Horsesh

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oe Crabs

Ancient coastal arthropods face daunting challenges in the modern age

by Jessica Fischer

When I see a female horseshoe crab on the beach laying her eggs, I think about them hatching, and what the young will have to endure to survive in the complex estuarine environment. Then I smile and remember that horseshoe crabs are one of the most rugged, hardy animals left on this planet. They have survived and adapted through eras when other animals went extinct, and I'm not talking about the time of passenger pigeons, Labrador ducks or even dodos. No, I am talking about way before birds ever existed – the time of pterodactyls and T-rexes. Yes, horseshoe crabs were around 400 million years ago, when dinosaurs dominated the world, and managed to survive multiple ice ages and mass extinctions. Incredible!

Numerous species of horseshoe crabs were evolving during the Paleozoic Era. Four distinct species have survived: three of them inhabit areas along the coast of Southeast Asia, while one – *Limulus polyphemus*, the horseshoe crab we all know and love – lives in North America. Its range spans from Nova Scotia to Florida and the Gulf of Mexico to the Yucatan Peninsula.

Blue Blood and Bait

Horseshoe crabs aren't crabs at all; they are in the arthropod family, but are more closely related to spiders and scorpions. These bottom-dwelling creatures, which inhabit estuaries and bays, play an important role in the survival of multiple species, including humans.

Since the 1970s, scientists have used horseshoe crabs' unique blue blood for important medical testing, drawing blood to extract Limulus Amebocyte Lysate (LAL), a naturally occurring protein. LAL is a clotting agent that is used to, among other things, test medical devices and vaccines for the presence of bacteria that could be harmful to humans. Horseshoe crab blood looks blue because of the presence of a copper pigment in the animals' hemocyanin, which carries oxygen in their bloodstream (much like hemoglobin in mammals). Biomedical companies wash the horseshoe crabs and draw their blood in a laboratory. They extract an average of 30% of each horseshoe crab's blood before it clots naturally; the animals are then released alive where they were captured or sold to the bait industry. Further research is needed to identify the mortality associated with the bleeding procedure; estimates put the figure at 3 to 15 percent.

People also use horseshoe crabs as bait in the American eel and whelk fisheries. In the American eel fishery, female horseshoe crabs with eggs are used – they, not the males, give off an odor that is highly desirable to eels. Whelks (sea snails) are drawn to both male and female horseshoe crabs, which are used as bait in this fishery to meet the ever-increasing overseas demand for whelks.

Horseshoe crabs have a very slow maturation rate, with males averaging 9-11 years to reach sexual maturity and females averaging 10-12 years, so harvesting these animals for bait is quite costly to the species. They are also vulnerable to overexploitation because spawning adults are easily harvested during the spring and summer months as they come to shore, and are commonly taken before they complete their spawning. Fishermen are responding to the overharvest concern, using newer bait bags and cups that allow them to use just one-tenth of the bait previously used by traditional methods, which should help conserve horseshoe crabs. There are hopes that an artificial bait, based on the unusual biochemistry of horseshoe crabs, will one day enable whelk and eel harvesters to phase out their use of the animals altogether.

From top*: In late May through June, horseshoe crabs emerge on the shores of Great Bay for their annual gathering to spawn; During spawning, the female may lay as many as 60,000 eggs, which the male fertilizes as the female pulls it over the nest; After several weeks, larvae will hatch from the eggs and swim for 5 to 7 days, after which they will settle to begin their first molt; As the young horseshoe crabs continue to grow, they move to deeper waters and molt as many as 17 times before reaching sexual maturity.*

Several species of migratory shorebirds rely on horseshoe crab eggs for food. The red knot (above) has one of the longest migratory treks of any bird; it depends heavily on the protein-rich eggs for fuel. Other shorebirds include (from top right) the ruddy turnstone, sanderling and semipalmated plover.

Eggs for Red Knots

Needless to say, it's not only commercial interests that have a stake in healthy populations of horseshoe crabs. Shorebirds, too, have become dependent on this prehistoric arthropod.

The Delaware Bay is the second-largest staging area for migrating shorebirds on the Atlantic Flyway. Birds stop to restore their fat reserves on their long journey from South America to their breeding grounds in the Canadian Arctic. Horseshoe crab eggs, being high in fat and protein, help the birds complete their long journey to their nesting sites. These birds depart with perfect timing, arriving in the bay at the peak of the horseshoe crab spawning season in mid-May and June. Some of the species that rely on protein-rich horseshoe crabs eggs are the red knot, ruddy turnstone, semipalmated plover and sanderling. Red knots rely heavily on the eggs, as they have one of the longest migration routes of any bird: each year, they fly 9,000 miles from Tierra del Fuego on the southern tip of South America to the Arctic! No wonder they are hungry! By some estimates, about 90% of the entire population of red knots (American subspecies) may be present on a single day in Delaware Bay.

