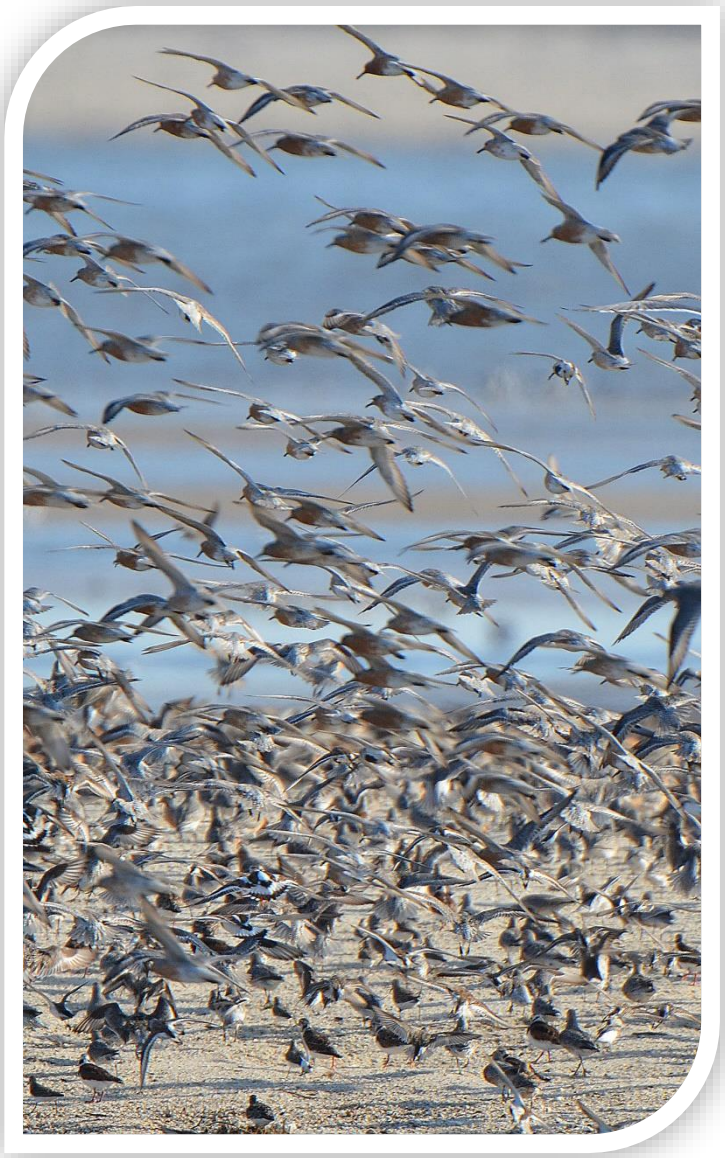
Horseshoe Crabs and Shorebirds

Grades 5 – 12



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Horseshoe Crabs and Shorebirds

Each May when the moon shines full and bright on the Delaware Bay, ancient creatures, unchanged for hundreds of millions of years, crawl from the shallows and onto the Bay's sandy beaches. High tide after high tide, horseshoe crabs return to the water's edge to deposit billions of eggs. This bountiful egg laying, awe-inspiring in itself, is only part of the drama that unfolds along the shores of the Bay. In May, thousands of shorebirds, migrating north to Arctic breeding grounds, stop along the Bayshore to gorge themselves on the high energy food buried in the sand of Bayshore beaches.

This booklet contains information and activities to help prepare you and your class for your trip to The Wetlands Institute. The activities are designed for pre and post-visit sessions. However, feel free to use the activities in a manner best suited to the needs of your class.

PRE-VISIT ACTIVITIES

1. Horseshoe crabs have remained virtually unchanged for hundreds of millions of years. **Horseshoe Crab Anatomy** will introduce your students to the anatomical adaptations responsible for the survival of this living fossil.

2. Shorebirds undertake some of the most incredible of all migrations. In **Mapping Migration** your students will chart the course of a shorebird in its flight from southern wintering grounds to its Arctic nesting territory.

POST-VISIT ACTIVITIES

1. More than fifty species of shorebirds breed in North America. Several of these species nest right here in New Jersey. **Shorebirds, Shorebirds, Shorebirds!** is a research activity to introduce your students to this interesting and diverse group of birds.

2. A visit to the Delaware Bay in the spring is the best way to observe horseshoe crab behavior first hand. However, horseshoe crabs adapt well to life in captivity and you can keep these ancient creatures in your classroom. **Horseshoes in the Classroom** provides information about The Wetlands Institute's Horseshoe Crabs in the Classroom Program.

BACKGROUND INFORMATION

A Living Fossil

Horseshoe crabs belong to an ancient group of **arthropods** that first appeared during the Paleozoic era over 500 million years ago. Horseshoe crab fossils over 300 million years old are virtually the same as the crabs of today. Horseshoe crabs get their name from the hoof-like shape of the shell. While they do remotely resemble crabs, horseshoe crabs and true crabs belong to separate **taxonomic** groups.

Both horseshoe crabs and true crabs are arthropods. Arthropods have segmented bodies, jointed appendages, and an **exoskeleton** composed of **chitin**. True crabs belong to a group of arthropods called **mandibulates**. Mandibulates have mouth parts called mandibles and sensory organs called antennae. This group includes crustaceans (crabs and their relatives), insects, centipedes and millipedes. Horseshoe crabs are chelicerates. Chelicerates have mouth parts called **chelicerae** and lack antennae. Arachnids are also members of this group.

Atlantic Horseshoe Crab, Limulus polyphemus

There are four living species of horseshoe crabs. Three species are found on the Pacific coast of Asia, from Japan and Korea south to the East Indies. The Atlantic horseshoe crab is found along the Atlantic and Gulf coasts from Maine and Nova Scotia to the Yucatan. The largest population of horseshoe crabs in the world is found in the mid-Atlantic region. This population contains an estimated two to four million animals. However, it is a small fraction of what it once was. In the late 1800s, four million horseshoe crabs were annually harvested from the Delaware Bay.

