interview
- Paraphrasing
- Facts
- An explanation
- A simile.

After students have located and discussed the simile, ask them to write their own similes about damage to coral beds. Teachers might display the similes with student artwork, photographs of coral reefs and coral jewelry.

Sail Along Using e-Replica



Each e-Replica issue of *The Washington Post* has many features to receive,

Galapagos Islands

www.darwinfoundation.org/english/pages/index.php

Charles Darwin Foundation

News, scientific research for the sustainability of the Galapagos, video and images, career opportunities



http://visibleearth.nasa.gov/view_set.php?categoryID=5227

Visible Earth: Galapagos Islands

Images of flyby, underwater tour, and phytoplankton presence

<http://channel.nationalgeographic.com/series/galapagos/all/overview>

Galapagos: This Place Is Like No Other

TV program video and interactive

<http://earthobservatory.nasa.gov/IOTD/view.php?id=37003>

Wolf Volcano, Galapagos Islands

Volcanic activity, rosada iguanas

<http://earthobservatory.nasa.gov/blogs/fromthefield/category/journey-to-galapagos/>

Journey to Galapagos

Blog of research cruise includes photographs, video, erupting volcano, animals and people

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locate and organize information. Two reproducibles, each giving students practice in using e-Replica features with topics that relate to our guide's focus on ocean quality, marine life and science reporting, are found under the title "An Ocean of Information." In the first activity, students are asked to locate the Science page of *The Post* using the Table of Contents and Calendar features. In addition, a writing exercise asks students to write a Science Digest news brief. The news brief could be written based on information in a Science page article or one of the articles in this guide.

In the second activity, students are asked to locate science articles in current and past issues of *The Post* using the Search and Advanced Search features.

Bake a Cake

Respected professor and ethnobotanist Dr. Isabella Abbott, the first native Hawaiian woman to earn a PhD in science at UC Berkeley, gave permission to share her recipe for Seaweed Cake. This cake may be prepared in class or baked at home and brought to school to share. Lisa Wu, TJHSST oceanography lab director, has students prepare it at home; then compare the results in class.

The Food section is found in the Wednesday *Washington Post*. Plan a Food section in which articles about sustainable seafood and the nutritious merits of eating seaweed appear. Include recipes that students have collected from parents, neighbors and other sources. Together, the class may adapt a recipe such as the Seaweed Cake recipe found in this guide (adapt a carrot cake recipe).

Don't have time to develop your own Food section? Use past issues of

the Wednesday Food section (using the Calendar feature of the e-Replica edition to find them). After discussing sustainable seafood, have students search for recipes that would be best choices. Combine them in different ways to create menus for lunch and dinner. Have students use the NUTRITION information to add up calories and other values per meal. Recipes may also be found online at www.washingtonpost.com/recipes.

See Seaweed in a New Light

Locate these countries on a map: Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia, and Sweden. What do students know about the climate, products, history and government of them? What geographic feature unites them and gives them a regional name? [Baltic Sea]

Give students the Science page article "A Seaweed Divided Against Itself Upsets Oceanic Order" to read. Why do students think an article on this subject was published in *BMC Evolutionary Biology*? What is a "peer-reviewed journal"?

"Bladder Wrack in the Baltic Sea," study questions to guide reading and discussion, is provided in this guide. Students may be asked to define the vocabulary terms and/or find them in the context of the article. When discussing question 6, teachers might refer to the KidsPost article, "Cute? No. Cool? You Bet," in this guide.

Extension questions and activities would include the following:

- How do scientists speculate the effect of climate change on the seaweeds in the Baltic Sea?
- Bladder wrack is used as a fertilizer and nutritional supplement. Research other

Coral

<http://coris.noaa.gov/>

NOAA's Coral Reef Information System

Central point for coral reef news and data, especially NOAA's Coral Reef Conservation Program; link to glossary containing more than 5,300 technical terms

www.epa.gov/OWOW/oceans/coral/

Coral Reef Protection

Introduction to coral, importance, problems and solutions. Links to Habitat Protection program resources.

www.coral.org/

Coral Reef Alliance

International organization working to save coral reefs

www.panda.org/what_we_do/how_we_work/conservation/marine/protected_areas/increasing_protection/corals_mangroves/

Increasing Protection: Coral Reefs and Mangrove Forests

Worldwide programs to protect coral

<http://animals.nationalgeographic.com/animals/invertebrates/coral.html>

Coral: Anthozoa

National Geographic site covers facts, photos and video and profile of this endangered carnivore

www.panda.org/what_we_do/where_we_work/coraltriangle/

Coral Triangle

Considered the nursery of the seas, view an 18-month photojournalism expedition, investigating the connection of wildlife, people and the marine environment.

www.npr.org/templates/story/story.php?storyId=111663503

Oceans at Risk

NPR special series available online and by podcast. Topics include acidity, warming world and coral, fishing and zoning plans.

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products that are made from seaweed.

- There are over 500 species and subspecies in the *Fucus* genus. What defines a species? How are new species named?
- Conduct a chromatography lab with seaweed.
- Review the economic development material found on the Baltic Ecoregion Programme Web site. Search the *Washington Post* Business section for articles on the Baltic region and American investment in this EU development and other projects.

Create a Herbarium

The basis of any algal or seaweed study begins with the correct identification of the specimen collected. Plant specimens are stored in a herbarium (pl. herbaria). Herbarium specimens may be pressed or mounted plants, fluid preserved fruits, seeds, pollen, microscope slides, or even frozen DNA extractions.

The creation of a herbarium mount is a natural interdisciplinary project, bringing together art and science. Teachers even recycle the newspaper. "Herbarium Mounts" in this guide provides background, supplies list, specimen source and procedure.

Enriching several areas of study, this activity can be used to:

- Collect data on a field study in science;
- Investigate adaptations of plants and identify common forms of seaweeds;
- Learn how to make a herbarium mount of seaweed specimens;
- Build a collection of seaweeds; and
- Appreciate herbarium mounts as an artistic product.

The mounts could be displayed in the classroom or in a school display.

Clean Up Ballast

Before reading "Major Shipping Route Fosters a Plague of Sea Life," locate the following geographic areas and countries on a map: Black Sea, Ukraine, Eurasia, Caspian Sea, China, Asia, Northern Europe and Atlantic Coast. What products might people in these areas buy from the U.S.? What products and goods might U.S. businesses sell to them? What would be the most efficient and economical means of transporting goods back and forth?

Explain the use of water as ballast by ships.

Give students "Invaders From a Ship's Belly." Locate the Atlantic Ocean and Great Lakes. What important role does the St. Lawrence River play? Teachers may give a quick history of the creation of the St. Lawrence Seaway. [The first paragraph of the article is a mini-summary.] Note the map key and the ports.

Give students the Science page article to read. "Major Shipping Route ..." takes a closer look at an unexpected invasion — one of non-native aquatic species. Discussion would include:

- Examples of damage and expenses caused by non-native aquatic species,
- The spread of these species beyond their native areas and the Great Lakes,
- Development of EPA and Coast Guard requirements and standards,
- International Maritime Organization mandates,
- Methods of cleaning ballast water,

Take a Deeper Look

www.panda.org/what_we_do/where_we_work/baltic/

Baltic Ecoregion Programme

The Baltic Sea is home to rich biodiversity, nine coastal countries and one of the most threatened marine ecosystems on the planet. Introduction to projects.

<http://eu.baltic.net/#>

Baltic Sea Region Programme 2007-2013

European Union's development project to make the "Baltic Sea an attractive place to invest, work and live." View ShowCase Environment, Transport and Business Development videos.

www.energy-enviro.fi/index.php?PAGE=1801&NODE_ID=1801&LANG=1

Energy & Enviro Finland

Report on impact of climate change on eutrophication in the Baltic Sea

www.nationalgeographic.com/crittercam/CrittercamChronicles

Experience the world of the Deep Sea through a camera deployed on a sperm whale. Explore other sea worlds, visit kid section and educators for lesson material.

www.baltic.com/countries.asp

The Baltic Region

History and contemporary life in the nine countries that lie on the Baltic Sea

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- Economic trade-offs and alternative transportation of goods.

Write an Editorial

The Post editorial “Signs of Life” comments on a successful project on the Great Wicomico River in Virginia. Oysters are thriving on one of the man-made reefs.

- Are the projects’ two approaches taken by scientists clearly presented?
- What scientific and economic information is provided?
- What problem are scientists trying to solve?
- In what ways has the government or political entities been involved in the issue?
- What is the position of the *Washington Post* editorial board?

Debate Marine Issues

The articles in this guide cover many contemporary marine life activities and accompanying dilemmas and environmental and economic issues. Students could debate different perspectives on one or more issues — developing ecotourism, sustaining resources, facing pollution and climate change, endangering species, tampering with the food web, and funding scientific research.

The debate could also be framed in economic concepts: Scarcity, resources, choice, incentives, consumption, and supply and demand.

Use the articles as the starting point for research, identifying the issues and taking stands.

Hold a Town Meeting

Read and discuss “Galapagos Fishermen Pressed to Change Careers; Ravaged Ecosystem Threatens

Islands’ Tourism Industry.” Assign students different roles to play at a town meeting. These may include:

- Charles Darwin Foundation representative
- Chef on a cruise liner
- Conservationists
- Cruise line owner and captain
- Galapagos Marine Reserve park officials
- Galapagos National Park director of tourism
- Santa Cruz Island Cooperative fishermen
- Shop owners (souvenirs, restaurant, café, camera supplies)
- Tourists
- UNESCO World Heritage representative

Students should decide who should moderate the town hall. What organization or official will give all points of view a fair opportunity to be heard? Give students one to two days to do some additional reading to clarify their positions.

