

THIRD MEETING



WESTERN HEMISPHERE SHOREBIRD GROUP, 9–13 MARCH 2009, MAZATLÁN, MEXICO

INTRODUCTION BY RICHARD LANCTOT

The Third Meeting of the Western Hemisphere Shorebird Group (a.k.a. Shorebird Science in the Western Hemisphere) was held in Mazatlán, Mexico during 9–13 March 2009. The first such meeting took place in Boulder, Colorado, in February 2006 (see *Wader Study Group Bull.* 109: 15–66) at which time the Western Hemisphere Shorebird Group was formally created. The second meeting was held in conjunction with the VIII Neotropical Ornithological Congress at Maturín, Venezuela, in May 2007 (see *Wader Study Group Bull.* 113: 13–27). These three meetings fulfill one of the original goals of the Western Hemisphere Shorebird Group, which was to hold regular meetings on shorebird biology and conservation for species that occur in the Western Hemisphere.

The Third Meeting of the Western Hemisphere Shorebird Group (WHSG) took place over five days, and consisted of four plenary lectures, eight symposia (three species-based and five on broader issues consisting of 56 papers), 35 general papers among six subject themes, and 21 posters. As in the past, the Shorebird Research Group of the Americas (SRGA) led by Stephen Brown did a superb job of organizing the science component of the meeting. In addition to the meeting presentations, this year we added or partnered with other groups to have educational courses at the beginning and end of the meeting. Prior to the formal meeting, Dr Brett Sandercock, Associate Professor at Kansas State University, graciously taught a two-day Population Demographic Modeling Workshop on 7–8 March 2009. Forty professionals and students from throughout the Western Hemisphere were taught demographic methods to investigate patterns of variation in the life-history traits of organisms and address management issues for populations of threatened or harvested species. After the meeting, 19 students participated in the 2009 International Course on Avian Movements and



Rick Lanctot, overall coordinator of the Third Western Hemisphere Shorebird Group meeting, presenting awards on the final night.

Migration Technology held during 15–19 March 2009. Ten faculty members presented the latest information on GIS/spatial analyses, genetics, tracking methods, stable isotopes, physiology, and migration theory relevant to understanding animal migration.

The Third Meeting had the largest number of participants to date, with over 140 representatives from 11 Western Hemisphere countries and two other continents. Much of the professional Latin American and student presence was possible because of financial support from the U.S. Fish and Wildlife Service (Migratory Bird Management Division), the U.S. Forest Service (International Program), Manomet Center for Conservation Sciences, and the U.S. Geological Survey (Alaska Biological Sciences Center). Local sponsors, who provided many amenities for the meeting, included the Centro de Ciencias de Sinaloa, Instituto de Ciencias del Mar y Limnología, Ducks Unlimited de México, Pronatura Programa Nacional de Conservación de Aves, Aveoptica, and Emulsiones y Pavimentos de Sinaloa. The local hosts were the Western Hemisphere Shorebird Reserve Network, the Instituto de Ciencias del Mar y Limnología, and the Hotel Playa Mazatlán.

Like the Boulder meeting, each day began with a plenary lecture. On Monday, Pavel Tomkovich's talk *Shorebird Studies in Russia* described the creation and operation of the Working Group on Waders – the Russian version of the WHSG that was established in 1987. Then he described the type of studies and logistical challenges associated with conducting research in different portions of the Russian Arctic. Despite setbacks associated with the break-up of the Soviet Union, Pavel described an amazing array of studies and collaborative projects being conducted by a small number of dedicated Russian ornithologists.

On Tuesday, Eduardo Palacios Castro gave a stimulating talk entitled *Conservation of shorebirds and their habitats in north-west Mexico* during which he discussed the importance of north-west Mexico to shorebirds and perspectives to protect their habitats. He clearly showed how north-west Mexico provides critical wintering, nesting and stopover habitats for millions of shorebirds, and that conservation of these areas is principally due to waterfowl conservation efforts funded through NAWCA Mexico Program (thank you duck supporters).

On Wednesday, the participants were treated to one of four different field trips led by local field guides from Sendero México. These included trips to the Foothills of the Sierra Madre, the Tufted Jay Preserve, the town of Cosalá and Playa Cueta (a Western Hemisphere Shorebird Reserve Network Site), and the Teacapán estuary, which is part of the Marismas Nacionales. The opportunity to visit local sites in Mexico was a welcome addition to the meeting (as was the break during





Left to right: Rick Lanctot, overall coordinator of the Third Western Hemisphere Shorebird Group meeting, and plenary speakers Pavel Tomkovich, Nils Warnock, Eduardo Palacios Castro, and David (Dov) Lank.

the middle of the meeting), and we hope to replicate this experience in subsequent meetings.

On day four of the meeting, we heard from Nils Warnock as he described the ecology of shorebird migration around the Pacific Basin. His talk entitled *Wings over borders – migration of shorebirds around the Pacific Basin* discussed research findings from the ground breaking conventional and satellite telemetry studies he and his colleagues have conducted over the past 15 years. Highlights included their documentation of some of the longest nonstop flapping flights known among birds – courtesy of the Bristle-thighed Curlew and Bar-tailed Godwits that breed in Alaska.

On the last day of the meeting, the audience was treated to a humorous and very interesting talk by David (Dov) Lank entitled *Why are ruffs the most interesting birds in the world?* Dov presented results from a 25-year study in which he investigated the ruff's unique plumage polymorphism, the three genetically-distinct behavioural and plumage types of males and female mimics, multiple paternity, and other aspects of their behaviour. His fascinating video footages and his narration were enjoyed by all.

During each day of the meeting, there were one or two symposia focused on particular species/genera or broader issues. The three species- or genera-based symposia focused on the (1) Red Knot – a newly declared candidate species on the U.S. Fish and Wildlife Service's Endangered Species list, (2) Western Sandpiper research program in the Americas, and (3) a variety of plover species that are also declining due to increased human disturbance along beaches in the Western Hemisphere. Like prior meetings, there were symposia



focused on South American endemics, migration ecology and techniques, education and outreach, and the Western Hemisphere Shorebird Reserve Network. The remaining symposium was on human mediated landscape change in the Arctic and the impacts of this on shorebirds (see summaries and abstracts below). It was refreshing to hear that many of the ideas and results of these talks were due to newly formed collaborations that began during the first meeting in Boulder. Students presented more than a third of the talks and over half the posters, so winning one of the student awards was no mean achievement. Congratulations to Paul Smith for best paper, Laura McKinnon for second best paper, Medardo Cruz-López for best poster and Jean-François Lamarre for second best poster.

Despite the busy schedule, we managed to have two breakout gatherings where we discussed the future role of the Western Hemisphere Shorebird Group. Most people agreed that a stand-alone meeting comparable to this one was valuable and badly needed at least once every two years if not more frequently. They also expressed a desire for the meetings to be bilingual (a new feature for this meeting) and to hold the meetings in locations where field trips were possible (i.e. warm locations, preferably with a beach!). We also revisited whether we should continue to hold every other meeting in conjunction with the Neotropical Ornithology Congress, and most agreed that this was not necessary but that Latin Americans should continue using this venue to hold regional meetings on shorebirds. We bantered around several possible venues for the next meeting but decided it would be better to allow the entire shorebird community to vote on this subject. This process will take place through the newly created internet forum (see next item) during the upcoming Nearctic winter (Neotropical summer).

I want to thank the leaders of the symposia, the many presenters, and the people behind the scenes that allowed the science to take place, and the participants to attend. I also want to thank Xicotencátl "Xico" Vega and Guillermo J. Fernández Aceves for co-chairing the Local Organizing committee, Stephen Brown for chairing the Scientific Program committee, Jim Johnson for chairing the Travel Award committee, Lewis Oring for chairing the Student Presentation Award committee, Andrea Pomeroy for chairing the Silent Auction Committee (which raised over \$1,700 USD for the next meeting), and Caleb Spiegel for developing the program booklet. Thanks to these people and the many members of their committees that made the meeting possible. I also appreciate Brett Sandercock's extra efforts to put on a very informative demographics course, and Sue Haig for working behind the scenes to coordinate this meeting with the MIGRATE course.

Left: Committee Chairs for the Third Western Hemisphere Shorebird Group Meeting (left to right): Guillermo J. Fernández Aceves (Local Organizer), Jim Johnson (Travel Awards), Xicotencátl "Xico" Vega (Local Organizer), Stephen Brown (Scientific Program), Caleb Spiegel (Program Booklet), and Lewis Oring (Student Presentation Award committee). Missing from the photo is Andrea Pomeroy who chaired the Silent Auction Committee which raised over \$1,700 USD for the next meeting.



Finally, I want to encourage everyone to keep alive the enthusiasm experienced by all of us at Mazatlán. Brian McCaffery's songs *Bye-bye, Numeniini* and *Las Aves Play-eras* brought many of us to tears about the potential loss of these great species (see lyrics below). I would encourage each of you to do whatever you can to further shorebird conservation in your small part of the world. If you reside in the Western Hemisphere, please participate in the Western Hemisphere Shorebird Group, the Western Hemisphere Shorebird Reserve Network, the Shorebird Research Group of the Americas, the Program for Regional and International Shorebird Monitoring, the Shorebird Sister School Program, or other local organizations that contribute to the conservation of shorebirds. Only your efforts will keep other species from going the way of the Eskimo Curlew; remember our motto: *Not in our lifetimes!* Hope to see all of you at the **Fourth Western Hemisphere Shorebird Meeting** to be held in March/April of 2011. Remember to sign up for the internet forum so that you can learn about and vote for the location of the next meeting and stay connected with your fellow shorebird enthusiasts.

Signing up to the Western Hemisphere Shorebird Group Forum

Please consider signing up for the newly-created bi-lingual (Spanish and English) Western Hemisphere Shorebird Group Forum kindly provided to us by the Rainforest Alliance (http://www.eco-index.org/forums/nmbc_topic.cfm?id=shorebird_waterbird). Visiting the Forum is open to the public, but in order to post information and upload photos or reports through the "Post a New Entry" page (www.eco-index.org/forums/nmbc_post.cfm), users must log in. You can register by visiting the "Create an Account" page: http://www.eco-index.org/forums/nmbc_account_request.cfm. Members will be alerted by e-mail when a new posting to the forum has been made (be sure to check the appropriate box to receive postings). Please use this forum to communicate to the greater shorebird community about special events and notices. I look forward to using this new resource to help us create a cohesive network of partners for the Western Hemisphere Shorebird Group.

CONFERENCE SONGS

Written and sung by Brian McCaffery, with guitar accompaniment by Dov Lank, during celebrations, which took place in the Hotel Playa Mazatlán, Mexico, on the last night of the Third Western Hemisphere Shorebird Group meeting

Bye-bye, Numeniini

A long, long time ago, I can still remember how those nature stories made me smile.
 And I knew that if had my chance, I'd be part of the romance of
 Helping to keep wildlife here awhile
 But then one story made me shiver, with all the sadness it delivered.
 The tale with all the bad news was "The Last of the Curlews."
 I can't remember if I cried when I read about his fallen bride,
 But something touched me deep inside, the day the curlew died.

So, bye-bye to Numeniini
 None too heavy by the levee 'cause the levee was dry
 And long-billeds wander fields of barley and rye
 Singing, "Will this be the day that I die? Will this be the day that I die?"

Well, have you ever seen curlew love, and have you watched courtship flights above,
 Or did the BNAs tell you so?
 And do you believe somebody stole the flame within a curlew's soul,
 And can you calculate the real toll?

Well, I know their future's looking grim and their prospects now seem mighty slim.
 Were they destined to lose by the habitats they choose?
 Who woulda ever thought they'd end up stuck on drowning atolls just like Truk?
 Rising sea levels—they're outta luck, the day the curlews die.

So, bye-bye to Numeniini . . .

Well, for eons, they were on their own where moss and lichen,
 sedge and stone
 Stretched out to eternity.
 But all too soon their habitat was lost, and the curlews had to
 pay the cost
 When the prairie and the steppe were no longer free.
 While their spring home was plowed and carved, their main
 prey died out and so they starved.
 Where Mother Nature was spurned, no curlews have returned.

Brian McCaffery singing *Bye-Bye, Numeniini* at the Third Western Hemisphere Shorebird Group meeting accompanied by Dov Lank (guitar) and Paul Smith (Powerpoint).



And while market gunners shot them down, their carcasses littered the ground
While wagon-loads went off to town, the day the curlews died.

So, bye-bye to Numeniini . . .

Helter-skelter in a tropic swelter; the curlews had no fall-out shelter
Radiation falling fast

The air was filled with noxious gas; some atolls vanished in the blast,
And the damage to surviving reefs was vast.

The curlews breathed the deadly fumes that drifted from the toxic plumes.

On the poisoned coral sands, they never had a chance,

Because the Yanks and French had learned to wield nukes of devastating yield.
To the blind, nothing was revealed the day the curlews died.

So, bye-bye to Numeniini . . .

I held her and felt her in a summer swelter, and mourned the hand that we had dealt her.

I banded her, then set her free.

She needn't fear the owls and hawks, just the predator who walks and talks
And into whose bloody hands fell her destiny.

While the bristle-thighed defends its crèche, the thin-billed flies to Marrakesh

To drink from the same chalice that doomed poor *borealis*.

And all the best data suggest, I think, this population's in a sink

And all too soon will be extinct, the day the curlew dies.

So, bye-bye to Numeniini . . .

To follow birds from place to place, we use satellites up in space

To bounce their signals back again.

So, come on, track the whimbrel, track him quick, track him through the thin and thick

Because we may be a whimbrel's only friends.

And as I watched him try to stage, my hands were clenched in fists of rage.

His home had gone to hell, destroyed by Satan's spell.

And as I watched him fly into the night, I knew that we just had no right

To let him die without a fight, the day the curlew died.

So, bye-bye to Numeniini . . .

I met a girl who worked the sloughs, and I asked her for some happy news.

She just wept and turned away.

So I went down to the sacred shore where I'd heard curlews years before,

But the man there said, "No curlews here today."

Now while I sleep it surely seems that curlews thrive within my dreams,

But when I have awoken, the flyways all are broken.

And the curlew I desired most became nothing more than a ghost

That haunts the zephyrs down the coast, the day the curlew died.

So, bye-bye to Numeniini

None too heavy by the levee 'cause the levee was dry

And long-billeds wander fields of barley and rye

Singing, "Will this be the day that I die?"

Las Aves Playeras

I am a sincere man from where the tundra grows.
I am a sincere man from where the tundra grows,
And before I die, I want to share the verses of my soul.

Shorebirds! When will we save the shorebirds?
Shorebirds! When will we save the shorebirds?

The sea is light green and it is flaming crimson.
The sea is light green and it is flaming crimson.
There is a wounded plover that seeks refuge on the shore.

Shorebirds! When will we save the shorebirds?
Shorebirds! When will we save the shorebirds?

I dream a lovely dream; I see a curlew.
Then, near the estuary, I observe an oystercatcher.
The birds follow the waves, and are followed by the waves.

Shorebirds! When will we save the shorebirds?
Shorebirds! When will we save the shorebirds?

The vision continues; I see a godwit.
He is the sentinel, ready to shout when
The hawk dives from the sky.

Shorebirds! When will we save the shorebirds?
Shorebirds! When will we save the shorebirds?

Through the fog, I hear the yellowlegs.
And at the rocky coast, I see the turnstone.
Thunder on the shore gently calms my soul.

Shorebirds! When will we save the shorebirds?
Shorebirds! When will we save the shorebirds?

With all the shorebirds, I want to share my fate.
With all the shorebirds, I want to share my fate,
And if they disappear, I want to die in the sea.

Shorebirds! When will we save the shorebirds?
Shorebirds! When will we save the shorebirds?



PLENARY TALKS

Shorebirds in Russia

Pavel Tomkovich

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Northern Russia, like the Alaskan and Canadian Arctic, are prominent breeding areas for shorebirds. The European and Siberian Arctic also serve as the northern terminus for many flyways that extend to different parts of the world, including flyways of North America, Europe, Africa, Asia, Australasia and probably South America. In this talk, I will first describe the creation and operation of the Working Group on Waders (= shorebirds), which was established in the former USSR in 1987 for the exchange of information and to stimulate research and conservation in the USSR and then in the Commonwealth of Independent States. Next I will describe the type of studies and logistical challenges associated with conducting research in different portions of the Russian Arctic. Studies in Russia are limited due to difficult logistics, including few human resources, absence of amateur ornithologists, and most recently, lack of funding. Being more accessible, parts of the European and West-Siberian Arctic are better surveyed, and population estimates for breeding shorebirds were obtained there in the framework of a project of the International Wader Study Group. Most work today includes faunistic surveys in a few tundra areas and counts at stopover sites in southern parts of Russia. There are few studies that focus on the breeding ecology and social organization of shorebirds. Accumulated band recoveries have allowed us to assign most populations of shorebirds to particular global flyways. We have nearly completed the *Atlas of the Breeding Shorebirds of the Russian Arctic*. We also coordinate the Arctic Birds Breeding Conditions Survey, which examines patterns of bird abundance and productivity in relation to weather, alternative food resources and other parameters throughout the circumpolar Arctic. In Russia, federal and regional Red Data books are the only effective official tool for conservation of rare and declining species. The Spoon-billed Sandpiper is the only species whose monitoring is underway in the region.

Conservation of shorebirds and their habitats in north-west Mexico

Eduardo Palacios

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North-west Mexico hosts eight out of 11 WHSRN sites in Mexico. It provides critical wintering, nesting, and stopover habitats for millions of a wide variety of shorebirds, including priority species and populations. Most conservation attention has been on shorebird species that aggregate in mudflats during winter and migration. However, coastal habitats such as sandy beaches and salt flats are used by breeding shorebirds and coastal specialists that migrate along coastlines. Loss and degradation of habitat by coastal development and disturbance are the main problems. Therefore, shorebird conservation in the region is a matter of habitat protection. Most conservation efforts in the region have resulted from

waterfowl conservation funded by the NAWCA Mexico Program, including land and water acquisitions, establishment of conservation easements, dedication of federal land for habitat conservation, and wetland restoration. Designing and then protecting habitats efficiently, more than restoring or protecting single species, are essential for the maintenance of shorebird diversity, including migratory and breeding populations in north-west Mexico. Current projects include environmental education, status of Snowy Plovers, and a shorebird conservation plan in north-west Mexico. Information on shorebird abundance and distribution, limiting factors, habitat requirements, habitat threats, and conservation opportunities are needed to support well-informed decisions by politicians and managers at priority sites. Conservation planning to protect important aggregations of shorebirds as well as important sites for dispersed breeding and migrant coastal specialists is needed in this region. I will provide an overview on the importance of north-west Mexico to shorebirds and perspectives to protect their habitats.

Wings over borders – migration of shorebirds around the Pacific Basin

Nils Warnock

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I will talk about the ecology of shorebird migration around the Pacific Basin, focusing on studies I (and an extensive list of essential collaborators) have carried out over the past 18 years. I will discuss initial research focused on the spring migration of small shorebirds like the Western Sandpiper, Dunlin, and dowitchers through western North America. Through the use of radio-telemetry we have looked at migration connectivity and examined parameters affecting the use of stopover sites along the way. Results indicate that these birds make multiple stops as they fly northward, but are capable of non-stop flights of over 3,000 km in a matter of less than two days. These migration strategies will then be compared to some of the recent results of research following satellite tagged members of the tribe of shorebirds known as the Numeniini (godwits and curlews) around the Pacific Basin, ranging from New Zealand and Australia to Alaska to the Central Valley of California. We document some of the longest non-stop flapping flights known among birds. I will discuss conservation threats to this suite of shorebirds including loss of habitat, climate change, and a variety of other factors.

Why are Ruffs the most interesting birds in the world?

David B. Lank

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Shorebirds have a wide diversity of mating and parental systems, ranging from lek or territorial polygyny through biparental and uniparental monogamy to sequential and simultaneous polyandry with sole male care of young. The



Ruff *Philomachus pugnax*, which breeds across the Eurasian low arctic, and at one site in Canada, stands out with respect to the complexity of its breeding system. I will present results from my 34-year study of this species and other literature. Starting with a lekking system with exclusive female parental care, the ruff adds: (1) a unique plumage polymorphism, in which 98% of breeding males have individually distinctive elaborate breeding plumages; (2) three genetically distinct behavioral and plumage types of males, including dark-plumaged lek territorial, white-plumaged non-territorial “satellites-cooperators”, and “female mimics”, which lack

elaborate plumage and male display behavior; (3) the highest rates of multiple paternity (genetic polyandry) among shorebird females, and longest sperm in males; (4) sex ratio allocation strategies by breeding females; (5) possible sperm selection with respect to mate relatedness; and (6) unexplained changes in winter plumages with age among the non-territorial morph. I will focus on trying to explain (a) what maintains the extreme plumage polymorphism, (b) why there is an evolutionarily stable equilibrium among competing types of males, and (c) how female mimics obtain matings.

SYMPOSIA

TRACKING LARGE-BODIED SHOREBIRDS SYMPOSIUM

ORGANIZERS: C. ALEX HARTMAN (calexhartman@gmail.com),
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Technological advancements have greatly increased the capacity to study shorebird movements and natural history over the past few years. The Tracking Large-bodied Shorebirds Symposium was organized to share information and present results on studies of Numeniini shorebirds. There were seven presented papers and a poster.

Lee Tibbitts began the symposium with a comparative analysis of the efficiency, accuracy and longevity of implantable versus external solar-powered satellite transmitters on five Numeniini species. Two presentations on Marbled Godwit migration using satellite telemetry followed. Bridget Olson examined movements and biogeography of Marbled Godwits captured at Great Salt Lake, Utah, USA, Akimiski Island, Nunavut, Canada, San Blas, Nayarit, Mexico and along the Atlantic Coast of Georgia, USA. Robert Gill detailed the effects of atmospheric teleconnections on the southward migration of Marbled Godwits breeding in southwest Alaska. These studies have given a clearer picture of the mechanics of Marbled Godwit migration and described migratory paths between the different breeding subpopulations found at overlapping wintering sites. Information from these studies will be used to further conservation goals outlined in the Marbled Godwit Conservation Plan.

The symposium then switched to studies concerning movements, abundance and habitat associations of Long-billed Curlews on the breeding and non-breeding grounds. Alex Hartman compared results of Long-billed Curlew migratory connectivity and winter site fidelity obtained using color band sighting reports versus satellite telemetry. Kristin Sesser used satellite telemetry to investigate habitat use, space use, movement and site fidelity of Long-billed Curlews wintering in California's Central Valley. Cory Gregory provided estimates of chick survival and described local movement patterns of Long-billed Curlew broods in Nebraska, USA, using radio telemetry. Alina Olalla presented information on seasonal abundances, diet and satellite telemetry-based movements of Long-billed Curlews wintering in the Chihuahuan Desert, Mexico. Kyle Stone presented a poster on the use of

digital video recorders and bullet cameras to examine incubation behavior of Long-billed Curlews at Great Salt Lake. These five studies address current action items identified in the Long-billed Curlew Status Assessment and Conservation Plan and will lay the ground work for further conservation and management activities for this species.

The Tracking Large-bodied Shorebirds Symposium provided a great forum for the presentation and discussion of the use of technology in the study of shorebirds. Satellite telemetry allows for the direct tracking of large shorebirds between breeding and non-breeding areas in fine detail. Coupled with land cover data, satellite telemetry can be a useful tool for remotely studying habitat associations of non-breeding birds for conservation planning. Moreover, using satellite telemetry, researchers can delineate migratory pathways, identify staging and stopover sites, measure the speed and duration of migration legs and examine breeding and non-breeding site fidelity more accurately than with traditional methods.