Anatomy

The horseshoe crab, because of its unique appearance, is one of the most easily recognized marine invertebrates. Adult female crabs can reach lengths of twenty-four inches. Males are about one third smaller. The body is dark brown in color and divided into three parts, the **cephalothorax**, the **abdomen** and the **telson**. The upper surface of the cephalothorax is marked by three ridges. Located along each of the outer ridges is a compound eye. These eyes are not as well developed as the compound eyes of insects. Horseshoe crabs are capable of perceiving motion but they cannot see images. At the forward end of the central ridge are a pair of simple eyes, only capable of light reception.

A fleshy muscular "hinge" marks the spot where the cephalothorax and abdomen meet. Along both sides of the abdomen are six moveable spines. A long pointed, spike-like tail

called the telson is attached to the rear of the abdomen. The telson is used for locomotion and is not a defensive weapon. It is used for turning right side up when accidentally upended and as an aid in moving across beaches or exposed mudflats.

Appearing harmless from above, when turned upside-down the flailing telson and ten writhing legs clawing the air can be frightening. Appearances are deceiving. The cephalothorax bears six pairs of appendages. The small first pair are the chelicerae. They are used to manipulate food into the mouth. In the larger females, the next four pairs of appendages are similar in appearance. Each jointed leg ends in a weak pincher. These legs are used for pulling the crab along, digging and moving food toward the mouth. In males, the first pair of legs, called **pedipalps**, end with a round bulb, armed with a hook. It is used to grasp and hold on to a female during mating. The fifth pair of appendages bear four leaf-shaped blades. These legs are used for pushing the crab along and for cleaning the gills. The base of the legs, called **gnathobases** are covered with stout bristle-like spines. The spines grind food as it is passed to the mouth, which is located between the first pair of legs.

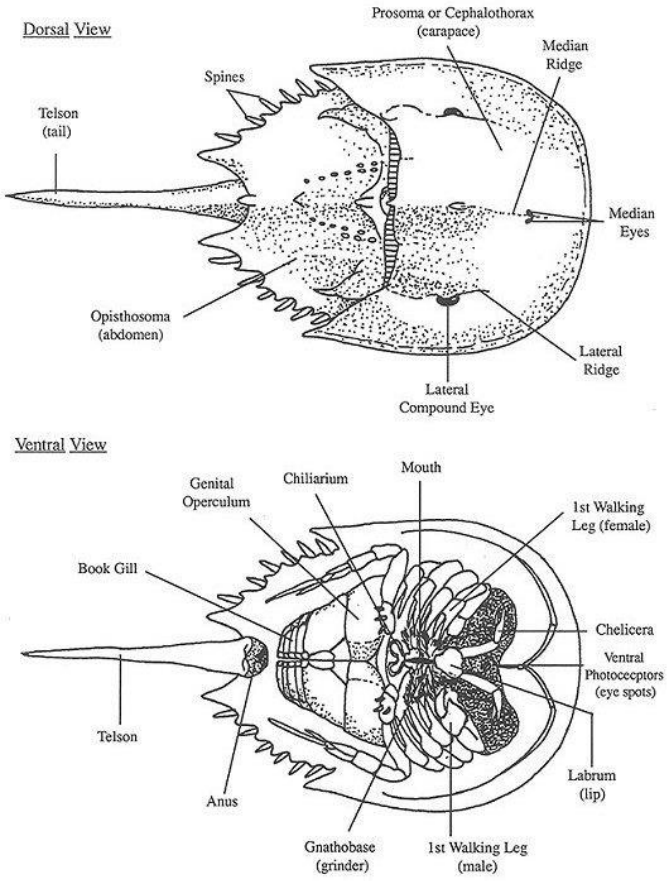


Illustration of Atlantic Horseshoe Crab Anatomy
Image Credit: NC State University

Five leathery flaps on the underside of the abdomen conceal the gills. Each flap protects about 150 leaf-like folds which provide the surface for oxygen exchange. They are called book gills because they are arranged like the pages of a book. Horseshoe crabs also use their gills as paddles when swimming. Swimming is most often done by small individuals, but large horseshoe crabs can occasionally be seen backstroking across the Delaware Bay.

Horseshoe crabs feed on a wide variety of food items. They prefer small clams, but also eat a variety of worms, other bottom animals and algae. Horseshoe crabs are also **scavengers** and males will occasionally eat horseshoe crab eggs. Food is passed by the legs and chelicerae to the gnathobases where it is "chewed." Food is passed into the mouth and travels through the esophagus and crop to a muscular gizzard. Food is ground in the gizzard and indigestible particles are regurgitated. The remaining material is passed on to the stomach and intestine where digestion occurs. Wastes are passed through the anus, which is located on the bottom of the abdomen just in front of the telson.

Horseshoe crabs possess a well-developed circulatory system. Blood is pumped from a long tubular heart to the appendages and gills through a system of arteries and sinuses. Blood is oxygenated at the book gills. Movement of these structures not only creates a water flow, but also pumps blood into and out of the gills. Oxygenated horseshoe crab blood is blue. Its blood cells contain copper instead of iron.

Rites of Spring

In early spring, male horseshoe crabs begin their **migration** to the shallow waters along shore. The crabs spend the winter in the deep channels of the Delaware Bay and in adjacent ocean waters. As spring progresses, more crabs, including the females, travel to the shore to begin mating. The nesting season lasts from the beginning of May until at least the end of July. Egg laying peaks around the spring tides of May and June.

One Female Atlantic Horseshoe Crab with Four Males Attached

In the waters just offshore, males pursue females in an attempt to grab hold of their abdomens with their pedipalps. When the tide is high the female, with an attached male, drags herself to the edge of the surf. The Bayshore during peak egg laying periods is literally crawling with horseshoe crabs. In the Delaware Bay, male crabs outnumber females at most nesting beaches by at least two to one. On some beaches, there may be as many as five males for each female. At the water's edge unmated males often crowd around mated pairs in an attempt to dislodge the attached male. At the height of the nesting season, on one beach, male crabs may form a nearly solid mass five feet wide and a mile long.