Report About Science

Science articles in *The Post* provide models for presenting technical information and science news in a manner that informs readers. Readers do not have to be scientists or experts in a certain field to understand the issues.

Annotate the articles to explore how *Post* staff writers organize the material, the people they interview and the sources they absorb in order to do their job.

If students have prepared a science fair project or senior research paper, ask them to rewrite the information as a science article. This may also be done as a science brief. The class’s briefs could be collected to reflect the kinds of science exploration that

Seaweed Enterprises

Seaweed is purchased as plants or in dehydrated form — flakes, powder, leaves or in sheets. Used as packing material for orders such as live lobster. Found in recipes for an entire meal — salad, soup, sushi, stir-fry, casserole and dessert.

Read the labels. Seek terms such as alaria, bladder wrack, digitata, dulse, kelp, laver, nori and sea lettuce. See how many products made with seaweed you can locate. Seaweed is used in products for these purposes:

*Alternative medicine**Balm**Bath**Beverage**Cellulite treatment**Cosmetics**Decoration**Dermatology**Fertilizer**Food**Gelatin**Medicine**Packaging**Pet food**Salve**Skin care**Spa treatment*

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is being done. Send these briefs (or blog or tweet them) to the principal, science supervisor and parents.

ENRICHMENT: Confronting Waste Water

In both the Baltic Sea and Galapagos Islands, cruise ships bring tourists to invigorate an ecotourism economy. They also bring hungry passengers and dump refuse and sewage.

- The World Wildlife Federation estimates that 250-300 cruise ships each year dump waste-water that contains 113 tons of nitrogen and 38 tons of phosphorus in the Baltic Sea. Waste water can also contain bacteria, viruses and pathogens. Why should these be a concern?
- You are the director of an international project with a mission to improve the quality of the Earth's waters. What proposals do you offer this question: What can be done to reduce or eliminate waste-water discharges from cruise ships?

Balancing Baltic Betterment

The European Union has a plan for regional development of eleven countries around the Baltic Sea (<http://eu.baltic.net/#>). Review material on the official Web site. After viewing the ShowCase videos, assign students different projects and

countries to research. You may discuss the following:

- Developing an integrated rail-sea-truck system to transport goods by containers
- Improving the economy and lives of citizens of the Baltic countries and Europe
- Doing no harm to the natural environment
- Integrating the uses of the Baltic Sea to develop sustainable energy, maintain traditional jobs, develop new relations with formerly closed borders, and create a green corridor
- Ways in which the European Union plan may be applied to the United States or to North, Central and South Americas

Learning More About Algae

1. Research where major herbaria are located in the world.
2. Research several uses of pressed algae.
3. Display a collection of pressed seaweeds.
4. Create an algal collage by using two or more specimens.
5. If collecting in the field, design a project to compare locations, depth, distance from shore, changes in seasons and different substrates. Remember that algal and seaweed growth is limited by wave action, light penetration and grazing animals. ■

Sustainable Seafood

Seafood is sustainable when “the population of that species of fish is managed in a way that provides for today’s needs without damaging the ability of the species to reproduce and be available for future generations,” according to the National Marine Fisheries Service.

www.montereybayaquarium.org/cr/seafoodwatch.aspx

Seafood Watch

Recipes and recommendations for seafood to buy or avoid, ways to become advocates for ocean-friendly seafood. Ocean issues in four categories: bycatch, habitat damage, aquaculture and overfishing. Pocket guide and iPhone application to download.

www.nmfs.noaa.gov/fishwatch

FishWatch

NOAA provides U.S. seafood facts to “make informed decisions about the seafood you eat”

www.goodcatch.org.uk/home.html

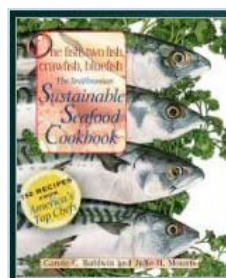
Good Catch

British resource for foodservice professionals; *Good Catch Manual* provides guidelines to decide responsibly which items to put on a menu

www.mnh.si.edu/seafood/

Sustainable Seafood

Recipes, choices and issues. Seafood Market, a virtual market, tests your knowledge of species and decision to buy or not to buy.



One Fish, Two Fish, Crawfish, Bluefish — The Smithsonian Sustainable Seafood Cookbook
Baldwin, Carole and Julie H. Mounts
Smithsonian Books, 2003

ANSWERS | “Bladder Wrack in Baltic Sea Upsets Oceanic Order.”

1. Ecological implications for the food web – effect on fish, crustaceans, barnacles; loss of genetic diversity (as they outcompete the native bladder wrack).
2. How does it reproduce? Is it a new species or a sub-species? What is preventing gene-flow between the *F. radicans* and the *F. vesiculosus*?
3. It grows in clear water; the deeper it grows the healthier the water.
4. a. Nutrient pollution leads to harmful algal blooms which block light from reaching the bladder wrack; b. Low oxygen zones are caused by the bacteria consuming oxygen as they decompose the plants that are dying off; c. Competition from the narrow wrack seaweeds.
5. Low salinity favors asexual reproduction; the low salinity impedes the eggs' ability to prevent fertilization by multiple sperm.
6. Bladder wrack is similar to sea grass beds in the Chesapeake; its disappearance impacts shellfish industry. The extreme habits force species to evolve differently.

Introduce Seaweeds

What touches each of our lives on land, determines the destiny of millions of aquatic organisms, and is estimated to be worth over a million dollars a year per square mile? What if we said they may thrust skyward from the sea floor forming canopies where assorted seabirds vie for perches, carpet rocks in intertidal zones, fortify coral reefs, or, dislodged and washed up on a beach, form a wrack line for beachcombers and buffet for small crustaceans?

Neither plants nor animals, seaweeds are classified into three major groups – the red algae, green algae and brown algae – a distinction which is not always obvious by their apparent color. In addition to pigments, structure and shape, their classification is still being debated and is based on reproductive characteristics, cell wall composition and the chemical nature of their photosynthetic products.

The economic value of certain species is based on the harvest of commercially important fish and shellfish supported by these “non plants” as well as the extraction of cellular materials used for pharmaceutical and industrial purposes.

Download “A Seaweed Divided,” a PowerPoint found at www.washpost.com/nie. It provides an introduction to seaweeds that can be paired with *The Washington Post* article “A Seaweed Divided Against Itself Upsets Oceanic Order.”



PHOTO BY AP/U.S. GEOLOGICAL SURVEY

A healthy elkhorn coral near St. Croix, U.S. Virgin Islands

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Growing Coral at the National Zoo



BY MEGHAN MURPHY

Michael Henley is trying to grow coral, hoping to replace coral that has been destroyed.

"Coral is the best animal in the world," said Henley, who works at the National Zoo. Henley works with elkhorn coral, a hard, antlerlike coral covered with thousands of living polyps. Once a year, just after the first full moon in August, elkhorn corals release sperm and eggs into the ocean at the same time. "You can set your watch by it," Henley said.

Henley goes to Puerto Rico every year to capture thousands of larvae. Last year, one of Henley's larvae made it to the growing-polyp stage in a tank at the National Zoo before it died. ("I think I overfed it," Henley said sadly.)

— Margaret Webb Pressler

Science Journalism

www.ej.msu.edu

**Knight Center for
Environmental Journalism**

Student work, magazine
articles, projects including
Great Lakes Echo



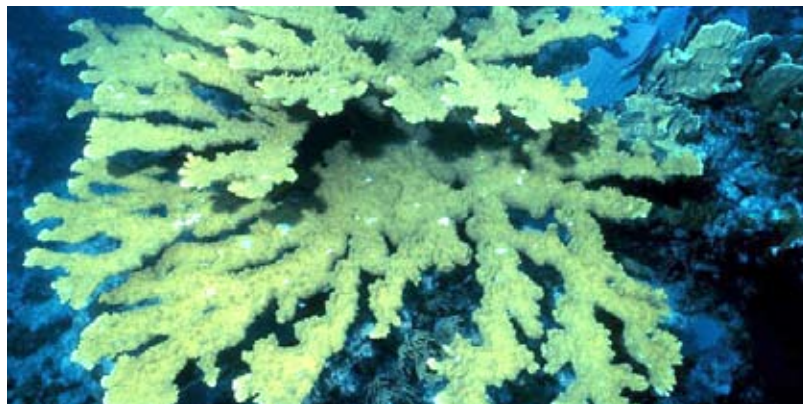
Jean-Michel Cousteau, host of "Jean-Michel Cousteau: Ocean Adventures," taking a close look at a coral reef.

AP PHOTO/PBS, TOM ORDWAY



Elkhorn coral

SMITHSONIAN INSTITUTION



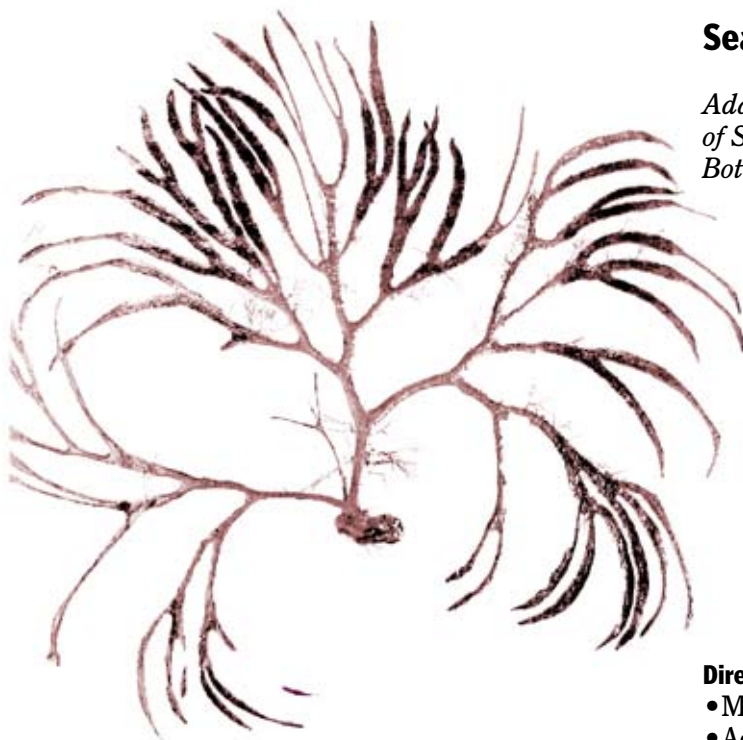
Elkhorn coral in the NOAA Florida Keys National Marine Sanctuary

NOAA

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Seaweed Cake

Adapted from I. A. Abbot, Limu, An Ethnobotanical Study of Some Hawaiian Seaweeds, 4th edition, National Tropical Botanical Garden, Lawa'i, Kaua'i, Hawai'i, 1996.