Performance of satellite transmitters in tracking large-bodied shorebirds

Lee Tibbitts¹, Robert Gill¹, David Douglas¹,
Daniel Mulcahy¹ & Nils Warnock²

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² School of Veterinary Medicine, University of California, Davis, USA

Recent studies utilizing satellite tracking with the Argos system have yielded unprecedented insights into shorebird migration. Since 2005, we have gained experience with this technology while investigating the local and migratory movements of shorebirds in the Pacific Basin. Here, we report on the technical performance of 104 satellite transmitters (PTTs) deployed on 5 species of large-bodied (250–760 g) shorebirds. Birds were tagged with either a battery-powered PTT (26 g) surgically implanted into the coelomic cavity ($n = 67$) or with a solar-powered PTT (9.5 or 18 g) attached as a back-



pack using a leg-loop harness ($n = 37$). Mortality possibly attributable to capture and tagging (i.e., bird died within 4 weeks of tagging) occurred at a low rate (<6%) and most birds successfully carried PTTs for months or years often while completing migratory flights of thousands of kilometers. PTTs provided over 45,800 locations and their performance (e.g., accuracy, battery longevity) varied with the type, size, and age. In most cases, PTT performance met or exceeded our expectations, and we were able to track movements of individuals with reasonable levels of detail and accuracy. For example, the data collection efficiency (number of locations per hour of transmission time) of the battery-powered units averaged 0.81 ± 0.20 SD and their location accuracy (proportion of Argos Class-3 locations among all locations) averaged $23\% \pm 12$ SD. Overall, satellite tracking proved to be an effective, though expensive, tool for monitoring the movements of large-bodied shorebirds.

Biogeography of Marbled Godwit populations in North America

Bridget Olson & Adrian Farmer

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The Marbled Godwit *Limosa fedoa* is a shorebird species of conservation concern. Though the distribution of Marbled Godwit habitats across the landscape is known, the links between them are not. In the *Conservation Plan for the Marbled Godwit* the authors identified the need to determine the location of specific wintering, breeding, and migratory stopover areas used by each sub-population as a priority for research. We equipped Marbled Godwit with satellite platform transmitter terminals (PTTs) to determine migratory connectivity of habitat areas in North America. Seventeen godwits were equipped with PTTs at Bear River Migratory Bird Refuge, Utah, a major staging area, and seven from breeding grounds on Akimiski Island, Nunavut Territory, Canada. In addition two godwits were tracked from wintering areas along the west coast of Mexico and eight from the wintering population off the Atlantic Coast of Georgia, USA. A clear understanding of the links between godwit seasonal habitats would allow for focused, on-the-ground conservation action for each subpopulation.

Satellite telemetry captures the southward migration of Marbled Godwits from Alaska

Robert Gill, Lee Tibbitts & Dan Ruthrauff

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The smallest, most isolated, and least known of the three Marbled Godwit populations (*Limosa fedoa beringiae*) breeds on the Alaska Peninsula. Gibson & Kessel (1989, *Condor* 91: 436–443) had earlier used biometrics to suggest this population wintered along the Pacific coast from Washington to N California. In mid-June 2008, we captured nine godwits (two males, seven females) on their nests and attached 9.5 g solar-powered satellite transmitters (PTTs) to each with a figure-eight leg loop harness. Eight birds departed the breeding grounds on eight different dates between 12 July and 15 August (1 PTT failed in late June). Departures occurred between 0100 and 0500 ADT and were not correlated with stage of tide at the departure sites. All birds followed great

circle routes across the NE Pacific to landfalls that extended from Vancouver Island to San Francisco Bay. Flights averaged 51 h (range 33–60 h) duration over an average distance of 2,700 km (range 2,100–3,400 km). Birds timed departures to avail of favorable winds en route and most appeared to maintain a constant air speed throughout the flights. Locations of landfalls appeared to be influenced by winds toward the end of the flights with about half the marked birds subsequently moving south an additional 500–1,400 km before settling on focal wintering sites.

Migratory connectivity and winter site fidelity of Long-billed Curlews *Numenius americanus* breeding in northern Nevada

C. Alex Hartman¹, Lew Oring¹, Nils Warnock², Gary Page³, Lee Tibbitts⁴ & Robert Gill⁴

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We investigated migratory connectivity and winter site fidelity of Long-billed Curlews breeding in northern Nevada using color-band sighting reports and satellite telemetry. Between 2002 and 2007, we color-banded 99 adult and 266 juvenile curlews in Ruby Valley, Nevada and 56 juvenile curlews at Carson Lake, Nevada. In addition, we tagged nine adults (4 males, 5 females) in Ruby Valley, Nevada with battery- and solar-powered PTTs in 2006 and 2007. Long-billed Curlews breeding in northern Nevada overwintered at coastal and interior locations as far north as Humboldt Bay, California and as far south as Laguna Ojo de Liebre in Baja California, Mexico. A total of eight curlews color-banded in northern Nevada were observed at least once on the wintering grounds. Among the curlews banded as adults in Ruby Valley, Nevada, two males and three females were seen at coastal locations in California and Mexico. An additional adult female mortality was recovered at Morro Bay, California. Two curlews banded as juveniles were observed in Humboldt Bay and Santa Barbara, California. Long-billed Curlews exhibited strong fidelity to wintering areas as four birds were observed at the same location in two or more winters and three birds were observed at the same location in four or more winters. PTT data similarly indicated strong winter site fidelity with four out of four curlews for which we had two years of winter location data returning to the same general area in the second year.

Habitat use of Long-billed Curlews in California's Central Valley

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A significant number of the world's population of Long-billed Curlews winter in California's Central Valley amidst a variety of human-altered habitats. We studied the movements and habitat use of 10 (5 male, 5 female) Long-billed Curlews



during two non-breeding seasons. Individual curlews differed greatly in their use of space with home ranges varying from 1,200 to 14,000 ha; one curlew moved about 500 km after settling initially in the southern San Joaquin Valley. We used multiple core use areas (50% probability) to examine habitat use and analyze second order habitat selection by comparing these areas to random locations. Curlews occupied a variety of agricultural habitats, including flooded alfalfa, rice, pastures, and some semi-natural wetlands. They tended to occur in areas of low road densities, suggesting that road-side monitoring might inadequately represent both habitat use and population estimates.

Movements and survival of Long-billed Curlew chicks *Numenius americanus* in Nebraska

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The Long-billed Curlew is listed as highly imperiled or vulnerable throughout most of its range. Despite being considered an at-risk species in Nebraska, Long-billed Curlews remain little studied and are therefore poorly understood. Many aspects of their breeding biology, including the movements of chicks, remain completely unknown in the state. During our 2008 field season, we studied movements and survival of Long-billed Curlew chicks using radio-telemetry. Our research took place at Crescent Lake National Wildlife Refuge and surrounding private lands in W Nebraska. Using a mark-recapture analysis, our preliminary data show an estimated daily survival of 0.988 (SE = 0.012) with no evidence for variation in daily survival across the chick-rearing period. In addition, chick movements were analyzed using ArcGIS and we found that chicks traveled an average of 883 m per day (n = 8, range 86 to 2,611 m). The direction, overall distance, and pattern of travel varied among individuals. One chick stayed within a 498 m radius whereas another chick traveled up to 12,352 m from where it was banded. We found no correlation ($R^2 = 0.02$) between age of chick and distance

traveled per day. This work will continue in the 2009 and 2010 nesting seasons and will ultimately provide a better understanding of the movements and survival of Long-billed Curlew chicks at an important breeding site. We hope this information will help guide future management and assessment of curlews in Nebraska.

Winter ecology of the Long-billed Curlew *Numenius americanus* in two sites of the Chihuahuan Desert, Mexico

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Grasslands in our country have deteriorated because of agriculture and cattle-raising causing habitat loss for many species, including the Long-billed Curlew. The two study areas (Janos, Chihuahua, and El Tokio, Nuevo León) are among the few remaining well preserved grasslands in Mexico. They support a large number of wintering Long-billed Curlews, but the lack of knowledge of their migratory routes and the few Mexican studies on this species, do not allow us to establish effective conservation measures. Therefore, the purpose of the present study is to complete the following objectives: winter census, winter diet, molecular sexing, color banding, and satellite telemetry. Monthly simultaneous surveys were carried out during the months of October through March (2007–2008 and 2008–2009), during which it was determined that the largest concentrations of wintering Long-Billed Curlews occurred in the Nuevo León grasslands, up to 3,500 individuals in a single sighting. To date we have collected 750 pellets in both regions, 317 of which have been measured and weighed, and 59 have been analyzed. The pellets collected in Chihuahua were, on average, larger, and in both areas we have identified 3 insect families, 4 non-identified insects, the scorpion order, seeds and small rocks. Up to December 2008, we have captured five curlews in Nuevo Leon, which were measured and banded, and blood samples were taken for molecular sexing, and one curlew was selected to carry a satellite transmitter so we can follow its local and migratory movements.



HUMAN-MEDIATED LANDSCAPE CHANGE IN THE ARCTIC: APPARENT AND PREDICTED IMPACTS ON SHOREBIRDS – SYMPOSIUM

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Shorebird populations have been documented to be declining worldwide, but determining the causes for the declines has continued to be challenging. For many species that nest in the arctic, environmental changes there caused by a variety of human activities may be contributing to population decline at present, or pose potential significant threats to the recovery of populations in the future. This symposium explored a wide range of actual and potential threats to shorebirds on their arctic breeding areas, with the goal of identifying major threats to arctic species, recommending important research activities, and exploring potential adaptation strategies to ongoing environmental change.

Taylor *et al.* (all references this volume) addressed one of the most widely recognized impacts likely to occur from global climate change, an increase in sea level and resulting impacts on coastal ecosystems. Major impacts identified included direct loss of coastal habitats through increased erosion rates, and changes in salinity in estuarine systems that may affect invertebrate food sources, potentially affecting critical staging sites where large numbers of birds were documented.

McKinnon *et al.* explored additional climate change impacts, focusing on direct and indirect trophic interactions likely to be affected by a changing arctic climate. The mismatch hypothesis, which raises the issue of whether shorebirds can adapt their migration schedule to changes in the seasonal timing of prey availability, may be supported by data from study sites in Canada, where data suggest that emergence dates may be shifting earlier and occurring before traditional hatching dates.

Ballantyne *et al.* explored whether changes in vegetation types around Whimbrel nesting areas may have led to reduced nesting densities. Comparisons of historic abundances from as early as 1973 with more recent data show increased shrub density and reduced water cover which have reduced nesting habitat for this species.

Rausch and Johnston presented data on the impacts of existing and proposed oil development in the McKenzie Delta, and described strategies to improve protection of migratory birds under existing regulations. Predicted impacts to nesting birds were larger than the simple physical footprint of development sites, including ancillary impacts like increases in predators, requiring additional mitigation beyond what had been proposed. Long-term monitoring will be required to measure both actual impacts and potential additional affects like subsidence that may require further mitigation.

Liebezeit *et al.* described the results of a long-term and large-scale study across the arctic coastal plain that explored the potential impacts of human infrastructure and potentially associated predators on tundra nesting birds. While there was very high spatial and temporal variability in nesting success among sites and years, there was an increased risk of predation on passerine (but not on shorebird) nests in proximity to development. Targeted management to reduce impacts of predator populations, and additional research on predator populations are needed.

Lanctot *et al.* described the impacts of an arctic fox removal project aimed at supporting eider populations and

shorebirds nesting in the same areas. Shorebird nesting density and nest success both increased dramatically relative to years without fox control, suggesting that if predator populations are subsidized near human developments they may have significant effects on shorebird populations.

The final paper by Senner further explored changes in migration timing relative to a changing climate, focusing on Hudsonian Godwit migration. With day-length as the major cue for initiation of migration, faster migration may be necessary for godwits to arrive in time to nest and achieve synchronization of hatch with peak insect emergence. Determining the ability of the birds to shift migration behavior or use clues from previous years to adapt to changing conditions will require further study, which is planned using geo-locators.

As these papers illustrate, shorebirds face increasing threats from anthropogenic changes in their arctic environments. Determining the relative importance of the many different human impacts, and designing mitigation and adaptation strategies, will become increasingly important aspects of a range-wide approach to effective conservation for these declining species.

Effects of predicted sea level rise on shorebirds staging on the Beaufort Sea coast of northern Alaska

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Under most global warming scenarios, a rise in sea level of 1–6 meters is predicted to occur before the year 2200. Low-lying areas of Alaska's Beaufort Sea coast may be inundated as a result. Prior to fall migration, arctic-breeding shorebirds stage along the Beaufort Sea coast of Alaska to acquire energy reserves critical for southward migration. To identify important shorebird staging sites on this coast, we conducted aerial surveys of shorebird abundance and distribution within 100 m of the coastline in 2005–2007. The highest concentrations of staging shorebirds occurred along the western Beaufort Sea coast of Alaska: Point Barrow/Elson Lagoon, the east side of Dease Inlet, and near Pitt Point/Pogik Bay. We examined the degree to which predicted sea level rise may inundate these areas using inundation zone maps (based on grid cell elevation and proximity to shoreline). We determined that the east side of Dease Inlet and the Pitt Point/Pogik Bay areas would be inundated at 1 m sea level rise or more, and that much of the current Elson Lagoon coastline would be submerged at 5 m sea level rise or more. Thus, rising sea levels may eliminate areas of suitable and heavily used habitat for staging or migrating shorebirds. A conservative estimate of the number of shorebirds that could be impacted by sea level rise at these concentration areas is 7,000–19,000 individuals. We also discuss whether staging habitat lost to inundation



will be balanced by habitat gained as new areas become the Beaufort Sea coastline.

Potential effects of climate change on arctic nesting shorebirds via direct and indirect trophic interactions

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On the breeding grounds, shorebirds are highly susceptible to climate change, due to their dependence on temperature-affected arthropod resources and their vulnerability to changes in predator composition. Here we take an ecosystem approach to examine how trophic interactions affect breeding parameters in arctic-nesting shorebirds and how these interactions may be affected by future climate changes. Breeding shorebirds were monitored on Bylot Island, Nunavut, Canada, from 2005 to 2008. Data on breeding parameters (phenology and success), predation pressure (estimated using artificial nests), alternative prey availability (lemming and goose abundance), resource availability (seasonal abundance of insects), and local weather variables were collected. From 1996 to 2008, similar data were also available from up to seven additional sites throughout the Canadian arctic permitting the study of trophic interactions on both local and regional scales. At the local scale (Bylot Island), predation risk (based on real and artificial nest survival) was negatively related to lemming abundance. The timing of chick hatch coincided with peak insect abundance in 2 out of 3 years. On a regional scale, predation risk decreased with latitude, and peaks in insect abundance varied spatially. These trophic interactions will inevitably be affected by climate changes (e.g. northward expansion of predator communities, dampening of cycles in lemming populations, changes in insect phenology). It is important to understand these interactions to better anticipate the impact of global warming on shorebird populations.

Whimbrel *Numenius phaeopus* nesting habitat associations, shifted nesting distribution and habitat change

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We studied Whimbrel nesting habitat near Churchill, Manitoba, Canada. Whimbrel occupied two main habitat types characterized either by high percent cover of 1) lichen and Dryas heath, or 2) standing water and graminoids. Whimbrel avoided shrubby and treed habitats. Hatching success using the logistic-exposure model was 26% in 2007 and 14% in 2008, corresponding to daily nest survival rates of 0.947 and 0.924, respectively. These success rates are lower than previously reported. Current nesting distribution contrasts with that reported in the 1930s (Taverner & Sutton 1934) and 1970s (Skeel 1976), in the same study area, but resembles the distribution reported in the 1990s (Lin 1997), with greater use of sedge-meadow, fen and coastal tundra habitat, and much lower use of hummock-bog habitat adjacent to tree lines. To examine the hypothesis that Whimbrels have abandoned an area of historic nesting importance due to habitat change, we compared aerial photography from 1973, 1986, and high-

resolution satellite imagery from 2006 of a 2.55 km² area of hummock-bog habitat just north of a functional tree-line. Comparison of imagery from the three time periods shows that shrubs and trees have increased by 12.6% and 6.9% respectively, and that water cover and other vegetation has decreased by 4.4% and 16.7% respectively. These localized results add to the growing documentation of shrub and tree expansion and wetland drying occurring across the sub-Arctic and Arctic. Change in vegetation structure has implications for Whimbrels and other shorebirds, and is probably resulting in a decrease of Whimbrel nesting habitat in the Churchill area.

Shorebirds in the Mackenzie Delta, North-west Territories: current and future impacts of oil and gas development

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Intensive surveys of shorebirds in the Mackenzie Delta commenced in 2004 in response to the 2002 announcement that a consortium of gas producers were applying for regulatory approval for the proposed Mackenzie Gas Project (MGP) in the Mackenzie Delta region of the North-west Territories, Canada. The MGP sparked one of the largest environmental impact reviews in Canadian history and has required biologists and scientists from many different fields to begin new research projects and conduct baseline monitoring so we can examine the impacts that large scale gas development will have on this region. Complicating the environmental assessment process is that two of the three proposed production facilities (and several existing Significant Discovery Licenses) are located within a Federal Migratory Bird Sanctuary, the Kendall Island Bird Sanctuary. Impacts to shorebirds include direct loss of habitat at the production facilities and along the pipeline corridor, potential habitat loss due to ground subsidence, increased noise disturbance, and increased predator presence around man-made structures. Our shorebird surveys have provided a baseline population estimate for cumulative effects monitoring, the data for Arctic PRISM Region 12 (which spans from the Yukon North Slope, Yukon to the Tuktoyaktuk Peninsula, North-west Territories), and we are in the process of identifying potential habitat loss off-set areas adjacent to the Kendall Island Bird Sanctuary. All species of birds are being recorded. However, the main shorebird species being monitored are Whimbrel, Red-necked Phalarope, Semipalmated Sandpiper, Stilt Sandpiper and Pectoral Sandpiper.



Influence of human development and predators on nest survival of tundra birds, Arctic Coastal Plain, Alaska

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Nest predation may influence population dynamics of birds on the Arctic Coastal Plain (ACP) of Alaska. Anthropogenic development on the ACP is increasing, which may attract nest predators by providing artificial sources of food, perches, den sites, and nest sites. Enhanced populations or concentrations of human-subsidized predators may reduce nest survival for tundra-nesting birds.

We tested the hypothesis that nest survival decreases in proximity to human infrastructure. We monitored 1,257 nests of 13 shorebird species and 619 nests of four passerine species at seven sites from 2002–05. Study sites were chosen to represent a range of distances to infrastructure. We used Cox proportional hazards regression models to evaluate the effects of background (i.e., natural) factors and infrastructure on nest survival. We documented high spatial and temporal variability in nest survival, and site and year were both included in the best background model. We did not detect an overall effect of human infrastructure on nest survival for shorebirds, but found evidence of increased risk of predation for passerine nests. This finding provides quantitative evidence of a relationship between infrastructure and nest survival for breeding passerines on the ACP. High variability in environmental conditions, nest survival, and predator numbers between sites and years may have contributed to inconsistent results. We recommend targeted management actions to minimize anthropogenic effects and suggest new research. In particular, we recommend research on demography of key predators and their importance with respect to nest survival, and experimental studies that better address challenges posed by high natural variability.

Impacts from enhanced predator numbers near arctic communities on shorebird productivity: results from an experimental fox removal study

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Monitoring the status and population trends of breeding shorebirds relies primarily on monitoring nesting densities and success. Factors that affect shorebird nesting may include predators, prey, weather, natural fluctuations, and other factors operating indirectly (e.g., lemming numbers). Understanding the relative influence of these factors is difficult, but experimental modifications provide one avenue of study. I investigated the relative role that fox predation may play on

shorebird nest density and success. In the Arctic, where shorebirds nest in high numbers, human development can lead to enhance fox numbers through provisioning of anthropogenic food (via landfills, dumpsters, etc.) and increased availability of artificial denning sites (e.g., culverts). To evaluate how Arctic Fox *Alopex lagopus* may affect nesting shorebirds, I compared nest density and hatching success at Barrow, Alaska, between 2003 and 2004, when no fox control was in place, and 2005–2008 when foxes were removed to benefit nesting eiders. Nest density increased from an average of 59.3 to an average of 102.5 nests/km² when foxes were removed. Similarly, hatching success increased from an average of 32 to 79% when foxes were removed. This increase in nest success occurred despite two of the four years with fox control having very high avian predator numbers. These results indicate that current increases in the number and size of Arctic settlements and natural resource developments (e.g., oil and gas) may severely impair local shorebird numbers unless efforts are made to control factors that subsidize predators.

The impacts of climate change on the breeding success and migration strategy of Hudsonian Godwits *Limosa haemastica*

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Global climate change is rapidly altering the nature of interactions between trophic levels around the world. The Northern Hemisphere, and particularly the Arctic and subarctic, are changing more rapidly than other latitudes. Long-distance migratory birds that nest in these regions are hypothesized to be especially vulnerable to these changes. Already, as a result of climatic changes, long-distance migratory birds in some areas have suffered declines in annual fecundity and undergone range shifts and altered migratory patterns. Little work, however, has been done in the Nearctic to document whether or not similar changes have occurred in that region. During the boreal summer of 2008, we documented the daily and weekly fluctuations in insect biomass and local climate and their relationship to the breeding success of a population of Hudsonian Godwits *Limosa haemastica* near Churchill, Manitoba. We then used these data and historical climate records to back-calculate the dates of insect emergence and peak abundance and compared these to historic spring godwit arrival dates from the region. The combination of these analyses allow us to make a preliminary assessment of the impacts of climate change on the Hudson Bay population of Hudsonian Godwits, which is estimated to be the species' largest breeding population. Future steps in the project include the attachment of geolocation tracking-devices to a cohort of godwits from this and the other two breeding populations. These devices will potentially allow us to quantify the responses of these three populations to climate change over the course of a three-year period.



WHSRN SPECIES CONSERVATION PLANS: NEXT STEPS AND IMPLEMENTATION – SYMPOSIUM

ORGANIZER: MEREDITH GUTOWSKI (mgutowski@manomet.org)

The Canadian and U.S. Shorebird Conservation Plans identify 27 shorebird species or subspecies that occur regularly in North America and are either “Highly Imperiled” or a “Species of High Concern.” The Executive Office of the Western Hemisphere Shorebird Reserve Network (WHSRN), with generous support from the National Fish and Wildlife Foundation, is working with shorebird experts and other conservation partners to develop range-wide, action-oriented Species Conservation Plans for the most at-risk of these species (excluding those federally listed). To date, nine species plans have been completed and several more are near-final or significantly underway (www.whsrn.org). The goals of the “WHSRN Species Conservation Plans: Next Steps and Implementation” symposium were to:

- Gain perspectives and lessons learned from a variety of shorebird conservation implementers and funders;
- Identify avenues and strategies for implementing action items, and gaps or impediments to implementation, throughout the hemisphere;
- Identify opportunities for more efficient implementation of action items by considering species with action items and/or important sites in common.

Charles Duncan, Executive Director, WHSRN Executive Office, opened the symposium with an overview of the Species Conservation Plan initiative and progress to date, followed by presentations by:

- **Bernd Cordes, Director of Marine Birds Program, Packard Foundation**
The development of Packard’s strategy for funding migratory bird conservation, its current “shorebird portfolio” in particular, and its approach to site-based strategies.
- **Brad Winn, Georgia Department of Natural Resources**
The National Fish and Wildlife Foundation’s approach to funding shorebird conservation, the species-specific “Conservation Business Plan” model, and its application to the American Oystercatcher recovery project.
- **Joaquín Aldabe, Aves Uruguay, Southern Cone Grasslands Alliance**

The Alliance’s formation, members, and mission. Successes and challenges of working on geographically focused, habitat-scale conservation, addressing multiple species’ needs. The Alliance’s role, approach, and experience in conserving grassland-dependent shorebirds.

