

Shorebird Science in the Western Hemisphere Meeting, 27 February–2 March 2006, Boulder, Colorado, USA



Introduction by Richard Lanctot

Through their prodigious long-distance migration, shorebirds provide biological linkages between countries where they stop to breed, stage, and winter. While the benefits associated with sharing

information across countries and continents seem obvious, efforts to connect researchers studying shorebirds in different parts of the Western Hemisphere have seldom taken place. Two notable exceptions come to mind. The first was a meeting held in Quito, Ecuador, in conjunction with the IV Neotropical Ornithology Congress in 1991. There, biologists shared their latest research in shorebird migration, ecology and conservation. This meeting also provided a rare opportunity for researchers to forge scientific partnerships, many of which continue through today.

The exception was the Western Hemisphere Shorebird Reserve Network (WHSRN) Workshop held in Ottawa in 1995. This workshop, while focused primarily on promoting and conserving WHSRN sites, called for greater coordination at all geographic scales and the need for a hemispheric shorebird conservation strategy. Of course these meetings were not being held in a vacuum. Many smaller, region-wide, and generally more informal meetings were taking place, such as the Western Sandpiper Research Network, the American Oystercatcher Working Group and others. Nevertheless, a full 11 years transpired before a hemisphere-wide meeting, entitled *Shorebird Science in the Western Hemisphere*, was held in Boulder, Colorado, between 27 February and 2 March 2006. It is interesting to ponder why such a long break between meetings occurred? I believe the timing was right given the recent realization that shorebirds are declining worldwide. This knowledge provided the impetus to form a variety of species-specific working groups that began the difficult process of determining what factors are limiting shorebird numbers. I also think 11 years elapsed because there was no mechanism to ensure another meeting occurred. Below, I discuss one way to remedy this situation, but first describe the Boulder meeting in more detail.

The Shorebird Science in the Western Hemisphere meeting took place over four days, and consisted of 4 plenary lectures, 9 symposia (6 species-based and 3 on broader issues consisting of 61 papers), 43 general papers among 10 subject themes, and 34 posters. Representatives from at least 10 Western Hemisphere countries and three other continents were present. Much of the Latin American presence was possible because of financial support from the U.S. Fish and Wildlife Service and the Canadian Wildlife Service, and I thank the different regional non-game coordinators for their assistance.

Each day of the meeting began with a plenary lecture. Bob Gill's talk on Monday morning, *Are we a flock and do we know where we are going?* set the stage for the meeting by exploring past attempts to unite shorebird efforts in the Western Hemisphere and looking at how other shorebird groups throughout the world have addressed this issue. He offered ideas for a Western Hemisphere model that could function without adding undue structure and administrative burden. Bob's talk was

scheduled first in the meeting because we wanted participants to consider the possibility of forming a hemisphere-wide group throughout the meeting.

On Tuesday morning we shifted hemispheres and heard from Phil Battley whose plenary *To beg, borrow and steal: the art of doing research on the East Asian–Australasian Flyway* provided an overview of how shorebird conservation and research is conducted in another, shorebird-rich corner of the world. He described a system that consists of primarily volunteers and few government or university research projects. Though short on funds, biologists along the flyway have initiated extensive banding programs and used species such as the Great Knot, Bar-tailed Godwit, Spoon-billed Sandpiper and others to galvanize support and enthusiasm for shorebird conservation.

On day three of the meeting we returned to the Western Hemisphere and South America in particular and heard from Luis Germán Naranjo. His plenary entitled *Shorebird biology and the development of Colombian ornithology* described the contributions of shorebird biology to the development of modern ornithology in Colombia and Northern South America. Luis discussed several milestones, including the formation of ornithology schools and the initiation of annual ornithological meetings in Columbia that led to substantial increases in waterbird studies in that country.

On Thursday, Lew Oring gave a stimulating and well-received talk (*'Our' shorebirds: Gondwana northward and back again*) during which he discussed how shorebirds as a group emerged temporally and spatially on the world scene and how such actions as glaciation and historic and contemporary human influences have shaped the shorebird fauna as we know it. He clearly showed how anthropogenic and natural alteration of the environment has affected shorebird abundance, distribution, and behavior.

This meeting also served as the inaugural meeting of the Shorebird Research Group of the Americas (SRGA) – a group designed to bring shorebird researchers together to increase our knowledge of shorebirds in the Americas and ensure that information is available for conservation purposes. As their first project, SRGA is promoting a cooperative approach to determining the causes of shorebird population declines. I would advise all to read Robert Butler *et al.*'s summary describing the formation and function of this important group.

In addition to a SRGA symposium, eight other symposia were held. Two of these were on broader issues and six were species based. The Shorebird Movements symposium focused on factors that affect how shorebirds navigate through their environment. The Neotropical Priorities symposium sought to put a world and South American perspective on the conservation status of North American shorebird species, and to initiate an assessment of the conservation status of Neotropical-breeding shorebird taxa. Species-based symposia covered the Black Oystercatcher, Buff-breasted Sandpiper, Long-billed Curlew, Marbled Godwit, Snowy Plover, and Western Sandpiper. Although the Western Sandpiper Research Network was meeting for an unprecedented 9th time, many of the other



groups had never met before and consequently this was the first opportunity for researchers to finally meet people they had corresponded with for years. I think most people would agree that such personal exchanges lay the groundwork for the establishment of other collaborative efforts. This certainly has been the case for the Western Sandpiper group, whose members have published a record number of articles on many aspects of this species breeding, staging and winter ecology. Only the future will reveal the success of these initial meetings. Representatives from three other species-based working groups also gave short presentations, although these groups did not formally meet. These included Red-necked Phalarope, Semipalmated Sandpiper and American Oystercatcher.

Stimulated by the enthusiasm generated by the meeting, especially Bob Gill's plenary talk, a number of those present suggested that there was sufficient momentum to form a Western Hemisphere Shorebird Group. This group would be the "glue" that binds the many other shorebird initiatives together, including the Shorebird Research Group of the Americas (research branch), the Program for Regional and International Shorebird Monitoring (and ISS, the monitoring branch), the Western Hemisphere Shorebird Reserve Network (site-based conservation branch), Shorebird Sister Schools Program (outreach/education branch), the U.S. and Canadian Shorebird Conservation plans and councils (national implementation framework branches), and the many other state and regional shorebird entities. The principal tasks of a Western Hemisphere group would be to:

1. organize and hold scientific meetings once every two years (to avoid another 11-year hiatus!)
2. establish a website with links to information on a wide variety of shorebird topics at various geographic scales
3. prepare a bi-annual electronic newsletter that would report on ongoing projects, provide regional summaries, and foster a hemispheric-wide shorebird identity.

At this point, we do not advocate creating a formal governing body but rather relying on a small group of people, composed of regional representatives from different parts of the Western Hemisphere, to accomplish the tasks mentioned above. I think it is important for all to recognize that the establishment of such a group would not replace existing or prevent the formation of new entities dealing with shorebirds in the Western Hemisphere. A letter and questionnaire will be sent through various channels in the near future inviting people to participate in determining the shape of the new Western Hemisphere Shorebird Group.

As the overall coordinator of the Shorebird Science in the Western Hemisphere meeting, I would like to end by acknowledging some of the key people who made major contributions to the meeting's success. First, I thank Brad Andres, who served as local organizer. He not only made all of the logistical arrangements but together with his wife, Heather Johnson, provided lovely background music for us to enjoy during the poster session. Second, I thank Stephen Brown who chaired the Science Committee and ensured the programs ran seamlessly together. Many other people contributed to the success of the meeting, including the many presenters, and I am grateful to them all.

Finally, I would like to encourage everyone to keep alive the enthusiasm experienced by all of us at the meeting (remember Brian McCaffery and Dov Lank singing *Hotel Boulderado!*) by participating in the Western Hemisphere Shorebird Group or other local organizations that contribute to the conservation of shorebirds. Only your efforts, fortified by a truly amazing amount of passion and commitment, will ensure that no other species goes the way of the Eskimo Curlew – *Not in our lifetimes* should be our theme song. Hope to see all of you at the **2nd Shorebird Science in the Western Hemisphere meeting** that will be held in conjunction with the VIII Neotropical Ornithological Congress in **Maturin, Venezuela, during 13–19 May 2007**. Mark your calendars!



CONFERENCE SONG: HOTEL BOULDERADO

Written by Brian McCaffery and sung by Brian McCaffery and Dov Lank

(to a tune associated with a well-known group of raptors) during celebrations, which took place in the Hotel Boulderado, on the last night of the Shorebird Science in the Western Hemisphere meeting.

On a dark coastal flyway, just above Delaware,
Small flocks of *canutus* drifting down through the air
Up ahead in the distance, they saw the end of their flight
Their wings were heavy and their fat was thin; they had to stop for the night.

They roosted on the shoreline, there was a salty smell.
The knots were thinking to themselves, "This could be heaven or this could be hell."
Sun rose up like a candle, and they saw to their dismay
There were no horseshoes spawning on the shore. I thought I heard them say...

Figure it out at the Hotel Boulderado, why our ancient race is gone without a trace.
Try to find out at the Hotel Boulderado, why now every year, there is less food here.

Her mind was *Tryngites*-twisted on arctic river bends
She got a lot of pretty, pretty boys she'll check out with her friends
Males dance on their courtyards, sweet summer lek
Trying not to remember their population's a wreck

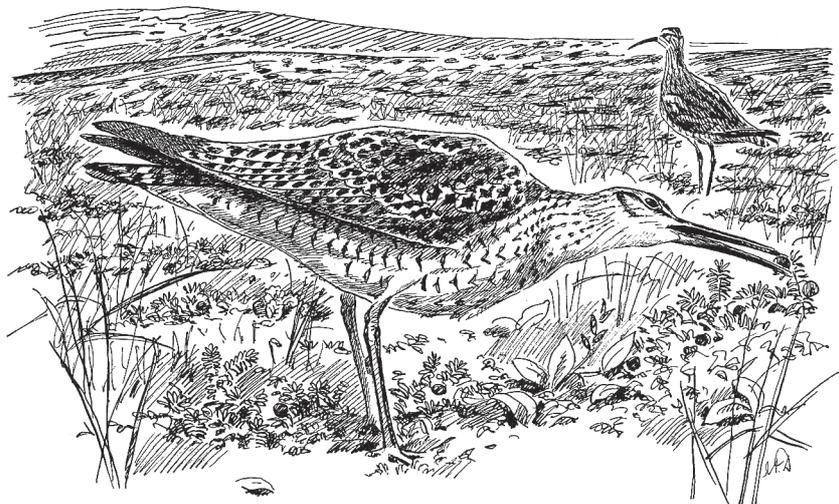
Don't go looking for buffies way down in the Argentine
There haven't been good numbers there since 1969
Now so few shorebirds are flying from far away
Over Kansas in the middle of the night, you can hear them say...

Figure it out at the Hotel Boulderado, why our ancient race is gone without a trace.
Try to find out at the Hotel Boulderado, such a rude surprise, to see our demise.

Trapped beneath a gray ceiling, in the land of snow and ice
Shorebirds are just prisoners here in a tightening vise
Out on the Copper Delta, Dunlin, Western and Least
They stab the mudflat with their slender bills, but they just can't find the feast.

Last thing I remember, they were flying from the shore
They had to find the passage back to where the habitat was before.
"Relax," said the falcon, "They are programmed to believe
They can stage here any time they like, but they can never leave!"

Figure it out at the Hotel Boulderado, such a big disgrace if we lose this race.
If we meet again at the Hotel Boulderado in some future year, will waders still be here?



Maksim Dementyev



PLENARY TALKS

Are we a flock and do we know where we are going?

Robert Gill, (robert_gill@usgs.gov), USGS, Alaska Science Center, Anchorage, Alaska

Core communities of shorebird enthusiasts in Australasia, Europe, and the Russian Federation exist and are driven by the recognized need for communication. Since the early 1980s several attempts have been made to unite those working on shorebirds in the Western Hemisphere. The result has been several successful taxon-specific, regional, and national efforts, but lacking has been a vehicle that promotes and facilitates communication among major shorebird interests throughout the hemisphere. This talk will explore past attempts to achieve a unified effort, look at how other shorebird groups throughout the world have tackled the issue, and offer ideas for a Western Hemisphere model that could function without adding undue structure and administrative burden. Foremost are vehicles that will foster communication, including:

- 1) a regularly scheduled meeting,
- 2) a website, and
- 3) an electronic newsletter.

The scientific meeting could be held every two years and rotate between sites in Latin America and North America, preferably in Latin America in conjunction with the Neotropical Ornithological Congress. The website (not a listserver!) would act as a portal or clearinghouse with links to information on shorebirds at various geographic scales from regional to international and include, for example, general information on species, a photo library, descriptions of field and analytical techniques, meeting announcements, a list of job opportunities, and a list of contacts. The electronic, multi-lingual newsletter would focus on the Western Hemisphere and be published twice a year by a team of regional editors/compilers that would:

- 1) report on ongoing projects,
- 2) provide regional summaries (e.g., Canada, United States, Mexico and Caribbean, northern and southern South America),
- 3) announce and facilitate cooperative projects,
- 4) feature individuals or regional shorebird groups, and
- 5) most importantly create and foster a hemispheric-wide shorebird identity.

These efforts would not require undue formal structure or a cumbersome governing body and they would not replace existing or prevent the formation of new entities dealing with shorebirds in the Western Hemisphere.

To beg, borrow and steal: the art of doing research on the East Asian–Australasian Flyway

Phil F. Battley, (philbattley@quicksilver.net.nz), Department of Mathematics and Statistics, University of Otago, New Zealand

The East Asian–Australasian Flyway (EAAF) reaches from breeding grounds in central Siberia to western Alaska, down through Asia to Australia and New Zealand. A fairly small

flyway in global bird terms (~7 million shorebirds), it contains around a third of the world's population. Unfortunately, this does not translate through to holding a third of the world's waterbird biologists, and the flyway is seriously under-resourced in terms of shorebird scientists. Nevertheless, an active Wader Study Group and a small number of university-based researchers are working on some of the principle migrants, including Red Knots, Great Knots and Bar-tailed Godwits. In this talk I will explore the development of migratory shorebird research in the EAAF, and highlight the problems to overcome in conducting such work. Some of these issues are common to all Flyways (funding, personnel), one we hope will not be (Avian Influenza), and some may be particular to the EAAF (large-scale reclamation, a politically off-limit country). We have overcome some of these constraints by begging, some by borrowing, and academically we are open to stealing good ideas. Certain species are high-profile research subjects in the EAAF, particularly godwits and knots, but while such flagship species may be required to promote the migratory shorebirds of a region, the majority of shorebirds on the EAAF does not migrate like these long-haul migrants. We may need to raise the profile of a smaller sandpiper to even the balance up.

Shorebird biology and the development of Columbian ornithology

Luis Germán Naranjo (Ignaranjo@wwf.org.co), Northern Andes Ecoregion Coordinator, WWF Colombia

The history of Colombian ornithology is the history of the country in the 20th century. However, the study of the biology of aquatic birds barely started in the 1940s, when pioneering work was done by a few Colombian ornithologists. After those first steps, only a few studies were carried out until the late 1970's, when the first inventory of sea and shorebirds in the country opened new fields of research and new opportunities for the participation of ornithologists in a wide range of endeavors. In this speech, I will analyze the contributions of shorebird biology to the development of modern ornithology in Colombia and Northern South America:

- 1) increased knowledge of the composition of shorebird communities has been instrumental for the identification of priority areas for conservation in the Pacific and Caribbean coasts
- 2) studies on habitat selection and foraging ecology of migratory shorebirds have helped to develop an integrated framework for the characterization of coastal ecosystems
- 3) long term banding studies have provided a solid basis for the design of monitoring protocols and more importantly, for the maintenance of training modules that have educated a growing number of dedicated ornithologists
- 4) the need to integrate the expectations of local communities into site management/conservation plans led to the design of innovative education tools reaching a large number of stakeholders in the Colombian Pacific coast
- 5) the development of policy instruments to promote the conservation of water birds and their habitats in Colombia has been facilitated by the growing body of knowledge on these species.



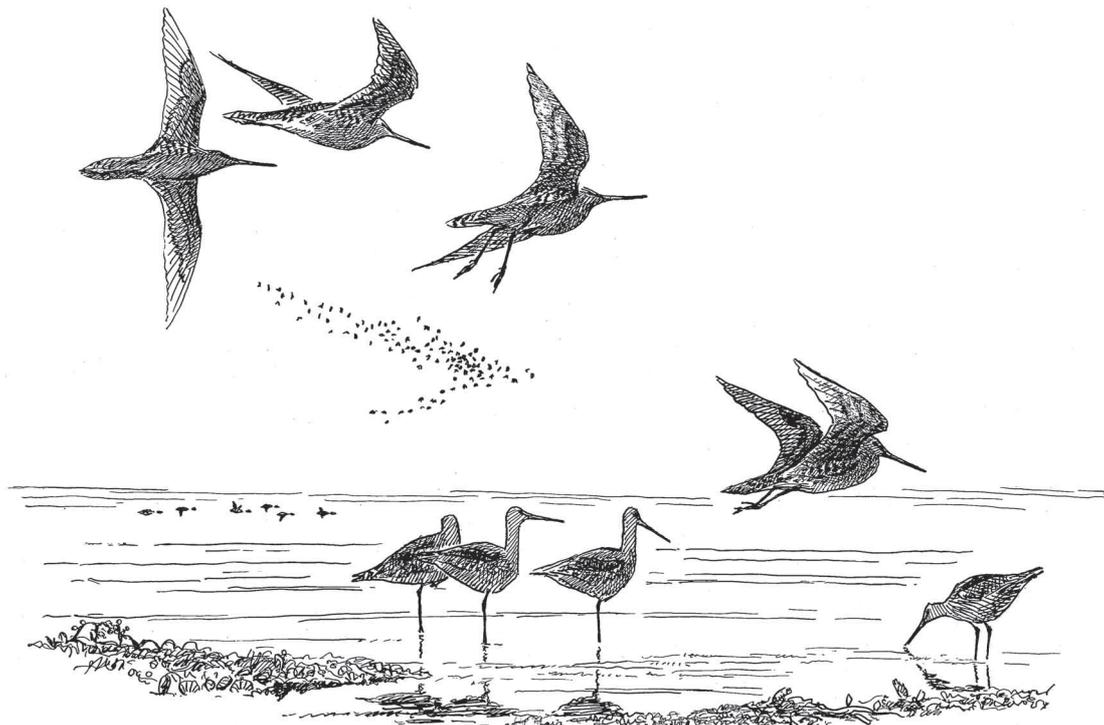
Waterbird biology is a vibrant field of study in Colombia and a significant proportion of ongoing research focus on shorebird ecology. Despite funding shortages and limited institutional support, shorebird biologists managed to occupy a research niche that was vacant for a very long time and are playing a major role in the collective development of the new Colombian ornithology.

**“Our” shorebirds: Gondwana northward
and back again**

*Lewis W. Oring (oring@cabnr.unr.edu), Department
of Natural Resources and Environmental Science,
University of Nevada, Reno*

All major shorebird families were Gondwana inventions. During the Miocene these groups expanded across North America yielding much of our modern shorebird fauna. At the end of the

Pliocene we entered a 2+ million year glacial period involving 17 glacial pulses spaced by intervening warm spells. Plant communities, megafauna and shorebird distribution patterns were radically altered. Then 13,200 years ago man entered North America, exerting new influences on shorebird distribution and abundance. In the 19th century yet more drastic human influences were exerted via market hunting and agriculture-related landscape change, resulting in severe declines in many shorebird species. Modern studies of shorebird populations and behavior (1900 to present) have not been conducted on pristine populations, but rather on populations resulting from and adapted to prior events. Details will be presented from studies of North American shorebird species, illustrating the dynamic nature of shorebird biology and its response to changing environments. We must be active participants in determining the rate and magnitude of environmental change.



Maksim Dementyev



SYMPOSIA

Buff-breasted Sandpiper Symposium

ORGANIZER: RICHARD LANCTOT (Richard_Lanctot@fws.gov)

Presentations given during the Buff-breasted Sandpiper symposium clearly demonstrated how cosmopolitan this species has become. From initial studies on the breeding grounds in northern Alaska in the early 1990s, biologists are now investigating how and where the species spends its time during the breeding season in Alaska, while migrating through the Midwestern United States, and when wintering in the southern cone of South America. This attention is primarily a result of the species being included in several national and international lists, including the Appendix I of the Convention on the Conservation of Migratory Species of Wild Animals, as a species of conservation concern in the United States and Canadian shorebird conservation plans, and as a Near Threatened species in the IUCN Red Data Book. Below I provide a brief summary of each presentation and then conclude by providing a list of research and conservation priorities identified during the symposium discussions.

During the first presentation, I provided background information on the species, including age and sex-related differences in plumage and morphology, seasonal movements and chronology, historic and contemporary declines in the species, and a description of limiting factors that may be affecting the species in the Arctic. I suggested that habitat loss and increasing predator numbers may be having a subtle but negative effect on the species' breeding range in Alaska.

Next, Joel Jorgensen and his colleagues described survey work performed in the Rainwater Basin (RWB) of Nebraska – a key migratory route for Buff-breasted Sandpipers as the birds pass northward through the Midwest on their way to the Arctic. By extrapolating densities established using distance sampling techniques, they estimated that between 16,000 and 32,000 birds pass through the RWB each year. This number is far higher than the previous world's population estimate of 15,000 to 20,000 individuals. This estimate, when matched with comparable or higher numbers from Wayne Norling in the Gulf Coastal Plain of Texas and Louisiana, indicated the species population size may be larger than previously thought. Joel also found that Buff-breasted Sandpipers showed some habitat selection, appearing to prefer soybean fields over corn fields and avoiding human development.

In the third presentation, Arne Lesterhuis and his colleagues described the distribution and number of Buff-breasted Sandpipers found historically and more recently in Paraguay. He described the relatively large (~4% of world population) and modest number of birds that use Bahía de Asunción during the spring and fall migration, respectively. Arne also summarized surveys conducted along the Paraguay River, which appears to be a major migratory corridor through Paraguay. A modest banding effort at Bahía de Asunción also resulted in the first direct links between Paraguay and Lagoa do Peixe National Park in Brazil (3 of 19 birds resighted). Finally, Arne indicated contaminants and habitat loss were the major threats to the species in Paraguay.

Next Daniel Blanco and his colleagues reviewed the species wintering distribution and habitat requirements in Argentina and Uruguay. They assessed different strategies to protect areas used by the species, with their work focused around Samborombón

Bay in Argentina and in the surroundings of the Rocha and Castillos coastal lagoons in Uruguay. In 2005, they evaluated different cattle management practices, assessed the interest of ranch owners to participate in a conservation initiative, and investigated different tools available to promote habitat conservation in private lands in both countries. Finally, they indicated habitat loss and contaminants might be the greatest threats to Buff-breasts in Argentina and Uruguay.

The fifth presentation by Juliana Almeida and her colleagues discussed site tenacity, density and body mass of Buff-breasted Sandpipers at three wintering locations in Brazil. Using the Double-observer sampling technique, they showed that the density of birds varied between 0 and 18 birds/ha throughout the winter months of 2003–2005, and was fairly consistent at the National Park Lagoa do Peixe and Torotama field sites. Using a large number of marked birds, they showed that the species exhibits high site-tenacity at the National Park (40–63%), allowing population modeling and estimates of apparent survival. The variable number of birds at the Taim field site also suggested that individuals move among sites depending on habitat suitability, which appears to be affected by vegetation height, water levels and soil moisture.

The last presentation by Khara Strum and colleagues discussed a new ecotoxicology study that will investigate the potential impacts of organophosphate and carbamate exposure on migrating and wintering shorebirds. Buff-breasted Sandpipers are particularly likely to encounter these agrochemicals due to their use of rice fields and sod farms. Field work will start in Texas, Kansas and Nebraska during the spring migration of 2006, and continue in Brazil, Argentina, Uruguay and Paraguay during the nonbreeding season in 2006. A combination of blood samples, feather samples and foot washing will be collected at each location, and the results will be compared between control sites and treatment sites. Information from this project will provide baseline data on the exposure of Buff-breasted Sandpipers and other migratory shorebirds to cholinesterase inhibiting pesticides, and will be used to assess habitat quality and to make recommendations for the regulation of pesticide use at important wintering grounds and migration stopover sites.

During the final hour of discussion, symposium participants (estimated at about 35 people) indicated the species should remain classified as a Near Threatened Species within the IUCN Red List, and identified a number of key areas to focus future research and conservation efforts. These included (not in order of priority):

1. *Non-breeding*

- determine in an experimental fashion how cattle management practices and moisture levels influence the use of an area,
- document exposure to contaminants of birds using rice fields,
- determine the most appropriate approach for maintaining nonbreeding areas in a fashion suitable for this species (e.g., land purchase or lease),
- estimate apparent adult survival, and begin modeling the population dynamics of the species.



2. Migration

- determine the migration pathway and whether any major stopover sites are present in the northern regions of South America,
- document length of stay to better ascertain the number of birds passing through the Rainwater Basin of Nebraska and other key migration stopover sites,
- document numbers of birds and length of stay at other key stopover sites in the Midwest, including Texas and Louisiana,
- document exposure to contaminants of birds using rice fields, sod farms, and other human-altered habitats.

3. Breeding

- determine how oil and gas development on the North Slope of Alaska and parts of northern Canada directly and indirectly influence Buff-breasted Sandpipers,
- better ascertain habitat use and geographic distribution.

4. All Stages

- complete a conservation plan for the species,
- conduct studies to connect birds using different breeding, migration, and nonbreeding areas using stable isotopes and genetic markers.
- ascertain the population size and trend of the species.

Finally, I think all symposium participants will agree that having all members of the Buff-breasted Sandpiper Working Group in one room at the same time provided a much needed catalyst that will ensure the species continues to be studied, that the most pressing questions are addressed, and that the ultimate goal of saving this near threatened species is realized.

Buff-breasted Sandpipers: natural history and factors limiting population growth

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The Buff-breasted Sandpiper is a medium-sized shorebird that breeds sporadically along arctic coasts in Russia, Alaska, and Canada; migrates through the central and eastern portions of North and South America; and winters in coastal areas of Argentina, Uruguay, and Brazil. Buff-breasted sandpipers are unique among North American shorebirds in having a lek mating system; although this system is far from a typical lek-breeder. Buff-breasted Sandpiper leks are very ephemeral in time and space, and males employ numerous tactics for obtaining mates. Once abundant, the population decreased substantially in numbers owing to commercial hunting in the late 1800s and to loss of habitat along its migratory route in the central United States and its wintering grounds in South America. Recent surveys on breeding, migration, and wintering grounds suggest this species may still be declining, although more study is needed to accurately determine the size of its population. In 1999, the Buff-breasted Sandpiper was added to Appendix I of the Convention on the Conservation of Migratory Species of Wild Animals at the request of Argentina. The species is also ranked as one of high concern in the United States and Canadian shorebird conservation plans, and is listed as “nearly threatened” in the Revised Brazilian Endangered Species List. These certifications encourage the study, management, and conservation of the species. Reasons for the lack of recovery will be discussed as an introduction to the other talks in this symposium.

Buff-breasted Sandpiper abundance, distribution, and habitat use during migration in the Rainwater Basin, Nebraska (and Texas)

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Department of Biology, University of Nebraska at
Omaha; John P. McCarty; L. LaReesa Wolfenbarger;
Marc Ealy; Brent Ortego*

The Buff-breasted Sandpiper is a shorebird of conservation concern whose migration is poorly understood. Only recently has the Rainwater Basin, Nebraska, been identified as a regularly-used and perhaps primary stopover site. We measured habitat use during spring stopover in both Nebraska and the Texas central coastal counties. At both regularly-used and important stopover areas birds were primarily found in agricultural fields. Agriculture covers more than 80% of the land area in the Rainwater Basin and along the coast in Texas. The Rainwater Basin is outside the focus of regional conservation efforts which focus on wetland and upland prairie restoration. We determined that birds are more likely to occupy landscapes within the Rainwater Basin that contain wetlands even though they were infrequently seen using wetlands, and birds were more likely to use turf grass farms and early growth stages of rice fields in Texas. We used a GIS to evaluate habitat use and generate a spatial model identifying areas within the Rainwater Basin, Nebraska, where Buff-breasted Sandpipers are more likely to be found during migration. Birds also prefer agricultural fields that were planted to soybeans the previous growing season over those in other land uses such as corn in Nebraska. Habitat use in the Rainwater Basin is compared to habitat use in Texas.

A review of the status of Buff-breasted Sandpiper *Tryngites subruficollis* in Paraguay

*Arne J. Lesterhuis (arne_j_lesterhuis@yahoo.co.uk),
Guyra Paraguay; Rob P. Clay; Cristina Morales;
Leticia López*

Little information exists regarding the distribution and habitat use of the Buff-breasted Sandpiper (*Tryngites subruficollis*) along its migration route. However, surveys conducted in Paraguay since 2000 have started to redress this. Fieldwork has primarily focused on the Bahía de Asunción, a shallow bay along the northern outskirts of Asunción, separated from the Paraguay River by a narrow peninsula. Small flocks of Buff-breasted Sandpipers occur regularly in the bay from September to November (mean size of 28.5 birds during 2004, maximum count of 250 birds), where they forage in areas of mesophytic and halophytic short-grass meadow. During 2004, 19 individuals were color-banded, and observations of these individuals plus other data suggest turnover rates of 3 to 7 days. Four of these birds were observed later in 2004 at Lagoa de Peixe, in southern Brazil. Surveys along the Paraguay River recorded small flocks (mean flock size 13) of Buff-breasted Sandpipers on sandbanks within the river, supporting speculation that the river is a key migration route for the species, though flocks also regularly occur away from the river. Insufficient data exist regarding population trends. However, habitat loss has occurred at a number of important stopover sites (desiccation and salinization in the Riacho Yacare Sur watershed, wetland drainage in Estero Patiño), and the Bahía de Asunción suffers from high levels of contamination. Birds at this site also suffer from disturbance and (to a lesser extent) hunting. Furthermore, planned dredging and canalization of the Paraguay River will likely reduce the future availability of sandbanks.



