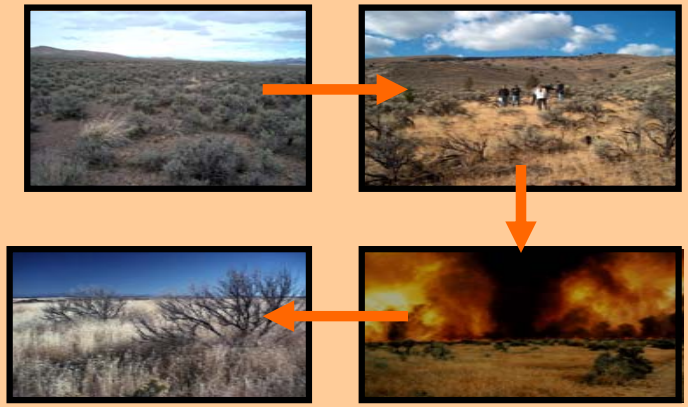
Our lab examines the ecology and control of weeds affecting productivity and ecosystem values of Great Basin rangelands.

Our expertise includes:

Plant community and ecosystem ecology
(Dr. Carla D'Antonio, Lab Coordinator)
Seedbed and range ecology (Dr. James Young)
Soil biogeochemistry (Dr. Bob Blank)
Vertebrate ecology (Dr. Bill Longland)

The Grass-Fire Cycle in the Great Basin



Cheatgrass (*Bromus tectorum*), an annual grass from Asia, has invaded western rangelands over the last century. By promoting fire, it has caused the loss of native species and opened the range to invasion by further damaging weeds. Currently its expansion downslope into salt desert habitat and upslope into mountain sagebrush, juniper habitat present new threats to Great Basin rangelands.

New projects initiated by Carla D'Antonio's lab:

I. Invasion of cheatgrass into salt desert habitat:

A. What is the role of local adaptation?

Hypothesis I: Outcrossing during wet years provides genetic variation that has contributed to invasion into salt desert (Longland & Ashley, in progress since 2000)

Hypothesis II: Morphological, physiological and life history changes contribute to success in salt desert (Haubensak, D'Antonio, & Embry)

In order to test Hypothesis II, we implemented a greenhouse study where we grew cheatgrass from seed collected in both upland (sagebrush) and adjacent lowland (salt desert) habitats from three regions of central Nevada. Seeds were grown in both their native soil and soil collected from the adjacent habitat:

Seed source x soil source

Salt desert → Salt desert
Sagebrush → Sagebrush

We are measuring the following parameters:

- Root elongation (3,7, & 14 days after germination)
- PS at peak physiology
- Root:shoot ratios
- Total above/below biomass
- #, wt flowering shoots
- Mycorrhizal colonization
- Soil chemistry (nutrient cations, available nitrogen & phosphorus, and exchangable sodium)

Overview of one of the three sites near Lovelock, NV where we are conducting an experiment to test the roles of biotic crusts and native shrubs in promoting community resistance to cheatgrass invasion.

B. What are the roles of biotic crusts & native shrubs in promoting resistance to invasion in salt desert?

Biotic crusts:

These crusts include lichens, mosses and cyanobacteria. When intact, crusts have been shown to inhibit germination of some species by decreasing seed retention and preventing emerging roots from penetrating into the soil.

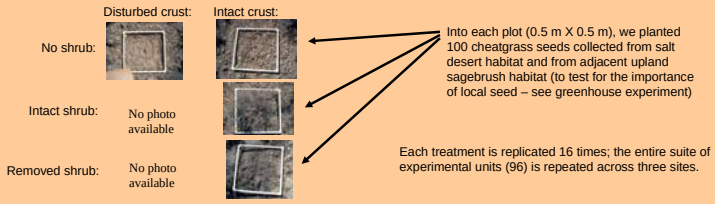
Shadscale (*Atriplex confertifolia*)

Native shrubs:

Salt desert communities are dominated by shadscale (*Atriplex confertifolia*), four-wing saltbush (*Atriplex canescens*), winterfat (*Krascheninnikovia lanata*) and budsage (*Artemesia spinescens*). These shrubs may represent islands of fertility and increased water availability in salt desert habitat and they provide winter forage for livestock.