○ **Brad Andres, U.S. Fish and Wildlife Service, Black Oystercatcher Working Group**

The Working Group’s formation, members, and mission. Perspective on the successes and challenges of working on range-wide, species-specific conservation. Overview of the plan’s conservation action items, progress made, and lessons learned.

In the second half of the symposium, participants from North, Central, and South America (approx. 60 total) had an engaging, open discussion identifying avenues and strategies for implementing the species plans, as well as challenges or impediments. They also considered opportunities to more efficiently address the needs of species with action items or important sites in common, guided by preliminary compilations of information by WHSRN.

Species Plans (in order by date)

Red-necked Phalarope *Phalaropus lobatus* (2005) • **Marbled Godwit** *Limosa fedoa* (2006) • **Western Sandpiper** *Calidris mauri* (2006) • **American Oystercatcher** [U.S. Atlantic & Gulf Coasts] *Haematopus palliatus* (2006) • **Black Oystercatcher** *Haematopus bachmani* (2007) • **Red Knot** *Calidris canutus* (2007) • **Hudsonian Godwit** *Limosa haemastica* (2007) • **Dunlin** *Calidris alpina* (2008) • **Upland Sandpiper** *Bartramia longicauda* (2008) • **Buff-breasted Sandpiper** *Tryngites subruficollis* (final draft) • **Mountain Plover** *Charadrius montanus* (final draft) • **Long-billed Curlew** *Numenius americanus* (final draft) • **Wilson’s Plover** *Charadrius wilsonia* (underway) • **Snowy Plover** *Charadrius alexandrinus* (underway) • **Whimbrel** *Numenius phaeopus* (underway) • **Sanderling** *Calidris alba* (underway) • **American Golden-Plover** *Pluvialis dominica* (underway) • **American Oystercatcher** [Hemispheric] *Haematopus palliatus* (underway) • **Semipalmated Sandpiper** *Calidris pusilla* (underway).



WESTERN SANDPIPER SYMPOSIUM

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The Western Sandpiper Symposium included contributions from the Simon Fraser and Mexican Baja Groups. Dov Lank presented an overview of the collaborative Western Sandpiper migratory connectivity project, which includes sample collection throughout the species' range, and involves most of the long term, and some new cooperators in the Western Sandpiper Research Network. Birgit Schwarz discussed plans for the genetic analysis side of this project, and Guillermo Fernández took time out from his extensive pre-meeting organization to summarize morphological and other patterns of data collected from sites around the Gulf of California a month earlier, in cooperation with the larger migratory connectivity study, as well as for shorebird planning goals. Roberto Carmona's group from La Paz was well represented, having moved on from their studies at La Paz to new projects at Guerrero Negro, in western Baja California. Nallely Arce Villavicencio discussed seasonal and habitat specific population structure and body masses. Carmona presented Rosalba Vázquez's talk on inter-annual site-fidelity at La Paz, as she was unable to attend due to an impending birth. Andrea Pomeroy discussed her attempt to experimentally alter anti-predator behaviour of migrant Westerns through wing-clipping experiments. In a related poster, Dave Hope presented a poster on his M.Sc. study of age differences in anti-predator strategies of Western Sandpipers at stopovers on southward migration. Finally, Samantha Franks contrasted moult patterns of Western, Least, and Semipalmated Sandpipers within the context of their migration ranges.

Western Sandpiper issues were also presented outside the symposium papers, including three of the four plenary talks: Pavel Tomkovitch showed that Western Sandpipers appear to be undergoing a range expansion on the Chukotka Peninsula, Nils Warnock discussed several aspects of Western Sandpiper northward migration during his excellent plenary overview of radio-tracking studies, and the species is considered in the North-west Mexico Shorebird Conservation plan discussed by Eduardo Palacios. Habitat usage at Guerrero Negro also was considered in Victor Ayala-Perez's talk and an additional talk by Carmona, and patterns at Laguna San Ignacio were discussed by Luis Mendoza. Jorge Correa-Sandoval stressed the importance of coastal wetland sites in the Northern Yucatan Peninsula for migrant Westerns and other shorebird species. Information on Westerns as also presented in Sandra Giner's talk on the use of wetlands in Falcon State, Venezuela, and Carlos Ruiz-Guerra's talk on abundances of shorebird species on the Caribbean coast of Colombia.

A major outcome of the symposium and the meeting is closer integration of northern and southern researchers. The high representation of Latin American participants combined with the simultaneous translation, which worked remarkably well throughout the meetings, facilitated scientific communication more strongly than ever before. We hope that this will lead to even closer integration of our work together.

Western Sandpiper connectivity project: preliminary results from the north-western Mexico campaign

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The Western Sandpiper Connectivity Project will develop methods to track movements of migratory shorebirds throughout the annual cycle. We sampled north-western Mexico, one of the key wintering regions, to develop a ground base map. Western Sandpipers were studied at seven sites, ranging from the Colorado River Delta in Baja California to Huizache-Caimanero in Sinaloa, separated by over 1,600 km. Previous work has established that Western Sandpipers are differential migrants by sex, age, and body size. We used this effort to test the consistency of these latitudinal patterns, including other potential factors such as site size.

As expected, males predominated at northern wintering sites in the Baja, and females at the southern wintering sites in Sinaloa. Contrary to our expectations the distribution of age classes did not vary with latitude. Sex and age ratios did not vary with site size. For the morphological data, bill and wing length, but not tarsus, increased in both males and females from north to south. Body mass for both sexes did not vary with latitude, but it differed among sites. There was an inverse relationship between bill and wing length and site size; however, this pattern did not hold for tarsus length which was independent of site size. Interestingly, females were heavier at large sites and males were lighter at small sites. Even though these analyses are preliminary, they suggest that latitudinal variation may interact directly with local ecological conditions to define the Western Sandpiper population structure and morphology.

Migratory and winter use of natural and artificial wetlands on Guerrero Negro, B.C.S., by the Western Sandpiper

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During the migration and wintering periods the Western Sandpiper *Calidris mauri* is the most abundant shorebird along the Baja California peninsula. The Ojo de Liebre Lagoon and the contiguous Guerrero Negro saltworks are located in the mid-western portion of the peninsula, and the Western Sandpiper is also the most abundant species in this complex. During the 2005–2006 season, we evaluated and compared the species' abundance in and use of two sites, natural site AN, and artificial site S1-A. We observed the greatest abundances in winter



for both sites, although in autumn the Western Sandpiper used S1-A more (alternate feeding site), possibly in response to the energetic demands of this time. The sex ratio in favor of males (3:1) was expected given the latitudinal pattern of males predominating in the northern part of the range. The greater abundance of males in AN, and females in S1-A is apparently related to their different feeding methods, pecking and probing, respectively. The adult-to-juvenile age ratio (1:1) was different from the bias toward juveniles expected at this latitude, which suggests that the peninsula is a suboptimal site in comparison to the continental coasts. The adults were more abundant in S1-A, the site where we detected fewer attacks by predators. In general, weights of birds were heaviest in spring, in preparation for migration and reproduction. The heaviest males were in AN, and the heaviest females in S1-A. Adults weighed more than juveniles, reflecting their greater foraging success.

Fidelity to Ensenada de La Paz, B.C.S., Mexico, among wintering Western Sandpipers *Calidris mauri*

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From observations of Western Sandpipers *Calidris mauri* banded during the 2001–2002 season, we determined the species' site fidelity and temporary use of the Chametla wetlands at Ensenada de La Paz as a wintering site (2002–2003 season). During 57 field visits (1 Nov 2002 to 8 Apr 2003) we made 1,385 sightings of 479 individuals; the return rate, based on a total of 856 birds banded (2001–2002 season), was 56%. This observed high fidelity is presumably a result of the fact that Chametla is the only wetland available for shorebirds in the south-east portion of the peninsula of Baja California. Males showed higher return rates (61%) and sighting frequencies (41%) than females which reflects the latitudinal distribution pattern of the species. First-year adult males were sighted more frequently than adult males over two years old, which may relate to the nomadic behavior of the latter. The return rate varied with month of capture; lower rates were observed for birds banded in fall (7%) and higher rates for birds banded in winter (78%), reflecting the higher proportion of birds using the area as a stopover site in fall. The median departure date of banded birds was 28 Feb. There was no difference in departure dates according to sex and age-class. This indicates that there is no separation of the sexes on the wintering ground, at least in this area.

Increased wing loading influences stopover site usage by Western Sandpipers

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Migrants make feeding decisions on stopover based on site attributes (e.g. distribution of food and predation danger) and individual attributes (e.g. fuel load, escape performance etc.). As migrants gain fuel at stopover sites their wing-

load increases (mass/wing area) and their ability to escape predators declines. We clipped the tips (2–4 mm) of migrant Western Sandpipers flight feathers, experimentally reducing their escape performance, to test the hypothesis that migrants with a lower ability to escape avian predators feed in safer habitats (with less food) than unclipped birds. We applied 30 small transmitters to clipped (treatment) and unclipped (control) male sandpipers and used radio telemetry to measure their habitat usage during northward migration in 2005 at Boundary Bay, British Columbia. Of the 30 birds tagged, eight were not detected again; six of those birds had clipped wings. Clipped birds were detected on fewer days after capture ($P = 0.009$) and had fewer detections overall ($P = 0.004$). On average, heavier birds fed further from the shoreline (both treatment groups, $P = 0.06$), and clipped birds fed in safer-low food habitats (e.g. far from shore) than unclipped birds ($P = 0.09$). Both results are consistent with our hypothesis. However, although we predicted that birds would feed in safer habitats (with less food) with increasing date after capture (i.e. as they fattened), birds in both treatment groups were recorded feeding closer to shore ($P = 0.015$). This preliminary study indicates that a slight increase in wing load, on a very small sample size of individuals, affects stopover site usage by migrating Western Sandpipers.

Variability in the timing of annual cycle events in three long-distance migrant sandpiper species

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Reproduction, migration and moult are the three most important events in the annual cycle of migratory birds. Their relative timing is especially critical for long-distance migrants that experience extreme variability in their environment. Migration and moult represent a forum for conflict and trade-offs in the evolution of avian life-history strategies because they both occur during the same period of the annual cycle. A range of factors can influence the timing of moult and migration both among species and within species. Decisions about migration and moult can subsequently influence other aspects of stopover ecology. We investigated migration and moult strategies and stopover duration in southward migrant Least, Semipalmated, and Western Sandpipers at a mid-continent stopover site. Most Least Sandpipers and many Western Sandpipers used a stopover moult-migration strategy, while few to no Semipalmated Sandpipers used this strategy. Least Sandpipers began moulting earlier than Western Sandpipers. Neither intra-specific nor inter-specific differences in moult strategy could be explained by differences in the degree of flight feather wear. Moulting birds had longer stopover durations than non-moulting birds. These data suggest that moult and migration strategies are highly variable both within and between species and that individuals have different considerations when making decisions about the timing of annual cycle events and migration stopover ecology. This variability in critical annual cycle events should be an important consideration when formulating conservation management plans that are species- or population-specific.



Using intrinsic markers to develop management tools for migratory shorebirds

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Management of migratory populations requires knowledge of the connectivity between breeding, migration, and non-breeding areas. Using Western Sandpiper as a model species, we will develop novel methods for determining movement patterns of individual migratory birds between areas, using intrinsic biological, physical, and biochemical markers. We will collect feather and blood samples, and test the potential of (1) stable isotope ratios from feathers, (2) trace element profiles in feathers, (3) AFLP and other genetic markers, and (4) morphometrics, separately and in combination, to determine probable connectivity among sites. We will use genetic information to describe population structure on the breeding grounds, and stable isotope and trace element analyses to create a base map of wintering sites. We will develop statistical methodology for determining the probabilities that individual birds moved from one area to another, taking regional population estimates into account. Preliminary results from stable hydrogen isotope analysis of feathers indicate a latitudinal gradient in wintering ground hydrogen isotope signatures, and trace element analysis of feathers appears to provide a more local site-level basis for assignment to wintering sites (Norris *et al.* 2007, *Can. J. Zool.*). We will determine which approaches will be most useful for determining patterns of migratory connectivity in species of shorebirds of more immediate conservation concern.

Who travels where? Unraveling population structure, migratory connectivity, and life history patterns in western sandpipers

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Western Sandpipers *Calidris mauri* are long-distance migrants that breed in Western Alaska and Eastern Siberia. In the winter they migrate south to sites along the west coast of southern North America, Central America and northern South America. A small part of the population winters on the east coast and in the Caribbean. Western Sandpipers show "differential migration" across this range with respect to sex, size, age, and life history strategy. Juveniles that spend their first winter closer to the breeding grounds (e.g. Mexico) travel back to the breeding grounds in their first spring, whereas those wintering further south (e.g. Panama) delay reproduction and do not migrate to the breeding grounds until their second spring. This difference in life history strategies and differences in morphology may reflect population differentiation in this species. Using the genetic fingerprinting technique AFLP (Amplified Fragment Length Polymorphism) we will investigate the genetic population structure of Western Sandpipers. Using existing blood samples from the breeding grounds we will determine the degree of genetic variation between the different breeding sites and develop suitable markers for each site with this technique. We will use these markers to determine the breeding origin of birds on the wintering grounds and at migratory stopover sites to detect possible patterns of migratory connectivity and to determine how these connectivity patterns relate to the observed patterns of differential migration and life history strategies in this species.

PLOVER SYMPOSIUM

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Eleven species of "ringed" plovers (*Charadrius* spp.) breed regularly in the Western Hemisphere, and two additional species (Little Ringed Plover, *C. dubius*; Eurasian Dotterel, *C. morinellus*) have bred sparingly in Alaska. *Charadrius* plovers generally prefer patches of unvegetated substrates for nesting, and at least half of the species nest on shorelines of rivers, lakes, or the ocean. Papers for this symposium were loosely organized into a session that addressed three species: Piping *C. melodus*, Snowy *C. alexandrinus*, and Wilson's *C. wilsonia* Plovers.

Sue Thomas (U.S. Fish and Wildlife Service) started the session with an overview of a breeding survey for Snowy Plovers in the U.S. and Mexico. Although the Pacific coast breeding population, which is listed under the USA Endangered Species Act, has been well-monitored in recent years, this survey was the first attempt to estimate the population size of the interior-breeding population; coastal sites in Mexico were also surveyed. Although data are still being analyzed,

the survey uncovered some new, important nesting sites and will update breeding numbers for previously known sites. Somewhat disturbing was the decline of coastal-breeding Snowy Plovers in Baja California, Mexico.

Four other papers were presented on Snowy Plovers that addressed their biology and conservation at a more local scale. Mark Colwell (Humboldt State University) and his students (Kevin Brindock and Noah Burrell) have been studying Snowy Plovers along the northern California coast. Kevin focused on assessing factors that influence habitat selection during the non-breeding season. Using home range analysis, he found that non-breeding plovers occurred most often on wide beaches that had few raptors and low levels of disturbance by dogs. Another interesting habitat component was the presence of large amounts of brown algae, which the plovers were using as an invertebrate food source. Noah evaluated habitat quality and productivity to determine limiting factors at breeding sites. His analysis, albeit with relatively small



sample sizes, suggested that predation by corvids was the most important ecological factor limiting Snowy Plover population growth. The suggestion of possible predator control stimulated a lively discussion. Mark presented information on the demographics, based on seven years of study, for Snowy Plovers breeding in Humboldt County. Breeding sites have shifted dramatically among years in their study area (where some birds nest on riparian gravel bars), and estimates of survival indicate that the local population cannot sustain itself without immigration. Mark suggested that habitat quality and individual movements drive the source-sink dynamics of disjunct populations of Snowy Plovers along the Pacific coast. Xico Vega (Western Hemisphere Shorebird Reserve Network) presented information on Snowy Plovers breeding near Elota, Sinaloa, Mexico. Prior to Xico's work, this breeding site in an old salt works was unknown. In a typical year, 43 pairs were nesting in the salina; the greatest sources of nest loss were predation and flooding.

Turning to Piping Plovers, Elise Elliot-Smith (U.S. Geological Survey) presented the recent update (2006) of the International Piping Plover Census. Numbers from the recent survey are encouraging, with increases in all three populations (Great Plains, Great Lakes, and Atlantic Coast). Increases in survey effort lead to the discovery of a relatively large number of plovers wintering in the Bahamas (11% of the wintering population). A detectability study was initiated in 2006, which will be used to adjust population estimates in the future. Daniel Catlin and Joy Felio (Virginia Polytechnic Institute and State University) gave presentations on the use of engineered sandbars by Piping Plovers nesting on the Missouri River. Dan found that nest density was seven times higher on engineered sandbars than on natural sandbars and that nest success was also higher on engineered sandbars. Chick survival was similar among these two habitat types, and productivity of engineered sandbars decreased as they aged. Expanding on Dan's work, Joy found a similar pattern with recruitment. She suggested that newly engineered sandbars provide adequate breeding habitat but may require periodic maintenance to retain high Piping Plover use and productivity. Future work will examine density-dependent effects on nest site selection and productivity.

Margo Zdravkovic (Coastal Bird Conservation Program) provided new information on Wilson's Plover that she uncovered while developing a species conservation plan for the Western Hemisphere Shorebird Reserve Network. Recent surveys in Laguna Madre (Texas and Tamaulipas) indicate that the population of the nominate subspecies (*C. w. wilsonia*) may be about 10,000 individuals. Little is known about the *cinnamoni* or *beldingi* subspecies of Wilson's Plover. Because of their dependence on coastal habitats, diligence is required to monitor the conservation status of Wilson's Plovers throughout their range.

These studies indicate the need to continue to monitor the conservation status of *Charadrius* plovers in North America and throughout the Western Hemisphere. Hopefully at future meetings, we will have presentations on those species or populations breeding in South America.

Results of a range-wide breeding season survey of Snowy Plovers

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I will present preliminary results from a range-wide breeding season survey of Snowy Plovers conducted during the spring of 2007 and 2008. The goal of the project was to assess the distribution and abundance of plovers in the interior and Gulf Coast of the U.S and the Pacific and Gulf coast of Mexico and interior Mexico. Objectives include: 1) Estimate the North American breeding population 2) Provide information for evaluation under Mexico's Federal Species Program; 3) Provide information for a species conservation action plan under development by the USFWS with partners; and 4) Provide states with current site-specific information for implementation of State Wildlife Action Plans. In 2007, 236 discrete sites known to support breeding plovers in the U.S. were surveyed completely. In addition, 8 large-scale sites (e.g. the Great Salt Lake) for which surveys could not be completed in a single day were sampled. In 2008, two of the largest sample sites were resurveyed with similar intensity to expand on sample size and increase precision of the estimate. In Mexico, 230 sites were surveyed along the Pacific and Gulf coasts in 2007 and 21 sites in the interior were surveyed in 2008.

Habitat selection of Western Snowy Plovers *Charadrius alexandrinus nivosus* during the nonbreeding season in northern California

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The Western Snowy Plover *Charadrius alexandrinus nivosus* is a threatened subspecies that breeds and winters along the west coast of North America, from Baja, Mexico to Washington, USA. Conservation efforts to manage this species require knowledge of the factors that influence habitat selection during both the breeding and non-breeding season. While previous studies have examined habitat selection during the breeding season, little is understood of the variables that influence habitat use during the non-breeding season. We examined the influence of habitat characteristics on the distribution of non-breeding Snowy Plovers in northern California. Data collected in two winters (2007/2008 and 2008/2009) were used to explore the relationship between beach width, slope of beach, ground cover, disturbance, prey abundance, and presence of predators on habitat selection of Snowy Plover. The locations of marked plovers ($n = 42$) were used to determine home-range size to examine habitat selection for the establishment of a home range. A set of *a priori* models were examined with logistic regression analysis and models evaluated using Akaike's Information Criterion. Results indicate that plovers occurred on wider beaches, with more brown algae and associated invertebrates, fewer raptors, and at locations with lower disturbance from dogs. We recommend that these factors be considered in managing habitat for Snowy Plovers.



**Breeding patch dynamics of
the Western Snowy Plover *Charadrius alexandrinus
nivosus* in Humboldt County, California**

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Effective management of threatened bird populations relies on identifying factors contributing to population limitation and ameliorating those factors. The U.S. Fish and Wildlife Service identified three factors acting to limit productivity of the Western Snowy Plover *Charadrius alexandrinus nivosus*: predation of chicks and eggs, loss and degradation of breeding habitat owing to exotic species, and human disturbance. Using direct and indirect measures of habitat quality, we examined the dynamics of plover occupancy, density, and productivity at 20 historic breeding locations in Humboldt County, California, from 2001–08, and compared these measures to indices of limiting factors. To evaluate the relationships of habitat quality and productivity across the breeding sites, we conducted a multiple linear regression *a priori* parsimonious model selection strategy using eight candidate models. With daily survival rate as the response variable, the most competitive model accounted for 25% of Akaike weight and consisted of only one covariate: corvids. The estimate for the most competitive model suggests that plover average daily nest survival rate is negatively associated with corvid abundance (-0.054 ± 0.026). Additionally, we found that there was considerable variability in direct and indirect measures of habitat quality among breeding sites. Based on these results, and other evidence collected over the 8-year study, we consider predation by corvids to be the most important ecological factor limiting the Snowy Plover population in Humboldt County. We recommend that management actions designed to increase the productivity of Snowy Plovers in Humboldt County be directed at ameliorating the effects of predation by corvids.

Apparent survival and population growth of Snowy Plovers in coastal northern California

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Accurate survival estimates and an understanding of how survival is related to a population's growth are required to effect conservation for threatened and endangered species. Consequently, estimates of adult and juvenile survival were quantified for a population of the threatened Western Snowy Plover *Charadrius alexandrinus nivosus* in coastal northern California over seven years (2001–2007). Additionally, population structure and growth were evaluated to determine the relative importance of immigration and local recruitment. Apparent survival for adult males ($\phi = 0.61 \pm 0.08$) was greater than that of adult females ($\phi = 0.53 \pm 0.08$), and survival of adults was greater than juveniles ($\phi = 0.29 \pm 0.04$). An algebraic assessment of population growth (λ) revealed that fecundity and survival were insufficient to maintain the population ($\lambda = 0.74$) whereas an estimate based on a Pradel model showed the population was stable ($\lambda = 0.98 \pm 0.10$).

These results, combined with annual variation in the number of immigrants, indicate that the local population is maintained by immigration. Source/sink dynamics probably occur in the spatially disjunct populations of Snowy Plovers along the Pacific coast due to differences in habitat quality and wide-ranging movements of individuals.

**The 2006 International Piping Plover census:
reflections on the population status of an
endangered species over 15 years**

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In 2006, for the fourth time in 15 years, a comprehensive inventory of Piping Plovers *Charadrius melodus* was conducted across their winter and breeding range in the U.S., Canada, France (islands near Canada), Mexico, and the Caribbean. The Census is coordinated every five years to assess population status, distribution, and progress made toward recovery goals for this species which is listed in the U.S. and Canada as threatened or endangered across its range. Surveys were conducted on over 12,250 km of coastal, bay, river, lake, and other shorelines (and flats) at 2,475 sites, by over 1,300 observers. A total of 3,884 Piping Plovers were detected across their winter range on a variety of habitats in the southern Atlantic and Gulf coasts of the U.S. and northern Mexico. Increased coverage in the Bahamas and northern Caribbean led to the discovery of a relatively large population in the Bahamas (417 birds, or 10.7% of the winter total). During the Breeding Census, 8,065 adult Piping Plovers were counted using many different habitat types on the Atlantic Coast, Great Lakes, Northern Great Plains and Prairies of the U.S. and Canada. This number was higher than for any prior Census, both overall, and for each of the three breeding populations. Preliminary analyses suggest that detectability is relatively high for this species on its breeding grounds. Since this is the first year we assessed detectability, we cannot conclusively determine population trends. However, in some regions Piping Plovers are very likely increasing and approaching recovery goals.

