



MIGRATION BY JANE QIU

STEMMING THE TIDE

The bar-tailed godwit journeys more than **10,200 MILES** from its winter home in New Zealand to its breeding grounds in Alaska—stopping only once in East Asia's **YELLOW SEA** to refuel. All the more reason to save vital habitat for it and other long-distance shorebird migrants.

By the time this dunlin (left) arrived in South Korea's Saemangeum estuary, the tidal flats were gone, transformed into a vast stretch of desert by a seawall that was built to keep out the water. Researchers and conservationists are racing to prevent similar large-scale disasters elsewhere in the Yellow Sea, where millions of migrating birds stop over, even as its mudflats continue to be filled in for development (above).

On a subdued April afternoon in Nanpu, an industrial town on China's Bohai Bay, the air is salty and acidic from the salt pans, oil refineries, and steel and soda factories that cram along the coast. The mudflat slowly emerges from the receding tide, its soft sediment shimmering like a gigantic tin roof. Large flocks of shorebirds—bar-tailed godwits, dunlins, red knots, great knots, curlew sandpipers, whimbrels, sanderlings, and red-necked stilts—feed frenetically at the water's edge. With their highly specialized bills, they quickly dig out a feast of worms, clams, and crabs from the seemingly lifeless tidal flats.

Some of the birds are already in their bright-colored breeding plumage, while others still have most of their winter feathers. Their incessant pecking hints at a sense of urgency. "They have no time to waste," says Yang Hongyan, a postdoctoral researcher at Beijing Forestry University. Indeed, these seemingly delicate creatures are among the 5 million shorebirds of 60 species—about half of the world's shorebird species—that stream from Australia and New Zealand every spring over featureless ocean toward their breeding grounds, some going as far north as the Arctic, including Alaska. The route constitutes one of the world's most important flyways, the East Asian-Australasian Flyway (EAAF).

Before setting out on the final leg to the Arctic, most of the birds stop to rest and refuel along the shorelines of the Yellow Sea—a marginal sea of the Pacific Ocean enclosed by northeastern China and the Korean Peninsula—including Bohai Bay. They fatten up considerably during their short stay here, in some cases doubling their typical body weight, in order to reach northern Alaska or Siberia and still have plenty of reserves upon arrival, when feeding conditions may be poor. "The Yellow Sea is like a gas station for these long-distance migrants," says Nils

Warnock, executive director of Audubon Alaska. "If they can't fill the tank, they will end up in the middle of the ocean."

But with a strong push for economic growth and infrastructure development, China and South Korea are rushing to convert the Yellow Sea's mudflats to ports, industrial complexes, aquaculture enclosures, and residences. The mudflats "have been a critical staging site for thousands of years but are now disappearing fast," says Theunis Piersma, an evolutionary biologist at the University of Groningen and the Royal Netherlands Institute for Sea Research. Yellow Sea tidal flats have declined by 65 percent in the past 50 years. This "has made the EAAF one of the most threatened flyways in the world," says Doug Watkins, manager of Wetlands International-Oceania and chair of the Yellow Sea Ecoregion Task Force of the EAAF Partnership, a conservation group that promotes international cooperation in protecting shorebirds and their habitats on the flyway.

Twenty-four shorebird species that use the flyway are heading toward extinction, with many others facing exceptionally rapid losses, sometimes as high as 5 percent to 9 percent a year, according to a report released last October by the International Union for Conservation of Nature (IUCN). The worst hit are the long-distance, Arctic-breeding migrants such as the red knot and the spoon-billed sandpiper; the latter, declining at a rate of 26 percent a year and with fewer than 200 breeding pairs in the wild, is listed by the IUCN as critically endangered. These rates are among the highest of any on the planet, the report says. And all species identified as declining rely on the Yellow Sea shoreline during migration.

It's extremely challenging to make an airtight case that the marked reduction of mudflats in East Asia, especially on the

"We have to act now. Many of these bird populations will collapse in the foreseeable future if the rate of land reclamation does not slow down soon."



