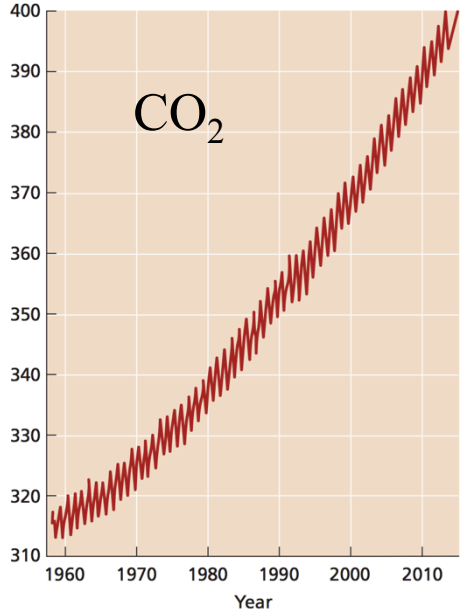

Restoration ecology:
putting the system
back together again

Plant Ecology in a Changing World

Jim Ehleringer, University of Utah
http://plantecology.net

What drives the need for restoration and what landscapes need restoring?

Restoration ecology is a relatively young field, built on our understanding of ecological principles, of adaptation limits of organisms, of the multiple biotic interactions (plant-plant, plant-animal, plant-microbe) in an ecosystem, and of the micro-environmental requirements of plants.

An implicit assumption in restoration ecology is the environmental degradation has occurred and that this situation is reversible (or partly reversible). Restoring ecological cycles is often the primary objective.

Tree planting on deforested landscapes to create the riparian buffers so that soil erosion into the streams does not occur.

http://www.greenvalleys.org/wp-content/uploads/2013/01/DSCF3904_web.jpg

Restoration requires an understanding of biotic interactions and stress responses

ecophysiology and stress tolerances
e.g., water stress, light stress, and microclimates

ecotypic variation and adaptation

plant – microbe relationships
e.g., mycororrhizal innoculations

water availability in the soil and a plant's capacity to reach that moistures

nutrient availability relationships
e.g., macro- and micro-nutrients

processes limiting establishment
e.g., nurse plants, plant succession

toxic nutrients distribution in soils
e.g., aluminum toxicity, salinity

Why restore landscapes?

- Restoration as compensation for habitat loss
- Restoration to deliver ecosystem services
- Restoration to ensure resilience
- Restoration as a legal requirement following surface disturbance

Al four concepts have merit, but are difficult to assign quantitative metrics to.

The quantitative merits of restoration are critical because often
- there is a legal requirement to restore the landscape
- there is a legal description of restoration based on law and not science
- often there is a lack of data for complex metrics (e.g., nutrient cycles)
- the time to achieve recovery is far longer than the business cycle

Toward an Era of Restoration in Ecology: Successes, Failures and Opportunities Ahead

Annu. Rev. Ecol. Evol. Syst. 2011. 42:465–87

Katharine N. Suding

What are some of the ecological landscapes that need restoring?

- Landscapes where the surface vegetation has been removed by man (e.g., clear-cut forest harvesting)
- Landscapes where the surface vegetation and soil structure have been modified by human activities (e.g., strip mining; topsoil saved yes/no)
- Landscapes where human activities have altered natural fire cycles (e.g., historical fire suppression in California's sequoia forests)
- Landscapes where invasive species have invaded and altered ecological processes in an undesirable manner
- Terrestrial landscapes where surface and subsurface runoff activities negatively impact aquatic nutrient quality and nutrient abundances

A goal of restoration ecology is a functioning ecosystem in terms of ecological cycles (not necessarily the original plant species). In this way, restoration ecology is different from conservation ecology, with its focus of preserving species or preserving biodiversity at a location.


