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▲ **Piping Plovers, like all shorebirds, care for their chicks by brooding them (tucking them under their body and wings). This male has excavated a shallow brood cavity in the sand and is calling his two-day-old chicks to come under his warm feathers. In beach-nesting shorebirds, this brood process may also serve to cool them in the hot summer sun.** NJ, JUNE

oystercatchers, stilts, and avocets, both parents tend to the young after hatching.

After juvenile feathers grow in, the remaining adult sandpiper leaves the chicks to fend for themselves while they are still flightless (16–45 days, with smaller shorebirds fledging quicker). This is a perilous time for the visible young chicks, with danger around every corner on the ground and from the air. Gulls, jaegers, foxes, and other predators are prepared for this vulnerable period, and they work hard to find and eat the flightless young. In some shorebird species, such as the oystercatchers, both adults care for and feed the young for longer periods, up to several or more months.

Meanwhile the nonattending adults feed continuously in Arctic habitats for up to a month or so before starting their southbound migration. The chicks often gather in groups as they wait for the power of flight, after which they form feeding flocks before migrating a few weeks after the adults. These juveniles undertake amazing long journeys of up to 8,000 miles without adult guidance and arrive at the same general locations as the adults as a result of genetic information imprinted in their brains! Juveniles of a few shorebird species, such as Purple and Rock Sandpipers, migrate with adults.

Arctic-Breeding Shorebirds

As mentioned, more than half the regular breeding shorebirds in North America do so in Arctic or subarctic regions. These birds face incredible hardships during the breeding season, including often-frigid summer temperatures and a host of savvy predators.

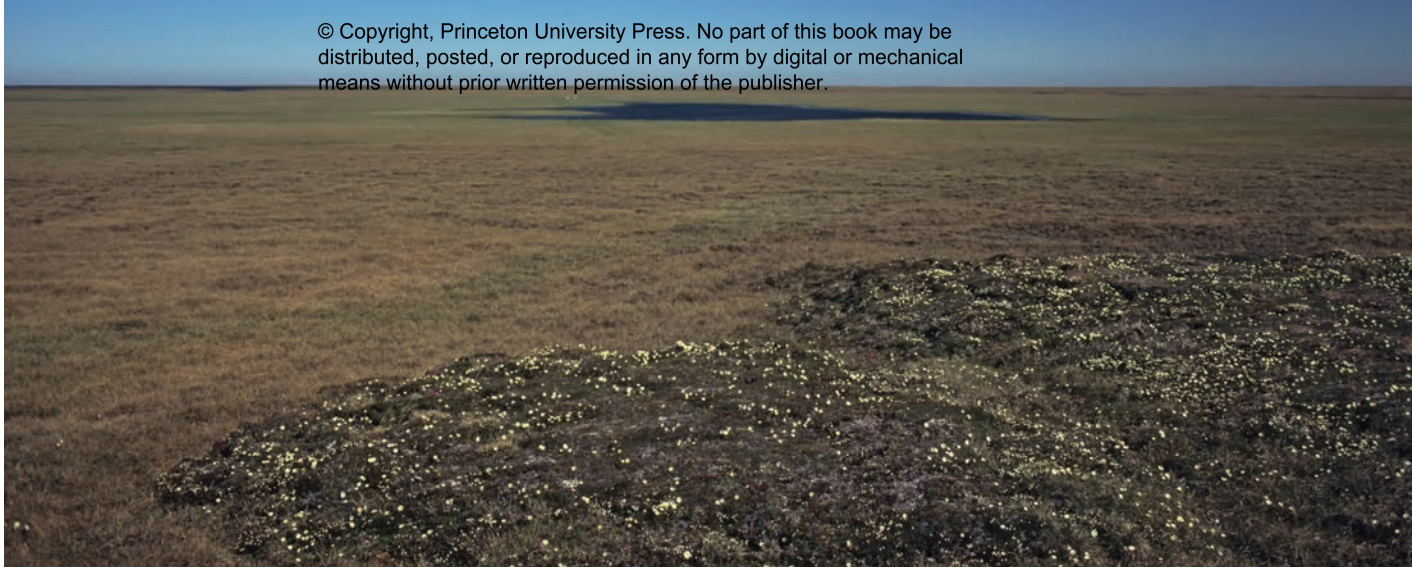
These harsh environments initially appear unsuitable as breeding locations for long-distance shorebird migrants, but they provide some benefits that help with successful nesting. A few of these are the 24 hours of daylight for up to 70 days in summer that allow for constant food gathering, and the rapid propagation of insects and their larvae that shorebirds rely on to feed themselves and their young. Another is the lack of bushes, trees, or geographic features where mammalian predators can hide, thus enabling shorebirds to see danger coming at great distances.

After surviving a long return journey full of pitfalls, shorebirds work fast to squeeze in successful nesting during the short Arctic summer. They feed continuously while seeking a mate, after which a nest is constructed and eggs are laid. If a predator takes the eggs, Arctic shorebirds have only a short time to repeat the nest process (usually until late June), as accumulating snowfall and bad weather come as soon as mid-August in high Arctic regions.

In some shorebird groups, including the large plovers, the male builds the nest and adorns it with decorative vegetation. The female then either accepts or rejects the nest. If the nest is rejected, the male constructs additional nests until the female accepts one. Afterward, the female lays three or four eggs. Imagine the physical stress of forming and laying one egg every few days, with the four eggs weighing as much or more than the adult female!

Temperate-Breeding Shorebirds

Apart from Arctic, subarctic, and taiga breeders, other shorebirds nest mostly on beachfronts, grasslands, marshes, river and lake edges, woodlands, and high-elevation or



▲ **This photo shows Arctic tundra from the North Slope of Alaska, including moist graminoid tundra, which makes up about 80% of the 186,000 square miles of tundra above the Brooks Mountain Range. The raised areas in the foreground are drier high-centered polygons, prime nest habitat for large plovers.** ALASKA, JUNE

▶ **A male Ruddy Turnstone is shown sitting on an open tundra nest on the North Slope of Alaska in June. This species is a fierce protector of its nest and breeding territory, and woe to any aerial predator that ventures into Ruddy's airspace.**

▶ **A few-days-old American Oystercatcher chick plays dead near some seaweed after its parents went off to posture in flight with several pairs of neighboring oystercatchers. The chick's camouflaged plumage renders it virtually invisible from the air, and the lack of motion also protects it. This behavior is ingrained in the chick's DNA and needs no prompting from adults.** NJ, MAY

alpine locations. Nest biology, strategy, and behaviors are mostly similar regardless of habitat and location, though slight differences have evolved in each habitat.

Beachfront nesting is similar to barren Arctic tundra breeding in that both locations lack any appreciable vegetative cover to retreat to for safety. In North America, three of the four small plovers (Piping, Snowy, and Wilson's) nest on open beaches or adjacent alkaline salt flats, and American and occasionally Black Oystercatchers nest on open beaches adjacent to oceans, bays, and the Gulf of Mexico. Eastern Willet is a large sandpiper that nests in grassy areas or marshes that border the Atlantic Ocean and tidal areas with brackish water, including the Gulf of Mexico, while its relative Western Willet breeds in grassy areas adjacent to or near western interior freshwater ponds or lakes.

Without appreciable cover, shorebirds that breed on open beaches protect their nests by performing distraction displays when danger approaches, including a "broken wing" display. Another protection for the eggs and chicks is their incredible camouflage that blends in perfectly with the habitat where they nest. These camouflaged eggs and chicks make it extremely difficult for aerial predators such as gulls and crows to see them, especially if the chicks are

not moving. If an aerial or ground predator comes near, the adult gives an alarm call, which commands the chicks to play dead and stop moving. It is difficult even for ground predators to see the chicks crouched down on the sand if they are not moving, and they must rely on their keen sense of smell to locate the motionless chicks.

Marsh nesters often lay their eggs on small islands in ponds or marshes, which prevents smaller mammals from reaching their nests, and grassland breeders typically nest in taller grass areas (often near ponds), which provide excellent cover from both aerial and ground predators due to the uniformity of habitat over large areas.

Migration

Overview

Migration is the regular movement of creatures from one location to another for a variety of reasons. The most widely known type of migration occurs on a seasonal basis, where individuals arrive on the breeding grounds in spring and travel back to warmer climates at the end of their breeding cycle. Most shorebirds fall into this category.

Migration is energetically expensive and filled with peril, but it permits birds to avoid the privations of the northern winter and exploit seasonally abundant food resources in more temperate or tropical regions and the waxing resources of the extreme Southern Hemisphere as these regions enter the austral summer.

In days of yore, humans watched birds set their wings to the sky and disappear beyond the horizon and could only wonder what distant shores were knit by their wings. Today we simply marvel that these creatures of flesh and bone, feathers, and muscle, can vault entire hemispheres, relying solely on their powers of flight and genetic programing.

During migration, many birds, including geese, fly in echelons, or V-shaped configurations. Such formations allow birds to conserve energy by drafting off the wingtips of the bird ahead, reducing drag and conserving as much as 50% of the energetic cost of flying solo. Fighter aircraft fly in formation for much the same reason. Migratory stopovers, as well as wintering locations, are contingent on abundant food resources, so birds apportion themselves accordingly.