CHARLES PAGE. MAP BY MIKE REAGAN

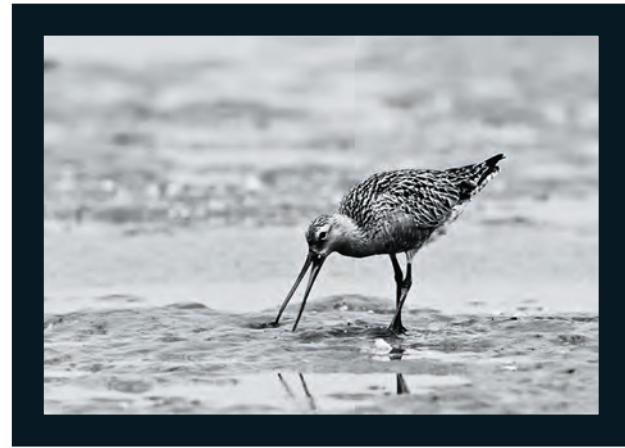


SUPERHIGHWAY

Migrants funnel through the Yellow Sea each spring on their way to Alaska. Dunlins winter in East Asia and summer in Alaska. Satellite tags revealed that a bar-tailed godwit and a ruddy turnstone paused midway from New Zealand and Australia, respectively, before making the final push north. While adult sharp-tailed sandpipers migrate between Australasia and Siberia, in late summer up to 40,000 juveniles head to Alaska, then fly nonstop to Australasia to join the adults.

Yellow Sea, is responsible for the rapid decline in flyway populations of such species as the red knot and spoon-billed sandpiper. It's also hard to persuade policy makers to step up protection of the remaining key stopover habitat. This is the mission that Piersma—a world-renowned expert on the red knot and the namesake of one of its subspecies, *Calidris canutus piersmai*—and his team, including Yang, have set out to accomplish.

In the past couple of years, national newspapers in China have started covering the issue, running stories on the importance of tidal flats and featuring senior politicians speaking



A bar-tailed godwit forages on South Korean mudflats (above), packing on weight for its migration. Just before its trip, digestive organs not needed during the flight decrease in size, and the heart gets bigger. Dunlins flock near the shore of Bohai Bay (opposite).

out against massive reclamation projects. With the situation so critical, scientists and conservation groups are campaigning hard to save the remaining vital staging sites on the Yellow Sea. “We have to act now,” says Zhijun Ma, an ornithologist at Fudan University in Shanghai. “Many of these bird populations will collapse in the foreseeable future if the rate of land reclamation does not slow down soon.”

Thousands of red knots approach the salty shallows from afar, moving continuously in perfect unison. As the flock drifts upward and downward, probably inspecting the rolling waves, it looks like a gigantic feathered quilt flapping gently in the spring breeze. The birds—a different subspecies than those that migrate along the U.S. East Coast—finally join the others on the mudflat and eagerly commence feeding. Lining up on a dike that flanks the salt pans is a group of equally eager bird researchers from China, Australia, New Zealand, and the United Kingdom.

“Aha, here he is,” cries out David Melville, part of a surveying team from Fudan University led by Ma. He and his colleagues are surveying shorebirds along the coast of the Yellow Sea, from its southern end in Shanghai to its northern tip in the Yalu Jiang estuary. Through his powerful spotting scope, he locates a bar-tailed godwit with a little white flag and colored rings attached to his legs. “I captured and banded him six years ago in Golden Bay [in New Zealand]. It's so nice to see him again,” Melville says, like reuniting with an old friend. “He has been coming here each spring,” says Matt Slaymaker, who has surveyed banded shorebirds in Bohai Bay every year since 2010 with Global Flyway Network, an organization that aims to monitor and understand changing shorebird populations worldwide. This is common for shorebirds, a phenomenon that scientists call site specificity—that

is, they go to the same staging location every year. The trait makes them extremely vulnerable if such places are destroyed.

Ornithologists have been banding birds for decades to figure out which go where. Since 1990 flyway countries have adopted a color-coded scheme, so individuals could be regionally identified and their movements traced. Such re-sighting work has pinpointed a few significant staging sites on the Yellow Sea, such as Bohai Bay, the Yalu Jiang estuary in northeastern China, and the Saemangeum estuary in southwestern South Korea. But it's “limited to accessible regions and offers only a snapshot of what's going on,” says Melville.

