the former habitat types, waders could in principle allocate their energetic and nutritional investments to sustained exercise and thermoregulation rather than to build-up and maintain disease resistance.

On the basis of these associations between the characteristics of breeding and wintering habitats and other comparative evidence (low apparent immunocompetence in marine wintering species, and very high levels of energy expenditure and fast growth in wader chicks in the High Arctic), a trade-off between investments in immuno-functioning (disease resistance) and sustained exercise (migration, thermoregulation) is suggested. For species restricted to parasite-poor habitats (high arctic tundra, exposed seashores) small investments in immunodefence mechanisms are sufficient. However, as such habitats are few and far between, this lifestyle necessitates long and demanding migratory flights in the course of an annual cycle. Also, the chosen habitats are often energetically costly to live in.

In summary, waders restricted to relatively parasite-poor habitats such as tundra and seashores would not invest in disease resistance. This would allow for high rates of energy expenditure without detrimental effects on survival. The lack of parasites would enable very high rates of energy expenditure before and during non-stop migration flights of 3,000-8,000 km, and for maintenance in cold and exposed habitats. Additionally, loss of immunodefence-related genetic diversity (*e.g.* MHC gene complex) might be of little consequence. For example, such species might quite easily survive extreme population crashes during climatic intervals with large habitat loss, something that may have happened repeatedly to Knots.

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Wetland Connectivity and Waterbird Conservation in the Western Great Basin of the United States

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INTRODUCTION

As scientists, managers and landowners, we have come to realize that to best understand the local and regional value of individual wetlands, we need to take a broad geographic, taxonomic, and management view. In December 1994, a symposium was held in Reno, Nevada that addressed this topic for shorebirds by bringing together researchers and managers from the Western Great Basin to discuss shorebird research and management in the region (Reed *et al.* 1997, *International Wader Studies 9*). In February 1998, a similar, but broader, symposium was held in Bend, Oregon that addressed wetland connectivity and waterbird conservation in the Western Great Basin. Over 100 participants spent one day listening to talks from waterbird researchers that focused on multi-scale habitat use and movements of birds in the region. From American Avocets *Recurvirostra americana* to White Pelicans *Pelcanus erythrorhynchos* we learned of phenomenal intra-season movements throughout the Basin and the value of collecting detailed data of this nature for representative waterbirds. We learned also about the National Shorebird Conservation Plan and spent the next day in discussion groups where future research and management priorities were outlined. These discussions were the first regional planning effort for the National Plan.

Western Great Basin wetlands stretch from Malheur National Wildlife Refuge in central Oregon to Mono Lake, California. This string of desert oases provides habitat to hundreds of thousands of waterbirds (shorebirds, wading birds, waterfowl, *etc.*) throughout the annual cycle. Over 48% (78/161) of North American waterbird species and 63% (29/46) of North American shorebird species commonly occur in the area. Furthermore, over 43% (9/21) of non-Arctic breeding shorebird species occur as breeders. Constant pressures for multiple use

combined with the ephemeral nature of these habitats render these wetlands and the waterbirds that inhabit them vulnerable to habitat degradation and the loss of population viability. This symposium is the first effort to bring together pertinent waterbird expertise from throughout the region and serves as an example for other regional wetland conservation planning efforts.

SYMPOSIUM ABSTRACTS

Wetland connectivity and landscape conservation strategies for birds in the western Great Basin.

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The current conservation crisis calls for research and management to be carried out on a long-term, multi-species basis at large spatial scales. Unfortunately, scientists, managers, and agencies often are stymied in their effort to conduct these studies because of a lack of appropriate technology, methodology, and funding. This issue is of particular concern for wetland conservation in the Western Great Basin where the standard landscape approach may consider a arge tract of land but fails to incorporate the suite of sites frequently used by highly mobile organisms such as waterbirds (*e.g.*, shorebirds, wading birds, waterfowl). In the symposium today, we will consider solutions to these current obstacles. As we will see, the solutions will represent a trade-off between typical in-depth single species studies and more generic multi-species studies. They include studying within- and among-season movements of waterbirds on a spatial scale appropriate to both widely dispersing and more stationary species; multi-species censuses at multiple sites; further development and use of technology such as satellite transmitters and population-specific molecular markers; development of spatially-explicit population models that consider within-season movements of waterbirds; and recognition from funding agencies that landscape-level issues cannot adequately be addressed without support for these types of studies.

Western Great Basin lakes and wetlands: threats and restoration strategies.

