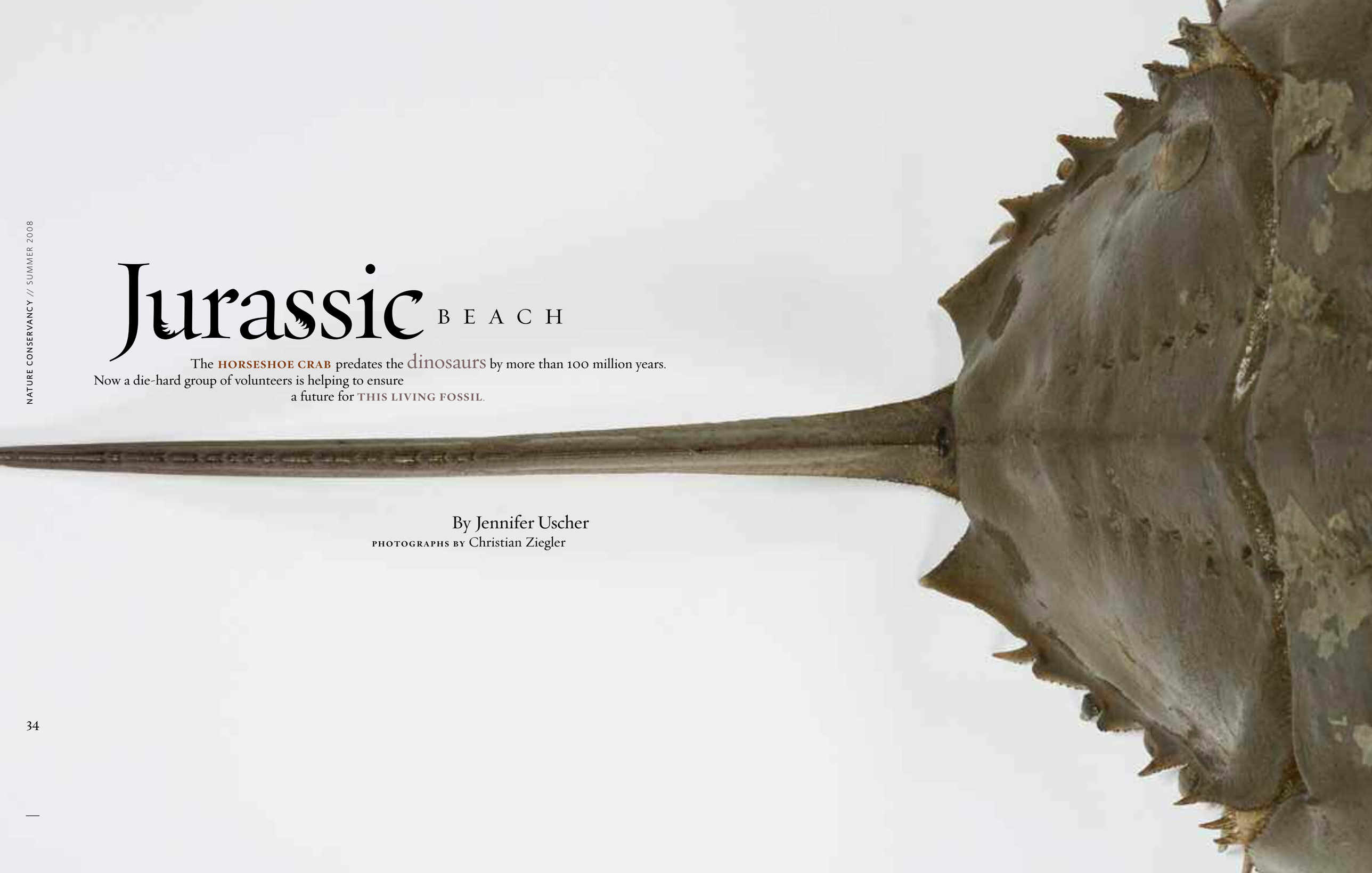
Jurassic BEACH

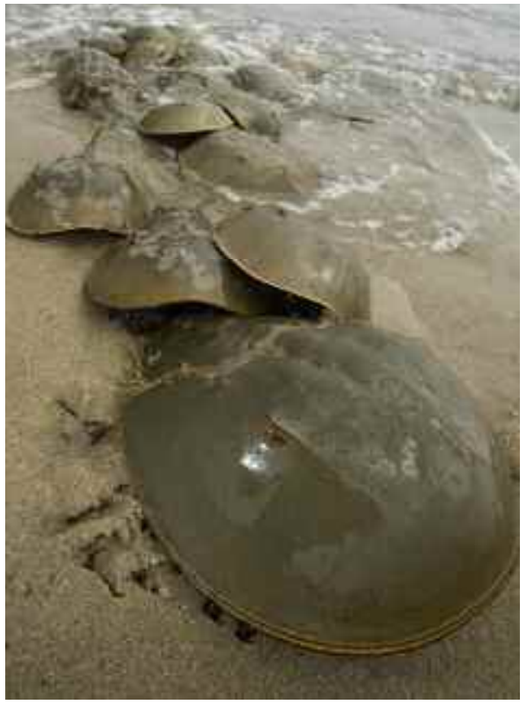
The **HORSESHOE CRAB** predates the dinosaurs by more than 100 million years. Now a die-hard group of volunteers is helping to ensure a future for **THIS LIVING FOSSIL**.



By Jennifer Uscher

PHOTOGRAPHS BY Christian Ziegler

ARMORED CRAB: Despite its fierce-looking shell and a tail that is often mistaken for a stinger, the horseshoe crab is harmless to beach goers.



IT'S NEAR MIDNIGHT WHEN BOB BROZEK STEPS through the rolling surf at Delaware's Big Stone Beach, suited up in knee-high rubber boots, a windbreaker and a headlamp. Hours earlier he finished his shift at the Valero oil refinery 25 miles away in Delaware City, where he works as an inspector, climbing inside giant storage tanks and boilers to check for cracks and defects.

On this misty May night, Brozek has strong-armed a team of his buddies from the refinery to forgo their usual weekend activities in favor of helping out with a massive environmental monitoring project. Joe Matlack, 60, dressed in a protective Tyvek suit, and Jamie Arpino, 49, in neon-yellow waterproof pants and rubber boots, trudge across the sand with the 55-year-old Brozek. They haul along essential tools for the evening—a white rope with knots tied every 3 feet, a clipboard and a collection of plastic pipes.