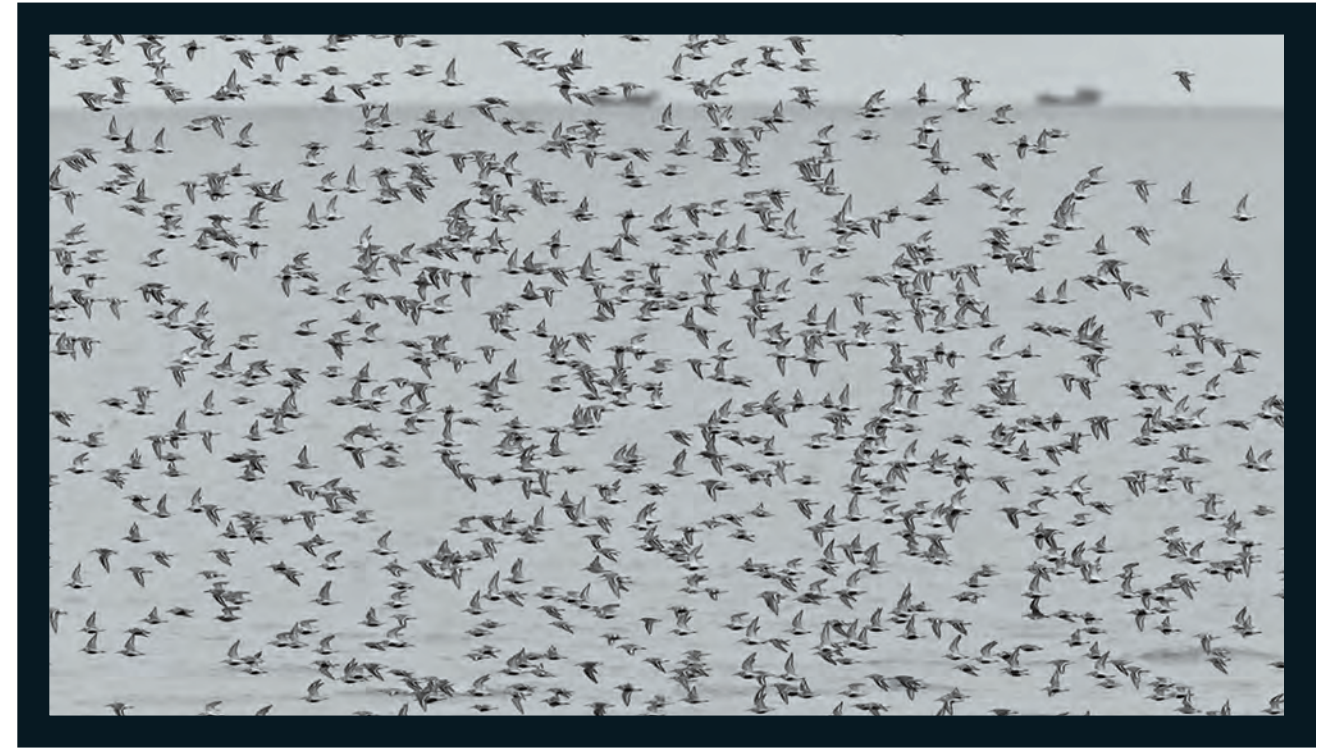
The importance of these sites came into fuller focus in 2007, says Warnock, when satellite tracking revealed the full migratory cycle and the epic journey of bar-tailed godwits (an Audubon priority species, in significant need of conservation efforts). Most scientists had assumed that these long-distance migrants stopped at a series of islands to rest and eat. But the tracking study, led by Robert Gill, a research wildlife biologist emeritus at the U.S. Geological Survey, stunned the world. All 17 godwits tagged in New Zealand with satellite transmitters followed a three-part route: First they flew 6,300 miles nonstop in a week from New Zealand to the Yellow Sea; after packing on weight for six weeks, the birds departed for Alaska, traveling an additional 4,200 miles in one go. Then, at the end of the breeding season, they flew directly back to their wintering ground, nonstop for 7,300 miles.

Subsequent research using either satellite transmitters or a different kind of tracking device called a geolocator shows that the bar-tailed godwit has company; other flyway shorebirds, such as whimbrels, ruddy turnstones, and bristle-thighed curlews, also fly several thousand miles nonstop on their migrations. Such studies “have not only revealed the impressive odysseys of these avian athletes but also crystalized the importance of the Yellow Sea,” says Yang, who is part of Piersma's team. “This is where they recover from one super-marathon and prepare for the next. If the sites are gone, then they are doomed.”

At first glance, mudflats are hardly inspiring. They're uniformly gray and dull and, at low tide, can stretch for miles to the horizon without any landmarks other than puddles. But “their bleak appearance is deceptive,” says Yang, pushing a white cylinder into the mud. When she lifts it, a core of mud pops out. As the sediment goes through a sieve, a plethora of creatures emerge—worms, clams, shrimp, snails, slugs, and crabs. A square meter of mud in Bohai Bay typically contains 50,000 tiny gem clams, the red knot's favorite



The great knot, long classified as a species of least concern, became “vulnerable” in 2010. The reason: rapid population decline caused by the reclamation of stopover grounds in the Saemangeum estuary.