An intentional blur photo captures the dynamic motion of Red Knot and Ruddy Turnstones as these two long-distance migrants explode into flight in May at Delaware Bay, NJ. Both species vault hemispheres as they migrate from the high Arctic to South America and back again in spring.

Dunlin, Short-billed Dowitchers, and Semipalmated Sandpipers are shown during spring migration, when all form large flocks. These three species often join together in tight flocks when taking to flight after sensing danger. NJ, MAY

Shorebird Migration

Most shorebirds migrate after breeding, whether short or long distances. Cold-climate breeders migrate south to access temperate or tropical locations, while others migrate from high-elevation breeding sites to lower elevations or coastal areas where the weather is not as severe in winter. Some shorebirds don't technically migrate at all but remain in the general vicinity of their breeding sites, or a relatively short distance away. Others travel from inland to coastal locations to access better food sources in winter.

As a group, shorebirds undertake some of the most spectacular long-distance migrations of any creature on the planet. These long distances are possible because of their relatively light weight due to hollow bone structure and the evolution of aerodynamically advanced feathered wing design in long-distance migrants. While flight patterns on breeding and wintering grounds appear graceful and almost effortless, long-distance migration requires direct powerful flight and a few physiological changes that are hard for us to comprehend.

Shorebird migration lasts a long time, unlike that of most other bird families. "Spring" migration begins in February for some extreme southern wintering species and ends in early June, while southbound "fall" migration starts in late June for some failed breeding adults and continues until mid-November, typically with juveniles. There are barely a few weeks in between spring and fall movements when shorebirds are not in migration mode.

Migration strategies vary greatly among shorebirds, with some species undertaking long, nonstop migrations while others make a few or numerous stops along the way to recharge their energy and replenish body fat reserves, thus accessing a variety of often-unfamiliar habitats during these journeys. Some of these stops comprise a few days, while others might last several weeks.

An example of this last scenario involves Buff-breasted Sandpiper, which leaves its wintering areas in southern South America in February and follows the north/south mountain ranges until reaching Texas and other south/central US locations in mid to late April. They fatten up in rice fields, wet meadows, moist lawns, and other agricultural areas for several weeks, after which they take up to a month to finish their protracted journey to high Arctic breeding grounds.

A good number of long-distance migrant shorebirds use a protracted migration like this to replace non-crucial feathers, such as head, body, and back feathers (scapulars), enabling them to molt partially into or out of breeding plumage while enjoying the benefits of food and rest during this energy-draining feather replacement. This strategy also allows them to dedicate all their time to setting up a territory and finding a mate upon arrival at their breeding grounds.

Shorebirds do not migrate in family groups like geese, swans, or cranes, except for some migratory oystercatchers where the young depend on their parents for food extraction for several months. In both spring and fall migrations, there is often a difference in timing between the movements of females and males, with males eager to get back to the breeding grounds in spring to set up territories before females arrive. After breeding, females of many species begin their southbound migration as soon as or slightly after the eggs hatch, often from late June to early July, leaving the male alone to care for the young.

What It Takes to Be a Flying Machine

Shorebirds are flying machines, and their physiological refinements are specifically designed to meet the extraordinary metabolic demands of flight. One adaptation is weight reduction, as the bones of most birds are hollow, and the feathers that encase them not only help to control their body temperature but also serve as airfoils (enabling lift or flight) at a weight cost of "light as a feather." And flight muscles of shorebirds are huge, constituting up to one-third of their total weight.

Shorebirds have also enhanced respiratory and circulatory systems, with highly efficient four-chambered hearts up to twice as large as those of mammals of comparable size, and lungs whose exchange of exhaust carbon dioxide with fresh oxygenated air approaches 100% with every breath cycle. In addition, the higher metabolism of birds facilitates the delivery of fuel (or metabolic material) to meet the energetic demands of flight muscles working at peak capacity. In shorebirds, these muscles as well as the heart and lungs increase in size prior to migration.

Feathers, those remarkable instruments of flight, are subject to wear and must be replaced each year by molt. To ensure that wings are operating at peak efficiency, many long-distance migrants wait until reaching the wintering grounds before replacing wing and tail feathers (the most crucial flight feathers). The very body shape of shorebirds is an aerodynamic, football-shaped marvel designed to reduce drag and propelled by scimitar-shaped wings with low camber arc and high aspect ratio to further reduce wind drag.

The fuel for long-distance migrants is stored fat, laid down in layers beneath the skin, with some infused through the muscles themselves. It is precisely the capacity for rapid weight gain (hyperphagy) that makes long-distance flight possible while using a minimum of food-rich staging areas. This stored fat, which may double the normal weight of some species prior to departure, offers twice the energy and water of protein or carbohydrates, with this water necessary to keep birds hydrated during long, nonstop flights. A further weight-saving measure is the shrinking of unnecessary internal organs preceding these long flights (including the liver, kidneys, digestive tract, and gonads) to reduce wing loading.

Despite these modifications, most shorebirds carry only enough fuel to fly several thousand miles before having to stop at critical staging areas to refuel. Flying conditions determine the rate of energy consumption, and a favorable tail wind reduces metabolic demand. This more efficient use of energy is why many southbound migrants to South America fly out over the Atlantic Ocean, trusting the east-blowing trade winds to assist them on the long journey. Tail winds do not necessarily speed a bird's journey, but they allow them to throttle back and reduce fuel consumption.

As a last resort, if shorebirds exhaust their fat reserves, they begin metabolizing muscle tissue to fuel their flight. Protein is not as energy packed as fat, and when the engine begins to burn itself, the end is near. Twice a year golden-plovers, godwits, Red Knot, White-rumped Sandpiper, and other long-distance shorebird migrants play out this drama in the skies over two hemispheres, with evolution siding with the birds and a capricious universe offering long odds.

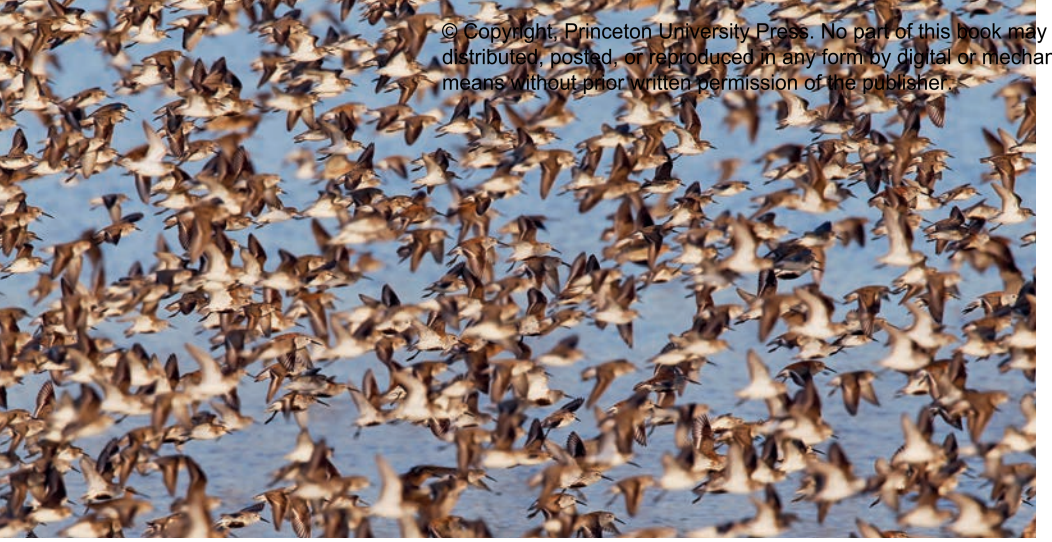
Spring and Fall Migration

Spring migration is shorter and faster paced than its fall counterpart. Many of the numerous Arctic-breeding shorebird species travel in large flocks in spring and tend to bottleneck at strategic stopover sites during a short few-week period from mid-April to late May, depending on the location in North America and the species involved.

They are racing to get to Arctic breeding grounds within days or weeks of the snow melt to begin their swift nesting season of a few months when they must define a territory, find a mate, lay eggs, and brood their young. In the high Arctic, this season starts in early June and is over by mid-August, when snow once again covers the ground until the next spring.

