Predicting Climate Change Impacts on Semi-arid Land Wetlands, Migratory Birds, and Their Prey

Susan Haig, John Matthews, Mark Miller, Dan Roby, Travis Schmidt, Collin Eagles-Smith, Thomas Mullins, Branden Johnson

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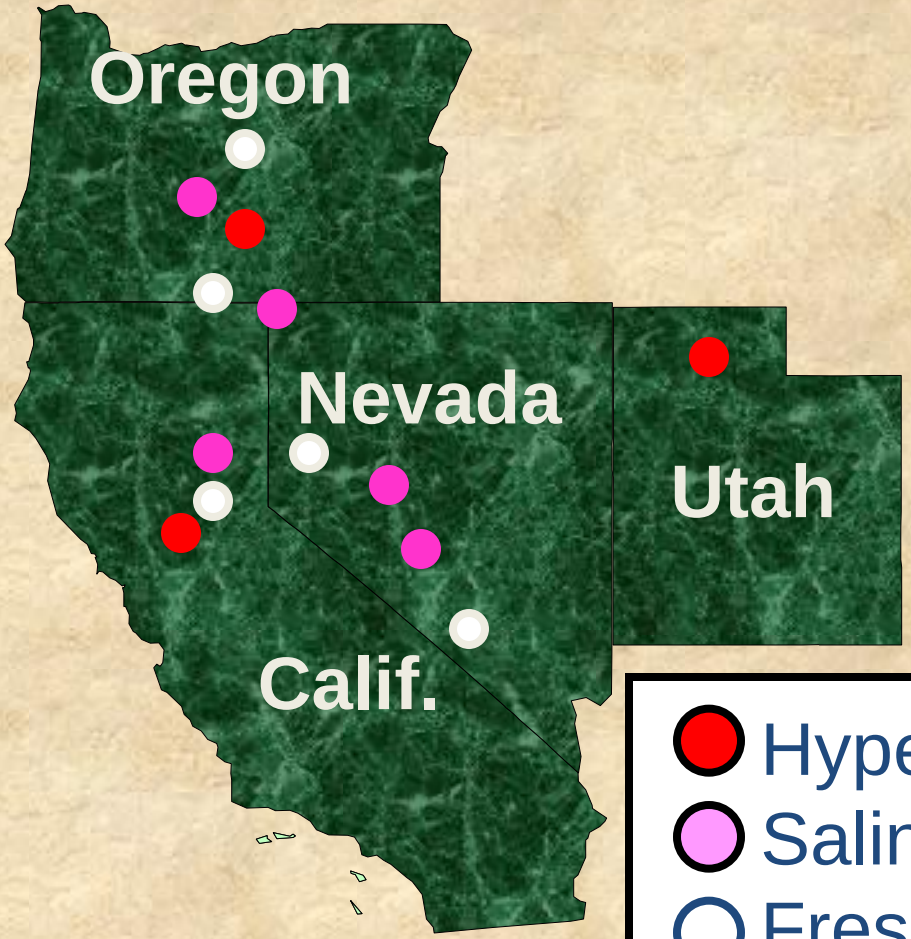
A Mosaic of Wetlands



- Hypersaline
- Saline
- Fresh

Great Basin Waterbirds

Great Salt Lake is the most important inland waterbird site in North America

Five sites in the Great Basin surpass WHSRN Hemispheric status (over 500,000 birds use each annually): Great Salt Lake UT, Lake Abert OR, Summer Lake OR, Mono Lake CA, and Lahontan Valley NV.

Great Basin is of critical importance to particular species:

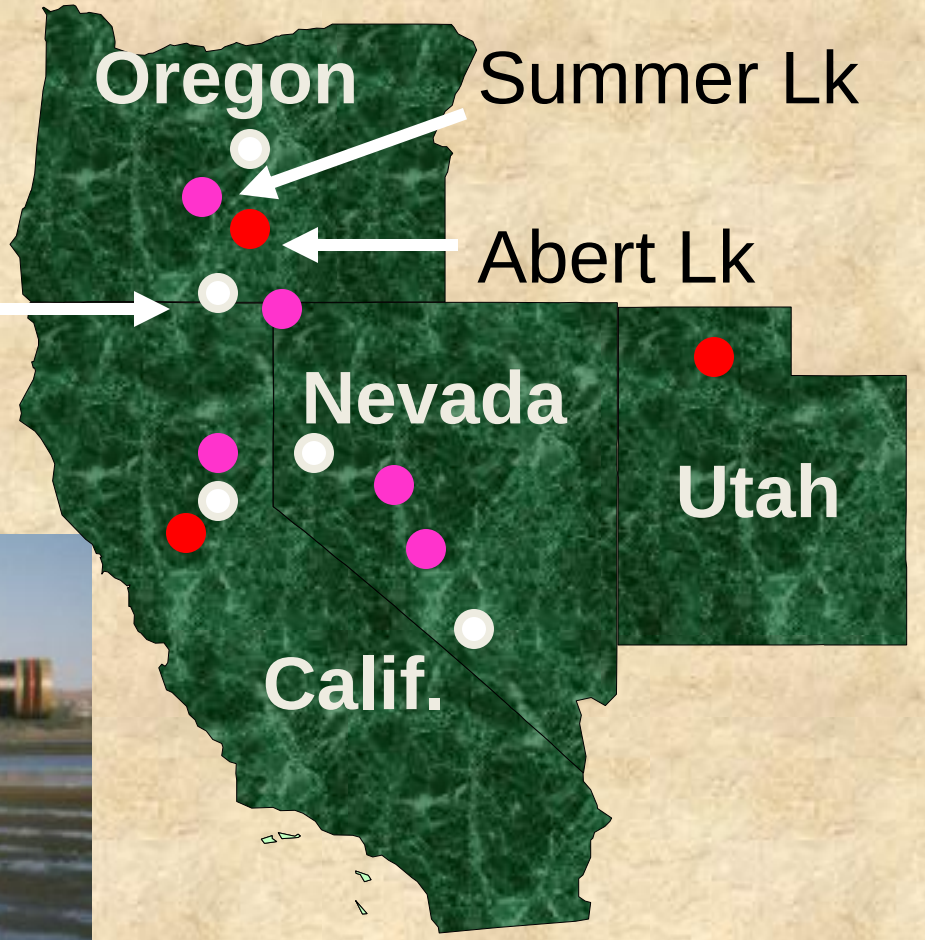
1) Most of North America's Snowy Plovers breed in the region.

2) Most of North America's Eared Grebes, Long-billed Dowitchers, and the all of the world's Wilson's Phalaropes use the region during migration.

3) Most of the world's American Avocets use the region for an extended post-breeding period; over 50% of the species breed in the Great Basin.

4) Most of the world's White-faced Ibis breed in the Great Basin.

Tracking Shorebirds



Breeding Space Use: Killdeer

- All adults (n = 106) were found only at 1 freshwater site.
- Only 27% of 106 birds moved more > 1km.