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food, in spring. “It's an extremely productive system,” she says.

But “not all mudflats are the same,” says Piersma. A number of conditions, such as currents, topography, and sediment size, must coincide to make a productive tidal area. In addition, shorebirds prefer beaches with an extremely gradual slope, so that the slightest shift in wind or tide exposes vast areas of mudflat. There are only 16 such regions in the world that serve as critical shorebird habitats. “The Yellow Sea is one of the largest and the most productive,” he says.

The abundant food in the mudflat, however, is available only to those with the tools to access them. Shorebirds have developed highly specialized systems—bills, sensory organs, and digestive tracts—to feed on tidal flats. The length of their bills determines how deep they forage in the mud. Some find their prey by touch, others by detecting the vibration of moving animals. Then there are the red knots, which locate their food remotely by sensing changes in the pressure waves they send out when they poke their bills into wet sand. Since most shorebirds swallow their catch whole and crush it with their muscular stomachs, they're particularly fussy about the size and type of prey they eat. “Many shorebirds simply cannot feed efficiently in habitats other than mudflats,” says Ma.

Driving around Nanpu and other parts of Luannan County is like navigating a gigantic maze. The coastal waters are crisscrossed with seawalls that divide numerous salt pans and shrimp ponds as well as bridges that connect the coast to an increasing number of manmade islands. Between 1994 and 2010 development gobbled up 34 percent of the intertidal mudflats in western and northern Bohai Bay—about 168 square miles. “This has squeezed migratory birds into an ever-smaller remaining area,”

says Yang. Her studies—partly supported by the International Crane Foundation—show, for instance, that the number of red knots in Luannan increased from 13 percent in 2007 to 62 percent in 2010 of the total flyway population, which at the same time has been declining by 5 percent to 9 percent a year. Other spring staging species, such as curlew sandpipers, broad-billed sandpipers, and sanderlings, and wintering populations, like Eurasian curlews, are also cramming into the region.

Luannan has therefore become the last resort for both migratory and wintering bird populations. The red knot will be hit worst: 75 percent of the flyway population depends on the coastline along Bohai Bay. Since the 1990s the total number of red knots along the flyway has been declining. This is puzzling because their breeding success in the Arctic and survival rate in wintering grounds in Australia and New Zealand “seem adequate,” says Piersma, whose studies on the flyway have been made possible by BirdLife Netherlands and WWF Netherlands. “There are a lot of concerns about what's going on.”

The distribution and survival of wintering red knot populations in Australia and New Zealand have been studied for decades and are relatively easy to pinpoint. But estimating their survival rate during migration is tricky. The birds, which weigh about 3.5 ounces—one-third the weight of a godwit—are too small to carry satellite transmitters. So the researchers have turned to old-fashioned re-sighting studies. As a result of work supported by the Australasian Wader Studies Group and Miranda Naturalists' Trust, a New Zealand-based charitable organization, more than 1,000 red knots have been banded. Since

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■ **Migration** CONTINUED FROM PAGE 41
 2009 the Global Flyway Network, headed by Piersma, has been systematically counting them at Bohai Bay during the entire spring migration season, noting how many arrive and when they leave. Combined with results from other sites, the researchers have found signs of a decreasing survival rate during the birds' time away from Australia. They're still analyzing the data, "but preliminary findings do point to a strong 'Bohai effect,'" says Piersma.

Several common greenshanks circle over the shallow waters, chirping their characteristic three-note call: *teu-teu-teu*. A flock of bar-tailed godwits suddenly takes to the air, while the rest are unperturbed, moving away from the dike as they forage in the receding tide. Despite the flurry of adjacent industrial development, the scene is surprisingly peaceful. "How long will it last?" asks Ying Chen, a Ph.D. student of Ma's at Fudan University. Her surveys are pro-

viding a new benchmark to compare with those from a decade ago, and to assess the impact of ongoing land reclamation.

The worst fear for researchers and conservationists is that South Korea's Saemangeum disaster is duplicated in China. Saemangeum's once vast, fertile tidal mudflats were one of the most important staging sites for shorebirds along the flyway. When South Korea undertook this massive land reclamation project there was intense domestic and international criticism from scientists and environmental groups. But that didn't stop it from damming the entire estuary with a 21-mile-long seawall, converting 180 square miles of mudflats and 68 square miles of sea shallows into a desert.

