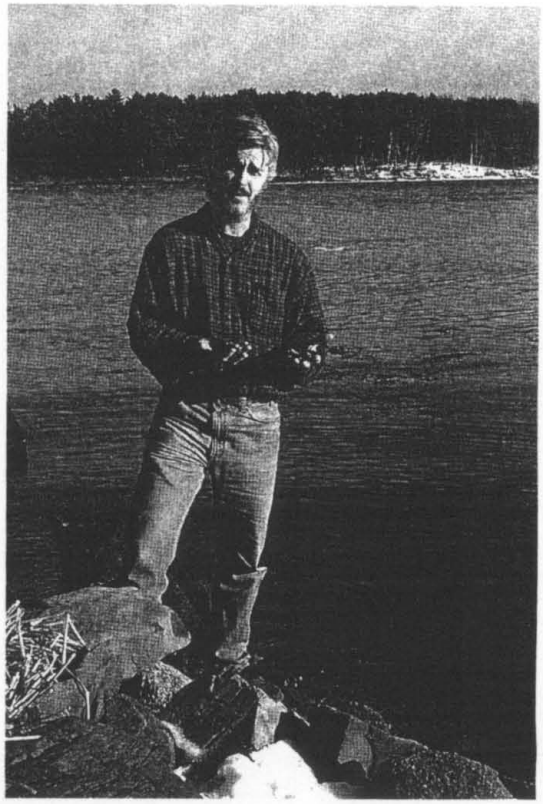
Blue Mussels as Biomonitors

Gulf of Maine Bivalves Reveal Pollution Hotspots



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-Stephen Jones

Story and photo by Catherine Schmitt

When the tank vessel *Provence* spilled 1,000 gallons of heavy, number six oil into the Piscataqua River in 1996, scientists and managers turned to the blue mussel for perspective. A program called Gulfwatch had been using mussels to monitor for contaminants in New Hampshire's coastal waters. Data collected from a nearby mussel-monitoring site a few years before served as useful background for assessing the effects of the oil spill. Mussel tissue showed a sharp increase in petroleum compounds in the weeks following the spill, and a subsequent recovery in the years following the spill. If the mussels had not been monitored before the spill, it would have been much more difficult to measure the environmental impact and recovery.

Blue mussels have been used throughout the world to measure chemical exposure. Mussel monitoring is part of Gulfwatch, an international program that has monitored the level and extent of chemical contamination in the Gulf of Maine since 1991. More than 75 sites are monitored for toxic metals, pesticides, oil and industrial pollutants. Gulfwatch data is used by state and provincial environmental managers, The Gulf of Maine Council on the Marine Environment, researchers, scientists and citizen monitoring groups.

Blue mussels make great bioindicators. They are native and abundant in the Gulf of Maine. They don't move around, so they can be placed in specific locations and easily collected and transported. Much is known about their biology and habitat. Also, mussels are a commercially important food species, and mussel aquaculture is a growing industry in the region, making contamination a concern for human health. Despite a wealth of information on the effects of toxic contaminants on a variety of animal species, limited data is available on the human health effects of consumption of chemically contaminated shellfish. While few sites have mussel tissue contaminant concentrations that exceed Canadian or American seafood human health tolerances, some have levels that are high enough to warrant evaluations of potential human health risk.

Most importantly, mussels are suspension feeders. "Mussels have the capacity to filter incredible amounts of water," says Dr. Stephen Jones, Gulfwatch project manager and University of New Hampshire professor. As mussels pump large volumes of water through their bodies to obtain food particles, any chemicals that may be in the water concentrate in their tissues. Amounts of a chemical in the surrounding water accumulate to levels that can be measured, and also represent the exposure actually experienced by living organisms.

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The Gulfwatch program is effective for more than isolated incidents, like the Piscataqua River spill; it also gives a regional perspective. "Gulfwatch is one of the few truly region-wide monitoring efforts in existence," says Jones. Monitoring such a large area allows for a regional perspective of the Gulf, and results have shown that levels of organic contaminants in mussels increase from northeast to southwest. Most of these substances come from human activities, so it is expected that concentrations will be higher in areas of greater population density. For metal contamination, trends are less clear. Elevated levels of mercury occur over a wide area throughout the Gulf of Maine, suggesting this contaminant does not come from a single local source but a more regional input. In contrast, elevated levels of lead and silver occur in specific study sites, suggesting local sources of these metals.

There are some "hotspot" areas of metal contamination, however. Scientists were surprised to find elevated silver levels in mussels in Sandwich, Massachusetts, a site off Cape Cod thought to be relatively pristine. Large amounts of silver are found in discharges of municipal sewage. Approximately 300 billion gallons of wastewater are discharged annually into the Gulf of Maine. Over one billion gallons were historically discharged into Boston Harbor alone, where concentrations of silver are up to 1,000 times higher than the rest of the Gulf of Maine. Scientists now believe that silver-containing particles remain suspended in the water, where they can be transported further into Cape Cod Bay.

Not all contamination is associated with a large population center. According to Jim Stahlnecker, a biologist with the Maine Department of Environmental Protection (DEP), Division of Environmental Assessment, who samples mussels for Gulfwatch, low levels of copper and zinc are widespread in Maine's coastal waters. These metals are leached from the bottom paint of small boats, and are found wherever there is boat traffic.

Lead levels in Boothbay Harbor, Maine, are higher than at other sites; the specific source is not known. New Hampshire waters also have elevated lead concentrations, which may be related to the nearby Portsmouth Naval Shipyard, where numerous and varied hazardous wastes were buried, disposed or stored.

How do these levels compare to other areas in the U.S.? The National Oceanic and Atmospheric Administration's National Status and Trends Program uses the blue mussel to monitor toxics at 274 coastal sites around the country, half of which are near urban areas. Gulfwatch data can be compared to national data for greater perspective. For example, mercury levels in the Gulf of Maine are unusually high, especially in New Hampshire. More than half of the mercury deposited on the northeastern U.S. and Canada originates from sources outside the region (primarily airborne pollutants from upwind industrial sources). Mercury falling onto the land is washed into rivers, where it combines with direct inputs of the chemical and eventually reaches the sea.

Have things improved over time in the Gulf of Maine? "Our ability to say something about change over time is relatively minimal," says Jones. This is in part due to the limited number of sampling years. Trends may emerge with more years of monitoring. There appear to be overall decreases in most contaminants, with the exception of polycyclic aromatic hydrocarbons (PAHs), which are increasing in some areas. PAHs typically come from the combustion of petroleum products. They are washed into rivers and bays during storms, or may be directly introduced into marine waters from ships and boats.

As shown by the case of the *Provence*, information from an existing long-term monitoring program such as Gulfwatch serves as a baseline against which scientists can measure the impacts of environmental accidents and disasters. "If you have background data, it helps to gauge the extent to which something has been contaminated from a discreet pollution event," says Jones.

"Long-term data sets are really helpful," agrees Jim Stahlnecker of the Maine DEP. While Gulfwatch managers are continually evaluating which chemicals to test for and which sites to sample from, consistency is important. "There's always the pressure as well as the temptation to do things in a new way," says Stahlnecker, "but you sacrifice the ability to compare to the data you've accumulated."