Buff-breasted Sandpiper habitat conservation in southern South America

*Daniel E. Blanco (deblanco@wamani.apc.org),
Wetlands International, Argentina; Diego Moreno*

The current population estimate for the Buff-Breasted Sandpiper (*Tryngites subruficollis*) is around 15,000–20,000 birds. Today the species is categorized as Low Risk and Near Threatened and it was included in the Appendix I of the Convention for Migratory Species (CMS).

Recent studies identified and described the species main wintering areas in southern South America, documenting a positive association with high grazed fields resulting from cattle raising. In this study we reviewed the species wintering distribution and habitat requirements as the basis for the development of an habitat conservation strategy in Samborombón bay (Argentina) and in the surroundings of the Rocha and Castillos coastal lagoons (Uruguay).

Our main objective is to assess different strategies pointed out to establish private protected areas in cattle raising lands, promoting those practices that improve habitat condition for this species. During 2005, we evaluated the main cattle management practices, the interest of ranch owners to participate in a conservation initiative and the different tools available to promote habitat conservation in private lands in both countries. After the interviews with land owners, we identified those properties of high priority for Buff-Breasted Sandpipers habitat conservation in Argentina and Uruguay. We discuss medium/long term strategies and present a working plan for the coming years.

Winter ecology of Buff-breasted Sandpipers at three Brazilian sites

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Lewis W. Oring; Richard B. Lanctot*

To obtain information on wintering ecology of Buff-breasted Sandpipers (BBSA), we monitored density, site fidelity, movement within and among sites, and body mass of individual birds at three major wintering sites in Brazil: Parque Nacional da Lagoa do Peixe (PNLP), Ilha da Torotama (IT) and Estação Ecológica do Taim (EET).

The density of birds varied among and within years at each site. Major differences were observed at EET where BBSA decreased from 15 to 0 birds/ha within 2002 and remained 0 birds/ha in 2003 and 2004. Densities of birds at IT and EET were less variable, but highly dependent on water levels in the surrounding areas. Most (222) of the 259 BBSA captured were at PNL; 27% and 63% of these birds were resighted in 2003

and 2004, respectively. Marked BBSA were resighted only at the site in which they were banded, and within PNL, they moved primarily between two of three pastures surveyed. Body mass of BBSA was measured for 70 males, 106 females and 39 juveniles.

Within each age and sex class, average body mass in November and February remained the same, suggesting that BBSA are not accumulating fat prior to migration.

These results suggest that the use of an area by BBSA is dependent upon the location and year, and that BBSA rely on stopover sites during northward migration. We recommend that future studies concentrate on long-term spatial use and habitat characteristics of wintering sites, and identify important stopover sites along the migration route.

Ecotoxicology of migratory shorebirds

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Biology, Kansas State University; Mike Hooper;
Kevin Johnson; Richard Lanctot; Brett Sandercock*

Monitoring programs indicate that numerous shorebird populations are subject to on-going declines. Twenty-seven shorebird species are listed as species of high concern and seven are highly imperiled, including the Buff-breasted Sandpiper (*Tryngites subruficollis*). One hypothesis for ongoing population declines is exposure to toxic chemicals and pollutants. The purpose of this project is to investigate the potential impacts of organophosphate and carbamate exposure on migrating and wintering shorebirds including the Buff-breasted Sandpiper. Consumption of these pesticides can shut down the respiratory system, and lead to death or cause a variety of sub-lethal effects. Buff-breasted Sandpipers are particularly likely to encounter these agrochemicals due to their habitat selection on the nonbreeding grounds. Sampling will commence with the spring migration in 2006 and will be conducted in Texas, Kansas, and Nebraska with a second season in 2007. Samples from wintering shorebirds will be obtained during the winter of 2006 from Brazil, Argentina, Uruguay and Paraguay. A combination of blood samples, feather samples, and foot washing will be collected from control sites, where pesticide exposure is unlikely, and treatment sites, where pesticide exposure is anticipated. Lower levels of cholinesterase activity and higher levels of reactivation indicative of organophosphate or carbamate poisoning are expected in areas where agrochemicals are in use. This project will provide baseline data on the exposure of shorebirds to cholinesterase inhibiting pesticides. Results will be used to assess habitat quality and to make recommendations for the regulation of pesticide use at important wintering grounds and migration stopover sites.



Marbled Godwit Symposium

ORGANIZER: ADRIAN FARMER (adrian_farmer@usgs.gov)

The Marbled Godwit Symposium was organized to include presenters on all aspects of the annual cycle, with the purpose of summarizing what was currently known about the species and identifying priority research and conservation topics. The lead presenter, Cheri Gratto-Trevor, presented an overview of the species' life history and summarized the state of knowledge about the species. Breeding populations and habitats were addressed by Neal Niemuth (mid-continent population), Diane Granfors (mid-continent population), Robert Gill (Alaska population), and Ken Abraham (James Bay population). Bridget Olson focused on migration habitats, especially the Bear River Migratory Bird Refuge, and wintering populations/habitats were addressed by Brad Winn (south Atlantic U.S.) and Guillermo Fernandez (Pacific U.S. and Mexico). The timing of the symposium was excellent because it helped to maintain momentum generated by other recent activities: a formal Marbled Godwit working group had recently been formed by interested biologists from Canada, Mexico and the U.S. the previous August, and a range-wide Conservation Plan had recently been completed under the auspices of the working group and the Manomet Center for Conservation Sciences.

Most Marbled Godwits (about 168,000 individuals) breed in the Canadian Prairies or the U.S. Northern Great Plains. Disjunct populations breed on the Alaska Peninsula (*L. fedoa beringiae*; about 200 individuals) and in the Hudson Bay area of Ontario and Quebec (about 2,000 individuals). Little is known about linkages between these breeding areas and specific wintering grounds. The mid-continent population is thought to winter on the Pacific coasts of California and Mexico, the Alaska subspecies is thought to winter in the northern part of the U.S. Pacific range, and the Hudson Bay population is believed to winter in the southeastern U.S. The main evidence for these presumed linkages is circumstantial; e.g. the total number of birds that winter along the southern Atlantic coast of the U.S., about 1,700 individuals, is roughly equal to the size of the Hudson Bay population, and it seems reasonable to assume that the most easterly breeding population would occupy the most easterly wintering grounds.

The status of migration habitats has been little studied. Recent work at the Bear River Migratory Bird Refuge, perhaps the most important migration stopover site in terms of number of Godwits (peak counts exceed 30,000 individuals), has shown that godwits stage there for up to three months during the fall migration, and that they do wing and body feather molt during this period, rather than on the wintering grounds as do the birds that winter along the southern Atlantic coasts. Wintering distributions along the southern Atlantic are relatively well-known, and godwits are regularly seen during the winter at several sites from North Carolina south to Florida.

There appears to be some site fidelity from year-to-year; e.g., the primary high-tide roost site in South Carolina is comprised of two boat docks on private property in the Cape Romain area. In contrast, wintering habitat and populations are less well known in the Pacific region. This region is thought to hold about 65% of the midcontinent population. The Pacific region also holds a significant over-summering population, suggesting that the region may be particularly important for younger, pre-breeding birds.

The Marbled Godwit has been categorized as a species of

special interest by the U.S. Fish and Wildlife Service and in the U.S. Shorebird Conservation Plan due to perceptions that populations have declined in recent years, and perhaps still are declining. However, there are few hard data to directly support this perception. The best evidence for changes in population status is indirect. There have been substantial losses of wetland and grassland habitats in the eastern portion (Minnesota and the eastern Dakotas) of the breeding range during the last 30 years. The Breeding Bird Survey (BBS) also shows very significant decreases in godwit numbers in this same region since the 1970's; hence there is an obvious correlation between habitat losses and decreases in godwits detected in BBS in this region. The BBS data also suggest that breeding numbers have been stable (or increased moderately in some sites) in other parts of the breeding range, so it would be natural to assume that range-wide populations have declined commensurate with breeding habitat losses, but such an assumption is not strongly supported by the existing information.

Symposium participants identified the need to begin work to establish linkages between wintering and breeding grounds, especially for the two disjunct breeding populations in Alaska and Canada. While still at the shorebird conference, participants began working on a proposal to begin a joint project to establish these linkages, perhaps using a combination of methods, genetics, stable isotopes, and satellite telemetry. Thus, the Marbled Godwit symposium had some immediate spin-off benefits in terms of getting interested parties together to plan joint research and conservation activities.

Introducing Marbled Godwits

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Marbled Godwits are one of only four species of godwits in the world, and one of the two primarily temperate breeding species. Most (about 168,000) Marbled Godwits breed in the Canadian Prairies or U.S. Great Plains, while an isolated population of approximately 3000 breeds on the Alaska Peninsula and another of about 2000 breeds in the Hudson Bay area of Ontario and Quebec. Marbled Godwit females are considerably larger in mass and bill length than males. The birds are monogamous, with bi-parental incubation of approximately 25 days. The precocial young fledge in about 28 days. Mate and site fidelity are high. In a study from 1995–2001 in Alberta, nests lost in June were rarely replaced, while most birds losing nests in May did replace the clutch. Nest success was variable (Mayfield 16–66%, average 25%), as was fledging success (in 18–60% of hatched nests, at least one chick fledged). Adult survival was very high (93%). Age of first breeding is unknown. Both adults remained with the brood until fledging in 24% of broods, the male remained longest in 58%, and the female longest in 18%. Only one marked Alberta godwit wintered in California, with the remainder in Mexico. The Alaskan subspecies is thought to winter in the northern part of the U.S. Pacific coast range, and the Hudson Bay population in the southeastern U.S. coast, but data are lacking. The origin of birds wintering in more southern areas of California is unknown.



Population assessment of Marbled Godwits in Alaska

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In May 2004 and 2005 we surveyed the Alaska-breeding population of Marbled Godwits (*L. f. beringiae*) across a major portion of their suspected breeding range to estimate the size of this isolated population. We surveyed 352 point transects across a stratified random sample of 24 plots (5 × 5 km²) to delineate breeding range and to identify fine-scale nesting habitats. Godwits were restricted to 12 plots within a 130 × 50 km² area of the central Alaska Peninsula in southwest Alaska. Average detection rate (godwits per point) on ground plots was 0.34±0.51 SD (*n* = 128 godwits in 106 groups). We surveyed 840 km of aerial line transects to estimate density of breeding godwits within two areas located to the east (600 sq km in size) and south (1,500 km²) of Ugashik Bay (57°33'N, 157°37'W). We detected a total of 64 godwits in 46 groups with almost all sightings occurring on the larger census area south of Ugashik Bay. We estimated densities (using DISTANCE) at 0.862±0.208 SE godwits per sq km on the southern census area and 0.098±0.065 on the eastern area. These densities project to a population estimate of 1,352 birds (859–2,204 95% CI) over the two census areas combined. Based on available information, the two census areas likely represent about half of this subspecies' breeding range in Alaska. Surveys in 2006 will focus on the remainder of the range so that we can generate a population estimate for the *beringiae* population.

Distribution and abundance of Marbled Godwit in James Bay, Canada

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A small, unquantified breeding population of Marbled Godwit occurs in James Bay, Canada. Distribution has been reasonably assessed by two iterations of the Ontario Breeding Bird Atlas (1981–1985, 2001–2005). Distribution was similar in both atlases and does not appear to have changed since the 1960s. Although confirmed breeding evidence (nests and young) is sparse, behavior indicates widespread, low-density breeding. Marbled Godwits were observed during the presumed breeding season from the Quebec-Ontario border to north-west James Bay, including Akimiski Island. This represents a coastline of over 900 km dominated by intertidal, supratidal and fen habitats with abundant wetlands. Short-graminoid habitat, with wetlands suitable for breeding, occurs in two primary circumstances: the intertidal-supratidal zone (which varies from a few metres to almost 5 km wide) and the muskeg – wet tundra zone (which is extensive in parts of the range where Godwits were observed). Highest observed densities occur on Akimiski Island (0.5–1.0 pairs per linear km). Assuming that mainland coastal intertidal–supratidal areas are uniformly occupied at the lower (conservative) density, a crude estimate of 450 pairs is obtained (however, this assumption may be unwarranted; abundance is, at best, a guess at this time). However, we estimated over 150 pairs on Akimiski Island using more intensive methods. Occurrence in the muskeg and tundra habitats is so poorly known that no estimate can be made, but this habitat type is extensive in the north-west part of James Bay and interior Akimiski Island, and has potential as breeding habitat for many additional breeding pairs.

Understanding mid-continent Marbled Godwit populations in a landscape context

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Populations of Marbled Godwits appear to be declining in portions of the Prairie Pothole Region, which is the core of the species' range. However, our ability to infer population status and trend is limited by a paucity of data. Breeding Bird Survey data provide some insight into patterns of population trend, but their effectiveness is diminished by timing of surveys and the limited number of routes on which Marbled Godwits were detected. In an attempt to gain a better understanding of Marbled Godwits and assist in their conservation, the U.S. Fish and Wildlife Service has initiated surveys for breeding shorebirds in the Prairie Pothole Region. Data from these surveys indicate that Marbled Godwits were more likely to be found in landscapes with greater amounts of native prairie and temporary, seasonal, and semi-permanent wetlands and little forest cover.

In addition, Marbled Godwits were more likely to use wetlands with extensive shorelines, brackish or saline water, little emergent vegetation, and surrounded by a grassland buffer or with large amounts of grassland in the surrounding landscape. Data from surveys were used to create spatially explicit models, which agree well with conceptual models developed from expert opinion. These models are used to guide conservation efforts and develop estimates of Marbled Godwit populations in the region. Population estimates are highly dependent on assumptions, which highlight the need for additional, basic information on the ecology of breeding Marbled Godwits.

Mid-continent Marbled Godwits: past privation, current pressures, and future prospects

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Marbled Godwits have suffered significant range contraction in mid-continent breeding areas, primarily in the southeastern portion of the range. Widespread conversion of grass and wetland landscapes to agriculture during early European settlement was no doubt a large contributing factor to the demise of godwits in their southeastern range. Areas previously unsuitable for tillage retain seemingly stable core populations, though numbers may still be declining on the fringes.

Where wetland and grassland habitats remain, habitat quality may be declining due to agricultural byproducts such as siltation and pesticides. Additional threats include conversion from a mixed farming–ranching agricultural system to a more uniform cropland landscape, lack of disturbance to set back succession on protected lands, and invasive species in native prairies. As human encroachment continues, new pressures include development of innovative methods for converting untilled land into tillable acres, powerline construction through pristine areas, and exurban development along human population corridors.

Federal programs such as the Conservation Reserve Program, Wetland Reserve Program, and grassland and wetland easements show promise for restoring some of the habitat loss, but care must be taken that such programs are applied judiciously due to limited funding. The philopatric nature of Marbled Godwits may also have consequences for what can be done to restore populations and how restoration efforts should be managed.



The role of Bear River Migratory Bird Refuge in conservation of the Marbled Godwit

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Bear River Migratory Bird Refuge can host up to 25% (43,000) of the global population of Marbled Godwit. Systematic counts of Refuge waterbirds (1946 to present) reveal a trend of increasing use by Marbled Godwit as evidenced by higher monthly averages in the past fourteen years. As a Refuge priority species, the habitat requirements of the Marbled Godwit are given special consideration during the annual habitat management planning process. To further define the role of the Refuge in the conservation of Marbled Godwits, a project to determine capture methods, marking protocols and migration ecology was initiated in April of 2005. A total of 19 godwits were captured using decoys, taped-calls and mist nets. A color band, engraved with a duplicated alpha-numeric combination was fitted on each upper leg for re-sighting. Using standard glue-on attachment protocols, a total of seven birds were equipped with radio transmitters (2 in April, 5 in August, 2005). Two birds caught 25 April were detected only one day post catch. Five birds captured 11 August remained in the vicinity of the Refuge for 21 to 47 days post capture. Marbled Godwits caught in August on the Refuge were undergoing a full body molt. Prior to this discovery, Marbled Godwits were thought to molt on their wintering grounds in Mexico.

The distribution and estimate of wintering Marbled Godwit in the south-eastern Atlantic states

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Wintering Marbled Godwit (MAGO) are found regularly in the Atlantic States of North Carolina, South Carolina, Georgia, and Florida. A small number of specific locations appear to support the majority of wintering marbled godwit in the SE states. Several important sites for Marbled Godwit in North Carolina (including recent high counts), are Rachel Carson NERR (375, December 2005), Howell Rock, Shackleford Banks, Masonboro Island (158, December 2004), Lower Cape Fear River (141, December 2004), Clam Shoals and Ocracoke Inlet (312, December 2003). Most winter distribution data from North Carolina is from Christmas Bird Counts (CBC). A South Carolina statewide winter survey in 2001 documented a total of 462 MAGO. The primary winter high tide roosting habitat was 2 docks on the AICW in Cape Romain. Two surveys just in Cape Romain NWR had the peak counts for the state. One on 15 September

2003, with 960 MAGO and the second was 10 January 2002, with 626. For Georgia, the results of an annual winter waterbird survey indicate the importance of two areas which support an average of 91% of MAGO in that state. The first is St Catherines Sound, including the South end of Ossabaw Island, St Catherines Island Bar, and the North beach of St Catherines Island. The second site includes the islands of the Altamaha River mouth, Wolf Island NWR, Little Egg Island Bar, and Little St Simons Island. Winter counts of MAGO in Georgia average 324 \pm 95, range 165–442, $n = 7$. Site fidelity of individually marked godwit appears to be very high, both within and between years. There is some limited movement between Georgia's two main wintering areas as well as movement out-of-state. Most Marbled Godwit appear to leave Georgia in mid May, and reappear in larger numbers by late July. Individually marked adult birds have returned as early as 27 June.

Overview of Marbled Godwit abundance and distribution in Mexico

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Eduardo Palacios; Xicoténcatl Vega-Picos

A paucity of information on shorebird abundance and distribution during the nonbreeding season has precluded quantitative assessment of population trends, limiting factors, and conservation actions. We reviewed the information available for Marbled Godwits (*Limosa fedoa*) in México. Although most studies are limited in seasonality and area surveyed, the Pacific and Gulf of California region host the largest concentrations of wintering Marbled Godwits, and combined they are believed to host ~65% of the mid-continental population in winter. Marbled Godwits are the second most abundant species in Baja California and delta del Río Colorado (25% and 9% of the wintering shorebirds respectively), while in the southern Pacific and Gulf of Mexico coasts Marbled Godwits made up less than 3% of the wintering shorebirds. Also, the Pacific and Gulf of California region host a significant over-summering population, suggesting that the region may be particularly important for younger birds. By far the most important site is the complex Ojo de Liebre–Guerrero Negro in the Baja California, where the winter high count of nearly 70,000 could represent up to 50% of the global population. Most foraging Marbled Godwits are restricted to intertidal mudflats; while during high tide, godwits roost at salt ponds and nearby marshes adjacent to bays and lagoons. Although some important sites are designated as protected areas, site managers do not consider shorebirds among their priority actions. Adequate monitoring and research programs to assess population distribution, trends, and structure of Marbled Godwits in Mexico should be made a high priority.



Western Sandpiper Symposium

ORGANIZER: DAVID B. LANK (dlank@sfu.ca)

Research on Western Sandpipers has flourished in the past 15 years due to independent initiatives taken by Canadian, U.S., and Latin American researchers, and communication among many of them through the loosely organized Western Sandpiper Research Network. The network has held eight somewhat annual workshops over the past 10 years. The 2005 meeting in Portland was one of several at which the Shorebird Research Group of the Americas organized itself, and it also helped stimulate the organization of this thrilling Shorebird Science meeting.

The Western Sandpiper symposium was thus our 9th workshop. It included contributions from breeding grounds, migration stopovers and non-breeding grounds, covering topics from breeding dispersion (Matthew Johnson) to habitat use and moult on wintering grounds (Lorena Morales-Gopar, Guillermo Fernández and Daniel Galindo-Espinosa), behavioral ecology of feeding/danger tradeoffs on migration (Andrea Pomeroy), novel feeding techniques and sources (Dieta Lund and Tomohiro Kuwae) and ways to measure them (Rob Butler), an individually based model of northward migration (Caz Taylor), a review of population trends and the prospects for historical reconstructions of same (myself), and presentation of the Western Sandpiper Conservation Plan (Guillermo Fernández). As a special treat, our session was followed immediately by a rescheduled Plenary presentation by Luis Naranjo, whose pioneering netting of Western Sandpipers off the coast of Columbia set the stage for much future work on the non-breeding grounds. I, for one, had not appreciated the logistical difficulty of this field work.

The most controversial papers in the symposium presented support for the hypothesis that Western Sandpipers – and presumably other calidrids – obtain a substantial fraction of their diet through ingestion and assimilation of biofilm, a mucilaginous matrix of carbohydrate and algae produced on the surface of mudflats. Bob Elner, from the Canadian Wildlife Service in Delta BC, has been advancing this theory for several years, supported in part by ultrastructural analysis of sandpiper tongues (Elner *et al.* 2005. *Marine Biology* 146: 1223–1234). Dieta Lund reviewed ultrastructural, behavioural, and direct evidence from stomach contents (e.g. diatoms) to establish that the birds ingest more sediment than might be expected if intake were simply incidental to taking larger prey items. Tomohiro Kuwae, a visiting scientist from Japan to the CWS, showed high speed videos of sandpipers feeding movements, and presented a stable isotope analysis that suggests that 25–50% of migrant Western Sandpipers' diets derive from biofilm. Essentially, carbon and nitrogen isotope ratios of the birds' faeces were too close to that of primary producers to be generated by feeding on invertebrate prey. This makes these sandpipers the first known vertebrate "primary consumers", feeding in part at the same trophic level as most of their macroinvertebrate prey.

One is reminded of the situation 10–12 years ago when the Dutch group reevaluated their assessment of the food available on Mauritania's coastline by including previously neglected meiofauna component. It now appears that we shall have to go to an even smaller level, and include the "snot", as Elner's folks fondly call the biofilm, as a non-trivial diet component for sandpipers. How, you may ask, can we measure its abundance? Rob Butler suggested that infrared pictures of mudflats may help. Previous work showed that such pictures did not well predict

macro-invertebrate abundances on mudflats (Pomeroy & Butler 2005. *Waterbirds* 28: 1–7). However, Rob reported that the relationship between the pictures and measures of biofilm was much more promising.

Additional papers on Westerns were presented outside the symposium. Matthew Johnson's experimental paper on parent-offspring communication won the "Best Student" paper award. Audrey Taylor noted that surprising numbers of Westerns move to the North Slope of Alaska prior to migrating southward. Jorge Correa-Sandoval presented both a talk on population structure and habitat use at his study site on the Yucatan Peninsula. Ryan Norris presented a poster showing that trace element profiles from flight feathers could distinguish birds caught on beaches as little as 2 km apart, adding this is a potential tool for assessing migratory connectivity. Mary-Anne Bishop updated her work with Nils Warnock and others on their on-going radio-tracking studies of Westerns and other species, with a focus on the Copper River Delta.

The Western Sandpiper symposium focused on research and spent relatively little time on conservation issues, compared with other species groups. We remain poorly informed about population trend, perhaps the most basic question of all. The information reviewed and presented in my talk was unconvincing with respect to evidence for or against major population change in Western Sandpipers. I did suggest that assembling additional existing data particularly from the West Coast and wintering areas should be a priority, as well as returning to resurvey selected places with counts from past years, replicating their methodology. Guillermo Fernandez distributed a draft Western Sandpiper Conservation Plan for comment, developed with support from Manomet Centre for Conservation Science and the Western Hemisphere Reserve Network. The lesser emphasis on conservation and greater emphasis on research in the Western Sandpiper symposium reflect the species' abundance, on the one hand, which may mask real problems, and on the other hand, the relative ease of working with the species, which is fairly easy to catch and observe.

Because we ceded time to Naranjo's rescheduled talk, our general discussion was limited. I will suggest here themes that might have emerged. We believe that using Western Sandpipers as a "model species" to develop techniques and test hypotheses, which may then be more efficiently applied to or tested with other less tractable species of greater immediate concern, has and will continue to be of value. For example, studies of Western Sandpipers by Tony Williams and his students have provided justification and guided interpretation for using circulating triglycerides levels as indices of fattening rate, through captive and field studies (Seaman *et al.* 2005. *J. Exp. Biol.* 208: 761–769; Guglielmo *et al.* 2002. *Auk* 119: 437–445; Ydenberg *et al.* 2002. *J. Avian Biol.* 33: 47–55). We have detected non-breeding patterns of population differentiation with respect to sexes, age classes, body size, and life-history patterns (Nebel *et al.* 2002. *Auk* 119: 922–928; O'Hara *et al.* 2005. *J. Avian Biol.* 36: 191–202; O'Hara *et al.* 2006, *Condor* 108: 225–232), with substantial implications for conservation action, which may well occur in other species, but be more difficult to detect. We expect our basic research to continue with an eye on this larger goal.



Proximate and ultimate factors that promote aggregated breeding in a territorial species: are monogamous breeding aggregations an evolutionary precursor to coloniality or polygamy?

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Breeding aggregations have been observed in numerous aquatic and terrestrial animals. We assume that animals aggregate because the costs of social interaction are alleviated by fitness gains, and hypotheses explaining aggregated breeding may be grouped as either resource-based (natural selection) or socially driven (sexual selection). Mechanistic and evolutionary processes that result in avian breeding aggregations are often studied among colonial nesting and lekking species. I am investigating social and other ecological factors that promote aggregated breeding in the monogamous Western Sandpiper. I investigate proximate and ultimate mechanisms underlying monogamous breeding aggregations and ask whether breeding aggregations represent an evolutionary precursor to coloniality or polygamy. Analyses indicate the distributions of birds/nests are aggregated (rather than random or even), and male behaviors are correlated with nearest-neighbor distances. Aggregated males chase conspecifics less frequently compared to more dispersed individuals. Breeding aggregations are not associated with obvious habitat features and are not spatially consistent across years. Reduced male agonistic behavior among aggregated individuals lends support to the hypothesis that aggregated breeding in this system represents an evolutionary precursor to coloniality. Greater male-male competition among aggregated individuals would be expected if selection favored breeding aggregations as a precursor to polygamy. Alternately, males may aggregate to increase their probability of obtaining a mate. Aggregations may be more conspicuous to unpaired females (Allee effect), or recently arrived males may cluster around established individuals to accelerate access to potential mates. Future study in this system will examine the effect male aggregation has on mate acquisition and reproductive success.

Use of coastal and alternative habitats by Western Sandpiper in Ensenada de La Paz, B.C.S, Mexico

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In Ensenada de La Paz, the Western Sandpiper commonly occupies coastal mudflats, but also uses oxidation ponds as alternative habitats. Our objective was to compare the use and distribution of Western Sandpiper between these two environments. We estimated abundance and density through simultaneous census twice monthly (August 2004 to April 2005). Additionally, we surveyed the oxidation ponds during high tide periods. Sex ratio, age groups, predator presence and prey abundance were determined at both sites. Density was not different between habitats during fall ($p = 0.21$); however, during winter and spring the coastal area had higher densities ($p < 0.05$). This may relate to the greater energetic demand that the southward migration entails. Western Sandpipers preferentially used the oxidation ponds during high tide periods ($p < 0.05$). There were no differences between sites regarding sex ratio ($p = 0.30$), with close to 65% of males for both areas. Adults represented

a higher proportion of the coastal aggregations during winter ($p < 0.05$), whereas juveniles were predominant at the oxidation ponds. Juveniles may be relegated to suboptimal habitats by the adults. Predators were more abundant at the oxidation ponds, contributing to a higher predation risk. Preliminary data showed that prey abundance was equal for both sites in early fall; additionally we demonstrated that a sample size of 12 mud cores (26 mm in diameter and 40 mm deep) are enough to properly estimate prey abundance at those areas. The described differences in habitat use and predator abundance suggest that coastal mudflats might be a better habitat for Western Sandpipers than oxidation ponds.

Differences in patterns of wing feather molt between Western and Least Sandpipers

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Guillermo Fernández; Luis Sauma

Intraspecific patterns of wing feather molt are not well known in Nearctic migratory shorebirds. Here, we examined differences in the phenology of wing feather molt and standardized body mass between sex classes of Western Sandpipers (*Calidris mauri*, WESA) and Least Sandpipers (*C. minutilla*, LESA) in Ensenada de La Paz, Mexico. From 2001–2003, we captured 710 adult sandpipers (WESA = 529 and LESA = 181) throughout the June–October migratory period. Patterns of wing feather molt differed between species. LESA completed wing feather molt before WESA (August–September vs. August–October). In both species, all individuals had a complete uninterrupted molt, starting with the first innermost primaries (1st–5th), then progressing outwards, with the 9th and 10th primaries molted last. Some individuals molted their wing feathers in La Paz and continued their southward migration. Within each species, the phenology of wing feather molt did not differ between sex classes. The relationship between standardized body mass and total molt score differed between species. In WESA, both sexes decreased their standardized body mass as total molt score increased, but females changed their body mass more rapidly than did males. Conversely, in LESA standardized body mass did not change with total molt score between sex classes. Our results, coupled with known molting schedules, indicate that wing feather molt of sandpipers in La Paz started earlier but more leisurely compared to those in Panamá, suggesting that patterns of wing molt are related to migration distance.

Sex- and age-related differences in preparation for northward migration in Western Sandpipers

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Western Sandpipers (*Calidris mauri*) are differential migrants by sex and age on their nonbreeding grounds. Earlier passage of males in the spring has been explained by sexual differences in winter latitude (male-biased sex ratios at more northerly areas) and onset of migration (males departing earlier). In February–April 2000, I examined patterns of population structure, body mass, rate of fat deposition, and prealternate molt among sex-age categories of Western Sandpipers at Bahía Santa María, north-west Mexico. The proportion of males among captured birds decreased throughout the February–April migratory period. However, the age composition within each sex did not differ. Western Sandpipers became heavier and had a higher fat score throughout the migratory period, with differences among



sex-age categories. Adults were marginally heavier than juveniles, and females were lighter but had a higher mass gain than males. Adults also increased their fat score faster than juveniles, and females were more likely to have a higher fat score than males. The extent of prealternate molt differed among sex-age categories. Adults molted into breeding plumage faster than juveniles. Within adults, both sexes molted similarly during the migratory period, whereas within juveniles, males molted at a slower rate than females. These results indicate that adult males departed earlier and at relatively lighter weights than adult females, and juvenile males were more likely to stay in the area. For adults, especially males, there may be selection to reach the breeding grounds early because they must arrive early enough to compete against other males for nesting territories.