http://blogs.agu.org/martianchronicles/files/2011/07/IMG_5482-IMG_5487.jpg


http://images.fineartamerica.com/images-medium-large/virginia-city-
mine-tailings-linda-phelps.jpg


http://landrehab.org/userfiles/images/cunningham12sm.jpg
EXIT
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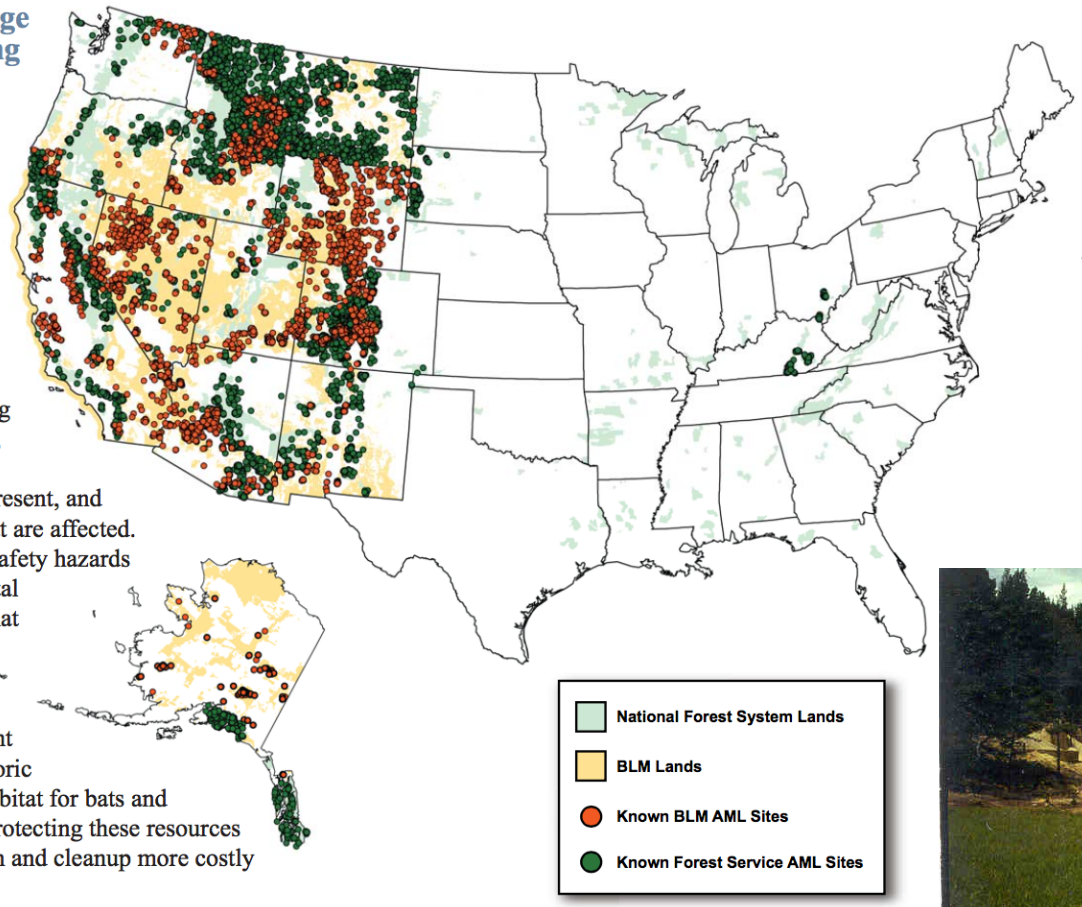
35

The challenges of mining reclamation in the West cannot be underestimated

The Challenge of Reclaiming AMLs

The cost of reclaiming a single abandoned mine may range from tens of thousands of dollars to tens of millions of dollars depending on size, location, the nature of contamination present, and the resources that are affected. Aside from the safety hazards and environmental contamination that may exist, abandoned mines can also be signi cant cultural and historic resources and habitat for bats and other wildlife. Protecting these resources makes mitigation and cleanup more costly at these sites.