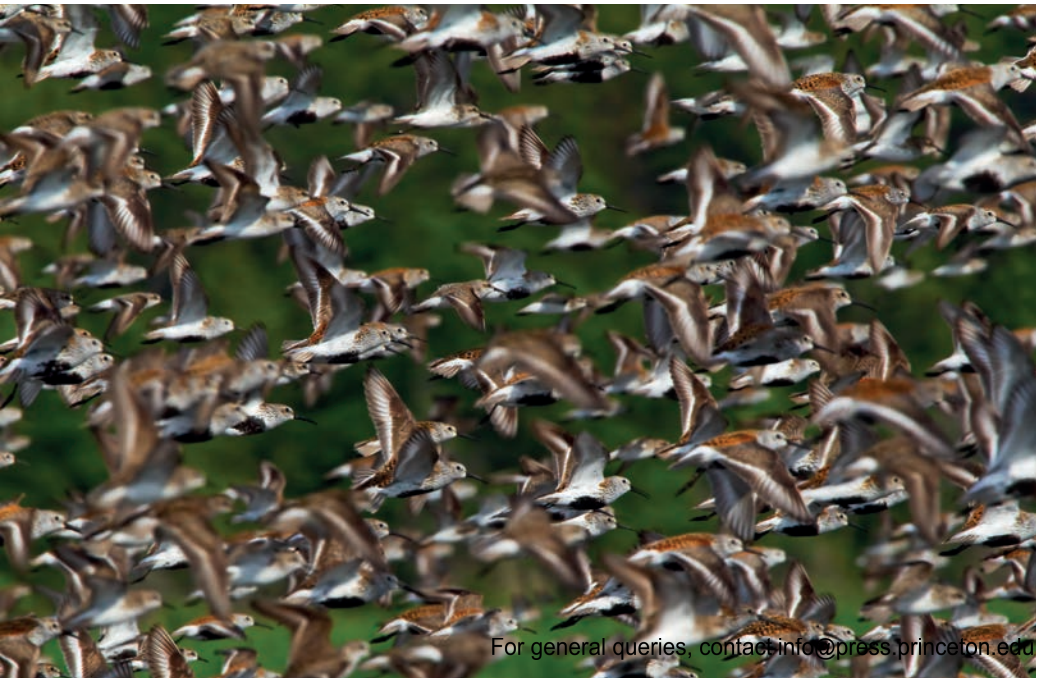
This timetable is crucial to nest success, so the birds tend to move north in large flocks during a relatively short time frame. Temperate-breeding shorebirds also move during this same window to ensure a timely arrival on their breeding grounds, where they must define breeding territories and attract mates before too much competition arrives.

Fall shorebird migration is more protracted and relaxed, and occurs in waves, beginning in late June and continuing into November. The first shorebirds to head south are failed breeders with no young to raise, and this occurs from late June to early July. Next are half of each sandpiper pair, usually females, who abandon the nest area right after the eggs hatch, or shortly afterward, leaving the other adult to care for the flightless young until a full complement of juvenile feathers grows in. After forming loose flocks and feeding for a few weeks, these adults begin their southbound migration, usually in mid to late July for high Arctic breeders, and slightly earlier for lower Arctic and taiga breeders.



◀ Semipalmated Sandpipers and Dunlin are tightly packed in this large spring migrant flight at Heislerville, NJ in May, an important stopover location. These extended stops allow shorebirds to feed constantly and pack on more weight and fat for the remaining long journey to Arctic breeding grounds.

◀ A nonbreeding Short-billed Dowitcher makes a running start to flight at Bolivar Flats, Texas in September. The streamlined football-shaped body and long scimitar-shaped wings are some of the physical adaptations that allow shorebirds to more easily cut through the air during long migratory flights.



◀ Some shorebirds like Dunlin form large migratory flocks in spring that pause at important feeding areas to fatten up for a long remaining journey. Spring migration is faster paced than fall, as it is crucial to arrive at breeding grounds in time to complete the nesting process. A few Semipalmated Sandpipers are mixed in this mostly Dunlin flock at Heislerville, NJ in May.

▲ **A low center of gravity and short sturdy legs allow Purple Sandpipers to exploit the surf zone of rocky coasts. These adventurous birds feed where other shorebirds fear to tread, in the rushing waters of the Atlantic Ocean. This 1st-spring bird in mostly breeding plumage was photographed in early May in NJ.**

▼ **Feathered black wingpits are visible on this juvenile Black-bellied Plover as it lifts off an Atlantic Ocean beach in NJ on New Year's Eve. Some juvenile shorebirds migrate thousands of miles to wintering grounds without guidance from experienced adults, relying only on accurate imprinted genetic information in brains the size of peas and beans. Simply amazing!**

A few exceptions include Purple and Rock Sandpipers and Dunlin. Purple and Rock Sandpipers remain on or near their breeding sites for a few months after nesting before migrating to Atlantic and Pacific rocky coastlines for the winter in October/November, while Dunlin remains on or near its Arctic or subarctic breeding sites until late August or September.

Arctic- and subarctic-breeding male and female plovers, who stay with their chicks until they are fully feathered, migrate south from mid-July onward, depending on the nest initiation date or a successful re-nest. These plovers may be present in s. Canada or n. US locations as migrants from mid-July to October, and into early winter for Black-bellied Plover.

Fall shorebird migrants also use stopover sites to fatten up during their long journeys, but most species are not concentrated in nearly the same numbers as in spring. They also spread their migration out over a period of months in late summer and fall compared with weeks in the spring, as there is no dire urgency to get to their wintering sites. Shorebirds also use fringe wetlands and feeding locations besides the main stopover sites as refueling stops. Without the rush to breed, the migratory pace to wintering areas is relatively leisurely compared with spring migration.

Temperate-breeding shorebirds, including beachfront, grassland, marsh, and prairie nesters, utilize a wide range of arrival and departure dates for migration, depending on climate and other environmental factors. Some species, particularly beach nesters, may remain in the general vicinity of their nest site year-round, or only migrate relatively short distances to access a slightly warmer climate or better food sources, or both.

While most of the super long-distance shorebird migrants involve high Arctic breeders, some temperate shorebird nesters also migrate deep into South America. Some of these species include Eastern and Western Willets, Solitary and Spotted Sandpipers, and Wilson's Phalarope. Wilson's visits several important stopover sites to fatten up before undertaking long-distance, nonstop flights to winter in high-elevation lakes in the southern Andes, as well as in the Patagonian lowlands and Tierra del Fuego.

Juvenile Shorebird Migration

Most juvenile shorebirds typically leave the breeding grounds a few weeks to a month after adults and travel to specific shared winter locations with no guidance from experienced adults. These accurate initial flights are

possible due to imprinted genetic locational information in shorebird brains that are only the size of peas or beans, and this information is similar in precision to our present-day GPS navigational systems. We don't know how this information is transferred into action, and it is truly one of the great mysteries of the animal kingdom.

Arctic-breeding juvenile shorebirds usually arrive at most Canadian and US locations from late July to September, depending on a variety of factors, including date of nest initiation, latitude of nest site, and duration of incubation and fledging. Juveniles often remain at migratory stopover sites much later than adults, sometimes into October and occasionally early November, before continuing to their wintering locations

Migration Perils

Although more than 20 million shorebirds migrate through the United States to the Arctic each year, Arctic shorebird biologist Pete Myers and his colleagues captured the attention of the ornithological and conservation communities with their discovery that the long-term survival of even abundant species may be in jeopardy.

Their studies show that Sanderlings, Ruddy Turnstones, Red Knots, Dunlins, and White-rumped, Baird's, Stilt, Western, and Semipalmated Sandpipers form enormous concentrations at several key staging areas along their migration route. Each of these spots is critical for successful migration of these species, providing superabundant food resources that enable the birds to quickly replenish their energy reserves and continue on their journey.

In North America, six such sites support millions of shorebirds annually: Alaska's Copper River Delta; Washington's Gray's Harbor; the Bay of Fundy in e. Canada; Kansas's Cheyenne Bottoms and Quivera National Wildlife Refuges; and the beaches of Delaware Bay in New Jersey and Delaware. More than 80% of the entire North American population of some species may join ranks at any of these key locations, with virtually all 4 million Western Sandpipers staging at the Copper River Delta site in May.

Other vital locations of similar importance are also recognized throughout the Americas, and these critical staging areas underpin the entire migration system of New World shorebirds. As Myers points out, such enormous concentrations dependent on so few widely spaced locales

▼ **Great numbers are no bulwark against population declines. Whole populations of some shorebirds like these migrating Western Sandpipers may be concentrated in a few key staging areas for short periods, making them vulnerable to natural and man-made perturbations. More than 4 million Western Sandpipers stage in Cordova, Alaska each May on the way to their Arctic breeding grounds.**

break the usual link between a species' abundance and its immunity to population crashes or extinction.

The series of critical stopover sites is typified by Delaware Bay. The arrival and departure of 500,000+ shorebirds within a span of three to four weeks is synchronized with the annual breeding cycle of the Bay's enormous population of horseshoe crabs, for it is the eggs of the crabs that supply the energy required by the birds to complete their spring journey to the Arctic.

Each evening, after daylong feasting on crab eggs, the birds move east to roost in tidal marshes on the outer beaches of the Atlantic coast. Coastal and wetlands development have forced the birds into ever smaller foraging and roosting sites as the number of suitable areas dwindle. On high-tide nights, tens of thousands of shorebirds may be packed into a few hundred yards of beach.

Fortunately, efforts are now under way to link the key staging sites connecting wintering and breeding areas into a system of sister reserves. Shorebird biologists, backed by the World Wildlife Fund U.S., the International Association of Fish and Wildlife Agencies, and the National Audubon Society are working toward establishment of these critical reserves throughout the Americas. Success hinges on persuading local, regional, and national governments that such a system is not only desirable but absolutely necessary to ensure the survival of migratory shorebirds. As a first step, in May 1986, the governors of New Jersey and Delaware mandated the lower estuary of Delaware Bay as a reserve for shorebird conservation.

Amazing Shorebird Migratory Journeys

While it is no secret that many shorebirds migrate long distances to their breeding and wintering grounds each year, the how and why of such movements remain a puzzle to humans. For example, how do shorebirds know exactly where they are going over thousands of miles, especially during extended travel over open oceans, and how do they know when to start these return migrations when they are in the mid-latitude tropics, where daylight hours are near constant? Could it be the angle of the sun that precipitates their northward journey in late winter? Another mystery is why they travel in large groups during these journeys. There is much that we don't understand about shorebird migration, and even if they could communicate with us, they might just answer "because it works."