Biofilm in the diet of the Western Sandpiper

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Western Sandpipers (*Calidris mauri*) are Alaska-breeding shorebirds that migrate to the southern US and northern South America for winter. During this migration, large numbers of the birds (up to 500,000 estimated in a single day) stopover in the Fraser River estuary to refuel. Traditionally, they have been thought to be feeding primarily on large macrofauna such as polychaetes and amphipods by probing and pecking in the muddy substrate. However, recent investigations into tongue and bill morphology as well as isotope analysis of fecal samples and field observations suggest that sandpipers may be instead feeding primarily, or at least additionally, on microalgae, meiofauna, and organic detritus suspended in a thin layer of water on top of the mud, collectively known as biofilm. In order to investigate this hypothesis, an analysis of the stomach contents of Western Sandpipers ($n = 98$) and Dunlin ($n = 60$) has been undertaken, that in contrast with previous studies, looks specifically at biofilm components, such as diatoms. Initial results appear to support the idea of the Western Sandpiper as a primary consumer, especially the finding that diatomaceous sediment, indicative of biofilm-intake, accounts for the vast majority of the stomach volume – whereas identifiable prey remains make up only a small fraction. The Western Sandpiper contents are also compared with those of Dunlin collected from the same foraging flock. The final results of this study could have implications for the conservation efforts of the Western Sandpiper and the protection of its foraging habitat.

Biofilm as a primary diet for Western Sandpipers: evidence from stable isotope ratios and foraging behavior

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Sandpipers obtain their prey from sediments and soils. Although a broad size spectrum of prey has been reported, focal observations of feeding behavior and field experiments often result in missing captured items; thereby the presence of other hitherto unknown small size food has been suspected. Here we show, using stable isotopes and the detailed video image analysis of feeding behavior, that biofilm on mud sediment surface is a primary food source for Western Sandpipers (*Calidris mauri*). This new food source, biofilm, contributes 24–52% of total food source for the sandpipers. The discovery of the quantitative

importance of biofilm as a diet of Western Sandpipers, which is also the first report of biofilm grazers in vertebrates, places them as primary consumers and extends the conventional concept of sandpipers as secondary or higher consumers in the trophic level of intertidal flat ecosystems.

Remote sensing of shorebird prey

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The recent discovery by Elnor and his colleagues that biofilm is an important source of prey for Western Sandpiper opens opportunities to remotely census relative prey densities within and between beaches using infrared photography. We show that infrared photography is useful to determine the relative densities of phytoenthos on beaches in British Columbia. On a geographic scale, chlorophyll a concentration as a measure of biofilm densities are also available on the internet and have been used to estimate shorebird distributions world wide.

Food abundance and danger from predators affects stopover site usage by Western Sandpipers in the Georgia Basin and Puget Sound region

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On migration, birds should acquire reserves quickly while avoiding predators that hunt them. Therefore, to optimize migration, birds should use sites that are both safe from predators and rich in food. We tested the hypothesis that migrant Western Sandpipers select stopover sites that balance food abundance and safety from predators by measuring macro-invertebrate density, safety, and site usage by sandpipers at 18 mud and sand flats in the Georgia Basin/Puget Sound region. At each site, invertebrate density was measured by mud core sampling. Since predation danger for shorebirds is highest close to the shoreline where there is approach cover for falcons, the maximum distance from the shoreline at each site was used as an index of safety. We predicted that sandpipers would use sites that were high in food and safe from predators while sites that were dangerous and low in food would not be used. Of 18 sites, nine were used by Western Sandpipers on migration. The sites that were used had greater invertebrate densities (t-test: $P < 0.0001$) and were safer (t-test: $P = 0.02$) than those not used. Nominal logistic regression was used to estimate the probability of site usage. A model including both food and safety was a better predictor of usage than either variable alone ($\div 2 = 11.19$, $P = 0.004$, $R(U)^2 = 0.45$). This model correctly predicted usage of 15 of the 18 sites surveyed. Our results support the hypothesis that Western Sandpipers use stopover sites that balance food and safety on migration.

An individual-based model of the migration of Western Sandpipers along the north Pacific coast

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We will report on initial results from an individual-based model of the northward migration of Western Sandpipers along the coastal Pacific Flyway. The model simulates daily movements



of individual birds between stopover sites from San Francisco to their Alaskan breeding grounds. At each site, food or energy intake is influenced by the density of other birds at the stopover site; mortality due to predation is influenced by both numbers of conspecifics at the site and by individual fuel stores of the migrating birds; and flight distance is affected by wind conditions and individual fuel stores. Movement between sites is controlled by departure and stopover behavioral decision rules that can be unique to each individual. By optimizing for arrival time and fuel levels at arrival, we find the best behavioral strategies and determine to what extent these are influenced by density of conspecifics, by food intake rates, by date, by distance along the flyway, by predation, by wind conditions and by individual fuel stores. The model will be used to assess the consequences of changes in stopover site availability and suitability on migration patterns.

An approach to reconstructing shorebird population changes in the absence of monitoring data

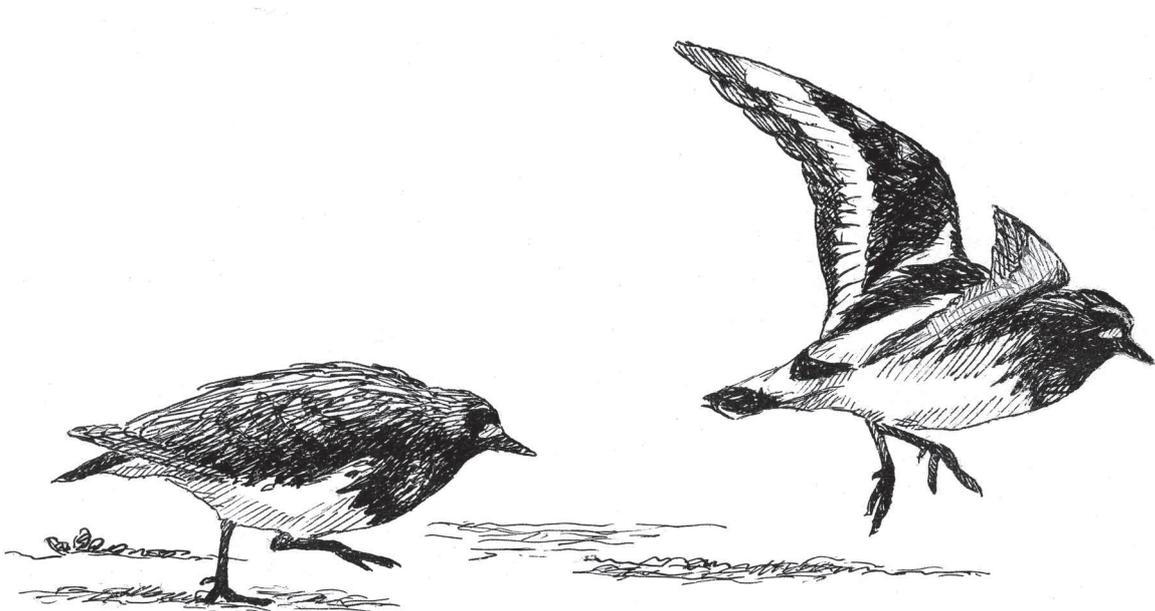
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Current opinion about shorebird population trends in North

America derives largely from the International Shorebird Survey and or Maritime Shorebird Survey monitoring schemes established in eastern North America since the 1970s. Unfortunately, these provided limited or no coverage of species and populations migrating through the center and western part of the continent and hemisphere. Is it possible to reconstruct an index of shorebird population size changes in the absence of such data? We consider the prognosis for doing so for Western Sandpipers, an abundant species where current opinion about long term population trends is based on examples from very few sites. The basic approach will be to:

1. obtain as many records as possible of historical counts
2. replicate such counts over the coming years by site, date, and methodology, cognizant of changes in the physical properties of sites
3. plot differences from current counts in a chronological sequence.

Such sequences could show long-term trends, cycles on multi-year scales (e.g. arctic rodent-driven), cycles on climatological scales (e.g. El Niño), or nothing at all. Despite issues of scale and statistical rigor, such an approach should enable us to make substantially more confident statements about population trends than we are able to at present.



Maksim Dementyev



Long-billed Curlew Symposium

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The Long-billed Curlew symposium was organized to facilitate sharing of research and management ideas among the rapidly growing community of persons concerned about this highly imperiled species. More than 50 people attended all or most symposium presentations and participated in the closing discussion. There were seven presented papers: four concerned with breeding biology and habitat relationships on the breeding grounds, one about the changing landscape in the Midwest and its impact on curlew breeding distribution, one relating to conservation and management on the breeding grounds, and one describing abundance, spatial distributions and social systems on the non-breeding grounds.

Long-billed Curlews suffered a severe decline in the 19th century due, initially, to market hunting followed swiftly by extensive destruction of prairie. Recently the species has erroneously been thought of as a short-grass prairie species while, in fact, it once thrived throughout the tall grass prairie biome. The species never fully recovered from market hunting. Recent declines have continued with ongoing loss of prairie; however populations have increased in areas of the west where curlews are breeding at unparalleled densities in irrigated pastures and hayfields. Many ranching areas are threatened or are likely to be threatened by urban development and the loss of water rights. Loss of non-native grasslands would be devastating to Long-billed Curlew populations, especially in the west. Conservation of Long-billed Curlew breeding habitat, therefore requires a concerted effort to maintain viable ranching operations.

The most urgent priority for the future is determining the global population of Long-billed Curlews. The lack of an accurate global population estimate is a detriment to conservation planning. The most logical life history stage for assessing curlew population size is winter since this is when birds are most aggregated and most likely to be consistently positioned for a lengthy period of time. A coordinated winter survey should be conducted in the near future. In addition to measuring Long-billed Curlew population size, this survey will allow delineation of important Long-billed Curlew wintering areas, especially in previously unsurveyed areas of interior Mexico.

Perhaps the most important breakthrough of the Long-billed Curlew Symposium was a new awareness that exposure to contaminants on the wintering grounds likely is impacting Long-billed Curlew breeding success by reducing egg hatchability. Among successful Long-billed Curlew nests, 20% and 24% of eggs failed to hatch in northeastern Nevada and western South Dakota, respectively. This had the direct effect of lowering chick production and the indirect effect of lowering the fledging probability of chicks from smaller broods. An analysis of eggshells for the northeastern Nevada population showed that eggshell thickness was significantly thinner than pre-DDT specimens. It was agreed that an ecotoxicology study is urgently needed to identify the source of Long-billed Curlew egg inviability. In 2006, a sample of Long-billed Curlew eggs from northeastern Nevada and western South Dakota will be collected for preliminary ecotoxicology analyses.

Another Long-billed Curlew research priority is linking breeding and overwintering locations of specific populations. This information is critical for managing Long-billed Curlew habitats for specific populations throughout the year. In addition, if reduced egg hatchability in Nevada and South Dakota

are in due to contaminants picked up on the wintering grounds, identifying where birds are accumulating these contaminants is a necessary first step for addressing the problem. In the near future, Long-billed Curlews in South Dakota and Nevada will be fitted with satellite transmitters to track migration routes, identify staging areas and determine overwinter destinations.

There is a growing awareness of the complexity of predation relative to curlew reproductive success. Both the source of predation and its intensity vary enormously from site to site indicating a need for long-term, landscape level studies both of predation, and of predator life histories. As human activities continue to cause increases in predator populations, this problem is likely to become even more severe.

The working group also proposed development of a Long-billed Curlew research "handbook" in order to standardize research protocols. This would include information on trapping methods, banding protocols, nest searching and monitoring, and vegetation sampling. This handbook would allow for some transferability and thus accurate comparisons among studies.

Perhaps the greatest void in our understanding of Long-billed Curlews concerns winter ecology. To date, little research has been conducted on Long-billed Curlews during the eight months outside of the breeding season. Of the seven papers in the Long-billed Curlew Symposium, only one dealt with winter ecology. Additional studies, throughout the winter range, are urgently needed. Studies that involve marking of wintering birds would be especially valuable as they would facilitate addressing many questions of interest including length of stay at stop-over sites, winter residency patterns, winter site fidelity, and behavior. In addition, marking and resighting juveniles on the wintering grounds would allow for modeling of juvenile survival rates, a key demographic parameter difficult to address through studies conducted solely on the breeding grounds.

The early history of the Long-billed Curlew (*Numenius americanus*) in the Midwest

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Once a locally common breeding bird as far east as southeastern Wisconsin and northeastern Illinois, the Long-billed Curlew *Numenius americanus* rapidly declined in the Midwest in the middle- to late 19th century. A state-by-state survey shows a similar pattern of abundance and loss throughout the region. The loss has been attributed to overhunting and plowing of the original sod for agriculture, but may have initially begun when bison were regionally extirpated by early settlers and hunters. Later 20th century declines may have locally involved loss of a grazing economy, severe droughts, wetland drainage, and the spread of exotic invasive plants. Currently, the species breeds no farther east than the Missouri River in the Dakotas and southwestern Kansas. The author suggests that the curlew is a potential candidate for reintroduction following the regional successes of other charismatic species including Trumpeter Swan *Cygnus buccinator*, Peregrine Falcon *Falco peregrinus*, and Bald Eagle *Haliaeetus leucocephalus* and the current conservation trend of establishing large blocks of mid- to tall grass prairie preserves within the historic range of the species. Several potentially suitable sites are suggested for reintroduction.



Hayfields in the American West: critical habitat for highly imperiled Long-billed Curlews

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Long-billed Curlews have both suffered and benefited from the westward expansion of agriculture. The plowing of prairies for row crop production caused radical declines in both population size and breeding distribution of curlews. However, in many areas of the arid West, development of hayfields created curlew habitat where little or none had existed previously. In Nevada, natural grasslands are scarce and highly degraded, yet approximately 4,000 km² of irrigated pastures and hayfields have been developed. We studied the suitability of hayfields as curlew breeding habitat in western (Carson Lake) and northeastern (Ruby Valley) Nevada. At Carson Lake, apparent nest success was high (60%), yet extreme predation of chicks by Coyotes and Prairie Falcons resulted in only one of 69 chicks fledging in two years. Ruby Valley has one of the densest breeding assemblages of Long-billed Curlews ever reported – 5 pairs/km² and a total population of 400–500 individuals. In Ruby Valley, hayfields were preferred over arid rangeland for both nesting and brood-rearing. Furthermore, renesting occurred in 85% of marked curlews losing first clutches (n = 20), a phenomenon not previously documented in rangeland habitats. The success of Ruby Valley curlews was dependent on exploitation of a superabundant earthworm resource. Due to curlew dependence on hayfields in Nevada, maintaining viable ranching operations that sustain these critical habitats are essential to Long-billed Curlew conservation. However, high levels of egg and chick depredation, due primarily to mammalian predators, suggest consideration of active predator management.

Long-billed Curlew nest-site selection and nest survival at large and small spatial scales

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We studied nest-site selection and nest survival of Long-billed Curlews breeding in northeastern Nevada cattle ranches in 2004 and 2005. Cattle ranches contained two distinct habitat types, hayfields and adjacent rangeland, both of which were used by nesting curlews. In April, these habitats have similar vegetation structure. However, by mid May, hayfield vegetation is taller and denser than nearby rangelands due to irrigation and cessation of cattle grazing. We evaluated curlew nest-site selection and nest survival at a habitat patch scale and a microhabitat scale. At the habitat patch scale (25–100 hectares) we examined the proportion of curlew nests initiated in hayfield and rangeland patches of varying vegetation height, density and evenness. At the microsite scale (1 m²) we compared attributes of individual nests found within 2 weeks of clutch completion to random sites taken within the same habitat patches. Nest density was greater in hayfields than in adjacent rangeland. At the microsite scale, vegetation height around early-season nests was greater than at random sites. However, late-season renesting attempts exhibited the opposite pattern. Within hayfields, both early- and late-season nests exhibited denser surrounding vegetation than random sites. Nest survival was greater for early-initiated nests, nests with more uniform surrounding vegetation height and nests located further from water. Patch-level vegeta-

tion variables did not impact nest survival. While Long-billed Curlews generally prefer short-stature vegetation for nesting, our results indicate that they are relatively plastic in their nest-site selection and are successful in habitats containing tall, relatively homogeneous vegetation.

Nesting success, brood survival, and habitat use of Long-billed Curlews in grazed landscapes of western South Dakota

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In the spring of 2005, we initiated a two-year study investigating nesting success, brood survival, and habitat use of Long-billed Curlews breeding on the Triple U Buffalo Ranch in Stanley Co., South Dakota. Twenty-six curlews were captured on the nest and radio-marked, after which eighteen nests were monitored to determine fate. Nest success was approximately 0.41 indicating a 41% chance that a nest would survive through the 28-day incubation period. Seventy-five percent of observed nest failure was due to trampling by bison, while the other 25% was due to abandonment after a disturbance. We suggest that livestock should not be grazed, or grazed only at low densities, during the nesting period in pastures used by breeding curlews. We tracked ten broods using radio-signals from brood-rearing adults. One week after hatching only 50% of these broods were still viable and we suspect that many curlew chicks fell prey to Northern Harriers and Short-eared Owls, which we observed in large numbers on the study site. Habitat measurements were taken at nest-sites, brood location points, and random points and we have initiated analysis of habitat preference based on these data. During our 2006 field season, we additionally plan on comparing breeding densities and nesting success in areas grazed by cattle to areas grazed by bison, and tracking the migration route of curlews breeding on our study site to a specific wintering area(s). This information will help establish guidelines for habitat management in breeding areas and identify important migratory and wintering habitat.

Population ecology of Long-billed Curlews breeding in north-eastern Nevada

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The Long-billed Curlew is one of the most threatened shorebirds in North America. Habitat loss and degradation has led to a severe contraction of the Long-billed Curlew's historic breeding range and a significant reduction in global population size. In portions of the western United States, however, curlew numbers have increased in association with the development of non-native grasslands such as hayfields and irrigated cattle pastures. We studied the population ecology of Long-billed Curlews breeding in hayfields and adjacent rangeland habitat in northern Nevada during the springs and summers of 2003–2005. Absolute nest success was consistently low among years and averaged 25 percent. A high propensity for renesting, however, resulted in a per female nest success rate of 41 percent. Chick survival varied among years, with the greatest fledging success recorded during the wet year of 2005. On average, females fledged 0.16 female chicks per year, which coupled with high juvenile and adult annual survival rates, corresponds to a



slightly declining to stable population. Long-billed Curlew productivity appears to be limited during the nesting phase as nest predation rates were quite high. Additionally, egg inviability reduced the number of young hatched from successful clutches.

Conservation and management of Long-billed Curlews and waterbirds in the Foester's Slough wetland complex, Teton Valley, Idaho

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The Foster's Slough area is a highly productive complex of wetlands and associated uplands along the Upper Teton River in Teton County, Idaho that provides breeding habitat for a large population of Long-billed Curlew (LBCU). Based on LBCU surveys conducted in 2004 and 2005, Teton Regional Land Trust (TRLT) biologists estimate that 50 curlew pairs may breed throughout the wetland complex. Other nesting shorebirds in the area include Willet, Wilson's Phalarope, Killdeer, Wilson's Snipe and Spotted Sandpiper. The Foster's Slough area is also important to nesting and staging Sandhill Cranes, wintering Trumpeter Swans and waterfowl. Much of the Foster's Slough complex also provides important forage resources for ranching families that have contributed significantly to the conservation of the area. To date, TRLT has worked with willing landowners to protect over 2,200 acres of the Foster's Slough area through conservation easement agreements and has developed a landowner working group to promote continued conservation and resource management. Monitoring in the Foster's Slough shows that LBCU are nesting in moderate to heavily grazed areas but post nesting LBCU are using areas in or near dense cover. Therefore, LBCU may require a mosaic of short grass habitat for nesting and dense cover for brood-rearing. Current grazing practices may not provide an optimal habitat mosaic for LBCU and broods may be particularly vulnerable to avian predators. TRLT and landowners are developing a grass banking system whereby non-ranching landowners allow some grazing on their properties to ranch families operating within the Foster's Slough area. The goal of the grass banking is to pro-

vide a mosaic of habitat conditions from short grass to dense cover that provides LBCU nesting, foraging and brood-rearing habitat and also key habitat elements for other priority waterbird species. Planned habitat restoration/enhancements in the area will target improved foraging and brood rearing habitat for LBCU in proximity to nesting areas.

Abundance, spatial distributions, and social system of Long-billed Curlews in coastal northern California

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The Long-billed Curlew *Numenius americanus* is among the most imperiled North American shorebirds, but little is known of its ecology during the nonbreeding season. Consequently, we studied curlews at Humboldt Bay, California, at the northern limit of the species' winter range. From June–April, ~300 curlews (~1% of the world's population) were resident in the area. Females arrived as early as late June; whereas males and juveniles arrived later. Departures of individuals to breeding areas typically occurred in early April. At low tide, curlews were aggregated on bay tidal flats; the locations of these aggregations were repeatable over multiple surveys. At one site with particularly high curlew densities, 10–15 curlews defended low-tide feeding territories ranging in size from 0.2–4.7 ha. Residency of individuals on these territories varied greatly (12–71% of 130 daily low tide observations from June–April). This variation in residency was partly explained by tide height and precipitation: several curlews occupying low elevation territories were absent during neap (low) tides because their territories were inundated; other individuals were consistently absent during periods of rain. Winter rains created supplemental foraging habitats in pastures adjacent to the bay, where 100 of more curlews fed on earthworms and other invertebrates. Conservation will require planning for sea level rises associated with global warming, especially given that levees currently limit expansion of intertidal habitats. Pastures may prove critical to the persistence of wintering curlews at Humboldt Bay.



Black Oystercatcher Symposium

ORGANIZER: DAVID F. TESSLER (david_tessler@fishgame.state.ak.us)

The *ad hoc* Alaska Black Oystercatcher Working Group was founded in 2003 to exchange information on the current state of research on this species, define future research priorities, and to organize projects and collaborative partnerships with standardized methods to address those priorities. One year later, the International Black Oystercatcher Working Group coalesced with the same basic premise but extending it throughout the species' range.

The 2006 Black Oystercatcher Symposium was the first opportunity for researchers to report their progress in addressing the priorities, projects, and collaborations developed by the International BLOY Working Group. The intent was to assess our progress, re-examine priorities, and establish the next round of targeted research. I will describe the presentations from the southern portion of the range to the north. Black Oystercatchers are the unspecified subjects of all projects.

Elise Elliot-Smith (U.S. Geologic Survey) and Liz Kelly (USFWS) reported the results of the first comprehensive survey across Oregon (2005), and discussed their upcoming efforts for a coordinated survey of the entire southern portion of the range (Washington to Baja). They will also be assessing detectability and productivity in Oregon in 2006. David Nysewander and Ruth Milner of the Washington Department of Fish and Wildlife presented their inventory work of the San Juan Islands, and the preliminary results of a detectability study aimed at correcting for the proportion of birds undetected in a single survey; 2006 will be their culminating effort. Pam Sanguinetti, U.S. Fish and Wildlife Service, demonstrated a positive breeding response to public closures on specific portions of shoreline in the Dungeness and Protection Island National Wildlife Refuges in Washington. Mike Goldstein described the efforts of the U.S. Forest Service, Glacier Ranger District to survey and inventory all breeding territories in western Prince William Sound. A simultaneous effort by the Cordova Ranger District surveyed the eastern half of the Sound. David Tessler presented preliminary results from a coordinated study at several sites in Alaska and British Columbia that demonstrate low variable hatching success and productivity at all sites; predation and tidal flooding are important limitations on productivity; and limiting factors vary between sites and years. In addition to pronounced sexual dimorphism, there appear to be morphological distinctions between local populations. Results from rangewide genetic study and winter surveys are pending.

Three graduate students presented their results as well: Julie Morse (University of Alaska Fairbanks), Brian Guzzetti (University of Alaska Fairbanks), and Caleb Speigel (Oregon State University). Theirs were among the most imaginative projects highlighted at the symposium. Julie Morse detailed her experimental approach to identifying the effects of human recreational disturbance in Alaska and tied this to the larger picture of how to conceptualize the ecological consequences of disturbance. Brian Guzzetti discussed his work investigating paternity at Middleton Island, seasonal use of that island, and his joint discovery of a novel field sexing technique. Caleb Speigel described his first year in an effort to study behavior and limiting factors using constant digital video surveillance on nests, and captured some fascinating behaviors never before witnessed.

A short meeting in which we assessed these current efforts

in relation to outstanding research needs followed the presentations. A number of additional small meetings of various BLOY Working Group members also took place opportunistically throughout the week of the conference. By the close of the Shorebird Science in the Western Hemisphere Conference 2006, we established our priority research directions for black oystercatchers for the next couple of years. Most of the future priorities that we identified are already either funded and in the pipeline, or are currently the subjects of planning, strategizing, and funding efforts. The regional research priorities we identified follow in the list below. The expected year of initiation for each identified project is in parentheses.

Southern portion of the range (Washington, Oregon, California, and Baja):

- Conduct a comprehensive inventory of the entire Southern Portion of the Range (2007).
- Develop detectability information for the different habitats encountered in Oregon and Washington to correct survey data (2006).
- Initiate the first study on productivity and limiting factors in the south (Oregon, 2006).
- Collect the first genetic material from the south for inclusion in the current analysis of genetic population structuring (2006).

Northern portion of the range (Alaska and British Columbia):

- Complete the Aerial Winter surveys in Alaska (2007).
- Implement a targeted VHF telemetry study of interseasonal movements for a few key areas (as a stepping stone to a larger effort) (2006).
- Initial survey and inventory of specific sites hypothesized to be important in unsurveyed areas of Southeast Alaska (2006).
- Develop detectability and availability corrections for future northern survey efforts (2006).

Rangewide:

- Rangewide habitat suitability model to guide and stratify future survey and inventory efforts (esp. SE Alaska & B.C.). Will be validated by work in AK, OR, WA (2007).
- Rangewide interseasonal movement project: Satellite transmitters will be deployed in key areas in Alaska, British Columbia, Washington, and Oregon (2007).

Black Oystercatcher inventory and long term monitoring across the southern half of the species range with initial steps focused in Oregon

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Despite much conservation concern for Black Oystercatchers by federal, state, and non-governmental agencies, little research has been conducted across the southern half of the species range and it uncertain whether populations are declining. There are approximately 11,000 birds or fewer rangewide, with about 1,400–1,800 individuals in the southern portion of the species range from northern Washington to Baja California. Historically



there have been local efforts to survey in some portions of the Black Oystercatcher's southern range, however, we are teaming up to assess coast-wide distribution, abundance, conservation status, and population trends. USGS-FRESC in cooperation with USFWS Migratory Birds is planning a comprehensive inventory of Black Oystercatchers across the southern half of their range. We have created a digital geodatabase of known and potential habitat and have developed a long term monitoring plan. During the 2006 breeding season we plan to conduct a detectability study which will be used to refine survey methods and develop a strategy for conducting the comprehensive inventory in 2007. USGS FRESC has developed and tested survey protocols in cooperation with USFWS Newport Field Office. Together, we organized comprehensive surveys across the state of Oregon during the 2005 breeding season. A total of 323 birds were detected during this survey which included seventy volunteer surveyors from many State and Federal agencies, in addition to local birders. During the 2006 breeding season, USGS FRESC, USFWS Newport Field Office and Oregon Coast National Wildlife Refuge Complex will team up to assess the reproductive success of Black Oystercatchers on the Oregon Coast.

Black Oystercatcher nest inventory and monitoring in western Prince William Sound, Alaska

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Black Oystercatchers *Haematopus bachmani* have been identified as a species of concern by federal agencies, state agencies, and conservation organizations. They are a Management Indicator Species in the 2002 Chugach National Forest revised Land and Resource Management Plan because they have been shown to be sensitive to disturbance caused by shoreline and near-shore recreation. Since human use across Prince William Sound continues to expand, we were concerned at the potential effects of increased human use on Black Oystercatcher nesting habitat. We inventoried approximately 1,500 km of shoreline and identified 105 nesting locations in western Prince William during June and July of 2001–2004. We also collected human use information during that time. We will present results from the four years of inventory and monitoring, including a baseline distribution of nesting oystercatchers, habitat use, apparent nest success, and the spatial relationship between human recreation sites and bird nesting and foraging areas.

Use of video cameras to document nest failure, nesting disturbance, and incubation behavior of Black Oystercatchers (*Haematopus bachmani*) in Alaska

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The Black Oystercatcher is an important indicator of intertidal ecosystem health, and a species of concern in both the U.S. and Canadian Shorebird Conservation Plans. Understanding factors that limit reproductive success is vital for conservation and man-

agement of the species. As part of an ongoing study of Oystercatcher demography in Alaska, we documented nesting behavior and hatch success at 11 Black Oystercatcher nests in western Prince William Sound, AK using digital video cameras and recorders.

Use of video technology allowed continuous nest monitoring throughout the nesting period, eliminating ambiguity in identifying causes of nest failure and disturbance, and permitting detailed examination of parental nesting behavior 24-hours per day. We documented nest failure from both tidal flooding and predation, identifying a previously undocumented nest predator, American mink, in our study area.

We also obtained video evidence of previously unverified behaviors in the species such as re-incubation of flooded eggs, and chick abandonment. Hatching success of nests monitored with video cameras was higher than average hatch success at all nests at our field site (82%, n = 8, vs. 32%, n = 15). Our study demonstrates that video monitoring of shorebird nests can be a valuable research tool, eliminating guesswork in determining causes of nest failure, and providing a comprehensive record of nesting behavior. Future analysis will determine whether differences in nest attendance and incubation behavior effect reproductive success, identify sex-based differences in nest care throughout the nesting cycle, and quantify the amount of time parents are kept from incubation by specific disturbance factors.

Productivity, paternity, mate and site fidelity in Black Oystercatchers (*Haematopus bachmani*) on Middleton Island, Alaska

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The number of Black Oystercatchers on Middleton Island has increased from zero to over 700 following the 1964 earthquake. Middleton now supports the highest known breeding density of this species. In the summers of 2004 and 2005, we investigated patterns of paternity, mate and site fidelity by implementing a banding and DNA collection program, and followed breeding effort, hatching success, and productivity in a sample of breeding pairs. We also tracked seasonal abundance with monthly island-wide censuses during the breeding season. In 2004, we monitored 48 nests, banded 62 adults, and collected 92 samples from chicks and failed eggs. We monitored 60 nests in 2005, banded 20 adults, and collected 135 samples from offspring. Fifty-four banded adults from 2004, 87%, were resighted in 2005. No chicks were resighted in 2005. The banding program will allow us to assess mate fidelity, site fidelity, and eventually natal philopatry.