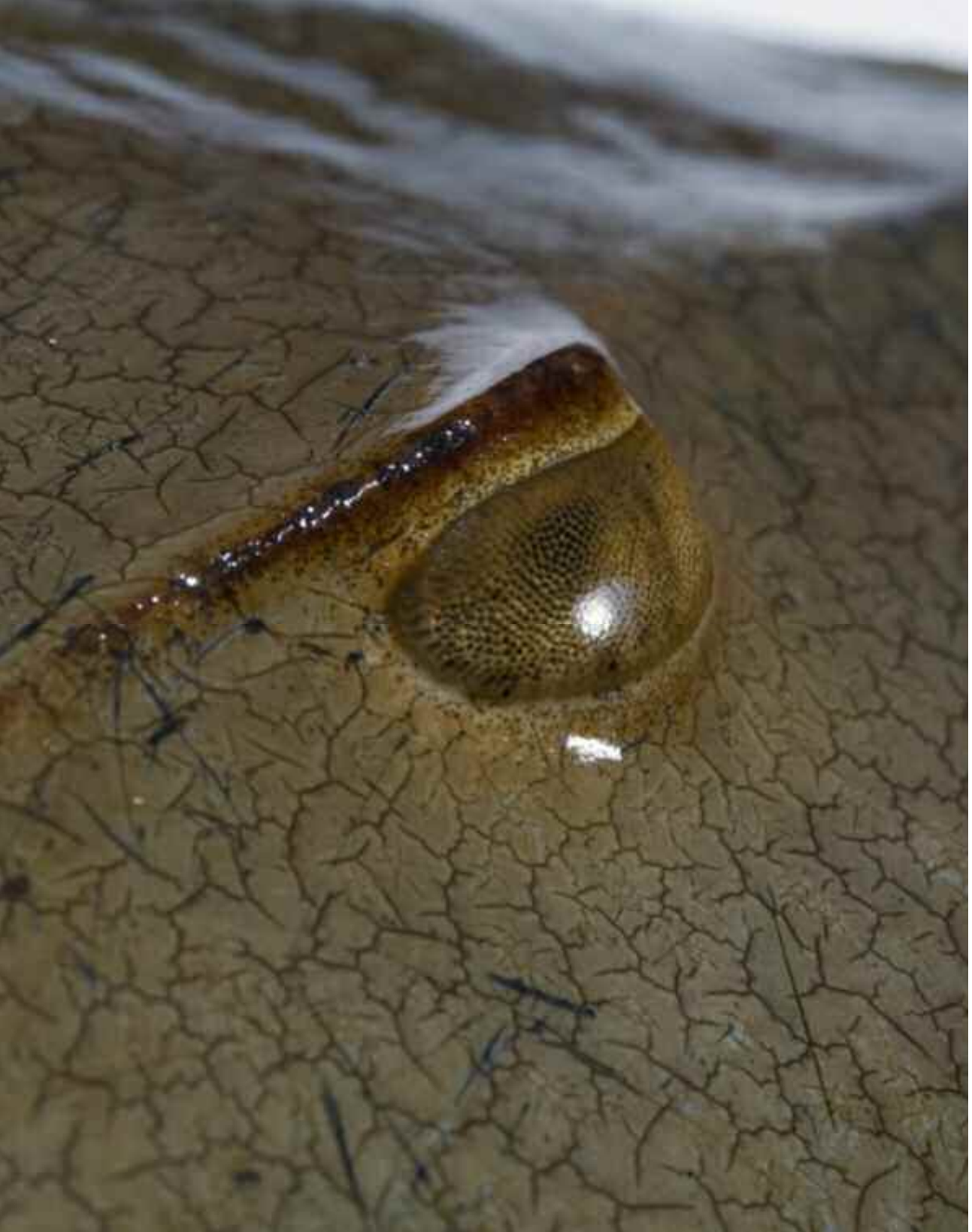
Farther up the beach, Lois Davis watches the progress of Brozek's crew. For the past four years, she has coordinated Nature Conservancy volunteers helping to count horseshoe crabs at Big Stone Beach, which is part of the Conservancy's Milford Neck Preserve, and at the adjoining Bennett's Beach. Each spring, during all 12 evening high tides in May and June, more than 200 people turn out to help. "There's a lot of concern about the crab," Davis says.

As the high tide rolls in wave by wave, hundreds of horseshoe crabs appear out of the foamy surf, dragging their bodies up the beach in an annual ritual known as a spawning aggregation (see "Delaware's Dinosaur," page 40). The light from the team's headlamps outlines olive-green shells, sharp stingerlike tails and dark unblinking eyes advancing up the beach.

The team moves into action, laying down a giant square fashioned out of white plastic pipes. Holding the clipboard, Brozek tallies up the number of male and female crabs inside the plastic quadrant positioned in the sand. When he finishes counting, the team picks up the square and uses the knots on the rope to measure a few yards down the beach, where they begin another tally. "We're seeing way, way more crabs this year," says Brozek, struggling to avoid stepping on their shells. "Last year, we were happy if we got three or four when we threw down the square."