Here are a few examples of long-distance movements involving three species of super shorebird migrants.

Bar-tailed Godwit—The Champion of Migration

After breeding in the Arctic tundra, North American Bar-tailed Godwits add up to 55% body weight by continuous eating of tiny clams for about a month in August on tidal flats in w. Alaska. Then they wait for predictable strong storms in late summer to get a tail wind that takes them about 1,000 miles south with little effort. Without these

Tens of thousands of migrant shorebirds are packed into 20+ miles of narrow beach during spring migration on Delaware Bay, NJ. Red Knots, Ruddy Turnstones, and Sanderlings constitute a large portion of shorebirds at this critical migratory stopover location in May.

A female Bar-tailed Godwit on its Alaskan breeding grounds on the Y-K Delta in late May. After nesting, she undertakes the longest nonstop migration of any creature on the planet, flying more than 7,000 miles in 7–11 days from Alaska to New Zealand and Australia.

Hudsonian Godwits undertake remarkable long-distance migrations to and from their boreal forest/taiga breeding grounds in Canada and Alaska. A handful of journeys of several thousand miles each are coupled together during these epic flights, with a few important extended feeding stops mixed in.
ALASKA, MAY

storms, they would not be able to physically complete their amazing nonstop migratory journey of 7,000–9,000 miles to New Zealand over a period of 7–11 days. With this tail wind, they can fly as fast as 60 miles per hour!

This is tantamount to humans eating continuously for three or four weeks and doubling their body weight, and then running nonstop for 1,000 miles over seven days without the benefit of food, water, or sleep. It truly is a physical feat approaching miracle status, and well beyond human capability or comprehension.

A nagging question Kevin always pondered while working on the Alaskan Arctic tundra is, "why do shorebirds go so far when there is ample wintering habitat much closer to the breeding areas?" These questions remain unanswered 30 years later, although complete glaciation of much of North America except for Arctic tundra habitats north of the Brooks Range during the last Ice Age more than 10,000 years ago might have set a pattern that has not changed today.

To add to these amazing physical feats, Bar-tailed Godwit shrinks non-critical body organs as a weight-saving measure for this flight. Kidneys, liver, and intestines that are not used during the 7–11 day flights become lighter to facilitate the journey and represent another part of this miraculous adventure in which a combination of factors is necessary for the success of this migration.

Hudsonian Godwits—Kendall and Sig

Recent satellite transmitter data show that Hudsonian Godwit undertakes similar marathon nonstop migrations from Canada and Alaska to southern South America, and

back again in spring. Hudsonian is a large shorebird that breeds in North American boreal forest habitats (about 67% of their population) as well as in subarctic tundra, and like Bar-tailed Godwit it undertakes some of the longest nonstop migrations in the world, with a good part of these flights occurring offshore over Atlantic and Pacific oceans.

The Canadian breeding population stages near Hudson and James bays in Canada after breeding and then flies out over the Atlantic Ocean in late summer to fall (juveniles) to travel mostly nonstop to South America, where they often encounter bad weather storms en route. The Alaskan breeding population, which is a separate subspecies, also makes similar long, nonstop migrations to southern Chile

and back again in spring, with a few nonstop legs of several thousand miles each.

This excerpt from an article titled "Hudsonian Godwits Go Long" (Watts and Smith 2014) documents the fall migration of two Hudsonian Godwits fitted with satellite transmitters on the Mackenzie Delta in nw. Canada by Dr. Fletcher Smith, a shorebird biologist with the Center for Conservation Biology in the summer of 2013.

> *Kendall, an adult male, left the breeding grounds on 12 July and flew 1,529 miles to Churchill (Manitoba Province) in just over 2 days, staged for 2 weeks before moving down to Hudson Bay to stage for an additional 4 weeks. Sig, an adult female, left the breeding grounds on 10 July and flew to Churchill in just over 70 hours and staged for an incredible 3 months along Hudson and James Bays. Kendall left Hudson Bay (after 4 weeks) and made a dramatic 3,900-mile, nonstop, 5-day flight to the Orinoco River Basin in Venezuela, where he staged for 3 weeks in wetlands and agricultural fields. He then moved to the Amazon Basin to stage for an additional month, leaving Manaus, Brazil and flying to Santa Fe province Argentina. Kendall moved on to Buenos Aires and out to Samborombón Bay.*

Sig followed a similar pattern, flying 3,124 miles in 4.5 days from James Bay to coastal Colombia where she staged for more than 3 weeks in Los Flamencos Nature Sanctuary along the Caribbean Coast of Colombia. From here, she flew to Bolivia, staging for 23 days before flying to Santa Fe Province in Argentina. Both these birds have spent considerable time within agricultural landscapes containing high densities of ponds.

Red Knot—"Moonbird, B95"

Red Knot is an American Robin-sized shorebird whose annual migration is one of the longest of any creature on the planet. Flocks of Red Knot migrate along the Atlantic Flyway between Tierra del Fuego, Argentina, and their breeding grounds in the high Canadian Arctic, which encompasses about 20,000 miles a year! This subspecies of Red Knot (*Calidris canutus rufa*) usually makes this northbound epic journey with only a few stops, culminating at a major staging area in May along the Delaware Bayshore of New Jersey and Delaware.

Red Knots arrive famished and undernourished (sometimes weighing as little as 130 grams) along Delaware Bay and feed continuously on horseshoe crab eggs for about two to three weeks, when they strive to achieve a desired body weight of 200–225 grams, or just under half a pound. This extra fat reserve enables them to make the final nonstop flight of 2,875 miles to the Canadian Archipelago high Arctic region, where they breed. There are no adequate stopover feeding sites along this final leg of their journey, so if they don't achieve sufficient body fat reserves, they will drop into the vast boreal forests of Canada, where they search for life-sustaining riverbeds. These birds will typically perish or not continue to breeding areas.

While the movements of Red Knot are legendary, it took a very special individual to bring international attention to

Red Knot is one of the champions of long-distance migration, flying up to 20,000 miles round trip each year from high Arctic breeding grounds to southern South American wintering locations. A few important stopover feeding locations are included in these flights, including Delaware Bay. NJ, MAY

◀ **A breeding Red Knot feeds on horseshoe crab eggs washed ashore in the surf line of Delaware Bay in May.**

▼ **A brine fly's-eye view of impending trouble cast in the form of a meal-minded Wilson's Phalarope by Lloyd Spitalnik. This somewhat terrestrial member of the phalarope clan winters mostly in hypersaline lakes in the high Andes of South America, not in open oceans like its two family members.**

NYC, LATE AUGUST

this story. In February 1995, Argentine biologist Patricia González put an orange band on the leg of a Red Knot in Rio Grande, Tierra del Fuego, Argentina. The bird was at least two years old, and the band number was B95. This was the beginning a long saga that captured the attention and affection of millions of people worldwide and resulted in many articles and a book about this bird.

Why all the attention? The bird, a male Red Knot, was resighted a number of times over the next two decades along the Delaware Bay in New Jersey, and it was also spotted in May 2014 by Dr. Patricia González in the Canadian Arctic. It was recaptured at least three times (the last time in 2007) and sighted for the last time in May 2016 along the Delaware Bay, making the bird at least 21 years of age.

A little math determined that B95 had flown more than 400,000 miles over the course of those 21 years—roughly equivalent to flying to the moon and halfway back again. B95 was fondly given the name "Moonbird," and Phillip Hoose wrote an award-winning book about him titled *Moonbird: A Year on the Wind with the Great Survivor B95* (2012).

This publicity brought public attention to the perils of shorebirds and their migrations, and the importance of supporting conservation and research by shorebird biologists. With more than just facts and figures, the personification of B95 brought this struggle down to the human level of emotion and understanding, which is crucial to the future of shorebirds' survival and their support. There is a statue of B95 in Mispillion Harbor on Delaware Bay, and the city of Río Grande in Tierra del Fuego is said to have proclaimed B95 its "natural ambassador."

Shorebirds in Winter

Outside the breeding season, shorebirds are mostly social and coastally concentrated, where they find an abundance of invertebrate prey. Of course, there are exceptions, including those members of the grassland guild (Upland Sandpiper, Buff-breasted Sandpiper, and American Golden-Plover) that remain true to form and winter in the Pampas grasslands of Argentina and Uruguay, far from coastal areas, where they feed on an abundance of grasshoppers. Wilson's Phalarope is another outlier, wintering mostly in hypersaline lakes in the Andes, while Red and Red-necked Phalaropes mostly winter at sea off the coasts of the southern continents.

▲ **Merlin is the main aerial predator of small- to medium-sized shorebirds, as this unfortunate Western Sandpiper in Cordova, Alaska can attest. Rapid flight and ability to change directions on a dime allow Merlin to pursue and catch retreating shorebirds, as does their ability to surprise roosting shorebirds by flying low and fast across open spaces.** ALASKA, MAY

In fall and winter, most shorebirds are cryptically and often blandly plumaged, and many species join large mixed-species flocks that are ever vigilant for raptors that specialize in hunting shorebirds, most notably Peregrine Falcon and Merlin. Predator pressure also affects winter shorebird numbers and their distribution. At Bolinas Lagoon in California, hunting by Peregrines, Merlins, and Short-eared Owls is estimated to kill up to 20% of wintering Dunlin.