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Since the mid-1800s wetlands and lakes in the Western Great Basin have experienced a common series of threats related to modification of the natural hydrology as water rights have been appropriated for agriculture, mining, and municipal and industrial uses. Changes in the quantity of water inflow into terminal wetlands and lakes is the most common threat. Changes in the quality of water flowing into these systems, often due to the increasing importance of agricultural return flow as a water source, is a closely related threat. Many of these wetlands and lakes have faced an overall reduction in water inflow, as well as a reduction in the quality of water feeding them. Other threats include: the loss of flood plain wetlands due to channelization and modification of the river channel and flood plain, poorly managed grazing, fragmentation of wetland habitat, poorly conceived management schemes and long-term accumulation of toxins in closed basins.

In the past two decades a number of successful conservation efforts have been initiated on behalf of Great Basin Wetlands, including Mono Lake, Pyramid Lake, Lahontan Valley wetlands. These campaigns have focused on three major strategies: 1) grass-roots advocacy and coalition-building (Lahontan Valley wetlands, Mono Lake); 2) litigation and administrative action (Pyramid Lake, Mono Lake); and 3) acquisition of water rights through market mechanism (Lahontan Valley wetlands and Pyramid Lake). Even when these conservation strategies are successful, there are still difficult questions about the long- and short-term goals of the restoration program. These questions need to be related to, and inform, the conservation strategy.

Environmental contaminants in waterbirds from the Great Basin.

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During the last two decades, eggs and carcasses of waterbirds have been analyzed from numerous sites in the Great Basin including Summer Lake, Malheur National Wildlife Refuge (NWR), Stillwater NWR, Carson Lake, Ruby Lake NWR, Humboldt River, Lahontan Reservoir, and Snake River. These studies were sometimes designed to evaluate regional patterns and temporal trends in contaminant concentrations, but sometimes also to evaluate effects related to specific point sources, *e.g.*, mercury from the Comstock gold mining days in Virginia City during the last century, or the affects on birds of cyanide use in gold mining today. In the latter ecase, man-made ponds containing cyanide were created in the desert and attracted migrating waterbirds in the spring and fall. This overview will discuss findings, *i.e.*, reproductive success, bone strength, direct mortality, etc., related to the following contaminants: DDE, polychlorinated biphenyls (PCBs), selenium, mercury, boron, fluoride and cyanide.

Surveys of inland-breeding seabirds in northeastern California.

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In 1997, surveys of inland-breeding seabird colonies were conducted throughout the Modoc Plateau and Great Basin region of northeastern California. Species surveyed included the American White Pelican, Double-crested Cormorant *Phalocrocorax auritus*, Ring-billed Gull *Larus delawarensis*, California Gull *L. californicus*, Caspian Tern *Sterna caspia*, Forsters Tern *S. fosteri*, and Black Tern *Chlidonias niger*. Surveys used a combination of aerial photography and motor boat, kayak, and ground techniques depending on particular species biology or logistical restraints. A special focus was placed on the Black Tern because little information is available on its distribution, abundance, and habitat needs in California and it has suffered long-term population declines throughout North America. Most species were restricted to relatively few sites with suitable undisturbed nesting islands, which were well represented on wildlife reserves. By contrast, the marsh-nesting Black Tern was widely distributed, but less than 5% of the regional population occurred on state and federal wildlife areas. Nongame species will benefit the most from wetland restoration and enhancement if information on their breeding requirements are specifically incorporated in project design and management plans.

Species richness, abundance, and wetland use by shorebirds in the western Great Basin: a comparison of census methods.

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Large-scale bird surveys have been attempted within North America with mixed results. Arid regions, such as the Great Basin, are often poorly sampled due to inaccessibility of sites and low densities of ornithologists. Extreme variability in habitat conditions in these regions present special censusing problems. We report results of largescale censuses in the Western Great Basin. We discuss problems with censusing these areas and compare ground and aerial surveys methods. Ground surveys documented 31 species of shorebirds. Significant differences in species composition were detected among sites. During aerial surveys of three large alkali lakes (Goose, Summer and Abert), we counted >300,000 shorebirds during our censuses in 1997, of which 67% were American Avocets and 30% phalaropes. This was twice the number counted in 1996. Summer Lake and Lake Abert supported high numbers of American Avocets (>15,000 on single day counts at each site), qualifying the lakes for Hemispheric classification under WHSRN guidelines. A mixture of ground and aerial surveys must be conducted to get an accurate picture of the diversity and density of shorebirds in the Western Great Basin. These data will enable researchers and managers to make informed decisions regarding the management and conservation of shorebirds in this and other arid regions.

White-faced Ibis in the northwest Great Basin: relationship to surface water condition and inter-colony movements.