Brozek has participated in the crab counts for the past two years. While he's quick to point out that he's no tree-hugger, he and his co-workers from the refinery are happy to help out this bottom-dwelling underdog. And though Brozek says "the whales and seals get all the glory," in the past decade this creature, which vaguely resembles an old Buick, has become a sort of mascot for the mid-Atlantic seaboard. Delaware even voted to make the horseshoe the state's official marine animal.

Increased interest in the crab is no accident. Studies



indicate its numbers had plummeted in recent years, placing the crab at the center of an ongoing series of public debates, legislative battles and legal challenges over its management.

As it turns out, beneath that tanklike exterior lies a vulnerable creature whose well-being has widespread ramifications for ecosystems and economies alike—and even for human health. Now, more than ever, researchers are counting on volunteers like Brozek's team to help them round up the data they need to get the crab population back on an even keel.

Lifesaver

THROUGHOUT MOST OF THE PAST CENTURY, THE horseshoe crab never registered as much more than an oddity for beach goers to step around. From the mid-1800s to the 1950s, a few outfits collected horseshoes on beaches or in nets, dried them and ground them into a nitrogen-rich fertilizer for crops. "My grandparents fed them to their chickens and their hogs; it was the only thing they were good for," says Bill Hall, a marine researcher and education specialist at the University of Delaware.

Then, in the 1950s, scientists discovered a compound in the crab's copper-based blood that clots when it comes into contact with harmful bacteria. Many countries, including the United States, now require that the biomedical industry use this compound, called lysate, to test just about any object or substance used during a medical procedure that could cause infection—syringes, scalpels, intravenous drugs.

"Most people have no idea," says Hall. "They put the horseshoe crab right up there with the mosquito in terms of its value to people." But thanks to lysate's ability to alert against infection, the horseshoe crab has helped save many lives—more than a million people, according to one estimate—since the compound was discovered.

To supply the biomedical industry with this anti-infection compound, however, approximately 300,000 crabs are caught and bled each year. While some of these crabs are returned to the ocean, only a little worse for the wear, as much as 40 percent of the catch dies from the trauma or is sold to the bait industry. Bill Hall helped start the crab count in 1990 in part to monitor the impact of the biomedical industry, which had—and still has—a huge stake in sustainably managing the horseshoe harvest. "This crab saves lives," says Hall. "There is nothing to replace it."

While the biomedical industry's limited catch was not considered a major threat to the horseshoe crab population, in the mid-1990s Hall and others began to notice signs that something was going wrong with the numbers of crabs coming onto shore during the annual spawning counts.

Half a world away, a culinary trend was sending the Delaware Bay horseshoe crab population into a downward spiral. Beginning in the 1990s, surging demand in Asia for

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CRABS COUNT: Data gathered by volunteers (above) help to manage the crab population, which was threatened by overfishing for bait and biomedical use. Of interest to biomedical researchers are the crab's 10 eyes (one shown at left), which are similar to those of vertebrates.

DELAWARE'S DINOSAUR

The American horseshoe crab is an ancient species whose closest relative—the trilobite—died out more than 250 million years ago. The horseshoe predates the dinosaurs by more than 100 million years and survived their extinction unphased. "It has remained basically unchanged for 245 million years," says Wendy Scott, who has been volunteering at crab counts for seven years. "It hasn't needed to evolve, because it's basically perfect already."

But horseshoes aren't actually true crabs. They are not even crustaceans, but are more closely related to arachnids, such as spiders and scorpions.

There are four distinct species of horseshoe crab. However, only the American horseshoe crab can be found in the Atlantic. The other three species live in the Indian and Pacific Oceans.

The scientific name of the American horseshoe crab is *Limulus polyphemus*. In Latin, *limulus* means "sideways" or "odd." *Polyphemus* is the name of the one-eyed giant, Cyclops, from Greek mythology—which the horseshoe, with one pair of eyes set close together in the middle of its shell, is said to resemble.

The horseshoe crab has 10 eyes in all, including a number of small eyes and photoreceptors on its shell and tail. The crab has been studied by vision researchers for more than 70 years because its eyes are similar to those of vertebrates.