And while it is safe to say that many shorebirds winter in the Southern Hemisphere, there are quite a few that don't. Some of our southern coastal plovers (Snowy and Wilson's) remain for the most part in their natal area, gathering in small and often mixed flocks on coastal beaches. Jacana is essentially resident, relocating locally as water conditions dictate. Mountain Plover is a short-distance migrant, relocating from prairie breeding grounds to dry interior plains in California, the Southwest, Texas, and northern Mexico, where they seek out well-grazed grasslands and increasingly fallow agricultural fields caused by the loss of native grassland habitats. Some of the Beringia breeding Rock Sandpipers are

▼ **Like an M. C. Escher illustration, a large flock of American Avocets at Bolivar Flats, Texas in April feeds in typical synchronous fashion after finding a concentration of small bait fish. Note the orderly layers of feeding birds with their back feathers (scapulars) spiked up in excitement. This is truly an amazing spectacle to observe.**

essentially resident, relocating from tundra breeding areas to adjacent coastal locations, where they often gather in large flocks outside the breeding season.

Conversely, there are shorebirds whose latitudinal wintering range spans both hemispheres. Sanderlings winter coastally from New England and British Columbia south to the Straits of Magellan, and Surfbird winters coastally from Kodiak Island, Alaska, to the southern tip of South America. This extensive distribution affords a level of protection in the same way that a diverse portfolio imparts economic security.

But this does not explain why an individual Sanderling might elect to fly the additional 6,500 miles to Tierra del Fuego when there are Sanderling-calibrated sandy beaches and lots of wintering Sanderlings for company on Long Island, NY. If nothing else, the Sanderling's apparent indifference to migratory stress is a tribute to how superbly refined these long-distance migrants truly are. It is worth noting that among Sanderlings, there is no difference in the latitudinal wintering distribution of adults compared with juveniles, but many juvenile Sanderlings that winter in South America do not return to Arctic breeding grounds in their second year.

When not roosting or avoiding predators, much of a shorebird's daily nonbreeding activity pattern revolves around foraging, mostly at low or falling tide. Birds wintering in colder climates necessarily feed more heavily than those in temperate regions, as they burn more energy keeping warm. The doughty Rock Sandpiper winters mostly in coastal Alaska and forages on every low tide cycle, day or night. Even in areas rich in small bivalves, Rock Sandpipers must spend at least half their daily time budget feeding to keep up with the high metabolic demands of wintering in coastal Alaska. This helps to explain why Sanderling and other *Calidris* sandpipers are willing to invest the energy they do in migration, the energetic equivalent of paying forward.

Wintering shorebird energetics are further complicated by the need to replace their body and flight feathers to attain breeding plumage, a transformation that typically starts in late winter, just prior to migration, and continues during migration, especially at important extended stopover sites. Feather replacement consumes lots of energy, but the biological payoff is the privilege of moving your genes forward.

It is precisely in winter that shorebirds reach their highest level of artistic expression. During the breeding season, they are spread out over thousands of miles, but in massed flocks in winter, we find shorebirds in their aggregate finest, foraging in massed waves and wheeling in synchronous clouds to foil hunting raptors. The ranks of Sanderlings playing tag with the waves impart an element of animation to the winter-scoured landscape, while the thick, crowded ranks of American Avocets mantling the Bolivar Flats recall the works of the Dutch graphic artist Maurits Cornelis Escher.

When the tide turns, sending waves of Dunlin in search of higher ground, the air fairly sizzles with their rapid wing beats, and onlookers marvel that the tiny birds can pack so much enchantment into their twice-daily commute. We are not accustomed to this level of intimacy with birds, but shorebirds, because of their commanding attributes, can

A flock of hardy Dunlin sit out a frigid NJ winter's day on the Atlantic coast in December when the temperature was 10 °F with a wind chill below zero. Kevin was able to walk through this pack without flushing a single bird. They just shuffled aside and quickly put their bills back under their warm back feathers, hoping Kevin would go away without harming them.

As the hardiest of all shorebirds, these Rock Sandpipers are spending the winter near breeding sites in w. Alaska, often in frigid, icy conditions where food is hard to come by and the weather is less than hospitable. More Rock Sandpipers than rocks in this photo by Brian Guzzetti in February.

afford to be both confiding and engaging. We repay their confidence with admiration, wonder and verse.

SANDPIPERS
Carl Sandburg

Sandland where the saltwater kills the sweet potatoes.

Homes for sandpipers—the script of their feet is on the sea shingles—they write in the morning, it is gone at noon—they write at noon, it is gone at night.

Pity the land, the sea, the ten-mile flats, pity anything but the sandpiper's wire legs and feet.

Shorebird Mortality and Declining Fortunes

With their somewhat low reproductive capacity, high natal mortality, and relatively short life span, becoming a breeding-aged shorebird might well constitute one of the animal world's greatest accomplishments. Literally living on the edge, shorebirds are exceedingly vulnerable to perturbations within their life cycle. Some shorebird populations have suffered an alarming 70% decline since the first book titled *The Shorebirds of North America* was published in 1967 (Stout et al. 1967). The vast numbers that shorebirds have long relied on to sustain them no longer seems the bulwark it once was against population declines.

In some portions of the Arctic and subarctic, dramatically increased Snow Goose numbers have denuded great swaths of vegetative tundra that once supported breeding shorebirds, especially in the taiga-tundra ecotones of Hudson and James bays in Canada. Reduced snowpack has also caused regional reductions in lemming numbers, resulting in higher predation on nesting shorebirds by foxes, jaegers, and gulls that find shorebird eggs and nestlings an alternative to lemmings.

In migration, shorebirds face challenges fostered by humans, whose coastal development and efforts to combat sea level rise diminish shorebird habitat. Shorebirds also face human hunting pressure in protein-starved portions of their migratory and nonbreeding ranges, especially in South America and China. Changing agricultural practices and direct competition for food resources also levy a toll on the birds. A prime example is the overharvest of horseshoe crabs in Delaware Bay, depleting the eggs on which tens of thousands of migratory shorebirds depend to fuel up for the final leg of their journey to the Arctic. Indeed, the authors witnessed this harvest and worked to halt the decline.

Piping Plover, whose coastal subspecies ekes out a tenuous existence on the Atlantic shoreline, has disappeared from some beaches because increased human beachgoer traffic disrupts the nesting cycle and prevents chicks from

▲ **A few-days-old Piping Plover chick has to maneuver around beachgoers to reach its feeding area in the Atlantic surf zone. Sharing ocean beachfronts with humans in summer, these cute, tiny puffballs with long legs are virtually unnoticed by their human neighbors, but feeding is often interrupted by the large number of beach enthusiasts.** NJ, MAY

▶ **A dapper male Piping Plover of the subspecies *C. m. circumcinctus* is part of an inland population of this vulnerable species that has increased over the last few decades, which is good news for this federally Threatened species. This increase will likely allow Piping Plover to survive the devastating effects of sea level rise, which threatens to extirpate the coastal subspecies in future years.** FLORIDA, APRIL

reaching the water's edge to feed. The result is that nest productivity has fallen below the threshold needed to maintain local populations in a number of places. Their nest success has also declined as a result of climate change, with rising sea levels, higher tides, and summer storms washing out nests that would have been safely situated 40 years ago. These negative factors affect only the Atlantic coastal breeding population, with the inland subspecies only one of three shorebird species that have noticeably increased in numbers over the last several decades.

Year by year, challenge by compounded challenge, it is becoming harder and harder to become an adult shorebird, and whole populations are faltering in some species. For now, the Arctic air still sizzles with the tinkling flight song of White-rumped Sandpiper, the whistled yelp of Golden-Plover, and the rhythmic hoot of Pectoral Sandpiper, yet ours may be the last generation to be enriched by these auditory treasures.

But this book is a tribute to shorebirds, not a eulogy. Shorebirds have endured comet strikes that killed off their dinosaur kin and market gunning that greatly thinned their ranks in the last half of the 19th and beginning of the 20th centuries. Climate change is just the most recent challenge faced by this bird group.

THE TRAGEDY AT DELAWARE BAY (ALSO HOPE FOR RECOVERY)

The earliest reference to the annual gathering of crabs and shorebirds on the beaches of Delaware Bay harks back to the early 1800s, including the account by ornithologist Alexander Wilson of the Ruddy Turnstone, one of the four principal shorebird species dependent on the annual tribute of horseshoe crab eggs to fuel their migration and breeding success. The other three species are Red Knot, Sanderling, and Semipalmated Sandpiper. Said Wilson of the density of mating crabs in his account of the bird that he called the "horse foot snipe" (Ruddy Turnstone): "A person could walk ten miles east from the mouth of the Maurice River on the backs of crabs and that stroller's feet would never touch the sand."

Such was the concentration of crabs in the early 1980s, before the ranks of crabs were decimated by the greed of "crabbers." While Wilson did not specifically link Red Knot to the eggs of the horseshoe crab, his name for Ruddy Turnstone ("horse foot snipe"), which forages generally higher in the bay than Red Knot, clearly indicates a historic link between the hosts of birds and crabs going back more than two centuries.