"The impact on the shorebirds has been devastating," says Niall Moores, director of the Busan-based conservation group Birds Korea. There were large declines in shorebird populations when the seawall was under construction. Then, within weeks of its completion in 2006, millions of mollusks perished and populations of the birds that rely on the mudflats as a staging site decreased sharply. A study co-led by Moores shows a decline of 137,000 water birds, some of which are shorebirds—including 90,000 great knots, nearly a quarter of the global population—from Saemangeum between 2006 and 2008 on their northward migrations. The other 18 most numerous species were also badly hit, including a 91 percent drop for spoon-billed sandpipers.

Surveys of South Korea's remaining tidal flats showed no evidence that water birds lost to Saemangeum had relocated elsewhere in the country. The closure of the seawall was soon followed by "a sudden drop in wintering populations of almost every species in Australia, especially great knots," says Danny Rogers, chair of

the scientific committee of the Australasian Wader Studies Group.

Both China and South Korea see land reclamation as a path to quick financial returns. "Urbanization [in China] is much more intense than just a decade ago, and 70 percent of gross domestic product now relies on infrastructure construction," says Wang Songlin, a marine program officer for WWF China.

In a controversial move, the Chinese central government unleashed a \$649 billion stimulus package in 2008 to spur the economy—with matching funds of an additional \$1.6 trillion from provincial governments. "Most of the money has gone into infrastructure construction," says Wang. Several new projects in Bohai Bay have been approved, including a second deep-sea port, which are likely to encroach on residual mudflats in Luannan. Even in the Yalu Jiang estuary—a dedicated national nature reserve and a key staging site for bar-tailed godwits, dunlins, and other shorebirds and water birds—the boundary of the core protection zone has been redrawn twice to give way to development projects.

To Wang, most such projects across China are totally unsustainable and serve only to boost the local GDP and careers of government officials in the short term.

Indeed, many reclamation projects, including the Saemangeum, are put on hold or even abandoned after mudflats are filled because of a lack of further investment. "The likely outcome is that the environment is destroyed, with little real benefit to the economy," he says.

Yet there are glimmers of hope. Yin Xikun, a senior member of the Chinese People's Political Consultative Committee, is lobbying the central government to protect the residual tidal flats in Bohai Bay—the first elected leader to do so. And at least one multinational corporation is making strides to safeguard habitat in the area. Australian mining giant Rio Tinto Group, the largest supplier of coal and iron ore in Bohai Bay, is negotiating with the local government about setting up a wetland visitor center near Luannan. The company, the only corporate member in the EAAF Partnership, is committed to sustainable development and having a net positive impact on biodiversity. "The visitors' center will give local communities access to these still-wild places, and build awareness about the importance of conserving them," says Yang.

Meanwhile, the forestry bureau of Hebei province, with support from the Tangshan city government, is evaluating whether to set aside parts of the Luannan

coastline as a provincial nature reserve—partly because of advocacy by the EAAF Partnership, the Wetlands International-China program, and WWF China. "It remains to be seen where the boundary lies and whether it's big enough to make a difference," says Watkins.

And developers may soon face more hurdles: 189 signature countries of the United Nations' Millennium Declaration—including China and South Korea—have agreed, starting in 2015, to base development projects on this precautionary principle: If an action has the suspected risk of causing harm to the public or the environment, the onus of proof that it is not harmful falls on those taking the action. "This should shift the burden of proof significantly," says Moores. At the moment, the lack of scientific certainty that the loss of tidal flats can cause an irreversible decline in shorebird populations is the developers' common argument to justify their destructive behavior. Such efforts might be the only fighting chance for those amazing trans-Pacific long-range migrants whose survival depends on the Yellow Sea. ■

Jane Qiu is a writer in Beijing. Her work is regularly featured in publications including Nature, Science, and The Economist.

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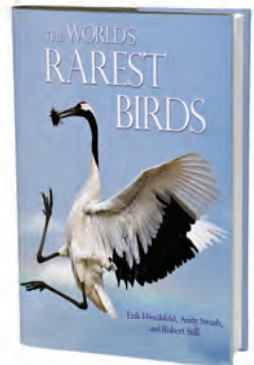
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WHAT YOU CAN DO

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