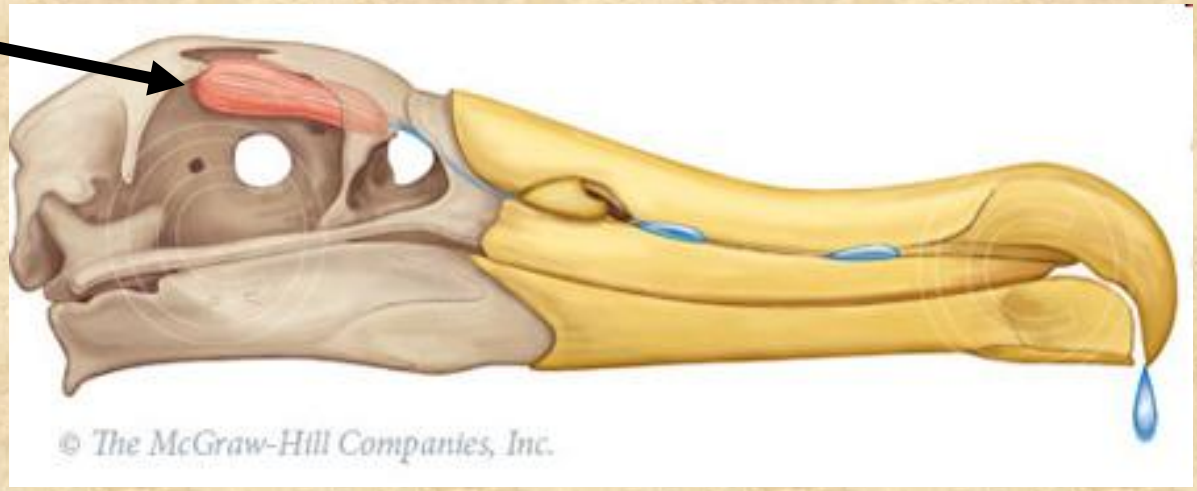
Breeding Space Use: Willets

- Adults bred near freshwater, foraged in saline wetlands.
- Willets were found at one site only.

Breeding Space Use: American Avocet

- Bred near freshwater, foraged in saline wetlands.
- Adult avocets were detected at up to 6 sites.
- 22% of 185 radioed birds moved (north) more than 200 km.

Salt Gland Development in Waterbirds



Birds possess a supraorbital gland where larger gland size is associated with saline habitats.

Avian osmoregulation in saline environments is metabolically expensive because salt excretion across salt gland membranes is an active transport process.

Studies of salt tolerance in hatchling birds have shown that ducklings and shorebird chicks exposed to saltwater rearing regimes failed to gain weight normally, and that mortality was high in birds less than 3 d old.

Climate Change and Great Basin Waterbirds

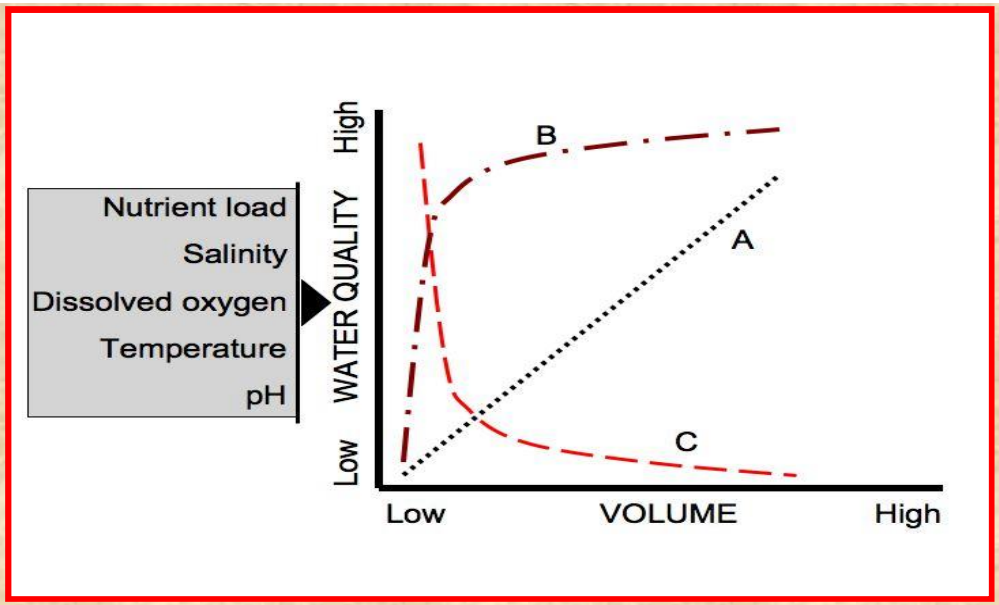
Climate Change in the Great Basin

The Great Basin has already undergone increases in air temperature and mean annual precipitation.

This has resulted in altered seasonality of precipitation, and more variability in extreme events such as droughts and floods.

These changes are altering the volume, depth, salinity, and relative permanence of water bodies.

Changes in Water Quality with Changes in Water Volume



- Most freshwater systems have high water quality with high water volume.
- However, changes in water quality with volume may not be linear.
- Saline systems often have habitat specialists that perceive high water volume as a decline in water quality.

Our Climate Change Predictions

How will Climate Change affect migratory bird species dependent on climate-sensitive wetlands in the Great Basin?