Nearly 90% of this crucial migratory food source was wiped out in the 1990s and early 2000s by uncaring opportunists who overharvested horseshoe crabs with no regard for sustainable yields or the birds that relied on their eggs for survival. At this time, there were no NJ state or federal regulations to limit the crab harvest, and excessive numbers were taken. Another major contributing factor to the crab's rapid decline was the bottom dragging of Delaware Bay, which not only yielded a large number of crabs but also disturbed the fragile ecosystem of these fertile spawning grounds. Much of the harvest resulted in crabs that were chopped up and used as bait for a local eel prized in Japan as a high-priced delicacy, but not sold or desired in the United States.

A unique crab's-eye view from the Delaware Bay shoreline in May shows a mating frenzy with larger female horseshoe crabs attracting smaller, eager males. These crabs are the sole catalyst of the entire Delaware Bay shorebird phenomenon in spring.

▶ **Ornithologist Alexander Wilson wrote in the early 1800s that the number of mating crabs on the Delaware Bayshore was so prolific that a person strolling could walk several miles without touching the sand. Numbers are greatly reduced today, but this small microcosm captures the phenomenon described by Wilson.**

▼ **As a large female horseshoe crab lays eggs just under the sand on the shores of Delaware Bay in May, nine smaller males deposit their sperm in the vicinity of the eggs to enable fertilization to take place. Note the tiny size of the lipid-rich crab eggs compared with a penny in the right photo.**

This conflict over resources caused a great deal of consternation between environmentalists and the Delaware Baymen, who viewed the eventual protective regulations for horseshoe crab harvest as an infringement on their right to earn a living. At 25 cents per crab in the 1980s, only a handful of local Baymen were harvesting crabs, so the impact to the crab population was negligible at that time.

But when the price rose to $1.75 per crab in the mid-1990s because of increased demand for a rapidly shrinking resource, a good number of out-of-state businesses filled large tractor trailers with burlap bags of horseshoe crabs without concern for the decimation of their numbers. Local opportunists also joined the handful of Baymen and contributed to the overharvesting in the 1990s. With a paltry license fee of $50 per season and no bag limits, the crab harvesters wiped out a large percentage of the crab population (fide Kevin Karlson).

Further exacerbating the problem was the purposeful selective harvest of large adult female crabs, which fetched a higher price on the market. Horseshoe crabs take about ten years to reach sexual maturity, and when you selectively harvest sexually mature female crabs, the entire population suffers in a short period of time. The impact on Red Knot numbers was catastrophic, declining from more than 100,000 birds on Delaware Bay in the early 1990s to a low of about 12,000 birds in the mid-2000s. This was a rallying cry for birdwatchers and environmentalists, and the conjoined voices of many supporters of Red Knots

In the late 1980s and 1990s, high demand for horseshoe crabs for bait resulted in unregulated, indiscriminate harvesting by Baymen and local residents, as shown by the pickup truck with crabs crawling out onto the roadway, only to be crushed by vehicles. Only large, mature female crabs were taken for the higher pay, which devastated the population, as horseshoe crabs take about 10 years to reach sexual maturity. The population of crabs declined more than 90% in just over a decade, resulting in long-overdue regulations on harvesting these living relatives of arthropod trilobites from 400+ million years ago. NJ, MAY

and horseshoe crabs resulted in protective regulations for harvesting crabs enacted by the State of NJ in the late 1990s and mid-2000s.

After a decade or so, Red Knot numbers for the subspecies *C. c. rufa* rebounded to a high of about 40,429 birds, based on a comprehensive study undertaken on the Atlantic Coast on May 23–25, 2012, which found 25,548 knots in Delaware Bay; 1,500 in salt marshes around Stone Harbor, New Jersey; 8,621 in Maryland and Virginia; and 4,850 in North Carolina south to Florida. Add in the 2,000 knots counted in winter 2012 in the nw. Gulf of Mexico (D. Newstead, unpub. data), and the *C. c. rufa* population in 2012 was about 42,000 (Andres et al. 2012; Amanda Dey, pers. comm.). This higher number was despite a paltry record low of 9,850 wintering knots counted during aerial surveys in southern South America in 2011, but this number rebounded to 13,000 birds counted in January 2012, with ground observations noting the presence of numerous juveniles reflecting a successful breeding season in 2011.

Larry Niles, from the Conserve Wildlife Foundation of NJ and Wildlife Restoration Partnerships, and Amanda Dey, from the NJ Dept. of Environmental Protection, Endangered and Nongame Species Program, head a team of international scientists and researchers who study, band, and count Red Knots and other shorebirds on Delaware Bay. This research began in the early 1990s and continues to the present day. They use the findings of their research to establish reliable data for the protection and ongoing monitoring of this bird that is living literally on the edge of survival, and to educate the public about the ongoing crisis

Groups of Red Knots, with a few Sanderlings, feed feverishly in a horseshoe crab egg concentration hole on a Delaware Bay beach in May. Note the worn orange leg band from Argentina on one of the knots, which Kevin hopes is "Moonbird—B95." This photo was taken in 2005, nine years after Moonbird was banded in 1996 by Kevin's friend Dr. Patricia González in Rio Grande, Argentina. Hope springs eternal, since the band is worn, and the numbers are not visible.

A shorebird banding operation is shown in this photo from May 1998 on Delaware Bay, NJ. Biologists gather important information, including arrival and recapture weights that indicate whether birds are physically prepared for the several-thousand-mile flight to high Arctic breeding grounds. Dedicated shorebird researchers like these are responsible for the Red Knot recovery in progress today.

of a species in peril. They also secured federal grant money after Hurricane Sandy for habitat restoration of parts of the Delaware Bay shoreline that are critical feeding areas for the birds that use this resource.

The ecological disaster that transpired in Delaware Bay has still not fully recovered after 25 years of protective management of the crab harvest, but recent trends indicate a possible recovery in progress. During the winter of 2022, numbers of Red Knots counted at key sites in southern South America were the highest since 2012, with 14,521 birds tallied.

In retrospect, however, it should never have happened. The spring concentrations of birds and crabs were among the ecological wonders of the world, and they were widely known to birdwatchers and ornithologists, well-studied and documented, and supported a thriving tourist industry. Two state and one federal agency were charged with protecting the birds, and multiple conservation organizations vigorously decried the harvest.

New Jersey's Governor Christie Todd Whitman favored regulation in 1997, and the state even passed a few laws to protect the crabs, but local state legislators representing (they believed) the wishes of their constituents stymied efforts to fully halt the harvest. It is not the first time in our history that the needs of birds have gone head-to-head against localized self-interest groups and lost crucial battles, but regulations passed by Governor Corzine in 2004 and 2006 have further restricted the crab harvest, and a full moratorium on harvesting crabs for bait went into effect in 2008. Sadly, the progress toward recovery in the Delaware Bay is the exception, not the norm, which does not bode well for shorebirds facing increased challenges because of changing land and water use practices, here and elsewhere.

With increasing numbers evident today, a group of Red Knots and Ruddy Turnstones lift up from a Delaware Bay island in May, NJ. "Build it and they will come," a misquoted line from the movie *Field of Dreams*, is appropriate on the Delaware Bayshore after Larry Niles and associates secured relief money from the federal government after Hurricane Sandy in 2012 to replenish lost sand on the NJ Bayshore, with local businesses and government helping to truck the sand into place. Huzzah!

Market Gunning: "Sins of our Fathers

A Short Historical Essay

PETE DUNNE

It is difficult for those of us living in this conservation-minded age to contemplate a time when systematic slaughter of wildlife was not just sanctioned, but near universally accepted. We find it incomprehensible that members of our species would exterminate birds to the point where their very populations became threatened. But this is precisely what happened between 1800 and 1918, the years regarded as the "market gunning era." What's more, it all evolved quite naturally.

Today we brand those market gunners "game hogs" and "game bootleggers," but in their time, they were just ordinary tradesmen and valuable members of the community plying a trade that predates agriculture and animal husbandry. It was ingenuity and market demand that took a cottage industry and turned it into an industrial-scale business of slaughter.

Imagine the astonishment of those first Europeans to set foot on our shores. Immigrants fleeing a land of nutritional impoverishment whose protein needs were drawn mostly from the sea by the 1600s, finding in the New World a veritable Garden of Eden replete with innumerable quantities of "bustards" (turkey) and "fowl" (geese and ducks).

When the early settlers first arrived in North America, the abundance of Wild Turkeys were a welcome sight, and many a meal was prepared for their families with this bounty. However, by 1830, John J. Audubon noted that overharvesting had resulted in the birds being hard to find.

There was certainly a seasonality to the bounty, when waterfowl blanketed the bays in winter and shorebirds made marshes vibrate with motion in spring and summer. There seemed no limit to the numbers, and no regulations governed the harvest of such bounty. It is likely that in no other corner of this planet was there a greater abundance of feathered game than was found in North America before the arrival of Europeans to these shores.

Villages sprang up, and men with primitive fowling pieces went out to harvest game to feed their families, just as native people were doing. A skilled hunter might bring home more game than he could use, so he shared his spoils with his neighbors, or perhaps he traded a goose or a brace of curlews to a neighboring farmer for a commensurate measure of corn or barley. In favorable times, he negotiated an exchange with the local innkeeper for a pint or two. There were no bag limits beyond a man's skill with a firearm.