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The Great Basin White-faced Ibis *Plegadis chihi* population is dependent upon ephemeral palusterine wetland communities for survival and reproduction. Consequently, Whitefaced Ibis appear to be highly opportunistic in response to dynamic changes in breeding habitat caused by natural recurring droughts and floods. Several authors suggest that abrupt changes in local ibis nesting populations are due to water level fluctuations on both a local and regional scale. I examined these hypotheses with pair count data from two of the three major and persistent breeding colonies: Lower Carson River Basin and Malheur NWR. I used multiple linear regression techniques to test: 1) the number of breeding pairs in the Lower Carson River Basin are not related to local surface water conditions, and 2) surface water conditions in the Lower Carson River Basin have no affect on the number of breeding pairs in Malheur NWR. Local surface water conditions in May of the current year and in March through August of the previous year explained 57% of the variation in the number of breeding pairs in the Lower Carson River Basin. Surface water conditions in May affect breeding habitat suitability and availability during a critical period when the majority of ibis begin egg laying. Surface water conditions during the previous spring-summer influence the current years emergent vegetation growth, invertebrate prey base, and perhaps return rate. The number of breeding pairs in Malheur NWR were not affected by the surface water conditions in the Lower Carson River Basin. Intercolony movements and displacement between these two breeding concentrations is not supported.

The importance of mono lake and Great Salt Lake to Eared Grebes nesting in British Columbia.

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In July of 1995 and 1996, we captured Eared Grebes *Podiceps nigricollis* at Riske Creek, in interior British Columbia, and marked them with implant transmitters. We tracked 40-50% of these birds to Mono Lake, CA in October of both years (relatively good coverage). Only about 10% of these birds were found at Great Salt Lake, UT (relatively poor coverage). A few marked birds were also found on Salton Sea, CA in March (also relatively poor coverage). It was interesting to find that Grebes from the same breeding colony were found on Mono Lake and Great Salt Lake at the same time. We also

conducted aircounts on Mono Lake in mid1996 and 1997 and arrived at 1.5.-1.6 million ±5% (SE) in both years. These results show the importance of Mono Lake and Great Salt Lake to Eared Grebes nesting in interior British Columbia and (probably) across a wider area of North America. They also point out important connections between these large saline lakes in terms of grebe movement.

Spatial and temporal differences in migration of arctic nesting geese through the Great Basin.

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Lesser Snow *Anser c. caerulescens* and Greater White-fronted geese *A. albifrons* are Arctic nesting waterfowl which migrate over 5,000 km to wintering areas, spending half of their annual cycle in migration. Three populations of Greater White-fronted Geese which migrate through the Great Basin have distinctive spatial and temporal patterns: Tule Geese *A. albifrons gambeli* breed in south-central Alaska and arrive early (Aug) in the fall and stopover at Summer Lake and Warner Lake wetlands with longer and more dispersed staging during the spring; Pacific geese from western Alaska stop at the Klamath Basin during both the fall (Oct-Nov) and the spring (Feb-Apr); while the Bristol Bay population from southwestern Alaska also use the Klamath Basin but arrive and leave earlier (Sep) in the fall and use more easterly wetlands during the spring. Lesser Snow Goose populations from Wrangel Island, Russia and Banks Island, Canada both use Summer Lake Wildlife Area as a major stopover but they separate temporally: the Wrangel Island population travels farther but arrives more than a month (Sept) before birds from Banks Island in the fall. Both populations exhibit shorter stays and wider dispersal to the Klamath and Harney Basins during the spring. Differences in migration strategies of these populations result in their temporal and spatial separation and possibly reduced resource competition in limited Great Basin wetland habitats. In addition, Arctic nesting geese use different within-wetland areas than do shorebirds. Thus, management of the Great Basin wetlands as migratory bird stopover areas must include consideration for differences in spatial and temporal use among both species and populations.

Sandhill cranes in the Great Basin

Gary Ivey, Malheur NWR, HC 72, Box 245, Princeton, OR 97721, USA (gary_ivey@mail.sws.gov).

Two populations of Greater Sandhill Cranes *Grus canadensis* breed in the Great Basin. The Central Valley Population breeds primarily in northeast California and eastern Oregon and winters in the Central Valley of California. The Lower Colorado River Population breeds in eastern Nevada and winters at the California-Arizona border along the Colorado River. Large numbers of Pacific Flyway lesser Sandhill Cranes migrate through the Great Basin, between Alaska and Canada nesting areas and Californias Central Valley, staging at many locations in this region.

Space use and dispersal of breeding Killdeer in the western Great Basin

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Understanding movement decisions of birds is pivotal to their management and conservation. Managers who can manipulate dispersal decisions can affect population densities and reproductive success. All of the ringed plovers breeding in the continental United States have experienced recent severe population declines. Killdeer *Charadrius vociferus*, while abundant and widespread, have experienced significant declines in the western states. Thus, we undertook a study of Killdeer movements as part of our larger interest in understanding shorebird space use in the Western Great Basin. Populations were studied at Honey Lake, California and Summer Lake Wildlife Area, Oregon.