**Breeding biology of the Snowy Plover
Charadrius alexandrinus in Ceuta Bay, Sinaloa,
Mexico: factors affecting its reproduction and
problems for its conservation**

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From 2000 to 2004 we studied factors affecting the reproductive performance of Snowy Plover *Charadrius alexandrinus* in an area known as the "old salina of Ceuta", Elota, Sinaloa, Mexico. We made weekly visits from March to July. The Mayfield method was utilized to determine the reproductive success of the colony. Median colony size was 43 nests from a total of 217 nests. Median nest density per hectare was estimated at 0.87 nests, highest nest density was 1.80 nest/ha in 2004 and lowest nest density was in 2002 with 0.42 nest/ha. The median laying-date was 10 May. A steady decrease



was observed at the end of May. Median modal clutch size was three with a nesting success of 0.50%. Six causes of nest failure were found: in 36% of nest failures the reason could not be determined, 22.6% were depredated, 19.4% were flooded, abandoned nests accounted for 15%, infertility for 4.3%; nests lost to vehicles were 2.1%.

Piping Plover colonization of engineered breeding habitat on the Missouri River, South Dakota

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To increase the Piping Plover population nesting on the Missouri River, the U.S. Army Corps of Engineers has begun building open sand habitat by depositing dredged material in the river. Sandbars were built along a stretch of river currently used by more than 300 nesting adults. We have banded most of the Piping Plovers in the study area with color band combinations for individual identification. We identified the individuals colonizing newly engineered sandbars and documented their nesting success and fledgling production. Nesting was initiated slightly later on the newly engineered sandbars than on natural sandbars or sandbars engineered three years prior to the study. Of the 125 marked birds that nested on newly engineered sandbars, 9% were known yearlings that had recruited from the study site. On older sandbars, 4.5% of the 197 marked birds were yearling recruits. Newly engineered sandbars appear to provide adequate nesting habitat for Piping Plovers and encourage recruitment from within the population. Further investigation of Piping Plover nesting on engineered habitat will examine the role nesting density and intraspecific aggression play in nest site selection and productivity. In describing the colonization and use of engineered sandbar habitat by breeding Piping Plovers, we hope to enable the U.S. Army Corps of Engineers to evaluate the effectiveness of this intensive and costly management strategy.

Population dynamics of Piping Plovers *Charadrius melodus* using engineered and natural sandbars on the Missouri River

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In 2004, the U.S. Army Corps of Engineers began engineering sandbar habitat in response to habitat limitation for the threatened Piping Plover *Charadrius melodus*. Beginning in 2005, we compared the fates of nests, broods, and adults on natural sandbars with those on engineered sandbars. We monitored 623 nests from which we banded 357 adults and 694 chicks to investigate the factors affecting nest survival, juvenile and adult survival, and movement. Nesting adult plovers selected for engineered habitats; there were more nests initiated on engineered habitat than would be expected based on area, nesting birds were more likely to move to engineered sandbars than to natural sandbars, and nesting densities on engi-

neered sandbars were approximately seven times as high as on natural sandbars. Furthermore, nesting success was higher on engineered habitat than on natural habitat. Pre-fledging survival was similar, on average, between natural and engineered sandbars, but chick survival on engineered sandbars was highly variable. Post-fledgling survival also was similar on the two sandbar types, but fidelity to study area was lower for birds hatched on natural habitat. In general, engineered habitat was more productive than the natural habitat, but the productivity on these sandbars decreased with age. Management for population growth should include considerations of habitat availability, nesting densities, amount of foraging habitat, and the effects of water management on these factors. It appears that appropriately timed and controlled addition of engineered habitat could contribute to recovery efforts, but continued investigation of the longevity of engineered habitat is required.

Wilson's Plover *Charadrius wilsonia* range-wide species conservation plan highlights: a presentation of new data including subspecies population estimates, important sites, distribution and abundance, and recommendations for species stabilization

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The Wilson's Plover *Charadrius wilsonia* breeding adult population estimate is approximately 6,000 individuals according to the U.S. *Shorebird Conservation Plan* (Brown *et al.* 2001). The species' breeding range is contracting at the northern limits, with birds no longer nesting north of Virginia (Corbat & Bergstrom 2000). Limited trend data available indicate that Wilson's Plover populations are in decline due to human-caused disturbance and loss of habitat. Recent comprehensive surveys estimate the U.S. population at approximately 5,980 breeding adults. The population estimate for subspecies *C. w. wilsonia* is 9,830–10,130 breeding adults, with the Laguna Madre Region of Texas and Mexico supporting the highest breeding populations in North America. No comprehensive population data exist for subspecies *C. w. cinnamoni* or *C. w. beldingi*. Population estimates based on breeding densities for known areas were used to extrapolate estimates of 5,500–7,500 breeding adults for *C. w. cinnamoni* as well as for *C. w. beldingi*. The combined subspecies' estimates produce a range-wide species total of 20,830–25,130 breeding adults. The Wilson's Plover warrants immediate conservation action due to: low and declining population and contracting species range; ongoing range-wide loss of habitat; lack of range-wide monitoring data to determine population status; and high vulnerability to climate change. The Wilson's Plover Conservation Plan (Zdravkovic *in prep*) recommends: U.S. federally listed status for subspecies *C. w. wilsonia*; aggressive action to preserve key remaining coastal habitat throughout the species range; monitoring of population status and trends through standardized, range-wide surveys; and prioritizing research that directly relates to preservation and increase of the Wilson's Plover and its habitat.



SECOND NEOTROPICAL ENDEMIC SYMPOSIUM

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Gaps in knowledge of Neotropical shorebirds have become a concern across the Western Hemisphere and the globe. These species are among the least studied shorebirds in the world and several are suspected to be under immediate threat. Four species are *Near Threatened* but habitat loss in the wetlands of the High Andes, coastal estuaries, river banks and grasslands suggests that others could soon be affected. The lack of key information on many Neotropical shorebirds precludes accurate estimation of population size, characterization of habitat and diet, delineation of flyways and formulation of site-based conservation priorities, all of which are essential aspects of science-based conservation in Neartic species.

The Second Neotropical Endemics Symposium (2nd NES) continues an initiative that started in 2006 with the Neotropical Priorities Workshop during the 1st Western Hemisphere Shorebird Group Meeting at Boulder, USA, and continued with the 1st NES at Maturín, Venezuela in May 2007. The goal was to gather together experts from across the Neotropics who could provide a broad perspective on current approaches to Neotropical shorebird research and share knowledge of those species. Distributional patterns, breeding and demography were the focus of the 2nd NES, which included papers from five countries (Argentina, Chile, Colombia, Uruguay and Venezuela) addressing issues related with species, country-level analysis and initiatives for the whole region, such as the Neotropical Waterbird Counts (NWC). New data on nesting, demography, diet, habitat-use, population size and distribution were presented on a variety of species including Magellanic Plover *Pluvianellus socialis*, Diademed Sandpiper-Plover *Phegornis mitchelli*, Black-necked Stilt *Himantopus mexicanus* and Collared Plover *Charadrius collaris*.

Issues emerging from the 2nd NES were diverse: 1) The need for practical definitions of geographic and taxonomic parameters in relation to Neotropical endemic species, involving both biogeographic and conservation criteria, 2) The need for criteria to identify important sites for species that do not aggregate together similar to those used for Western Hemisphere Shorebird Reserves Network, 3) The opportunity to improve knowledge of Neotropical endemic species by supporting current initiatives for censuses and banding at a national scale and coordinating them through regional projects, such as NWC and cooperative studies of species with a wide distribution like Collared Plover and Southern Lapwing *Vanellus chilensis*, 4) Funding opportunities are greater when priorities for Neotropical Endemics overlap geographically with those for Neartic species; and finally 5) A priority of the group is to maintain and improve communication between researchers through the publication of scientific papers and the use of listserv (avesplayerasdelneotropico@yahoo.com.ar) and social networks.

Distribution and abundance of neotropical shorebirds based on the neotropical waterbird census

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The Neotropical Waterbird Census (NWC) is a regional waterbird monitoring program in South America initiated in 1990 and coordinated by Wetland International's Latin American & Caribbean Program. The main objectives of the NWC are to identify key sites for waterbirds, provide a basis for waterbird population estimates, and monitor changes in waterbird numbers throughout the region. The program is a site-based counting scheme that carries out standardized counts at the same sites every year, once in February and once in July, by more than 500 volunteers. Data are gathered on all waterbird species and include all shorebird species that occur in South America, either as migrants or residents. Here we present an overview on distribution and abundance of Neotropical shorebirds based on NWC data for the period 1990–2006. Data on 27 species endemic to the region (the South American continent) were analyzed, excluding species with populations also occurring elsewhere (e.g. American Oystercatcher *Haematopus palliatus*). The NWC currently contains nearly 10,000 records for the selected species and eleven species have data coverage for almost the entire period, providing a good basis for a variety of analyses on distribution, abundance, and trends. We choose four of these eleven species, Magellanic Oystercatcher *Haematopus leucopodus*, Two-banded Plover *Charadrius falklandicus*, Rufous-chested Dotterel *Charadrius modestus* and South American Snipe *Gallinago paraguaiiae*, to carry out analyses in more detail, including trend examination and maps showing distribution and abundance. The overall goal of this presentation is to show the value of the NWC program and promote increased participation in the region.

Identifying important areas for neotropical shorebirds in Colombia

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Setting priorities for site-conservation for shorebirds classically involves the location of sites where shorebirds occur in large numbers or which support a substantial proportion (>1%) of a biogeographic population. Use of such criteria to locate important sites for Neotropical breeding shorebirds has at least two limitations: (1) Some Neotropical shorebirds do not occur in aggregations and (2) lack of information on shorebird abundance constrains the capacity to propose



population thresholds and consequently the possibility of identifying sites supporting them. We use historic and recent shorebird records and data on distribution of suitable habitat to locate potentially important shorebird sites in Colombia. Areas for Neartic and Neotropical shorebird conservation in Colombia only overlap in the inter-Andean valleys, the high Andean lagoons and the Llanos. Important sites for Neartic shorebirds are often small (<1000 ha) and located in coastal areas. By contrast, Neotropical shorebirds often require huge wetland complexes to support minimum population thresholds. Such species may inhabit freshwater wetlands, such as Andean bogs, and huge river watersheds, including the Magdalena, Amazon and Orinoco. The study and conservation of Neotropical shorebirds in such sites will require the efforts of nations and close cooperation between Latin-American countries.

Current knowledge on the status of endemic shorebirds in Venezuela

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Nine Neotropical endemic shorebird species occur in Venezuela, but to date they have only been the subject of a few studies. There have been studies of the reproductive biology and predator avoidance behavior of two species and on the vision physiology of two others. Most of the information comes from sightings, scientific collections, and checklists of birds occurring in defined areas. Two species (Andean Snipe *Gallinago jamesoni* and South American Snipe *G. paraguayae*) are regarded as game species in Venezuela. The species with the widest distributions are Wattled Jacana *Jacana jacana*, Double-striped Thick-Knee *Burhinus bistriatus*, Southern Lapwing *Vanellus chilensis*, Pied Lapwing *V. cayanus*, Collared Plover *Charadrius collaris* and South American Snipe. These species occur in at least 9 to 30 Important Bird Areas. Only Noble Snipe *G. nobilis*, a restricted species in the northern part of the Andes (NAN, BirdLife International), has been recorded in only one IBA (El Tamá). To evaluate the status of shorebird species we reviewed information from the Neotropical Waterbird Census (CNA) and museum collections (COP, EBRG and NHLS). Results from the CNA indicate that the most common endemic shorebird species are Wattled Jacana, Southern Lapwing and Collared Plover. The *Gallinago* spp. showed a low frequency with only one record in the CNA. Reports on sport hunting activities indicate that *Gallinago* are taken by hunters relatively frequently in the states of Carabobo, Falcón and Miranda. There is a need to study the population status of all species in the genus *Gallinago*.

Reproduction of Collared Plover *Charadrius collaris* in association with Yellow-billed Tern *Sterna superciliaris* at Rocha Lagoon sandbar, Uruguay

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Many species of aquatic birds breed in mixed and dense

colonies in order to protect nests from predation. However, when nests are separately distributed and one of the species exhibits aggressive behavior against predators, benefits may be gained by the passive species. This is the case for some species of plovers breeding close to aggressive terns. The objective of this study was to describe the breeding biology of the Collared Plover and the Yellow-billed Tern at Rocha lagoon sandbar and to investigate the possible benefits for Collared Plovers of breeding next to Yellow-billed Terns.

Between 2001 and 2009, we collected information about the duration of the breeding season, number of nests, distance between nests, number of eggs, egg measurements, and reproductive success of both species at Rocha lagoon sandbar. The breeding seasons of both species extend from mid-Oct to mid-Mar. The maximum number of breeding pairs observed at the same time was 12 Yellow-billed Terns and three Collared Plovers. Maximum number of eggs per nest was three in both species, with a modal clutch size of three in Yellow-billed Terns and two in Collared Plovers. Breeding success was low in Yellow-billed Terns, with 1–3 juveniles observed by the end of each season, and comparatively high in Collared Plovers, with 2–3 juveniles. Systematic research across many seasons is still needed in order to accurately determine the breeding success of both species and the influence of the terns on the plovers.

Elucidating the rarity of the Magellanic Plover *Pluvianellus socialis*: habitat use and demographic characteristics

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As rare species are more vulnerable to extinction than common species, it is important to understand the factors that cause a species to be rare. We studied four factors related to the rarity of the Magellanic Plover *Pluvianellus socialis*: geographic distribution, habitat use, local abundance, and demographics. Breeding locations of *P. socialis* were searched and monitored in two breeding seasons: 2006–2007 and 2007. The species was found to have a restricted geographic range in southern Argentina. By comparing occupied sites with unused available sites at three spatial scales, we showed that birds selected specific habitat characteristics: saline lakes with well-developed aeolian lunettes, territories near freshwater channels with minimal vegetation cover, and microsites with minimal clay. The species exhibited small local population sizes where 1–4 pairs occupied a single lake. One lake was an exception and supported 14 breeding pairs. Nests contained 1–2 eggs. Pairs double- or triple-brooded when annual precipitation and lake water levels were favourable. Average number of young raised per season was 1.36. Finite population growth rate, using survivorship estimates based on a mass-survival rate equation, was estimated at 0.80, indicating a declining population. Restricted geographic range, ephemeral nesting habitat, low local abundance, and low annual fecundity suggest that *P. socialis* is vulnerable to extinction.



Current status of Black-necked Stilt and Collared Plover, neotropical shorebirds overlooked in Colombia

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The Black-necked Stilt *Himantopus mexicanus* and Collared Plover *Charadrius collaris* are among the most common Neotropical shorebirds in Colombia, and although they occur throughout the country, they have hardly ever been studied. Between 2007 and 2008 we collected information about their location, habitat, and some aspects of their breeding in Colombia. Our results show that the Important Bird Area Ciénaga Grande de Santa Marta is the most important habitat for Black-necked Stilt since it is a major nesting site and the largest concentration of individuals occurs there. Likewise, two IBAs located in the Amazon basin and Sinú delta (a river in the Caribbean region), were identified as the sites with the largest concentration of Collared Plovers (and most likely nesting areas). The habitats used most frequently by these species are inland and coastal wetlands and pastures, but other habitats such as rice fields, saltworks, and aquaculture installations have become important alternative sites because of loss and degradation of natural habitats, which is the main threat to both species. Lack of information is also a matter of concern because several aspects of the biology of these shorebirds are still unknown, especially the breeding biology of the Collared Plover and reliable population estimates of the Black-necked Stilt. Conducting breeding censuses and surveys in the Eastern region (Amazon and Orinoco basins)

of Colombia is strongly recommended in order to obtain more key data about these species.

Habitat model for *Phegornis mitchelli*: local and landscape restrictions

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The Diademed Sandpiper-Plover *Phegornis mitchelli* is a specialist bird inhabiting Andean mires. In the Central Andes, during the breeding season (summer) it occupies areas between 2,000 and 3,000 meters. The patchy and discrete structure of mires at the landscape level may be limiting movement of individuals between habitat patches. We studied the relationship between the physical and biological attributes of mires and their use by the species. Among the variables that seem to influence habitat use is the amount of running water. Additionally, we analyzed the spatial configuration of the mire system in the Central Andes of Chile and Argentina, and assessed how connectivity for the species is affected by such spatial patterns. Cost of movement for birds among mires was calculated using a cost-distance model. The greatest connectivity index (calculated as the number of accessible mires from a given mire) was located on the south-east sector of the study area, corresponding to the Argentinean Andes. Additionally, eight mire groups (number of mires within 20 km) for the species were identified. This work is a first approach to the study of habitat use of *Phegornis mitchelli* in the Central Andes.

EDUCATION AND OUTREACH SYMPOSIUM

ORGANIZERS: TAMARA ZELLER (*Tamara_Zeller@fws.gov*) & SUZANNE D. FELLOWS (*Suzanne_Fellows@fws.gov*)

Seven representatives from across the Western Hemisphere discussed aspects of integrating education, outreach, and research to develop sustainable shorebird conservation. The overall goal for the symposium was to present examples of how several outreach and education programs have broken the barriers between research and community-driven shorebird conservation. Six oral presentations and a poster were included in the symposium.

Suzanne Fellows explained how shorebirds became the rallying point when researchers in Homer, Alaska were able to effectively conserve vital habitat through community outreach and education. Next, Brian McCaffery demonstrated how broad scale dissemination of information is not always the most successful outreach strategy. By targeting a smaller, select audience, shared conservation visions were developed and community members have become an integral element to shorebird conservation solutions in Alaska.

John Cavitt described the Linking Communities Partnership between three WHSRN sites: Chaplin Lakes, Saskatchewan, Canada, Great Salt Lake, Utah, USA, and the Marismas Nacionales, Nayarit, Mexico. Shorebirds are used to bridge cultural, economic, and political divides and deliver effective education, ecotourism, research, and habitat conservation to local communities. Carlos Villar (no abstract available)

then described some of the challenges of delivering these conservation partnerships in Nayarit. Concepts of land and wildlife ownership, the historic lack of wildlife management university programs, and a lack of political support must all be overcome. Strategic plans, monitoring programs, community liaisons, and wildlife scientist training programs have been developed and are being implemented. Enforcement of wildlife and habitat regulations remains a challenge. However, by using ecotourism as “environmental education” local communities see the value of habitat conservation and how it can serve as a sustainable use for them.

Luis Bala described the three primary objectives of the wetland laboratory in Chubut, Argentina to develop wetland conservation. Research projects on shorebirds, the benthic community, and the effects of agricultural practices on the entire watershed are conducted. Undergraduate- and graduate-level interns and projects are supported. Information is then disseminated through training programs for park rangers, conservation agents, teachers, tourism guides and professionals working with the public at important shorebird sites along the coast of Patagonia, through school programs, through a variety of scientific publications, and a website.

Carlos Albriue then described how community ownership was developed for the protection of shorebird habitat through



several outreach strategies in Bahía de San Julián, Río Gallegos, Argentina. By delivering conservation messages to the local community using radio and television programs, books, brochures, school programs, discussions and public meetings, the area's importance for shorebirds has been communicated both locally and internationally.

The final presentation in the symposium was a poster by Patricia Falk-Fernández describing her work at the Sanquianga National Park, along the Pacific Coast of Columbia. Ornithologists were trained, several annual festivals are celebrated, and programs are provided for young children. By increasing community involvement through training and leadership development, further research projects and sustainable conservation can be achieved.

The Education and Outreach Symposium concluded with a lively conversation which further emphasized how education and outreach products come in many forms and can involve many diverse partners. They give communities ownership in their wildlife resources and will create sustainable conservation when based on, and coupled with, scientific research.

Kachemak Bay Shorebird Festival – a grassroots effort for shorebird conservation

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Combining science and outreach can be a very powerful and effective means of achieving habitat and wildlife conservation and is illustrated by the success of the Kachemak Bay Shorebird Festival in Homer, Alaska. In 1992, the city of Homer proposed filling Mariner Park Lagoon along the shores of Kachemak Bay to make way for an recreation vehicle park. In response, a collection of scientists and concerned citizens wrote a paper about the ecological value of the lagoon and created the Kachemak Bay Shorebird Festival. The goal was to raise awareness about shorebirds in Homer and to make additional allies for habitat protection. Not only has the festival generated enough public pressure to prevent the filling of the lagoon, but also has been an economic success for this small Alaska town. In addition, an education program called Shorebird Sister Schools was formed and has informed people throughout the United States and abroad about the needs of shorebirds and the importance of conserving wetlands. Kachemak Bay is now designated as a WHSRN site of international importance with thousands of visitors gathering every May to witness the spectacular arrival of the shorebirds.

Narrowing the field: are outreach scale and effectiveness inversely correlated?

Brian J. McCaffery

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Outreach is a critical component of many conservation efforts. Outreach specialists frequently adhere to a promiscuous paradigm whereby information is disseminated on a broad scale, particularly in programs for younger citizens. The persistence of some conservation challenges, even in areas with extensive environmental education, suggests that this approach has limitations. For example, in the Yukon Delta National Wildlife Refuge in western Alaska, information and

education programs about waterbird conservation over the last quarter-century have had decidedly mixed results.

In search of more effective approaches, we have recently augmented our traditional programs with more focused efforts that target much smaller audiences. Via science camps, internships, and community-level conservation projects, we are introducing conservation science to high school and college-aged Yup'ik Eskimo students by encouraging their participation in a variety of research projects. By making a greater investment in fewer students, we hope to a) provide opportunities for educational advancement in the biological science field by native students from our region, b) evaluate the effectiveness of our efforts on an individual or community basis, so as to better implement adaptive changes to our outreach approach, c) develop long-lasting partnerships with the students, their families, and their communities, and d) create a stronger sense of shared values between rural communities dependent on natural resources and the government agencies responsible for safe-guarding those resources. Along the way, we hope to more effectively inculcate a broader and deeper conservation ethic that is informed and inspired by scientific research.

Linking communities, wetlands, and migratory birds: a partnership for shorebirds

John F. Cavitt

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One of the central questions in bird conservation is how to build and plan for range-wide conservation efforts. Beginning in 1998, biologists from Canada, the United States and Mexico began a long-term collaboration to develop a comprehensive initiative for the conservation of migratory birds throughout their geographic range. Three critical sites; the Chaplin Lake area of Saskatchewan, the Great Salt Lake of Utah and the Marismas Nacionales complex of Nayarit were "linked" as part of this conservation initiative. Each of these sites has been identified as part of the Western Hemisphere Shorebird Reserve Network (WHSRN). With funding from the North American Fund for Environmental Cooperation, the "Linking Communities, Wetlands, and Migratory Birds Initiative" (Linking) was established. Since its inception Linking has worked through local partnerships in the three countries to carry out conservation activities. The primary emphases have been on shared formal and informal education, developing ecotourism partnerships and collective science and habitat conservation. As important as the projects to the success of Linking are, it is the working relationships and shared vision of the partners that powers the success of this collaboration. A broader conservation perspective has developed with new partnerships, but migratory bird conservation remains the primary emphasis. These initiatives and projects will be discussed to illustrate how outreach, education, research and conservation can be applied across political and cultural divides.