From this low-key subsistence hunting and barter system, market gunning evolved. Villages became towns, and some towns became centers of commerce, which were later engines of the industrial revolution. Year after year, more and more Europeans flocked to the New World, especially Germans, Swedes, Irish, and Poles. By 1850, more than 23 million people were US residents (up from 2.5 million in 1776), and many of these new arrivals moved into the industrial centers of Boston, New York, Philadelphia, Baltimore, Charleston, New Orleans, and Chicago, where they found employment.

These city dwellers were deprived of access to the natural supermarket that had sustained earlier immigrants, so they were reliant on city markets to provide nourishment. What they craved in that age before Tyson chickens and Hormel hams was an inexpensive source of protein, a need that was served for many years by the slaughter of wild Passenger Pigeons and waterfowl. But after the demise of the Passenger Pigeon in the late 1800s and the gradual depletion of waterfowl, the market and gunners came to accept shorebirds as the ideal substitute. Large, abundant, and highly appetizing, the ranks of shorebirds were not only abundant but also obliging enough to ferry themselves to coastal marshes close to population centers. From the gunner's standpoint, shorebirds were close to ideal, as they flew in tight flocks, decoyed well, and were easily killed by a blast of fine bird shot.

An accomplished gunner could fill barrels with birds and reap a profit. In the days of plenty (1800–1880), only the larger shorebird species were gunned, with the smaller sandpipers not deemed worth the shot and powder. By the late 1880s, with Eskimo Curlew all but eliminated and Long-billed Curlews along the Atlantic Seaboard a distant memory, the guns turned upon the tiny "sand snipe." Gunners in Cape May would lie in wait for flocks of Least and Semipalmated Sandpipers and mow them down by the "hundreds" (Stone 1937).

Edward Howe Forbush, a noted Massachusetts ornithologist, writing in 1912, puts numbers to the slaughter: "116 yellowlegs killed with a single shot; 127 Red-breasted Snipe (dowitchers) killed in three shots" (John J. Audubon in Forbush 1912); 340 Wilson's Snipe killed in a single day on the Sangamon River in Illinois by two gunners. But these numbers pale compared with Audubon's account of 48,000

Shorebirds come in a range of sizes, from the largest Long-billed Curlew to the smaller "peeps," like this Western Sandpiper. Long-billed Curlews were a favorite target for market gunners in the 1800s, when this species was eliminated from the Atlantic Coast.

(American) Golden-Plovers annihilated by a battery of gunners on March 11, 1821, near Lake Saint John, Louisiana (Audubon 1827). There is no reason to question the accuracy of Audubon's tabulation, nor any reason to believe that this was an isolated event. The slaughter was well planned by gunners who knew the habits of the birds through past experience. The sad diminishment of the ranks of American Golden-Plovers attests to the systematic slaughter.

Initially, the market gunning industry was held in check by a reliance on slow muzzle-loading weapons, but as weapons technology improved, so did the rate and deadliness of fire. The slaughter increased in measure. By 1855, the double-barreled breach-loading shotgun was in common use. Where a man armed with a muzzle-loading weapon might need minutes to reload, now with factory-produced shells, it could be done in seconds, just in time to fire a second charge at birds returning to the cries of fallen flock mates.

Bigger, boat-mounted weapons called Punt guns reaped a terrible toll on massed birds. Also employed was a diabolical practice known as fire-lighting, which involved two or more men. One brandished a mesmerizing kerosene lantern, and the other, the harvester, wore a gunny sack slung over his shoulder. With no firearm, he would sneak up on the bedazzled birds from behind, grab them by hand, and after administering a judicious bite to the neck, toss the limp form into the sack. It was primitive but very cost effective.

The other technological revolution that accelerated the slaughter was the railroad, whose capillary network of rail lines linked the killing fields of the prairies to market centers in the East. The spring shooting of breeding adult shorebirds was particularly impactful on bird populations, and in this age before refrigeration, many barrels of birds rotted before reaching markets.

Forbush (1912) offers an account of two Boston firms, which in 1890 received 40 barrels "closely packed" with

One of the most attractive of all shorebirds, a male American Golden-Plover protests a disturbance near its tundra nest in Alaska by performing a distraction display. It is hard to believe that this species has come back from the indiscriminate slaughter by market and sport gunners in the 1800s, with 48,000 killed in a single day in March 1821 in Louisiana by a battery of gunners.

Buff-breasted Sandpipers numbered almost a million strong in the early 1800s, but were almost extirpated when market and sport gunners in the Midwest slaughtered them without mercy during their northbound migration for food and just for the sake of shooting them for "fun." Today their numbers are hovering around 56,000, although they remain a species of concern in North America (Andres et al. 2012).

Eskimo Curlews, Golden-Plovers, and "Upland Plovers" (now Sandpiper) from Nebraska, Missouri, and Texas. He goes on to lament that Golden-Plover had "almost disappeared" from New England, falling off 90% in 15 years.

While declines in some species were noted as early as the mid-1800s, and calls for restraint and an end to spring shooting came from some quarters, regulation of an industry so steeped in tradition and fueled by the myth of America's inexhaustible resources was slow in coming.

It wasn't until the passage of the Weeks-McLean Migratory Bird Act in 1913 that spring and night shooting were prohibited. But blanket protection did not occur until 1918 with the signing of the International Migratory Bird Treaty between the United States and Canada, which stated that all shorebirds except snipe and woodcock were given nongame status. The legislation was not in time to save the Eskimo Curlew, but it likely did save the Golden-Plover, Upland Sandpiper, and Buff-breasted Sandpiper from annihilation.

If market gunning brought out the worst in us, successive efforts to redress our crimes against nature reflect our best intentions to be good stewards of this planet. These efforts began with the Weeks-McLean Migratory Bird Act of 1913; the Migratory Bird Treaty of 1918, affording protection to most migratory birds; the signing of the Duck Stamp Act in 1934, directing revenue generated by the sale of stamps to the migratory bird conservation fund; and establishment of the U.S. Fish and Wildlife Service in 1940, an agency overseeing migratory birds and the procurement and enhancement of land for wildlife. Today this federal agency manages 560 refuges, covering 150 million acres of prime (mostly wetland) habitat. In 1947, the Canadian Government followed suit with a Canadian Wildlife Service.

Other nongovernmental institutions working toward the betterment of shorebirds and the habitat they require include The Western Hemisphere Shorebird Reserve Network (WHSRN), The National Audubon Society, Ducks Unlimited, American Bird Conservancy, Manomet Bird Observatory, The US Shorebird Conservation Partnership, and Partners in Flight.

We cannot bring back the Eskimo Curlew, but we should be able to prevent another species from joining the curlew in oblivion.

"The beauty and genius of a work of art may be reconceived, though its first material expression be destroyed; a vanished harmony may yet inspire the composer, but when the last individual of a race of things breaths no more, another heaven and earth must pass before such a one can be again."

William Beebe, ornithologist

SECTION 2
Shorebird Species Profiles

North American shorebirds encompass six or more family groups as different from each other as warblers are from woodpeckers and thrushes are from jays. Things they have in common are an affinity for open, often semiaquatic habitats and a dedicated focus on invertebrate prey. All shorebirds are carnivores, and it is precisely the techniques they use to capture prey, in conjunction with physical adaptations, that facilitate these strategies. This permits plovers and sandpipers to forage in close proximity and not directly compete. Plovers and sandpipers account for most of the planet's shorebirds, but both confront the challenges of being shorebirds in markedly different ways.

A male Buff-breasted Sandpiper performs a single-wing courtship display at his mating post in a lek on the North Slope of Alaska in June. This display is done from a raised portion of tundra, allowing the intricate pattern of his white underwing to be seen by prospective females from a great distance.

Stilts and Avocets (Family Recurvirostridae)

These elegant, pied water striders are near cosmopolitan in their distribution, and they use their long legs, necks, and bills to exploit the invertebrate riches of shallow wetlands beyond the functional reach of less elongated shorebird species. The rapier-fine bills are straight and needle-like on stilts, and gracefully upturned in avocets, especially females.

Fresh, tidal, and hypersaline bodies of water are all acceptable habitats for these birds, particularly avocets, as long as they include an abundance of mostly invertebrate prey in the water column. The planet's seven Recurvirostridae species are closely related to the oystercatchers but could not be more different in terms of foraging techniques. Gone are the hardened chisel-like bills of oystercatchers, replaced by long, thin, flexible-tipped bills that are swished or stabbed into the water column and adjacent mud for aquatic invertebrates and small vertebrates (most notably small fish).

Avocets feed primarily by swishing their bills through the water column, a maneuver called "scything." They seine small food particles through their partially opened bills, which are then trapped in a complex system of lamellae and later whisked into the mouth by the avocet's fleshy tongue. Avocets are also visual hunters and may swim to feed in deeper water in pursuit of prey by using their partially webbed feet. Stilts consume mostly insects, crustaceans, amphibians, snails, and flies that are targeted mostly visually, although they can and do sweep their bills like avocets, snatching small fish from the water column.

Members of the Recurvirostridae family are among the most social of shorebirds, often nesting communally in small, loose groups. In winter, avocets gather in dense concentrations on coastal flats teeming with food, or at inland fresh or saltwater wetlands that don't freeze, most notably the Great Salt Lake. Stilts and avocets typically breed in shallow wetlands when local conditions are favorable to nest success. If conditions are not favorable in usual nest locations, birds may delay breeding or move to more suitable sites that provide reliable water levels, an abundance of prey, or reduced predation.