Killdeer at both areas are migratory. Males arrive early and defend territories. Overall, males returned to breeding sites more often than females. Reproductive success significantly affected male return rate, *e.g.*, 79% of males hatching one or more eggs returned *vs.* 44% for failed males. By contrast, return of females was identical for failed and successful breeders (52%). Home ranges of breeding males and females is similar, hence the potential to obtain local information useful for dispersal decisions is similar for both sexes. However, females leave breeding territories earlier than males, at times moving to new and distant sites where they may breed in future years.
In contrast to American Avocets and Black-winged Stilts *Himantopus mexicanus*, which readily disperse across large bodies of water such as Honey Lake or Summer Lake, Killdeer normally move only short distances between successive nesting attempts within a year. Even between years, dispersal events of adults in excess of 10 kms are rare. Dispersing individuals normally move to adjacent subpopulations. Management efforts for Killdeer should support a constellation of adjacent management zones, each including a dependable fresh water supply and ground predator-free breeding sites. Successful management strategies will be summarized here and detailed in the predator workshop on Thursday.

Post-breeding movements of American Avocets in the western Great Basin

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Determining the extent of habitat use by migratory species throughout an annual period is necessary for determining appropriate spatial scales for conservation efforts. Western Great Basin wetlands form an important series of breeding and migratory staging areas for American Avocet populations. The ephemeral nature of these habitats at both seasonal and multi-year time scales, in addition to the patchy distribution of wetlands across otherwise arid landscapes, pose particular lifehistory challenges to breeding populations in this region. To examine one aspect of how individual birds utilize these wetland habitats, we used radio telemetry methods to examine premigratory movement patterns of breeding American Avocets throughout the region. In 1996 and 1997, 185 breeding adults were captured, uniquely color-banded and fitted with radios at five breeding areas in Oregon, California, and Nevada. Aerial and ground surveys of radio-tagged birds were conducted weekly or biweekly at the five main study areas from June through September, or until all avocets had departed the lake system. Other wetlands in the Western Great Basin were surveyed less frequently by aircraft for the presence of radiobirds. Fifty-six percent of radio-marked avocets were still detected in the region at least 8 weeks after capture. Each of these individuals was detected at an average of 2.1 lakes (range: 0), with 74% found at more than one lake system. Forty-two radiomarked individuals moved at least 200km between wetlands prior to migration. Of these, northward movements by individuals breeding at the southern lake systems were detected far more often than southward movements of Oregon breeders. Male and female patterns did not differ significantly. These results demonstrate wide-rangeing and highly variable dispersal patterns in this species and suggest a need for consideration of large-scale habitat connectivity issues in establishing conservation strategies for Western Great Basin wetland ecosystems.

Movements of American White Pelicans from Nevada through the western United States

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We radiotagged 17 American white pelicans *Pelecanus erythrorhynchos* in the vicinity of Stillwater National Wildlife Refuge, NV during the breeding seasons of 1996 (n=7) and 1997 (n=10), and tracked their movements through the western United States using telemetry via satellite. The transmitters (PTTs) provided location estimates every 2-3 days. In 1996, 2 birds captured in mid-June flew to central California within a week, and one made several trips back to the Stillwater area. Another bird left for central California 4-5 weeks after capture. One bird from central California went as far north as the Tule NWR, CA in September. After one month a bird flew from Stillwater, to Malheur NWR, OR, and then to Payette, ID; in mid-September it flew to the Great Salt Lake, UT, the Salton Sea, CA, and to Colima state, Mexico by December. Seven weeks after capture, a bird flew to the Cache Valley, UT, and by 11 Oct. it was at the Salton Sea. We continue to track several birds marked at Stillwater and Pyramid L., NV in May and June 1997. Pelicans captured as breeding birds remained in the Lahontan Valley, NV area longer than many others. Central California was a common destination again. One bird flew to OR, ID, and UT before going to central Mexico. Five birds used the Salton Sea, six have made it to Mexico. We will present information about the proximity of pelican locations to "drainage layer" features from the Digital Chart of the World (Environmental Research Systems Inst.).

The Intermountain West Joint Venture: building partnerships for wetland habitat conservation

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The Intermountain West Joint Venture was established in 1994 to promote and coordinate voluntary and cooperative wetland habitat conservation efforts under the auspices of the North American Waterfowl Management Plan. The Intermountain West Joint Venture area encompasses parts of 11 western states, including all of the Western Great Basin. Overseen by a management board made up of representatives of state and federal agencies, conservation organizations and industry and business interests, the joint venture promotes and assists habitat conservation efforts implemented through partnerships at the state and local levels. Development of "focus area" plans to guide joint venture actions is under way in most areas, and joint venture partners have initiated a number of largescale projects to protect, restore or enhance key wetland habitats. Project funding has been derived from a variety of public and private sources. The joint venture can support waterbird conservation strategies by developing partnerships and funding for habitat conservation projects and promoting broader public awareness of wetland habitat values and functions.