In 2006, we will be using microsatellites to determine sex and paternity. Preliminary analysis indicates that microsatellite sexing in the lab may also provide a sex-identifying characteristic which is easily visible in the field. In 2004, the June census yielded 285 territorial pairs and 211 nonbreeding oystercatchers for a total of 781 oystercatchers on Middleton's roughly 28km of shoreline. The season-high census for 2005, taken in July, dropped to 238 territorial pairs and 240 non-breeders, totaling 716 birds. In February 2005, no wintering oystercatchers were found on Middleton Island. In September 2005, 62 oystercatchers, three banded during the breeding season, were recorded.



**Black Oystercatcher (*Haematopus bachmani*)
breeding response to public use closures at
Dungeness and Protection Island National
Wildlife refuges, Washington**

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U.S. Fish and Wildlife Service, WA Maritime NWR
Complex; Neil Holcomb*

One of the world's largest natural sand spits, Dungeness National Wildlife Refuge (NWR) is a major destination shoreline for 100,000 visitors annually. Although a historical Black Oystercatcher nesting area, by 1993 no nests were found. In 1997, the Refuge was divided into zones, effectively closing about 75% of the shoreline. Management used the natural driftwood backbone of the spit, which averages 100 metres wide at the lowest tides, to set a boundary. Intensive monitoring of the zones from 1994–2005 has found a slow, but significant return of nests ($n = 6$). In contrast, annual monitoring found Black Oystercatcher breeding territories at nearby Protection Island NWR have significantly declined since the 1980's when the Refuge was closed to public access. To determine what factors caused this downward trend, in 2004 and 2005 we intensively observed the remaining territories from a small boat throughout the breeding season. We found that Black Oystercatchers were not successful when nesting adjacent to a Glaucous-winged Gull *Larus glaucescens* breeding colony due to egg predation. Although we saw agonistic behavior directed at the numerous ($n = 50$) Bald Eagles *Haliaeetus leucocephalus*, nests were more productive on shorelines with higher Eagle counts and fewer gull nests. Neither Refuge was free from human disturbance. Trespass did occur and two nests with eggs at Dungeness and two chicks at Protection Island were burned in three fires set in the driftwood. We recommend continuing long-term studies into the complex interaction of natural and human influenced factors on breeding Black Oystercatchers.

**Does recreational disturbance impact
Black Oystercatchers breeding in
Kenai Fjords National Park?**

*Julie A. Morse (julie.morse@uaf.edu), Department of
Biology and Wildlife, University of Alaska, Fairbanks;
Abby N. Powell*

National parks in Alaska are generally assumed to be high-quality undisturbed wildlife habitats. However, these parks also attract recreational users, whose presence may in turn reduce the suitability of key habitats for nesting shorebirds. In Kenai Fjords National Park, Black Oystercatchers *Haematopus bachmani* often breed on gravel beaches that are also popular campsites. In response to increasing recreational activity in coastal Alaska, we monitored survival of nests and broods on 35 to 39 breeding territories annually from 2001–2004. Additionally, to assess the direct effects of recreational disturbance on breeding parameters we conducted standardized field experiments in 2004 and 2005. Annual productivity was low (0.35 chicks/pair) but was not adversely affected by recreational disturbance. Daily survival of nests varied annually and declined over the season. Our results suggest that nest survival was lower during periods of extreme high tides. Daily survival rate of broods increased over the season and was higher on island than mainland territories, likely due to differences in predator communities. Occupancy rate of territories and site fidelity was high; 95% of color-banded oystercatchers returned to the same breeding territories in the subsequent year. Black Oystercatcher pairs decreased

incubation constancy by an average of 39% in response to experimental disturbance; we found no evidence that oystercatchers habituated to disturbance, either within seasons or between years. We concluded that recreational disturbance impacted individual breeding behavior, but not population dynamics; thus, we suggest Black Oystercatchers are resilient to recreational disturbance at the low levels observed.

**Baseline monitoring established
for breeding territories of Black Oystercatchers
2000–2005 in the northern inner marine waters
of Washington state,
addressing repeatable minimum objectives,
utilizing selected established and new techniques**

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Ruth Milner; Thomas Cyra; Joseph Evenson*

Significant numbers of breeding Black Oystercatchers have been historically associated with many of the offshore small islets and rocks found throughout the San Juan Islands and nearby waters in Bellingham Bay and Deception Pass. Yet no standardized minimum survey or baseline data had been established for much of the oystercatchers breeding in these Washington waters. These breeders were suspected to have experienced changes over the last 25 years in these areas, in terms of breeding distributions and densities, possibly related to increasing mortality or disturbance factors related to recovery of predators like eagles and peregrine falcons, or increased presence of varied human activities near their preferred breeding sites. Surveys were conducted over 13–14 days of effort between May 10 and June 10 each year of the five years surveyed between 2000 and 2005. Over 100 islands were examined closely from a nearby small boat platform, and breeding territories were found on 48 of these. In 2005, these 48 sites contained 71 definite nesting territories, defined by egg-laying, plus three highly probable additional nesting attempts. Fifty other nonbreeding oystercatchers were noted. The surveys were designed to set up a minimum standardized monitoring of breeding sites, looking primarily at breeding territorial defense and nesting attempts, using a boat-based survey platform that minimized disturbance by not requiring landing. New methods, including playing recorded oystercatcher calls and use of duplicate observers, were also used and provided us with an insight into the numbers of birds or territories missed in earlier or historical survey efforts.

**An integrated regional ecological assessment of
the Black Oystercatcher (*Haematopus bachmani*)**

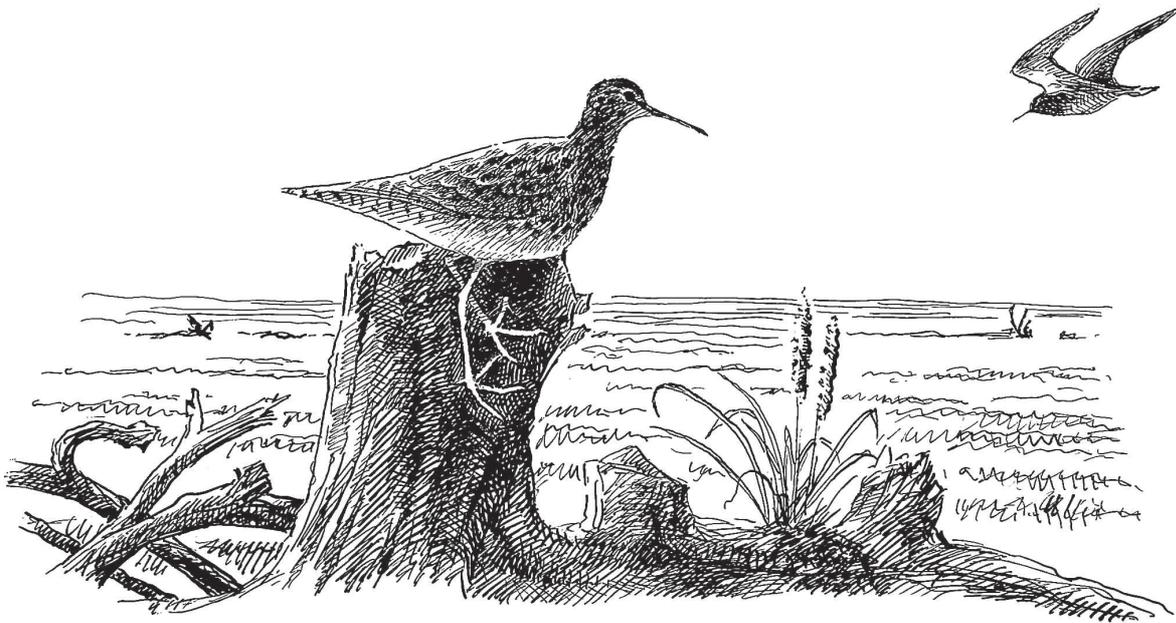
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Sandra Talbot; Mike Tetreau; Sue Haig;
Caleb Spiegel*

This project aligns and expands several previously unrelated studies of the Black Oystercatcher at multiple sites in the heart of the species' range. Coordinated efforts to assess breeding ecology, productivity, local threats, survival, mate and site fidelity, and population structuring began in 2003 and will continue through summer 2006 in Alaska at Kenai Fjords, Glacier Bay, Prince William Sound, and Middleton Island, and in



British Columbia on Vancouver Island and the Queen Charlotte Islands. Winter surveys throughout Alaska to identify important wintering areas and interseasonal movements began in 2005 and will continue in 2006. Since 2003, we have banded over 400 oystercatchers in Alaska (4–5% of the global population), monitored 330 territory-seasons, and collected over 400 genetic samples in Alaska and British Columbia. Clutch size, hatching percentage, fledging success, overall productivity, and causes of egg and chick loss vary widely both between study areas and between years. When study areas and years are considered

together, the average clutch has 2.43 eggs; 32.8% of eggs survive to hatch; 18.5% of eggs laid successfully fledge. Overall productivity (fledglings \times pair⁻¹ \times season⁻¹) is 0.32. The greatest documented cause of egg loss is tidal inundation, accounting for over 40% of 2005 losses. Although severe weather curtailed most 2005 winter efforts, aerial surveys of the western Aleutian Peninsula sighted 121 birds, boat based surveys of Kodiak Island documented at least 1,716 oystercatchers, none of which were banded, and winter ground counts on Middleton Island failed to detect a single oystercatcher.



Maksim Dementyev



Snowy Plover Symposium

ORGANIZER: SUE THOMAS (Sue_Thomas@fws.gov)

The main goal of the Snowy Plover Symposium was to share information on current research and conservation efforts throughout the range of this species. To that end, the Snowy Plover Symposium was well diversified with presentations describing large-scale research, conservation, and survey efforts as well as more intensive, site-specific research designed to inform and improve management efforts. Large-scale research, conservation, and survey effort presentations initiated with Dr. Susan Haig (U.S. Geological Survey, USGS) presented recent results from an analysis of the genetic structure of Snowy Plovers in North America and Puerto Rico. The analysis was designed to quantify variation within and among breeding years and test the validity of two previously recognized subspecies. Catherine Hickey (PRBO Conservation Science) provided an overview of the status of the threatened Distinct Population Segment (DPS) along the U.S. Pacific Coast and an assessment of the Draft Economic Analysis of proposed Critical Habitat Designation. This assessment was initiated because the U.S. Fish and Wildlife Service (USFWS) is currently re-assessing the listing status of the species.

An extensive review of banding and monitoring efforts from 1977–1995 in the interior and U.S. Pacific Coast support continued listing of this DPS under the Endangered Species Act due to extremely limited inter-regional recruitment. Discussion followed this presentation focusing on clarification of results from the genetic analysis and assessment of the Draft Economic Analysis. Sue Thomas (USFWS) then presented information on an emerging comprehensive Snowy Plover breeding season inventory planned for 2007. The goal of this inventory is to assess the abundance and distribution of breeding Snowy Plovers in the interior of the U.S. and Canada, the Gulf coast of the U.S. and Mexico and the Pacific Coast of Mexico. Given the extensive scale of this effort, coordination with partners involved with ongoing breeding season monitoring or interested in initiating local area inventories for this effort is key to its success. Discussion followed this presentation focused on habitat characteristics suitable for potential habitat modeling and survey techniques.

Intensive, site-specific research presentations initiated with Ryan DiGaudio (PRBO Conservation Science) and a discussion on intensive management efforts used to recover a portion of the threatened, distinct population segment in the Monterey Bay recovery area. DiGaudio presented evidence that supports the continued use of intensive management practices to maintain the current population level including habitat restoration, signing and fencing in nesting and brood-rearing areas, and predator control. Alex Hoffman (Humboldt State University) presented research on the variation of female Snowy Plover incubation behavior and nest attentiveness in Northern California. Results were presented on how differences in human disturbance and experience of the incubating female could account for variation in incubation behavior between individual nests. Zach Nelson (Humboldt State University) presented research on individual use of conspecifics to assess habitat in Northern California and how individuals, particularly first time local breeders, used conspecifics to assess habitat quality. Moving to the interior U.S., Matthew Sexson (Fort Hays State University) presented research on nest site selection and reproductive success of Snowy Plovers breeding in Kansas. This presentation provided

detailed information on nest site selection with regards to reproductive success and management strategies, such as creating elevated nesting pads and the use of electric fences, to encourage nest success.

The symposium was successful in bringing together researchers, managers, and biologists from throughout the range of the species and developing a more comprehensive approach toward Snowy Plover conservation in the near future. Future research priorities include:

- 1) collecting additional samples from Snowy Plovers breeding in Puerto Rico to fully assess whether plovers found in Puerto Rico are part of a separate subspecies
- 2) continued site-specific research on nesting success throughout the range of the species to determine limiting factors and inform management decisions.

A coordinated, range-wide working group does not exist for this species, however, a dedicated group coordinate within the Western Snowy Plover Working Team on the recovery of the listed DPS through habitat management and control or mitigation of disturbance. Future management priorities include continued management for the listed, DPS along the U.S. Pacific Coast to assure that the threats facing the coastal population are mitigated with appropriate management practices.

As described above, the USFWS in collaboration with USGS and other partners is initiating a comprehensive inventory of Snowy Plovers breeding in the interior of the U.S., Canada and Mexico; the Gulf Coast of the U.S. and Mexico; and the Pacific Coast of Mexico during the spring of 2007. Partner involvement is key to the success of this effort. To address advanced planning and accurately assess the level of effort required for this inventory, we are currently requesting information on known or potential Snowy Plover breeding sites in the U.S., Canada, and Mexico. This effort will provide valuable information for partner conservation initiatives such as implementing a Snowy Plover Action Plan under development by the USFWS and partners; in evaluating the species status for listing under the Federal Species Program in Mexico; implementing State Wildlife Action Plans; and initiating joint venture habitat conservation plans.

We encourage your participation in the conservation of this cosmopolitan species by collaborating with any of the partners who participated in this symposium. Contact information is included in the following abstracts.

Comprehensive survey for Snowy Plovers

*Sue Thomas (sue_thomas@fws.gov),
USFWS Migratory Birds and Habitat Programs;
Elise Elliott-Smith*

The U.S. Fish and Wildlife Service (USFWS) and U.S. Geological Survey are collaborating on the development of a comprehensive breeding-season survey for Snowy Plovers scheduled for the spring of 2007. The goal of this project is to assess the distribution and abundance of Snowy Plovers breeding in the interior and Gulf coast of the U.S., Mexico, and Canada and the Pacific coast of Mexico. Overall survey objectives include:



- 1) Estimate the North American breeding population number in coordination with existing surveys;
- 2) Provide information for an Action Plan for the conservation of the species under development by the USFWS with partners;
- 3) Provide information for the evaluation of the species under Mexico's Federal Species Program;
- 4) Provide states with current site-specific information for implementation of State Wildlife Action Plans; and
- 5) Provide other partners, such as JVs, with information for site-specific habitat conservation.

The Snowy Plover is considered a high priority species throughout its range in the U.S., Canadian, and regional Shorebird Conservation Plans; a priority species in most State Wildlife Action Plans; and is listed in many states range-wide. In addition, it is a USFWS Bird of Conservation Concern and an Audubon Watch List species. High concern for this species stems from loss or degradation of habitat and low population numbers.

A comprehensive assessment of distribution and abundance, range-wide, is a necessary first step toward long-term conservation of this species. However, a sound survey design will rely on comprehensive distribution and abundance data from partners.

During the initial planning phase, we will collect recent and historic data on breeding distribution and phenology to assess the level of effort required to complete such a comprehensive inventory. We will then provide a strong foundation through peer reviewed statistical development and reporting and a complete georeferenced database.

We will work closely with partners to coordinate survey methodologies and timing for ongoing surveys such as the breeding season window survey developed for the listed population on the U.S. Pacific Coast.

Subspecies definition and population distinction in North American Snowy Plovers

*Susan M. Haig (susan_haig@usgs.gov),
USGS Forest and Rangeland Ecosystem Science
Center; Thomas D. Mullins; W. Chris Funk*

While circumpolar in its distribution, *Charadrius alexandrinus* has two described subspecies in North America. Molecular confirmation of these subspecies as well as characterization of Snowy Plover population structure is critical for assessing their current conservation status.

Furthermore, a distinct population segment (DPS) has been listed under the U.S. Endangered Species Act for Snowy Plovers breeding on the west coast of North America. However, movement of birds into and out of this population suggests it may not be genetically distinct. While genetic distinctness is not an absolute requirement for listing a DPS, clarification of the taxonomic identity and genetic status of this group relative to other Snowy Plovers may help ameliorate the current controversy surrounding this listing.

To address this, we sequenced 700 base pairs from the mitochondrial control region and examined 10 polymorphic microsatellite loci in over 300 individuals from across the species North American distribution.

Results will resolve the taxonomic distinctness issue and will show the utility of using molecular markers in ESA assessments.

The threatened status of the Pacific coast population of the Western Snowy Plover

*Catherine M. Hickey (chickey@prbo.org),
PRBO Conservation Science; Ryan DiGaudio;
Lynne E. Stenzel; Gary W. Page*

The USFWS is currently re-assessing the listing status of the Pacific Coast population of the Western Snowy Plover *Charadrius alexandrinus nivosus*, wherein the population must qualify as a Distinct Population Segment (DPS) in order to maintain its status as threatened. We have summarized banding and monitoring efforts on the Pacific coast of the U.S. and at interior sites west of the Rocky Mountains to document movements of plovers banded in the period 1977–1993. Data from this period reveal extremely limited inter-region recruitment, indicating that the Pacific coast population is largely reproductively isolated from other plovers in the *nivosus* subspecies, thereby supporting its DPS designation. Using the Monterey Bay area as a case study, we show that intensive management has been necessary to reverse the population decline of *C. a. nivosus* and restore it to recovery goal levels – the Monterey Bay area is one of the only areas to have done so. Since the threats facing the coastal population, especially human disturbance, habitat degradation, and predator populations, are likely to increase rather than abate, we argue that its survival depends on the protections afforded by the Endangered Species Act. We address the challenges recently posed to its listing status and concerns about the process – and resulting conservation implications – of critical habitat designation and the associated economic analysis. With many North American shorebird populations in decline, we stress the relevance of having regulatory backstops in place to enact our national responsibility to the conservation of migratory birds.

Western Snowy Plover management in the Monterey Bay region

*Ryan DiGaudio (rdigaudio@prbo.org),
PRBO Conservation Science; Jane C. Warriner;
John S. Warriner; Gary W. Page; Jenny Erbes;
Carleton Eyster; Kriss Neuman; Lynne E. Stenzel;
Catherine M. Hickey*

We will demonstrate how intensive management activities have enabled the Western Snowy Plover *Charadrius alexandrinus nivosus* population in the Monterey Bay area of California to reach recovery goal numbers for the region. The major threats to the Monterey Bay population include human recreational use of beach habitat, introduced predators such as Red Fox *Vulpes vulpes regalis*, expanding populations of native predators, especially Common Ravens *Corvus corax* and American Crows *Corvus brachyrhynchos*, and invasive dune vegetation. Since the coastal population of *C. a. nivosus* was listed as threatened in 1993, management strategies used to address these threats have included the use of signs and linear cable fences to protect nesting and brood rearing areas, limited use of predator exclusion devices to protect nests, removal or relocation of certain predators, and habitat restoration. Reproductive success increased within the managed areas, thus leading to an overall increase in the regions breeding population. In 1991, prior to management activities in the Monterey Bay area, there were just 176 breeding adults. After nearly a decade of intense management, in 2003 the population exceeded the regional draft recov-



ery plan target of 338 breeders; the population has remained above this target through 2005. Maintaining the population at this level will require continued intensive management near its current level of effort because existing threats are likely to increase rather than abate. Successfully executing this management program highlights the importance of partnerships, as it relies on the cooperation between private organizations and federal, state, and county government agencies.

Evidence for conspecific attraction in the breeding distribution of the western Snowy Plover in coastal northern California

Zach Nelson (*zjn1@humboldt.edu*), Humboldt State University; Mark Colwell

Physical features of habitat are often examined to explain species' distributions, but individuals may also use conspecifics to assess habitat. We examined whether conspecific attraction influenced settlement and distribution of a marked breeding population of the Snowy Plover *Charadrius alexandrinus nivosus*. Over 5 years in northern California, distribution and abundance of plovers varied among 18 occupied sites; other historical breeding locations remained unoccupied. At these 18 sites, first-time local breeders (e.g., philopatric yearlings, immigrant yearlings and unmarked immigrant adults) were more likely to settle at sites with more resident breeders. Plovers also appeared to nest near conspecifics. At one site with 19–27 breeding plovers over the 5 years, nests were spatially clumped; however, location of these aggregations varied among years. Some individuals initiated nests nearer established nests than would be expected by chance; in other cases, however, this was not the case. These findings suggest that conspecific attraction influenced decisions of individual plovers seeking a breeding location. Individuals settling for the first time may use the presence of conspecifics, especially those incubating clutches or tending chicks, to gauge habitat quality. We discuss our findings in light of commonly used management activities (e.g., predator exclosures) to increase reproductive success of shorebirds.

Tight sitters and busy beach life: individual variation in female Snowy Plover incubation behavior in northern California

Alexandra Hoffmann (*AHoffmann1@gmx.net*), Wildlife Department, Humboldt State University; Mark Colwell

In Western Snowy Plovers *Charadrius alexandrinus nivosus*, both parents share incubation duties, with males typically incubating at night and females incubating during the day. Typically, plovers run off the nest at a long distance from potential nest

predators, including humans. Thus, human disturbance in recreationally used beach areas may affect incubation behavior of female plovers during daytime. We studied Snowy Plovers nesting on two differently managed sites in Humboldt County, California. We conducted focal observations on incubating females during mornings and recorded nest attentiveness, number and causes of off-bouts, and counted human and natural disturbance within 100 m of nests. While natural disturbance on both sites was comparable, nests in a northern area experienced substantially higher levels of human disturbance than nests on an adjacent (southern) beach. We examined if differences in disturbance and experience of the incubating female could help explain variation in incubation behavior between individual nests. Experienced females and birds nesting in areas of low human disturbance tended to have higher nest attentiveness and lower variation in incubation behavior than inexperienced females and birds exposed to high levels of human activity. Across nests, variation in incubation behavior was most apparent in the early stage of incubation (days 0–10 after clutch completion).

Nest-site selection and reproductive success of the Snowy Plover in Kansas

Matthew G. Sexson (*mgsexson@scatcat.fhsu.edu*), Department of Biological Sciences, Fort Hays State University; Greg H. Farley

As a result of the detectable Western Snowy Plover *Charadrius alexandrinus nivosus* population decline throughout the United States, the species was listed as threatened in Kansas in 1987. As such, information regarding reproductive success and habitat requirements are valuable in guiding management and conservation activities at the state and regional scales. In 2005, we located and monitored 263 Snowy Plover nests at Quivira National Wildlife Refuge ($n = 232$) and Cheyenne Bottoms Wildlife Management Area ($n = 31$) in Kansas. Each nest was checked for an attending adult at least once per week during the (18 April–10 August) breeding season, and estimated hatch date was established using egg flotation. In the event that eggs in a nest did not hatch, we attempted to determine the cause. Our preliminary analysis indicated that, of 263 nests, 31.1% had eggs that hatched, 28.8% were lost to flooding, 23.9% had an unknown fate, 8.0% were abandoned, 7.6% had eggs that were depredated, and 0.7% were lost to human disturbance. Post hatching, we attempted to monitor chicks through fledging. At the conclusion of the breeding season, nest characteristics such as nest substrate and surrounding vegetation were surveyed using a 1 m² quadrat centered on each nest, and compared to paired random sites. The results of reproductive success and habitat data analysis will be discussed.



Shorebird Movements Symposium

ORGANIZER: NILS WARNOCK (nwarnock@prbo.org)

Reflecting the ever-increasing diversity of ways to study how shorebirds move about their landscapes, twelve talks were presented emphasizing the complexity of variables that influence how shorebirds navigate their environment. The first talk by Jesse Conklin and Mark Colwell focused on the relatively little studied phenomenon of roost use by shorebirds (in this case Dunlin) in northern California, USA, and using radio-marked birds demonstrated clear differences in the use of diurnal and nocturnal roost sites. The second talk by Oriane Taft and her group (given by Peter Sanzenbacher) also presented a study of movements by radio-marked Dunlin but focused on how these birds were moving around the Willamette Valley, Oregon, an interior, grassland dominated valley in northwestern USA. Moving to the east coast of USA but also emphasizing local and regional movements through radio-telemetry and stable isotope research, two studies were presented on movements of Red Knots.

Phil Atkinson (presented by Nigel Clark) and colleagues used stable isotope technology to help understand differential resource use by knots in Delaware Bay, while Kevin Kalasz and co-workers talked about their work understanding Red Knot movements in the same area using an array of 14 stationary digital telemetry receivers located throughout Delaware Bay to continuously track shorebird and horseshoe crab individuals (at Delaware Bay, horseshoe crab eggs are one of the main prey by shorebirds). Going from high tech to low tech, Cheri Gratto-Trevor in her study of the local and long distance movements and dispersal of endangered Saskatchewan Piping Plovers showed that we can gather equally high tech information using banded birds if enough are banded and search effort is adequate.

Traveling from Canada to northern Alaska, Audrey Taylor and colleagues presented research on the regional movements and length of stay of radio-marked shorebirds marked at two interior breeding sites, three coastal breeding sites, and five coastal staging sites along the coastal plain in northern Alaska. This talk was followed by a discussion by Graciela Escudero who presented her ideas on how distributions and migratory strategies of shorebirds are shaped by a parasite-mediated trade-off between investment in immunocompetence versus other physiological functions. Laura Payne and co-authors then continued with an emphasis on shorebird migration patterns by presenting an analysis of a 26-year database of shorebird counts at 1,500 wetland sites throughout the eastern U.S. to determine whether spatial patterns of shorebirds systematically changed between 1975 and 2000. Switching back to stable isotope techniques, Julián Torres-Dowdall and Adrian Farmer showed that for non-breeding shorebirds in Argentina, isotopes can be used, with limited accuracy, to link non-breeding shorebird populations with specific migration corridors and breeding sites.

The last three talks presented data on movements of different shorebird species on a global scale. First, Nigel Clark and co-workers, expanding on their stable isotope study presented earlier in this symposium, offered a look at the migration system of Red Knots, and how different populations of Red Knots disperse across the global flyway. Mary Anne Bishop and her colleagues presented radio-telemetry data gathered over the last decade on various shorebirds of the Pacific Flyway, and showed how individual birds are navigating the flyway during their

spring migration towards the breeding grounds. Finally, Sue Haig, citing a number of studies that she and her co-researchers have done over the years, offered up a detailed look at the pros and cons of using genetic techniques to elucidate shorebird populations and their migrations.

Overall, the four hours of talks presented at the shorebirds movements symposium revealed some of the complexity of techniques which we have to study how shorebird populations move about this earth, ranging from relatively simple ways of marking birds with color-bands to look for movements to more complicated techniques of describing stable isotope signatures or molecular markers for revealing where birds have been and/or are coming from.

Techniques like radio-telemetry allow us to look at shorebird movements that we would not normally be able to do and describe patterns previously unknown, like the nocturnal movements of roosting Dunlin in northern California from a coastal estuary to inland pastures 10 km away or correlating hourly movements of individual Red Knots with movements of their Horseshoe Crab prey.

Molecular markers and stable isotope signatures are helping us link shorebird movements with their breeding and non-breeding grounds (and areas in between), allowing for better conservation and management of populations that show ecological and evolutionary distinctions at and below the species level. Overall, the topic of shorebird movements offers a great deal of exciting research that is still largely untapped with untold potential for helping us better protect global shorebird populations. All of you undecided student researchers take note – this might be a topic for you!

Diurnal and nocturnal roost site-fidelity of wintering Dunlin (*Calidris alpina pacifica*)

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Department of Wildlife, Humboldt State University;
Mark A. Colwell

Roosts represent an important, yet poorly understood, aspect of the ecology of nonbreeding shorebirds, especially in coastal habitats where tides predictably inundate foraging areas. Roosts are often considered “traditional” based on predictable occupancy by large numbers of birds over long time intervals. However, little is known of the day-to-day fidelity of individuals to particular roosts, especially on a spatial scale of individual home range.

Consequently, we studied fidelity of Dunlin to high-tide roosts during the day and night using radio-tagged birds wintering on Humboldt Bay in northern California, USA. Individuals had significantly higher fidelity to fewer roosts and higher use of terrestrial habitat (vs. marine habitat) at night than during the day. Precipitation and predation danger appear to be the factors most influencing roost choice. We suggest that the notion of tradition is scale-dependent. At the scale of individual home range, fidelity to roosts was lower than reported by others working over larger spatial and longer temporal scales. These findings have implications for the notion of habitat limitation, especially under the influence of natural and anthropogenic disturbance.



Movements of wintering Dunlin and changing habitat availability in an agricultural wetland landscape

Oriane W. Taft (oriane_taft@usgs.gov), USGS Forest and Rangeland Ecosystem Science Center; Peter M. Sanzenbacher; Susan M. Haig

Few researchers have studied how the dynamics of wetland bird movements relate to changing resource availability. Within Oregon's Willamette Valley, we examined resident wintering Dunlin movements in relation to decreased availability of preferred shorebird foraging habitat (moist/shallowly flooded with < 50% vegetative cover) from early (December/January) to late winter (February/March) of 1999–2000. By tracking movements of 15 (early-winter) and 12 (late-winter) radio-marked individuals, we calculated home ranges (95% minimum convex polygons) and characterized presence/absence of a preference for shorebird foraging habitat each season. We compared: 1) proportion of foraging habitat in home ranges to availability of this habitat in the landscape (regional preference), and 2) proportion of radio locations in foraging habitat to availability of this habitat within home ranges (local preference). Average home range sizes increased in late winter by a factor of 2.8. Although percent of landscape with available foraging habitat dramatically decreased by 75% between seasons, average amount of habitat in home ranges declined by only 40%. At the regional scale, Dunlin home ranges in early winter included significantly greater proportions of foraging habitat than was available in the greater landscape, but by late winter, proportions of habitat in home ranges matched landscape availability. At the local scale, Dunlin were located in preferred foraging habitat disproportionate to its availability within home ranges during both seasons. Results suggest wet, unvegetated habitat is sought-after by Dunlin throughout winter, but that individuals could not select home ranges in late winter that fully compensated for seasonal loss of habitat.