Both stilts and avocets nest in scrapes on the ground, often on small mud islands and typically in places with scant vegetation. These scrapes are often adorned with sticks, bits of bone, and shells (see page 63, left photo). A typical clutch is 3 or 4 eggs, and nonstop incubation commonly begins with the third or last egg. After hatching, downy young are able to run and feed themselves within a few hours.

Breeding success is variable from year to year, given the mercurial nature of shallow wetlands. Dropping water

▼ **While generally tolerant of each other, it is apparent that a Black-necked Stilt wandered too close to an American Avocet's nest site. American Avocets are dominant where these two species share similar habitats.** SALT LAKE CITY, UTAH, MAY

levels allow predators easier access to the nest site if a dry season occurs, and one good breeding season may be followed by several years of low productivity. Black-necked Stilts enjoy exceptionally long lives if conditions are favorable, with a possible life span of 19 or more years.

While the populations of American Avocets and Black-necked Stilts appear stable, the shallow wetlands that sustain them are vulnerable to modification, draining, drought, reduced water flow and pollution. Both these species have benefited greatly by the National Wildlife Refuge system, whose managed wetlands are ideal habitats for breeding and wintering stilts, avocets, and many other shorebirds. Buy Duck Stamps, which help to support the NWR system!

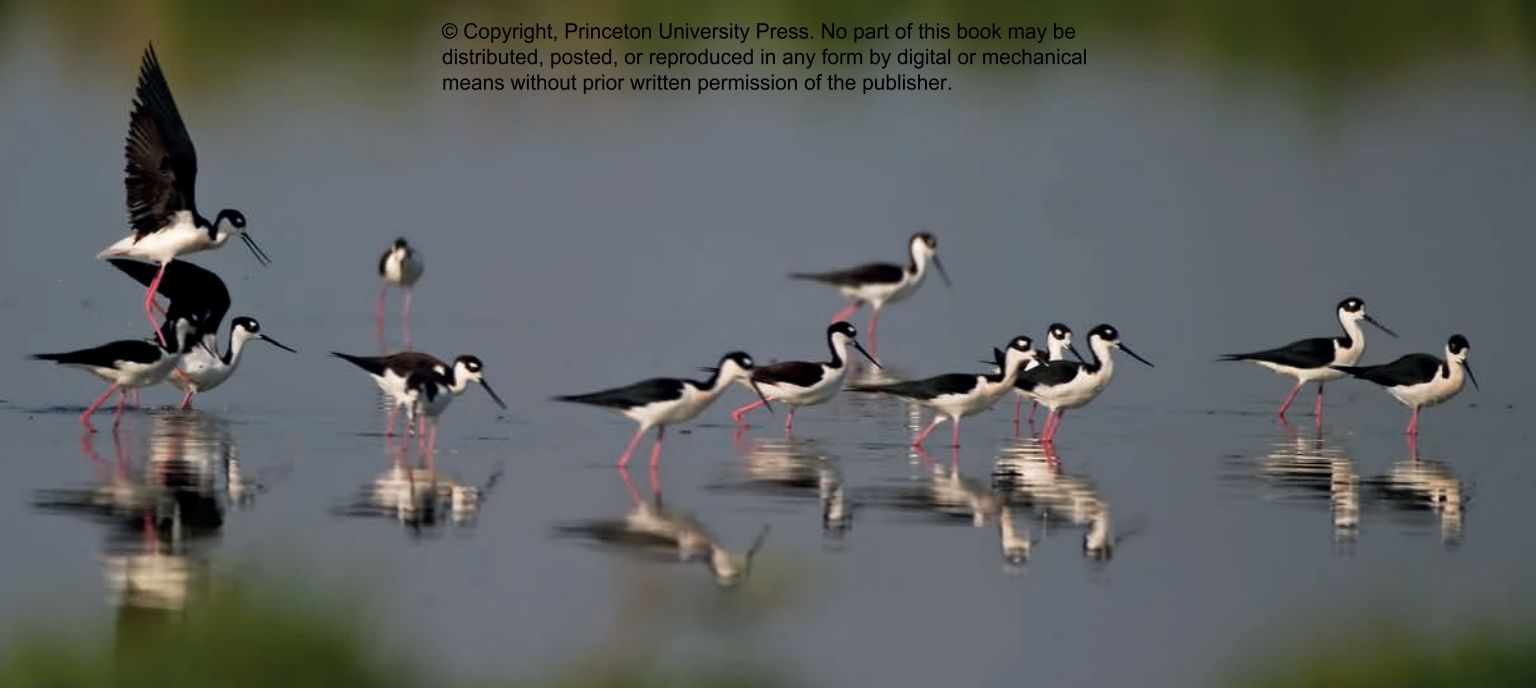
Black-necked Stilt
Himantopus mexicanus

BIOMETRICS 14–15½ inches long; wingspan: 29–32½ inches; weight: 136–220 grams (4.8–7.8 ounces)
STRUCTURE Slender body with pointed rear end; extremely long legs; long, slim neck; long, needle-thin bill
STATUS Common in the West and South; scarce in Northeast; population appears stable or slightly increasing

This formally attired marsh bird strides through standing water on exquisitely long, red legs. Nicknamed Lawyer-bird because of its crisp blackish upperparts and gleaming white underparts, and perhaps because of its verbosity,

A dapper male Black-necked Stilt with pied plumage sports long legs that would make Betty Grable envious. Males have bluish-black backs in breeding season and long bubble-gum pink legs. TEXAS, APRIL

After copulation, Black-necked Stilts walk side-by-side with affection and grace (*left*) as they celebrate the deed that was just done. Quiet, freshwater pools are favorite habitats for this species, including this pool in the oil fields near High Island, Texas (*right*). TEXAS, APRIL



It's rare to find so many quiescent stilts. A new arrival to the group (bird on the left) typically triggers a chorus of yaps from the high-strung "marsh poodles." TEXAS, APRIL

it is also somewhat irreverently called "marsh poodle." This is a clear reference to the bird's incessant yipping calls that it gives when excited, when danger is perceived, or just because a new member of the clan has joined the main group. Wherever they occur, Black-necked Stilts are among the most conspicuous and readily identifiable of all shorebirds.

Black-necked Stilts are high-strung birds and often react to any changes in their social grouping with aggressive posturing and loud "yipping" calls. Their breeding displays and behaviors are some of the most sensitive of any bird group, as evidenced by their post-copulation strutting where the male wraps his bill around the female's as they strut elegantly together while celebrating the special act that just occurred.

Stilts and avocets often share the same habitat, but stilts are generally less communal, although adults will congregate to add their voices to antipredator displays. While Black-necked Stilts are typically seen in small to medium groups of 5–30 birds in winter, large concentrations of up to 100 birds are possible. Stilts are also partial to freshwater wetlands with emergent vegetation, while avocets prefer open, non-vegetated mudflats with shallow water.

Black-necked Stilts have a widely spaced and disjunctive breeding range in the United States and Mexico south to southern South America, as well as the West Indies and Caribbean islands. In North America, the breeding range includes the Great Basin north to Oregon, Alberta, and Saskatchewan, and southern portions of the high prairies.

Elegance in motion. The folks in Creation's R&D Department took the rest of the day off after rolling out the Black-necked Stilt line. A flock of these attractive birds always garners the attention of nearby birdwatchers.
TEXAS, APRIL

▲ **A female Black-necked Stilt with brown back (*left*) is a picture of elegance and symmetry in flight. A juvenile stilt (*right*) lacks the bold blackish plumage of adults and has a brownish wash to the back and head.** TEXAS, APRIL

California and coastal Texas have a good number of year-round resident populations, and migratory populations occur from Delaware south to Florida and the upper Gulf Coast. Interior breeders other than those in California are migratory, and many southern breeders move only short distances south for the winter months.

This species adapts well to wildlife refuges and their requisite man-made, shallow impoundments. It breeds in both fresh and tidal wetlands, with scrapes situated on islands, dikes, or elevated platforms close to water, and less commonly on mats of floating vegetation. Pair bonding may occur on winter territories. Nest initiation is primarily late April to mid-May, with egg dates from early April to mid-August. Incubation is 18–27 days, and young can fly after about 28–32 days.

Black-necked Stilt is a partial to intermediate distance migrant, mostly through the interior, and they migrate primarily at night and early morning. Spring migration is from mid-February through mid-June, and fall migration takes place from July to December. Adults depart most breeding areas from early July to early September, often gathering in flocks at nearby staging areas in August. Southbound juveniles depart breeding locations from mid-July to early September and migrate mostly with adults.

After heavy rains or tidal flooding, Stilts may forage in roadside ditches and large puddles. Their primary prey is small aquatic invertebrates, and they will occasionally forage in water up to their breast. Prey is mostly detected visually and secured by pecking or plunging, although small invertebrates and fish are captured in deeper

▶ **Flying with Long-billed Dowitchers and Stilt Sandpipers, these wintering Black-necked Stilts at Llano Grande State Park in the Rio Grande Valley of Texas in November add a bit of flash to this flock of otherwise drab plumaged shorebirds.**

(continued...)