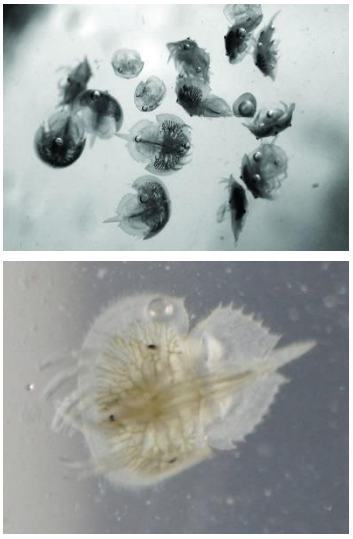
Once at the water's edge the female digs into the sand to lay her eggs. Nests are usually between 2 and 8 inches deep. Eggs are small, bluish-green spheres about 1.5 mm in diameter. The eggs are deposited in clumps, mixed with sand and pebbles, which contain about 3,500 eggs. Five to seven of these clumps may be deposited in each nest. As the eggs are deposited they are fertilized by the male. When the eggs have been laid, the pair covers the nest and returns with the retreating tide. The female and her attached mate will return to the beach on several high tides. A female may lay up to 80,000 eggs during the nesting season.

Horseshoe Crab Egg Clump

The egg laying process is not without its hazards. Horseshoe crabs are often overturned by the surf. Many crabs, unable to right themselves, die as a result of such stranding. Death may occur as the gills dry and are unable to function or the crab may have its soft parts eaten by herring or black-backed gulls. As many as 200,000 horseshoe crabs die as a result of stranding in the Delaware Bay each year. Many individuals are stranded by the retreating tide. Horseshoe crabs are capable of crawling back to the water on a sloping beach. On a flat beach, they have a harder time determining which direction to travel to return to the water. These animals most often bury themselves in the sand. As long as the book gills are kept moist, a horseshoe crab can survive out of water for many days. On the next high tide, the crab will emerge and return to the water.

Horseshoe crab eggs hatch in two to ten weeks. In shallow nests, near the high tide line, where heat from the sun warms beach sand, development is rapid. In deep nests or nests close to the low tide line, where sands are cooler, development is much slower. During that time, the eggs and developing larvae go through several changes. Six days after fertilization the egg swells and the dark outer covering is shed. The egg is now transparent and the developing embryo can be seen rotating within the egg membrane. On the sixth day, the embryo molts for the first time.

The exoskeleton of arthropods does not grow. In order for the animal to get larger, it must shed, or **molt,** its exoskeleton. Adult horseshoe crabs molt in the summer. Before molting, they burrow into the bottom below the low tide line. The exoskeleton ruptures along the front edge of the cephalothorax and the crab crawls out of its old shell. It may take several hours for a crab to molt. The newly emerged crab's shell is soft, wrinkled and pleated. The animal swells, by taking in water at the gills, its shell becomes smooth and it hardens.



Trilobite Larvae

The embryo molts three more times before it hatches. The newly hatched crabs are called trilobite larvae. At this stage, the crabs lack a telson and resemble the extinct trilobites. The larvae spend several days in a free swimming stage before settling to the bottom. During their first year, horseshoe crabs molt five times. They molt twice in their second and third years and then once each following year. Male crabs reach maturity in their ninth year, females in their tenth. They probably live several years after becoming adults.

The eggs and young of horseshoe crabs are preyed upon by a host of organisms. Sand shrimp, amphipods, fiddler crabs, several species of fish, and birds feed upon the eggs and larvae of horseshoe crabs. Young horseshoe crabs are eaten by a number of true crabs. Even the heavily armored adults are food for other animals. Loggerhead sea turtles and some sharks prey on adults. When they emerge to nest, the crabs are sometimes attacked by gulls. Gulls turn the crabs over and eat the exposed soft parts. Human are also predators of horseshoe crabs. Horseshoe crabs were once harvested in large numbers for use in fertilizers and livestock feed. Today, they are collected for use as eel and whelk bait.

A Feast on the Beach

In the spring, Delaware Bay beaches are crowded with more than just horseshoe crabs. In early May, as the first horseshoe crabs emerge to lay their eggs, several species of **shorebirds** begin to appear along the Delaware Bay. At first, they arrive in a trickle. By mid-month, they flow onto the beaches in waves. After non-stop flights of several days, and up to two or three thousand miles, they need food, and lots of it. Just beneath the surface of the Bay's beaches is the energy that will fuel one last flight to the birds' Arctic nesting grounds.

Shorebirds Gathering on the Delaware Bay Beaches

The word shorebird is used to describe a group of relatively long-legged, long-billed relatives of gulls and terns. It includes many species of sandpipers, plovers, oystercatchers, stilts and avocets. The name implies that these birds frequent the shore. However, there are several species that prefer upland habitats and are rarely found on beaches or mudflats.

Illustration Showing the Northbound Migration Route of the Red Knot

Most shorebirds are long distance migrants. Several species travel from one end of the earth to the other between wintering and breeding grounds. Most bird migrations occur over a wide front with individuals utilizing available food resources along the way. Shorebird migration is different. Shorebirds rely on a few key stopping points, called staging areas, between extended, nonstop flights, to fuel their migration to summer nesting grounds. The Delaware Bay is the most important **staging area** in eastern North America. Between 500,000 and 1.5 million shorebirds depend on the energy contained in the eggs hidden beneath the Bay's sandy beaches.

Several species of shorebirds stop along the Delaware Bay. Red knots, ruddy turnstones, sanderlings and semipalmated sandpipers are the most numerous. Red knots, the largest of the four, are about ten inches long. In breeding plumage, red knots have an unmarked reddish-brown breast and belly and their upperparts are a mosaic of black, reddish brown and white. The first red knots appear along the Bay in early May. By the end of the month, nearly 80% of the red knots in the Western Hemisphere have gorged themselves on the bounty of horseshoe crab eggs.

Ruddy turnstones, with their harlequin coloration and aggressive behavior, are easily recognized. The head and underparts are white. The head is marked by a black mask, collar and bib. The back is reddish brown and black and the legs are bright orange. Its bright coloration only enhances the ruddy turnstone's bold, aggressive demeanor. Unlike the other shorebirds, which probe in the sand for eggs, ruddy turnstones dig, excavating holes two to four inches deep with their beaks. These holes are vigorously defended. Ruddy turnstones will attack and chase rival shorebirds in attempts to defend their feeding areas. The birds often seem to spend more time fighting than feeding.

