HORSESHOE CRAB

Their ecological and medical importance

Horseshoe crabs are amazing animals! They have been on Earth for over 350 million years, making them living fossils. Their longevity means that they are an established and vital part of the ecosystem and have developed unique and successful strategies that have allowed them to survive for so many years. Read how healthy horseshoe crab populations are necessary for maintaining other important species and how they help save millions of human lives every year.

ANNUAL MIGRATION

Horseshoe crabs (*Limulus polyphemus*) appear on Long Island's beaches each year by the hundreds to mate. This takes place from May to June during new or full moons. During this time, females deposit around 4,000 eggs in a cluster and they can create multiple clusters per night. Over the course of a spawning season, one female can lay over 100,000 eggs. With many females doing the same thing, horseshoe crabs deposit millions of eggs on our beaches each season. These events are important for not just keeping healthy horseshoe crab populations but also for the health of other species, including humans.

If horseshoe crabs lay millions of eggs each year, why are we worried about their populations? There are two evolutionary strategies for species when it comes to reproduction. They can be **r-selected** species, like horseshoe crabs, that produce many offspring that are "cheap" or easy to produce. Alternatively, there are **k-selected** species, like humans and other mammals, that produce few offspring that are well-developed or "expensive" to create. R-selected species live in environments where predation by other species make it so few will survive. This means that they have to produce large quantities of offspring so there are better odds that some will survive and reach adulthood. K-selected species can provide reliable, parental care for their young which better ensures survival in the wild. Therefore, they do not need to produce as many because the few they do have will likely survive. Horseshoe crabs produce many eggs because most will not reach adulthood.

HORSESHOE CRABS AND MIGRATORY SHOREBIRDS

Horseshoe crabs lay millions of eggs each year to ensure that some will survive and make it to adulthood and can contribute to the population. Many are lost due to predation, often before the eggs even hatch. Horseshoe crab eggs are important food sources for many species, especially migratory shorebirds.

Migratory shorebirds are species that rely on beaches and embark on annual migrations each year to their breeding grounds or wintering locations. These species travel thousands of miles, often having breeding grounds in the Arctic region and wintering sites in South America or even Antarctica.

Red Knot (*Calidris canutus*)
NYS Status: Threatened

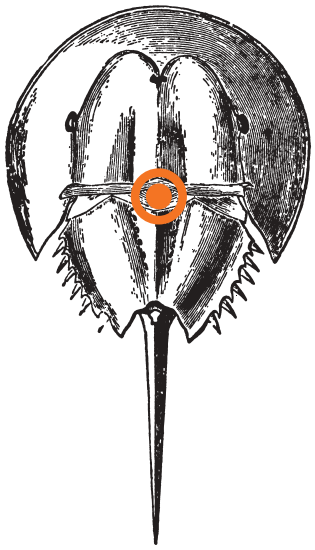
Breed in Canadian Arctic and winter on southern tip of South America. Common to Long Island in the spring and fall. Populations declined by 75% since the 1980s at Federal level and have been declining in NYS since the 1950s. Moved from endangered to threatened in 2014 due to conservation efforts. dec.ny.gov

Long Island is a **stopping point** for many of these migratory shorebirds, including the Red Knot (*Calidris canutus*), Ruddy Turnstones (*Arenaria interpres*), and Semipalmated Sandpipers (*Calidris pusilla*). Their migrations overlap with key events each year, like horseshoe crab spawning. Long Island and other coastal regions in the northeastern U.S. are often the last stop for these shorebirds before they continue on to their breeding grounds in the Arctic. They often only have a week or two to double their body weight before continuing on. This requires high quantities of a reliable, calorie rich food source to reach an acceptable body weight to have enough energy stores for the trip and breeding when they arrive. Migratory shorebird populations have declined in past decades, coinciding with decreases in horseshoe crab populations and thus, decreased spawning events and egg availability.