From the generation to the transference of knowledge: the experience of the CENPAT-CONICET Shorebirds Wetlands Laboratory

Bala, Luis Oscar, María de los Angeles Hernández & Luciana Raquel Musmeci

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In the shorebirds wetlands laboratory at the National Patagonian Center CONICET, Chubut, Argentina, three programs have been developed: Investigation, Education, and Conservation. For five years, we have been giving the latter major significance. The project "Importance of the coastal Patagonian wetlands as critical sites for the survival of shorebirds: Towards a strong environmental education action directed to the community and governmental and intermediate entities" has the general aim of emphasizing the value of the wetlands used by shorebirds in order to achieve their conservation and responsible management. We are working closely with the communities in key sites along the Patagonian coast associated with wetlands of importance for shorebirds, including specific courses for different types of people: park rangers, agents of conservation, tourism guides, and teachers. We also coordinate activities in schools for children of different ages and the public in general, and have made presentations to more than 3,500 people to let them know about the life histories of shorebirds. Since 1994, we have conducted investigations into Neotropical and Nearctic migrant shorebirds, generating a strong base of information to inform planning efforts and to help avoid direct or indirect impacts on the populations of shorebirds. We believe that communities should be informed about the natural resources of their regions to enable them to plan responsible management.

Strengthening capacities for shorebird conservation and mangroves in the Colombian Pacific

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In efforts to strengthen a social base that participates in the conservation of shorebirds and marine birds along the Colombian Pacific coast we have initiated and developed an education project in Sanquianga National Park, a protected area of the Colombian Pacific. Applying the program's experience in education, we trained four young community investigators who carry out research focusing on ancestral knowledge and censuses investigating avian population concentrations. Additionally, we have helped organize and execute Migratory Species Festivals which have been celebrated annually since 1999. These festivals have empowered communities within Sanquianga National Park and neighboring areas. Every one of the seven towns in which the festival takes place organizes resources, plans, and develops activities for the festivals. We have found that training and strengthening leaders also supports research development and the sustainability of our

conservation initiatives. Generally, the education projects have been directed at young school children. However, some lessons are directed towards adolescents and teachers encouraging education extending to students and the community as a whole. We have found that strengthening community involvement is a key component to achieve the conservation designation of national conservation areas and acceptance on the part of the community and local authorities. Such socially based projects have integrally linked conservation initiatives to the culture and have promoted an exchange of knowledge in the process.

From research to conservation at Río Gallegos estuary, southern Patagonia, Argentina

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Since 1998, we have been conducting studies at Río Gallegos estuary; such studies became the basis for determining the site's importance to shorebirds as well as for identifying key sites and threats to their conservation, the most pressing one being habitat loss by land claim for urban development. This situation made us aware of the urgent need to transform the results of our investigations into conservation action with the aim of minimizing the accelerated degradation of the wetland.

We developed four interrelated areas of work: investigation, training, conservation measures, and communication/environmental education, through inter-institutional joint work with municipal and provincial governmental agencies, education agencies and local, regional, and international NGOs. We conduct programs to disseminate knowledge and raise awareness, in an attempt to induce environmentally friendly practices (Training for Conservation Agents, Permanent Environmental Education activities offered by the Municipality, Birds for Children, and The Reserve Comes to the Neighbourhoods). Among the most important results are the creation of two protected areas, the designation of a WHSRN Site of International Importance and an IBA site, the design of a management plan for one of the reserves, and a restriction on reclaiming salt marshes. A strategy applied to strengthen conservation actions in the long term is the participation of university students and professionals graduated from the university in the different activities which, along with the creation of a local non-government organisation (Ambiente Sur), consolidated the programs devoted to transfer knowledge to local people. The links established through these lines of action have contributed to the immediate knowledge transfer to the environmental agency, thus producing a multiplier effect that facilitates access to the different stakeholders.



RED KNOT SYMPOSIUM

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Of the six subspecies of the Red Knot *Calidris canutus* worldwide, the two that now have the smallest populations are those of the Western Hemisphere, *rufa* and *roselaari*. As recently as 2001, the U.S. *Shorebird Conservation Plan* (Brown *et al.* 2001) estimated the *rufa* population at 170,000 and that of *roselaari* at 150,000. Undoubtedly both estimates were far too high at the time they were made; now it seems unlikely that either numbers more than about 30,000.

Intensive studies on *rufa*, which occurs mainly in the West Atlantic Flyway, started in 1997 and have covered all major-use areas from breeding grounds in the Canadian Arctic, stopover sites in Canada, the US, Brazil and Argentina, to wintering sites in Florida, Brazil and Tierra del Fuego. Studies of *roselaari*, which breeds on Wrangel Island and in Alaska and appears to be confined to the Pacific coast of America in winter, have increased over the past five years and have focused on the main known wintering site in Baja California, and stopover sites in Washington and Alaska, and have included one expedition to the breeding areas on Wrangel Island.

After such a long, sustained effort, which has resulted in many publications, it is time to take stock of what has been achieved and to formulate a coherent strategy for future studies. That is the reason for this symposium, which started with an overview of the status of both subspecies and the key role of Delaware Bay for *rufa* by Amanda Dey. This was followed by six talks on *rufa* followed by four on *roselaari*.

Brian Harrington showed that studies of fall migration of *rufa* in Massachusetts indicate that most are from the Tierra del Fuego wintering population but a rapidly increasing proportion are from northern wintering sites, such as Florida.

James Fraser reported on the spring stopover in Virginia, showing that total numbers were in the range 7,000–12,000 over 2006–2008 and that most do all of their pre-migratory fattening there rather than in Delaware Bay. Studies of foraging ecology showed that the birds fed either on sandy beaches or on peat banks and that the main prey items taken were clams, mussels, crustaceans and false angel wings.

Amy Schwarzer focused on the wintering population of south-west Florida where numbers have dropped from 7,000–10,000 in the 1990s to 500–2,000 in 2005–2009. She described a variety of research initiatives aimed at reaching an understanding of the ecology and problems of the knots that winter in Florida.

Conor McGowan described a new modeling project using the structured decision making procedure to develop prescriptions for managing Red Knot and horseshoe crab populations in Delaware Bay.

Using staple isotope analysis to determine wintering origin, Philip Atkinson showed that survival rates of knots from northern and southern wintering populations stopping over in Delaware Bay were not significantly different over 2004–2008. At 93–94%, the average survival rates shown by this study were improbably high and this is a matter for further investigation.

The final *rufa* talk was by Verónica D'Amico who had studied the impact of parasites on migration strategy. Knots wintering in tropical Brazil were heavily infected by ectoparasites but those wintering in Tierra del Fuego had relatively

few. However, birds from each population stopping over in Delaware Bay in spring had similar infection rates suggesting that southern birds become parasitized during migration. Thus there seems to be little advantage in the long flight to a parasite-free wintering site in Tierra del Fuego as it is offset by a high risk of infection during migration.

Pavel Tomkovich kicked off the *roselaari* talks with a wide-ranging account of the taxonomy of the various knot populations of Beringia. Originally *roselaari* was described on the basis of museum skins and was thought to breed on Wrangel Island and in Alaska and winter along the American Pacific coast. This connectivity had only recently been confirmed when a knot marked on Wrangel Island in the summer of 2007 was seen in Baja California later the same year. A key priority is to learn more about the identity, size and distribution of the Alaskan breeding population.

Brian McCaffery discussed trends over 30 years in the numbers and phenology of knots stopping over in Alaska in May. Apart from an anomalous very high count of about 100,000 in 1980, there was no evidence of any change in stopover numbers and there was little indication of an alteration in phenology.

In separate talks, Roberto Carmona and Nalley Arce presented the results of monthly counts of knots during 2006–2007 and 2007–2008 at Guerrero Negro, Baja California, the only known major wintering site on the American Pacific coast. Peak yearly counts were 6,458 and 5,536 respectively. Especially in the second winter period, numbers were consistent from autumn through winter to spring, suggesting little or no onward migration.

Finally, Humphrey Sitters listed some of the most important gaps in our knowledge of American knot populations, a session that developed into a wide-ranging discussion of current issues and how to take them forward.

Update on the status of the Red Knot in the Americas

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The *rufa* subspecies comprises the winter populations in Tierra del Fuego, Maranhão and the south-east U.S. and *roselaari* is largely confined to the Pacific coast. Depending on the subspecific status of knots in Alaska, *roselaari* number about 10,000 with no indications of trend. All three winter populations of *rufa* are smaller than reported in 2006 when the USFWS designated it as a candidate species for listing under the U.S. federal Endangered Species Act: Tierra del Fuego by 15%, South-west Florida by 40% and Maranhão by 48%. New analyses show that all but the earliest arriving knots in Delaware Bay in spring have suffered reduced rates of mass gain. The percentage of birds achieving 180 g in catches during 26–28 May remains low (<20%). Knot numbers in Delaware Bay have been low but stable over 2004–2008 at 12,000–15,000. Numbers of horseshoe crabs and their eggs in Delaware Bay were stable over 2005–2008



although offshore trawl surveys show some increase. 27,375 knots counted on the Atlantic Coast in May 2008 were about 7,000 more than indicated by winter surveys, suggesting a larger population than currently known. A Texas coast survey found up to 4,000 knots in fall 2008. In NE Florida and SW Georgia 1,400 knots were counted in early 2009. USFWS has recently increased the listing priority of Red Knot. There has been no moratorium on horseshoe crab harvest (except in New Jersey) despite pressure from conservation groups. Harvests are lower than in recent years, but similar to those of the early 1990s.

Current and historical use of the Massachusetts coast by Red Knots

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They (formerly) collected in immense numbers and rose in "clouds" before the hunters' guns. E.H. Forbush, 1925.

Historically the Massachusetts coast was a major stopover location for Red Knots *Calidris canutus* during their migrations. This paper reviews knots' occurrence and numbers on the Massachusetts coast over the last half century, and examines more recent observations during southward migration, the principal season of knots' occurrence in Massachusetts. The evaluation further explores knots' migration phenology and habitat-use during July–November 2007/2008 and earlier. Based on molt patterns and resightings of color bands, this work suggests that the majority of knots found in Massachusetts during autumn are from the Patagonian-wintering group, but that some, and probably a rapidly increasing fraction, are from a northern-wintering group that includes knots that visit Florida coasts during winter.

Red Knot spring stopover ecology in Virginia

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We examined Red Knot numbers, turnover, and habitat selection during the spring stopover in Virginia, in 2006–2008. Estimated stopover population, accounting for turnover, was 7,224, 8,332, and 12,167 in 2006, 2007, and 2008 respectively. Few radio tagged birds were relocated in the Delaware Bay region in the tagging year, and those only at the end of the stopover season, suggesting that most birds in Virginia by 20 May did most of their premigratory fattening there. The most commonly available prey items in the sandy intertidal zone were coquina clams *Donax variabilis* and crustaceans. On peat banks, the most common prey items were blue mussels *Mytilus edulis*, false angel wings *Petricolaria pholadiformis* and crustaceans. Foraging sites had more clams and crustaceans than unused sites. Coquina and crustacean abundance and coquina size increased during the 2007 and 2008 stopover. Mean flock size in 2007 increased with mean clam length and decreased with distance from night use locations.

The larger clams selected by Red Knots were not depleted during the 2007 and 2008 stopovers, suggesting that prey abundance was not likely to be a population-limiting factor. Our data suggest that Virginia may be able to support an increasing Red Knot population, at least in some years, and that Virginia should be included in Red Knot recovery planning.

Florida's winter population of Red Knots: a summary of on-going work

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Since the winter of 2005–2006 researchers from Florida and New Jersey have been attempting to assess the body condition, distribution and movement patterns of wintering Red Knots in Florida. Aerial surveys and banding efforts have focused largely on the south-western portion of the state, where the bulk of Florida knots have traditionally occurred. Average body weights over four years are consistent with a relatively healthy population (127.4 g, SD = 10.4, n = 925), but the low average counts (1,455, min = 515 in 2007, max = 2,061 in 2005) suggests that this population has drastically decreased from the estimated 7,000–10,000 birds in the 1990's. Resightings have highlighted the importance of the north-eastern part of the State as a migratory stopover for both Florida and South American birds and the Panhandle as an important secondary wintering site. Current work includes: a) the use of plasma metabolites to examine the condition of birds during the wintering and migratory periods, b) coverage of a larger geographic area during aerial surveys, and c) expanded trapping efforts both temporally (November–May instead of January only) and spatially (Cedar Key and north-east Florida). The diet of wintering knots has also been documented. Preliminary results suggest that horseshoe crab eggs may constitute an important part of the pre-migratory diet for knots (e.g., Cedar Key). The conceptual framework guiding these efforts will be presented.

Using structured decision making to manage for both Red Knots and horseshoe crabs in the Delaware Bay

Conor P. McGowan¹, David R. Smith², James D. Nichols¹, Julien Martin¹, John Sweka³, James E. Lyons⁴, Lawrence J. Niles⁵, Kevin Kalasz⁶, Richard Wong⁶, Jeffery Brust⁷ & Michelle Davis⁸

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Structured Decision Making (SDM) is a formal and transparent approach to decision making that incorporates all stakeholders and utilizes predictive modeling to assess the potential consequences of alternative actions. Used as a part of SDM, optimization modeling, specifically stochastic dynamic programming, enables managers to maximize gain or minimize risk in the face of uncertainty about the managed system. We are applying these decision-making and modeling tools to the Delaware Bay system where it is believed past over-harvest of breeding horseshoe crabs has negatively affected the migrating shorebirds using the Delaware Bay as a stopover site during their epic northward migration. We are developing models that link Red Knot population dynamics to horseshoe crabs in the Delaware Bay through weight gain and differential survival and/or reproductive success for heavyweight versus lightweight birds. We are using modified versions of published population models for both species that rely on empirical data for parameterization. Initial simulations indicate that Red Knot population viability may be linked to horseshoe crab dynamics and crab harvest rates. The magnitude of the effect depends on many factors including the strength and shape of the Red Knot weight gain function, the difference in survival between fat and skinny birds, and the size of the permitted Horseshoe crab harvests. This is continuing work that will proceed over the next 6–12 months leading to recommendations about crab harvests that are optimal with respect to objectives that include both the red knot population and crab fishery interests.

Estimating survival of mixed populations of Red Knot at a major staging area using stable isotopes and individually marked birds

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The rufa population of Red Knot has experienced a rapid and sustained decline in numbers. An understanding the survival and recruitment is essential to the conservation of this subspecies. However, with wintering areas ranging from the south-eastern part of the USA to the tip of Tierra del Fuego, it is difficult to determine whether there have been similar changes in demographic parameters across the populations or whether survival and recruitment varies between wintering populations. Rather than use data from individual wintering areas we used birds caught in Delaware Bay, their main spring staging area. Using stable isotopes in flight feathers, we classified individuals into different wintering areas and

used resightings of flagged individuals in subsequent years to estimate survival and rates into the adult population.

Role of parasite pressure in the migratory strategies of Red Knots *Calidris canutus rufa* wintering populations in South America

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We test whether migratory strategies in Red Knots *Calidris canutus rufa* are a response to spatial variation in parasite pressure at different sites: Río Grande (RG), Tierra del Fuego, Maranhão (MA), Brazil, and Delaware Bay (DB), USA along the same migratory cycle. A “parasite” hypothesis predicts that birds should evolve migrations to low-parasite marine wintering sites to reduce the fitness consequences of high parasite load in tropical MA, but there is likely to be a tradeoff with increased mortality for long-distance migration to cold-temperate RG. Ectoparasites were scored visually and blood parasites were searched for with molecular assays and observations of smears. Birds refueling in DB were assigned to either northern (MA) or southern wintering sites (RG) using stable isotopes in feathers. All ectoparasites found were feather lice Mallophaga. In RG 4.4 % of birds had ectoparasites whereas all birds in MA were parasitized. In DB the proportion of parasitized birds from northern and southern sites was not significantly different, indicating that many southern birds had been infected during a short stop-over on the northward migration or by direct contact in DB. Blood parasite assays were negative, consistent with the low incidence of vectors in marine shores. Observations in each wintering site support the “parasite hypothesis” in Red Knots. However, studies in birds at DB have to be extended since results could suggest that southern populations would have detrimental effects of longer migration and ectoparasites, whereas northern populations only would suffer the negative effects of the ectoparasites.

Subspecies and connectivity of Beringia Red Knots

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Knowledge of a species' population structure, migration routes and connectivity between specific breeding and non-breeding grounds are some of the key characteristics necessary for the development of effective population-based conservation strategies. Considerable progress has been achieved on these issues in relation to Beringia Red Knot populations over recent decades. Breeding ranges have been established for the different populations. Two new subspecies (*Calidris canutus roselaari*, which breeds on Wrangel Island and Alaska, and *C. c. piersmai*, which breeds on the New Siberian Islands) have been described (based on external morphology) along with suggestions as to which flyways they belong. Recently several band recoveries and sight-records of color-marked birds have fully confirmed the former speculations



based on morphology. Red Knots of the subspecies *piersmai* and *rogersi* follow the East Asian-Australasian Flyway, while *roselaari* birds migrate along the Pacific coast of America. A breeding density survey of *roselaari* Red Knots on Wrangel Island in 2007 indicated that there had probably been a major population decline. Population trends in the other Beringia subspecies, *rogersi* and *piersmae*, are not known, though reports of numbers in the Australasian wintering areas indicate that neither population is threatened. Key priorities are to establish population monitoring programs for each subspecies and to learn more about the identity, size and distribution of the Alaskan breeding population.

The status of Red Knots during spring migration on the central Yukon-Kuskokwim Delta

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We have summarized 74 site-years of Red Knot spring migration data from the central Yukon-Kuskokwim Delta. From 1978 through 2008, we worked at the Tutakoke River mouth on the Bering Sea coast, as well as at Old Chevak and Kanaryaraq, 20 and 25 km, respectively, from the coast. Knots occurred annually on the central YKD, being found along ≥ 100 km of shoreline adjacent to nearly 200 km² of intertidal mudflats. Including inland habitats, migrant knots on the central Delta may occupy an area exceeding 600 km². The mean and median arrival dates were 14 and 13 May, respectively (range 3–30 May). Mean first arrival dates did not vary among sites. The mean and median dates of annual peak counts were 19 and 20 May, respectively, and the last north-bound knots departed from the Delta during the first week of June. Over the three decades, we detected no temporal trends in first arrival dates or the timing of peak counts, either overall or at individual sites. Annual peak daily counts at Tutakoke, Old Chevak, and Kanaryaraq averaged 1744, 1362, and 18, respectively. In fact, with the exception of 19–23 May 1980, when up to 100,000 knots were detected at Tutakoke, peak daily counts never exceeded 6,000 birds at any site in any year. Although the source of the extraordinary total in 1980 remains a mystery, there is no compelling evidence for a long-term decline in the number of knots regularly using the central Yukon-Kuskokwim Delta during spring migration.

Seasonal abundance of Red Knots in the Guerrero Negro–Ojo De Liebre coastal lagoon complex, Baja California Sur, Mexico

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To determine the spatial and temporal distribution of the Red Knot *Calidris canutus roselaari* in the Guerrero Negro–Ojo de Liebre coastal lagoon complex, including the Guerrero Negro Saltworks, we carried out a monthly census from July 2006 to June 2007. The aggregate total of the 12 monthly counts was 32,059, and the maximum count of 6,458 was

made in September 2006. Red Knots arrived in July (400 birds) and August (4,600) and their numbers were high until October (5,800), decreased in November (2,600), and increased again in December (to 4,600), but then declined constantly until March (126); in April there was a notable increase (4,600). 77% of all knots counted occurred in 11 of the 45 zones into which we divided the study area. We classified the 11 zones into four sections according to their seasonal use by the knots: Los Medanitos was important in autumn, Estero Norte in spring; Guerrero Negro was consistent and with regular abundance throughout the year, and Salitrales showed large fluctuations. We conclude that the abundance of knots in these four sections can be used to estimate the total number in the entire lagoon/saltworks complex ($R^2 = 0.94$). We propose that at least 4,000 Red Knots winter in the region.

Guerrero Negro, stopover site or wintering area for Red Knots *Calidris canutus roselaari*?

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We determined the abundance of Red Knots *Calidris canutus roselaari* in the Guerrero Negro and Ojo de Liebre lagoons (natural area) and in Exportadora de Sal (artificial area), Baja California Peninsula, from July 2007 to June 2008. We recorded a total of 38,470 observations (maximum = 5,536 birds in November). The birds arrived from July (320 individuals) to September (5,200). We observed similar abundances between late autumn (mean 5,280 birds) and winter (4,300), and a decrease until the end of April (2,500). We captured 239 birds (213 adults and 26 juveniles). Inside the complex the birds exhibit strong site fidelity: 100% of the birds marked in the natural area and 80% in the artificial zone were seen in their original sites. The age ratio (9:1 in favor of the adults) suggests three hypotheses: (1) low reproductive success, (2) the juveniles migrate through other regions, and (3) the juveniles are in other sites of the region that we have not yet discovered. The weights were low when the birds arrived in autumn (mean 128 g) and increased slightly by winter (133 g). Additionally, between September and October 98% of the adults were molting or had already completed the molt of the primary feathers. The observed trends in abundance and weight, and the stage of molt suggest that most of the Red Knots were wintering in the region. In addition, one of our birds was observed in California, ten in Washington, and three in Alaska, thus confirming the migratory route.

Red Knots in the Americas: the unknowns that remain and where do we go from here?

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Despite twelve years of intensive studies throughout the West Atlantic Flyway and four years of studies in the East Pacific Flyway, many gaps remain in our knowledge of American Red Knot populations. We will identify those that we consider to be the most important to our understanding of population processes and the needs of conservation. Among these are:



- Uncertainty concerning the relative subspecific and population status of the knots that winter in the SE US, Brazil and Tierra del Fuego,
- Inconsistency between larger counts during northward migration on the U.S. east coast and smaller known wintering populations,
- The need for greater certainty as to the size of the horseshoe crab population needed to sustain the May stopover in Delaware Bay,
- The implications of what appears to be a poor quality food supply in Tierra del Fuego,
- The need to define more fully and accurately the breeding and wintering ranges of both subspecies,
- The need to extend the monitoring of demographic rates to include survival and reproduction of each wintering population,
- The need to more fully understand the migratory strategy of the *roselaari* population, especially whether any part of it migrates further south of Baja California,
- The need to determine the reasons why the *roselaari* population appears to have undergone a major decline,
- The long term discrepancy between greater numbers of *roselaari* in Alaska in May than can be accounted for further south along the Pacific coast on passage and in winter.

We will suggest ways in which these questions might be addressed. We will also propose practical arrangements for facilitating better communication between fieldworkers including the formation of an American Red Knot Study Group and the setting up and maintenance of communal datasets of banding and resighting data.