When a hole is abandoned by its defender, sanderlings and semipalmated sandpipers will quickly move in to devour any remaining eggs. These two species are more difficult to identify than red knots or ruddy turnstones. They are smaller and less boldly colored. Sanderlings are about eight inches long, semipalmated sandpipers, six inches long. Both have brown upperparts. Sanderlings are rusty colored on the head and breast. Semipalmated sandpipers have brown heads and the breast is marked by fine streaks of brown.

From Left to Right: Red Knot, Ruddy Turnstone, Sanderling, Semipalmated Sandpiper

Of the four species, sanderlings are probably the best known. Their extensive winter range includes both coasts of North America from Washington and Massachusetts to the tip of South America. Sanderlings are the small sandpipers seen racing up and down the beach chasing waves in search of food. Ruddy turnstones also have a large winter range. It is almost as extensive as the sanderling's extending from the mid-Atlantic and California coast to Chile and Argentina. While a few red knots winter in the U.S., along the Gulf coast and in California, most winter along the coasts of Argentina and Chile. Semipalmated sandpipers winter in the West Indies, Central America and northern South America.

All of these birds breed on the Arctic tundra from Labrador to Alaska. Sanderlings, red knots and ruddy turnstones also nest in Greenland and the Arctic islands of Canada. The nesting season is short, often lasting only a few weeks. These birds spend most of their lives in their winter range and in migration. Spring migration is a critical time for shorebirds. They must arrive in the Arctic with enough time and energy to nest, raise their young and return south before the long Arctic winter begins. The staging areas along the way provide the fuel for this trip. Delaware Bay is the last staging area before the birds nest. Horseshoe crab eggs provide the energy for one last flight, courtship, nest building and egg laying once they arrive in the Arctic. Timing is critical. A bird that arrives late to the nesting grounds will not be able to raise young before the coming of winter.

The birds spend about two weeks feeding on horseshoe crab eggs along the Bay. Depleted of energy after non-stop flights of several days from South America, the birds spend most of the daylight hours feeding, resting, and preening. In two weeks of feeding, many of the birds nearly double their weight. A sanderling may require 135,000 eggs in that period or one egg every five seconds. Fifty thousand of these birds could consume 6 billion eggs, which would weigh 27 tons.

At dusk, for reasons yet unknown, the shorebirds leave the Bay to spend the night along the Atlantic shore. Sanderlings prefer to roost on the few remaining undeveloped, sandy beaches while the other species prefer to spend the night in the salt marshes. During high spring tides, these birds are driven off the marsh and join the sanderlings on the beach.

Adult Laughing Gull

Laughing gulls are also an important player in the drama on the Delaware Bay shoreline. The gulls nest in nearby Atlantic coast salt marshes. They winter along the southern Atlantic and Gulf coasts of the United States and in Central America. The gulls return to southern New Jersey nesting colonies in March. During March and April they feed on insects, mollusks, and crustaceans until the horseshoe crabs return to the Bay to mate. In May and June, the birds leave their roosts in the nesting colonies at dawn to gorge on horseshoe crab eggs. They probe into the sand with their bills like shorebirds, wade in the surf eating eggs washed out of nests, and grab whole clumps of eggs as they are laid by the female. On some beaches, tens of thousands of gulls line the shore, even standing on mating horseshoe crabs, snatching any eggs that come their way. On the beaches, they intimidate and bully shorebirds. Even the aggressive ruddy turnstones give way to the gulls. At dusk, the gulls return to their nesting colonies in a seemingly unending stream.

An Uncertain Future

For thousands of years, horseshoe crabs and shorebirds have played out their drama along the shores of the Delaware Bay. The dependence of large portions of entire shorebird populations on a few key migratory staging areas places these birds at risk of catastrophic declines. Such large concentrations of birds could easily be decimated by an outbreak of disease. Loss of the food resource which makes the staging areas so important could also spell disaster. Staging areas are unique in that they provide astronomical amounts of food capable of sustaining large concentrations of birds. If a staging area is lost, there is no alternative site waiting to be discovered.

More recently, humans have emerged on the scene to become another important player in this drama. In the nineteenth century, during spring and fall migration, shorebirds were

heavily hunted by market gunners. By the early twentieth century, most shorebird populations were severely depleted. In 1918, the United States and Great Britain (on behalf of Canada) signed the Migratory Bird Treaty, which ended hunting of all but a few species of shorebirds. Most shorebird populations have slowly rebounded. Today, many species are again common along the migration routes.

Since the early nineteenth century, horseshoe crabs have been harvested for human use. In the 1870s, 4 million horseshoe crabs were harvested and ground at mills for use in fertilizer and livestock feed. By the 1960s, horseshoe crab harvests had declined to just 1% of historic highs. Horseshoe crabs are still harvested today for use as eel and whelk bait. Crabs are also collected for use by the pharmaceutical industry. A compound in the blood of horseshoe crabs is used to test for toxins in drugs. The crabs are bled, held for a short period and then returned to the water alive. It is estimated that between 15-30% of bled crabs die. The Atlantic States Marine Fisheries Committee reported that in 2021, 697,025 crabs were bled for biomedical purposes. There is no set quota for harvesting crabs for biomedical purposes. Companies are also not required to report the number of crabs bled. The horseshoe crab endemic to the East Coast of the United States is listed as vulnerable. In other parts of the world, the Japanese horseshoe crab is considered endangered.

But human impacts go beyond the out-right killing of birds or crabs. Destruction of habitat is by far the most important factor in the decline of most species. Horseshoe crabs, shorebirds and humans are all attracted to the shore. Horseshoe crabs need undisturbed beaches in which to lay their eggs. Shorebirds need the horseshoe crabs to insure the completion of nesting and the creation of a new generation of birds. Shorebirds also need salt marshes and Atlantic beaches for roosting. Humans just like to live near the beach. Living near the beach in itself would pose little threat to crabs and birds. It's living on the beach that causes problems. Bulkheads, sea walls, jetties and other beach protection devices, which become necessary to protect shorefront property, are not compatible with horseshoe crab spawning. These structures tend to increase beach erosion, limiting or eliminating areas where crabs can lay eggs. Coastal development has also taken a toll on salt marshes. Once considered useless, marshes were drained and filled to provide land for homes, businesses and even parking lots.