In order to chew its prey of clams and marine worms, the crab must be walking. It has no jaws, but instead uses its walking legs to help crush food. Its front appendages help move food into its mouth, which is located at the center of its body.

While horseshoes can be found along the coastline from Maine to the Yucatán Peninsula, most of the population is concentrated between

Virginia and New Jersey. They spend winters in deeper waters and in springtime head to shallow waters and beaches to spawn.

The crab's epicenter, the Delaware Bay, offers miles of ideal spawning habitat: sandy beaches protected from heavy wind and waves. On spring nights with a full or new moon, the New Jersey and Delaware shores host the world's largest concentration of spawning horseshoe crabs.

At high tide, hundreds of thousands of horseshoes leave the water and scoot onto the beaches for their annual spawning aggregation. As the much-larger females arrive, they dig nests in the sand and lay eggs. The males crowd around, jostling to be the first to clasp the back of the female's shell with clawed appendages called pedipalps. Each female lays as many as 20,000 eggs in the sand, while the males, still attached to the females, are dragged around as they try to fertilize the eggs.

The crabs' annual spawning ritual in turn attracts a host of other species, most of them looking to get a free meal out of the event. Shorebirds mainly eat the eggs that have been brought to the surface by the waves or the movements of the crabs—eggs that wouldn't have hatched anyway.

At least 11 species of migratory birds, including semipalmated sandpipers, sanderlings and red knots, depend on horseshoe eggs to help fuel their migrations. The dove-sized red knots more than double their weight during their two-week stopover in the Delaware Bay. "That's the highest weight gain for any vertebrate in the world," says Kevin Kalasz, a scientist with the Delaware fish and wildlife agency's Endangered Species Program. —J.U.

whelk (or conch, as it is called) and American eel gave watermen along the Atlantic Coast a big incentive to catch horseshoe crabs, which they slice up and use as bait in traps. Suddenly, a single horseshoe could fetch more than a dollar, and fishermen were scooping them up by the millions each year. From the late 1960s to 1996, the annual catch increased from 10 tons to 2,550 tons.

A crash in the horseshoe population wasn't far behind. And as the crab population declined, it put at risk dozens of other species, including threatened loggerhead sea turtles (one of the few predators large enough to consume adult horseshoes) and at least 11 species of migratory birds, which rely on the crab's protein-packed eggs as a crucial food source during their intercontinental spring migrations. The *rufa* subspecies of the red knot, a shorebird famous for its 9,000-mile migration from the tip of South America to the Canadian Arctic, was hit especially hard. The number of these red knots stopping over in the Delaware Bay dropped from 90,000 in 1989 to 13,000 in 2006. "They have declined to the point of being candidates for the endangered species list," says Dave Smith, a biological statistician with the U.S. Geological Survey.

But the horseshoe crab isn't important just for the support it provides birds and marine animals, says Bill Hall. They are "a model of why we should be concerned about biodiversity," he says. "The crab has a lot of implications for our lives."

Upper Management

THE HORSESHOE HARVEST WAS LARGELY unregulated until 1999. Since that time, federal and state catch limits and protected areas have been established, including a 1,500-square-mile horseshoe-crab reserve at the mouth of the Delaware Bay, where no commercial fishing of horseshoes is permitted. In 2006, New Jersey and Delaware announced a two-year moratorium on horseshoe harvesting. Because of these efforts, the harvest declined by 70 percent between 1998 and 2006.

But efforts to restore the crab and regulate its catch have been complicated by a lack of solid population data. Without a crystal-clear picture of the threats to the crab, industry groups have been able to overturn or water down harvest limits. Last year, watermen won a lawsuit overturning Delaware's moratorium on horseshoe harvests, arguing that harvesting 100,000 male crabs in the state's waters would not undermine conservation efforts.

