

SEA OTTERS NEED SO MANY CALORIES, THEY TEND TO EAT FREQUENTLY THROUGHOUT THE DAY.

Save the Sea Otters

TOXIC ALGAL BLOOMS ARE MAKING BIRDS AND MAMMALS SICK. CLIMATE CHANGE ISN'T JUST HEATING THE OCEAN, IT'S POISONING IT, TOO.

BY JILL NEIMARK

IN JULY 2017, A YOUNG male sea otter was found, stranded and weak, on a northern California beach. "He was lethargic, underweight, depressed and not able to stand," recalls Cary Field, medical director of the world's largest marine mammal hospital, headquartered in Sausalito, California. Rescuers named the sea otter Yankee Doodle and took him to the hospital for rehabilitation.

Field, who is both a veterinarian and a zoologist, suspected Yankee Doodle's problem was domoic acid poisoning. Domoic acid is a biotoxin produced by microscopic algae called *Pseudo-nitschzia*; harmful blooms and outbreaks of the algae are increasing in frequency worldwide.

This particular algae is not alone. Ocean warming since the 1980s has greatly expanded the niche of toxic algal blooms in both the North Atlantic and North Pacific oceans. The blooms flourish in the warming oceans, which have become especially heated in the past five years. Growth is propelled still more with the runoff of nitrogen-rich fertilizer from farms. A 2015 bloom was so enormous, it reached from Santa Barbara, California, to Alaska, closing fisheries along the way.

The toxin-producing algae accumulate in microscopic animals called zooplankton, shellfish and fish, moving up the food chain to sea otters, sea lions, seabirds and humans, who eat shellfish and fish. The impacts of long-term low-level exposure are of particular concern. Scientific research shows domoic acid poisoning can be both acute and chronic, damaging the brain and the heart.

When Yankee Doodle was brought to the marine mammal hospital, magnetic resonance imaging showed that his hippocampus, a brain region responsible for learning and memory, was impaired. This is a telltale sign of domoic acid poisoning. The acid mimics the neurotransmitter glutamate, leading to overactivation of hippocampus nerve cells.

For three months, Yankee Doodle got medication; his own special pool at the hospital; and a delicious diet of clams, mussels, shrimp and squid. Finally given a clean bill of health, he was released, and as he swam into the welcoming ocean, he turned around several times to look at his rescuers, as if to thank them for saving his life. Tags on his flipper soon identified him hundreds of miles north.

Not all sea otters are as lucky as Yankee Doodle. Field says the hospital's network feeds as many as a thousand sea otters and sea lions annually. Many are so sick, they are discovered comatose; suffer from vomiting, hallucinations and seizures; and are euthanized. "It's horrifying," says Field of the endearing creatures, who when healthy are seen cuddling with their siblings or lying in the ocean on their backs with a rock on their stomach, cracking fresh crabs and clams and enjoying their marine feasts. "These animals are giving us a clear message," says Field. "The ocean is off-balance."

Sea otters, along with sea lions, are vulnerable to algal blooms because of their dependence on shellfish and fish.

Otters have no blubber to keep them warm, so they eat around a quarter of their body weight in food each day, feasting on squid, sea urchins, clams, snails, shrimp and more.

They are also a keystone species, meaning they are critical to balancing ocean ecosystems such as the kelp forests they like to nest in. These kelp forests are home to many marine animals and absorb carbon, helping reduce global warming. When sea otter populations decline, sea urchins overpopulate and then devour kelp, toppling the delicate balance.

Today, sea otters are protected from hunting by the Marine Mammal Protection Act and the Endangered Species Act. But increasing algal blooms may eventually render that protection inadequate.

"Sea otters are sentinel species, like canaries in the coal mine," says wildlife veterinarian Megan Moriarty. Moriarty and her colleagues at the University of California, Davis found that domoic acid accumulates not just in the animal's brain but also in the heart and may be responsible for cardiomyopathy, a deadly heart condition that often kills sea otters. In a recent study, they looked at domoic acid levels as well as the life histories of 186 sea otters from 2001 and 2017. Forty-eight of those otters died, and an astonishing 34 had died of heart disease. The study found that sea otters have a 1.7 times higher risk of dying from heart disease if they have been exposed to high levels of the toxin within the past year. For those otters with a diet high in crabs and clams, the risk was 2.5 times higher. And young adults of reproductive age (about 4 years old) were at 2.3 times the risk of dying from heart disease when exposed to high levels of the toxin.

Moriarty says this research suggests there may be similar impacts for human health as well, since chronic exposures to domoic acid, repeated over a lifetime, might damage the human heart and brain in ways we aren't yet aware of. Currently, around 60,000 humans a year are poisoned by harmful algal blooms.

"Even if people follow public health rules and avoid shellfish when levels of domoic acid are high," Moriarty says, "long-term, chronic exposure over a lifetime may have harmful effects. Sea otters are the tip of the iceberg. The impacts of this toxin are much deeper than we thought." Indeed, an eight-year study of 500 Native Americans living along the coast of the Pacific Northwest who had a diet high in shellfish and clams found there was a significant but small decline in memory recall associated with chronic, low-level domoic acid exposure.

Moriarty and her colleagues are now finishing up a study looking at domoic acid in light of climate change, warming oceans and the projected future levels of the toxin over the next 15 years. She says the initial results show that domoic acid exposure may be particularly detrimental for adult sea otters during their prime reproductive years.

Meanwhile, back at the marine mammal hospital, 24,000 sea animals have been rescued to date. "Every animal has a story to tell," says Cary Field. "And their stories tell us that we need to change our ways." •

ACID OCEANS

ALGAL BLOOMS ARE HARDLY THE ONLY ACIDIC THREAT TO OCEAN LIFE; BECAUSE OF CLIMATE CHANGE, THE OCEAN WATERS THEMSELVES ARE BECOMING ACIDIC AT AN ALARMING RATE.

Oceans absorb heat from the atmosphere—but at a cost. Since 1960, surface waters of the ocean have become 30% more acidic, and it's projected that by the end of this century, oceans will be twice as acidic as they once were.

Here's how it works. As the concentration of carbon dioxide in our atmosphere goes up, oceans become both warmer and more acidic. The extra carbon dioxide dissolves in the salty water, forming a weak acid called carbonic acid. Carbonic acid then breaks down into bicarbonate and hydrogen, which is acidic. At the same time, there is less calcium carbonate, which clams, crabs, corals and phytoplankton, among others, need in order to grow their shells and thrive. In fact, some vulnerable species, such as the "sea butterfly," a sea snail the size of a pea, see their shells literally start dissolving, Coral reefs, which provide a home for sponges, oysters, clams, crabs, sea stars, sea urchins, fish and algae, are harmed by warm, acid oceans too. As water heats up, corals literally expel their algae, losing the important nutrients the algae offered. This loss is called bleaching (see "Ecosystem Rescue," page 66). But the phenomenon is made much worse when levels of acid in the ocean increase, depriving coral communities of the quantities of calcium carbonate they need to grow strong skeletons and spring back to life.