The Western Hemisphere Shorebird Reserve Network and the U.S. National Shorebird Conservation Plan

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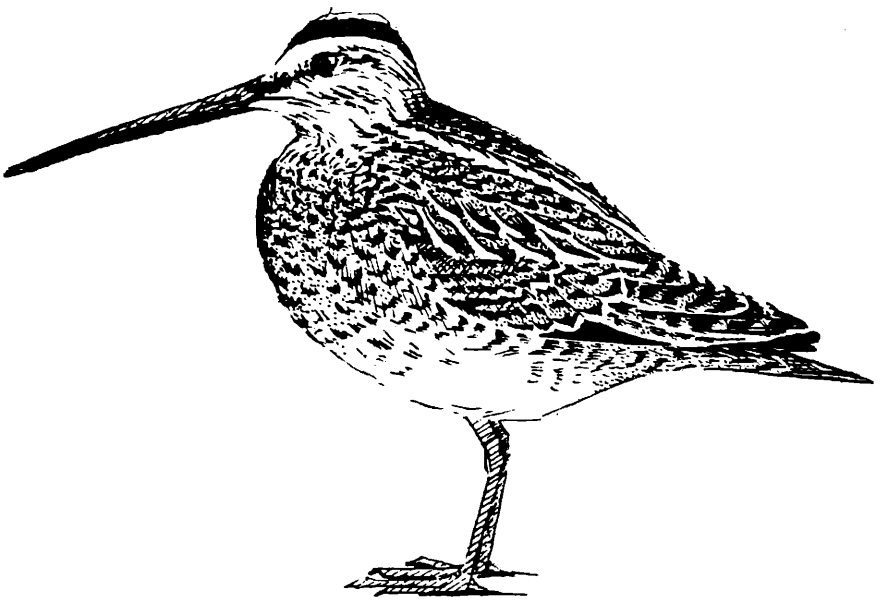
Shorebird populations are suffering rapid and substantial declines. Of the 41 shorebird species which migrate through North America, 5 are projected to decline by 25% or more over the next five years, and 16 others have projected or actual population declines of 5 to 20%. In 1986, the Western Hemisphere Shorebird Reserve Network (WHSRN) was created to conserve staging areas critical to the survival of these hemispheric migrants. The Network currently protects over 9 million acres at 34 sites, most of which host hundreds of thousands to millions of shorebirds annually. The framework of WHSRN is based on 1) field monitoring (ISS and others),
2) technical assistance and training for land management, 3) public outreach and environmental education. Presently we recognize three types of reserve sites (Hemispheric, International, and Regional) all of which are focused on critical staging areas. This has been and remains and sound foundation for the program. However, the growing crisis in wetlands and coastal habitat conservation requires a more dynamic approach.

WHSRN is responding to this need in several new ways. International conservation is a complex issue that lends itself to creative approaches and new institutional linkages.
Collaboration with Partners in Flight, the North American Waterfowl Management Plan, Wetlands International, CEC, The Nature Conservancy, businesses, and untapped governmental agencies all represent an important beginning. We are reassessing our scientific basis to identify needs and opportunities to improve our technical approach.
Perhaps most fundamental are initiatives to design national shorebird conservation plans that will identify and prioritize the key issues and provide a comprehensive strategy to address shorebird conservation on a continental and hemispheric scale.

The National Plan will address three primary objectives: a) develop a standardized, scientificallysystem for monitoring and studying shorebird populations that will provide practical information to researchers and land managers for shorebird habitat conservation;
b) identify the principles and practices upon which local, regional and national management plans can effectively integrate shorebird habitat conservation with multiple species strategies; c) design an integrated strategy for increasing public awareness and information concerning wetlands and shorebirds. The recommendations of research, management, and education working groups will be incorporated into a draft national shorebird plan by the middle of the second year of Federal Aid support. The development of a scientific, habitat-based national plan for the conservation of shorebirds and their habitats will provide land and wildlife managers in all 50 States with a detailed guide for integrating shorebird management with conservation activities for other species.