We predict Climate Change will alter Great Basin wetlands in number, distribution, and quality (e.g., salinity). This will have a significant effect on the distribution, abundance, and success of waterbirds.

Objectives

Determine the current spatial/temporal extent of the wetland network across the Great Basin.

Determine the climate drivers that may alter that extent.

Use DNA markers to measure the level of key aquatic prey population connectivity throughout the network.

Examine the level of contaminants and their predicted effect on migratory waterbirds across wetlands.

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

An Integration of Remote Sensing, Molecular Genetics, Hydrology, and Environmental Modeling

Regional Circulation Models

Molecular Patterns of Prey Connectivity

Digital Wetland Models

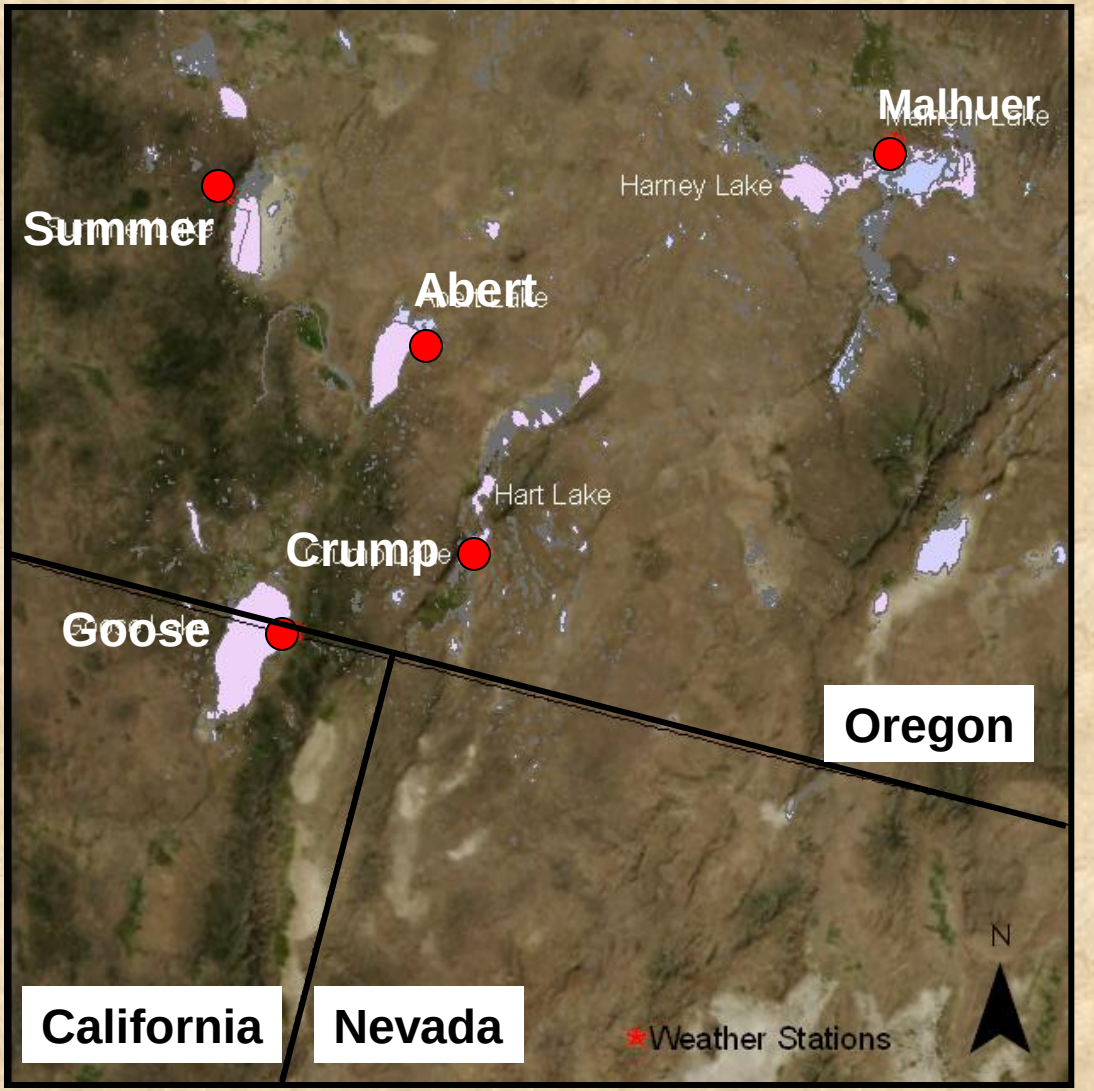
Contaminant Loads

Climate Impacts

Weather Stations

Weather stations will constantly record:

- temperature
- relative humidity
- barometric pressure
- precipitation
- wind speed/direction

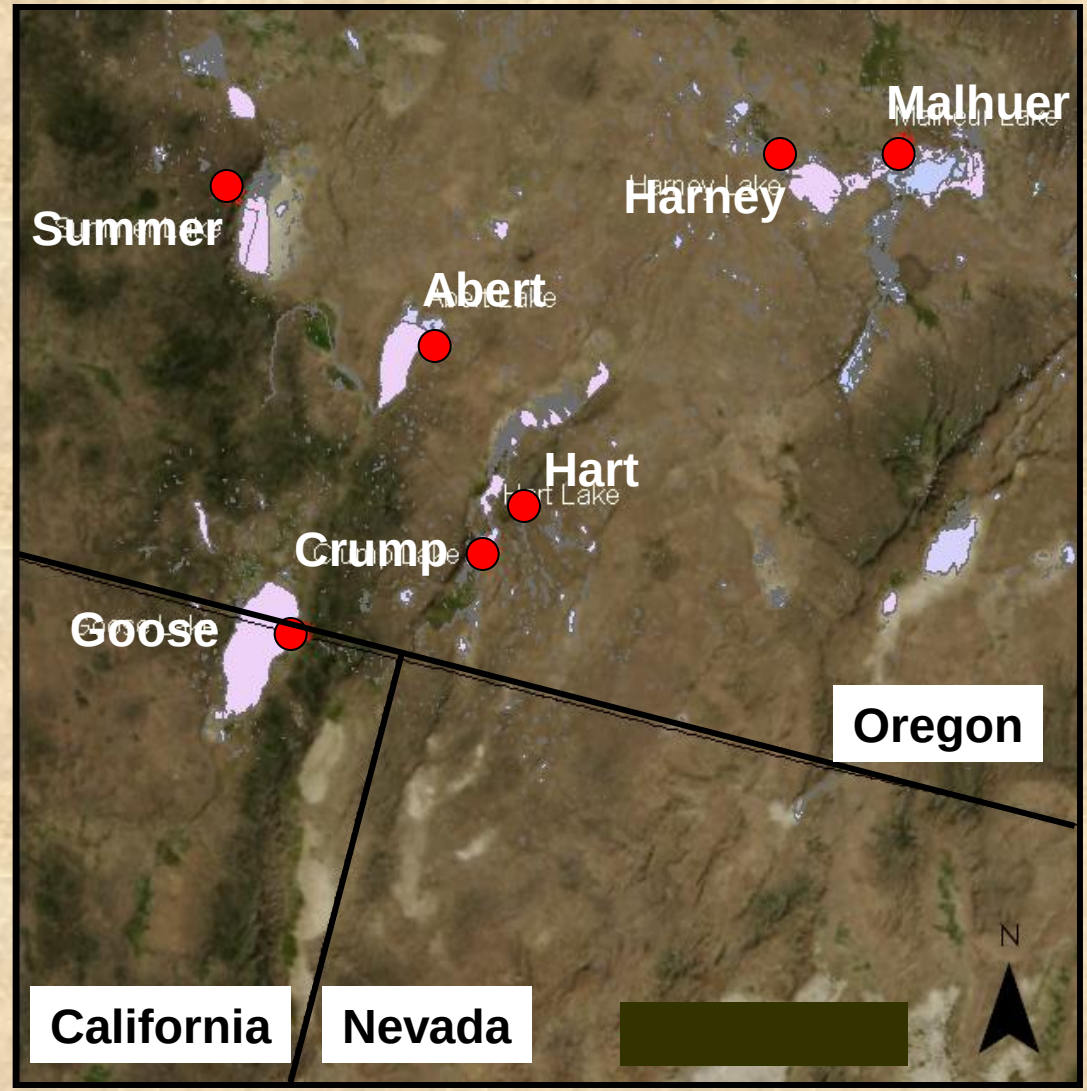


Water Measurements

Data loggers (20) will be deployed in our main southcentral Oregon lake sites and their source water:

Partners are collecting data at:

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



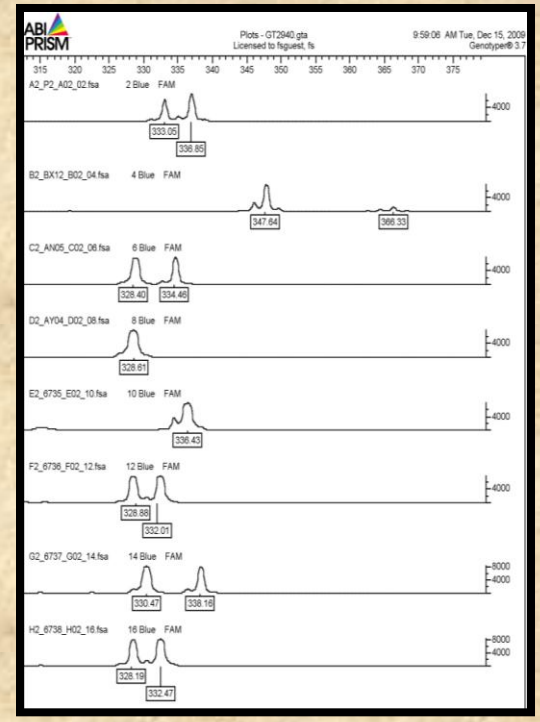
Landscape Genetics of Waterbird Food

Vagility of waterbirds prevents using molecular markers to track them directly.

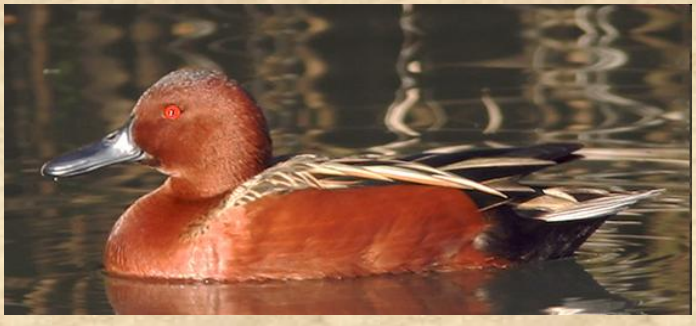
Lack of vagility among their prey makes them perfect focal species to track changes in water quality and quantity across the Great Basin. Ultimately, the birds will be where the food is.

We are using multiplexed massively parallel sequencing (MMPS), recently reviewed by Fleischer (Auk 2010), to create thousands of variable microsatellite loci for each species.

We are sampling 10 focal prey species at each study site throughout the annual cycle.



Contaminant Loads in Great Basin Waterbirds and Wetlands



Evidence of egg-shell thinning in LBCU lead us to begin an investigation into Contaminant loads in migratory birds across the Great Basin.

This summer we will continue our collection of waterbird eggs (1 per nest).

Please let us know if you come upon viable eggs!

Help for Managers

Within 1-2 years:

- Network of 20 digital weather stations and data loggers.
- Results of contaminant analyses for several waterbird species of concern.
- GIS analyses showing past changes in water quality and quantity in the Great Basin.

Within 3-6 years:

- A set of predictions about the future of abiotic aquatic resources in the Great Basin.
- A model flexible enough to tailor strategies to respond to a near-term drought at a local scale.
  →will my wetland dry up this year?
- A model to examine long-term challenges over the wetland network.
  →how will my wetlands respond to increased precipitation by 2020?
- User-friendly web-based management tool to help sort out these options.

Summary

- We need to take a broader, more integrative approach to understanding challenges faced by waterbirds in this age of Climate Change.

- Often we will not be able to use direct tracking methods to understand ecosystem level effects on movement.

- Climate change is altering an already dynamic system such that we need a better understanding of this in order to help managers make the best decisions for the resource.

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