- 1 cup salad oil
- 2 cups sugar
- 3 eggs
- 2 cups grated or chopped seaweed: ogo (*Gracilaria* species), *Eucheuma* (local species from Hawai'i), kelp such as *Alaria*¹
- 2 cups grated carrots
- 1 cup crushed, drained pineapple (or 1 cup grated coconut, preferably fresh)²
- 2 ½ cups flour
- 1 tsp baking soda
- ½ tsp salt
- 1 tsp cinnamon
- 1 cup chopped walnuts (optional)

Directions:

- Mix together well the sugar and salad oil.
- Add the eggs, one at a time, beating well after each egg is added.
- Add the seaweed, carrots, and pineapple (or coconut).
- Sift together the flour, baking soda, salt, and cinnamon in a separate bowl; add to moist batter. Mix well.
- Add the chopped walnuts if desired.
- Bake in oblong or bread-loaf pan at 160° C (350° F) for 45 to 50 minutes.
- Cake may be covered with butter cream frosting.³

Enjoy!

Special Notes

¹ If you are not harvesting your own seaweed from the ocean, local Asian food markets and Health Food stores will usually have dried seaweed in packages for purchase. You may find the same names as mentioned above. If not, try to find red seaweed (*Gracilaria*, or *dulse*). These can be rehydrated in tap water and will plump up to become fleshy. Do not select the thin sheets of seaweed wrappers used for preparing sushi. These will not contain enough moisture for the recipe. Once you have rehydrated the seaweed, coarsely cut it using a meat grinder or chopper just slightly finer than small chunks of pineapple. *Alaria* is a genus that has species on the Pacific and Atlantic coasts. *Gracilaria* species may be found on both coasts.

² Fresh grated coconut can be purchased in small bags in the frozen food section in most grocery stores. It is almost as good as climbing a tree and collecting your own. Both taste fresh and eliminate all the extra sugar.

³ With icing, this cake is similar to a carrot cake. It is just as good plain or sprinkled with a light dusting of powdered sugar.



Dr. I. A. Abbott

Dr. Isabella A. Abbott, a Native Hawaiian, a phycologist and ethnobotanist, is a professor emerita at both the University of Hawaii at Manoa and Stanford University in California. Having conducted extensive research in ethnobotany, the taxonomy of marine plants, and edible and useful marine algae, Dr. Abbott is considered to be the world's leading expert on Hawaiian seaweeds. She has authored of more than 150 publications, including eight books. Her work has been credited with advancing not just scientific understanding but cultural awareness.

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Corals Are Animals, Too

It May Not Seem Like It, But These Threatened Creatures Are Important to Marine Life

THE OCEAN

You have probably seen or held a piece of coral, either in or out of the ocean. You may even have heard that coral is threatened by global warming and pollution. But most people don't know much more about these vital ocean-dwelling creatures.

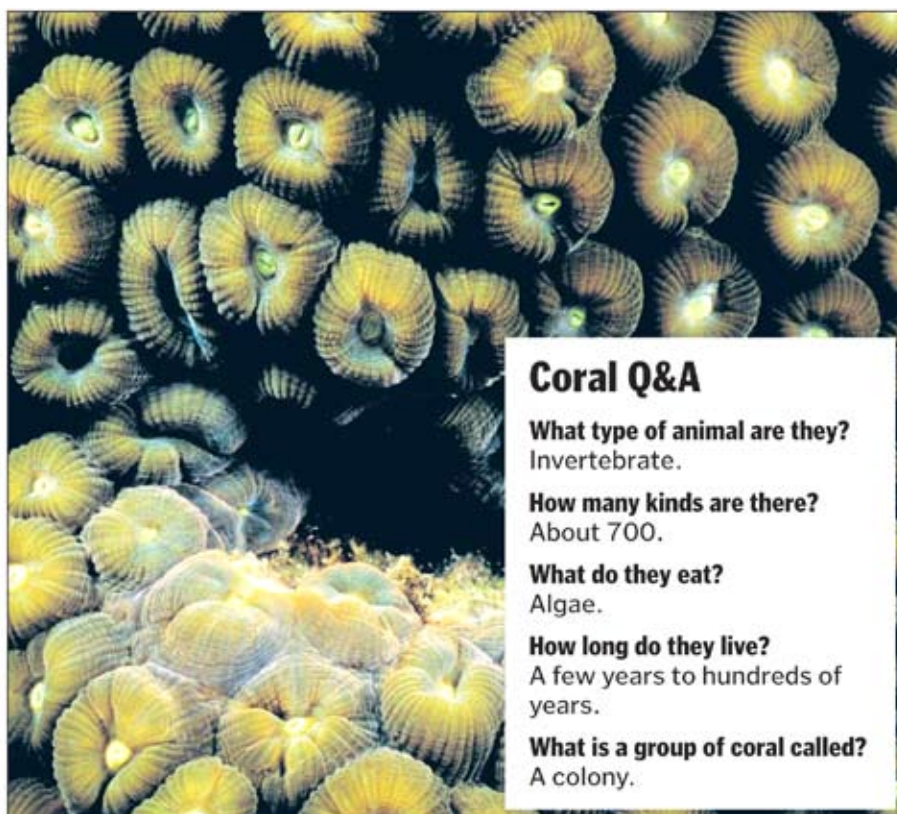
"People don't realize that corals are really animals — they think about corals ... as rocks or boulders or tree trunks," said Dawn Martin, who runs SeaWeb, an organization that works on protecting the oceans and ocean life. Since corals don't have the adorable faces of some endangered critters, it has been difficult for them to win the kind of protection — and awareness — that other threatened species have.

But it's important to protect coral, because a quarter of the fish species in the ocean depend on coral to live. Coral reefs provide these fish with food, shelter from predators and a place to spawn (produce young).

The main threats to coral are rising ocean temperatures, which can kill the algae that coral eat, and pollution. Other kinds of man-made damage also are harmful, such as fishing practices that break up coral on the sea floor and turning coral into jewelry.

SeaWeb has started a campaign called "Too Precious To Wear," designed to get out the message that buying coral items at the beach contributes to the destruction of reefs. More than 3 million pounds of living coral is removed from the ocean each year for use in these decorative products, Martin said.

When coral is destroyed, it can take hundreds, even thousands, of years to grow back. The hard coral that builds into huge, rocklike formations started out as a single coral polyp. The polyps grow a calcium skeleton and thousands,



Coral Q&A

What type of animal are they?
Invertebrate.

How many kinds are there?
About 700.

What do they eat?
Algae.

How long do they live?
A few years to hundreds of years.

What is a group of coral called?
A colony.

BY CHUCK SAVALL VIA WWW.TOOPRECIOUSTOWEAR.ORG

Coral reefs provide fish with food, shelter from predators and a place to produce young.

even millions, of additional coral polyps grow on the skeleton, each one a separate animal. As older generations die off, newer generations continue to build on the hard, old coral.

Damaging such coral beds "is like clear-cutting an old-growth forest," Martin said. "We will certainly not be able to replace them in our lifetime." ■

— Margaret Webb Pressler

August 19, 2009

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PHOTOS BY ANN CAMERON SIEGAL FOR THE WASHINGTON POST

Marine Iguanas, the world's only sea-going lizards, use their teeth to scrape algae off the rocks of the islands where they live. Sharp claws help them hang on while eating, even in rough surf.

Cute? No. Cool? You Bet.

Darwin Discovered Marine Iguanas in 1835, and Scientists Are Still Learning About Them

You don't have to be cute to be fascinating. Marine iguanas are proof of that.

When Charles Darwin, the British naturalist who developed the theory of evolution, first saw these prehistoric-looking critters in 1835, he didn't say, "Awwwww, how adorable." Instead, he described them as "disgusting clumsy Lizards."

Let's look closer. Marine iguanas, the world's only sea-going lizards, live in the Galapagos, a chain of volcanic islands that straddle the equator 600 miles west

of Ecuador. Scientists are not really sure how iguanas got there. Possibly they drifted on clumps of vegetation that broke free from the mainland millions of years ago.

Marine iguanas are good swimmers, propelled by powerful tails that whip back and forth like an alligator's. Their blunt noses and sharp teeth make it easy to scrape their primary food source, algae, off submerged rocks. Long, sharp claws help them hang on while eating, even in rough surf.

