Ripple Marks

The Story Behind the Story

BY CHERYL LYN DYBAS

Getting in the Way of a Big Ship Might Kill You: From Heart Disease or Lung Cancer

THE NEXT TIME you visit your doctor, he or she may ask about more than your diet and exercise: how close you live to a major shipping lane may be on the list of questions.

Pollution from marine shipping causes some 60,000 premature cardiopulmonary and lung cancer deaths, according to James Corbett of the University of Delaware, James Winebrake from the Rochester Institute of Technology, and colleagues, who published their results in the December 15, 2007, issue of the journal *Environmental Science & Technology*.

For the first time, the findings put a number on annual deaths caused worldwide by pollution from marine vessels, and show that the coastal regions of Asia and Europe are the most affected.

Corbett's and Winebrake's research correlates the global distribution of particulate matter—black carbon, sulfur, nitrogen, and organic particles—released from ships' smokestacks with heart disease and lung cancer mortality in adults.

The scientists estimate that annual mortality from ship emissions could increase 40% by 2012.

"Epidemiological studies consistently link concentrations of particulate matter to negative health impacts," said Corbett, "including asthma, heart attacks, hospital admissions, and premature mortality."

Annually, ocean-going ships are estimated to emit 1.2–1.6 million metric tons of particulate matter. Nearly 70% of these emissions occur within 400 km of land, said Corbett.

"Although emissions from international ships are increasingly a focus for proposed regulations in local, national, and international arenas," he said, "in many ways the deliberations have not been fully informed. The extent of shipping emissions-related health impacts has been unknown."

Previous assessments, say the researchers, focused on European or western US regions, and ignored long-range and hemispheric pollutant transport.

Annual deaths related to shipping emissions in Europe are estimated at 26,710, while these deaths reached 19,870 in East Asia and 9,950 in South Asia. North America has approximately 5,000 premature deaths, concentrated in the Gulf Coast, the West Coast and the Northeast. The eastern coast of South America has 790 such deaths.

Ships run on residual oil, said Winebrake, which has sulfur content thousands of times greater than on-road diesel fuel. "Residual oil is a byproduct of the refinery process, and tends to be much dirtier than other petroleum products.

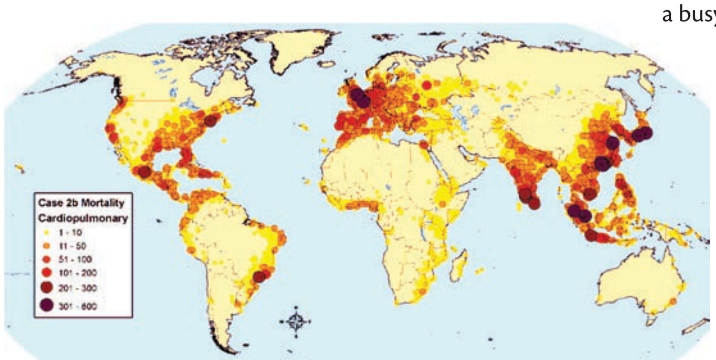
"We needed to know what the benefits are of cleaning up this fuel. Now we can evaluate the health impacts of policies to require low-sulfur fuels for the shipping industry, or that require ships to put emissions control technology on their vessels."

Until recently, scientists had few data with which to work. Emissions data for marine vessels were linked to data tracking the movements of ships around the world. Corbett and Winebrake mapped marine pollution concentrations over the oceans and on land, estimating global and regional mortalities from ship emissions by integrating ship inventories, atmospheric models, and health-impacts analyses.

Their study didn't address effects on children, or other health issues like respiratory disease, asthma, hospital admissions, or the economic impact of missed workdays and lost productivity.

"Our research quantifies the baseline estimates of mortality due to ship emissions, from which future work could estimate mitigation benefits," said Corbett.

For now, his advice is: don't live near a busy port.