Examples of Beach Protection Devices

Other human uses of the Delaware Bay also pose a threat to the crabs and birds. The ports of Philadelphia and Wilmington, on the Delaware River, make up the second largest petrochemical complex in the United States. Each day, tankers carrying millions of gallons of oil and petroleum products travel up and down the Bay. If an accident were to occur during the height of migration whole populations of shorebirds and millions of horseshoe crabs could be lost.

A Helping Hand

In the 1980s, after a decade and a half of research, scientists made an alarming announcement. Populations of several species of shorebirds had decreased drastically during this period. Sanderling populations had decreased by eighty percent. Loss of habitat along migration routes and in wintering areas was probably the cause of this decline.

In 1984, several conservation groups, including the World Wildlife Fund, the Academy of Natural Sciences, and New Jersey's Division of Fish, Game and Wildlife, joined forces to protect the unique ecological phenomenon in the Delaware Bay. In 1985, the governors of New Jersey and Delaware declared the Delaware Bay a reserve for the conservation of shorebirds. It was the beginning of the Western Hemisphere Shorebird Reserve Network, a program designed to identify and preserve important areas used by shorebirds in North, Central and South America.

An international effort of this scope is essential if shorebird populations are to be protected. To preserve just one staging site would be useless. Staging areas are like links in a chain. Each link is an important component of the chain. Remove a link and the integrity of the chain is compromised. If just one staging area is lost or degraded to the point that it cannot support large populations, shorebirds could disappear forever.

The future is uncertain. However, each spring, in response to rhythms older even than the living fossil that makes its way to edges of Delaware Bay, horseshoe crabs crawl onto the beaches to spawn. Out of the skies rain shorebirds by the thousands, alighting briefly before continuing on to their ancestral nesting grounds. With increased public education and awareness and the commitment of government and conservation organizations we can preserve not only Delaware Bay, but also equally important sites just a shorebird flight away.

SUPPLEMENTAL BACKGROUND INFORMATION

Take a deeper dive into shorebirds using the following supplemental information guide: *A Beginner's Guide to the Delaware Bay Shorebirds*.

A Beginner's Guide to the Delaware Bay Shorebirds

Ruddy Turnstone

Striking black and white head and bib, black and chestnut back, and orange legs in breeding plumage. Bib pattern and orange leg color retained in winter plumage. Nests on coastal tundra. Winters on mudflats, sandy beaches and rocky shores.

Red Knot

Chunky and short legged. Brown, black and chestnut back with buffy chestnut face and breast in breeding plumage. In winter, back pale gray and underparts are white. Nests on tundra. Feeds along sandy beaches and mudflats.

Sanderling

Head, mantle and breast are rusty in breeding plumage. In winter, pale back, white below, and bill and legs are black. Palest sandpiper in winter. Bold white wing stripe is visible in flight. Nests on tundra. Feeds on sandy beaches, running to feed on invertebrates exposed by retreating waves. Often seen in flocks and roosting on jetties with other shorebirds

Semipalmated Sandpiper

Have black legs and a tubular looking, straight bill of variable length. In breeding plumage, bird displays a tinge of rust on crown, ear patch and scapulars. Breeds on the tundra.

Horseshoe Crab Anatomy

Identify and label the parts of the horseshoe crab.

Compound eye
Telson
Simple eyes
Male
Female
Hinge
Cephalothorax (carapace)
Moveable spines
Anus
Book gills
Pusher leg
Walking legs
Mouth
Operculum with genital pores
Chelicerae
First leg
Opisthosoma (abdomen)