Hard or soft-shelled prey? Migration strategy determines resource use by Red Knot on their final stopover in Delaware Bay

Philip W. Atkinson (phil.atkinson@bto.org), British Trust for Ornithology; Allan J. Baker; Karen A. Bennett; Nigel A. Clark; Jacquie A. Clark; Kimberly B. Cole; Amanda Dey; Simon Gillings; Patricia M. Gonzalez; Brian A. Harrington; Clive D.T. Minton; Ines de Lima Serrano; Jason Newton; Lawrence J. Niles; Robert A. Robinson; Humphrey P. Sitters

Many kinds of shorebird undergo remarkable physiological changes just prior to undertaking long-distance migrations, reducing the size of their digestive organs and increasing size of organs needed for prolonged flight. Such phenotypic flexibility is crucial to overcome the physiological challenges of long-distance migration, but may be a disadvantage by limiting the pace of migration, as birds may have to spend time regrowing these organs to take advantage of food resources on stopover sites. We explore this issue using Red Knot passing through Delaware Bay on spring migration. Here they rapidly put on mass before flying directly to the Arctic breeding areas. Using stable isotopes in flight feathers to identify wintering area, we found that short-distance migrants, wintering in the south-eastern USA, were able to arrive early enough to feed on *Mytilus edulis* spat, a hard-shelled prey. Longer-distance migrants from

northern Brazil and Patagonia/Tierra del Fuego mostly avoided *Mytilus* and fed in areas with a high abundance of Horseshoe Crab *Limulus polyphemus* eggs and we hypothesize that this was because there was insufficient time to regrow their digestive organs sufficiently to feed on other prey and leave on time. Reductions in the availability of crab eggs, caused by the harvest of adults in a long-term bait fishery, will have the most severe impact on long distance migrants. Severe declines (>70%) have been observed amongst the Red Knot wintering in southern South America, but not amongst the birds wintering in SE USA.

Simultaneous tracking of shorebirds and horseshoe crabs in Delaware Bay using bay-wide radio telemetry array: implications for conservation and management

Kevin Kalasz, (kevin.kalasz@state.de.us), Delaware Natural Heritage and Endangered Species Program, Division of Fish and Wildlife; Lorne Brousseau; David Smith; Michael Millard

Shorebirds that use Delaware Bay as a stopover including Red Knots *Calidris canutus* and Ruddy Turnstones *Arenaria interpres* rely heavily on Horseshoe Crab *Limulus polyphemus* eggs to gain the weight needed to fuel the remainder of their migration and the initiation of nesting. Food resources and energy consumption are important factors at this final stopover where birds are time constrained and need to gain weight rapidly. Identifying important shorebird habitat and understanding their movements has important conservation implications for shorebird populations using the Bay. An array of 14 stationary digital telemetry receivers located throughout Delaware Bay was used to continuously track shorebird and horseshoe crab individuals during the 2004 and 2005 migratory and spawning period. More than 200 horseshoe crabs were fixed with transmitters each year. In 2004, 10 Red Knots and 10 Ruddy Turnstones were tracked to compare site use and movement patterns between the two species. In 2005, 30 Red Knot individuals were tracked to identify important feeding and roosting sites and to link site use and movement to conditions encountered on the Bay. Spatial and temporal overlap of red knots and horseshoe crabs were assessed in both years. This work has revealed key differences in site use and movement patterns between Red Knots and Ruddy Turnstones in Delaware Bay. In addition, it has revealed important factors that influence Red Knot habitat use and movement. These data will be used to conserve and manage critical shorebird habitats to further protect this important shorebird stopover site.

Color-bands and Piping Plovers: studying shorebird movements the old-fashioned way!

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This paper discusses use of a 'primitive' technique in examining local and long distance movements and dispersal in endangered Saskatchewan Piping Plovers. To accurately interpret results of the five-year census (for population trends), we need to know whether (as suggested), large numbers of breeders move between breeding sites in Prairie Canada and the northern U.S. In addition, to interpret effectiveness of local management techniques, we need to know movements of breeders and dispersal of young within Saskatchewan. For effective conservation, we need to know where birds from different areas



winter. Therefore, from 2002 to 2005, 663 adult plovers were uniquely color banded at four sites across Saskatchewan (Lake Diefenbaker, Big Quill Lake, the Missouri Coteau, Chaplin Lake). One chick per brood (377) at the Big Quill and Coteau sites was also uniquely marked. Plovers were reported subsequently at marking sites, elsewhere in Saskatchewan, other provinces, nearby states, and on the wintering grounds. To date, 76% (413/540) of adults have been seen subsequently on the breeding grounds, none in the U.S. Only 12% of these (50/413) were seen away from their marking site. To date, of 55 chicks seen subsequently on the breeding grounds, 79% (43) were seen back at the banding site, 16% (9) elsewhere in Saskatchewan, 2% (1) in Alberta, and 4% (2) in the northern U.S. As of spring 2004, 18% (88/464) of birds had been observed at winter sites: only 9% of those were from the U.S. Atlantic coast, and the remainder from the Gulf Coast.

**Should I stay or should I go now:
the importance of staging sites to shorebirds
on Alaska's north slope**

Audrey Taylor (ftart@uaf.edu), University of Alaska Fairbanks; Richard Lanctot; Abby Powell; Tony Williams

Pre-migratory shorebirds depend on resources found in coastal areas on the North Slope of Alaska to acquire fat necessary for southward migration, yet little information exists on how shorebirds use these areas or what sites are most important in preparing birds for migration. Such information is critical for evaluating potential impacts of human development occurring along Alaska's North Slope. To assess shorebird use of coastal areas prior to fall migration, we conducted an aerial survey of the coastline in August 2005 to identify "hotspots" of bird abundance. We also monitored the movements and tenure times of 119 adult and juvenile shorebirds captured and equipped with radio transmitters at two interior breeding sites, three coastal breeding sites, and five coastal staging sites. Analysis of the movement data indicates that breeding birds move to adjacent coastal areas to stage prior to migration, but there is limited movement between coastal sites during the staging period. Large temporal and spatial variation in the number of birds at staging sites indicates any given site is likely to host birds from a wide breeding area. Additionally, we collected blood samples from 337 individuals of five different species across the five coastal staging sites to examine rates of fat accumulation. We will discuss how this information can be used to assess the apparent quality of the five staging areas for each shorebird species, and will tie this information to the migration strategies of each species to predict how birds may use different staging sites.

**Pathogens and parasites shaping migratory
strategies and shorebird biology**

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A recent hypothesis outlined by Piersma describes how species-specific shorebird life histories, global distributions and migratory strategies may be shaped by the parasite-mediated trade-off between investment in immunocompetence versus other physiological functions (such as growth, thermoregulation, and flight capacity). I will provide an introduction to the logic and proposed mechanisms of the hypothesis, as well as an overview of the various descriptive and experimental tests that are possible. One refinement in our thinking about the importance of para-

sites in shaping shorebird biology is that not all types of parasites and pathogens are expected to be equally involved, but that their importance it is expected to depend on their impact on fitness, their interaction with the immune system, and their potential as vectors for other parasites. I will give an overview and interpretation of tests conducted so far, including my own research on parasite loads and habitat use of Nearctic and Neotropical shorebirds in Argentina. Given the recent interest in the relationship between diseases in wildlife and humans (Avian influenza, West-Nile virus, St. Louis encephalitis), this research program will not only advance our fundamental understanding of shorebird biology and diversity, but may also contribute importantly to any future research and conflict management involving the protection of wildlife and public health issues.

**Changes in spatial distributions of migrating
shorebirds in the U.S.: 1975–2000**

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Shorebirds may be especially vulnerable to changes in land use and climatic conditions because of their long-distance migrations and dependence on wetland habitats. However, as yet there has been no systematic evaluation of whether patterns of space-use by shorebirds during their migrations are changing through time. We used a 26-year database of shorebird counts at 1500 wetland sites throughout the eastern U.S. to determine whether spatial patterns of shorebirds changed systematically between 1975 and 2000. We further asked whether habitat specialization by shorebird species affected the tendency of their spatial distributions to change, and whether changes in dispersion were correlated with species status. Nineteen (53%) of 36 species showed significant unidirectional change between 1975 and 2000. Most (84%) demonstrated significant trends in one season only. Similar numbers of species from each habitat class exhibited directional trends in spatial dispersion during spring (10 species total) and fall (12 species), and most (74%) became more dispersed through time. Changes in spatial dispersion had compelling convergence with established indices of population status. Most (69%) of the 16 coastal specialists were imperiled (i.e., ranked either as highly imperiled or species of high concern) compared to 29% of 14 inland specialists or 33% of 6 habitat generalists. Despite the uneven distribution of status rankings, changes in spatial dispersion were linked to species status. Importantly, a higher proportion of species in imperiled categories demonstrated directional changes in dispersion compared to species in lower risk categories. This relationship held across all status categories. Our results offer the first evidence of changing spatial patterns, and highlight the link between species status and spatial dispersion.

**Determining shorebird wintering locations in
Argentina using stable isotopes and
trace elements: problems and promises**

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We are evaluating the use of stable isotopes to identify wintering sites of individual Neotropical migratory shorebirds in Argentina, thereby helping to identify distinct areas used by different subpopulations. In January 2002 through 2005, we



collected flight feathers from shorebirds at 43 wintering sites distributed across 12 provinces in Argentina. Feathers samples were prepared and analyzed for ^{13}C , ^{15}N , ^{34}S , ^{18}O and D by continuous flow methods, and the concentrations of 23 chemical elements were analyzed from the feather shafts using laser ablation ICP-MS. In spite of the wide geographic spread of study sites, D values alone did not provide a strong ability to predict a shorebird's winter origin. When other isotopes were included in the analysis, prediction accuracy increased. The addition of trace elements further improved prediction accuracy compared to the use of stable isotopes alone. Stable isotope and trace element data can identify shorebird wintering sites in Argentina with a mean error of about 240 km. Prediction accuracy is constrained by a high degree of intra- and inter-bird variability, especially in the Pampas region, where there is wide variety of wetland/water conditions. There were also interspecific differences within sites as well as interannual differences within some sites. These results suggest that the technique can be used, with limited accuracy, to link wintering shorebird populations with specific migration corridors and breeding sites. Future studies will focus on characterizing local shorebird movements, and isotopic landscapes to better understand sources of isotopic variability and define limitations to the technique.

Using stable isotopes to understand migration systems in the Red Knot

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Understanding the migration systems of a declining species is a prerequisite for identifying the conservation actions that are needed to halt or reverse declines. For a species with multiple breeding and wintering areas this can be problematic. For many species, populations and migration routes have been identified using banding recoveries, morphometrics, plumage characteristics and genetic markers. However identifying the origins of individuals within mixed populations can be difficult as many of these methods are not precise. We used stable isotopes from flight feathers of different Red Knot (primary coverts) populations worldwide to provide additional information to link breeding and wintering areas. Most results confirmed previous work but with significant exceptions, suggesting that some populations may be taking different routes than previously thought. Data from museum skins of Red Knot collected from one breeding area suggests that birds from the same breeding location winter in locations many thousands of kilometers apart. In addition, samples from an Alaskan spring passage site, close to the breeding grounds, show birds with different isotope signatures and the possibility that these birds are wintering in Australasia rather than the southern USA is explored. Ideally feather samples would be collected from a large number of individuals on the breeding grounds and compared from reference samples from the wintering areas. This is not possible due to the dispersed nature of breeding Red Knot and the further use of museum skins is suggested.

Spring migration on the Pacific flyway: piecing together the big picture from radio-marked shorebirds

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Since 1995, we have successfully radio-tracked individual

Western Sandpiper, Dunlin, Long-billed and Short-billed Dowitcher during spring migration. During five spring seasons, we radio-marked birds at a series of inland and coastal sites ranging from Sinaloa Mexico to the Yukon-Kuskokwim Delta in western Alaska.

Our results provide an unprecedented opportunity to evaluate where, when, and how long these shorebird species stop at major Pacific Flyway stopover sites. Based on relocations, the Copper River Delta Alaska is the single most important coastal stopover site for all four species. San Francisco Bay is the second most important site, based on results from two years when we banded birds south of this site. Washington's Willapa Bay/Grays Harbor wetlands complex is the third most important coastal site.

Mean length of stay among stopover sites varied significantly (1–8 d), depending on species and location. At both San Francisco Bay and the Copper River Delta, length of stay was negatively related to arrival date. Our studies reveal both the importance of conserving linked stopover sites and the complexity of migration strategies used within and among shorebird species along the Pacific Flyway.

Relative utility of molecular markers and stable isotopes to identify populations and movements of North American shorebirds

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Molecular markers are often thought of as a panacea for tracking migratory organisms throughout the annual cycle and for identification of specific populations.

However, Pleistocene processes in North America have often left relatively little differentiation among migratory populations of North American shorebirds. Thus, identifying population-specific molecular markers can be difficult in North American shorebirds. Conversely, use of stable isotopes can offer regional identification of populations, providing better resolution of movements in some cases. Yet lack of specific isotopic maps can limit this resolution as well.

In this talk, we will assess these various methods using data from species-wide molecular assessments of Piping Plovers *Charadrius melodus* and Snowy Plovers *C. alexandrinus*, as well as regional assessments of American Avocets *Recurvirostra americana* and Western Willets *Catoptrophorus semipalmatus*.

Molecular results from both plovers indicate population-specific markers for some areas and lack of markers in others can be explained by movement among populations. Isotopic signatures for American Avocets in areas just 60 km apart suggested differentiation/identification at a very fine scale.

Extensive banding and radio telemetry work on Willets points to a potential new subspecies not previously identified. Thus, a combination of methods may be necessary to get a complete picture of the annual movements of individuals in populations and the effect of those movements on population structure.

In addition, identification of these populations/units has never been more important for conservation planning, particularly when an Endangered Species Listing is under consideration.



Neotropical Priorities Workshop: Next Steps in Assessing the Conservation Status of Western Hemisphere Shorebirds

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Recent analyses of shorebird population trends suggest that many species are declining. Thus, there is a clear need to set priorities for conservation action, to ensure that those species more at risk are given the attention needed to avoid significant further declines. Growing recognition exists of this need, with, for example, the 2003 Cadiz Wader Study Group conference concluding that there is an urgent need to update the IUCN Red List evaluation for South American shorebird species. Consequently, the Neotropical Priorities Workshop at the Shorebird Science in the Western Hemisphere meeting was convened with three main goals:

1. Ensure that all Western Hemisphere shorebird species have been evaluated against the global IUCN criteria for extinction risk, taking into consideration the latest available information and knowledge.
2. Re-evaluate non-breeding threat and non-breeding distribution scores for North American-breeding taxa based on inputs from experts in the Neotropics.
3. Initiate an assessment of the conservation status of Neotropical-breeding shorebird taxa.

At a global level, the IUCN Red List identifies those species at highest risk of extinction, providing a globally standardized system which facilitates prioritization among different taxa and geographic areas. Many international instruments, such as the Convention on Migratory Species, base decisions on the Red List.

Currently, six Nearctic-breeding shorebird species are considered as globally threatened or near-threatened: Piping Plover *Charadrius melodus* (Near Threatened), Mountain Plover *Charadrius montanus* (Vulnerable), Eskimo Curlew *Numenius borealis* (Critically Endangered), Bristle-thighed Curlew *Numenius tahitiensis* (Vulnerable), Long-billed Curlew *Numenius americanus* (Near Threatened) and Buff-breasted Sandpiper *Tryngites subruficollis* (Near Threatened). A further four Neotropical-breeding species are all considered as Near Threatened: Diademed Sandpiper-plover *Phegornis mitchellii*, Magellanic Plover *Pluvianellus socialis*, Fuegian Snipe *Gallinago stricklandi* and Imperial Snipe *Gallinago imperialis*.

Workshop participants considered whether the existing data for population estimates and declines are sufficiently robust to evaluate the status of other Western Hemisphere shorebirds against three trigger questions derived from the IUCN criteria:

1. Reduction (past or future) in population size by 30% over 10 years or three generations (whichever is longest).
2. Extent of Occurrence (EoO) estimated to be less than 20,000 km² and severely fragmented (10 locations) with ongoing decline (in EoO and/or population).
3. Population less than 10,000 mature individuals and in continuing decline.

The overall consensus was that although existing data strongly suggest declines for many species, confidence levels are not high enough to justify upgrades in their current IUCN listings. In fact, for two species currently Red-Listed, Mountain Plover

Charadrius montanus and Buff-breasted Sandpiper *Tryngites subruficollis*, new data suggest their populations may be larger than previously estimated. In the case of Piping Plover *Charadrius melodus*, population increases in parts of its range have largely been countered by range retraction and declines in other areas. The results of the 2006 international census may warrant a re-assessment of the species' status. An additional Nearctic-breeding species which possibly merits further consideration is the Black Oystercatcher *Haematopus bachmani*, due to its small overall population combined with some evidence for local declines. Participants felt that too few data were available to assess the Red List status of the majority of Neotropical-breeding shorebirds. One potential exception is the Tawny-throated Dotterel *Oreopholus ruficollis*, which may merit consideration as Near Threatened due to small population size and apparent declines through hunting.

Clarification of the taxonomic status of a number of shorebird populations was found to have important implications for conservation status. A number of authors have proposed specific status for Hawaiian Stilt *Himantopus (mexicanus) knudseni*, Galapagos Oystercatcher *Haematopus (palliatius) galapogensis* and Ecuadorian Seedsnipe *Attagis (gayi) latreilli*. Treatment as separate species would lead to all three being considered as threatened, primarily due to the small size of their populations.

During the second part of the workshop, consideration was given to the prioritization methodology for shorebird species of concern developed for the U.S. and Canadian shorebird conservation plans, and specifically, its application in the Neotropics. Two important variables used in this methodology are threats during the non-breeding season (TN), and the extent of the non-breeding distribution (ND). To date, there has been relatively little input from shorebird biologists in the Neotropics regarding the scores for these two variables (for Nearctic-breeding species). Widespread agreement exists that the variables used in the system affect the final conservation status assessment of the species. For instance, the non-breeding threats score is the key trigger for listing ten taxa as Highly Imperiled (one taxon), High Concern (six taxa) or Moderate Concern (three taxa). Similarly, an increase by one in the score for non-breeding threat would upgrade the category of concern for 20 taxa (including seven from Moderate Concern to High Concern). A comparison of commonly available range maps with existing non-breeding distribution scores demonstrated the need for a more accurate assessment of non-breeding distribution, and a focus on those parts of the non-breeding range where the species is relatively sedentary (rather than on migration).

Finally, participants were asked to discuss the merits and opportunities for an assessment of the conservation status of Neotropical-breeding shorebird species, subspecies and populations. Despite the very poor knowledge of population sizes, trends and threats for many populations, data do exist (such as those gathered through the Neotropical Waterbird Census, which now spans 15 years), and there was recognition that a project-based approach may gather sufficient information to enable the application of the US/Canadian prioritization methodology to identify those Neotropical-breeding shorebird populations of greatest conservation concern.



In summary, the workshop concluded that:

1. Despite widespread evidence that many shorebird species are in decline, in the majority of cases the data are not robust enough to permit an assessment against the IUCN Red List criteria. For those species with sufficient data, BirdLife International's Globally Threatened Birds forum was presented as a mechanism for discussing their status.
2. There is a clear need to re-assess the non-breeding threat and non-breeding distribution scores for Nearctic-breeding species, with greater input from shorebird biologists in the Neotropics, and a refinement of non-breeding range maps. The upcoming Neotropical Ornithological Congress in Venezuela in 2007 was identified as one potential venue to initiate this process.
3. There is also clear need to systematically assess the conser-

vation status of Neotropical shorebirds. The compilation of existing data and knowledge, perhaps through a region-wide project, should allow the application (and adaptation) of the US/Canadian prioritization methodology.

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Maksim Dementyev



The Shorebird Research Group of the Americas Symposium

ORGANIZERS: ROB BUTLER (rob.butler@ec.gc.ca), STEPHEN BROWN & GARRY DONALDSON

The concept for Shorebird Research Group of the Americas (SRGA) began with research needs identified in the development of the national shorebird conservation plans in the United States and Canada; however, both recognized that it is essential that the group have a broader, hemispheric participation if it is to be effective. This broad geographical representation and function will define the SRGA yet, at the same time, it will still provide the research consultation functions of national shorebird plans and may be adopted as a centre of shorebird research expertise by other initiatives.

Shorebirds stand to benefit greatly from this model because of the vast distances many species fly during their annual cycle. Communication and collaboration among researchers from all countries of the Americas will greatly increase the efficiency with which research is conducted and will increase the likelihood that conservation efforts will be based on the best available information. To that end, the SRGA is designed to bring shorebird researchers together to increase our knowledge of shorebirds in the Americas and ensure that information is available for conservation purposes.

The overall goal of the SRGA is that important information gaps for shorebirds are identified and acted on, that research into shorebird biology not be constrained or hindered by a researcher's inability to communicate with others, and that conservation efforts for shorebirds and their habitat are implemented using a biological information base that is not compromised by any knowledge deficit.

The SRGA is comprised of researchers from institutions including universities, governments, and conservation groups interested in advancing shorebird research in the Americas. One of its principle activities will be to encourage research into all aspects of shorebird biology with a special aim to provide pertinent guidance for conservation activities. Collaboration and partnership will be cornerstone principles of this group.

Recognizing that other biodiversity conservation efforts can contribute to shorebird information and research, SRGA will operate as a participant and voice for shorebird science in this broader arena. SRGA will therefore ensure connections with initiatives such as the North American Bird Conservation Initiative, the Western Hemisphere Migratory Species Initiative, Waterbird Conservation for the Americas, the Ramsar Convention, the Convention on Migratory Species and Important Bird Areas program so that SRGA science will benefit from the actions of those working on other species or in other habitats. In addition, this will ensure that SRGA science is communicated to all who might benefit from shorebird focused science.

The motivation for research of any kind can come from a number of sources. In some cases it will come from independent researchers and for these individuals, the development of SRGA is intended to provide them with an arena to connect with others if their research could benefit from a broader team approach. Alternatively, the combined experience of the SRGA Committee may identify a research gap that is not currently being addressed and may decide as a group to promote the establishment of a team to address those questions.

SRGA will encourage project teams to be inclusive, and understands that they will operate in a largely autonomous fashion focusing on their specific questions and report progress to the SRGA Committee if only to ensure that new information for

shorebird conservation is communicated.

As an Example of what an SRGA approach can accomplish, the first project promoted by SRGA is a cooperative approach to determining the causes of shorebird population decline. Recent analyses of shorebird census data in North America indicate widespread and ongoing declining trends for shorebirds, comparable to declines being observed in other major flyways around the world. However, the data do not provide information about potential causes for the declines. Possible causes for ongoing declines include climate change, habitat loss in the breeding or wintering ranges, contaminants, reduced quality or loss of critical stopover locations, recovering predator populations, human disturbance, or some combination of these factors. Because many of these factors could be remedied by conservation action, it is essential to determine which factors limit shorebird populations for particular species experiencing declines.

Conservation action can be effective at restoring populations only if it addresses the factors actually limiting populations. For shorebirds, the research initiated to determine limiting factors must take into consideration the large ranges of species and thereby include projects on a hemispheric scale to reflect this.

The Shorebird Limiting Factors Project will encourage teams to form to explore the causes of declining shorebird populations. Questions will be addressed through a series of species groups, each looking at the same set of potential hypotheses.

Using the SRGA concept, a number of species specialist working groups are already functioning to determine limiting factors for populations many of which reported progress during the SRGA workshop. Groups for Buff-breasted Sandpiper, Marbled Godwit, Black Oystercatcher, American Oystercatcher, Long-billed Curlew, Western Sandpiper, Snowy Plover, Red-necked Phalarope and Piping Plover reported progress during this workshop.

Next steps for the group include development of its web presence which will provide the best mechanism for promoting coordination and cooperation among the shorebird researchers of the Americas. In addition, the SRGA Committee will be working towards building its ranks to include representation from all regions within the Americas to ensure that regional research interests and concerns are identified, acknowledged and acted on.

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Population decline in North American shorebirds: an hypothesis-testing approach

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Shorebird census data in North America indicate widespread ongoing declining trends, giving ample reason for concern about



the population health of many species. Monitoring programs generally give few solid leads about which of the possible causative agents of population decline are involved. In order to decide on effective conservation policy and action, research is needed to elucidate which factors might be operating. One approach is to challenge hypotheses based on suspected causative agents with the extensive data on some shorebird species built up over the past thirty or so years. In combination with specific newly-acquired information, this offers a science-based way to evaluate which of the several plausible causes are most likely involved. We outline possible general causes, the mechanisms by which they might be expected to affect shorebird population decline, and give examples of hypothesis-testing approaches.

Can intrinsic factors explain population declines in North American breeding shorebirds? A comparative analysis

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Many shorebirds that breed in North America are declining. These trends reflect global patterns in shorebird populations. Here we ask what factors make some shorebird species more prone to decline than others. Specifically, we test the influence of migratory behavior (route and distance), biogeography (population size and range), life history (body size, clutch size), and sexual selection (social mating system and testis size) on population trends in North American breeding shorebirds. Using phylogenetic comparative methods, we show that species that migrate across continental North America are more prone to decline than species that do not. Our finding that continental migrants are associated with population decline indicates that intrinsic factors may play an important role in pre-disposing a species to decline. Previous studies within the Class Aves have failed to identify migration route as a correlate of decline or extinction risk. Two other intrinsic factors (oceanic migrants and threats on the nonbreeding grounds) were also important in our overall models, although neither were significant alone. The

low explanatory power of our variables indicates that other factors are also important for explaining shorebird declines. We suggest contemporary threats, most notably habitat loss and degradation at migratory stopover sites, are likely to be important.

A species-wide assessment of Piping Plovers over the past 20 years: the importance of single species efforts

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In a world where multi-species/ecosystem level approaches to conservation are far more popular than traditional single species studies, in this talk, I will call attention to the importance of traditional single-species approaches. However, I will stress the need for taking a multi-temporal and spatial approach in these efforts. That is, looking at species needs over the annual cycle over a long period of time. And will advocate multi-species efforts when ranges, needs, or issues overlap. Twenty years ago this month, the U.S. federal ESA listing for the Piping Plover was approved. Shortly thereafter, their status changed to endangered in Canada. Since then, more effort and funds have been spent on their recovery than on any other shorebird in North America. As a result, we have been able to gather the manpower needed to examine the species status throughout the annual cycle and carry out recovery activities at the species level. For example, leaders of the seven recovery groups in North America have a representative on the International Piping Plover Recovery Group. This group meets quarterly to discuss issues affecting the species throughout its range. Further, every five years we carry out the International Piping Plover Census. This is the largest single species census effort we know of (1,500+ biologists participate) and encompasses birds at breeding and winter sites. Results of these cooperative, mostly voluntary efforts have provided comprehensive assessments that allow for precise evaluation of progress towards recovery. Recognizing limits to conservation funds as well as the need to assess species at multiple levels, we are now working on similar and simultaneous assessments for Snowy and Wilson's Plovers.



Maksim Dementyev



General Papers

BREEDING BIOLOGY AND BEHAVIOR

Parent–offspring communication in the Western Sandpiper (*Calidris mauri*)

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Western Sandpiper chicks are precocial and leave the nest shortly after hatch to forage independently. Chicks require thermoregulatory assistance from parents (brooding) for 5–10 days post hatch, and parent(s) facilitate chick survival for 2–3 weeks post hatch by leading and defending chicks. Parental vocal signals are likely involved in protecting chicks from predators, preventing them from wandering away and becoming lost, and leading them to good foraging locations. Using observational and experimental methods in the field, I describe and demonstrate the form and function of parent–chick communication in the Western Sandpiper. I document four distinct calls produced by parents that are apparently directed toward their chicks (brood call, gather call, alarm call, freeze call). Through experimental playback of parental and non-parental vocalizations to chicks in a small arena, I demonstrate: (1) chicks respond to the alarm call by vocalizing relatively less often and moving away from the signal source, (2) chicks respond to the gather call by vocalizing relatively more often and moving toward the signal source, (3) and chicks respond to the freeze call by vocalizing relatively less often and crouching motionless on the substrate for extended periods of time. I also discovered two distinct chick vocalizations (brood-contact call, chick-alarm call) during arena playback experiments. Results indicate that sandpiper parents are able to elicit anti-predatory chick behaviors, direct chick movement and vocalizations through vocal signals. Future study of parent–offspring communication should determine whether shorebird chicks exhibit parental recognition through vocalizations and the role of chick vocalizations in parental behavior.

Do some male shorebirds mate by mimicking females?

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The alternative male mating tactic of mimicking females is well known from fish and invertebrates. In birds, delayed plumage maturation has been interpreted in this context, but examples from mature males were unknown. We present three possible examples from shorebirds. In buff-breasted sandpipers *Tryngites subruficollis*, (Lanctot *et al.* 1998: *Anim. Behav.* 56: 419–432), which are plumage monomorphic and slightly size-dimorphic, males mimic the behavior of females by joining groups of females approaching displaying males. These “sneaky” males position themselves to “steal” copulations when females crouch to mate. Individuals switch between tactics depending on social context. In ruffs *Philomachus pugnax* (Jukema & Piersma 2004: *Limosa* 77:1–10, *Biol. Lett.*, in press), which are plumage and size sexually dimorphic, about 1 in 200 birds is intermediate in size between the sexes. In contrast to elaborately nuptial-plumaged males, these birds are small female-plumaged males,

which use only female mimicking tactics similar to those described for buff-breasts. Whether they are genetically distinct or develop conditionally is unknown. Finally, Snowy Plovers *Charadrius alexandrinus* are usually sexually size- and plumage-dimorphic. However, a population breeding in the Southern Great Plains of Texas contains a strongly bimodal distribution of male size and plumage phenotypes, with one mode quite female-like, particularly in plumage color (Conway 2001: PhD thesis, Texas Tech). Most of these “cryptic males” incubate, and generally produced male-biased broods, whereas non-cryptic males generally produced female biased broods. It is unknown if this cryptic phenotype is age-specific, plastic or permanent, or correlates with behavioral differences.