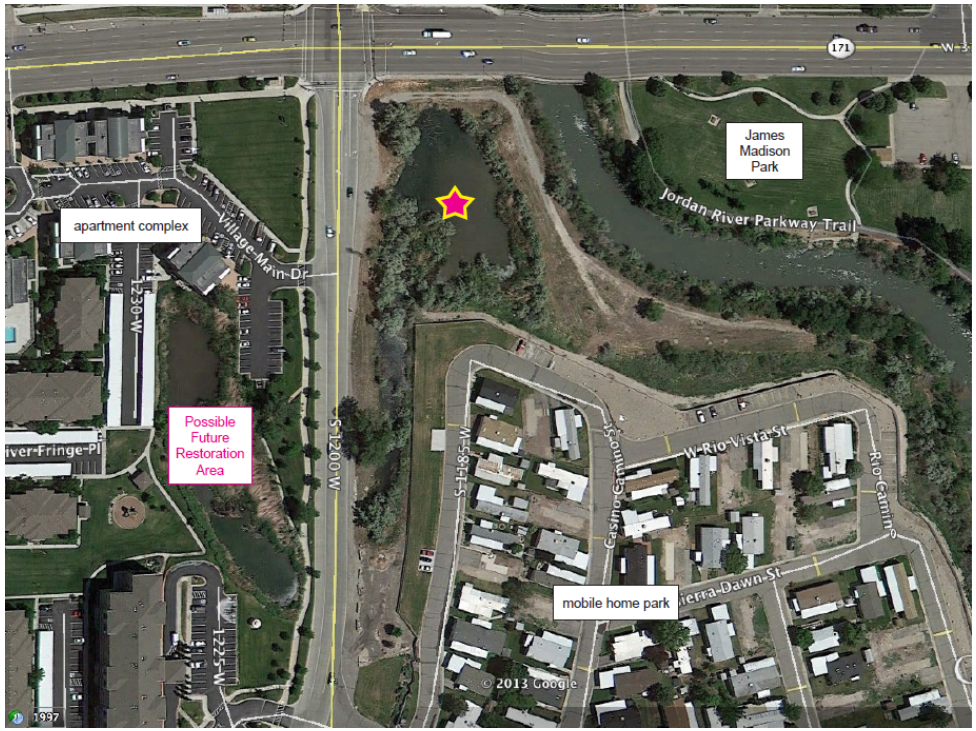
Toxic heavy metals and low pH are among the common soil features that prevent or reduce establishment of plants on mine spoil sites.

http://w3.cenn.org/CENN_Projects/BfW_mining/Training/Managing%20Effects%20of%20Major%20Mines/Reference%20Materials/Reclamation%20and%20Closure/AML%20report%20final_10_year.pdf
http://rydberg.biology.colostate.edu/phytoremediation/2008%20websites/Natasha%20website/mine_dump_lg.jpg