WORKSHOP SUMMARY

Wetland Connectivity and Waterbird Conservation in the Western Great Basin of the United States: Shorebird Management, Research, and Conservation

INTRODUCTION

The Great Basin of the United States is a closed basin that falls between the Cascade and Rocky Mountain ranges, principally in Oregon, California, Nevada, and Utah. It stretches over 700 km from north to south and 600 km from east to west. Although mostly a remote desert ecosystem, the wetlands that occur in the region are critical to migrant and breeding shorebirds. As more shorebird studies are conducted in the Western Great Basin, we have come to recognize the hemispheric significance of sites such as Abert Lake, Summer Lake, Stillwater/Carson area, and Mono Lake, as well as the importance of linkages such as the Surprise Valley, Malheur NWR, Warner Wetlands, Goose Lake, and Honey Lake. Furthermore, we acknowlege the fragility of these habitats and the lack of strategic planning for their conservation. Efforts such as the National Shorebird Conversion Plan strive to address these needs but require regional planning to begin. Thus, the summaries below came as a result of roundtable discussions with scientists, managers, and landowners and represent the beginnings of a strategic plan for the region that can serve as a contribution to the National Plan as well as be used by agencies in their own planning.

Human Conflicts with Shorebird Conservation in the Western Great Basin

Susan Haig, discussion leader, Forest and Rangeland Ecosytem Science Center, Corvallis OR 97331, USA; HaigS@FSL.ORST.EDU.

While it comes as no surprise for anyone living in the western United States, since the time of European settlement in the region water has been the limiting resource. As the human population increases overall and settlement in the West increases disproportionately to other areas in North America, the challenge of assuring adequate water resources (quantity and quality) for humans as well as native natural resources has reached a crisis level. Over 48% of North Americas waterbird diversity and 63% of shorebird diversity is represented in this region, hence this crisis facing the wetlands they inhabit has serious implications for their future viability.

In a general sense, solutions to increased demands for water will come from an understanding and appreciation of the problems and potential solutions. This needs to be carried out via better education of the general public, land managers, and scientists. In addition, we will need to focus more closely on land use planning, particularly for wetland conservation, on a local, regional, and national scale.

These land-use planning efforts will encompass such activities as 1) increased landowner easements and incentives to restore or conserve the wetlands on their property; 2) buying water rights in critical areas; 3) learning how to define the value of wetlands in currency common to everyone -- the value of a wetland to a shorebird biologist may not be the same as for a rancher trying to water his livestock; and 4) working on grazing reform -- that is, we need to work on policies that promote better stewardship of private and agency land and we need to work towards more fair grazing fees.

From a research and management perspective, we have a need to understand the vast, varying, yet few, ephemeral playa lakes that make up much of the shorebird habitat in the region. We know very little about their original distribution, abundance, and structure. We know almost nothing about what aspects of their structure are most critical to shorebirds and other species: what size, water quality, prey diversity and abundance, vegetation structure, *etc.* Currently, there are attempts to create artificial wetlands *in lieu* of the playas that have been lost, yet there is little information to help assure it is done properly. Finally, these wetlands are not isolated entities with no connection to other systems, hence a broader picture must be examined. For example, much of the water that makes up the playa lakes comes from streams and other riparian water flowing into them. These areas have been altered as a result of grazing, logging, and agriculture. Subsequently, the changing water quantity and quality that flows into the playa lakes may be changing their viability and habitat structure as well. Hence, we felt it was important to examine carefully this relationship so as to be able to make more responsible recommendations relative to their use.

More specifically, there is an important need to examine the use of cattle troughs in playa lakes. These troughs are dug deep into the playa lakes to assure a permanent source of water for cattle. As a result, the digging may break through the clay layer holding the water and it may drain the playa or change the water quality and quantity. Also, the troughs attract cattle, hence the area surrounding them becomes trampled and otherwise altered. Surprisingly, there is little information about the effects of the troughs on wetland viability. We do not know their distribution and abundance in the Great Basin, nor the effect they are having on shorebird (and many other species) success or hydrology in the region.

Other concerns about man-induced changes in shorebird habitat focused on an emerging brine shrimp industry on Lake Abert, Oregon, an area of international significance for American Avocets *Recurvirostra americana* and Wilson's Phalaropes *Phalaropus tricolor*. Here, permits have been granted to harvest brine shrimp with no understanding of the impact. Furthermore, the panel was concerned with military development of land in eastern Oregon and western Idaho that will potentially involve alteration of wetlands. Finally, we do not know the impact that recreational activities may be having on shorebird habitat in the Great Basin. Thus, it would be helpful to examine this question, if for no other reason than to help plan for the inevitable expansion of recreational activities on these wetlands in a way that will best continue to provide viable habitat for shorebirds.

In summary, the panel felt that given the enormity of the water problems in the west, we could not begin to solve them all. However, researchers and managers addressing issues of concern for playa lakes could provide a positive step forward that, when matched with other efforts, could begin to assure future viable wetlands for shorebirds and other species in the Great Basin.