Using egg flotation and eggshell evidence to determine age and fate of arctic shorebird nests

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Ann M. Wildman; Charles B. Johnson

We floated eggs to estimate incubation age and collected eggshell evidence to determine nest fate at nests of 11 species of shorebirds on the Arctic Coastal Plain of Alaska during 2002–2004. We present egg-flotation schedules for nine species to facilitate the estimation of nest age. We evaluated the predictive ability of an egg-flotation schedule for Semipalmated Sandpiper *Calidris pusilla* and were able to estimate incubation age within ~1–3 d of the assumed age. Patterns of eggshell evidence were similar across species, with eggshell fragments (1–5 mm) present at most successful nests (96%), and eggshell tops or bottoms present only at successful nests. We determined nest fate independently of eggshell evidence and then used discriminant function analysis to predict the probability of correctly classifying a nest’s fate using different types of eggshell evidence. The use of eggshell fragment evidence resulted in the correct classification of the fate of all 11 species of shorebirds in 92% of the cases. Both the egg-flotation technique and eggshell evidence can be used in future studies to calculate accurate measures of reproductive success that are needed for ecological investigations of shorebirds.

Effects of human recreation on the incubation behavior of American Oystercatchers

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The effect of human recreational disturbance on wildlife behavior and demography is of growing concern, particularly for ground nesting shorebirds. We monitored nest success of American Oystercatchers in coastal North Carolina in 2002 and 2003 and used video monitoring to observe the response of incubating birds to human recreation. We counted the number of trips to and from the nest per hour, and the percent of time spent incubating. We tested to see if different types of human activity (truck, all-terrain vehicles, and pedestrians) were associated with parental behavioral patterns. We used analyses that split the nests into groups of high or low activity to see if parental behaviors were associated with the probability of hatching. Factors associated with a bird leaving its nest (n = 548) included: ATV traffic (24%), truck traffic (17%), pedestrians



(3%), territorial fights or exchanging incubation duties (26%), and other causes (1%). ATV traffic had a positive association with the rate trips to and away from the nest ($\beta_1 = 0.7486$, $p < 0.0001$), and negative correlation with incubation rate ($\beta_1 = -0.0370$, $p = 0.0253$). Other forms of human recreation had no association with incubation behaviors. Hatching success was negatively associated with the rate of trips to and from the nest under certain conditions. There was no association between the percent of time spent incubating and hatching success. These data suggest that incubation behavior might be one mechanism through which human recreation affects oystercatcher reproductive success, however experiments that manipulate human disturbance will further our understanding of this relationship.

NESTING SUCCESS

Red-necked Phalarope (*Phalaropus lobatus*) nest fate and site preference in the Mackenzie delta, NWT, Canada

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Both arctic-breeding phalarope species are considered high priority for research in the Canadian and U.S. Shorebird Conservation Plans. Red-necked Phalaropes breed in wet arctic meadows and shallow ponds. Two threats related to global warming have been documented that have the potential to negatively impact breeding populations: warmer continental temperatures that lead to premature drying of ponds critical for raising young, and encroachment of shrub vegetation into previous meadow habitats. Construction of a habitat model for this species would provide the range of habitat conditions that the species can tolerate and describe habitats that result in the highest rate of reproductive success. Our objective was to examine *P. lobatus* nest fate and habitat preferences on Niglintgak Island, NWT. The 6 km² study site is at the mouth of the Mackenzie delta. This area consists primarily of low arctic wetland. In 2005 we located and determined the fates of 33 nests. Habitat measurements were determined at nest sites and random sites within home range and unoccupied sites. Nest and home range plots were surrounded by more graminoid and were closer to open water than unoccupied sites. 64% of nesting attempts successfully hatched at least one chick. The vegetation surrounding successful nests was taller and primarily composed of graminoid with little mud relative to nests that failed. These results suggest that *P. lobatus* do not have preference for particular habitat features of nest sites within their home range but they are choosing home ranges that are different from surrounding, unoccupied habitats. Furthermore, concealed nests have increased success compared to nests surrounded by shorter vegetation and a greater proportion of mud.

Modelling important landscape characteristics affecting Semipalmated Plover nest success on Akimiski Island, Nunavut

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We collected landscape characteristics on Semipalmated Plover *Charadrius semipalmatus* nests on the north shore of Akimiski Island, Nunavut, during 2003–2004. We used an information-

theoretic approach to assess and rank models that examined the relationship of nest and random sites, and successful and unsuccessful nests to landscape characteristics measured at three spatial scales. The models were evaluated by examining how well they predicted bird occurrence in a test set (2004 year) not included in the original analyses (2003 year), and at a different location within the region. The results of the 2003 training data could predict the probability of nest site selection and nest success of Semipalmated Plovers the following year, but was a poor predictor of the probability of occurrence for new locations. We view model development and refinement as an iterative process, where acceptable predictive models covering large spatial extents across the Semipalmated Plover's breed range can be developed.

The influence of nest site and parental behavior on shorebird nest success

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In environments such as Arctic tundra, where bird densities are low and habitats are comparatively homogeneous, suitable nest sites aren't likely to be limited. Under these conditions, reproductive success of birds may be determined by factors other than the habitat characteristics of nests. I studied the influence of nest habitat, food, nest distribution and parental behavior on the reproductive success of tundra breeding shorebirds at East Bay, Southampton Island, Nunavut. From 2000–2002, I monitored the nests of five species: Black-bellied Plover *Pluvialis squatarola*, Red Phalarope *Phalaropus fulicarius*, Ruddy Turnstone *Arenaria interpres*, White-rumped Sandpiper *Calidris fuscicollis* and Semipalmated Plover *Charadrius semipalmatus*. For each species, habitat differed between nest sites and random sites. In contrast, habitat differed between successful and failed nest sites only for White-rumped Sandpipers. Although nest success varied between species in all years, artificial nest experiments suggested that interspecific variation in predation rate was not related to habitat type. Shorebirds did not prefer to nest in habitats where food was most abundant. Instead, interspecific patterns of success are consistent with the hypothesis that reproductive success is related to the amount of parental activity near the nest; species taking fewer incubation recesses had higher nest success. This hypothesis will be further supported with results from work in progress.

Assessing shorebird nest productivity patterns across arctic Alaska

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Alaska's arctic coastal plain is an important breeding area for many shorebird species, some of which have experienced recent population declines. Human activity (including industrial development, military activities, and settlements) in this area may be contributing to these declines. Availability of human food sources and man-made structures for use as nest, den, or surveillance sites may positively influence local nest predator populations including Grizzly Bears *Ursus arctos*, Arctic Foxes *Alopex lagopus*, Common Ravens *Corvus corax*, and Glaucous Gulls *Larus hyperboreus*. Potential increases in these predator populations may have negative consequences for productivity



of breeding birds via increased loss of eggs and young. However, this predator–prey system is poorly understood. From 2002–2005, we formed a large collaboration of diverse stakeholders (including oil companies, federal agencies, and NGOs) to assess, at multiple sites, nest survival of shorebirds and other birds and predator abundance at various distances from the existing oil fields, including sites in the Arctic National Wildlife Refuge and near Teshekpuk Lake Special Area in the National Petroleum Reserve – Alaska. From this effort, we have monitored hundreds of shorebird nests from several species across a large region of arctic Alaska, and have documented patterns of year-to-year and geographic variation in several breeding parameters. We will present our common research design and preliminary results from our collaborative study, and briefly discuss regions of conservation concern and important gaps in our knowledge of shorebirds in arctic Alaska.

BREEDING HABITAT AND DISTRIBUTION

Distribution of breeding shorebirds on the arctic coastal plain of Alaska

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Available information on the distribution of breeding shorebirds across the Arctic Coastal Plain of Alaska is dated, fragmented, and limited in scope. Herein, we describe the distribution of 19 shorebird species from data gathered at 500 study plots between 1998 and 2004. This information was collected using a single-visit rapid area search technique when shorebirds are establishing nesting territories and are highly visible. We describe five different patterns of shorebird distribution, ranging from widespread to isolated occurrences. Although our distribution maps may not be able to predict species occurrence at any particular site, we believe they accurately portray species distributions at a regional scale. Our coarse grain sampling approach likely undersampled unique or rare habitats. We also present species richness values and discuss how these vary both latitudinally and longitudinally by natural physiographic features over the Arctic Coastal Plain of Alaska. Broad-scale distribution information is valuable for evaluating potential effects of human development and future global climate change on Arctic-breeding shorebird populations.

Shorebird distribution and abundance on the Arctic Refuge coastal plain

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The coastal plain of the Arctic National Wildlife Refuge hosts seven species of migratory shorebirds listed as highly imperiled or high priority by the U.S. Shorebird Conservation Plan, and five species listed as Birds of Conservation Concern by the U.S. Fish and Wildlife Service. We completed the first comprehensive survey of the 674,000-ha “1002 Area” on the coastal plain during June of 2002 and 2004. We recorded 14 species of breeding shorebirds in 197 rapidly surveyed plots, and estimated detection rates with a double counting technique on 37 inten-

sively studied plots across the North Slope of Alaska and Canada. We stratified the survey by major habitat types, including wetlands, moist areas, uplands, and riparian areas, using previously classified lands at imagery. The density of many species was highest in wetland or riparian habitats, which were clustered along the coast. We developed population estimates with confidence limits by species. We estimated the total number of shorebirds in the study area to be approximately 230,000 (95% CI 104,000–363,000), which exceeds the biological criteria for classification as both a Western Hemisphere Shorebird Reserve Network Site of International Importance (100,000 birds) and a Ramsar Wetland of International Importance (20,000 birds).

An eastern arctic ‘hotspot’ for shorebirds: Prince Charles and Air Force Esland, Foxe Basin, Nunavut

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I undertook two seasons of ground surveys for shorebirds on these islands in the Foxe Basin, Nunavut, in 1996 and 1997. I compared my results with those of surveys undertaken on the islands nine years previously. The islands’ population estimates are greater than 10% of the continental population estimates for five shorebird species. My survey results indicate that the islands are the most important breeding sites for Red Phalaropes and White-rumped Sandpipers in the entire eastern Canadian arctic. It also appears that populations of these two species have significantly declined over the nine year period between 1989 and 1997. This, coupled with evidence of drastic declines in Red Phalarope populations at two other eastern and central arctic locations, support migration count data that indicate significant declines in the eastern population of Red Phalaropes. I recommend 1) that these two islands be afforded legislative protection; 2) that the islands be resurveyed soon, to confirm a continuing declining trend in Red Phalarope and White-rumped Sandpiper populations; and 3) that focused attention be given to determining causes of decline in Red Phalaropes.

Mountain Plover density and abundance on prairie dog colonies in Montana

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Mountain Plovers breed on active Black-tailed Prairie Dog colonies in Phillips County, Montana. From 1992 to 1995, prairie dogs in this region experienced declines from a sylvatic plague epizootic. Our objective was to estimate yearly Mountain Plover densities on active prairie dog colonies using distance sampling. From 1991 through 2000, we estimated densities from a random sample of prairie dog colonies in southern Phillips County. Densities declined from the pre-epizootic year of 1991 ($D = 5.86$ plovers/km²) to 2000 ($D = 1.04$ plovers/km²). Since 2000, prairie dog numbers have generally increased. In 2004 and 2005, we estimated density and abundance on all prairie dog colonies in Phillips County using a size-biased sampling design. Plover densities were similar to pre-epizootic levels in both 2004 ($D = 7.2$ plovers/km²) and 2005 ($D = 6.12$ plovers/km²), and estimated plover abundance on prairie dog colonies in Phillips County was similar in both years (2003, $N = 758$; 2004, $N = 643$). Our results 1) document that densities on prairie dog colonies are among the greatest range-wide, 2) provide the first



rigorous estimate of the number of plovers breeding in this region of Montana, 3) illustrate the role of plague in influencing plover numbers, and 4) suggest that prairie dog conservation is necessary for plovers to persist in this region.

Breeding distribution, abundance, and habitat use of Snowy and Wilson's plovers and other beach nesting birds in coastal Texas, Louisiana and Mississippi

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From 2003 to 2005, National Audubon's Coastal Bird Conservation Program (CBCP) conducted the first comprehensive breeding surveys of beach nesting birds and identification of breeding habitat in coastal Texas (2003–04), Louisiana and Mississippi (2005). The focal species were Snowy Plovers, *Charadrius alexandrinus*, Wilson's Plovers, *Charadrius wilsonia* American Oystercatchers *Haematopus palliatus* and Least Terns *Sterna antillarum*. The CBCP conducted exact pair counts of breeding birds for all states surveyed. GPS coordinates were recorded for each pair to produce maps delineating all breeding habitat within each state. Our 2004 Texas census yielded 481 pairs of Snowy Plovers and 892 pairs of Wilson's Plovers over 1,840 km² of habitat. Our 2005 Louisiana census yielded 2 pairs of Snowy Plovers, 759 pairs of Wilson's Plovers, 57 pairs of American Oystercatchers and 1031 pairs of Least Terns over 519 km of coastal habitat. Our 2005 Mississippi census yielded 15 pairs of Snowy Plovers, 17 pairs of Wilson's Plovers and 21 pairs of American Oystercatchers over 202 km of coastal habitat. The CBCP's 2003–2005 census and monitoring efforts provide new baseline data on breeding abundance and distribution, habitat use, nesting chronology and breeding biology for Snowy and Wilson's Plovers and other beach-nesting species in coastal Texas, Louisiana and Mississippi. These data provide invaluable information for population assessments and conservation and management plans for these species on the U.S. Gulf coast. Future monitoring efforts of beach nesting birds should focus on range-wide breeding and wintering censuses, including Mexico and the Caribbean.

POPULATION STATUS

Status of the Hudsonian Godwit, *Limosa haemastica*, (Linné) 1785 in Llanquihue and Chiloé provinces, southern Chile, between years 1979 to 2005

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The status of the Hudsonian Godwit based on censuses carried twice a year since 1980 is analyzed for different localities of the 10th Region, southern Chile. The Hudsonian Godwit and the Marbled Godwit *L. fedoa* are the only members of the genus *Limosa* recorded to have occurred in Chile. Both are trans-hemispheric migratory species, but only Hudsonian is a regular visitor in substantial numbers. A large proportion of the total Hudsonian Godwit population spends the northern winter in the 10th Region of Chile (<10,000 birds in some years), most of the remainder go to Chilean Patagonia (and Tierra del Fuego). Habi-

tats used for feeding and resting are intertidal, coastal sandy-mudflats with abundant macroinfauna. These areas are also utilized by man for extractive activities like shellfisheries and aquaculture which are unregulated with little or no environmental control. This has led to constant disturbance and degradation of habitat, as well as a decline in food resources and environmental quality at the sites where godwits winter.

Status of Upland Sandpipers, Marbled Godwits, and Western Willets in South Dakota

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Spatial and temporal, population and species accounts for Upland Sandpipers *Bartramia longicauda*, Marbled Godwits *Limosa fedoa* and western Willets *Catoptrophorus semi-palmatus* in South Dakota and the northern Great Plains are sparse and inconsistent. The current status of these three species is a primary concern of natural resource managers, because the two main habitats these species need, native rangelands and wetlands, are being converted to other land uses at a rapid rate. We synthesized over 500 references to generate a comprehensive review on the occurrence and ecology of these species with relevance to South Dakota and nearby states to determine obvious and significant information gaps necessary to form population management plans. Our literature synthesis is aimed at species management and research priorities and should have application to other geographic areas in the northern Great Plains where these three species historically and currently occur. Major factors contributing to these species population declines and to their future welfare will be presented.

Winter population of Long-billed Curlew and Mountain Plover in the La Soledad Prairie, Galeana, Nuevo León, Mexico

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Fieldwork was done in the La Soledad prairie which covers an extension of 7,608 ha. and is situated in the South of the state of Nuevo León, Mexico. Samples were gathered during two winter seasons (January and December 2005). Twenty five random transects for field exploration were set. For Long-billed Curlew (LBCU), the transects were 1000 m × 300 m and 1000 m × 200 m (20 ha.); for Mountain Plover (MOPL) they were separated by 300 m, so that we could approximate their populations. During the first year, the estimated populations were 2860 and 1597 individuals for each species. For the second year, two samples were taken in December 2005, with intervals of two days, for the first sample. The estimated populations were: 334 and 4473 individuals for LBCU; and 2160 and 745 individuals for MOPL. The variation between estimated populations might be the product of the climatic conditions in which fieldwork was undertaken. The La Soledad prairie hosts 25 % of the World population of LBCU and MOPL. Thus, considering these data, the site was recently designated as part of the Western Hemisphere Shorebird Reserve Network (WHSRN).



Bar-tailed Godwits staging in Western Alaska: evidence of steep population decline

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The North American population of Bar-tailed Godwits *Limosa lapponica baueri* breeds in western and northern Alaska, and stages on intertidal flats from the Yukon-Kuskokwim Delta to the Alaska Peninsula. By scanning flocks at high tide roosts and determining the proportion of juveniles, we estimated the annual reproductive success of Alaskan-breeding godwits. At our primary study site, the proportion of juveniles has been consistently low since 1999, exceeding 3% only in 2005 (8.6%), with samples ranging from 1,500 to 40,000 birds each year. To evaluate the impact of such chronically low productivity, we developed a population model that predicted a population decline of approximately 9% per year. Aerial surveys conducted eight years apart are consistent with the decline predicted by the model (10% annual decrease from 94,000 godwits counted in 1997 to 42,000 godwits in 2005). Counts conducted at both breeding and non-breeding sites over the last decade provide additional evidence of a steep, recent population decline. The significance of these data remains to be determined. The possibility of spatial and/or temporal bias in the age data, and evidence for large long-term fluctuations in godwit numbers over the last several decades make interpretation of the apparent recent decline problematic. A special flyway-wide assessment of the status of *L. l. baueri* should be a conservation priority.

Uncertainty about the size and status of Red Knot populations in the Americas is a problem for conservation

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There are major gaps in our knowledge of the size and subspecific status of American Red Knot populations. One of the few certainties is that most *rufa* winter in Tierra del Fuego, where numbers have declined from 67,500 in 1985 to 17,500 in 2005. The only other known substantial wintering populations are those of Maranhao, N Brazil, (7,575 in Feb 2005) and Florida (about 7,500), but their subspecific status is uncertain. 35,000–50,000 knots occur in Alaska in late May and it is thought that they are *roselaari* which breeds in Alaska and on Wrangel Island and winters in the Americas. However, it is not possible to account for such numbers in winter. Possibly these birds include *rogersi* which breed in NE Siberia and winter in Australasia. Alternatively they are the birds that winter in Florida and/or Brazil and/or unidentified sites on the American Pacific coast. Banding data show that at least some Florida and Maranhao birds migrate through Delaware Bay in spring. Possibly they are *roselaari* en route for Alaska. However, stable isotope analysis of feathers and banding data show that the knots breeding on the southern edge of the *rufa* range (Southampton Island, Hudson Bay) include birds from both the northern

wintering area (the Brazil/Gulf region) and from Tierra del Fuego. These questions are of conservation importance as there may be more distinct populations of Red Knots in the Americas (or perhaps subspecies) than previously thought. As some would be very small, they would be particularly vulnerable to extinction through stochastic events and low adaptive genetic variation.

MIGRATION HABITAT

Use of rice fields by migratory shorebirds in southern South America: threats and conservation implications

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Rice fields cover an area bigger than any other wet crop in the world. In North America they are used by millions of migratory shorebirds each year, a phenomenon that has also been reported for northern South America. The scarce information available for the southern cone suggests a similar use. The objective of this study was to assess the use of rice fields by migratory shorebirds during the non-reproductive season in southern South America. Field work took place from November 2004 to April 2005 in Argentina, Brazil and Uruguay. We used variable circular plot sampling, recording all birds within a 150–200 m radius. We collected data on abundance, distance to observer and behavior, as well as information on habitat variables like rice coverage, plants height and water deep. A total of 341 points were completed in the three countries. Rice fields were used by 17 shorebirds, including 12 Nearctic species. The more common ones were *Vanellus chilensis*, *Calidris melanotos*, *Tringa flavipes*, *Pluvialis dominica*, *Himantopus melanurus* and *Calidris fuscicollis*. Some other shorebirds of special concern were registered during surveys, like *Bartramia longicauda* and *Tryngites subruficollis*. Densities varied between species and countries, with a maximum of 5.21 ind/ha for *P. dominica* in Uruguay. Abundances varied also with the rice cycle, with highest values registered when the rice is lower than 20 cm height. Our results suggest a significant use of rice fields by migratory shorebirds. We discuss these results and its conservation implications.

The importance and future scenarios of prairie wetlands as migratory shorebird habitat

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The extensive wetlands of the Prairie Pothole Region provide stopover resources for large populations of shorebirds during spring and fall migration. We estimated populations and identified important landscapes for highly mobile shorebirds dispersed across this dynamic wetland system. Based on assumed residency periods for each species, we estimate that 8 million shorebirds stop in the study area during spring migration, and 8.5 million shorebirds stop during the late-summer/fall study period. During spring and fall of our study, 48% and 16% of the shorebirds were calidrids. Although many shorebird species were associated with landscapes of numerous shallow palustrine wetlands during our study, wetlands of different water regimes



are needed to provide shallow habitat through the continuum of water cycles from flood to drought. The pre-European settlement landscape, often described as a seemingly endless landscape of grassland and abundant wetlands, has undergone extensive change with major implications for the conservation of shorebird migration stopover habitats. Shallow wetlands are highly vulnerable to conversion to cropland, sedimentation, vegetation encroachment, and climate change. We present predictions for landscape change relative to sedimentation rates and climate change. It is feasible that migration stopover habitat may already be or may soon become a limiting factor for declining shorebird species, especially calidrids.

Fall stopover duration at natural and managed sites in the prairie Pothole region

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The stopover biology of migrating shorebirds in the mid-continent of the United States is relatively unknown, particularly during fall migration. Most previous work has been completed at coastal estuarine stopover sites, which differ greatly from mid-continent sites. We investigated stopover duration and energetic condition of shorebirds at several small natural wetlands and a large managed wetland (Big Stone National Wildlife Refuge) in eastern South Dakota and western Minnesota. We predicted that stopover duration at mid-continent sites should be shorter than at coastal sites due to the ephemeral nature of mid-continent wetlands and the shorter distance between successive stopovers. Additionally, we predicted that stopover duration at the large managed wetland would be longer than at small natural wetlands due to the abundance of appropriate habitat. Stopover duration for Least Sandpipers, as measured by radio-tracking, averaged significantly ($P < 0.01$) shorter at natural wetlands, 5.7 ± 0.5 (SE) ($n = 77$) days, than at Big Stone NWR, 9.4 ± 1.0 ($n = 55$) days. For Pectoral Sandpipers no significant difference was found with stopover durations of 4.3 ± 0.6 ($n = 50$) days at natural sites and 5.9 ± 0.9 ($n = 29$) days at Big Stone NWR. Moreover, neither mass nor a coarse measure of energetic condition (mass/wing chord) differed significantly for Least, Semipalmated, or Pectoral sandpipers at natural and managed sites or between age classes, suggesting that energetic condition is similar between sites, irrespective of differences in stopover duration. These data suggest that Big Stone NWR and the surrounding natural wetlands both act as effective stopover sites for these sandpiper species.

WINTER BIOLOGY AND HABITAT

Habitat use, seasonal dynamics and behavior of shorebirds wintering in the southern Pacific coast of Colombia

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Between August 2003 and May 2004, we evaluated the habitat use, seasonal dynamics and behavior of shorebirds in the

Sanquianga National Park, southern Pacific coast of Colombia. We made monthly census in artificial grasslands, mudflats and sand beaches to know the dynamics of shorebird diversity and abundance. We also made observations of behavior of shorebirds related with each habitat. Diversity of shorebirds was highest in fall migration (September) with 19 species, while abundance peaks in spring (January–February) with more than 2500 individuals. Even the sandy beaches had more than two thirds of the area, the highest number of species was found in the tidal flats (69%) and pastures (62%). The shorebirds invested the biggest amount of time foraging (62%), and also preening (21%), resting (14%) and having aggressive interactions (3%). The surface foraging was the most used technique because of the preferred prey item was crustacean and polychaete worms. Sanquianga NP has one of the greatest richness (26 species) and abundance of shorebirds in the Colombian Pacific region because of a high availability of resting and foraging sites and it is a very important site during spring migration. Our results agree with general patterns of habitat use found in other sites of this region, but several species present variations in seasonal dynamics. Because of differences in methods and years of study, these are preliminary results. To clarify temporal and spatial dynamics of shorebirds in Colombian Pacific coast we recommend maintaining a monitoring and banding program in important sites.

Wintering ground fidelity and other features of Pacific Golden-Plovers on Saipan, Mariana Islands, with comparative observations from Oahu, Hawaiian islands

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We radio-tagged and uniquely color-banded Pacific Golden-Plovers *Pluvialis fulva* wintering on Saipan, Mariana Islands ($n = 36$, of which 24 were radio-tagged), and Oahu, Hawaiian Islands ($n = 10$, all radio-tagged) in spring 2005. The birds departed in late April at both locations, and their transmitter frequencies were then monitored from small aircraft in several regions of Alaska. The only signals detected were those of four Oahu plovers. During southbound passage in August, one of the Saipan birds was sighted in Japan. Fall returns to the study sites were 72% (26/36) on Saipan and 90% (9/10) on Oahu. Each of the Oahu birds reoccupied its previous wintering territory. Because most Saipan plovers were non-territorial and often difficult to locate, we probably did not find all returnees during fall surveys. Thus, the actual percentage return at Saipan was likely similar to that on Oahu where long-term rates have averaged around 80%. Although connectivity between Saipan and Alaska remains a possibility, finding no radio-tagged Saipan birds in Alaska suggests linkage with nesting grounds in Siberia. The most likely route for northward passage from Saipan is via Japan. There are also possible connections with major *fulva* stopovers in Mongolia and adjacent Russia. Saipan plovers were relatively lean compared to those on Oahu. Whether lower pre-departure mass is typical at Saipan or instead reflects diminished resources caused by lack of rainfall is uncertain. Our findings imply that spring migration from Saipan involves substantial fattening at stopovers while en route to breeding grounds.



Site fidelity, survivorship and local movements of non-breeding Semipalmated Plovers in south-eastern Georgia

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The degradation of estuarine systems in south temperate North America has raised concern for populations of migratory shorebirds that express site fidelity to specific non-breeding habitats. We individually color-banded 62 non-breeding Semipalmated Plovers *Charadrius semipalmatus* on Cumberland Island National Seashore in southeastern Georgia during the winter of 2004. With 42 resighting intervals we calculated, using Program MARK, apparent survival over a three year period ending in late winter 2006. There was significant heterogeneity in resighting probabilities over the period but no significant time dependence in apparent survival probabilities. The model with mass at initial capture influencing survival, and time dependence in resighting probabilities was almost as well supported as one without the inclusion of mass. Apparent survival increased slightly as a function of mass. Apparent survival estimates from these data overlapped with the 95% confidence intervals of survival estimated from mark-recapture studies conducted in two breeding areas (Churchill, Manitoba and Akimiski I., Nunavut) at between 60% and 70% annual local survival. Though a small number of marked Semipalmated Plovers were observed both to the north (8 km) and south (25 km) of the Cumberland system, most birds remained within a small local area. Over 30% of birds remained within the Cumberland estuary during the 2003 breeding season, implying important year-round use of the estuarine system as a staging ground for non-breeding, and possibly juvenile birds. Use of the surrounding saltmarsh, beach and mudflat habitat by banded birds suggest that a regional mosaic of foraging and roosting is important for maintaining populations of non-breeding Semipalmated Plovers, as variation in site availability requires a sufficient network of viable habitats.

Age and sex ratios of Western and Least Sandpipers in the Yucatan Peninsula

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During the winter 2004–2005 we caught 117 Western Sandpipers (WESA) and 115 Least Sandpipers (LESA) in the Ría Lagartos Biosphere Reserve in the northern coast of the Yucatan Peninsula, situated 7300 km away from Nome, AK. Bill length was used to determine sex, and plumage was used to distinguish juvenile from adult birds. WESA sex ratio was 1:1 ($\chi^2 = 0.0342$, $df = 1$, $P = 0.05$). LESA sex ratio was not established because of a large percentage (40%) of individuals that could not be assigned as either male or female; feathers were collected and sexes are being determined in a genetic laboratory. WESA adults seem to be slightly more abundant, however chi square analysis showed no difference ($\chi^2 = 0.4260$, $df = 1$, $P = 0.05$). LESA adults are more abundant ($\chi^2 = 5.4967$, $df = 1$, $P = 0.05$). WESA sex and age ratios are in accord to the known and predicted proportions for the species in the Americas. There has not been a continental evaluation for LESA.

FORAGING ECOLOGY/MANAGEMENT

Mass gain dynamics of Semipalmated and Least Sandpipers during spring migration stopovers in Delaware Bay

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From 1995–1997 (early period) and 2000–2005 (late period), we monitored mass gain in Semipalmated Sandpipers (SESA, *Calidris pusilla*) and Least Sandpipers (LESA, *C. minutilla*) during northbound migration stopovers in Delaware Bay, USA. We compared mean size-adjusted mass (SAM, $\text{mass}/\text{wing chord}^3 \times 10,000$) in daily capture cohorts between early and late periods and compared between-period mass gain rates (SAM \times date). Mean SAM in SESA was significantly greater during the early compared with the late period. In LESA, however, we found no significant period effect in SAM. During the early period, seasonal SAM gain rate in SESA was best described by a quadratic function (i.e., ΔAIC ; quadratic vs. linear), while during the late period SAM gain rates were best described by a linear function. In LESA, model selection criteria indicated that linear functions were the best fit for SAM gain rates during both periods. Furthermore, slopes of these functions were not significantly different. Our data suggest that SESA mass gain potential has declined in recent years, but that the same pattern is not apparent in LESA. Migration phenology, and potentially, food preferences and availability, may be influencing differences between the two species. SESA stage in Delaware Bay from mid-May to early June and feed predominantly on Horseshoe Crab *Limulus polyphemus* eggs. LESA arrive in late April and depart in mid-May, and miss the peak Horseshoe Crab spawning period. Recent harvest pressure on horseshoe crabs may be driving reduced mass gain potential and, possibly, documented population declines in SESA along the Atlantic Coast during migration.