Biologists studying red knots in their wintering areas in South America have noted a decline of more than 50 percent in the population. This dramatic drop may be attributable to the increased harvest of horseshoe crabs in the mid-Atlantic region since the 1990s. A decline in the horseshoe crab population or an oil spill in the Delaware Bay has the potential to have a catastrophic affect on the survival of the red knot.

Monitoring and Protecting Horseshoes

States have been working cooperatively along the Atlantic Coast to manage horseshoe crabs for all stakeholders, including shorebirds. Quotas have been established in New Jersey, Maryland, Delaware and Virginia to control harvest rates where horseshoe crabs are the most abundant. Horseshoe crab harvesting in New Hampshire is minimal; a harvest permit is required, under which harvesters may take 10 per day. A mandatory reporting requirement allows Fish and Game to monitor harvest rates.

Some states are acting to conserve horseshoe crabs – for example, prohibiting their harvest for bait during the peak of their spawning season. In some places, areas of the ocean are being protected

WHERE DO THEY MATE? YOU CAN HELP

In their quest to identify the potential horseshoe crab mating beaches around Great Bay Estuary, researchers are tracking "masses" of horseshoe crabs. If you see a large group, please make note of the following, and send your observations to Helen Cheng at ***hrw24@wildcats.unh.edu***.

- Beach/mating location, including closest address to the location and landmarks, so that researchers can attempt to get GPS coordinates and locate the horseshoe crabs.
- Approximate number of horseshoe crabs seen.
- Any tagged animals (see photo) – and, if possible, tag numbers.
- Day and time seen.

for these important animals, including the Carl N. Shuster Jr. Horseshoe Crab Reserve, which protects 1,500 square miles off of the mouth of Delaware Bay. Despite recent efforts to reduce harvest rates of horseshoe crabs, sadly, red knots are not showing any sign of recovery.

The New Hampshire Fish and Game Department takes part in the coast-wide effort to monitor the populations of horseshoe crabs. In the Great Bay Estuary, an annual survey is conducted at index stations throughout the bay. Biologists walk 300-foot transects at five stations on the new and full moons from May through July. The sites include Wagon Hill Farm, Adam's Point, Chapman's Landing, Sandy Point and Emery Point. The horseshoe crabs within the transect are counted, sexed and measured. Water temperature, salinity and weather conditions are also recorded. The biologists also try to capture juvenile horseshoe crabs using a dip net, but with little success. Juveniles are believed to inhabit areas close to their hatching location, but often burrow in the sediment, making them next to impossible to catch. Though the annual survey allows biologists to monitor trends in the population over time, it doesn't tell them how many horseshoe crabs actually inhabit Great Bay. That is about to change.

Promising New Research

An exciting horseshoe crab research project is underway at the University of New Hampshire. Master of Science Degree candidate Helen Cheng is studying horseshoe crabs, in part to provide managers with a better estimate of the size of the population living in the Great Bay Estuary. She is also working to identify the critical habitats horseshoe crabs use during each stage of their lives. To determine this, Cheng is establishing a monitoring system similar to the annual spawning horseshoe crab surveys in Delaware and Massachusetts. Trained volunteers will walk the high tide line of beaches, recording the number of horseshoe crabs present inside each "quadrat" (a square plastic or metal device of known area used for sampling purposes) for a given distance, and tagging each with an external marker as part of the Cooperative Tagging Program of the U.S. Fish and Wildlife Service. The data gathered will provide information about the approximate size of the local population in Great Bay; additionally, over time, we can learn the spawning frequency among males and females, and whether they use different spawning beaches to lay multiple clusters of eggs or if they continue to frequent the same beach.

Little is known about juvenile horseshoe crab habitats in Great Bay. Cheng's hypothesis is that they inhabit the mudflats adjacent to the spawning beaches. They are difficult to locate because they are very small and tend to burrow into the mud. Cheng plans to adapt methods developed by another researcher who has had success finding and studying juvenile horseshoe crab habitats in Delaware Bay with the use of a suction-dredge device. By constructing a similar device to use in Great Bay, Cheng hopes that she will be able to discover where juvenile horseshoe crabs make their homes. Once we have more specifics about the juveniles' whereabouts, we can work to protect their habitats. Research like Cheng's is critical to local managers and organizations involved with horseshoe crabs.

Survival of a Species

Most people I encounter on the annual monitoring survey know very little about horseshoe crabs, especially the fact that they were swimming in the sea before the age of the dinosaurs. Hopefully, after learning more about them and the importance they play in the ecosystem, people will have a new appreciation for horseshoe crabs. After all, they have survived for hundreds of millions of years, whereas modern humans as a species are estimated to have been around for a mere 200,000. No one knows what the planet and its inhabitants will be like over the next 400 million years, but it's certainly worth our efforts now to ensure that the horseshoe crab will survive to watch it unfold.

Jessica Fischer is a marine biologist in N.H. Fish and Game's Region 3 office in Durham. She works with American eel, rainbow smelt, northern shrimp, sea-run brown trout and horseshoe crabs.