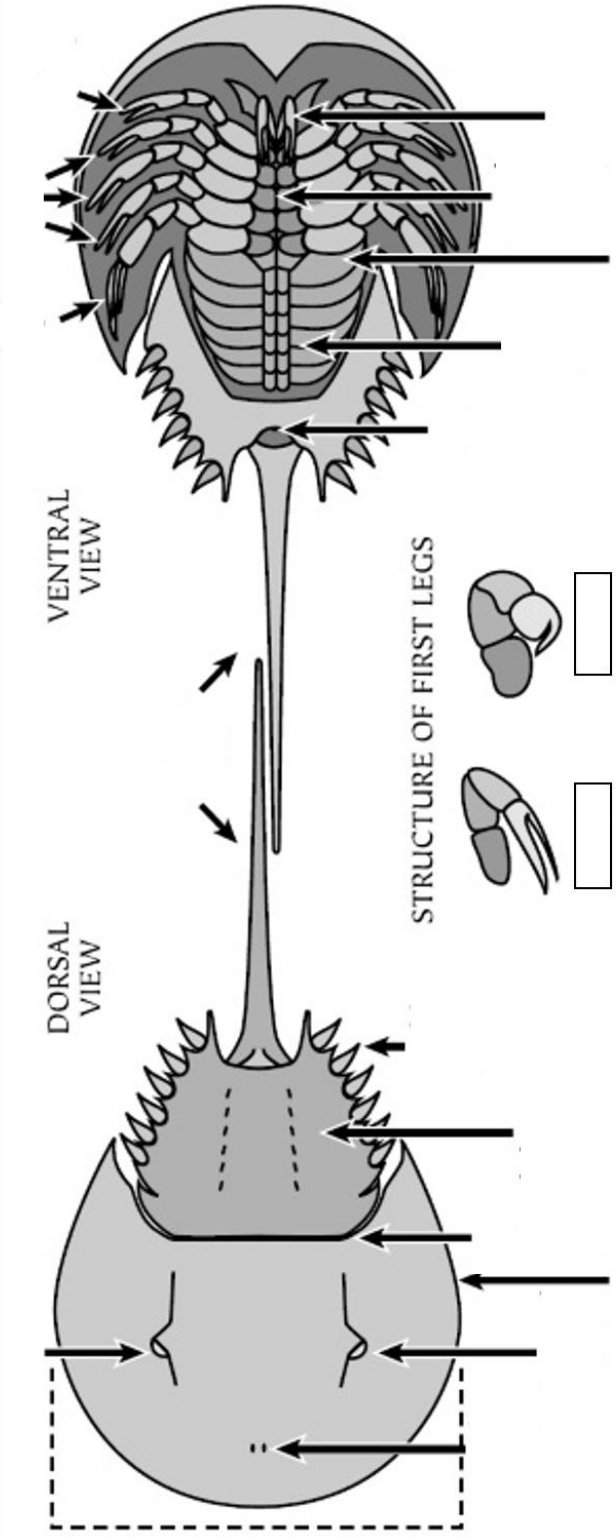


Image Credit: South Carolina Department of Natural Resources

Horseshoe Crab Anatomy Answer Key

Horseshoe Crab Anatomy

Identify and label the parts of the horseshoe crab.

Compound eye
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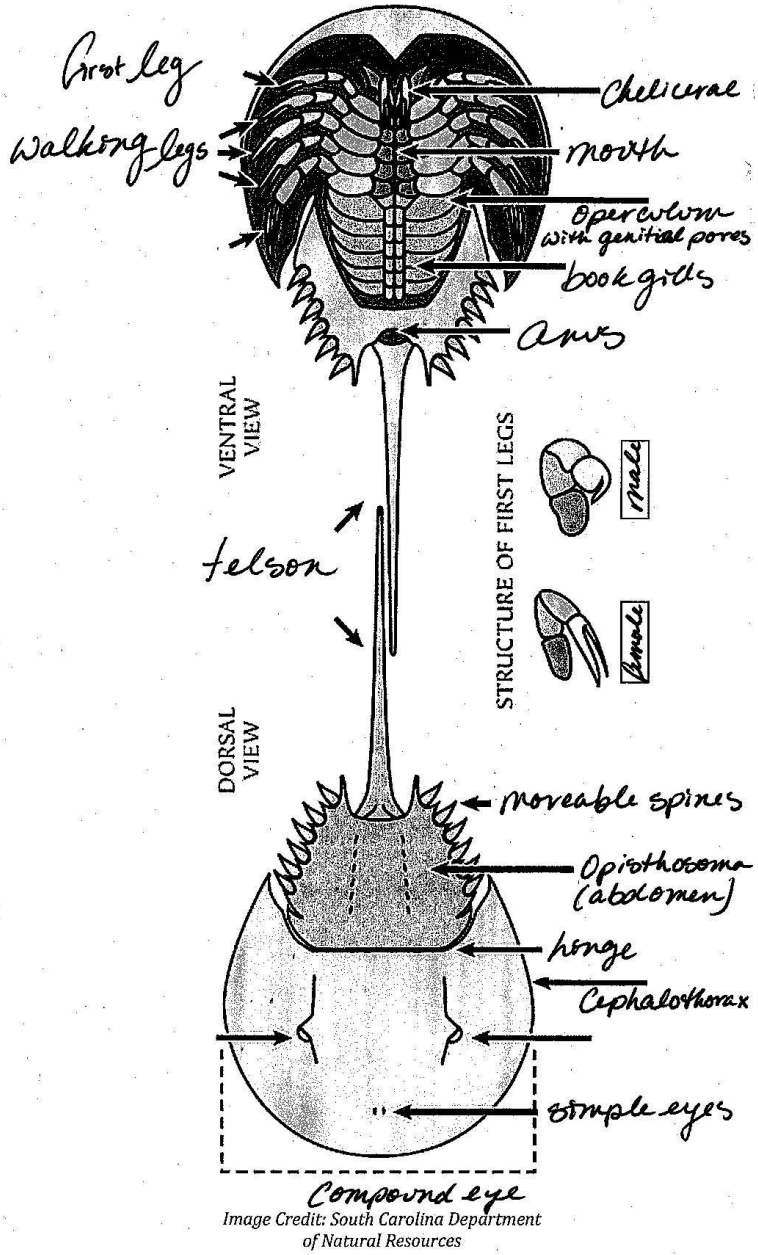


Image Credit: South Carolina Department of Natural Resources

Mapping Migration

Shorebirds undertake some of the most spectacular migrations in the animal world. Their journeys take them from one continent to another, over vast oceans and from one end of the earth to the other. Some species may spend most of their lives in migration.

Unraveling the mysteries of migration has been an important goal of scientists through the ages. In the past the seasonal disappearance and appearance of local breeding birds spawned fantastic theories. One theory stated that some birds hibernated at the bottom of the sea. In the last several decades bird banding, radio tagging and satellite tracking have unraveled many of the mysteries of migration.

In this activity, your students will map the migration routes of hypothetical banded shorebirds from wintering grounds to summer breeding areas.

Materials:

- Mapping Migration: Migration Map (1 per student)
- Mapping Migration: Shorebird Sighting Sheets, one bird per student (included)
- Colored pencils
- Pen or pencil

Procedure:

1. Pass out a copy of the migration map and one shorebird sighting sheet to each student.

2. Have the students identify the wintering range and breeding range of the bird. The students should mark these ranges in different colors on the map. Mark the map legend accordingly throughout the activity.

3. The students should then locate and mark on the map the locations where their bird was sited along its migration route.

4. Migration stops should then be connected by arrows to show the migration route the shorebird may have traveled if it flew the shortest possible route.

Extensions:

1. Before heading home, take stop along the Delaware Day to have your students look for color banded shorebirds. If found, record the species of shorebird and the sequence of color bands and flags on each leg. Record the bands from top to bottom. Report your sightings online to the Bird Banding Laboratory (BBL) at: https://www.pwrc.usgs.gov/bbl/bblretrv/ Your resighting will be entered into the national database and will inform the Master Bander or the organization

responsible for banding the bird. Once the information has been received, you will receive a certificate as a thank you!