Restoring native trees in Hawaii

http://hawp.org/auwahi-volunteer-trip-07-19-2014/

Restoring riparian ecosystems along the Jordan River in Utah

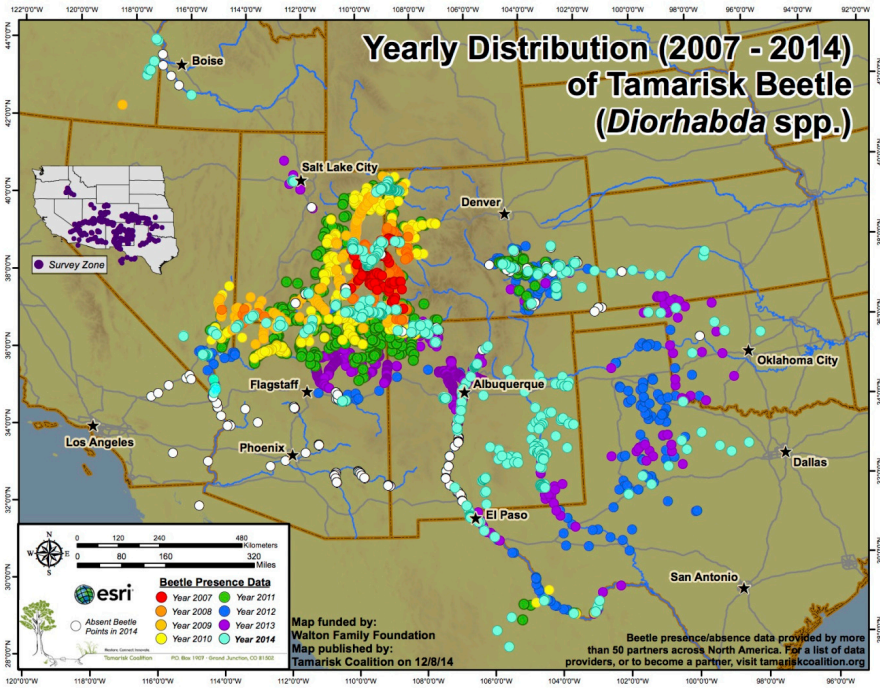


http://jordanrivercommission.com/event/west-valley-city-stormwater-pond-restoration-5/

Each restoration can have its own sets of requirements and challenges. Sometimes restoration is required by law as part of a surface disturbance project. At other times, the restoration is a community-focused project to restore ecological functioning, to improve the quality of life, and to enhance the vibrance of an area.

Bio-controls are generally not effective in restoring ecological landscapes.
Consider tamarisk and the salt cedar beetle introduced to eradicate tamarisk.

While such practices might eradicate a species, it is only the first step in a long restoration process.
Restoration objectives and metrics should be defined before a project is undertaken.
The challenges are establishment of 'restored communities' and the financial costs on grand scales.



https://coyotegulch.wordpress.com/category/colorado-water/tamarisk-control/#jp-carousel-59845
http://www.desertmuseum.org/programs/images/Tamchi1624020.jpg

Fire as a tool in restoration ecology

Winford et al. (2015)

These 2011 photographs illustrate the effect of a fuels treatment implemented prior to the 2008 American River Complex fire in Placer County. Nearly all the trees in the treated stand, bottom, survived the fire, while many trees in the denser, untreated stand, top, did not.

Restoration Ecology
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RESEARCH ARTICLE

Seedling Ecology and Restoration of Blackbrush (*Coleogyne ramosissima*) in the Mojave Desert, United States

Lisa C. Jones,[1,2] Susanne Schwinning,[1] and Todd C. Esque[3]