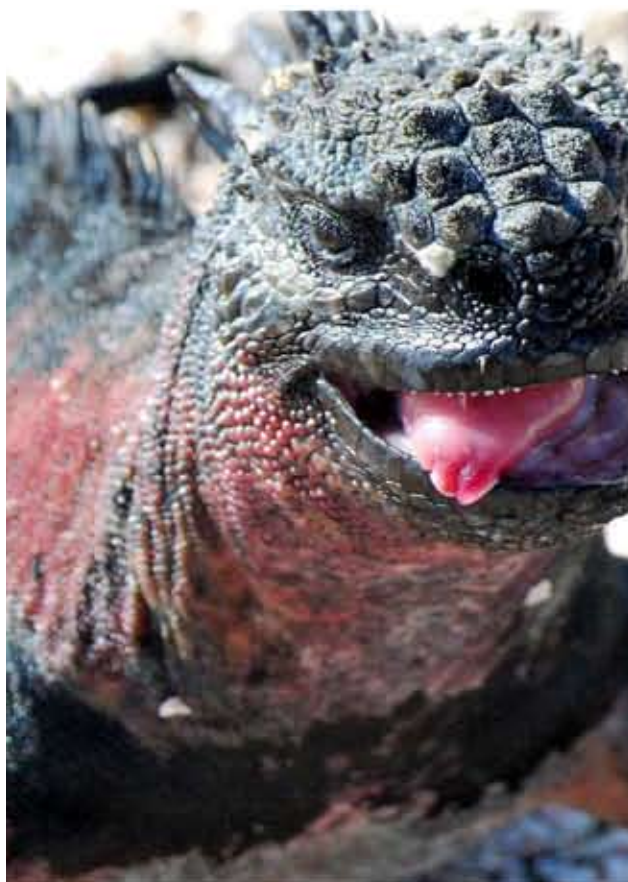
Although they usually munch on

algae close to shore, some venture into deeper water, diving more than 40 feet while holding their breath.

Marine iguanas look fierce, but they generally fight only to defend their territory. They'll strut, bob their heads and make threatening moves toward each other. Often, after acting really tough, one will just give up and walk away. Amazingly, these iguanas show little interest in humans, even those who get too close with a camera.

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As fierce as they look, marine iguanas are not aggressive. During the day, they bask on dark rocks to raise their body temperature, and they show little interest in humans.



About Marine Iguanas

Length: 2 to 5 feet, half of which is tail

Weight: 3 to 11 pounds

Life span: 20 years or more

Population: Estimated to be several hundred thousand



With tails that move like an alligator's, marine iguanas are good swimmers.

CONTINUED FROM PAGE 12

How would you like to spend your days sunbathing and swimming?

Marine iguanas do that for survival. Like all reptiles, they are cold-blooded, which means they can't regulate their own body temperature.

At night, they pile on top of each other to keep warm. During the day, they bask on the islands' dark lava rock (basalt), which absorbs heat from the sun's rays.

They need to get their body temperature up to 95.9 degrees before heading into the chilly waters around the islands to eat.

Once in the cold water, their body temperature drops rapidly. After about 30 minutes

they must return to the warmth of the black rocks. Otherwise, they become too weak to climb out of the water.

Iguanas sneeze frequently, but not because they are catching colds.

Everything they eat is saturated with salty seawater, so special glands in their heads act as the iguanas' own filtration system. Sneezing sends white globs of accumulated salt crystals spewing from their nostrils. This yucky stuff often lands in clumps on the iguanas' faces or heads — or on the camera lens of anyone who gets too close.

Thousands of marine iguanas died during the 1997-98 El Nino, a periodically abnormal warming of the islands' waters. Many others survived by shrinking: The iguanas' bones actually shortened while food was scarce, but grew back to normal size when the waters cooled and algae returned.

Scientists still have a lot to learn about how marine iguanas meet the challenges of their environment. ■

— Ann Cameron Siegal, April 14, 2009



Marine Iguanas — One of a Kind

Share What You Know

1. Share one interesting fact about lizards and iguanas.
2. Charles Darwin was born in England on the same day and year as Abraham Lincoln. How many years ago was this? He was a naturalist. What does a naturalist study?
3. What is the basic idea of Darwin's theory of evolution?

Answer a Few Questions

Complete the following questions after reading "Cute? No. Cool? You Bet."

4. How might iguanas have arrived on the Galapagos Islands?
5. Which features allow marine iguanas to gather their meals?
6. Why do marine iguanas spend so much time sunbathing?
7. Why do these iguanas sneeze so often?
8. Explain ways in which water temperature impacts the marine iguana.
9. List the adaptations that have helped marine iguanas to survive.
10. What else would you like to know about the marine iguana?

Words to Know

Algae
Bask
Cold-blooded
Evolution
Filtration
Iguana
Lizard
Marine
Naturalist
Reptile
Straddle
Strut

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**An Ocean of Information** | Science Page

Today we explore the Science page. On this special page, Post staff writers report and explain the varied aspects of science affecting our society.

The Science Page

1. Open your e-Replica edition and locate the Table of Contents. Is “Science” listed? If it is, click on it to read the Science page. If Science is not listed, you have another option to locate this special page.
2. Locate Calendar in the tool bar and select it. “Science” will appear most Mondays in the A section. Select the Monday issues in the last month.
 - On which dates did Science pages appear in that month?
 - List the topics covered.
 - Select one of the articles. After reading it, summarize the science news. Be sure to include the headline, date and page on which the article was found.

Since many of the topics covered may be technical or specialized, the Science page often provides photographs with captions and informational graphics. Select a Science page that has appeared in *The Post* in the last three months. Print the page.

Answer these questions about the page you have selected:

- What is the main idea of the article?
- In what ways do the photographs and/or informational graphics help you to understand the topic?

Science Digest

In addition to the main article on the Science page, you may find Science Digest, briefs of science news from around the U.S. and world.

- How many words do the Science Digest briefs average?
- What kind of information do you find in the first sentence of each brief? A summary of the article? An introduction to the topic? A teaser to get you to read more?
- List any words with which you are unfamiliar.
- Does the context of the article help you to figure out definitions of the technical terms?

Write a Science Digest brief.

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**An Ocean of Information** | Science Coverage

In addition to Science page coverage, articles about science discoveries, issues and news appear in *The Post*. In this activity, we are asking you to locate science articles in current and past issues of *The Post*.

Search and Advanced Search Features

Locate the Search and Advanced Search options on the tool bar of an e-Replica issue. Experiment with different ways to locate topics and information.

Narrow the Search Topic

- Use a word or phrase that states the category without being too broad. For example, “animal” does narrow possible topics, but you are likely to be more successful in finding the latest information in *Post* articles if you use a term that is closer to your research interest such as “tiger,” “lizard” or “coral.”

Use Punctuation

- If you are seeking general information (I wonder what *Post* reporters have covered on topic X, Y or Z), use commas to separate search terms. For example a search using three words without quotation marks (threatened, species, coral) resulted in three articles:
 1. “To Attract Butterflies to Your Garden ...” (Aug. 22)
 2. “Saving Species No Longer a Beauty Contest ...” (June 29)
 3. “Corals Are Animals, Too” (Aug. 19)
- If you are using a multi-word search term, put the words within quotation marks. For example, on August 30, the two words “marine, animals” with a comma between them got 61 results, but “marine animals” got no hits. A search using “‘threatened species’ and ‘coral’” resulted in the one article, “Corals Are Animals, Too.”

Use Each Timeframe Option

- If you want to know if today’s *Post* has an article on pollution in the Potomac River, you should first try a search of the current issue followed by a “last three days” search.

Practice using these terms: invasive species, Great Lakes, ballast. Which of the four search approaches and combinations yields the best results for you?

- a) Search for the three terms individually without quotation marks for the timeframe “last three days.”
- b) Vary the timeframe searches — this week, this month and anytime — for the three terms. Compare results.
- c) Using “anytime,” change the terms by adding quotations marks around “Great Lakes” and “invasive species.”
- d) Use the search in c above, but connect the three terms with the word “and.” Compare the results of approach c and d.

Which search approaches work for you?

Ecosystem Explorations

Practice using the research approaches using these 5 groupings.

- 1 Chesapeake Bay
Chesapeake Bay Foundation
Native Oyster Restoration
- 2 Magothy Bay Natural Area
Reserve
North American Wetlands
Conservation Act
Virginia barrier islands
- 3 Pollution
Baltic Sea
Seaweed
- 4 Continental Shelf
Mid-Atlantic Ocean Forum
(Baltimore, December 2008)
Mid-Atlantic Seascape
- 5 Chesapeake Bay Program
(EPA)
Great Wicomico River
Oysters

Down to the Sea, Again

The sea covers most of Earth's surface. Not earth and not sky, these large bodies of salt water were once known as the Seven Seas. They had names such as Mediterranean, Persian and Caspian. And before the Romans, they were called the Sea of Fars, Larwi, Harkand and Salahit.

Closely related to "sea" is "marine," "marina" and "mariner."

Marines serve at sea as well as land. A marina is a place to dock your boat and buy supplies. In Spain and Italy, it is the seashore. A little marine exploration discovers that the Middle English *marin* and *marine* are from Old French which is based in Latin *marīnus* and *mare*, meaning sea.

Seafarers are mariners who travel the seas. Sailors who were away from port many moons, ate fish and sea biscuits or sea bread, the hardtack made from flour and water. Today's Explorer Scouts can show their skill in seamanship and become Sea Explorers or Sea Scouts.

From surface to sea bed a wide array of life awaits the explorer. Above its waters fly sea fowl. Seashells are scattered on shore. Within the sea are found the sea cow and sea horse, sea cucumber, sea anemone and sea gooseberry. Sea fan and other coral accumulate to form reefs.

In Middle English our word "sea" was *see* which was formed from the Old English *sæ*. Can you hear the sea hitting the sand and shore, s-s-s-s-ea, s-s-s-s-ea, s-s-s-s-ea?

