PREDICTING AND MANAGING CLIMATE CHANGE: IMPACTS ON GREAT BASIN WETLANDS, SHOREBIRDS, AND THEIR PREY

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The Great Basin of North America

San Francisco, CA
Salt Lake City, UT
Las Vegas, NV

HYPERSALINE
SALINE
FRESH
The Great Basin of North America

Five sites surpass WHSRN Hemispheric status:
- Great Salt Lake, UT
- Lake Abert, OR
- Summer Lake, OR
- Mono Lake, CA
- Lahontan Valley, NV

Great Salt Lake is the most important inland waterbird site in North America
Breeding Shorebirds of the Great Basin

Nine species of shorebird breed in the Great Basin:

- **SNOWY PLOVER** (*Charadrius alexandrinus*)
  Most of North America’s Snowy Plovers breed in the region

- **AMERICAN AVOCET** (*Recurvirostra americana*)
  Over 50% of this species breed in the Great Basin

- **LONG-BILLED CURLEW** (*Numenius americanus*)
  Approximately 20% of species breeds

**Other breeding shorebird species:**

- Black-necked Stilt (*Himantopus mexicanus*)
- Wilson’s Phalarope (*Phalaropus tricolor*)
- Spotted Sandpiper (*Actitis macularia*)
- Willet (*Catoptrophorus semipalmatus*)
- Killdeer (*Charadrius vociferus*)
- Wilson’s Snipe (*Gallinago delicata*)
Migratory Shorebirds of the Great Basin

24 shorebird species use the Great Basin during migration:

• **WILSON’S PHALAROPES**
  Uses alkali lakes during migration while completing a molt migration

• **AMERICAN AVOCET**
  Most of the world’s American Avocets use the region for an extended post-breeding period

• The Great Basin is also important to migrant:
  – Western and Least Sandpipers
  – Most of North America’s Long-billed Dowitchers and Red-necked Phalaropes
Space Use in the Great Basin

- Adults used only one freshwater site ($n = 106$)
- Adults used an average of 6 ha over 6-10 months
- 27% of birds moved more than 1km

- Breed near freshwater, foraged in saline wetlands (up to 13km)
- Used only one site ($n = 68$)
- Daily movement from upland nests to wetlands

- Bred near freshwater, foraged in saline wetlands
- Average adult detected at 2.1 sites ($n = 185$, range 0-6)
- 22% of 185 radio-tagged birds moved (north) more than 200 km

Plissner et al. 2000

Haig et al. 2002

Plissner et al. 2000
Salt Gland Development in Waterbirds

- Supraorbital gland where larger gland size is associated with saline habitats
- Salt excretion is an active transport process
- Hatchling shorebirds exposed to saltwater rearing regimes:
  - Failed to gain weight normally
  - Higher mortality in birds less than 3 days old
The Relationship of Water Quality and Water Volume

**Freshwater systems**
- High quality w/ high volume
- Changes may not be linear

**Saline systems**
- Habitat specialists
- Low quality w/ high volume

Nutrient load
Salinity
Dissolved oxygen
Temperature
pH
• Western U.S. has undergone increases in air temperature (0.5°C) and mean annual precipitation (+5-20%) during 20th century

• Altered seasonality of precipitation and more variability in extreme events

• These changes are altering the volume, depth, salinity, and relative permanence of water bodies
How will climate change affect shorebirds dependent on climate-sensitive wetlands in the Great Basin?

Climate change will alter Great Basin wetlands in number, distribution, timing, and quality (e.g., salinity). This will have a significant effect on the distribution, abundance, and success of shorebirds.
Study Objectives

1. Understand the relationship of historic climate and hydrological data

2. Determine the spatial extent of wetlands across the Great Basin

3. Measure system connectivity using DNA markers of key aquatic prey throughout the network

4. Estimate how shifting climate drivers will alter the extent, level of connectivity for Great Basin wetland populations and communities
An Integrative Approach

- DIGITAL WETLAND MODELS
  - Historic Climate Trends
  - Remote Sensing
  - Local-scale Weather
- Global and Regional Circulation Models
- Molecular Patterns of Connectivity
- GREAT BASIN CLIMATE IMPACTS
Historic Trend Analysis

- Monthly spatial climate data
  - 800m resolution
  - 1900 - 2008
  - Temperature (mean, min, max)
  - Total precipitation

- Diagnosing trends across Great Basin

- Building hydrological archives to investigate relationship and timing of recharge

Hydrologic Unit 8 watersheds
Building a Wetlands Model

Data loggers and weather stations are deployed in our main south-central Oregon wetland/lake sites:

Partners are collecting data at:

- Great Salt Lake
- Mono Lake
- Walker Lake
- Pyramid Lake
- Carson Lake
- Eagle Lake
Water Measurements

Establish 3-yrs of fine scale data from a mosaic of Oregon wetlands based on their relative salinity

**Weather stations**
- Temperature
- Relative humidity
- Barometric pressure
- Precipitation
- Wind speed/direction

**Daily water quality**
- Depth
- Conductivity
- Temperature
- pH

**Monthly water quality**
- Conductivity
- Temperature
- pH
- Dissolved oxygen
- Oxidation reduction potential
- Total dissolved solids
- Salinity
- Resistivity
Landscape Genetics of Shorebird Food

• Vagility of shorebirds prevents using molecular markers to track them directly

• Their prey will be used to track changes in wetlands across the Great Basin

• Using multiplexed massively parallel sequencing (MMPS), recently reviewed by Fleischer (Auk 2010)

• We are sampling nine focal prey species at study sites throughout the annual cycle
An Integrative Approach

DIGITAL WETLAND MODELS

Remote Sensing

Local-scale Weather

Historic Climate Trends

Global and Regional Circulation Models

Molecular Patterns of Connectivity

GREAT BASIN CLIMATE IMPACTS
Predicted Winter Changes: 1990s to 2050s

**Snow Cover Change**
Change in fraction of days with snow cover

**Temperature Change**
Change in winter temperature (degrees C)

Salathé et al. 2008
Summary

• We need to take a broader, more integrative approach to movement studies in the face of climate change.

• Climate change is altering an already dynamic system such that we need a better understanding of how population and landscape connectivity are changing.

• This study will allow us to predict how different avian life-histories will fare in the face of shifting natural resources.
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