Nutritional status of fall migrants during stopover at natural and managed sites in the mid-continent

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Plasma metabolites serve as indicators of nutritional status in migrating birds and allow inference of differences in suitability among stopover sites. We measured plasma metabolites during stopover at natural and managed wetland sites in northeastern South Dakota and west-central Minnesota for three shorebird species; Least, Semipalmated and Pectoral Sandpipers. We measured plasma triglycerides, glycerol and β -hydroxybutyrate, and creatine kinase activity, to determine if nutritional status of birds differed between natural and managed sites. Triglycerides showed a significant positive relationship with energetic condition for Least ($R^2 = 0.19$, $P < 0.05$) and Semipalmated ($R^2 = 0.18$, $P < 0.01$) Sandpipers, suggesting that enhanced energetic condition was accomplished via fattening at stopover sites in these species. Triglyceride levels were generally higher at managed than at natural sites for Least Sandpipers, suggesting elevated rates of fattening at managed sites, but this was not the case for the other two species. β -hydroxybutyrate showed a significant negative relationship with energetic con-



dition for Least Sandpipers ($R^2 = 0.14$, $P < 0.05$) and a negative trend for Pectoral Sandpipers ($R^2 = 0.18$, $P = 0.07$), suggesting that increased energetic condition was associated with reduced fat catabolism in these species. Creatine kinase showed a non-significant negative trend with energetic condition for Semipalmated Sandpipers ($R^2 = 0.12$, $P = 0.09$), which suggests that birds repairing muscle during stopover were simultaneously depositing fat, but this was not consistent for the other two species. Taken together these data suggest that both natural and managed stopover sites in the northern prairie region are suitable for migrating shorebirds, but that managed sites may, perhaps, be more effective stopover sites for Least Sandpipers.

Assessing the status of WHSRN sites using a standard tool

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The Western Hemisphere Shorebird Reserve Network has begun major endeavors to carry out strategic planning for conservation action throughout the Hemisphere. Building on existing work and input from BirdLife, WWF, IUCN, USFWS and other partners, a Site Assessment Tool has been developed to involve the 63 sites of the network in regular assessments every three years beginning in 2006. These will be undertaken by sites with the assistance of the WHSRN Executive Office as well as government and BirdLife country partners. The assessments aim to review the current status of WHSRN sites in a standardized way in order to set priorities for shorebird conservation action and engage in adaptive management. The assessment tool is an adaptation of BirdLife International's Global Framework for Monitoring Important Bird Areas (IBAs) and WWF's Tracking Tool for Assessing Management Effectiveness in Wetland Protected Areas. The IBA monitoring uses the Pressure-State-Response framework, with standardized scores for state, threats and conservation actions. The tracking tool qualifies the many elements of management of protected areas, categorized by the World Commission on Protected Areas framework for evaluating effectiveness in criteria of Context, Planning, Inputs, Processes, Outputs and Outcomes. Using those frameworks, WHSRN guarantees compatibility with global conservation initiatives with overlapping interests, facilitating synergies and avoiding unnecessary duplication. The development of the tool involved literature research on protected area assessments and conservation planning tools, consultation with partners and the implementation of the assessment in three pilot sites, including a workshop using the tool for the Bay of Panama.

Tern and Plover conservation partnership: management of Least Terns and Piping Plovers nesting at sand and gravel operations

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Endangered interior Least Terns *Sterna antillarum athalassos* and threatened Piping Plovers *Charadrius melodus* nest in Nebraska on river sand bars, gravel mine spoil piles, and reservoir shorelines. These birds are imperiled in Nebraska primarily because of loss and degradation of their natural breeding habitat: elevated, barren sand bars in major rivers. They are also vulnerable to predation and potential conflicts with sand and

gravel mining operations. The Tern and Plover Conservation Partnership was established in 1999 to protect these and other river birds in a way that reduces conflicts with private industry and that educates and involves local communities. Partnership activities are conducted on the lower Platte River, the Elkhorn River, and portions of the central Platte and Loup Rivers. In 2000, a technique was developed to direct nesting toward more favorable areas within gravel mines. Mylar flagging was used as a deterrent and gravel was spread on the sand as an attractant. Mylar flagging continues to be a successful deterrent at sites where it is used but maintenance of the flags appears essential to success. From 1999–2005, protective electric fences were erected at several nesting sites to discourage terrestrial predators. Preliminary analysis of fencing data shows that fledging success was significantly higher for Least Terns in fenced areas. Fledging success for Piping Plovers appeared not to differ between fenced and unfenced areas, possibly related to their precocial behavior or to fencing variables. Our partnership approach with adaptive management has increased reproductive success and understanding of conservation needs.

BREEDING BIOLOGY AND ENERGETICS

Antiquity of shorebird acoustic displays

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Sexually-selected displays typically diverge during population divergence or speciation, hence differ substantially even among closely related species. Examples abound in the diverse nuptial/territorial vocal and non-vocal displays of shorebirds, which are assumed to be non-learned. It is becoming possible to estimate rates of evolutionary change in acoustic displays due to advances in knowledge of shorebird phylogeny through molecular studies. The same advances enable us to explore the little-investigated subject of evolutionary conservatism in displays. Using divergence times estimated from molecular data, many shorebird displays appear to be very old. For example, aerial Drumming is synapomorphic for snipe *Gallinago* plus semi-snipe *Coenocorypha*, so appeared >21 Ma; and communal Piping is a synapomorphy for all oystercatchers *Haematopus*, so originated >34 Ma. Non-sexually-selected displays (e.g., "alarm" calls) likely are even older. Acoustic displays offer rich material for investigating tempo and patterns of behavioral evolution in shorebirds, and will help to answer questions such as why many display classes or display traits have diverged slowly, whereas others diverged relatively rapidly (e.g., aerial nuptial/territorial display-vocalizations of eastern vs. western willets, *Catoptrophorus*; vocalizations of killdeer, *Charadrius vociferus*).

Sex specific survival of the Mountain Plover in Montana

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The Mountain Plover is a locally breeding shorebird of the Great Plains and has been the focus of considerable conservation efforts. I studied Mountain Plovers in Phillips County, Montana from 1995–2004 and used a robust design capture–recapture study to estimate annual survival of male and female plovers. I uniquely color banded a total of 742 plovers of 2 age classes (juveniles and adults) during the study. Using Program MARK,



I found evidence that annual survival varied by age and sex. Juvenile plovers had lower survival than adults, although within each age class the survival of males and females did not differ. Juvenile survival was also positively influenced by body mass at capture ($\beta_{Mass} = 0.86$, 95% CI was $-0.06, 1.79$) and varied by year. Juvenile annual survival rates varied from 0.52 to 0.89. Adult annual survival did not vary annually and was estimated at 0.78 for both males and females. Yearly estimates of temporary emigration were low ($\gamma' = 0.32$), suggesting moderate site fidelity for plovers nesting in this region. This study provides the first estimates of sex specific survival for this species, adds to our understanding of this species' mating system, and offers information that may prove useful for long-term population projection models of this species of conservation concern.

Temporal and biogeographic patterns in the energetics of Arctic-breeding sandpipers: the story over the past few decades

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Homeotherms living in cold environments generally experience high fixed metabolic costs, which may significantly constrain their performance. We consider temporal trends in these metabolic costs for sandpipers (Scolopacidae) breeding in the Canadian Arctic. We use weather data from 24 weather stations collected over 45 years (1958 to 2003), filtered through a biophysical model of dry heat transfer, to predict the fixed metabolic costs for a median-sized *Calidris* (White-rumped Sandpiper, *C. fuscicollis*) throughout the Arctic during the summer. We then use these metabolic estimates to consider how global climate change has influenced fixed metabolic costs in different places in the Canadian arctic. We detected significant linear trends based on season and general location: (1) mean metabolic rate has been increasing in the high arctic, and decreasing in the low arctic, (2) mean metabolic rate has been increasing in the late summer, and decreasing in the early summer, (3) metabolic rate is becoming less predictable (among days and among years) in mid summer, and more predictable early and late. Based on these results, we predict: (1) the community of arctic sandpipers has "shifted" in favor of low-arctic species, (2) breeding season has shortened and shifted to earlier in the year, (3) during the vulnerable incubation and chick-rearing stage, wild swings in metabolic costs have been increasing, increasing the probability of reproductive failure. Overall, all species of shorebirds are expected to have been impacted by changing weather on their breeding grounds, but shorebirds breeding in the high arctic are of particular concern.

MONITORING

Population status of Semipalmated Sandpipers based on mark-recapture and morphometrics of migrating birds in the upper Bay of Fundy

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Annually, 100,000s of the Semipalmated Sandpipers *Calidris pusilla* stopover in the upper Bay of Fundy and double their body mass feeding on *Corophium* before undertaking a nonstop migration to South America. Over 13 field seasons from 1981 to 2005, 33,872 individuals have been captured and banded along the shore of Johnson's Mills, New Brunswick, in the

upper Bay of Fundy. About half of these birds were measured (bill length, wing length and body mass). Banded birds were recaptured in subsequent years, which allowed for the calculation of annual mark-recapture estimates of the source population of the Johnson's Mills birds. Our estimates suggest a decline from about 800,000 birds in 1982 to about 260,000 in 2004, or about 5% per annum, in keeping with previous reports of the general population status for this species. Mean bill length of measured birds declined over the course of the study, perhaps reflecting a disproportionate loss of long-billed individuals known to breed in the more eastern parts of the species' range. The accuracy of our population estimates relies on how well the assumptions of mark-recapture methodology were achieved. We have evidence that at least one such assumption – that of independence of individual recapture probabilities – may not have been met. Forty groups of 2–5 birds, each captured in the same trap on the same day, were recaptured together, either in the year of banding ($n = 30$), in the next year ($n = 8$) or two years after ($n = 2$). Further tests will be needed to determine if these frequencies are greater than expected by chance, but the observation suggests the possibility that some Semipalmated Sandpipers associate in groups, which may persist within and between years and therefore across quite different life-stages of migration, over-wintering and breeding.

Estimating shorebird numbers at a migration stopover site

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We estimated the number of migrating shorebirds that used the Squaw Creek National Wildlife Refuge during spring and fall migration, by combining weekly shorebird counts with parameter estimates for detection probability, sampled proportion, and length-of-stay. Double sampling was used to determine detection probability and the estimated values varied among wetland units from a low of 0.07 to a high of 0.82. The sampled proportion was 1.0 for most wetland units but was lower in some of the larger units. Length-of stay (measured for Pectoral and Least Sandpipers) averaged 10.2 d in the spring and 3.7 d in the fall. Spring numbers were approximately 5 times greater than fall numbers on the Refuge. Annual shorebird numbers varied among years from an estimated low in 2003 of 15,491 to a high in 2002 of 68,563 shorebirds. The peak daily counts during study years averaged only 12% of estimated spring totals and only 4% of fall totals. An estimate of shorebird numbers based on summing the weekly counts, not corrected for detection probability of sampled proportion, would have been only 21% (spring)–31% (fall) of the total birds. These results demonstrate that peak counts and non-adjusted counts can significantly underestimate shorebird numbers that stop at migration stopover sites in the mid-continent of North America.

Demographic monitoring of shorebirds: a British perspective

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Understanding numeric changes in shorebird populations requires knowledge of the demographic parameters underlying such changes, i.e. survival and recruitment. Data from long-term monitoring programs involving dedicated volunteers are often crucial for obtaining these parameters. The British Trust for Ornithology has been involved with long-term monitoring



projects on shorebirds for over thirty years through its Integrated Population Monitoring (IPM) Program. I will provide a general overview of some common issues in the demographic monitoring of shorebirds within an IPM framework, particularly with regard to large-scale banding programs. I will refer to a number of case studies showing the utility of data collected at large-scales by volunteers in the research, conservation and policy arenas.

Spatiotemporal modeling of stopover habitat availability for migrating shorebirds in the Tennessee Valley

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Shorebird migration through the North American interior relies on ample stopover habitat distributed along migratory routes. These stopovers are often ephemeral habitats such as seasonally flooded lowlands rather than the stable perennial stopovers that characterize coastal migration. Late summer drawdown of reservoirs managed by the Tennessee Valley Authority (TVA) has provided reliable stopovers for southbound migrant shorebirds over the past sixty years; recent changes in reservoir management may impact those stopovers. The relationships between reservoir drawdown, mudflat exposure, and habitat availability are poorly understood. To quantify habitat exposed during drawdown, we used an airborne Light Detection and Ranging (LIDAR) system to create a fine-resolution digital elevation model (DEM) of mudflat habitats at Rankin Bottoms Wildlife Management Area, Tennessee. We then linked this DEM to real-time lake elevations during reservoir drawdown and used Geographic Information Systems to model the amount of mudflat area exposed at every reservoir elevation. Using historic reservoir data, we modeled stopover habitat availability over the past 30 years under three different management regimes, and combined this model with a chronology of shorebird migration in the Tennessee Valley to examine how stopover availability has changed for shorebirds during fall migration. This spatiotemporal model helps us to explore how active management of the reservoir system affects stopovers at a time when shorebirds are migrating. Combining shorebird monitoring with habitat modeling will enable us to develop a series of management recommendations that contribute to environmental decision making in TVA's multiple-use river system.

CONSERVATION

Conservation status of nearctic and neotropical shorebirds in Paraguay

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A total of 32 shorebird species have been recorded in Paraguay, of which 23 are Nearctic migrants, 8 are resident and one is an Austral migrant. Five species are considered to be vagrants (including the one austral migrant) and a further five species are best considered as scarce migrants. A recent assessment of the conservation status of the remaining 22 species, applying the IUCN Red List criteria at a national level, identified one species as Critically Endangered (Eskimo Curlew *Numenius borealis*) and five as Near Threatened. American Golden-Plover *Pluvialis dominica*, Buff-breasted Sandpiper *Tryngites sub-*

ruficollis and Upland Sandpiper *Bartramia longicauda* were considered threatened by the loss and degradation of grassland habitats. Giant Snipe *Gallinago undulata* by the loss of its wet valley habitat (largely a result of deforestation in surrounding areas), and Wilson's Phalarope *Phalaropus tricolor* due to the desiccation and salinization of lagoons in the Chaco. Anecdotal evidence suggests that Hudsonian Godwit *Limosa haemastica* numbers may also have declined, but insufficient data exists to assess trends and so the species was considered Data Deficient. Pied Lapwing *Vanellus cayanus* was also flagged as being potentially of conservation concern at a national level. This species is restricted to sandbanks and river beaches in the north-east of the country and is susceptible to disturbance. The analysis concluded that the long-term conservation of many of these species in Paraguay will depend on appropriate habitat management at a landscape scale, integrating conservation areas within the production landscape.

Population biology of Upland Sandpipers in response to experimental grazing and prescribed burns

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Upland Sandpipers *Bartramia longicauda* are a poorly studied neotropical migrant that requires native grasslands for breeding. We present field data from a 5-year population study at Konza Prairie Biological Station in northeast Kansas. Konza Prairie is a 3,600 ha tallgrass prairie site that is subdivided into 60 replicated experimental units. Each 60 ha unit is treated with a different combination of grazing and prescribed fire, creating an experimental landscape with a mosaic of grassland habitats. Our demographic analyses are based on a sample of 160 nests and encounter histories for 600 color-banded individuals. Uplands were flexible in nest placement but preferred habitats with accumulated vegetative debris. Nest survival rates were highest in unburned, grazed sites (31%) and lowest in burned sites (<16%). Renesting after nest failure was rare and contributed little to annual fecundity. Resightings of color-banded juveniles revealed that Uplands can breed as yearlings. Mark-recapture analyses based on robust design models indicated that apparent survival rates of adults were high ($\phi = 0.87$) but that annual encounter rates were low ($p = 0.38$). Monitoring of radio-marked birds indicated that survival was high during the 10-week breeding period ($S = 0.92$). Our estimates provide baseline information for a healthy population of Upland Sandpipers in good quality habitat. In the future, population models will be used to identify the demographic rates that have the greatest impact on the finite rate of population change.

Impacts of an introduced marine invertebrate on wintering shorebirds

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There continue to be unknown factors contributing to the decline of coastal shorebird populations. One relatively unexplored factor is possible multi-trophic effects of introduced marine species. To date, most studies on these effects have been conducted on plants. Studies on marine invertebrates are lacking. We used a novel experimental method to investigate the effects of an introduced marine predator, the European Green Crab *Carcinus maenas*, on wintering Dunlin *Calidris alpina*. In



Bodega Harbor, California, the green crab has significantly decreased population size of adult *Nutricola* spp. This bivalve was previously a dominant prey item for wintering Dunlin. We examined invertebrate abundance – including *Nutricola* spp. – in sediment cores after Dunlin had foraged under two conditions: in cages where crabs had previously foraged and in cages where crabs had not foraged. Where crabs had foraged, Dunlin consumed greater numbers of *Nutricola* than they did where green crabs had not foraged. However, the *Nutricola* consumed were typically smaller than 2 mm, the smallest size that green crabs are known to consume. In contrast, Dunlin reduced the density of polychaetes where crabs had not foraged, compared to areas where crabs had foraged. Our results suggest that green crabs can affect both quantity and quality of Dunlin food resources. Since wintering and migratory shorebirds require reliable food resources at critical times, it is possible that multi-trophic effects of introduced marine species may play a role in compromising shorebird populations.

Do endangered shorebird populations have the capacity to compensate for incidental take?

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Endangered species legislation allows for limited “take” of habitat or individuals of a protected species, as long as that take does not increase the “jeopardy” for that species. Legislation uses a harvest management paradigm and assumes that the protected populations have the capacity to compensate for the permitted “take.” The compensatory mechanism requires that populations produce more individuals each breeding season (i.e., fledglings, hatchlings or nests) than the environment can sustain, or a “doomed surplus.” Harvest management theory assumes that harvest mortality alleviates natural density-dependent mortality and that population size is unaffected by harvesting. However, wildlife managers must explore whether a protected species is able to buffer incidental take through compensatory demographic responses. We explore the capacity of the Great Plains population of Piping Plovers to compensate for incidental take of nests in intensively managed river systems. There is little evidence to support density dependant mortality of juveniles or adults in the nonbreeding season. Like many shorebirds, Piping Plovers have low annual reproductive capacity due to limited clutch size and low observed re-nesting rates, which reduces the possibility of producing a “doomed surplus”. Though we do not prove that Piping Plover populations cannot compensate for nests flooded in river systems, we do show that this is an important question to consider during the incidental take permitting process for endangered species. Shorebird managers should consider the capacity of a species to buffer the negative effects of permitted actions and should take steps to enhance compensation opportunities rather simply minimize incidental take.

Tourism and the conservation of migratory shorebirds in San Antonio Bay Protected Nature Reserve

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In response to an increasing demand for “sun and sand”, Las Grutas tourism center has undergone two decades of unplanned

and poorly measured growth, which could lead to irreversible damage to the environment in general, and to tourist attractions in particular. A total of 209,000 tourists were recorded during the 2005 summer season, representing a growth of 257% over the past eight years. Current tourist activities are showing a tendency to expand to other areas of the coast, reaching critical feeding and roosting sites for shorebirds in general, and for migratory species in particular. Without appropriate planning and zoning this could lead to irreversible changes in the environment, with the consequent loss of the resource. Migratory shorebirds constitute a potential tourist attraction, which is threatened by the above mentioned growth. Studies undertaken in the area have concluded that there is a need to develop bird watching as an ecotourist attraction, aimed at different sectors of the public, and generating alternatives for sustainable tourism development, in addition to acting as a tool for building environmental awareness. To meet this goal we are involved in the development of an Interpretation Center, and to help protect this important WHSRN site. We will present the plan for the center, in addition to the education program we have planned, and we hope to receive comments that will help us improve the positive impact of this initiative.

Colombia revisited, a regional important site for shorebirds on the Pacific coast of South America

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First reference to important sites for shorebird wintering in Colombia was available in the eighties with Morrison & Ross Atlas. In that evaluation, Guapi, Southern Pacific coast, was the most important site for the country. Twenty years later, between August 2003 and July 2004, we revisit Guapi area and include Sanquianga National Park, overlooked in the eighties. To update shorebird numbers and to establish species stopover or wintering in the area we use monthly ground-based census and mist-netting. Our preliminary results confirm that Colombian Pacific mangroves are important to shorebirds at regional level. A conservative estimate shows that at least 30,000 shorebirds used the area in 2003–2004 season, mainly Western Sandpiper (25%), Least Sandpiper (20%) and Spotted Sandpiper (13%). We also found that Sanquianga NP includes important roosting sites for two high concern species: Wilson’s Plover (600–750 individuals) and Whimbrel (931 individuals). Several species like Semipalmated and Spotted Sandpipers use the area during several months of the wintering period. For others species, mainly Wilson’s Plover, Sanquianga NP and surrounding area is a stopover site. At the moment of this study the area not encompasses local threats to shorebirds. However, the increase of fishing motorboats and local villages could disturb some of roosting sites in the future. We recommend the study of shorebird flyways involving pacific coast of Colombia and advance in the inclusion of Sanquianga NP and surrounding area in Western Hemisphere Shorebird Reserve Network.



General Posters

Deuterium levels in the feathers of migratory birds in Patagonia, Argentina

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Stable isotopes of various chemical elements occur naturally in the environment. Migratory shorebirds that breed in the Arctic and winter in South America replace their flight feathers once a year on the wintering grounds prior to their northward migration. Isotope levels vary as a function of annual precipitation. The objective of this study was to determine deuterium levels in the feathers of migratory birds during the nonbreeding season in Patagonia, Argentina, from 2002 to 2005. The study design was observational, descriptive, comparative, and longitudinal. Migratory shorebirds were captured at eight sites in Chubut province, six in Santa Cruz province, and two in Tierra de Fuego. Samples were analyzed for values of δD , δC , δN , δO and δS using the continuous flow methodology. The median value (Q25–Q75) for δD from Calafate was -84 (87.5; 82.5). Statistically significant differences in δD were recorded between the sites Calafate (Santa Cruz), María Cristina (Chubut) and Bahía Bustamante (Chubut).

Distribution and abundance of the Long-billed Curlew in south-western North Dakota

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We conducted range-wide surveys of the Long-billed Curlew to produce population estimates and geographic distribution for this species in southwestern North Dakota. Double-sampling intensive surveys were conducted in selected plots based on available native prairie grasslands. After curlews were observed, habitat use investigations were conducted during the birds' stay in North Dakota. Curlews were also monitored throughout their stay to determine offspring survival rates. There is very little historical information on breeding curlews in the state of North Dakota except for incidental sightings that were reported from biologists, landowners and birders in the late 1980's so this study was designed to collect data on these birds. Numbers of curlews have dwindled significantly since the early settlement in the state. Current numbers of Long-billed Curlews witnessed this past summer (2005) were 48. These birds were seen in a total of five counties in the southwest part of the state. Curlews were found breeding in short-growth grasslands, mixed-grass prairies, meadows, grazed mixed-grass and shrub communities, near cultivated fields and edges of ponds or wetlands. The topography was fairly flat, generally less than a 4° slope. Two nests were found near Amidon, ND each of which produced four fledglings. We recommend some management prescriptions that future management plans should focus on for survival of this species. Data generated from this study will allow wildlife managers to design more effective management practices for this species of special concern and implement them as soon as possible to safeguard this magnificent creature.

Factors that influence roost site selection of Dunlin (*Calidris alpina*) at Humboldt Bay, California

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Roosts are an important feature of the nonbreeding ecology of shorebirds, and traditional use is assumed based on repeated observations of flocks at locations. The extent to which individuals use roosts traditionally may be influenced by several factors, including safety from predators and proximity to foraging areas. We examined these two hypotheses at Humboldt Bay, CA, by tracking 21 radio-marked Dunlin *Calidris alpina* during the 4-h interval preceding high tide. Dunlin used a limited number of the total number of roosts known. Individuals tended to use roosts in close proximity to their foraging. And, individuals often left roosts during high tide when predators occurred. These findings indicate support for both hypotheses and suggest that roost sites are not limited by available habitat.

Shorebirds monitoring in Japan

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Three nationwide shorebirds censuses have been conducted in Japan (Wild Bird Society of Japan 1973–1985, Japan wetland action network (JAWAN) 1986–1988, Ministry of Environment (MoE) of Japan 1998) and two inventories were published. "Inventory of Shorebirds Habitat in Japan" (MoE 1997) includes 78 sites, and "Important Wetlands 500 in Japan" (MoE 2002) includes 53 sites. I analyzed shorebirds monitoring data in recent 5 years (1999–2004). The surveys were conducted at least once a season during northward (from April to May) and southward migrating period (from August to September), and nonbreeding season (from November to February). Sixty-three species were observed on average 94 sites in five years. The maximum number of individuals (an accumulation of the maximum number of individuals for each species) and the number of species were recorded on averages 84,144 birds and 52.5 species (northward migration), 39,001 birds and 53 species (southward migration), and 50,464 birds and 42.4 species (nonbreeding season). The number of individuals of dominant species didn't show any increasing or decreasing trend, but the maximum number of Dunlin showed decreasing trend (but one-day census data didn't show any trend) in five years. The number of shorebirds recorded in 2 of 8 sites in which occurred over 5,000 shorebirds fell below 5,000 due to habitat degradation and reclamation.

Results of the biometric and banding activities of *Calidris* spp. in Paracas Natural Reserve, RNP (Ica, Peru) during 2000–2001

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Paracas, located in the South American occidental coast (approximately 14° S), is an important place for rest and feeding of Nearctic migratory shorebirds populations. Since 1987 until



2001 (with some interruptions because of the lack of budget), many activities of biometrics, banding campaigns and census, have been carried out. The results of 11 months between August 2000 and August 2001 are presented in this work. During the 11 months, 107 individuals of *Calidris mauri*, 126 of *C. pusilla* and 16 of *C. alba* were banded with metal band. The greatest mean weight for *C. mauri* was recorded in February (29.0 ± 0.9 g SE), for *C. pusilla* was recorded in March ($24.3 + -0.8$ g SE), and for *C. alba* in April (63.0 ± 3.1 g SE). For *C. mauri* the sex was identified based on the bill length, finding a predominance of females (63.4%) compared to males (29.5%). The sex for *C. pusilla* was not identified. For *C. alba* the sex was identified with a discriminant function, which results showed that 86.7% of the captured individuals were males, and 13.3% females. The age, determined with the plumage, revealed a predominance of adults for the three species. The 75.8% of individuals of *C. mauri* were adults and 24.2% were juvenile. For *C. pusilla* there were 92.1% of adults and 7.9% of juveniles. Finally, for *C. alba* the 93.75% were adults and 6.25% were not determined.

Reservoir use by post-breeding shorebird in the south Platte River Valley, Ne Colorado

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As a contribution to The Nature Conservancy's Central Short-grass Prairie ecoregional planning effort, I surveyed reservoirs along the South Platte River in NE Colorado to determine use by post-breeding shorebirds. I conducted ground counts of four publicly-accessible reservoirs between 8 July and 21 October 2005 and recorded >10,000 individuals of 24 species; birders visiting the reservoirs observed an additional eight species. Baird's Sandpipers *Calidris bairdii* and Killdeer *Charadrius vociferous* were the most abundant species tallied (both >30% of observations) followed by Stilt Sandpiper *Calidris himantopus* and Lesser Yellowlegs *Tringa flavipes* (both >8% of observations). Reservoir water levels generally decreased throughout the post-breeding period, and the greatest numbers of shorebirds occurred during late August and early September. Basin topography and human use seemed to influence use of individual reservoirs by shorebird migrants. Assuming a seven-day turnover, I estimate that about 23,000 post-breeding shorebirds use these four reservoirs. If shorebird use of two private reservoirs that I was unable to survey was similar to sampled sites, the post-breeding passage through the South Platte River Valley might be as great as 39,000 individuals. Natural wetland loss in the region likely increases the value of artificial reservoirs to post-breeding shorebirds; timing of water removal favors use by hatching-year birds. Considered as a system, the shorebird use indicates that the reservoirs qualify as a Western Hemisphere Shorebird Reserve Network site of regional importance and as a Colorado Important Bird Area.

Detecting heavy metal contaminants in juvenile shorebirds in arctic Alaska

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Blood samples were taken from juvenile Semipalmated Sandpipers, Western Sandpipers, Red Phalaropes, and Red-Necked Phalaropes. The samples will be tested for several different heavy metal contaminants, yet to be determined. The blood sampling took place in Barrow, Alaska in August 2005, and the

analysis will take place in the winter of 2005–2006. The main focus of the project is to determine the presence or absence and levels of heavy metal contaminants in arctic shorebird species. All birds sampled were juveniles, giving the opportunity to pinpoint contaminants to the North Slope of Alaska. This small sampling may determine the need for a more extensive study in the region. The project will also compare levels of heavy metal contaminants between birds feeding in a heavily disturbed area and birds feeding in a minimally disturbed location. A final comparison between birds with different feeding habits (*Calidris* sp. vs. *Phalaropus* sp.) will be made. Preliminary results will be presented.

Restinga or sandflat?

Prey selection of Red Knots (*Calidris canutus rufa*) in 2004, an unusual northern migration season at San Antonio Oeste, Río Negro, Argentina

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From February to April, San Antonio Oeste is an important stopover site for Red Knots. During the day, birds feed on "restinga", a broad intertidal rocky flat, ingesting small mussels *Brachidontes rodriguezii* visually taken from patches. However, during March–April 2004 they were observed unusually in an extensive intertidal sandflat feeding by probing into the substrate. Benthos sampling plus nine samples of 100–150 droppings and 34 pellets collected in March and April 2004 showed that: Restinga: mussel size distribution, density of total and selected sizes, benthos biomass of selected sizes (19.4 to 78.8 g Ash Free Dry Mass total/m²) and biomass equivalent per dropping (0.063 to 0.065 g AFDMtotal/drop) were in the same range than a similar study done in 1992. Sandflat: the main prey was the clam *Darina solenoides* with a size distribution ranging from 9–35 mm shell length. Despite the low clam biomass of selected sizes (0.886 g AFDMtotal/m²), biomass equivalent per dropping (0.068 to 0.091 g) and per pellet (0.088 g) were higher than those found at the restinga. Mussels eaten (4–20 mm) and positively selected sizes (6–13 mm) were smaller than sizes of clams eaten (16–35 mm) and positively selected (16–24 mm) sizes. Clams were a better quality food than mussels, with thinner shells relative to biomass ($\text{AFDM}/\text{Ash}_{\text{clam}} = 2 \text{ AFDM}/\text{Ash}_{\text{mussel}}$ $p < 0.001$). In 2004, breeding plumage scores – as an index of Red Knot condition – were significantly higher than in 2001–2002 and 2003 seasons indicates that they fed on sandflat because of an unusual food supply of clams and not because of low availability of food in the restinga.