The study of marine and freshwater algae is called either phycology or algology. The ancient Greek word for seaweed was *phykos*, which could mean either the seaweed, probably Red Algae, or a red dye derived from it. In Latin, *alga* meant seaweed and *fucus* meant primarily rouge adorning women. It is believed that it is from an Aramaic word that described the

**Full fathom five thy father lies;
Of his bones are coral made;
Those are pearls that were his eyes:
Nothing of him that doth fade,
But doth suffer a sea change
Into something rich and strange.**

— *The Tempest. Act i. Sc. 2*

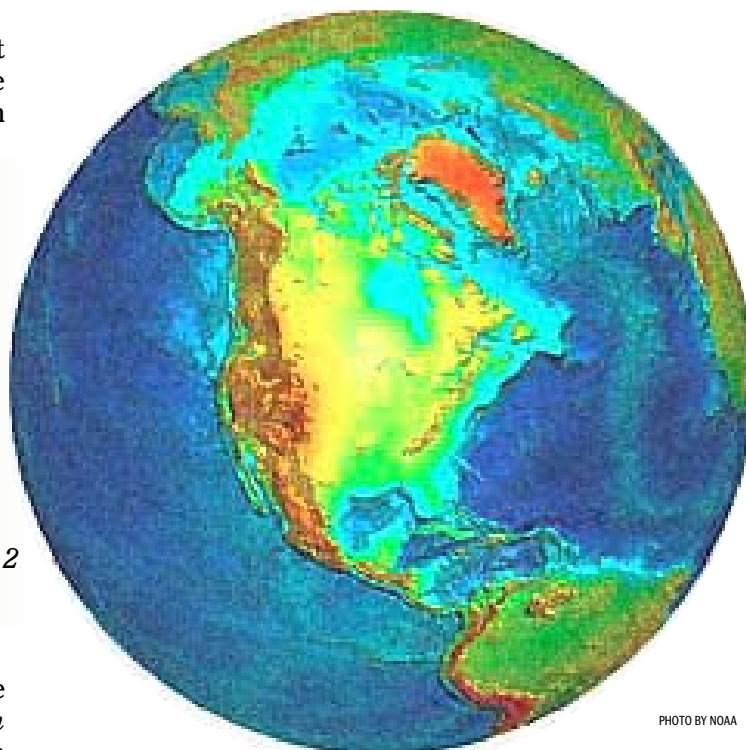


PHOTO BY NOAA

"paint" or cosmetic eye shadow used by the ancient Egyptians and other inhabitants of the eastern Mediterranean. It could be any color — black, red, green, blue.

Many poets, novelists and journalists have written about the sea. You may have read Hemingway's *Old Man and the Sea* or Samuel Taylor Coleridge's "The Rime of the Ancient Mariner." John Masefield in verse shares "I Must Go Down to the Sea, Again" and John McPhee tells of modern pirates in *Looking for a Ship*. William Shakespeare wrote of the change made by the sea:

**Full fathom five thy father lies;
Of his bones are coral made;
Those are pearls that were his eyes:
Nothing of him that doth fade,
But doth suffer a sea change
Into something rich and strange.**

— *The Tempest. Act i. Sc. 2*

Herbarium Mounts | A Seaweed Collection – Integrating Science and Art

Phycologists are scientists who study algae. Algae are important in aquatic ecosystems as primary producers of oxygen and food. They provide a habitat for denizens of organisms in freshwater as well as marine environments. Whether microscopic or macroscopic (seaweeds), algae differ from plants in that they lack true roots, stems and leaves. They are classified based on several characteristics such as cell structure and the type of pigment they contain.

Algae are being researched for new medicines, as nutritious sources of food for humans, as a potential fuel and a weapon to counteract global warming. The basis of any algal or seaweed study begins with the correct identification of the specimen collected. Plant specimens are stored in a herbarium (pl. herbaria). A herbarium may be within a university, museum, or research facility. Herbarium specimens may be pressed or mounted plants, fluid preserved fruits, seeds, pollen, microscope slides, or even frozen DNA extractions. These specimens are useful not only for specimen identification by other botanists but in a variety of disciplines including entomology, anthropology and forensics.

Enriching several areas of study, this activity can be used to:

- Collect data on a field study in science
- Investigate adaptations of plants and identify common forms of seaweeds
- Learn how to make a herbarium mount of seaweed specimens
- Build a collection of seaweeds
- Appreciate herbarium mounts as an artistic product

Supplies

- A source of specimens: local aquatic environments or specimens ordered from scientific supply catalogs or purchased at Asian food markets.
- Shallow pan, at least 30 cm x 30 cm
- Pieces of white paper — somewhat heavier (like an index card thickness or paper used for watercolors) approximately 8 ½ by 11
- Newspapers
- Wax paper
- Eye dropper
- Inexpensive small paint brush (from craft stores)
- Plain newsprint paper
- Card board (8 ½ x 11, may be pieces cut from boxes)
- Gum labels (5 cm x 8 cm) Believe it or not you can put these right through the laminating machine and preserve your beautiful specimens.
 - Plant press or 2 boards about the size of the paper you are using. These are used to distribute the weight evenly as the plants are being pressed.
 - Weights – this can be a stack of heavy books
 - Plant guides – if you plan to have students identify specimens.

Recording Data

Collecting in the Field: If students are collecting specimens in the field, be sure that a collecting permit is not needed and that they never collect in national parks or marine reserves without permission from authorities. Specimens should be kept wet until they are back in the lab. This can be done by placing the seaweed or algae in plastic baggies with water from the collection site. If possible record GPS location or at least the name and approximate location of the collection site, depth, substrate (what was it attached to), date, collector and name of specimen (if known). If students are asked to identify the specimens, this should be done before the specimen are pressed back in the lab. Special guides for identification will be required.

Ordering Specimens or Purchasing From a Market: A variety of specimens can be ordered from various scientific supply catalogs, pet stores, and mariculture companies. Asian grocery stores will have a variety of seaweeds as well. If these are dried, they may be rehydrated. This can be done by placing them in a bowl of freshwater. Since drying causes them to stick to one another, as the specimens rehydrate, they may need to be carefully teased apart from one another for smaller samples to press.



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Herbarium Mounts | *continued*

Procedure

- Fill the pan with enough water to submerge the paper (1 cm deep).
- Take a piece of white paper and place the paper in the water.
- Carefully center the algal specimen over the paper.
- Use the paint brush to arrange the plant to show all the details. The special arrangement, color, and clarity of details will contribute to its artistic as well as scientific value.
- Gently lift the paper out of the pan by holding one side or corner and allowing the water to slowly drain out.
- Use an eyedropper to squirt jets of water to areas to arrange seaweed if it has changed position during the draining of the water. The paintbrush can also be used as needed to gently move the plant over the paper into position.
- Place the wet paper with the specimen on top of a piece of newsprint.
- Place wax paper on top of the specimen. This prevents the specimen from sticking to the newsprint.
- Place the newsprint on top of several sheets of newspaper. (Using the plain newsprint prevents the ink from the newspaper from staining the white paper. Both act as blotters to absorb the water out of the specimen as well as the paper.)
- Names can be written on the newsprint for quick identification of each student's specimen.
- Place a piece of the cardboard on the top and bottom of the sandwiched specimen.
- Several specimens may be placed on top of one another with a piece of cardboard separating them.
- Limit the stack to about 30 cm high to prevent crinkles.
- Press specimens by putting a board on top of the stack and adding a heavy weight or stack of books.

Final Steps

Every 24 hours open the pressed stacks to replace damp papers and cardboard with fresh, dry ones. Repeat this procedure until pressed specimens are completely dry. This may take up to one week.

Once specimens are dried, a label with identification and field notes taken may be placed in the lower right hand corner.

Once labeled, the paper and specimen may be laminated for preservation.

Further Investigation and Discussion

1. Research where major herbaria are located in the world.
2. Research several uses of pressed algae.
3. Display a collection of pressed seaweeds.
4. Create an algal collage by using two or more specimens.
5. If collecting in the field, design a project to compare locations, depth, distance from shore, changes in seasons and different substrates. Remember that algal and seaweed growth is limited by wave action, light penetration and grazing animals.



Bladder Wrack in the Baltic Sea

Read “A Seaweed Divided Against Itself Upsets Oceanic Order,” written by *Washington Post* staff writer Kari Lydersen. Review vocabulary words found in the article.

Answer the questions.

1. Discuss two areas that concern scientists since the discovery of the new seaweed in the Baltic Sea.
 - a.
 - b.
2. What questions do scientists still have related to this seaweed?
3. How is bladder wrack used as an indicator of the overall health of the Baltic Sea?
4. Explain three threats to the native bladder wrack.
 - a.
 - b.
 - c.
5. How is salinity related to the reproductive cycle of the bladder wrack and the narrow wrack seaweed?
6. Two other geographic locations are mentioned in this article – the Chesapeake Bay and the Galapagos Islands. What analogies are made between the Baltic Sea and these locations?
7. Discuss factors that contribute to the rapid formation of this species.

Key Terms

Algal blooms
Asexual reproduction
Bladder wrack
Brackish water
Clone
Dead zones
Ecology
Eutrophication
Gametes
Genetic diversity
Marine
Narrow wrack
Nutrient
Phytoplankton
Salinity
Seaweed
Sexual reproduction
Species
Subspecies
Substrate

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A Seaweed Divided Against Itself Upsets Oceanic Order

Baltic Sea Offshoot Encroaches On A Vital Counterpart

BY KARI LYDERSEN
Washington Post Staff Writer

• Originally Published August 3, 2009

STOCKHOLM — Something is happening in the Baltic Sea's underwater forests.