2. Do any shorebirds migrate through your area? You don't have to live along the coast to see shorebirds. Shorebirds stop during migration in wetlands and along the shorelines of lakes and reservoirs. Several species also use agricultural fields and turf farms as feeding areas during migration. Contact a local Audubon Society chapter, bird club or nature center for checklists of the birds that can be seen in your area. Many states also have guides that tell you the best places in your state to look for birds. *Bird Finding in New Jersey*, *Birding the Delaware Valley Region,* and *Birds of Pennsylvania: When and Where to Find Them* are three excellent guides for our region. You may be able to plan a field trip to a local shorebird hotspot near your school.

3. Shorebirds spend brief periods of time in North America. They spend the greater part of their lives in South and Central America. How much do your students know about the winter habitats of these birds? Research for information about the Western Hemisphere Shorebird Reserve Network (WHSRN) and the important shorebird sites in South America.

Mapping Migration: Migration Map

Map Legend

Mapping Migration: Shorebird Sighting Sheets

Mapping Migration: Shorebird Sighting

Shorebird Sighting:	
Red Knot	
Lead Researcher's Name:	

Band Numbers	897-291 603-431 190-765
Wintering Range	Red Knots overwinter in South America. Most notably in Tierra del Fuego, an archipelago in Argentina.
Breeding range	Red Knots breed in middle in high arctic zones, from Greenland to northern Alaska.
Sighting Locations	*Band 897-291:* Tierra del Fuego, Argentina Sao Paulo, Brazil Paramaribo, Suriname Charleston , South Carolina Cape May, New Jersey Moosonee, Ontario *Band 603-431:* Montevideo, Uruguay Natal, Brazil Cape May, New Jersey *Band 190-765:* Santiago, Chile Tamarindo, Costa Rico Vancouver, British Columbia

Mapping Migration: Shorebird Sighting

Shorebird Sighting:	
Ruddy Turnstone	
Lead Researcher's Name:	

Band Numbers	247-994 235-554
Wintering Range	Ruddy Turnstones winter throughout the Americas. On coastlines from Washington and Massachusetts south to the southern parts of South America.
Breeding range	Ruddy turnstones breed in northern Alaska to Arctic Canada as far east as Baffin Island.
Sighting Locations	*Band 247-994:* Santa Isabel, Panama Nassau, Bahamas Jacksonville, Florida Bethany Beach, Delaware Prince Edward Island, Nova Scotia Prince Charles Island, Canada *Band 235-554:* San Carlos, Mexico Seattle, Washington Utqiagvik, Alaska

Mapping Migration: Shorebird Sighting

Shorebird Sighting:	
Semipalmated Sandpiper	
Lead Researcher's Name:	

Band Numbers	281-571 996-212 364-487
Wintering Range	Semipalmated Sandpipers overwinter along the coastlines of South America as far south as Peru on the west coast and Sao Paulo in Brazil. They are also found throughout the Caribbean in the winter.
Breeding range	Semipalmated Sandpipers breed in the southern tundra of Canada and Alaska, always near water.
Sighting Locations	*Band 281-571:* Barbados Bermuda Lewes, Delaware Toronto, Ontario Baker Lake, Nunavut *Band 996-487:* Virginia Beach, Virginia Nantuckut, Massachusetts Cartwright, Newfoundland *Band 364-487:* Newport, Oregon Nome, Alaska Wales, Alaska

Mapping Migration: Shorebird Sighting

Shorebird Sighting:	
Sanderling	
Lead Researcher's Name:	

Band Numbers	444-900 632-786 533-051
Wintering Range	Sanderlings overwinter along the coastlines of North America from around the Canada border south and through out the Caribbean.
Breeding range	Sanderlings breed in the Canadian Arctic Archipelago, Nunavut, Greenland and in some small sections of the northern coast of Alaska.
Sighting Locations	*Band 444-900:* Merida, Mexico New Orleans, Louisiana St. Louis, Missouri Cambridge Bay, Nunavut *Band 632-786:* Kingston, Jamaica Clearwater, Florida Ocean City, New Jersey Montauk, New York *Band 533-051:* Bella Bella, Vancouver Churchill, Manitoba Bathurst Island, Nunavut

Shorebirds, Shorebirds, Shorebirds!

The Delaware Bay is not the only place in the United States to see shorebirds. Shorebirds can be found along the Pacific, Gulf and Atlantic coasts, in wetlands in every state, on the high prairie, in forests and even on top of school buildings and apartment complexes. More than 50 species of shorebirds breed in North America, with at least 20 more that do not breed on the continent but have been seen in North America.

This activity will introduce your students, not only to the great diversity of North American shorebirds, but also to their habitat requirements, geographical distribution, and behavior.

Materials:

- Shorebirds, Shorebirds, Shorebirds! Activity Sheet (1 per student)
- Pen or pencil
- Shorebird Species that Breed in North America (included)

Shorebird Species that Breed in North America

American Oystercatcher	*Whimbrel*	*Common Snipe*
Black Oystercatcher	*Long-billed Curlew*	*Short-billed Dowitcher*
Black-necked Stilt	*Lesser Yellowlegs*	*Long-billed Dowitcher*
American Avocet	*Greater Yellowlegs*	*Red Knot*
Black-bellied Plover	*Solitary Sandpiper*	*Sanderling*
Lesser Golden Plover	*Willet*	*Western Sandpiper*
Semipalmated Plover	*Spotted Sandpiper*	*Semipalmated Sandpiper*
Snowy Plover	*Ruddy Turnstone*	*Least Sandpiper*
Mountain Plover	*Black Turnstone*	*White-rumped Sandpiper*
Wilson's Plover	*Wandering Tattler*	*Baird's Sandpiper*
Killdeer	*Surfbird*	*Pectoral Sandpiper*
Piping Plover	*Northern Phalarope*	*Purple Sandpiper*
Hudsonian Godwit	*Red Phalarope*	*Dunlin*
Marbled Godwit	*Wilson's Phalarope*	*Stilt Sandpiper*
Upland Sandpiper	*American Woodcock*	*Buff-breasted Sandpiper*

Procedure:

1. Assign, or have each student choose, a shorebird from the list provided.

2. Give each student a copy of the Shorebirds, Shorebirds, Shorebirds! Activity Sheet.

3. Students will conduct independent research to complete the activity sheet.

Extensions:

1. Have your students find out which species of shorebirds breed in your state. What are the habitat requirements of these species? Do any of these species breed in your county, in your town, or on your school grounds?