Southbound migration of juvenile shorebirds on Barrier Islands of the Copper River delta, Alaska

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We investigated juvenile shorebird migration at Egg Island, a barrier island on the Copper River Delta, Alaska from late July through mid October 2005. Based on plumage, juveniles comprised 48% of the aged birds observed in estuarine and beach habitats. We recorded juveniles from 21 species, and also observed but could not reliably age four species: Whimbrel,



Wilson's Snipe, Ruddy Turnstone and Dunlin. On the beach, juvenile Pacific Golden Plover, a migrant, and Semipalmated Plover, a local breeder, were the two most numerous species, followed by Black Turnstone and Baird's Sandpiper, both migrants from western Alaska. In the island's estuary, the dominant juvenile shorebird was Long-billed Dowitcher, a migrant. Juvenile Pectoral Sandpiper and Semipalmated Sandpiper, both migrants, also occurred in significant numbers in the estuary. We observed variation in migration timing by age and breeding grounds. Adult shorebird numbers peaked in early August while juvenile numbers peaked in mid September. However, for shorebirds of species known to breed locally (Semipalmated Plover, Greater and Lesser Yellowlegs, Least Sandpiper, and Short-billed Dowitcher), peak juvenile numbers were recorded from late July through early August. Observation of a color-marked, juvenile Semipalmated Sandpiper previously banded at Barrow, as well as sightings of juvenile Buff-breasted Sandpiper, indicate that some juvenile shorebirds originating from the North Slope use a Pacific coast route for at least a portion of their southward migration. Our findings suggest that the Copper River Delta is an important stopover site for juvenile shorebirds during fall migration.

Status of research on factors limiting high priority shorebird populations

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The Shorebird Research Group of the Americas proposed seven hypotheses that should be explored as possible causes of ongoing declines in shorebird populations. Working groups are being formed to develop research projects targeting each of these hypotheses for species listed as high priority in one of the existing conservation plans. We are reviewing the literature to determine how much progress has been made at testing these hypotheses for high priority species, and present preliminary results for several example species. We are planning to complete assessments for all high priority species, including rating each published paper with respect to several indices such as the degree of certainty associated with the relationship between the limiting factor and a population decline, and the extent of the species range or population size included in the study. For most high priority species, only a few of the relevant hypotheses have been directly tested, and for most either the degree of certainty attained or the extent at which the results are applicable are limited. Significant coordinated work is needed to determine which factors limit most shorebird population sizes. Results for the example species indicate that the range of work needed is highly variable among species. We are also reviewing papers that propose theoretical approaches to determining what limits population sizes, to help guide developing working group agendas.

Changes in the abundance of Marbled Godwits in coastal Washington

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Marbled Godwit *Limosa fedoa* abundance in Washington has increased dramatically in recent decades. I summarized seasonal data obtained from published field notes or my own observations from winter (November through February; 26 of 30 years between 1975–76 and 2004–05), spring (April; 23 of 38 years between 1967 and 2004) and autumn (August through October;

29 of 42 years between 1963 and 2004). In all seasons Marbled Godwit numbers increased dramatically since the 1960s or 1970s, when most counts were <36 birds. Recent high counts were 1500 (winter), 675 (spring), and 800 (autumn). There are at least three possible explanations for the dramatic increases in Marbled Godwit abundance. First, the increases may reflect better coverage of the site by bird watchers and ornithologists in recent years. This seems an unlikely explanation as these birds are very visible and have used the same foraging and roosting sites for more than three decades. Second, the increases may reflect actual population changes. Third, the increase may represent a shift in godwit distribution from further south. There are currently no data to evaluate the second and third hypotheses, which may not be mutually exclusive. The breeding distribution of godwits that occur as winter residents and migrants in Washington is unknown. Efforts to resolve this uncertainty may facilitate a better understanding of the factor(s) resulting in greater abundance of Marbled Godwits in coastal Washington.

Optimization of molecular methods for sexing of a monomorphic shorebird

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Sex identification is essential for addressing basic questions in population biology, behavioral ecology, and animal physiology. Unfortunately, many species of shorebirds are monomorphic in body size and coloration, and cannot be easily sexed by external features, even in the hand. We have optimized laboratory protocols for genetic sexing of Upland Sandpipers *Bartramia longicauda*. Blood samples were collected from the wing vein of birds in the field, stored in Queen's lysis buffer, and DNA was isolated with Qiaquick DNeasy extraction kits. We have experimented with protocols based on primers developed by Griffiths *et al.* (1998, *Mol. Ecol.* 7: 1071–1076), and have determined the environmental conditions that lead to successful PCR reactions. Preliminary sex information has revealed that female sandpipers have a greater body mass than males during the pre-laying period, but not during the latter part of the breeding season. The mating system of Upland Sandpipers is social monogamy: a majority of nests are jointly incubated by a mated pair, and males are responsible for parental care after hatching. Unexpectedly, we have found that several nests were attended by female–female pairs. We are currently screening microsatellite markers to conduct a parentage analyses for a sample of 30 family groups.

Factors affecting nesting success of coexisting shorebirds at Great Salt Lake, Utah

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The Great Salt Lake (GSL) in Utah is one of North America's most important inland shorebird sites. At least 22 species of shorebirds utilize the GSL during migration and eight species nest in habitats associated with the lake. The breeding population densities of American Avocets *Recurvirostra americana* and Black-necked Stilts *Himantopus mexicanus* are among the highest in North America. Despite the importance of the GSL to these populations, little information is available on their current productivity. Nesting success is of critical interest because fecundity is an important demographic parameter with the



potential of influencing population dynamics. I studied the nesting success of both American Avocets and Black-necked Stilts at four study sites within the GSL ecosystem during the 2003–2005 breeding seasons. Study plots were located and monitored within each site. Plots were searched twice weekly for the presence of nests and, once located, they were monitored every three to seven days. The data-set represents over 2,750 individual nest records. Predation and flooding of nests were the most important cause of nest failure for both species. Significant variation existed among study sites in nesting success with Mayfield estimates ranging from 0.09–0.810. This variation is likely explained by differences in predator densities and accessibility to sites.

Black Oystercatchers as indicators of healthy rocky intertidal ecosystems – what can they tell us?

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Parks Canada is attempting to identify a common suite of indicators that will serve as long term measures of rocky ecosystem health throughout Canada's Pacific Bio-Region. Black Oystercatchers have been proposed as one possible indicator. Specifically we propose to monitor a number of basic life history and demographic parameters at various oystercatcher nesting areas throughout the Gulf Islands, Pacific Rim and Gwaii Haanas National Park Reserves. Suggested parameters include: nesting effort (# nests and # territorial pairs), re-nesting effort, breeding chronology, clutch size, hatching and fledging success, and blood chemistry. In conjunction we are also considering a long-term banding program to monitor breeding and wintering site fidelity, mate fidelity, juvenile dispersal, and natal philopatry. Park baseline information suggests breeding Black Oystercatcher populations within these areas appear to be relatively stable and that suitable nesting habitat may be fully occupied. For example, in Pacific Rim National Park, data collected between 1970 – 2005 from 150 pairs at 40 nest sites show minimal variation in site use or density. Appropriate threshold indices or other management triggers are still being reviewed. Any deviation from historic nesting density or site use is one suggested measure that would trigger more in-depth analysis (e.g., how widespread is the deviation?). Appropriate sampling regimes, statistical rigor and other relevant intertidal indicators remain to be determined. Parks Canada is interested in receiving any relevant peer feedback regarding this proposal.

Shorebirds of the Yucatan Peninsula

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The shores and wetlands of the Yucatan Peninsula seem to be an important stopover and wintering region for shorebirds; however, species, variations of numbers along the year, as well as detailed distribution of shorebirds in this region have not been evaluated. In 2004 we began with support from DUMAC and the Ría Lagartos Biosphere Reserve a project with the following goals: a) To provide useful information for the management of wetlands and shorebirds locally, nationally and internationally. b) To assess how many shorebirds use the coastal wetlands of the Yucatan state and northern Campeche state during the year. c) To establish a shorebird banding pro-

gram in the Yucatan Peninsula. d) To determine the critical habitats for shorebirds in this region. e) To investigate how the most common species of shorebirds use each available micro-habitat. f) To further train local biologists in the identification and banding of shorebirds. To October 2005 we had morphological data of 857 individuals belonging to 14 species; we had banded 596 of them. We have had resightings of birds banded in the Yukon and in Saskatchewan. We have established three areas to monitor shorebird numbers in the places that we have found to be the more important in the region; 26 species had been recorded. Two undergraduate students are finishing their thesis work. We are working on determine the length of stay of *Calidris mauri* and *C. minutilla*. We advise that studies concentrate in understanding local movements, as well as to establish long distance links.

Space use of American Avocets in south San Francisco Bay

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Wetland conservation of endemic waterbirds may be improved with greater knowledge of their space use patterns. Life-history patterns are often not considered in the analysis of home range, core use areas, and spatial movements. From March through July 2005, we radio-marked 50 American Avocets *Recurvirostra americana* in the South San Francisco Bay and monitored 5 individuals from pre-breeding through post-breeding. Our results indicated that American Avocet space use did vary with life-history stage. Pre-breeding habitat use was primarily non-tidal salt ponds and some surrounding tidal areas, while avocets used only non-tidal salt ponds for nesting habitat. Pre-breeding home ranges (960 ha) and core use areas (133 ha) were greater than during the incubation stage (151 and 23 ha, respectively). Post-breeding home ranges (5,389 ha) and core use areas (1014 ha) were, in turn, greater than during pre-breeding and incubation stages. Pre-breeding and incubation stage core use areas often overlapped, indicating that avocets were prospecting in potential nesting locations prior to egg-laying. As expected, core use areas during the incubation stage centered on nest locations. Large post-breeding home ranges suggested that American Avocets used a wider range of foraging areas when not restricted by reproductive activities. During each stage, American Avocets used a wide variety of habitats, including non-tidal and tidal salt ponds, tidal sloughs, mud flats, and water treatment ponds. This species could benefit from management practices that include large foraging and nesting areas composed of a variety of wetland types.

Feeding ecology and diet of American Avocet and Black-necked Stilts at Great Salt Lake, Utah

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Both the American Avocet *Recurvirostra americana* and Black-necked Stilt *Himantopus mexicanus* overlap in breeding and foraging sites throughout much of their ranges. However, very little is known about the feeding ecology and diet of these species at Great Salt Lake, Utah; where the largest breeding assemblages in the western United States occur. We examined foraging strategies and diet of these species during the 2005



breeding season at three study sites within the Great Salt Lake ecosystem. Dietary information was obtained by direct examination of gut contents. Birds were randomly collected after being observed feeding for >15min. Esophageal, proventricular and ventricular contents were removed and placed in 80% ethanol. Invertebrates were identified to family, counted and % volume and dry mass of samples determined. Following each shorebird observation/collection, invertebrates were sampled from the benthos and water column within each foraging area. The results of this study indicate that both diet and foraging behavior was significantly different between species. For example, Chironomid larvae made up over 90% of the invertebrates identified in American Avocet stomachs but accounted for only 20% in Black-necked Stilts. These dietary differences may serve as a mechanism for niche partitioning during the breeding season.

Monitoring migratory and wintering shorebirds at Estero Santa Cruz, Sonora, Mexico

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From 2000–2004, we coordinated efforts to census migratory and wintering shorebirds in an estuary lying along the eastern shore of the Midriff Islands region of the Gulf of California. We documented 20 shorebird species during both winter and spring with 20 species observed in the spring (March–May) and 17 species observed during winter (Dec–Feb). The most abundant species during both seasons was Western Sandpiper with American Avocet being the second most abundant in the spring and Willet being the second most abundant species in the winter. Estero Santa Cruz (28°50'N, 111°55'W) is one of the northernmost mangrove estuaries in the world and is characterized by extensive mudflats with an assortment of broad channels draining into Bahia Kino, Sonora, Mexico. The estuary covers approximately 50 km² and is the closest major system of mudflats south of the Colorado River Delta, approximately 400 km to the north. Large estuarine ecosystems are uncommon in the Gulf of California, and absent altogether along its western (Baja California) shore. Estero Santa Cruz may represent a crucial site for shorebird wintering and refueling during annual migrations from breeding and wintering areas.

Shorebirds associated with the lagoons of the Cuare Wildlife Refuge, Falcón State, Venezuela

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Cuare Wildlife Refuge (RFSC), a Ramsar site since 1988, is a stopover site for migratory shorebirds in Falcón State, Venezuela. The lagoons, which cover an extensive area within the refuge, are foraging areas for a diverse and abundant aquatic avifauna. The study assessed the annual variation in diversity and abundance of shorebirds within the lagoons, and during 2005 their relationship with several abiotic characteristics of the lagoons. Four visits were made to three sites within the lagoons, with two censuses conducted at each site per visit. Lists of species were prepared for each site and for each visit. The abundance of individuals in each site was determined. Sampling plots were established at each site, and water depth, salinity and vegetation cover recorded. A dry period was found to occur during August, with two flood periods (in June and November). There was also

a marked variation in salinity, from 4‰ in June to 60‰ in October. Species richness increased during the migration period (August–October), with maximum diversity in October (15 species: 3 resident and 12 migrants). The highest abundance of individuals was recorded during August (1700). The lagoons constitute important shorebird feeding habitat, especially for three species of *Calidris* and *Tringa flavipes* and *T. melanoleuca*.

Assessing the development of shorebird eggs using the flotation method: species-specific and generalized regression models

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The relationship between how an egg floats in water and the age of a developing embryo was modeled for 26 species of shorebirds. Regression analyses were used to estimate incubation age by modeling continuous egg angle/float height data against incubation duration for 22 species. We also documented the relationship between how eggs floated, using five float categories, and embryo age for four species. For eggs in early incubation, we used linear regression analyses to relate logit transformed, continuously measured egg angles and embryo age. For eggs in late incubation, we used multiple regression analyses to relate continuously measured egg angles and float heights to embryo age. In 36 of 40 cases, these equations estimated embryo age to within two to four days for each species during early and late incubation. Flotation patterns did not differ between shorebirds that were grouped by size or taxonomy. However flotation progressed more rapidly in biparental versus uniparental incubators although this did not affect prediction accuracy. We then created a generalized regression equation that can be applied to all shorebird species. Estimates of embryo age for species where categorical data were collected were, overall, less accurate than the continuously collected data. Our flotation equations were less accurate than results reported in similar studies; data collected by multiple observers at multiple sites may have increased measurement error. We provide recommendations to ameliorate inaccuracies in predicting embryo age.

Breeding dispersal patterns in a southern nesting population of Semipalmated Plovers

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Socially monogamous shorebirds generally demonstrate sex biased breeding dispersal patterns, however the difference in these trends at different latitudes within a breeding range has not been considered. We studied factors affecting breeding dispersal decisions and mate fidelity of Semipalmated Plovers, *Charadrius semipalmatus*, at a southern breeding location on Akimiski Island in James Bay, Canada, and compared results with a well-



studied population in Churchill, Manitoba. From 2002–2005 we monitored nests until hatch or fail and recorded nest locations using a GPS unit. We color-banded adults at their nests ($n = 40$ males; 57 females) and observed return of marked individuals to the study area in subsequent years as well as location of subsequent nests. The male return rate of 62% was significantly higher than 45% for females compared with return rates of 60% and 41% respectively in the Churchill population. In the Akimiski population, there was no significant relationship between nest-site tenacity of successful and unsuccessful individuals ($p = 0.75$) which differs from a significant relationship in Churchill. No instances of reunited pairs were recorded out of 17 banded pairs on Akimiski which may reflect poorer mate fidelity in this population. Differences between the southern (Akimiski Island) and mid-range (Churchill) populations may be explained by differences in length of the breeding season and predation rates. Further research is recommended into variation in breeding behavior and ecology of this species across latitudes in the breeding range.

Shorebird sister schools – education on the wing

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The Shorebird Sister Schools Program (SSSP) is an Internet-based multinational environmental education program that connects students, educators, biologists, and birding enthusiasts along migratory flyways. Key components of the program include a website and curriculum (Explore the World with Shorebirds!) correlated to the National Education Standards in science, geography, math, language arts, social studies, history, art, and technology. SSSP is not only a unique, multi-disciplinary education program, but is also an effective outreach tool that supports managing and studying shorebirds throughout the world. While the primary audiences of the program are K-12 educators and students, SSSP can provide scientists, researchers, managers, and shorebird enthusiasts a way to connect with a broad audience, informing the public about shorebirds and habitat conservation needs both locally and globally. Tracking projects, reports from the field, assistance with species profiles, and answers to student questions, are all ways professional shorebird researchers can assist the SSSP in teaching the public about shorebirds. Visit <http://sssp.fws.gov> to learn more!

Optimizing radio retention and minimizing radio impacts in field studies of shorebirds

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We tested four methods of radio attachment for a natural population of Upland Sandpipers *Bartramia longicauda*, and estimated parameters with the 'nest survival' model of Program Mark. The daily probabilities of radio retention were 0.99 for a leg loop harness, 0.96 to 0.97 for radios glued to feathers or feather stubble, and 0.86 for radios glued to bare skin. Few radio-marked birds died during the study period, but four of eight mortality events were discovered within a week of radio-marking. After an initial acclimation period, the weekly probability of survival was high in both sexes ($S > 0.98$). Glue methods had no effect on annual return rates. Attachment of radios with leg harnesses resulted in lower return rates among radio-

marked birds (20.9%), than birds without radios (36.7%). Our results provide evidence of a tradeoff between maximizing radio retention and minimizing demographic impacts. All methods increased predation risk immediately after radio attachment. Glue techniques led to low retention rates, but had no long-term effect on annual return rates. Leg harnesses produced excellent radio retention and high weekly survival rates, but reduced annual return rates. Robust estimates of radio retention and survival will aid researchers to select attachment techniques that best meet the goals of future telemetry projects.

Dispersal and population dynamics of the American Oystercatcher (*Haematopus palliatus*) on Tuckernuck Island, Massachusetts

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Dispersal is a crucial ecological process that drives such processes as range expansion and colonization. Since the early 1900's the breeding range of the American Oystercatcher, *Haematopus palliatus*, has expanded north along the Atlantic coast. Since the 1970's the species has assumed a prominent role as a nesting shorebird along the Atlantic coast including Cape Cod, Massachusetts and the surrounding islands. We examined the productivity and movement of a population of oystercatchers during the 2005 breeding season on Tuckernuck and Muskeget Island, MA. A total of 27 oystercatchers of the local population were individually marked using a coded color band and observed to delineate feeding and territory ranges during the breeding season. Movements during the breeding season and persistence of oystercatchers at nesting grounds were recorded for marked individuals. Banded oystercatchers without fledged young left the island between 12 July and 10 August to join a staging population on Monomoy Island, MA. Auxiliary markings provided new information about the persistence at nesting grounds and have the potential to provide information about the degree of breeding site fidelity and the dynamics of a migrating population.

Nest site selection and nesting success of Snowy Plover at Great Salt Lake, Utah

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The Great Salt Lake is one of the most important inland breeding sites for Snowy Plover *Charadrius alexandrinus* in North America. It is estimated that approximately 10,000 Snowy Plovers breed within the Great Salt Lake ecosystem; representing close to 55% of the entire breeding population west of the Rockies. We examined nesting success and the factors influencing nest-site selection of Snowy Plovers during the 2003–2005 breeding seasons. Study sites were searched for nests throughout the breeding season and once located, were monitored every three to four days until either the eggs hatched or the nest failed. Following termination of the nest, we measured percent vegetative cover, maximum vegetation height, percent bare ground, density of vegetation, visual obstruction caused by vegetation, and percent rock cover. Nesting success was highly variable between sites and ranged from 24–54%. Snowy Plovers chose sites with significantly more bare ground and lower, sparser vegetation relative to unused sites. In addition, sites used by Snowy Plovers had a higher percentage of rocks less than 1 cm in size when compared to unused sites. The results of this study



provide critical information on both the nesting success and habitat selection of a highly imperiled species.

Using trace element profiles to examine migratory connectivity of Western Sandpipers: a preliminary study

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Determining the degree of connectivity between breeding and non-breeding areas is critical for understanding the ecology and evolution of migratory birds. Individuals carry substantial intrinsic information about their biological and geographical population structure, including genetic composition, physical size, and biochemical makeup. We explore a new approach towards determining the geographical origins of tissues based on compositional profiles of over 40 trace elements in newly grown primary feathers of Western sandpipers (*Calidris mauri*) gathered from 6 non-breeding sites in the U.S., Mexico, and Panama, plus feathers from juveniles grown in Alaska. Samples from different sites show consistent differences in their elemental profiles and provide the opportunity to explore connectivity between various stages of the annual cycle. We assess the ability to assign individuals caught on migration to specific non-breeding sites by applying a likelihood-based assignment test combined with a prior probability of relative abundance using Bayes' Rule. Trace element profiles appear to operate at quite local scales, in contrast to the broader regional assignments possible from other intrinsic markers such as stable isotopes.

Preliminary results of population genetics of the Pacific Golden-plover (*Pluvialis fulva*)

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The Pacific Golden-Plover *Pluvialis fulva* has a wide distribution, but little is known about migration patterns and population connectivity. To assess genetic structure and determine population trends, 57 individuals from Hawaii and Saipan/Tinian populations were examined at eight highly variable microsatellite DNA loci. Mean gene diversity (HE) was higher in Hawaii than in Saipan/Tinian (0.53 and 0.47; $P < 0.007$). Low heterozygote deficit (FIS) suggested no sub-structuring in either population. Genetic differentiation ($F_{ST} = 0.011$, $P = 0.223$) using the current sampling conditions was unable to support the results of recent radio-tagging and leg banding studies that suggest the maintenance of distinct breeding populations. No evidence of a recent bottleneck was found. The seven genetic markers in Hardy Weinberg Equilibrium were adequate to distinguish one among 7,153 individuals in Saipan/Tinian, but due to a small sample set were unable to assign probability of identity values for the Hawaii population.

Whimbrel and Hudsonian Godwit habitat preferences in the Mackenzie Delta, Northwest territories: building a predictive model

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The Mackenzie Gas Project is currently undergoing environmental assessment in the Northwest Territories. Approval of this

project will result in three onshore gas processing facilities in the outer Mackenzie Delta and a gas pipeline corridor along the Mackenzie River to Alberta. This construction may result in reduced habitat for shorebirds breeding in the Delta. I will survey three levels of habitat selection (landscape, territory and nest site) for Whimbrels and Hudsonian Godwits at three sites: Taglu Island, Fish Island, and Parsons Lake. In a preliminary survey of the Delta in 2005, both species were observed at Taglu and Fish Islands. Whimbrels have been observed in previous studies breeding in the Parsons Lake area. Taglu Island and Parsons Lake are proposed sites for two of the gas processing facilities and the pipeline will run across Fish Island. We plan to examine landscape habitat selection for all breeding shorebirds observed by Rapid survey crews throughout the Mackenzie Delta, by the Program for Regional and International Shorebird Monitoring (PRISM). We hope to develop a predictive habitat model for shorebird habitat preferences and use the model to draft conservation plans in order to mitigate potential effects of oil and gas development in this area.

Arctic prism: goals, approach and application

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The Program for Regional and International Shorebird Monitoring (PRISM) is designed to assess and monitor North American shorebird populations. It is comprised of three survey types: (i) breeding surveys in Arctic, Boreal, and Temperate biomes, (ii) migration and stopover surveys, and (iii) Neotropical 'wintering' surveys. Breeding surveys (Arctic) take place when populations are dispersed and birds are geographically static. Regional-scale population estimates are extrapolated from the smaller set of surveyed plots. In the Canadian Arctic breeding surveys are complicated by several factors including low bird densities and extreme annual weather variability. To address these limitations a three-tiered program was designed: Tier 1 – Extensive area surveys conducted every 10–20 years for shorebird abundance estimates; Tier 2 – Annual or semi-annual surveys conducted at 10–20 permanent sites selected from Tier 1 data; and Tier 3 – Opportunistic checklist data collected across the Arctic. The goal of Arctic PRISM is to estimate and monitor overall and species-specific shorebird populations. We started the Tier 1 surveys in 2001, and to date (2005) we have completed surveys in ten of 30 Arctic PRISM regions. Surveys are in progress at two more. Tier 2 will not be implemented until all Arctic PRISM regions have been surveyed. We are continuously collecting the Tier 3 checklist data. The Arctic PRISM program will provide accurate estimates and trends of shorebird populations across the Arctic which can be used to design and implement shorebird conservation plans. The analysis program for generating the population estimates is complete and preliminary population estimates from some of the surveyed regions have been produced.

Early history of the Marbled Godwit (*Limosa fedoa*) in the upper Midwest

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Once a local breeding bird as far east as south-eastern Wisconsin and northern Iowa, the Marbled Godwit *Limosa fedoa* declined in the latter half of the 19th century. A state-by-state survey shows a period of withdrawal from the eastern part of its breeding range with much of the original loss attributable to



overhunting and plowing of the original sod for agriculture. Locally, at least in Minnesota, some recolonization has apparently occurred following the early 20th century cessation of shorebird hunting, passage of the Migratory Bird Treaty Act, and initiation of large scale wetland conservation projects. Declines in the latter quarter of the 20th and early 21st century may involve issues as diverse as the loss of a grazing economy, tiling and wetland drainage, and landscape rock harvesting.

Habitat use and foraging ecology of Hudsonian Godwits, *Limosa haemastica*, in South America

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Hudsonian Godwits *Limosa haemastica* are widely distributed across the southern cone of South America during the austral spring, summer, and fall (September–April). Despite their relative abundance, little effort has been made to quantify the godwits' habitat use and foraging ecology during their stay in the southern hemisphere. During a tour of godwit migration stopover sites and nonbreeding staging areas in Peru, Brazil, Uruguay, Argentina, and Chile, I attempted to gain a better understanding of the type of habitat godwits frequent, their numbers there, and their foraging patterns. Due to limitations imposed by budget, time, and the accessibility of many of the sites, data collection was limited. However, based on observations and a small data set, it is still possible to draw some conclusions: Hudsonian Godwits prefer areas with soft, deep mud or stationary sediments and avoid areas dominated by sand or rocks, including the *restinga* that dominates much of the Argentine coast. The godwits spend the majority of their feeding time probing the soft mud, as many as 350 times in a 3-minute span, and prey mainly on small clams, polychete worms, and sand-fly larvae. Other foraging strategies are occasionally employed, including foraging by sight for prey items at or near the surface of shallow water. These basic habitat and foraging characterizations may prove important in identifying specific habitats worthy of protection, or possibly, in predicting areas that have not as of yet been documented as regular stopover areas during the migration.

West Nile Virus prevalence among Snowy Plovers in Kansas

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Since its first appearance in New York in 1999, West Nile Virus (WNV) has spread westerly across the United States and caused many human and avian deaths. To date, individuals in over 45 North American bird families, including Charadriidae, have tested positively for WNV. In addition, shorebirds frequent areas that have high densities of mosquitoes, a known vector of WNV. With the onset of shorebird migration, individuals carrying WNV have the potential to spread the infection to new areas and species. In 2005, nasopharyngeal epithelial tissue, blood, and/or molting feather samples were collected from Snowy Plover adults ($n = 64$) and chicks ($n = 11$) at Quivira National Wildlife Refuge and Cheyenne Bottoms Wildlife Area. Reverse transcriptase polymerase chain reaction (RT-PCR) is being used to test for WNV, as it provides an indication of WNV prevalence in live birds. The results of our analysis will be discussed.

Towards facilitating spatial predictive modeling of shorebird distributions and habitat: the benefits of free online databases

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Recent developments in spatial information availability and use such as GIS mapping, coastal environmental databases, public access to digital information online, Remote Sensing, and computational decision-support offer entirely new approaches to shorebird distribution and habitat research. Predictive spatial modeling allows us to determine the relative probability of occurrence for species of interest at specific locations and times, e.g. during migration stopover. This approach proves particularly useful for providing testable predictions of distribution and habitat suitability over large, poorly-studied areas. We present shorebird distributions in the Sea of Okhotsk (Russian Far East) as a global template for this method. This region consists of a huge, remote coastline along the East Asian–Australasian (EAA) Flyway; detailed shorebird distribution data, turn-over rates, and population estimates are unavailable. We compiled 'presence only' information and confirmed absence data from seven years of field work and from our larger Russian Literature Review (summarized in a GIS database) to predict the occurrence of Great Knot, Red Knot and Bar-tailed Godwit during fall and spring migration. For habitat predictors we used tidal range, river type and size, surrounding substrate type, and mudflat size obtained from Remote Sensing layers, software tools, hardcopy maps and others. A spatial modeling approach is presented using GIS and modeling algorithms such as GLMs, CART and MARS. We highlight the fact that much of this work would have been impossible without the aid of free online datasets, and encourage researchers to make shorebird and habitat survey data available in a similar format whenever possible.

Space use of male Snowy Plovers tending broods

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Individual space use and movements can have profound impacts on reproductive success and survival, especially for threatened species that occupy habitats valued by humans for recreation. From 2001–2005, we studied space use of male Western Snowy Plovers *Charadrius alexandrinus nivosus* tending 41 broods on beaches in coastal northern California. Day-to-day movements of broods varied greatly over the 28 d brood-rearing interval. Most males raised chicks near nest sites, whereas a small percentage moved broods 0.5–2.5 km from nest sites, often when chicks were less than 5 d old; there was no difference between successful and unsuccessful broods in this pattern. In two thirds of instances, males moved chicks to areas they used regularly during incubation recesses. Some males raised broods in the same area in consecutive years. These findings suggest experience and familiarity with an area influence choice of brood-rearing areas. Using overlapping brood ranges of multiple males, we identified four locations ("core brood-rearing areas") that were consistently used over multiple years. In years 4 and 5, we used these areas to guide the placement of symbolic fencing to provide a refuge for broods from human activity.