A new kind of seaweed is spreading over hundreds of miles in the north. Scientists call it a “super female clone” because most of the new plants are genetically identical females. Called *Fucus radicans*, or narrow wrack, it has apparently branched off in the past 400 to 1,000 years from *Fucus vesiculosus*, or bladder wrack, the tree-like vegetation common in the Baltic and other oceans worldwide.

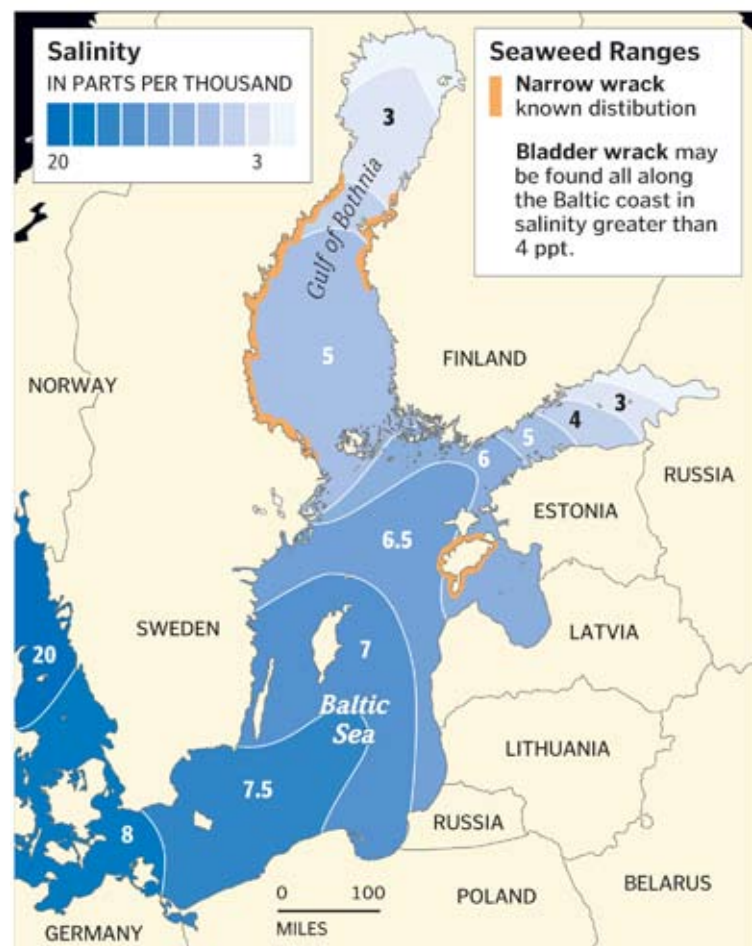
Researchers are concerned about the ecological implications, since the new species — or subspecies; some scientists dispute the classification — is smaller and much less ideal for fish, crustaceans, barnacles and other organisms that populate the sea.

The new seaweed has developed at an “unparalleled speed,” according to Lena Kautsky, a marine ecologist based in Stockholm. Kautsky worries that the loss of genetic diversity inherent in the spread of the new species could mean that disease or changing conditions will more easily wipe out large swaths of the older seaweed.

In ecological importance and function, bladder wrack is akin to the sea grass beds in the Chesapeake Bay, whose disappearance has withered the shellfish industry. In addition, Bladder wrack is used widely as fertilizer and in nutritional supplements, since its high iodine content is thought to combat hypothyroidism, and another compound helps reduce heartburn.

Bladder wrack is an indicator of the Baltic's overall health, since it grows well when the water is clear and light gets through. But it is stunted or dies when nutrient-fueled algal blooms block out the light. Kautsky and her brother Hans, also a marine ecologist, have spent years studying the depth at which bladder wrack occurs. (The deeper it grows, the healthier the sea.)

Bladder wrack growth came close to the surface in the 1970s. Since then, the Baltic's *Fucus* forests have regained some ground in the deep, but with nutrient pollution leading to



SOURCE: Lena Kautsky

BY PATTERSON CLARK — THE WASHINGTON POST

low-oxygen zones, competition and the unknown ramifications of the narrow wrack clone, their future is still tenuous.

“It’s a slowly dying forest,” Kautsky said.

Kautsky describes the love lives of bladder wrack in almost poetic terms — a moonlit ritual not shared by the newcomer. “It’s quite romantic,” she says.

Male and female bladder wrack reproduce primarily by releasing sperm and eggs into the water twice a month, in the evening, two days before the new and full moons. This precise timing allows sperm to fertilize eggs in the water, then the new embryo sinks, anchors itself to substrate on the sea floor and forms a new plant.

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Rapid Evolution

Relatively quickly, a new species of seaweed has appeared in the Baltic Sea, spreading mainly through asexual reproduction and thriving in water less salty than that preferred by its closest relative.

Narrow wrack (recently evolved species)
Fucus radicans

Capable of sexual reproduction but mainly propagates by releasing small fragments, which attach to rocks and grow.

Bladder wrack
Fucus vesiculosus

Fertilization primarily occurs two days before each full and new moon, at around 8 p.m.

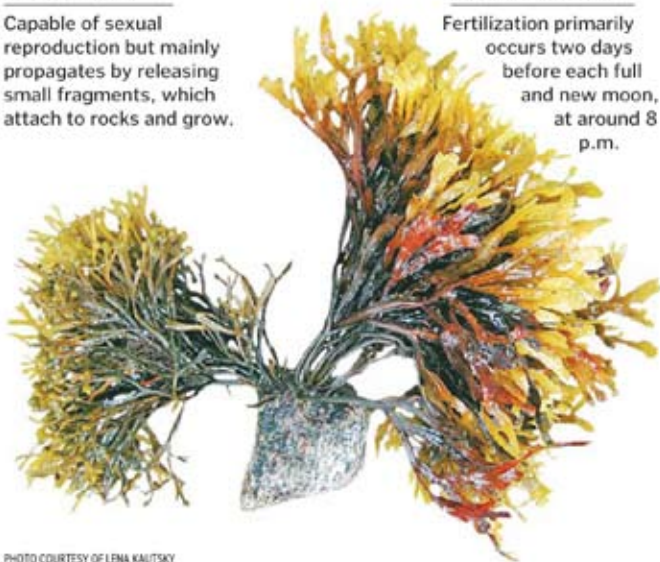


PHOTO COURTESY OF LENA KAUTSKY

There is virtually no tide in the Baltic, so it is a mystery how the bladder wrack know exactly when to release their gametes. Moonlight and gravity likely play a role.

But narrow wrack shuns this fertilization method. Though it exists in male and female genders and is capable of sexual reproduction, it normally prefers asexual reproduction, spinning off small fragments of seaweed that form new plants.

The northern reaches of the Baltic, far away from the inland sea's narrow connection to the Atlantic Ocean, have a very low salinity that impedes an egg's ability to make sure only one sperm enters it; in such environments, multiple sperm are likely to fertilize an egg, killing it.

Salinity in the Gulf of Bothnia in the northern Baltic is only one-tenth of the level in average ocean water, so it favors asexual reproduction. Scientists think climate change may decrease salinity significantly across the entire Baltic, thanks to much heavier rains diluting the brackish sea. That means the narrow wrack could potentially spread throughout the sea and compete with bladder wrack for space and light.

In a paper published in the peer-reviewed journal *BMC Evolutionary Biology* in March, Kautsky and her colleagues argued that the rapid development of *F. radicans* defies traditional evolutionary knowledge. New species generally take thousands of years to differentiate from their forebears, and do so in geographically isolated places such as islands.

"Although the Baltic is a very species-poor sea, it is actually very interesting from the evolutionary perspective, as the odd environment, low salinity, has changed many species rather dramatically over the short history of the sea," said Kerstin Johannesson, a marine ecologist at Sweden's University of Gothenburg. "Sometimes I actually make a parallel to the Galapagos Islands — an extreme habitat which has forced species to evolve differently in a relatively short period of time."

However other researchers think Kautsky and Johannesson are jumping the gun in declaring *F. radicans* a new species rather than a subspecies. They say more research is needed on just how different it is from *F. vesiculosus*. And they point out that there are various other types of *Fucus* around the world; if *F. radicans* deserves to be called a species, maybe those do as well.

"This is certainly a distinctive population," said Susan Brawley, a marine biologist at the University of Maine who studied *Fucus* in the Baltic in the 1990s. "Is it a species? That's where there's far more room for speculation and study."

She thinks *F. radicans* is reproducing sexually more often than Kautsky and her colleagues realize. She said fertilized embryos are actually attaching to the seaweed itself and then forming new plants when pieces break off, fooling scientists into thinking it is reproducing asexually. Researchers have missed this in part, Brawley said, because narrow wrack does most of its sexual reproducing in July, when Swedes are typically on holiday.

"I wouldn't have done it," she said of designating *F. radicans* a new species. "But I'm more of a lumpster" in terms of classifying species. "Being a splitter is also a valid position," she said.

Ester Serrão, a marine biologist at the University of Algarve in Portugal who studied under Brawley and has collaborated with Kautsky, thinks the species classification is somewhat beside the point.

"The boundary that defines when a differentiated entity can be considered a new species is often fuzzy," she said. "Genetic data show that there is some other type of barrier preventing gene flow between them and causing them to have different genetic characteristics. This is very interesting — in my view much more interesting than discussing the species name."

Meanwhile, bladder wrack also has another nemesis, the blue mussel, which happens to be the research focus of Kautsky's husband Nils for the past 35 years. Blue mussels and bladder wrack have something of a love-hate relationship, as the mussels filter phytoplankton out of the water, which allows more life-giving light to reach bladder wrack.