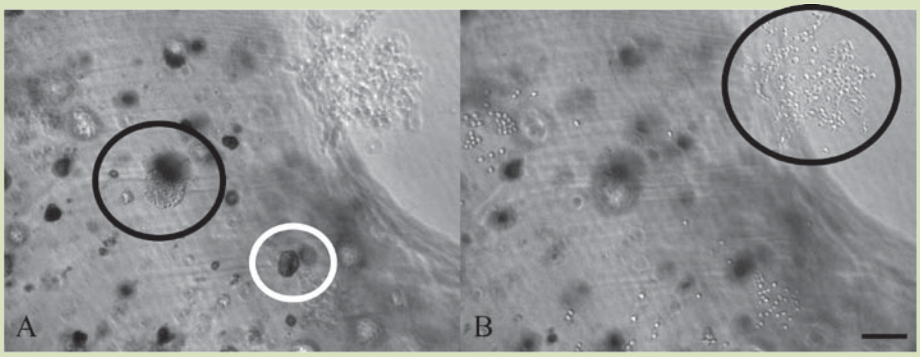


Cardiopulmonary mortality attributable to ship particulate matter emissions worldwide. *Figure 2 from Corbett et al., Mortality from ships: A global assessment. Reprinted with permission from* Environmental Science & Technology *41(24): 8,512-8,518. Copyright 2007 American Chemical Society.*

Alchemy at Work? Seaweed Transformed into Stem Cell Technology

A POLYMER FOUND in common brown seaweeds has been transformed into a device that can support the growth and release of stem cells at the site of an injury or the source of a disease.

The device, say the scientists, Randolph Ashton and Ravi Kane of Rensselaer Polytechnic Institute in Troy, New York, and their colleagues, marks an important step in efforts to develop new medical therapies using stem cells. They published results of their research online in the journal *Biomaterials* on September 19, 2007.



Release of neural progenitor cells (NPCs) from degradable alginate scaffolds. (A) Photograph of a degrading alginate hydrogel with a proliferating cluster of NPCs circled in black and a poly (lactide-co-glycolide) microsphere releasing alginate lyase circled in white. (B) Photograph of the same degrading alginate hydrogel at a different focal plane, i.e. the bottom of the culture plate, where NPCs released from the hydrogel are growing as a (circled in black) in contrast to the cluster growth observed in (A). Scale bar is 100 microns. *Courtesy of Ravi Kane.*

"We've developed a scaffold for stem cell culture that can degrade in the body at a controlled rate," said Kane, a chemical and biological engineer. "We can foster the growth of stem cells in the scaffold and direct how, when, and where we want them to be released."

The research team created the scaffold from a material known as alginate. Alginate is a complex carbohydrate found naturally in brown seaweeds, including *Macrocystis pyrifera*, *Ascophyllum nodosum*, and various species of *Laminaria*. When mixed with calcium, alginate gels into a rigid, three-dimensional mesh.

The scaffold, said Kane, could be widely used in regenerative medicine. The scientists hope the scaffold might release healthy bone stem cells at the site of a broken arm or leg, or neural stem cells in a brain affected by Alzheimer's disease.

In their experiments, the scientists encapsulated healthy neural stem cells in alginate mesh, producing a three-dimensional scaffold that degrades at a controlled rate. Once the scaffold was implanted in a body, the researchers used an enzyme called alginate lyase, which dissolves alginate, to release the embedded stem cells.