GENERAL PAPERS

ARCTIC BREEDING SHOREBIRDS

Shorebird distribution and abundance at coastal staging sites in the Arctic National Wildlife Refuge

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Before southbound migration, several species of shorebirds aggregate in coastal habitats of the Arctic National Wildlife Refuge (Arctic Refuge). Coastal areas are vulnerable to potential effects of oil development and altered sea conditions associated with climate change. Staging in these habitats is believed to be critical for building energy reserves necessary for migration, but the relative importance of staging sites along the Arctic Refuge coast and mechanisms determining habitat quality are largely unknown. Our objectives were to 1) assess the abundance, distribution, timing, species composition, and habitat use of shorebirds staging on coastal areas; and 2) determine how environmental conditions such as food availability, wind, weather, and water levels affect use of coastal habitats by post-breeding shorebirds. We surveyed every major river delta on the Arctic Refuge coastline for staging shorebirds in Jul and Aug of 2006–2008 using distance sampling along transects in mudflat habitats. Shorebird abundance differed significantly across years and sites: in 2006 the highest densities were at the Sadlerochit and Katakaturuk deltas, in 2007 at the Kongakut and Jago deltas, and in 2008 at the Canning, Hulahula/Okpilak and Jago river deltas. We also established field camps at several deltas for assessments of abundance, phenology, habitat use, and movements. Most shorebirds remained at a single staging area for <5 days. Timing of use varied by species: Semipalmated Sandpipers

and Red-necked Phalaropes were most abundant in late July and early August, followed by Dunlin and Pectoral Sandpipers later in August.

Predator abundance and incubation behaviour explain interannual and interspecific patterns of nest success for arctic breeding shorebirds

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We studied breeding shorebirds at two sites in the eastern Canadian arctic and related the interannual patterns in nest survival to factors such as weather and predator abundance. Interspecific variation in nest survival was also large, and we tested the hypothesis that risk of predation is lower for biparental incubators than for those that incubate alone and leave the nest unattended during frequent recesses. From 2000–2007, we monitored 899 nests of 12 species, and used program MARK to assess patterns in daily nest survival. Most of the interspecific variation was explained by grouping species by incubation strategy, with uniparental species showing consistently lower nest survival. Over eight years of study at East Bay, the average survival of nests from lay to hatch was 10% for uniparental species as compared to 42% for biparental species. Strong temporal patterns suggest that nest survival is highest early and late in the breeding season and depressed mid-season. Among years, variation in the encounter rate of predators was an extremely strong predictor of nest survival. Models received little support if they contained effects of weather or abundance of lemmings, which are assumed to be a primary prey for tundra predators. Changes in fox abundance explained variation in nest survival of biparental species whereas changes in abundance of jaegers explained variation in nest survival of uniparental species. Our results demonstrate that increases in predator abundance indeed



account for interannual variation in shorebird nest survival, but that the relationship may be influenced by the behaviour of both the predators and the shorebirds.

**Arcticola Dunlin *Calidris alpina arctica*
re-nesting response to experimental clutch removal
on Alaska's north slope**

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In 2007 and 2008, we conducted a study to evaluate how arctic-breeding Dunlin respond to experimental clutch removal. We measured re-nesting propensity, mate fidelity, territorial fidelity, and the interval between clutch removal and the laying of a replacement-clutch. We captured, color-marked, and radio-equipped adult Dunlin pairs and removed their clutches during early incubation (2007 and 2008) and late incubation (2008 only). Most Dunlin (85–91%) laid replacement clutches after clutches were removed during early incubation (mean = 5.9 days (d) into incubation, range 3–10 d, n = 42). Only 35% replaced clutches that were removed later (mean = 13.0 d into incubation, range 12–16 d, n = 19). Mate fidelity between initial and replacement clutches was high with only one pair per year divorcing. In both cases, males remained on their territory and females moved large distances to re-nest with a new mate. The average time between collection of the first clutch and initiation of the replacement clutch was 5.7 days and 6.5 days for early and late treatments, respectively. Our study revealed an unexpectedly high rate of clutch replacement, suggesting that a female's propensity to lay a replacement clutch is not likely to be constrained physiologically, but may be strongly related to timing of nest loss. Studies focusing on arctic shorebird breeding ecology would benefit from investigating frequency and proportion of replacement clutches in different mating systems as the presence of such nests leads to an over-estimate of nest density and potentially to an under-estimate of productivity.

**Factors affecting brood survival from initial
and replacement clutches of Dunlin *Calidris alpina*
near Barrow, Alaska, USA**

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Chick survival is an important demographic component that is generally unavailable but desperately needed to develop population models and thereby project population trends. In this study, we determined survival rates of Dunlin chicks near Barrow, Alaska, by following individual broods wherein the adult male and two chicks were equipped with radio transmitters. We investigated survival of chicks from initial nests as

well as chicks from replacement nests that had been re-laid after a pair's first nest was experimentally removed. Nests were experimentally removed during early (3–8 days) and late (12–16 days) incubation, and adults were followed to find their replacement nests. Arctic fox were also experimentally removed from the study area, allowing us the unique opportunity to evaluate the relative importance of other predators and environmental conditions on arctic chick survival. In total, we monitored 39 broods, including 20 from initial nests, and 13 and 6 from early and late replacement nests, respectively. In addition, we monitored other variables, including weather, weight at hatch, and insect, lemming, and predator abundances. Across all treatment groups, 26% of broods had at least one chick survive to fledge. Forty-five percent of the initial broods appear to have fledged at least one young, followed by 8% of the early replacement broods and 0% of late replacement broods. Causes of chick mortality included poor environmental conditions, and avian and mammalian predators. We plan to continue this study for at least one more season to further investigate how the various factors interact to affect chick survival.

**Shorebird incubation behaviour and
its influence on the risk of nest predation**

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Both nest survival and incubation behaviour are highly variable among shorebirds, and we tested whether more conspicuous incubation behaviour increased the risk of nest predation. From 2000–2006, we monitored 901 shorebird nests at three study sites across the circumpolar arctic. Using miniature video recorders and nest temperature sensors, we obtained 782 days of behavioural data for 161 nests of 11 species. We related nest fate to the rate and duration of nest absences or restless movements on the nest, as well as the total proportion of each day engaged in these activities. We found that nest predation was positively related to the proportion of time each species left the nest unattended. After controlling for species effects, the likelihood of a successful nesting attempt was lower for individuals that spent more time off the nest, but among failed nests, the number of days that a nest survived prior to depredation was not significantly predicted by our measures of incubation behaviour. To control for weather or seasonal effects, we paired observations from nests that were ultimately depredated with observations from successful nests of the same species on the same day. In this paired sample, both incubation recesses and restless movements were more numerous among failed versus successful nests. Our results suggest that more conspicuous incubation behaviour is indeed related to a higher risk of nest predation, and that this relationship may underlie patterns of nest survival within and among shorebird species.



SHOREBIRD MONITORING

The Program For Regional and International Shorebird Monitoring (PRISM) – an update

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The objectives of the Program for Regional and International Shorebird Monitoring (PRISM) are to (1) estimate the size of breeding populations of shorebirds, (2) describe shorebird distribution, abundance, and habitat relationships, (3) monitor trends in shorebird population size, and (4) monitor numbers at stopover and non-breeding locations. PRISM objectives contribute to our assessment of birds in general and are being incorporated into efforts in Canada and the U.S. to identify how well birds are monitored in each country. At its inception in 2000, PRISM primarily focused on shorebirds in North America, but is committed to extending cooperation towards shorebird monitoring across the Western Hemisphere. Over the past several years, substantial progress has been made across the broad spectrum of arctic and boreal breeding surveys, temperate breeding surveys, temperate non-breeding surveys, and neotropical surveys. The most comprehensive programs include migration monitoring, including the International Shorebird Survey and Maritime Shorebird Survey, and a broad-scale arctic monitoring effort. Single species efforts for temperate breeders include American Oystercatcher, Long-billed Curlew, and Snowy Plover. We also present a compilation of nearly 100 projects conducted since 2000 that inform shorebird monitoring, and we highlight some of the recent success stories.

National shorebird counts in El Salvador from February and April 2007 and 2008

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Shorebird counts (family Charadriidae and Scolopacidae) in coastal and continental wetlands were carried out in El Salvador. The methodology was direct observation, from left to right with an emphasis in areas of higher concentrations. We organized working groups by departments and we covered the most important wetlands in order to register the highest numbers of shorebird species. Data were analyzed by recorded species and species richness at each site. In February, comparing both years, there were some species with fewer numbers (Semipalmated Plover *Charadrius semipalmatus* 47%, Short-billed Dowitcher *Limnodromus griseus* 54%, and Spotted Sandpiper *Actitis macularia* 11%) and others with increases (Sanderling *Calidris alba* 68%, Stilt Sandpiper *C. himantopus* 99% and Least Sandpiper *C. minutilla* 79%). In April, species with smaller numbers were Sanderling (29%) and Marbled Godwit *Limosa fedoa* (89%), while the species with increases were Least Sandpiper (90%), Lesser Yellowlegs *Tringa flavipes* (97%) and Stilt Sandpiper (81%). In both years in February, Bahía de Jiquilisco reported higher numbers (1,161 and 1,146) and in April the Cerro Grande site had higher numbers (1,023 and 3,553). Through this informa-

tion we have been able to document the most important site for these birds and the occurrence of rare or less documented species such as Long-billed Curlew *Numenius americanus*, Surf-bird *Aphriza virgata*, Wilson's Phalarope *Phalaropus tricolor*, Wilson's Snipe *Gallinago delicata*, Red Knot *C. canutus* and Wandering Tattler *Tringa incana*. We recommend continuing the monitoring efforts for three or more years to generate information to protect and conserve shorebirds in El Salvador.

Estimating Whimbrel and Hudsonian Godwit populations on Chiloé Island, Chile

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A large proportion of the Hudsonian Godwits *Limosa haemastica* spending the boreal winter along the eastern Pacific coast are known to occur in the vicinity of Chiloé Island, Chile, but the importance of the region to Whimbrels *Numenius phaeopus* is less well known. Ground counts conducted in 2007 and 2008 increased published estimates for eastern Pacific coast populations by 27% for Whimbrels (33,150 individuals) and 51% for godwits (21,160). Bays and shorelines in the Chiloé Island region supported 99% of Hudsonian Godwits and 65% of Whimbrels estimated to occur along the eastern Pacific coast during the boreal winter. Whereas godwits aggregated in shallow bays on the northern and eastern sides of Chiloé Island, Whimbrels were more dispersed along the island's shorelines, reaching a density of 7.5 birds/km along sheltered gravel shorelines. Bays in the vicinity of Chiloé's capital, Castro, provided important foraging and roosting habitat for non-breeding birds; these sites supported 52% and 12% of eastern Pacific coast populations of Hudsonian Godwits and Whimbrels, respectively. Low human disturbance in Pullao and Putemún bays make these sites particularly attractive to non-breeding godwits and their permanent protection is urged.

A method for estimating survival of unmarked pre-fledged shorebird chicks

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Estimating reproductive success for shorebirds can be difficult because the precocial chicks leave nests soon after hatching and individuals or broods can be difficult to track. Instead, researchers estimate survival during the pre-fledging period and, though effective, mark-recapture based ap-



proaches are not always feasible due to cost, time and animal welfare concerns. We present a new method for estimating survival of precocial chicks during the pre-fledging period using a modified catch curve approach that does not require individual field marks. The approach has several ecological and statistical assumptions and our analyses were designed to minimize the probability of violating the assumptions. We applied the method using data from the U.S. Army Corps of Engineers Piping Plover monitoring efforts in which field crews conducted weekly counts and ageing of chicks. Annual daily survival estimates ranged from 0.825 (SD = 0.03) to 0.931 (0.02) depending on year and sampling period. The probability of survival to fledging ranged from 0.126 to 0.188. Our results are similar to other published estimates for this species in similar habitats. We further evaluated the approach using simulated data created in program R. In the simulations we intentionally violated some assumptions of the method (such as non independence of individuals) to see if resulting estimates were still accurate. This method of estimating chick survival may be useful for reproductive success research in a variety of shorebird species when mark recapture is not feasible and only count-based age class data are available.

Shorebirds of dispersed wetland landscapes: research and conservation challenges

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Many shorebird species that traverse the interior prairie states and provinces of North America refuel at broadly dispersed inland stopover sites, including “geographically isolated” wetlands and agricultural fields. Interior breeding shorebirds are also widely distributed across grassland and tundra landscapes. Many of these important interior habitats have been replaced by human-dominated land uses or are now threatened by agricultural practices and climate change. Population estimation of several breeding and migrant shorebirds has been approached using randomly selected survey sites within predetermined landscape strata and extrapolation of the counts to the strata. In these studies, the resulting population estimates of many species exceeded prior estimates. To address the importance of the extensive landscapes of dispersed wetlands, The Western Hemisphere Shorebird Reserve Network recently created a new designation of “Landscape of Hemispheric Importance” for landscapes that host more

than 500,000 shorebirds annually or more than 30% of the biogeographic population of a shorebird species. The Rainwater Basin of Nebraska, USA, has been nominated to be the first such designated landscape based on its importance to migrating Buff-breasted Sandpipers. Within the Rainwater Basin in spring, northbound Buff-breasted Sandpipers primarily occupy agricultural fields, which constitute >85% of all land area in the region. Over many areas, agriculture forms a continuous mosaic of human-dominated habitats that are used by the Buff-breasted Sandpiper. Research and conservation of dispersed shorebird populations can be highly challenging and require nontraditional techniques.

Whimbrel *Numenius phaeopus* breeding habitat in the Mackenzie Delta, North-west Territories, Canada

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In an effort to establish baseline information on Whimbrel and other shorebirds breeding in the Mackenzie Delta, North-west Territories, we have been conducting aerial and ground surveys since 2005. Through these surveys, we have established that Whimbrel breed in low densities but are widely scattered throughout the region. In 2007 and 2008, we evaluated the suitability of using helicopter surveys to census Whimbrel. While the large size and identifiable characteristics of Whimbrel make them ideal candidates for aerial identification, we were only able to detect 23% of Whimbrel using this method. Intensive ground surveys were done in two distinctly different habitats in the Delta: wet-sedge low-centred polygons (LCP) and rolling upland tundra with scattered wetland patches. From 2006 to 2007 we located, monitored and described the habitat for 28 Whimbrel nests (average 3.0 pairs/km²) in wet-sedge LCP habitat. Nest success was significantly higher for nests placed on raised mounds (69%) than those placed on ridges (19%) within the LCP. Successful nests had more vegetation, comprised mainly of graminoids and were further away from the nearest low shrub than failed nests. Surveys of an upland study site in 2008 found 13 Whimbrel nests (0.31 pairs/km²). Nests here had significantly more dwarf shrubs and more moss and lichen directly at the nest. There was also significantly less graminoid vegetation, and more shrubs in the area surrounding the upland nests in comparison with the LCP nests.



NON-BREEDING

The potential link between migratory connectivity and the conservation status of Canadian shorebirds

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Migratory connectivity defines the geographic linking of individuals or populations between different stages of the annual cycle, including between breeding, migration, and winter stages. Under strong connectivity (e.g. the majority of individuals in a breeding population winter in a small number of wintering sites), gene flow among subpopulations may be limited thereby increasing opportunities for local-adaptation and speciation among specific subpopulations. Specializations of this kind are likely to play an important role in the conservation status of a given species. Current studies for passerines generally support this notion. Unfortunately, similar support for shorebird species is lacking. Consequently, using shorebird conservation status data compiled by the WHSRN, we investigated whether the conservation status of 48 shorebird species known to breed throughout the Canadian Arctic was related to their relative strength of migratory connectivity. Results indicated a weak association between conservation status and migratory connectivity strength ($\chi^2 = 2.98$, $df = 1$, $P = 0.084$). Given the potential role of strong connectivity in shaping sub-species populations, we further investigated whether species containing sub-species showed a greater association between migratory connectivity and conservation status than those species without sub-species. Our data indicated that the strength of migratory connectivity of the sub-species ($\chi^2 = 1.92$, $df = 1$, $P = 0.166$) or species ($\chi^2 = 1.19$, $df = 1$, $P = 0.275$) investigated did not play a role in their conservation status. In order to fully resolve the potential link between migratory connectivity and the conservation status of shorebird species, more detailed connectivity data must be collected.

Estimating the demographic costs of migration in the Upland Sandpiper

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Conservation of migratory shorebirds would be aided by a better understanding of the seasonal components of demography in their annual cycle. Understanding seasonal components of demography is important for identifying the limiting factors and regulatory mechanisms that determine the population dynamics and the critical stages for effective conservation. We report demographic results for migratory Upland Sandpipers *Bartramia longicauda* from an 8-year breeding study in Kansas and a 1-year non-breeding study in northern Uruguay. Fecundity rates are low because clutch size is four eggs, nesting success is low, and re-nesting was infrequent. We used mark-recapture models that controlled for probability of detection and inclusion of transients and found that annual rates of apparent survival were moderate. Monitoring of radio-marked birds showed that seasonal survival was high during breeding and non-breeding stages

of the life cycle. Thus, most of the annual mortality apparently occurs during migration. Population models based on life-stage simulation analyses indicated that seasonal survival rates may have the greatest effect on population growth rates. In summary, models of seasonal demography can identify gaps in current knowledge and suggest useful avenues for future research.

Seasonal movement, residency, and migratory patterns of Wilson's Snipe *Gallinago delicata* across multiple phases of the annual cycle in Oregon

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Most cross-seasonal studies of avian movement either establish links between geographically distinct wintering, breeding, and migratory stopover locations, or assess site-fidelity and movement within distinct phases of the annual cycle. Far fewer studies investigate individual movement patterns within and among seasons over an annual cycle. Within western Oregon's Willamette Valley throughout 2007, we quantified intra- and inter-seasonal movement patterns, fidelity (regional/local), and migratory patterns of 37 radio-marked Wilson's Snipe *Gallinago delicata* to elucidate residency in a region of breeding- and wintering-range overlap. Telemetry revealed complex regional population structure, including winter residents (74%), winter transients (14%), summer residents (9%), and one year-round resident breeder (3%). Results indicated a lack of connectivity between winter and summer-capture populations, some evidence of partial migration, and between-season snipe fidelity to the region (winter-resident return; subsequent fall). Males departed an average of 9.7 days earlier than females in spring, whereas females departed before males in fall. Protracted spring migration indicated a gradual dispersal consistent with energy minimization migration strategies. Movements differed significantly by season and residency; individuals exhibited contracted movements during late winter and more expansive movements during precipitation-limited periods (late spring, summer, fall). Mean home-range size was 3.52 ± 0.93 km² (100% MCP) and 1.57 ± 0.42 km² (95% fixed kernel) and did not vary by sex; however, home-range varied markedly by season (range 100% MCP = 1.04 – 7.56 km²). Results highlight the need to consider seasonal and inter-specific differences in shorebird life histories and space-use requirements when developing wetland conservation plans.

Tidal effects on use of a natural and an artificial site by shorebirds on Guerrero Negro, B.C.S., Mexico

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Saltworks owned by the Compañía Exportadora de Sal (ESSA) are important shorebird habitat near the Ojo de Liebre lagoon, Baja California, Mexico. To determine the relation between the tide levels and use of the habitat by the



shorebirds in the two zones, we made 10 monthly censuses during autumn, winter, and spring (Aug 2005 to Mar 2006) in two representative sites during different tide levels. The most abundant species in both sites were Western Sandpiper, Marbled Godwit, dowitcher spp., and Dunlin. With respect to total abundances we observed a phase angle in the use of both sites, probably due to the hydrological conditions or the biomass of the benthos. The relationship between shorebird abundance and tide level was positive in the artificial site (ESSA) and negative in the lagoon (Ojo de Liebre). Furthermore, this relationship was particularly strong in the lagoon, and was due to the immediate effect of the tide. In both sites, we observed a more robust relationship during migratory periods. In the artificial site the tide level influenced numbers of Western Sandpipers and Dunlins in autumn and spring; Marbled Godwit abundance was affected in all three seasons, and tide had no effect on dowitcher abundance. For the natural site, only the Western Sandpiper showed an effect in all three seasons; tide influenced abundance of the three other species only in winter and spring. ESSA is an important alternative site for feeding and resting for the shorebirds when the natural area is not available.

Temporal abundance of shorebirds on the Guerrero Negro–Ojo de Liebre–Exportadora de Sal Coastal Lagoon Complex, Baja California Peninsula, Mexico

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We made 12 monthly censuses (Jul 2006 to Jun 2007) to determine temporal variation in abundance of shorebirds in the Guerrero Negro and Ojo de Liebre lagoons and in the Exportadora de Sal area, Baja California, Mexico. Total numbers varied from 17,642 (Jun) to 370,463 (Dec). The most important area of shorebird use was Ojo de Liebre (250,000 birds), followed by Guerrero Negro and Exportadora de Sal (95,000 and 83,000, respectively). The most abundant species were Western Sandpipers (41% of all records), Marbled Godwits (27%), and dowitchers (11%). At times throughout the year, the complex contains more than 1% of the populations of 10 species, including Marbled Godwit (49%) and Red Knot (32%). With respect to the temporal trends of these 10 species, three groups emerged. The first group (Marbled Godwit, Willet, Snowy Plover, and Long-billed Curlew) was most abundant in autumn and winter, with declining numbers in spring and summer, although in summer abundances approached 10%. In the second group (dowitcher and Black-bellied Plover) abundances were medium in autumn, reached their maxima in winter, diminished in spring, and were very low in summer. Species in the third group (Red Knot and Western Sandpiper) had high abundance in autumn, winter, and spring and were absent in summer. The two remaining species did not fall into any of these groups. Red-necked Phalaropes were abundant only in autumn. Dunlins were present in low numbers in autumn and higher numbers in winter and spring, but were absent in summer.

Patterns of migratory and winter use of the Guerrero Negro lagoon complex, B.C.S., Mexico, by Short-billed Dowitchers

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The Baja California Peninsula is used by two species of dowitcher, Short-billed *Limnodromus griseus caurinus* and Long-billed *L. scolopaceus*. It is probable that the Guerrero Negro area is used primarily by the Short-billed Dowitcher because: (1) fresh-water habitats do not exist, (2) all the birds that we have captured (530 from Oct 2006 to Nov 2008) have been Short-billed, and (3) the range of culmen lengths did not include the range for Long-billed females. To determine temporal patterns of abundance we made 12 monthly censuses (Jul 2006 to Jun 2007). At least 51,700 individuals used the lagoon complex (68% of the total of the subspecies). The birds arrived in July (11,900 individuals), and abundances increased to their maximum in Dec (51,700), diminished in Jan (27,460), and began increasing again in Feb (43,100), when they began to decline to their minimum in Jun (600). We identified seven sites used most heavily. The monthly average of culmen length increased from Aug to Oct, then dropped and stayed low and constant from Nov to Jan, which suggests that the proportion of females was greater in autumn. From Aug to Oct, body weights were high, indicating migratory movements; weights were low during the winter (Nov–Jan) and then increased in Feb. These results reflect different migratory waves. We conclude that the lagoon complex is particularly important for migrating females and wintering males.

Temporal and spatial distribution of shorebirds at Laguna San Ignacio, Baja California Sur, Mexico

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We studied spatial and temporal changes in the abundance and distribution of shorebirds at San Ignacio Lagoon. We made 12 monthly censuses (Oct 2007 to Sep 2008) of the entire internal perimeter of the lagoon, which we divided into 14 sub-areas. Shorebird abundance was lowest in May (1,585 birds) and greatest in Oct (47,410). The most abundant species were Marbled Godwits (55% of the aggregate total), Western Sandpipers (24%), Willet (11%), and dowitchers (4%). Numbers of Marbled Godwit were greatest in autumn, becoming stabilized in winter and spring and diminishing in summer. Western Sandpiper abundance was high in autumn with a maximum in early winter (December); abundance diminished through the rest of the winter, and the species was absent in summer. Willets showed few changes, with maxima in autumn and winter and minima in May and June. Dowitchers exhibited greatest abundances in autumn, with low and fluctuating numbers the rest of year. We observed



that 80% of the sightings were concentrated in six of the 14 sub-areas in the southern portion of the lagoon. We conclude that these six areas should be the focus of a monitoring plan for shorebirds at Laguna San Ignacio.