"The question is, how do you manage the harvest?" says Hall, who is sympathetic to the challenges of the fishing community. He explains that it takes the relatively long-lived horseshoes 9 to 12 years to reach maturity and start spawning. "Any time you have something that takes 10 years to

BEACH PARTY: A female horseshoe crab lays about 80,000 eggs each spring. The smaller male crabs line up behind, maneuvering to be the one to fertilize the eggs.

MAP: © DAN MARSIGLIO

mature sexually, you have to look ahead 10 years to what you're harvesting," he says. This makes the horseshoe crab especially difficult to manage, since it can take years to see if conservation efforts are working—and even longer to gauge the ripple effects on species that depend on the crab.

Even if the crab harvests are set right, it's not clear whether the horseshoes can quickly recover their numbers, warns U.S. Geological Survey horseshoe researcher Dave Smith. "We're not sure there's enough food for the horseshoes to bring them back to their peak levels," he says, pointing out a decline in marine worms and mollusks that the crabs depend on for food.

That's where the volunteer effort to count the crabs comes in. The participation of thousands of people like Bob Brozek who have collected data in the past decade is beginning to fill in gaps about how to manage the crab sustainably. "And as long as we have data that is reliable and applicable, then management is going to be successful," says Hall.

The latest census and other studies find that the crab population is no longer dropping and has, in fact, stabilized. "Several surveys indicate that the population may be increasing," says Smith. "But it's too early to be definite."

One by One

BACK ON BIG STONE BEACH, CONSERVANCY VOLUNTEER

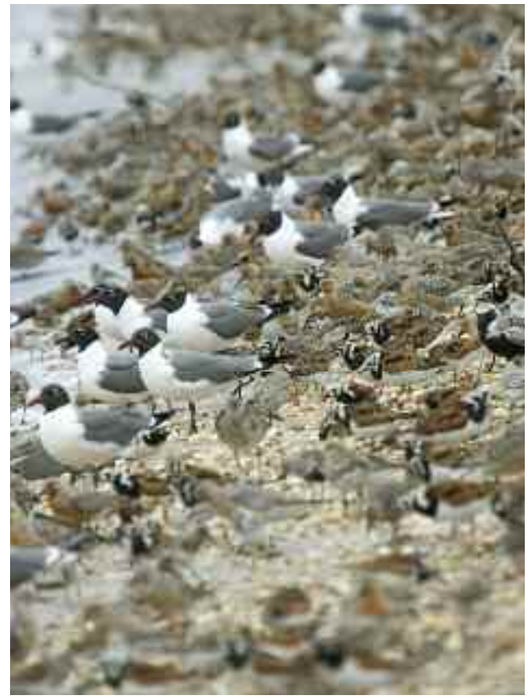
Lois Davis crouches down to look at a struggling horseshoe crab—one of many along the length of the beach. The crab has been flipped upside down by the waves, and its legs are flailing in the air. Some crabs manage to use their long spiky tail to right themselves, but this one looks stuck. Horseshoes are frequently stranded like this, and many will not survive; one study shows that up to 10 percent of the spawning population dies this way.

"There must have been rough waves earlier today if so many are turned over," says Davis. She reaches down and, lifting the crab by its shell—the proper technique, she says, rather than grabbing its tail—flips it over. "It's kind of addictive, turning them over and putting them back in the water," she says, smiling. "A lot of people like to flip them." After taking a moment to get its bearings, the crab scuttles back into the bay.

Even if she saves only a few horseshoes tonight, she says, it's satisfying to help them in such a simple way. It's the same way she feels about the crab count. As a volunteer for the Conservancy over the past four years, she has helped gather small bits of data for the annual spawning count, hoping it will tally up to something larger.

Davis wanders a bit farther down the beach and flips another crab. Several others sprawl out ahead of her, waiting for rescue.

She aims to be back next year. ▪



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FINE DINING: Crab eggs that wash up onto shore are snapped up by the countless migrating birds—including red knots and piping plovers—that stop at the Delaware Bay for a feast (above). Crabs that are flipped over by waves can sometimes right themselves using their spiky tail (left).