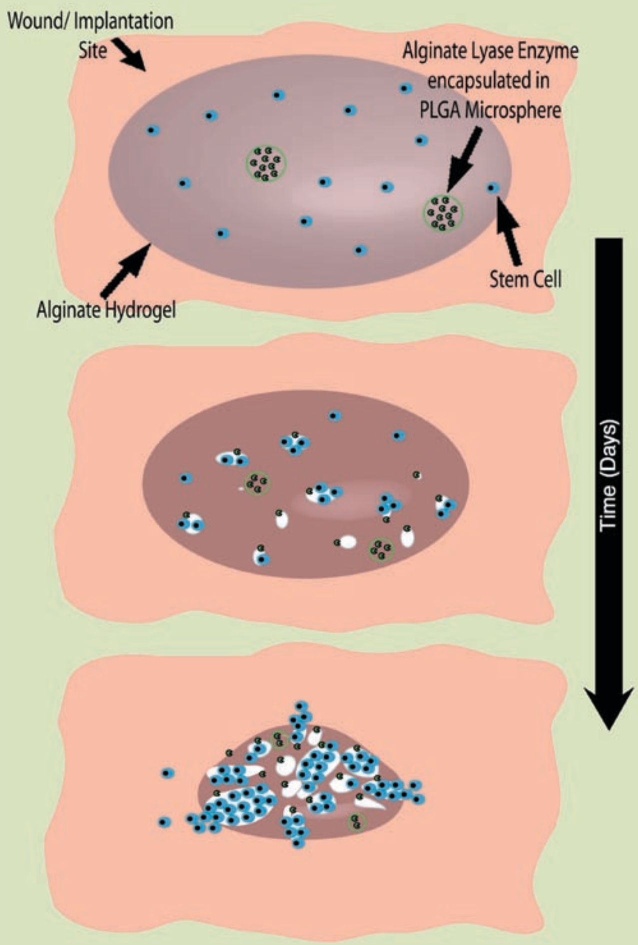
"Alginate lyase is naturally produced in some marine animals and bacterial strains," said Kane, "but not in humans."

To control the degradation of the scaffold, the researchers encapsulated varying amounts of alginate lyase into microscale beads, or microspheres. The microspheres were then placed in the larger alginate scaffolds, along with stem cells.

As the microspheres degraded, the alginate lyase enzyme was released into the scaffold and slowly began to eat away at its surface, releasing healthy stem cells in a controlled manner.

The microspheres, say the scientists, might be filled with more than alginate lyase and stem cells. "We can add drug molecules or proteins that, when released into the scaffold, could influence stem cells to become a certain type of mature, differentiated cell, such as a neuron."

Tangled brown seaweed, knotted and washed up along the shore, may be the next hot commodity.



Courtesy of Ravi Kane.

First International Deep-Sea Marine Protected Area Proposed

Courtesy of IFREMER

IN THE DARK ABYSS of the Pacific Ocean, in the Clarion-Clipperton Zone (CCZ) west of Central America, lie the world's largest fields of manganese nodules—boulders of rock laden with nickel, copper, and cobalt strewn across the seafloor. This vast resource soon may attract mining companies.

In an effort to safeguard biodiversity and ecosystems in the CCZ, deep-sea biologist Craig Smith of the University of Hawaii and colleagues are designing Preservation Reference Areas (PRAs). They hope that PRAs will form the largest network of marine protected areas in the world, the first in international waters—and the first created before exploitation of a resource.

Other scientists involved in the CCZ PRA effort include Tony Koslow of the Scripps Institution of Oceanography, Les Watling of the University of Hawaii, Malcolm Clark of the New Zealand National Institute of Water & Atmospheric Research, and Steven Gaines of the University of California at Santa Barbara.

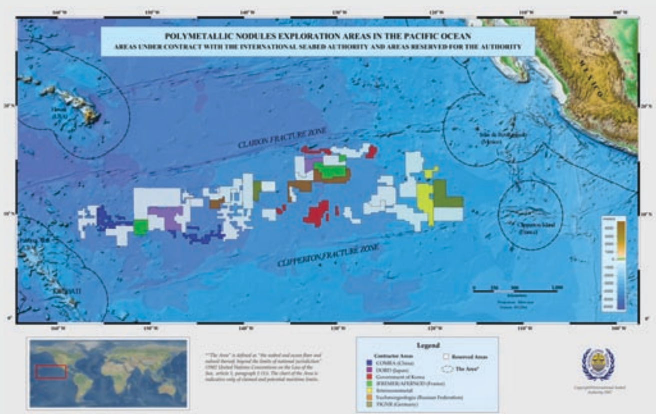
"Abyssal manganese nodule mining will affect large areas of the seafloor due to direct mining disturbance of 300 to 600 square kilometers each year," said Smith. "And redeposition of stirred-up sediment plumes will impact locations 10 to 100 kilometers from the mining sites."

Each mining claim area covers 75,000 square kilometers of seafloor. Over the likely 15-year time period of an individual mining operation, said Smith, "virtually anywhere within the claim could be mined, so for conservation management, the entire claim area must be considered to be directly impacted."