But blue mussels compete with bladder wrack for space to anchor on the rocky sea bottom, and in recent decades the mussels have gained the upper hand thanks to an excess of nutrients from agricultural and sewage flows into the Baltic that feed the algal blooms that blue mussels love to eat. These algal blooms are also responsible for eutrophication, the existence of large low-oxygen "dead zones" in the Baltic. ■

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Galapagos Fishermen Pressed To Change Careers;

Ravaged Ecosystem Threatens Islands' Tourism Industry

By KIRSTEN JOHNSON
Associated Press

• Originally Published Feb. 22, 2009

Fisherman Luis Enrique Bonilla just wants to make a living. Galapagos Islands conservationists, worried that the marine reserve is overfished, want him to work in tourism.

Bonilla and the local fishermen he represents say a move from commercial fishing to boat tours is an expensive and complex prospect for which they have no money or training. They've already made concessions to preserve marine species: each owning only one small boat and using simple lines and lures to catch fish by hand.

But even with the restrictions, some species in the Galapagos Marine Reserve have been decimated — including the sea cucumber and lobster — putting even more pressure on fishermen forced to live off smaller catches.

As Charles Darwin's 200th birthday is celebrated this month, Bonilla's story shows just how hard it is to protect the archipelago's biodiversity that Darwin made famous. Changing livelihoods from those that destroy the islands to those that sustain them is easier said than done.

"I want to be able to sell more fish," Bonilla said. "Right now that's hard to do with the way the rules are."

The marine reserve, home to more than 3,000 species, has

CONTINUED ON PAGE 24



BY AP PHOTO/KIRSTEN JOHNSON

A sea lion waits to capture leftovers from fishermen cleaning their catch in Puerto Ayora, Galapagos, Monday, Jan. 5, 2009. The Galapagos National Park wants much of the fishing sector to become part of the tourism sector, but many fishermen lack the training and the capital to make the switch.

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suffered over the years from fishermen eager to exploit local, national and international markets, park officials say.

Edwin Naula, director of tourism and a former director of the Galapagos National Park, said it has been a struggle to get fishermen to comply with rules to protect the reserve.

"It's like when you have your children in the house and everything is out of order. And of course the children get angry when the father comes home and tells them to put things in order," he said.

Darwin, who was born Feb. 12, 1809, first arrived nearly 175 years ago, discovering the unique species that would become the basis for his theory of evolution. The spectacular subjects of his work, including finches, giant tortoises, marine iguanas and blue-footed boobies, now draw more than 150,000 tourists a year to the Ecuadorian islands about 600 miles offshore in the Pacific Ocean.

They were declared a UNESCO World Heritage Site in 1979 for the unique animal and plant species and added in 2007 to UNESCO's list of sites in danger from environmental threats or overuse.

Although the fishing industry is still the second-most lucrative in the Galapagos, it is far behind tourism — bringing about \$3 million to the islands' economy vs. \$63 million from tourism, according to the Charles Darwin Foundation and the Galapagos Institute.

Bonilla, 43, who came to the Galapagos Islands at age 11 from mainland Ecuador, has been fishing for most of his life. He carries a license and is president of the Santa Cruz Island fishing cooperative, a group of more than 200 fishermen on the major inhabited island among 22 main islands and scores of smaller ones.

Industrial fishing has been prohibited in the marine reserve since 1998. So fishermen — at least those who fish legally — are limited to what they can catch with artisan methods. Bonilla, whose crew at times is his shy 12-year-old son, Luis Jr., trolls with lures on fishing expeditions that can last up to four days.

He fishes in a fiberglass boat named the *Eagle Ray*, one of many small vessels called *fibras*, and has no money to invest in modern equipment that would make his work more efficient. His onboard refrigeration, for example, is an ice chest he fills in the morning before he leaves, limiting the size of fresh



BY LARIS KARKLIS—THE WASHINGTON POST

catches he can keep until he can sell them to cruise ships.

Cooperative members see the regulations on their industry as unnecessarily strict. But overfishing also has made it hard for them to make a living.

The sea cucumber population dropped dramatically in the past decade, said Matthias Wolff, director of marine and coastal sciences for the Charles Darwin Foundation.

In 2001, he said, about 8 million sea cucumbers were harvested and sold for as much as \$1 each in Taiwan. By 2008, a negotiated sea cucumber quota of 1.2 million was not even met.

Without the sea cucumber and lobster, fishermen have turned to other species, such as sharks, which are illegal to fish. Though he follows the rules, Bonilla said most fishermen have landed illegal species at some time or another.

The national park officials see an alternative business for the fishermen in tourism, either in fishing trips showing visitors their simple methods or in day trips to go snorkeling or hiking.

Bonilla says he can't make money on the first option, and the second is too expensive, requiring life jackets, canopies and bathrooms, among other modifications.

The fishermen are limited by their small boats in attracting enough passengers to make a profit that would justify their investment, he added. And very few speak languages other than Spanish.

The park has been promising tourism licenses exclusively for members of the fishing cooperatives since 2001, but they've been bogged down in bureaucracy and disputes over how the licenses would be granted. Cooperative members complain that non-fishermen are getting fishing licenses just to qualify for the tourism licenses when they become available.

Even for those who can get licenses, it is expensive to launch even a small tourist operation. The environmental impact study alone can cost up to \$15,000, Bonilla said, more than the \$9,000 to \$14,000 fishermen make in a year.

There are other start-up costs, and it is difficult for local residents to get loans.

"When it's for the tourism sector, they can do anything they want," he said, referring to the cruise ships. "But for the fishing sector, they want us to change our boats." Bonilla would be happy to see others switch to tourism. It is good for him as well as the park if fewer people are fishing the reserve.

But he would never dream of doing anything else. ■

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Major Shipping Route Fosters a Plague of Sea Life

By KARI LYDERSEN
Washington Post Staff Writer

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The St. Lawrence Seaway opened in 1959 to great fanfare. The system of canals connecting the Atlantic Ocean and the five Great Lakes cut a lucrative international trade route through the heartland and gave the United States a refuge and staging ground for ships and submarines in case of war with the Soviet Union.

No one expected the seaway to become the key player in a different war, the invasion of non-native aquatic species into the Great Lakes, which has dramatically altered ecosystems and costs hundreds of millions of dollars a year. About a third of the 186 invasive species in the Great Lakes are thought to have entered on oceangoing ships in the ballast water they take on for stabilization when carrying little or no cargo.

Zebra and quagga mussels from the Black Sea clog intake structures for municipal water systems and power plants. The mussels also gobble plankton so voraciously that little is left for other organisms. Round gobies and other invasive fish beat out native fish for food supplies, harming the lucrative commercial and sport fishing industries. Ballast is even blamed for the emergence of viral hemorrhagic septicemia, often called “fish ebola,” resulting in large fish kills in the past several years.

And as infected pleasure boats are hauled to other lakes or species swim and float into tributaries, or even the

Mississippi River, invasive species that came in with the ballast are spreading throughout the United States. Large quagga and zebra mussel colonies have been found in California and Nevada and are threatening to spread through California’s many miles of municipal water pipes.

“The seaway turned the Great Lakes into a North American beachhead for invasives from other continents,” said Jeff Alexander, author of the book *Pandora’s Locks: The Opening of the Great Lakes-St. Lawrence Seaway*. “There’s no telling how much more damage these critters will cause and how much more money they’ll cost us.”

There are no federal standards for ballast treatment, although the Environmental Protection Agency and the Coast Guard are working on requirements that should reduce the amount of live organisms in ballast water.

Since 1993, ships have been required to exchange their ballast in the Atlantic before entering the Seaway, replacing water from whatever port they had last visited with high-seas water containing little life.

But until 2008, U.S.-bound ships loaded with cargo and hence containing no ballast were exempt from any regulations. These ships are called NOBOBs, for No Ballast on Board. But their “empty” ballast tanks contain many tons of muddy slop teeming with bacteria, small marine organisms, eggs and larva.

NOBOBs typically unload their cargo — often steel — in Great Lakes ports like Detroit and Cleveland, suck water into their ballast tanks, then head to other Great Lakes ports — Duluth, Toledo or

Milwaukee — to load up on grain and dump their ballast, now mixed with the biologically rich mud.

Since last year, NOBOBs have been required to “swish and spit,” or wash their tanks out with salt water, before entering the Seaway. This is aimed at killing most invasive organisms that could survive in the Great Lakes, since the species of concern generally come from brackish European estuaries and their cells burst when immersed in ocean saltwater. The practice appears to have been effective, as no new invasive species have been reported in the Great Lakes since the “bloody red shrimp” made its 2006 debut, according to David Reid, a research scientist with the National Oceanic and Atmospheric Administration.

Nonetheless, scientists and legislators say the ballast water and mud that remain in tanks must be treated to avoid future invasive species or contamination by pathogens such as cholera, *E. coli* and cryptosporidium, which also can lurk in tanks.