Research Priorities to Improve Management of Breeding and Migrant Shorebirds in the Western Great Basin

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This group discussed research activities aimed at augmenting management of both breeding and migrating shorebirds in the western Great Basin. It was recognized that conflicts exist among management priorities for various species, *e.g.*, pond depths optimum for diving ducks, or even breeding recurvirostrid shorebirds are not optimum for migrant shorebirds or perhaps even for certain other breeding shorebirds such as Common Snipe *Gallinago gallinago* and Wilson's Phalarope. Thus, the most fundamental management issue is priority setting at a regional level, *e.g.* for the Great Basin as a whole, or for the Western Great Basin. Once regional priorities for shorebird management are established, it becomes possible to set local priorities aimed at augmenting specific shorebird species that breed in or migrate through the Western Great Basin.

A. Priority Setting.

There is no mechanism bringing all federal, state, and private interests involved with shorebird management together for the purpose of setting regional priorities. One group with similar interests is the Intermountain West Joint Venture of the North American Waterfowl Management Plan. Thus, perhaps it is logical to think initially in terms of shorebird management in the inter-mountain (Rockies to Cascades) region, and then for priorities to be broken down to the Great Basin as a whole, the Western Great Basin, and then to local areas. Whatever organization takes on the task, it is essential that they set priorities based upon the potential contribution of different areas to global biodiversity. In considering shorebirds, it is essential that management issues be considered from both the perspective of breeding and of migrant birds.

Breeding shorebirds. The majority of Snowy Plovers *Charadrius alexandrinus* breeding in North America and American Avocets breeding in the world occur in the Great Basin. The area is also of critical importance for maintenance of Black-necked Stilt *Himantopus mexicanus* breeding populations. The Great Basin may be of importance to the maintenance of breeding populations of three additional shorebird species: Long-billed Curlew *Numenius americanus*, Wilson's Phalarope, and Willet *Catoptrophorus semipalmatus*. Long-term monitoring of these six species is needed.

Migrant shorebirds. Large numbers of migrant shorebirds pass through the Great Basin. The area is important as a staging area for three of the breeding species mentioned above: American Avocet, Wilson's Phalarope, and Black-necked Stilt. In addition, in some years, many of all the Long-billed Dowitchers *Limnodromus scolopaceus*, and Red-necked Phalaropes *Phalaropus lobatus* in the world may pass through the Great Basin. The area also hosts large numbers of migrant Western Sandpiper *Calidris mauri* and Least Sandpipers *Calidris minutilla*. Long-term population monitoring of at least these seven migrant species is a critical element in our ability to develop and evaluate shorebird manageemnt strategies in the Great Basin.

B. Research Priorities

The top research priority relative to shorebird management is the continuing assessment of shorebird resources in the Great Basin. This requires aerial and ground surveys over extensive areas and spanning a number of wet and dry years. Already, the Pacific Flyway Project (described below) has surveyed most of the important sites for migrant shorebirds. Furthermore, the Western Great Basin Wetland Biodiversity Initiative from FRESC (Haig and Oring, in prep.) described at this symposium and in Warnock *et al.* (in review) is nearing completion. The project included aerial and ground surveys conducted weekly or bi-weekly, spring through fall, at a number of important sites, primarily in the northern part of the western Great Basin (*e.g.*, aerial surveys of Lake Abert, Summer Lake, and Goose Lake in Oregon and California; ground surveys at Summer Lake Wildlife Area, OR and Honey Lake, CA). Expansion of this work to include additional aerial and ground sites would provide baseline numbers essential for setting management priorities.

A second, and critical priority is to understand the ecological functioning of

Great Basin wetlands. This must include analysis of the interactions among water quality and quanity, invertebrates, plants and birds. These studies should include large alkaline lakes, complex managed marshes and small playas.

Finally, we need to conduct research to develop management techniques specifically aimed at increasing productivity. In many cases this will mean decreasing predation and or managing water levels, *e.g.*, (a) studies on wetland geography, (b) fences as exclosures, *e.g.*, on dikes, (c) studies on primary predators themselves, i.e., coyotes and ravens, (d) technique development, *e.g.*, methods of improved survey, improved traps, island fence design, etc.

Censusing and Monitoring Shorebirds in the Western Great Basin

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Currently, there are two established shorebird monitoring programs used for assessing birds in the Great Basin. Each has their positive and negative aspects but both point out the difficulty of understanding bird use of such a vast ecosystem.

Pacific Flyway Project (PFP) - Lead by the Point Reyes Bird Observatory, this project has only recently been completed. The PFP was a broadscale comprehensive program that used ground and aerial surveys to cover a wide array of key sites within the Pacific Flyway used by migrant shorebirds. Through the PFP, baseline data was collected to identify the relative importance of major spring and fall staging areas along the coast and throughout the interior of North America. Censuses were conducted twice a year, and timed to hit peak periods of migration. Some sites were also surveyed in winter. Although the PFP was not designed as a monitoring project, continuation of data collection in the fashion of the PFP could offer monitoring value. The most positive aspect of PFP was that it gave a comprehensive picture of shorebird use of all key sites throughout western North America. Conversely, it covered sites only once a season, so picture of shorebird use not complete. Also, some counts may have missed the peak of migration.