Benthic ecosystem recovery from mining will be extremely slow, requiring decades for soft-sediment fauna—and thousands to millions of years for biota living on manganese nodules—to return. "The slow ecosystem recovery rates of the abyssal seafloor will cause widespread environmental impacts across the Clarion-Clipperton Zone," said Smith.

Smith brought together a group of marine scientists in Hawaii last October. Their charge: to design a network of protected areas in the CCZ and present their findings to the International Seabed Authority, which regulates the exploitation of seabed minerals in international waters. The oceanographers identified nine different habitats in the CCZ. Their plan, therefore, interconnects nine protected areas covering 1.44 million square kilometers, or some one-fourth of the zone.

Smith and others believe that each PRA should protect the full range of habitats found in its subregion. Abyssal plains/abyssal hills, seamounts, and fracture zones are common habitats in the CCZ.



This chart is indicative only of claimed and potential maritime limits, including the extent of the area, and is not to be used for navigation purposes.

Abyssal plains/hills cover most of the CCZ floor. Manganese abundance there varies from zero, said Smith, to an ocean bottom nearly completely obscured by nodules. Seamounts, with summits greater than 1,000 meters above the seafloor, and fracture zones, are also found in the CCZ. "These features represent distinct habitat types," said Smith, "with the potential to harbor unique or particularly vulnerable communities of animals. They also provide critical ecological habitat, for example, for deep-sea fish spawning."

With their raised surfaces, seamount habitats are especially likely to be affected by sediment plumes. "We're recommending that as many seamounts as possible, with a target of at least 40%, be included in the PRAs," said Smith.

Other suggestions of the group are that each PRA core area be surrounded by a buffer zone 100-km wide to ensure that the core is not affected by mining. To meet that goal, each PRA would need to be 400 square kilometers.

That dimension comes close to conservation guidelines of protecting 30–50% of available habitat to prevent losses of biodiversity. "It also approaches," said Smith, "the U.N. Millennium Development goal of placing 30% of the world's oceans in reserves.

"We hope that this effort will set a precedent for protecting seabed diversity—a common heritage of mankind."

Bear Predation Drives Salmon to Old Age

THE ANNUAL FISH FEAST enjoyed by brown bears in southwest Alaska as spawning sockeye salmon migrate upriver affects the rate at which the salmon age, according to scientist Stephanie Carlson, currently at the University of California at Santa Cruz. She and colleagues published their results in the December 2007 issue of the journal *PLoS ONE*.

Carlson studied salmon senescence—the process of a living organism approaching advanced age—in Southwest Alaska rivers in the Wood River Lakes area, during several levels of bear predation.

Bears, like humans, prefer to eat fresher, healthier fish, but the extra vitality of these fish makes them harder to catch, Carlson found. "So it's only in smaller streams, where struggling salmon are more vulnerable, that bears are able to exercise a choice," she said.

Where bears ate more exhausted fish, those fish populations aged more slowly. The findings suggest that the bears' eating habits are having an effect on the evolution of salmon senescence.

Evolutionary theory predicts that populations experiencing higher rates of environmentally caused (extrinsic) mortality should senesce, or age, more rapidly, but this theory neglects relationships between an individual's age and its susceptibility to extrinsic mortality, the researchers wrote in their paper.

Photos courtesy of Thomas Quinn.

They related senescence rates of sockeye salmon in six Alaska populations to the overall rate of extrinsic mortality, and to the degree of condition dependence (what condition the fish were in when they arrived at their natal streams).

Senescence rates were determined by modeling the mortality of individually tagged breeding salmon at each site.

Sockeye salmon in the study area return from the ocean in late June and then shoal in lakes adjacent to their natal streams for a few weeks until they have matured.

The salmon then enter natal streams over a period of two to four weeks, said Carlson. Each individual may live for another one to three weeks before dying of senescence—if it does not succumb first to predation or stranding.

Sockeye salmon populations where bears selectively killed fish showing advanced senescence were those that aged the least rapidly.

If you're a sockeye salmon, reaching a ripe old age may get you eaten by a bear, but take a last look around: you and your creek-mates will have the piscine equivalent of fewer wrinkles than any other fish you know.

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