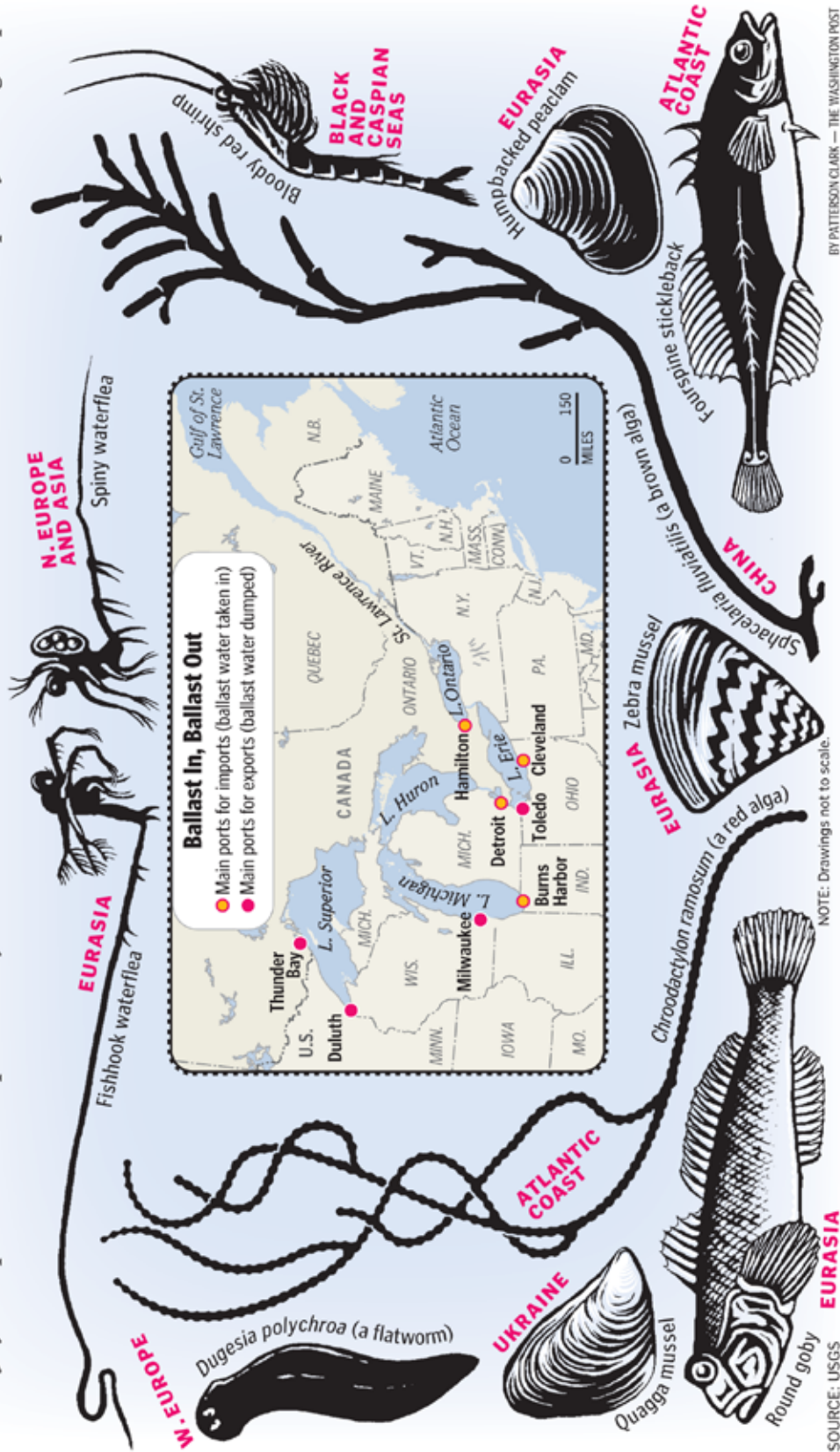
“Mother Nature always throws a variant at you,” Reid said. “There are organisms that can survive salt exposure and survive in the Great Lakes. Having well-documented functional treatment systems that do kill as many of the organisms in ballast as physically possible is a better idea than just relying on ballast exchange or salinity exposure with flushing.”

In 2004, the International Maritime Organization, part of the United Nations, drafted a treaty mandating that dumped ballast water contain no more than 10 live organisms larger than 50 micrometers

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Invaders From a Ship's Belly

Many of the aquatic invasive species now found in the Great Lakes were introduced in ballast water dumped by visiting ships.



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(about the width of a hair) per cubic meter of water. Pushing for stricter standards, the United States did not ratify the treaty, though it is the basis of permit requirements being considered by the EPA.

The Coast Guard issued long-awaited ballast regulations last week that basically mimic the International Maritime Organization's standards for five years and then become more stringent. The proposed regulations, open for a 90-day public comment period, are less ambitious than what environmentalists and many legislators say are needed to prevent more ballast-borne invasives.

For several years, Congress has considered legislation to set national ballast standards. The House passed a bill in 2008 that was supported by environmental and shipping interests, but the Senate did not pass it, partly because of fears raised by Sen. Barbara Boxer (D-Calif.) that the bill could preempt states' rights to regulate ballast.

With no federal action on ballast, states have been setting their own limits.

Steve Fisher, executive director of the American Great Lakes Ports Association, called different regulations in each state a "nightmare scenario." He said current technology cannot meet

New York's standards, which are 100 times stronger than the IMO treaty, and he expects that the state will have to close ports or relax its rules.

Jim Tierney, assistant commissioner for water resources at the New York State Department of Environmental Conservation, disagreed. "It's not that hard to kill things," he said. "You can heat them up, crush them, pressurize them, put a chemical on them. We think this is a problem that can be solved in a very economical fashion."

Environmental groups have called for a moratorium on St. Lawrence Seaway shipping or even closing the seaway altogether. Oceangoing vessels account for only about 5 percent of Great Lakes shipping, and studies by Grand Valley State University economists found that shifting that cargo to trains and trucks would cost only about \$55 million per year and actually result in 1,300 net jobs gained.

"There's no doubt it was an engineering marvel, but economically it's been an underachiever and an environmental disaster for the Great Lakes," said Alexander, the author. "The science shows if we did close the seaway, it would protect the lakes and wouldn't hurt us much economically. But the shipping industry should be given a chance to prove itself. Let's set a standard and give them a chance to meet it. If they can't meet it, it's time to stop letting these ships in." ■

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The Washington Post

AN INDEPENDENT NEWSPAPER

Signs of Life

WE INTERRUPT our usual (and justified) complaints about the sorry state of the Chesapeake Bay and its watershed to trumpet some good news. A five-year-old experiment 80 miles south of Washington has yielded an explosion of oyster life. Don't leap for the oyster forks, though. Replicating this success would be prohibitively expensive. And the danger that the thriving colony will be decimated by disease is ever-present. Still, there's reason to celebrate.

In 2004, researchers closed the Great Wicomico River in Virginia to oyster harvesting and planted two types of reefs made of old oyster shells over 87 acres. One was set a few inches over the river bottom, another piled one to two feet high. The taller reef gave baby oysters a place to latch onto that wasn't mired in the polluted muck on the bottom. This allowed the water-filtering bivalves to thrive. When researchers checked in on the oysters in 2007, they found an estimated 185 million of them. That's up to 1,000 oysters per square meter. Not only that, they also found an ecosystem humming around it.

That we find these results amazing just shows how bad things have gotten for the Chesapeake Bay and its 64,000-square-mile watershed. Because of centuries of overfishing and more recent pollution and disease, the oyster population is less than 1 percent of what it once was. The federal government has been trying to clean up the fabled waterway ever since President Reagan mentioned it in his 1984 State of the Union address. The Chesapeake Bay Program of the Environmental Protection Agency has spent about \$6 billion since then trying to restore its namesake's luster, to no avail. President Obama issued an executive order in May establishing the Federal Leadership Committee to better coordinate federal and state programs to save the bay. A draft of an overall strategy is due in the fall.

It would be great if the folks working on that committee could think about replicating the Great Wicomico River experiment throughout the watershed. But the price tag is out of reach. According to the Maryland Department of Natural Resources, the total cost for placing two feet of oyster shells on one acre of reef is estimated between \$80,000 and \$100,000. The agency says that 2,600 acres of oyster habitat are lost annually. For new reefs to offset these losses, up to \$260 million and 156 million bushels of oyster shells would be required. Still, there may be lessons, and glimmers of hope, in healthy oysters resisting the tides of history.

— August 6, 2009

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Academic Content Standards

This lesson addresses academic content standards of Maryland, Virginia and the District of Columbia.

Maryland

Science: By the end of Grade 8, students know and are able to do everything required at earlier grades and use evidence to support the idea that through reproduction (sexual and asexual, i.e., cuttings, selective breeding) genetic traits are passed from one generation to the next. (Genetics, MLO 3.8.4)

Science: The student will investigate how natural and man-made changes in environmental conditions will affect individual organisms and the dynamics of populations (depletion of food, destruction of habitats, disease, natural disasters, pollution, population increase, urbanization). (Ecology, CLG 3.5.3)

Virginia

Biology: The student will investigate and understand how populations change through time. Key concepts include:

- b) how genetic variation, reproductive strategies, and environmental pressures impact the survival of populations;
- c) how natural selection leads to adaptations;
- d) emergence of new species; and
- e) scientific explanations for biological evolution. (BIO.8)

Biology: The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include

- d) the effects of natural events and human activities on ecosystems (BIO.9)

Economics: The student will demonstrate knowledge of how economic decisions are made in the marketplace by

- a) applying the concepts of scarcity, resources, choice, opportunity cost, price, incentives, supply and demand, production and consumption. (CE.9a)

Washington, D.C.

Biology: Evolution and biodiversity are the result of genetic changes that occur in constantly changing environments. (B.5. Broad Concept)

3. Research and explain how natural selection provides a mechanism for evolution and leads to organisms that are optimally suited for survival in particular environments.

7. Research and explain that Darwin argued that only biologically inherited characteristics could be passed on to offspring, and that some of these characteristics would be different from the average and advantageous in surviving and reproducing; over generations, accumulation of these inherited advantages would lead to a new species.

The Maryland Voluntary State Curriculum Content Standards can be found online at <http://mdk12.org/assessments/vsc/index.html>.

Standards of Learning currently in effect for Virginia Public Schools can be found online at www.pen.k12.va.us/VDOE/Superintendent/Sols/home.shtml.

Learning Standards for DCPS are found online at www.k12.dc.us/dcps/Standards/standardsHome.htm.