Egg production has declined due to increases in beach activity, urbanization of shorelines, and the harvesting of horseshoe crabs for bait. Conserving horseshoe crabs is not just important for their populations, but the populations of many other species that rely on them.

HORSESHOE CRABS AND THE MEDICAL FIELD

Mass amounts of horseshoe crabs come onto beaches during horseshoe crab spawning events. Here, they are often awaited by research and medical teams that collect the crabs and bring them back to their labs to harvest their blood. **Why do they do this?**



Horseshoe crab have survived for millions of years, nearly unchanged. Their body system is rudimentary, but is efficient in controlling disease. Horseshoe crabs do not have an adaptive immune response like we do, where specialized cells identify pathogens or foreign cells in our bodies and create a targeted response against them. Horseshoe crabs, instead, have just an **innate immunity** with nonspecific **amebocytes** (mobile cells) that surround and neutralize pathogens or foreign substances in their body. When the amebocytes surround the bacteria, it coagulates, thus creating a visible indication that there is bacteria present. This immediate, visual response is unique and makes their immune response and blood valuable in the medical field.

Scientists extract blood from horseshoe crabs by inserting a syringe into their heart and taking blood (indicated by the orange target in the diagram). It is similar to how we give blood at the doctors office. Scientists extract amebocytes from their blood to create ***Limulus* amebocyte lysate** (LAL) tests, that can be used in small amounts to detect bacterial contamination of vaccines, insulin, implantable devices, and recombinant drugs before they are distributed to people. LAL saves millions of human lives each and every year!

However, horseshoe crabs are compromised when they are placed back into the wild. Scientists take 30% of their total blood, which can weaken or disorient the horseshoe crab and can impact survival when they are placed back into the wild. It is estimated that 15-30% of crabs do not survive after the bleeding process due to stress, transportation loss, or other factors. Scientists are working to reduce mortality rates by regulating handling techniques during transportation of crabs to and from labs and synthesizing alternatives for LAL tests.

Horseshoe crabs' blood is unique in many ways! Their blood is blue, not red like ours, because of its chemical makeup. Our blood contains hemoglobin, a compound that carries oxygen from our lungs throughout our bodies to our muscles and brain to make them function. The center of hemoglobin, contains four iron (Fe) atoms to hold the oxygen during transport. When Fe is oxidized, comes into contact with oxygen, it turns red. This is like when your car, or something metal, rusts and turns reddish in color. Horseshoe crabs' blood, however, uses hemocyanin instead of hemoglobin to transport oxygen. Hemocyanin has two copper (Cu) atoms at the center, not Fe, making the blood turn blue when it is oxidized.

TEST YOUR KNOWLEDGE - HORSESHOE CRABS

Question 1.

Write an "R" next to species that are r-selected and a "K" next to species that are k-selected.

r-selected - make many, "cheap" offspring, little to no parental care

k-selected - make few, well-developed offspring, lots of parental care

____ Elephant	____ Dandelion	____ Horseshoe Crab
____ Frog	____ Cockroaches	____ Human
____ Goldfish	____ Tiger	____ Salmon

Question 2.

Why is it especially important for migratory shorebirds to get reliable sources of high calorie food in Long Island and other stopping points during their migrations?

Question 3.

Why are horseshoe crab populations threatened? What could we do to help them?

Question 4.

How is the immune system of the horseshoe crab different from ours?

Question 5.

Horseshoe crab blood is $60,000 per gallon. Why is it so valuable?

TEST YOUR KNOWLEDGE - HORSESHOE CRABS

Question 6.
One horseshoe crab laid a total of 77,238 eggs one spawning season. She laid 3 clusters each night with 4,291 eggs each time. How many nights did this crab come to the beach to spawn?

Question 7.
Scientists improved their bleeding techniques and now have a mortality rate of only 2% instead of 15%. If an estimated 612,500 crabs are harvested each year for bleeding, how many more crabs will survive each year?

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