We hypothesized that crusts and shrubs may play opposing roles in cheatgrass invasion: intact crusts may contribute to invasion resistance, while shrubs may actually facilitate invasion by providing pockets of increased soil fertility and water availability. We implemented an experiment in summer 2003 to investigate the relative importance of these two factors in determining cheatgrass germination and growth in salt desert.

This experiment includes the following treatments (all possible combinations):



Into each plot (0.5 m X 0.5 m), we planted 100 cheatgrass seeds collected from salt desert habitat and from adjacent upland sagebrush habitat (to test for the importance of local seed – see greenhouse experiment)

Each treatment is replicated 16 times; the entire suite of experimental units (96) is repeated across three sites.

C. Prospects for recovery after cheatgrass invasion and fire:

We are currently conducting a 3-year survey of salt desert rangeland sites that burned in the 1998 fires plus adjacent sites that did not burn. In this survey we are asking: **What native species perform well in the post-fire environment and what factors correlate with better or worse post-fire recovery?**

Unburned salt desert

Burned salt desert – five years after fire

In this post-fire environment, exotic species such as cheatgrass, Russian thistle (*Salsola paulsenii*) and halogeten (*Halogeten glomeratus*) appear to dominate most of the landscape. Halogeton is toxic to livestock.

Russian thistle and cheatgrass

Halogeten

However, we have found a few native species that show potential for recovery and may be candidates for post-fire seeding. These include grasses such as squirreltail (*Elymus elimoides*) and Indian ricegrass (*Acnatherum hymenoides*). We are also observing recruitment of one native shrub from seed [shadscale (*Atriplex confertifolia*)].

Squirreltail bunches interpersed among cheatgrass in burned salt desert habitat.

We are measuring community composition and soil chemistry, plus other site factors including slope, aspect, and elevation, in order to develop a predictive framework for salt desert community recovery following fire.

II. Management strategies for pinyon-juniper invaded sagebrush-steppe habitat:

Profound changes in fire regime and vegetation communities have occurred in the Great Basin since European settlement of the region. Despite ongoing control efforts, pinyon and juniper expansion, and cheatgrass expansion pose significant threats to mountain sagebrush ecosystems and the wildlife and livestock they support. Large-scale collaborative efforts will be needed to reduce fire risk, reduce the likelihood of cheatgrass conversion with fire and to restore more desirable plant communities and fire regimes.

Toward that end, we are developing a multi-agency (ARS, BLM, FS, University) and interdisciplinary control/restoration project that would be supported by the Joint Fire Sciences Program and participating agencies.

The project goal is to develop a regional experiment that will evaluate the effects of fire, fire surrogate, and seeding treatments on the recovery potential and ecological condition of sagebrush communities of the Great Basin at risk of cheatgrass invasion/conversion and pinyon-juniper expansion.

Little understory vegetation exists where pinyon pine or western juniper has invaded, decreasing forage potential, increasing soil erosion and range value.

III. How do biocontrol agents affect *Tamarix* water use?

Water is a profoundly limited resource in the arid and semi-arid western U.S.A. One potentially important loss pathway is the diversion of groundwater to invasive, non-native plants that provide little habitat to wildlife but are possibly profligate water users.

Currently, the most important weed in this regard is saltcedar (tamarisk; *Tamarix* spp.). This Eurasian tree/shrub infests an estimated 1 to 1.6 million acres of floodplain ecosystems and reservoir margins across the west

Chemical and manual control are often used against saltcedar
But these methods are expensive and do not provide long term control.
As a result, USDA-ARS has been developing biological conrol agents for use against saltcedar.

Diorhabda elongata feeding on branch of *T. ramosissima*.

With the recent introduction of a natural enemy of *Tamarix* from Eurasia, the saltcedar leaf beetle (*Diorhabda elongata*) insect herbivory can now reduce leaf area in a system where herbivores were previously absent resulting in altered physiological and biomass allocation traits of *Tamarix*

Aerial view of portion of Lovelock site taken in October 2002 showing *Tamarix* stand where brown area indicates an area approx. 100 m across defoliated in 2002.

The long-term goal of the research is to contribute to our understanding of how biological control agents influence water salvage from *Tamarix* stands. The proposed research will provide the first quantitative information on the impacts of biocontrol agents on water transpiration by *Tamarix* plants.

We are interested in your feedback. Please e-mail Carla D'Antonio at dantonio@socrates.berkeley.edu