International Shorebird Survey (ISS) Coordinated by Manomet Center for Conservation Studies, the ISS's goal is to develop a long-term database to monitor trends in the use of traditional sites by shorebirds. A survey is conducted every 10 days during peak migration periods by driving along predetermined routes. The ISS has been conducted mainly east of the Rockies. The ISS is useful because it covers areas to provide data on long-term trends and coverage is relatively frequent within seasons. However, if it were extended to include the west, it would likely overlook important ephemeral sites that are not consistently used or miss many sites that are not accessible by road. Furthermore, it only covers portions of large sites (areas accessible by road). Because of the above biases, it may not provide a comprehensive picture of shorebird use in the Great Basin or similar regions.

Aware of the issues outlined above, yet recognizing the importance of censusing and monitoring shorebirds in the Great Basin, the group came up with the following recommendations:

Census and Monitor Population Sizes Within the Region There are some possibilities for monitoring the overall population size of certain numerically dominant species. However, for species that have very broad ranges, much of which lies outside the U.S., it may be very difficult to determine their population size, whether numerically dominant or not. Also, we may be able to monitor populations of some species on a local scale within the region, but the meaning and interpretation of these may be problematic. Thus, monitoring populations within the Intermountain region will only be meaningful if conducted within an even greater regional context (*e.g.*, Western North America).

Identify Important Sites --Most key sites are already known, primarily from the PFP and other research conducted in this region (research conducted by speakers of this symposium). But we need to have a better understanding and inventory of the relative importance of lesser known sites. We also need to be able to identify sites of high community richness.

Monitor Trends (following guidelines of *National Shorebird Conservation Plan*) Trends should to be evaluated for individual species, and evaluations must be statistically valid (see Warnock abstract). Furthermore, prior to setting priorities and in order to come up with robust and meaningful trend data, it will be imperative to first consider for what **species, seasons, sites, and at what scale** trends should be monitored. Finally, the group proposed steps to developing an intermountain west shorebird censusing and monitoring program under the *National Shorebird Conservation Plan*

Define the working region - The group discussed advantages of various definitions for a study area that includes the Great Basin. It was decided that the most reasonable and advantageous working region would be the Intermountain West (in terms of a funding framework being already in place for waterbirds, *e.g.*inter-mountain West Joint Venture of the North American Waterfowl Management Plan.

Coordinate Regional Committees and Working Groups Within the Region This will be a crucial component of the plan s success as it will be important to have regional feedback during all phases of the program s development. Committees and working groups would ideally comprise members that adequately represent regions within the Intermountain West area. Tara Zimmerman and Nils Warnock have volunteered to find and identify appropriate coordinators.

Design Monitoring System One point made was that before embarking on a monitoring study the questions one wants to answer have to be explicitly laid out. Key considerations will be:

1. *Species by species evaluation*: Because species have different life history strategies, the program should take a different monitoring approach and strategy for each species.

2. *Establish protocol*: Once monitoring approaches for each species are identified, specific protocols for monitoring can then be developed. Regional coordination will become a crucial part of developing, amending, and following these protocols.

3. *Critical statistical evaluation*: It will be crucial to develop a rigorous statistical evaluation of the power and precision of protocols.

Begin to develop a data storage, management and dissemination system, perhaps through some national agency (such as the Biological Resources Division of U.S.G.S.). This step was left somewhat unresolved by the group as managing a database like this will be a huge task. Developing it will come with time as the program evolves. However, one idea for management and dissemination of data was to use the internet/world wide web, although some participants of the symposium had doubts about the ability to maintain a long-term dataset on the internet.

In summary, this program will obviously have to rely on a large base of volunteers, and will require extensive coordination. Moreover, since it will be impossible to monitor all sites, the program will probably need to choose a manageable sample of sites. Compromises will need to be made with regards to available funding, logistical restraints, and the fact that variation in life history traits may dictate the need for a variety of monitoring techniques.

CONCLUSIONS

At the end of the two-day symposium there was a consensus that this sort of information sharing is essential if progress is to be made on wetland conservation in the region. Without any infrastructure for coordination, as is the current situation, this important task is left to dedicated managers and researchers who work in the area. Lack of funding (let alone long-term funding) for monitoring, management, and research renders this a challenge for even those who are dedicated to the area. Hopefully, this symposium will have served as a first step to begin to address this problem.