Migration and wintering of Marbled Godwit in Guerrero Negro, B.C.S., Mexico

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The Baja California peninsula is the most important wintering region for Marbled Godwits, and our censuses of the lagoon complex of Ojo de Liebre–Guerrero Negro–Exportadora de Sal confirm that this is one of the most important sites for this species. To determine temporal patterns of abundance we made 12 monthly censuses (Jul 2006 to Jun 2007) during which we recorded a total of 563,250 observations. The highest abundance, in Dec (84,524 individuals), represented 50% of the total population estimate. Abundance of godwits was as high in autumn as in winter and declined considerably by spring and summer, although in summer the numbers we observed were still notable (11% of the population estimate). Culmen length for 465 birds we captured (Aug 2007 to Apr 2008) was informative about use of the site by godwits. Culmen length for all data showed a bimodal distribution (94 and 114 mm), which reflects the sexual dimorphism, and apparently the sex-ratio was 2:1 in favor of males. This same bimodal distribution of culmen length and sex-ratio persisted across the seasons suggesting some degree of geographic segregation of the sexes. Finally, when we analyzed body weight by season and observed high variation disguising possible differences, caused by the size of the bird, which is why the weight was standardized with the culmen length. When the data were analyzed with the standardized weight, they showed the classic pattern, with medium values in autumn, lighter weights in winter, and heavier weights in spring prior to departure. Thus, Guerrero Negro is the most important wintering area for this species.

Abundance and phenology of charadriidae and scolopaciidae in the coastal wetlands of northern Yucatan Peninsula

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During 2004–2006, we conducted aerial surveys to locate shorebird concentrations and count birds to investigate to what extent the coastal wetlands of the north-western Yucatan Peninsula are used by resident and migratory shorebirds during the non-breeding season. A total of 27 species of shorebirds were identified using the area. The five most abundant were: Western Sandpiper *Calidris mauri* (32.3%), dowitchers *Limnodromus* spp. (16.1%), Least Sandpiper *C. minutilla* (16.1%), Sanderling *C. alba* (7.8%), and yellowlegs *Tringa* spp. (6.6%); these made up 79% of identified shorebirds. Using only peak counts for each species there were 37,911 shorebirds in winter 2004 and 26,818 in autumn 2006. Similarly, a total of 48,153 and 51,058 shorebirds were recorded in 2004–2005 and 2005–2006. Based on abundance the three

more important sites are La Carbonera, Ciénaga de Progreso, and Las Coloradas. The general phenology pattern shows a greater abundance during southbound migration, less during winter and even less during northbound migration; however when individual species abundances are analyzed, five different patterns are recognized. The region qualifies as a site of regional importance within the WHSRN. We anticipate that, as distribution and variability of food resources are understood and information on length of stay of the most abundant species allow us to re-compute total figures, the importance of the region in the life cycles of shorebirds will be better understood.

Distribution, abundance and habitat use of Buff-breasted Sandpiper *Tryngites subruficollis* in Estancia La Rinconada, Rocha Lagoon, Uruguay, as a basis for habitat management of the species

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Buff-breasted Sandpiper is a Nearctic–Neotropical migratory shorebird that has its main non-breeding concentrations in Argentina, Brazil, and Uruguay. The habitat of the species in the wintering areas is short grasslands (<10 cm) associated with grazing. The objective of this study was to evaluate the habitat use of the species in a cattle ranch (Rocha, Uruguay) in relation to land uses and cattle management. Monthly monitoring was carried out at a paddock scale using a transect method during two seasons. The main habitat types on the farm are natural grasslands, improved natural grasslands and, to a lesser degree, artificial prairies. Cattle numbers per paddock were related to habitat availability. Based on the use by the species, an importance value was assigned to each paddock using a relative importance index. Using the average density for the Estancia, we estimated the population size for the farm and for the whole lagoon. Main results indicate that the species is highly associated with natural grassland paddocks, especially those close to the lagoon. The paddocks with higher concentrations had an average cattle pressure of 0.70 Cattle Units/ha. There was an important association between the species distribution and the distribution of a soil type. This was used to extrapolate the estimated density and assess the population size, which was 842 individuals for the farm and 3,733 individuals for the whole lagoon (these are preliminary estimates that must be considered with caution). Research on local and regional movements is needed to adjust the estimated population sizes.

Finding key sites for shorebirds on the Caribbean coast of Colombia

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In February 1986, the Canadian Wildlife Service investigated shorebird distributions on the Colombian coastline by aerial surveys of both the Pacific and Caribbean coasts. Results from the surveys were published in the South American Shorebird Atlas authored by Morrison & Ross. Subsequently, no confirming surveys were carried out in Colombia until 22 years



later when the *Calidris* Association carried out aerial, aquatic, and terrestrial surveys between Dec 2007 and Jan 2008. These surveys were conducted to determine major wintering areas used by shorebirds on the Caribbean coast. We covered approximately 500 km of coastline including six provinces, some deltas, several mangrove swamps, inland wetlands and vast intertidal flats. To describe shorebird distribution patterns, the coast was broken down into four zones, each of which was subdivided into sectors with a distinctive ecological character. Ground surveys were undertaken in most of the zones surveyed to confirm the accuracy of aerial counts. More than 36,000 shorebirds were counted. Small species were predominant comprising 73% of the total. Both aerial and ground observations indicated that the largest flocks of peeps consisted predominantly of Western Sandpiper, Semipalmated Sandpiper, and Semipalmated Plover. Surveys clearly identified the wetlands of La Guajira coast and the Rio Magdalena delta as the most important wintering areas for shorebirds on Colombia's Caribbean coast. This information confirms and complements the Morrison and Ross data constituting an improved baseline to evaluate the conservation of shorebirds and their habitats on the Caribbean coast.

Population dynamics, molt, mass and life-history strategies of Buff-breasted Sandpipers in Brazil

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The Buff-breasted Sandpiper *Tryngites subruficollis* is a shorebird of critical conservation concern. Habitat loss on the wintering grounds has been suggested as the cause of recent declines. However, implementation of conservation actions within the wintering range is hindered by lack of accurate information on population dynamics and wintering ecology. To obtain needed information on the species' wintering ecology, we captured and banded 214 Buff-breasted Sandpipers over three consecutive boreal winters (Oct–Mar) at Lagoa do Peixe National Park, Brazil. Our objectives were to investigate variation in migration schedule, length of stay and site-tenacity, as well as molt schedule and mass gain among males and females and adults and juveniles, and associate these characteristics with life-history strategies. Buff-breasted Sandpipers were present at Lagoa do Peixe

from mid-Sep through mid-Mar. Mark–recapture analyses indicated that males initiated northward migration before females and suggested that males have a higher emigration rate. Males were in better body condition (index of mass/tarsus length) than females, but change in condition was not consistent among years. The heavy molt undertaken from late Oct until early Feb may explain the lack of mass gain during this period. Males finish wing and tail molt earlier than females, and adults finish wing molt earlier than juveniles. During the linear period of wing molt, males and birds in better condition had higher molt rates. These results indicate that migration strategies differ by sex, age, and body condition, with readiness to migrate being achieved first by adult males.

Foraging behavior of non-breeding Marbled Godwits, Whimbrels, and Long-billed Curlews in the Estero de Urias, Sinaloa, Mexico

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We studied the foraging behavior of nonbreeding Whimbrels *Numenius phaeopus*, Long-billed Curlews *N. americanus*, and Marbled Godwits *Limosa fedoa* in the Estero de Urias, Sinaloa, Mexico. Focal shorebird observations were conducted from Sep 2007 to Apr 2008 for two tide levels (<300 and 300–800 mm) during ebbing and rising tides. Foraging behavior was described using five metrics: foraging, walking, and intake rates (defined as the number of foraging attempts, steps, and prey captured per min, respectively), as well as the proportion of pecks and the proportion of successful foraging attempts. We observed differences in foraging behavior by species, tide levels, and site. All three species used a higher proportion of pecks than probes. Marbled Godwits had higher foraging, walking, and intakes rates, and proportion of successful foraging attempts than Whimbrels and Long-billed Curlews in the tide level of 300–800 mm. We confirmed that changes in foraging behavior in all three species are related to the tidal cycle. These findings imply that maintaining the overall value of the estuaries for foraging shorebirds requires extensive mudflats with areas available for different species at different tidal stages.



CONSERVATION

The effect of off-road vehicles on migrating shorebirds

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Dramatic declines in shorebird populations have sparked a flurry of research aimed at improving conservation efforts. However, there are still large gaps in knowledge concerning the causes of shorebird declines. Recent studies show that recreational activities pose a significant threat to shorebirds. Understanding how recreational activities affect shorebird populations is critical to piecing together the puzzle behind their decline. During 2007–2008, we examined the effect of off-road vehicles on shorebirds during spring and fall migration at Assateague Island National Seashore, Maryland. Species diversity showed a steady decrease as the volume of off-road vehicles on the beach increased. Likewise, abundance of commonly occurring species significantly declined with increasing off-road vehicle presence, while rarer species avoided areas with off-road vehicles entirely. Habitat quality was also affected by off-road vehicles, as evidenced by declines in roost abundances and food availability with increasing off-road vehicle presence. In addition to providing useful information for shorebird conservation efforts, these findings will also be incorporated into National Park Service management plans to minimize disturbance to migrating shorebirds. Future studies to conserve shorebirds and minimize the threat of recreational activities should be focused on fitness aspects such as physical condition of migrating shorebirds in areas with recreational activities compared to those without.

Farming for wildlife: creating shorebird habitat in the pacific flyway

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Loss of wetland habitats is one of the primary hypotheses for explaining the widespread population declines of shorebirds. In the Skagit River Delta of Washington, an area that supports significant numbers of shorebirds during the migration and non-breeding seasons, 70% of estuarine and 90% of freshwater wetlands have been lost during the last century to development and conversion for agriculture. To address this threat, The Nature Conservancy and partner agencies are working with farmers to assess the feasibility of creating temporary wetland habitats as part of their crop rotation program. Since 2007, shorebird use, invertebrate abundance, vegetation, and soil fertility data have been collected on flooded, grazed, and sod harvest treatment fields during migration and wintering periods. Preliminary data suggest shorebird use is highest on flooded fields during fall and spring migration, and is consistent across tide heights. The most abundant species observed on flooded fields were Least Sandpipers, Long-billed Dowitchers, and Greater Yellowlegs. Shorebird abundance on the flooded fields was significantly lower in 2008 during the second year of flooding. Concurrent research is examining the use of agricultural and estuarine habitats by tracking movements of radio-marked Dunlin in the winter. While much work remains to be done to quantify the ecological benefit

of wetland rotations, the project is promising as a means to provide shorebird habitat while also achieving agronomic and economic benefits for farmers.

Exposure of non-breeding migratory shorebirds to cholinesterase-inhibiting pesticides in the Western Hemisphere

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During their annual movements, shorebirds frequently forage and roost in agricultural habitats potentially increasing their risk of exposure to cholinesterase (ChE)-inhibiting pesticides. Organophosphorus (OP) and carbamate (CB) compounds are common anti-ChEs and exposure can cause sub-lethal effects and even death. To evaluate exposure of migratory shorebirds to OPs and CBs, we sampled birds at migratory stopover sites during north- and southbound migration in North America and at non-breeding sites in South America. We compared ChE activity between reference sites with no known OP or CB applications and agricultural sites where agrochemicals were recommended for control of crop pests. Plasma acetylcholinesterase (AChE) and butyrylcholinesterase (BChE) activity levels of Buff-breasted Sandpipers were lower at agricultural sites as compared to reference sites in South America, indicative of exposure to OP and CB pesticides. A meta-analysis across six study species resulted in four of six and one of six negative species-specific effect sizes for AChE and BChE, respectively, indicating negative effects of agricultural habitats on ChE activity. Results of plasma ChE reactivation assays and footwash analyses were inconclusive. Exposure to ChE-inhibitors can result in decreased body mass; however, comparisons of body mass between treatments and hemispheres suggest that habitat use did not affect body mass dynamics. Our results suggest that exposure to ChE-inhibiting pesticides is occurring at specific sites on the non-breeding grounds but not at migratory stopover sites. Future research should examine shorebird habitat use during the non-breeding season and identify other potential sites of exposure.

Planning for shorebird conservation in the Sonoran Joint Venture Area

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The Sonoran Joint Venture (SJV) includes the southern part of Arizona and California, and the Mexican states of Sonora,



Sinaloa, Baja California and Baja California Sur. Shorebird habitat is found at both inland sites such as the Salton Sea and along the over 3,000 miles of coastline. Habitats for shorebirds include desert playas, rocky shore, salt ponds, beach, and agricultural areas that are used for breeding, migration, and over-wintering. This presentation will focus on our planning process, recommendations, projects completed, and future shorebird conservation needs. For the SJV's planning process and resulting Bird Conservation Plan, shorebirds

were not considered as a separate group but were analyzed with landbirds, waterfowl, and waterbirds using a process similar to the Partners in Flight Species Assessment Process. If that analysis did not include a priority species from the U.S. Shorebird Plan, it was added. Congruity was high between the two methodologies (90%). Programs for Binational bird conservation used in the SJV area, specific projects, partnerships, and training will be showcased.

MIGRATION

The position of short- and intermediate-distance migrating shorebirds in the capital–income breeding continuum

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Many shorebirds migrate to breed in the north. To successfully breed, especially given the short season, individuals may bring reserves from wintering sites (i.e., capital breeding). The contrasting strategy is income breeding. Once they have arrived on the breeding grounds, animals obtain energy locally. Previous work shows that shorebirds are primarily income breeders. However, it is possible that the species examined may not have been representative of all shorebirds since they all had long migratory flights and to fuel these flights they would have likely drawn heavily on their energy reserve thus forcing them to adopt an income strategy. In contrast, short- to intermediate-distance migrants may arrive with reserves still present and thus employ a more capital strategy. In addition to migration distance, time available for breeding may also influence where individuals obtain resources for breeding. Where time available for breeding is limited (e.g., at high latitudes or when spring arrives late), it may be advantageous to invest capital to ensure an earlier start to breeding. Using stable isotopes, we examined how these variables influenced where short- to intermediate-distance migratory shorebirds fell along the capital–income continuum. We found that the birds we examined were primarily income breeders and that there was no significant effect of migration distance, season length (based on latitude and spring arrival), or nesting date. We surmise that the small size of these shorebirds, and potentially all shorebirds, tilts the balance of the costs and benefits of carrying reserves with them to the breeding grounds towards the income end of the continuum.

Spring stopover ecology of Whimbrel along the Delmarva Peninsula of Virginia

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Little is known about the location and relative significance of staging areas for Whimbrel *Numenius phaeopus* during migration. Aerial transect surveys conducted in the mid-1990s demonstrated that large numbers of Whimbrels stage along the lower Delmarva Peninsula in Virginia. The lack of significant numbers of Whimbrels to the north of this site and the timing of exodus relative to arrival on the breeding grounds suggest that this site is a terminal staging area along the Atlantic Coast. During the spring of 2008, we captured 26 Whimbrels during 30 April to 20 May. When mass was plotted over time, it appeared that mass increased throughout the stopover period by an average of 10 g per day. Initial mass was approximately 360 g (intercept value) and increased to a maximum of 640 g. Of 24 birds fitted with telemetry units, all left the study area within a 4-d period (third week of May). Birds appear to stage along the Delmarva Peninsula for a period of 3–4 wks before initiating a nonstop flight to the breeding grounds. A single individual fitted with a 9.5 g satellite transmitter was tracked on a nonstop, transcontinental flight to the MacKenzie River Delta and then on to a breeding location on the North Slope of Alaska. This finding suggests that the study area may represent a staging area for portions of both the Hudson Bay and Alaska breeding populations and is the only known site where these populations commingle.

Shorebird migration stopover in Falcon State, Venezuela

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Falcon State is the state with the largest number of coastal wetlands (17) and longest coastline (685 km) in Venezuela. Morrison conducted aerial surveys in 1982, including 25 localities in the state of Falcon, finding a total of 13,537 shorebirds. Some of the sites surveyed had no shorebirds, despite reports indicating their presence. This study presents the results of surveys carried out at eight sites covered by Morrison, showing numbers and species-diversity of shorebirds, and making comparisons between the two surveys. Censuses were carried out during 2007 and 2008, along transects at each site; we conducted 1–5 censuses at each locality. Using the maximum numbers in each census, there were 19,300 individual shorebirds, belonging to 22 species, including 15,000 small shorebirds, 2,500 middle-sized, and



1,800 large-sized shorebirds. These surveys showed that there were five times more shorebirds in the same eight sites than during the 1982 census and highlight the importance of the Falcon state for shorebirds. This arises because there are numerous suitable stopover and wintering sites, and, for some

there are shorebird records going back over 30 years, indicating recurring shorebird use. We recommend continuous monitoring during migration periods, extending monitoring to other potential stopover sites, and promoting the conservation of wetlands as a strategy for shorebird conservation.

TEMPERATE BREEDING & GENETICS

Incubation patterns and parental care of Black Oystercatchers *Haematopus bachmani* in Alaska

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Understanding factors that influence parental behavior is fundamental to the study of shorebird ecology and informed conservation practices. Egg care is an important aspect of parental behavior that is proximally influenced by a variable environment. This work examines the relationships of cyclical (time of day, tide cycle, temperature, seasonality) and stochastic (natural/human disturbance) processes with incubation patterns (attendance, bout lengths, recess rates) of the Black Oystercatcher *Haematopus bachmani*, a shorebird of conservation concern. Continuous video monitoring of 13 molecularly-sexed incubating oystercatcher pairs revealed behaviors poorly documented in the genus. Analyses of 3,177 h of video footage indicated greater nest attendance (54% vs. 42%, $P < 0.018$) and longer bout lengths among females (88 min vs. 73 min, $P < 0.004$), a near doubling of nocturnal bout length independent of sex ($P < 0.001$), and the influence of tide cycle and ambient temperature on incubation patterns. Bouts interrupted by disturbance were >50% shorter than undisturbed bouts ($P < 0.001$). Incubating males departed nests more frequently in response to nest-area disturbance stimuli than females, reflecting the greater role of males in nest defense ($P < 0.001$). Thirty-two percent of video-monitored nests failed, primarily due to egg predation by nocturnal mammals, implying higher nighttime risk of egg loss. Findings suggest that the sexes exhibit different, but complimentary incubation patterns, facilitating efficient incubation in a dynamic, fluctuating environment. This study emphasizes the importance of considering undisturbed patterns of nest behavior and natural disturbances in studies examining the impacts of anthropogenic disturbance.

Dispersal patterns in breeding Mountain Plovers *Charadrius montanus*

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The rapid multi-clutch mating system of the Mountain Plover

Charadrius montanus provides an opportunity to examine sex differences in natal, within-, and between-year breeding dispersal. We used nest locations from a Montana breeding population over a 14-year period to examine patterns of sex bias in natal and within-year breeding dispersal. Additionally, we modeled between-year dispersal distance with sex, previous nest fate, and presence of sylvatic plague as covariates. We found no sex bias in natal dispersal (mean = 12.96 km for 16 males; mean = 10.18 km for 22 females) or within-year breeding dispersal (mean = 2.81 km for 22 males; mean = 2.97 km for 26 females). The mean dispersal distance was 2.74 km ($n = 115$, $SE = 0.60$) for males nesting in consecutive years and 4.32 km ($n = 87$, $SE = 0.87$) for females. On average, birds that were successful moved 2.99 km ($n = 149$, $SE = 0.55$) between nesting attempts, while those whose nests had failed moved 4.63 km ($n = 53$, $SE = 1.18$). Sex of the tending adult and prior nest fate had the strongest effects on between-year breeding dispersal with a positive effect on dispersal distance for both females and birds whose nests had failed the previous year; there was a weak year effect but no effect of sylvatic plague. Our work provides 1) a better understanding of dispersal in an uncommon shorebird, 2) additional insight into a novel mating system, and 3) a basis for testing theories of avian dispersal.

Population genetic assessment in Piping Plovers

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In this study, we undertook the first comprehensive molecular, genetic-based investigation of Piping Plovers *Charadrius melodus*, a threatened or endangered shorebird throughout its range. Our goals were to 1) address higher level subspecific taxonomic issues, 2) characterize population genetic structure, and 3) make inferences regarding past bottlenecks and demographic processes. Our analyses were based on mitochondrial DNA sequences ($n = 245$ individuals) and eight nuclear microsatellite loci ($n = 229$ individuals). Based on our findings, we illustrate strong support for separate Coastal and Interior Piping Plover subspecies (*C. m. melodus* and *C. m. circumcinctus*, respectively). Birds from the Great Lakes region were allied with the Interior subspecies group. Population genetic analyses suggested that genetic structure was stronger among Coastal birds than Interior birds. Furthermore, demographic analyses suggested that Interior birds have previously experienced genetic bottlenecks, whereas no evidence for such patterns existed among the Atlantic subspe-



cies. Likewise, genetic analyses indicated that the Great Lakes region has experienced a population expansion. This finding may be interpreted as population growth following a previous bottleneck event. No evidence for population expansions were found for Atlantic individuals. We interpret our demographic insights in light of 15 years of International Piping Plover census data. Overall, differences observed between Interior and Atlantic birds may reflect differences in spatiotemporal stability of Piping Plover nesting habitat between regions.

Snowy vs Kentish Plover: a matter of genetics

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Molecular genetic analyses have provided new insights into the phylogeny and taxonomy of shorebirds. However, the tips of the phylogeny are often still poorly resolved. A number of shorebird species have large distributions but their

breeding populations are often scattered and it is not known whether the populations are reproductively isolated. We re-analysed phenotypic characters and used genetic markers to investigate population differentiation and divergence in the Kentish/Snowy Plover *Charadrius alexandrinus*. This cosmopolitan small shorebird can be found on all continents except Antarctica. Populations in Eurasia are usually called 'Kentish Plover' whilst populations in America are usually named 'Snowy Plover'. Whether they constitute one or several species has been debated, but currently all populations are considered as one species. A correct taxonomic classification is also of importance for conservation management since worldwide many populations are declining. We found consistent phenotypic differences between American and Eurasian populations in songs and tarsus length. Results from 26 microsatellite and three mitochondrial markers examined in 11 plover populations show that American and Eurasian populations are genetically different and that, in fact, Kentish Plovers are more closely related to African White-fronted Plovers *Charadrius marginatus* than to Snowy Plovers. Snowy plovers showed a remarkably low genetic diversity suggesting a major bottleneck in the past. Subspecies of both Kentish and Snowy Plover appeared to be genetically coherent despite population fragmentation. However, remote island populations differed from continental populations according to microsatellite, but not according to mitochondrial markers.

GENERAL POSTERS

San Julian's Bay, Southern Patagonia, Argentina: a new important site for shorebirds on the Patagonian coast

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San Julian's Bay has large tidal amplitude, extensive intertidal mudflats and sandflats, with abundant macro-invertebrates and salt marsh. Although the bay was listed as a potentially important site for shorebirds, the use of the site by shorebirds is not well known. We present information about the species occurring there, relative abundance, areas of feeding, resting, and breeding in the bay, from studies carried out in Feb–Mar 2007 and the literature. We found 15 shorebird species (seven Neartic and eight Patagonian), representing 65% of the listed shorebirds for the Patagonian coast. The most abundant species was a Neartic migrant, White-rumped Sandpiper *Calidris fuscicollis*, followed by two Patagonian species: Two-banded Plover *Charadrius falklandicus* and Magellanic Oystercatcher *Haematopus leucopodus*. We found nests of American Oystercatcher *Haematopus palliatus*, Blackish Oystercatcher *H. ater* and Two-banded Plover. We also recorded Hudsonian Godwit *Limosa haemastica* and Red Knot *Calidris canutus*, which were only observed during northward migration, and Whimbrel *Numenius phaeopus* which was recorded in both migration seasons. We conclude that San Julian's Bay is an important site for shorebirds in view of both the diversity and abundance of species and the fact that it is a nesting site for two Patagonian species. This emphasizes the need to iden-

tify the most important threats and to prioritize conservation actions.