2. Killdeer are a species of plover that nest widely in upland habitats in the United States. They nest on flat-roofed buildings, gravel driveways and parking lots, and in large open fields. Your school grounds probably have at least one of these habitats. Have your students survey the area around the school in search of killdeer. Try to discover, without disturbing the birds, whether the birds are nesting in the area. If you find a pair design a study to observe their behavior. *Ornithology in Laboratory and Field* by O.S. Pettingill, Jr. provides excellent information on bird behavior, and how to design a nest study.

Shorebirds, Shorebirds, Shorebirds! Activity Sheet

SHOREBIRDS, SHOREBIRDS, SHOREBIRDS!

SPECIES:

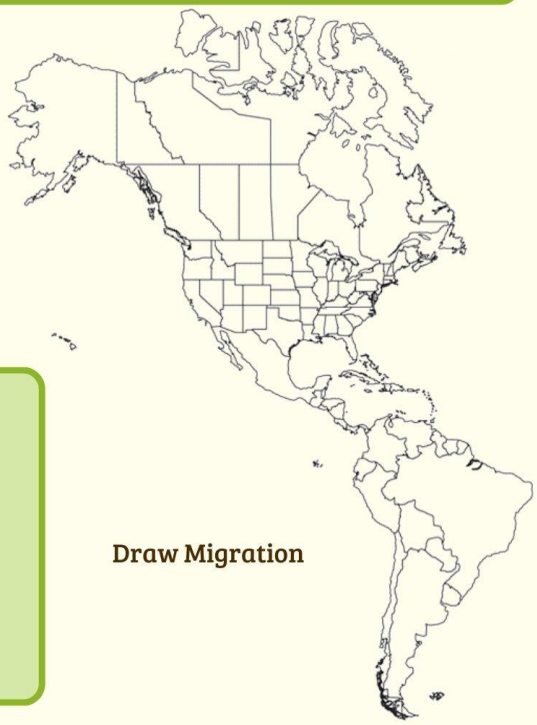
SCIENTIFIC NAME:

DRAWING:

DIET: include feeding behavior

DESCRIPTION:

NESTING GROUNDS:



Draw Migration

WINTERING GROUNDS:

Horseshoes in the Classroom

Horseshoe crabs are amazing creatures. They have remained unchanged for hundreds of millions of years. Horseshoe crabs have survived global changes that have resulted in the extinction of marine invertebrates, dinosaurs, flying reptiles and large mammals. An organism that can survive this can surely survive in your classroom.

In 2016, continuing efforts to conserve and restore the local Atlantic Horseshoe Crab population, The Wetlands Institute (TWI) partnered with the New Jersey DEP Fish and Wildlife, Bureau of Information and Education to launch the Horseshoe Crabs in the Classroom program, which allows teachers all around New Jersey to raise horseshoe crab hatchlings and eggs in specialized tanks in their classrooms. By raising horseshoe crab hatchlings in captivity, away from predation or disease, their probability of survival to adulthood greatly increases. Through specialized permitting, TWI staff collect and hatch approximately 6,000 fertilized horseshoe crab eggs from the beaches of the Delaware Bay.

Most of these eggs hatch and are released back into the bay, but others go to classrooms. Along with partners, The Wetlands Institute works to train New Jersey teachers receiving the horseshoe crab hatchlings and fertilized eggs on their care as well as proper set up and maintenance of their culture tank. To participate teachers must attend the Green Eggs and Sands Workshop with the Horseshoe Crabs in the Classroom extension. Additionally, tank set up costs about $220. New Jersey DEP Fish and Wildlife is available to provide a set up or you may choose to purchase and set up your own equipment, cost approximately $220. A detailed materials list will be provided to you. Participating in this collaborative Horseshoe Crabs in the Classroom Program allows you and your students to experience rearing and caring for live horseshoe crab hatchlings.

Contact The Wetlands Institute at education@wetlandsinstitute.org for more information about this program.

NEW JERSEY DEP
Fish and Wildlife

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

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Vocabulary

Abdomen mid section of the horseshoe crab body. Primary role is to house the book gills.

Arthropod a member of the phylum arthropoda which includes such diverse groups of organisms as insects, arachnids, crustaceans, millipedes, centipedes and others totaling several million species. Arthropods have in common; 1) body composed of segments, each of which usually bear a pair of jointed appendages, 2) one pair of appendages modified as "jaws", and 3) body enclosed in an exoskeleton composed of chitin which is shed periodically.

Cephalothorax the first body segment of horseshoe crabs and arachnids bearing organs and appendages found on the head and thorax of other arthropods.

Chelicerae one of the anterior appendages of arachnids and horseshoe crabs modified for feeding. In horseshoe crabs and scorpions the chelicerae are claw-like and used for manipulating food. In spiders they are poison "fangs."

Chitin a tough, resistant, nitrogen containing carbohydrate substance present in the exoskeleton of arthropods, found in the outer coverings of other invertebrates and in the cell walls of some fungi.

Exoskeleton a skeleton covering the outside of the body.

Gnathobase the first joint, or coxa, of the first four pairs of legs on a horseshoe crab. They are heavily armored with spines and used to "chew" and move food into the mouth.

Mandibulate A group of arthropods that include crustaceans (crabs and their relatives), insects, centipedes and millipedes. Mandibulates have mouth parts called mandibles and sensory organs called antennae.

Migration periodic or seasonal movement, typically of relatively long distance, from one habitat or climate to another.

Molt the act of shedding an exoskeleton.

Pedipalps leg-like appendages common to the chelicerates that serve in sensory, feeding, defensive and mating functions.

Scavenger any organism that feeds on carrion or organic refuse.

Shorebird name in America for a large group of similar or related birds which typically have relatively long legs and bills, most of which migrate long distances and are often but not always found along shorelines.

Staging area a location used by large numbers of migratory birds as feeding and resting areas during migration.

Taxonomy the theory and practice of describing, naming and classifying organisms.

Telson long, pointed, spike like tail that is used for locomotion, not defense.