Red Knots *Calidris canutus rufa* in Uruguay

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Historical and recent field records of Red Knots in Uruguay suggest that the coast of the country is used as a stopover site, but no examination of the existing information has been carried out. The objective of this study was to put all the field records together, both historical and recent, to contribute to the understanding of the timing and abundance of the species in Uruguay. Data were obtained from public databases, the literature, and field notes of local ornithologists. Additionally, two censuses were carried out in Dec 2007 and Apr 2008. The information obtained is not sufficiently complete to determine robust ecological patterns, but some preliminary conclusions and hypotheses can be made. First, the species makes use of the Uruguayan coast particularly during the months of Mar, Apr and May. The main areas are sandy beaches of the Department of Rocha: La Coronilla, Barra del Chuy, La Paloma, and Cabo Polonio. Some historical and recent records of the species were from southbound migration. Several records of a few individuals were obtained during the austral winter. This suggests that some individuals remain in wintering areas, at least for one austral winter. Just a few birds were recorded during April 2008 in La Coronilla-Barra del Chuy. This suggests that use of the Uruguayan coast might be variable between years. Research on population size, timing among years, and characterization of key sites is needed.



Shorebird migration through Popayán Plateau, Colombian Andes

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Non-coastal shorebird flyways in the Neotropics remain poorly understood. Museum skins from the mid-20th Century and surveys carried out in the 1990s show autumn migration of shorebirds through Popayán, a plateau located in the middle of the Central and Western ranges of the Colombian Andes. To assess habitat use and evaluate the current status of shorebirds using the plateau, we conducted weekly censuses during Sep–Dec 2007–2008 on pastures surrounding Popayán city. Eight shorebird species were recorded, with Upland Sandpiper accounting for 60% of records. Overall shorebird abundance decreased, the decline being close to 80% for Buff-Breasted, Pectoral and Baird's Sandpipers. Pasturelands were used mainly by Pectoral and Baird's Sandpiper and wetlands and seasonal ponds were used by Lesser Yellowlegs and Solitary Sandpiper during the rainy season (Oct). Urban expansion is the main threat to shorebird habitats on the Popayán Plateau. Searches of other stopover sites for shorebirds in the Andes and their relationships with breeding and wintering grounds are critical to understanding non-coastal shorebird migration. Local habitat conservation initiatives are necessary in order to maintain the value of the Popayán Plateau for shorebirds.

Breeding system and offspring survival of Snowy Plovers *Charadrius alexandrinus nivosus* breeding at Ceuta, Mexico

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Snowy Plovers are one of the few bird species with a very flexible breeding system that can include polyandry, polygyny and monogamy together with uniparental or biparental care. We studied the breeding biology of Pacific Snowy Plovers breeding in NW Mexico at Ceuta Bay (23°N, 106°W). Fieldwork was carried out during Apr–Jul 2006–2008 with the aim of recording all breeding attempts of Snowy Plovers. We considered adults as 'monogamous' when they retained their mate during subsequent breeding attempts. Adults that changed their mate were considered as polygamous (polyandrous females and polygynous males). We determined parental care and reproductive success by following families from hatching of the chicks until they had reached an age of 25 days or all chicks had died. Sixteen males were polygynous (2006 = 5, 2007 = 8, 2008 = 3), whilst 15 were monogamous (2006 = 5, 2007 = 7, 2008 = 3); 41 females were polyandrous (2006 = 9, 2007 = 22, 2008 = 10) whilst 15 females were monogamous

(2006 = 5, 2007 = 7, 2008 = 3). The proportion of biparental care decreased with brood-age as more females deserted their broods. We determined the fate of 110 broods (2006 = 36, 2007 = 44 and 2008 = 30). Of these, only 97 chicks survived until fledgling age over the study period. In conclusion, we found more females than males to be polygamous and male care is the predominant care-type in this population. The number of fledglings differed greatly across years, which is probably due to differences in availability of suitable brood habitat due to yearly fluctuation in water levels.

Observations of Red Knots *Calidris canutus rufa* in south and north-east Brazil

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This study reports on Red Knot ground surveys conducted in the states of Rio Grande do Sul (RS; 2005–2006) and Ceara (CE; 2008) in S and NE Brazil respectively. In RS c.8,000 birds were found in April 2005, 5,000 of which were concentrated in the vicinity of Lagoa do Peixe (LP) in southern RS. In May, we counted 3,600, most of which were along oceanic beaches. From Oct 2005 to May 2006, efforts were focused on LP, especially near the lagoon's inlet and on adjacent ocean beaches. In the lagoon, Red Knots were more abundant in Nov (180 birds), Feb (364), and Apr (813). On the beaches the larger numbers were recorded in Oct (90), Mar (93), and Apr (81). The *rufa* subspecies of the Red Knot has undergone a drastic population decline over the last decade and it is worth mentioning that the 5,000 birds observed in LP in April 2005 corresponded to almost a third of the Red Knot population that wintered in Tierra del Fuego that year. This reinforces the importance of the coast of RS for Red Knots while migrating north. We recently (Sep 2008) started new research in a tidal delta in CE. Maximum monthly numbers were: 537 in Sep, 441 in Oct, 216 in Nov, and 513 in Dec. We also resighted some birds with color bands/flags. This area has never been systematically surveyed before, and was not previously known as a significant wintering area for Red Knots.

Shorebirds in the Caimanero Lagoon, Sinaloa, Mexico: species composition and seasonal abundance

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This study describes the species composition, seasonal abundance, and habitat distribution of shorebirds in the Caimanero Lagoon, Sinaloa, Mexico. Surveys of shorebirds were conducted once a month from Nov 2007 to Sep 2008. We recorded 23 shorebird species. Taking the highest recorded number for each species, the estimated minimum abundance in the study period was 23,140 birds. The three most abundant species were Western Sandpiper, American Avocet, and dowitcher spp. The composition and seasonal abundance of shorebirds varied throughout the study. Species richness and abundance was high in Nov (21 species and 9,297 birds, respectively), decreased from Dec to Mar (14 species, 3,632 birds), peaked in Apr (18 species, 9,442 birds), and decreased



again after May with the lowest values in Jul (11 species, 674 birds). This pattern suggests that the lagoon is an important site for shorebirds during the winter and northbound migration. The habitat distribution of shorebirds was influenced by changes in water levels. During Nov–Feb, abundance of birds was similar throughout the lagoon. After Mar, shorebirds tended to concentrate in the south-western portion due to a decrease in water levels, which resulted in dry mudflats in the northern part of the lagoon. Species like American Oystercatcher, Snowy Plover, and Wilson’s Plover use the lagoon as a breeding area during Mar–Jun. Further development of the lagoon is planned, so it should be protected for the benefit of migratory and nesting shorebirds. Using Western Hemisphere Shorebird Network criteria, the lagoon is of Regional Importance for shorebirds.

Disturbance for shorebirds in the urban coast reserve Río Gallegos, southern Patagonia, Argentina, and response to human presence

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Shorebirds are particularly sensitive to disturbance in feeding or resting areas. In 2006–2007, with the object of contributing to planning for the Urban Coast Reserve Río Gallegos, Argentina, we identified disturbance sources in the area, considering as such, any event which altered the normal activities of the birds. In spring 2007, we analyzed the behaviour of Patagonian and Nearctic shorebirds, establishing the distance at which shorebirds responded to an approaching observer in different situations (different tidal levels, seasons and bird activity). We recorded the reason why shorebirds were disturbed in 71% of cases (n = 66), mainly during Nov–Feb. Walkers were the most frequent cause (43% 2006, 63% 2007), followed by dogs (36% 2006, 26% 2007), though dogs caused greater disturbance to the birds. The Magellanic Oystercatcher *Haematopus leucopodus* turned out to be one of the most vulnerable species, responding with alert behaviour at 38±18 m and taking flight at 34±8 m during high tide. They were more sensitive in the middle–low tide, when they were usually feeding (50±15 m and 41±8 m, respectively). To minimize impact and regulate the behaviour of people, we recommend using the data we have obtained to create interpretive paths and limit human use of the beach in areas where shorebirds are concentrated.

Foraging–predation tradeoffs and habitat use of shorebirds in a developing coastal landscape

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The Fraser River estuary supports millions of shorebirds annually, including internationally important numbers of Western Sandpipers *Calidris mauri* (2 million), Dunlin *Calidris alpina* (100,000) and Black-bellied Plovers *Pluvialis squatarola* (3,000–5,000) making it a key site in the Western Hemispheric Shorebird Reserve Network. My research builds on and synthesizes a decade of previous work examining the

use of this area by migrant Western Sandpipers and wintering Dunlin and has shown that habitat use is influenced by spatial and temporal (tidal and diurnal) variation in (1) food availability, and (2) predation risk, primarily from Peregrine Falcons *Falco peregrinus*, and, in some years, Snowy Owls *Bubo scandiacus*. I will use these basic findings to create predictive, spatially-explicit models of habitat use (both presence–absence and abundance) by shorebirds in the Fraser River Delta. This will involve (1) generation of GIS layers of the dynamics of food and safety with respect to day, tide, and season, (2) mapping shorebird presence and abundance on these surfaces, and (3) modeling the relationships between them. The variables behind the food availability surfaces include mudflat sediment characteristics, hydrology, and agricultural characteristics for farmland. Variables affecting spatial and temporal patterns of predation danger have also been established, but spatially explicit predictions have been limited to presence/absence and have been tested only at selected sites within the estuary. My composite model will integrate both components contributing to observed habitat distributions, adding the response variable of abundance, and will test the sensitivity of previous models at other locations.

The effect of predator migration on the age-specific migration strategies of the Western Sandpiper *Calidris mauri*

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Western Sandpiper *Calidris mauri* migration presents a model for examining the effect of predation on migratory and stopover behaviours in shorebirds. Each fall, adult *C. mauri* depart their breeding grounds one month before their juvenile offspring. The major predator of *C. mauri*, Peregrine Falcons *Falco peregrinus* migrates in increasing numbers throughout the juvenile migration. Based on optimal migration theory, we hypothesize that adult Western Sandpipers will act as “Time-minimizers” at stopover sites in order to reach their wintering grounds and molt before the migratory Peregrine Falcons arrive. Juveniles will behave as “Predation-minimizers” due to their temporal proximity to migrating *F. peregrinus*. We observed vigilance behaviour flight distance of foraging *C. mauri* at a fall stopover point in Boundary Bay, B.C., Canada. We predicted that adults would take more risks, including decreasing vigilance, and spending more time in high danger, high food abundance areas, in order to maximize food intake for maximized speed of migration. Juveniles were predicted to have increased vigilance and avoid dangerous habitats to increase detection rate of an attack, but decreasing food intake. Age was found to be a major factor influencing the proportion of time vigilant and the flight distance. Juveniles were more vigilant, but had a shorter flight distance than adults. Adults were also found in more dangerous habitat. Future work will be needed to explore the relationship between juvenile and adult Western Sandpipers and their predators at numerous stopover points along their southward migration.



Pacific Dunlins show a high propensity for second clutch production

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The breeding ecology of the Pacific Dunlin *Calidris alpina pacifica* was studied on the Yukon Kuskokwim Delta, Alaska, during the summers of 2004–2006. Nest and fledging success varied between years from 41 to 61% and 20% to 45% respectively. Pacific Dunlin showed a high propensity for re-nesting, and on average 75% of failed first clutches were replaced, though only 12% of the replacement clutches produced fledglings. Re-nesting increased the overall reproductive output from the study plots by 7%, from 37% to 44%. The amount of time between the loss of the first clutch and completion of the replacement clutch depended on how far into incubation the first clutch was lost, and whether the male re-nested with the same or a new mate. In this population, there was also a high frequency of double-brooding (i.e., individuals that deserted their first brood and went on to produce a second clutch with a new mate). About 19% of adults that deserted the broods of their first nest went on to double-brood on the study site. The earliest-laying individuals were more likely to double-brood, and deserted their broods after a shorter period of attendance than those that did not double-brood.

Fall stopover ecology of juvenile Semipalmated Plover *Charadrius semipalmatus* in the St Lawrence estuary

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The estuary of the St. Lawrence River in southern Québec, Canada, is an important stopover area for a large number of migrating shorebirds. However, stopover ecology is poorly documented for most species. We investigated space use and stopover duration of one of the most abundant medium size migrants in the Lower St Lawrence estuary, the Semipalmated Plover *Charadrius semipalmatus*. During the 2008 fall migration, 13 juveniles were equipped with glue-on transmitters in the Kamouraska region. Daily ground telemetry surveys were conducted from late Aug to mid-late Sep along 60 km of shoreline. Daily detection probability was 89.3% ± 8.4% (mean ± 1SD). One aerial flight was also performed in mid Sep to confirm the departure of individuals. We found strong individual variation in stopover duration, ranging from 1 to 28 days (mean 14.6 days, n = 11) and two marked birds were apparently killed by avian predators on the stopover site. Individual daily movements were generally limited but all birds progressively moved upriver towards the south-west during their stay. Factors explaining Semipalmated Plover stopover duration and space use along the lower St Lawrence estuary (such as body condition of individuals, predation pressure or prey availability) require further investigation.

The importance of the Teshekpuk Lake Special Area to breeding birds

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Within the Arctic coastal plain of Alaska, the Teshekpuk Lake Special Area (TLSA) is a region of exceptional importance to wildlife including breeding shorebird species, some of which are experiencing population declines. Because the TLSA is adjacent to existing oilfields there is increasing interest in expansion of oil development into this region. The objectives of this study include: 1) Provide baseline information on key nesting parameters including nest survivorship, nest densities, and habitat usage in the TLSA; 2) Evaluate the importance of the TLSA as a breeding ground by modeling nest survivorship and key variables with Teshekpuk and a site in the nearby Prudhoe Bay oilfield.

We discovered and monitored 1,074 nests of 26 species during 2005–2008 at both Teshekpuk and Prudhoe Bay. This included 592 nests of 11 shorebird species, 359 Lapland Longspur nests (the only passerine), and 123 of other bird groups. Overall nest density was significantly higher at Teshekpuk ($\bar{X} = 100.97 \pm 6.36$) compared to Prudhoe Bay ($\bar{X} = 76.67 \pm 7.73$; $T_{28} = -2.4230$, $P = 0.022$). At Teshekpuk, shorebirds showed nesting habitat usage different than expected ($\chi_3^2 = 8.30$, $P = 0.04$). Shorebirds tended to prefer wet/emergent over dry/moist habitat. The best Program MARK nest survivorship model for passerines indicated higher survival at Teshekpuk (versus Prudhoe Bay), higher survival in years of high lemming abundance, and increasing survivorship as the nesting season progressed. The best shorebird model indicated high variability in survivorship between years and sites, lower survivorship of uniparental shorebirds early during nest lifetime, and higher survivorship with increasing nest concealment. We provide recommendations for management.

Point counts underestimate the importance of arctic foxes as avian nest predators: evidence from remote video cameras in arctic Alaskan oil fields

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We used video-cameras to identify nest predators at active shorebird and passerine nests and, separately, conducted point-count surveys to determine species-richness and detection-frequency of potential nest predators in the Prudhoe Bay region of Alaska. We identified 16 potential nest predators from surveys with Glaucous Gulls *Larus hyperboreus* and Parasitic Jaegers *Stercorarius parasiticus* making up over 80% of the observations. Arctic foxes *Alopex lagopus*, however, were identified in five of six predation events recorded with the cameras. These results indicate that estimated abundances of predators alone may not accurately reflect their true or proportional importance as nest predators. We also found



that the identified predators removed all eggs and left the nests intact. Thus, attempts at identifying predators based solely on nest remains are not reliable for smaller bird species in this region. We found no evidence that camera-monitored nests were at greater risk of predation or desertion than camera-free nests. Overall, our ability to film predation events was hampered by the brief, highly-synchronized breeding season, harsh climate, and higher nest survivorship for shorebirds in this region relative to temperate-breeding passerines which have been the focus of most studies attempting to identify nest predators with camera systems at active nests.

**Nesting success of Snowy Plovers
Charadrius alexandrinus nivosus at Ceuta Bay,
Mexico: implications for conservation**

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Ceuta Bay, Sinaloa, Mexico (23°54'N, 106°57'W) is a well recognized stopover site for many migrant shorebirds during spring and fall migration. Adjacent to the lagoon there is a temporary salt flat which is flooded by brackish tidal and irrigation water for most of the year. This salt flat provides high quality breeding grounds for a number of shorebird species including the threatened Western Snowy Plover *Charadrius alexandrinus nivosus*. For three consecutive years we have studied the breeding biology and reproductive success of Snowy Plovers at Ceuta Bay. Between 76 and 161 Snowy Plover nests were recorded every year. Nesting success was high with on average more than 50% of the nests hatching at least one chick, whilst predation rate was low (average predation less than 20%). The nesting season is currently constrained to less than three months by the availability of suitable nesting grounds, whilst breeding activity for up to eight months has been reported from Northern populations in California. In Ceuta the plovers start breeding in mid April after the water has evaporated and the nesting season terminates in July when the nesting grounds get flooded by rain. We recommend a better management of the water influx to the site in order to increase the length of the breeding season and hence boost the productivity of breeding shorebirds. Other disturbance factors, such as increased human recreational use and cattle grazing, also need to be monitored carefully.

**Ecology and conservation of the Red Knot
Calidris canutus in Rocha, Uruguay**

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The Red Knot *Calidris canutus rufa* is a threatened subspecies whose population has declined dramatically over the past 20 years. Although little is known about this bird in Uruguay, recent observations indicate that significant numbers of this subspecies make regular use of the coastal area in the south-eastern part of the country, especially during northbound

migration. During 21–29 Mar 2008, daily counts were conducted on the coast between La Coronilla (33°54'S; 53°30'W) and Barra del Chuy (33°46'S; 53°24'W), Rocha, Uruguay. A total of 256 individuals were recorded feeding in the area, in groups that ranged from 7 to 163 birds; the largest flock was observed in Barra del Chuy, where 163 were seen on 28 Mar. However, flocks were found more frequently 5 km to the south, where most of the rest of the birds were recorded. Fifteen individuals were banded: seven in Argentina, seven in USA and one in Canada. These records, along with the occurrence of a mortality event that involved more than 300 individuals in April 2007, indicate that the area represents an important stopover site for these shorebirds. Additional field work will be conducted in 2009 to determine the value of the area for this subspecies and establish a conservation program that may help in its recovery.

**Terrestrial arthropod abundance in the Canadian
Arctic: investigating spatial and temporal variation in
resource availability for arctic-nesting insectivores**

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Insectivorous birds such as shorebirds breeding on the arctic tundra depend on arthropods (insects and spiders) for their survival and reproduction. Arthropods grow and reproduce within a very short period of favorable climatic conditions and birds must synchronize the hatching of their young with the short peak in arthropod abundance. This can be particularly challenging for long-distance migrants. The timing and amplitude of the peak in arthropod abundance are likely to change rapidly as a consequence of global warming. One of the possible outcomes is that peaks in arthropod abundance will occur earlier in the season, thereby disrupting the synchrony between nesting phenology of birds and their prey.

In order to better anticipate the response of wildlife to global warming, we investigated the effect of various environmental parameters on seasonal changes in arthropod availability. Using a standardized protocol, modified pitfall traps were set during one to three consecutive summers at four locations in the Canadian arctic: Bylot Island, Ellesmere Island, Herschel Island, and Southampton Island. Traps were deployed in wetland and mesic tundra and sampled every two days. By coupling trapping data with environmental parameters measured by automatic weather stations, we are building a model to explain seasonal changes in arthropod abundance. The model will be used to simulate past trends in arthropod availability and forecast their response to climate changes as well as provide a tool to assess the risk of a phenological mismatch between insectivorous birds and their prey in the arctic tundra.

**Importance of Akimiski Island, Nunavut,
as a stopover site for migrant shorebirds**

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Stopover ecology is a critically important aspect of shore-



bird conservation. Previous research has focused on a few well-known stopover areas. We examined shorebird abundance, habitat use, turnover rates and prey availability during spring (25 May to 23 Jun) and fall (19 Jul to 25 Aug) migration periods in 2008 on Akimiski Island, Nunavut, Canada (53°11'N, 81°35'W). Akimiski Island contains one of Nunavut's Migratory Bird Sanctuaries but has not previously been considered as a stopover site for shorebirds. During spring, approximately 1,538 shorebirds (17 species) were observed, with Hudsonian Godwits *Limosa haemastica* (336) and *Calidris* spp. (513) the two most abundant. During fall migration, approximately 16,036 shorebirds (19 species) were observed, with White-rumped Sandpipers *Calidris fuscicollis* (5,195), Semipalmated Sandpipers *Calidris pusilla* (4,337) and Pectoral Sandpipers (*Calidris melanotos*) (978) the most abundant. These results suggest that Akimiski Island is much more important as a stopover site for fall than spring migrants. Invertebrate peaks (3, 24 Jun, 24 Jul and 10 Aug) and shorebird peaks (2 Jun, 31 Jul and 18 Aug) corresponded in both seasons. Turnover rates, from resighting banded birds, ranged from 1–9 days for Lesser Yellowlegs, 1–5 days for Semipalmated Sandpipers and 0–9 days for White-rumped Sandpipers. Shorebirds foraged mostly in pools/streams and water edge habitats in both the spring (68%) and fall (81%), followed by mudflats and grass (26% and 15%) and dry (gravel and dry mud) (6% and 4%) habitats. In 2009, I will determine more precise turnover times and body condition of migrants to compare with results from other stopover locations.

Incubation rhythm and behavior of Long-billed Curlew at Great Salt Lake, Utah

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The Long-billed Curlew *Numenius americanus* is the largest of all North American shorebirds and is known to breed throughout the Great Plains and Great Basin. Unfortunately, little information is known about the incubation rhythm, duration of attentive periods and changeover activities of this species. We examined incubation behavior of adults nesting

at Great Salt Lake, Utah by placing bullet cameras connected to digital video recorders. This system allowed for continuous recording 24 hours per day. The results of these observations suggest that eggs are rarely left unattended and typically just during changeover periods. Males incubated continuously at night and females throughout the day. During the day, the incubation bout length was variable but averaged over 7.5 hours in duration.

A toolkit for bird educators: using education and outreach to support bird conservation

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Are you looking for ways to help create and implement education and outreach programs that directly contribute to shorebird conservation at local, regional, national, or even international levels? Many times education and outreach programs miss the opportunity to make this crucial link. The Bird Education Alliance for Conservation (BEAC) is working to link on-the-ground communications, education, and outreach efforts with national and regional bird conservation threats. The development of an online Toolkit is one of our approaches to doing just that. The Toolkit contains information about conservation threats and needed actions (drawn from national and regional Bird Conservation Plans like the U.S. Shorebird Plan), key concepts, potential target audiences, and information about existing resources. It also provides tools and guidelines for developing targeted messages appropriate for audiences at regional or local levels and ideas for determining the sorts of resources that might be appropriate for delivering the message to that audience. By using the Toolkit, you will be able to create education and outreach programs and products that directly support regional and national conservation objectives, making your program part of a larger effort to protect shorebirds and shorebird habitat.