Nurse plants help but also attract predators

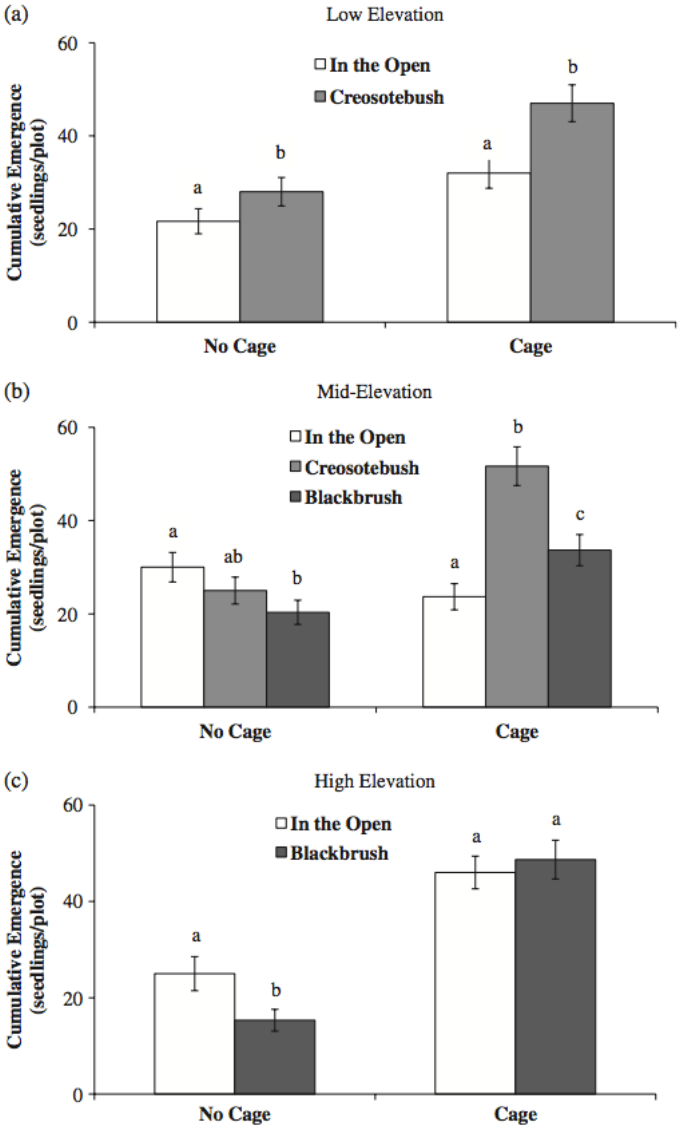

Figure 2. Cage*nurse plant interactions at Low (a), Mid- (b), and High Elevation (c). Mean number of seedlings per plot with standard error bars of the mean are shown. Lowercase letters indicate a significant effect of nurse plant on seedling emergence within the cage treatment.

Plant Community Recovery Following Restoration in Semiarid Grasslands

Seth M. Munson[1,2,3,4] and William K. Lauenroth[5]

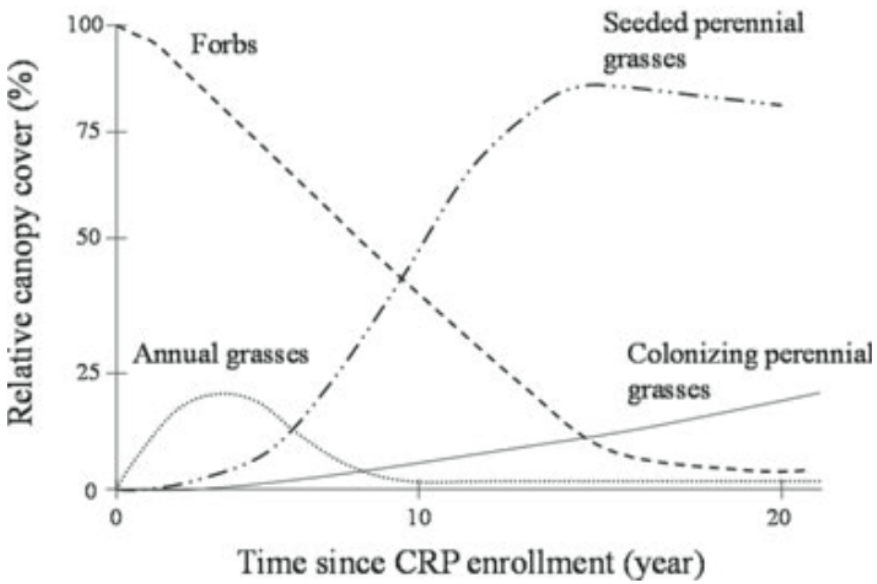

Figure 1. Conceptual model of plant community dynamics on CRP fields (modified from Coffin et al. 1996), which shows the trajectory of plant functional types (forbs, annual grasses, seeded perennial grasses, and colonizing perennial grasses) through time since CRP enrollment.

The Conservation Range Program (CRP) is a voluntary program for farmers. Through CRP a farmer receive annual payments to establish a restored long-term conservation land cover.

Implications for Practice

- Seeding with a native perennial grass mix in formerly cropped CRP fields of eastern Colorado promotes the recovery of perennial vegetation cover and composition to resemble undisturbed SGS.
- Seeding with introduced perennial grass mixes has the potential to restore perennial vegetation cover over the short-term, but slows the recovery of native species richness.
- Restoration practices in semiarid regions should account for low and variable water availability, which can limit potential cover of seeded perennial species and cause rapid shifts in plant community composition.
- Introduced annual species, such as *Bromus tectorum*, can be persistent and prolong perennial grass establishment. Restoration practices, such as the use of cover crops and seeding perennial grasses to the proper depth and spacing can minimize the spread of introduced annuals.
- Although forb species compose most species richness in restored fields, they can decline with increased dominance of perennial grasses. Restoration practices could enhance species richness by using more forb species, a greater number of forb seeds, or seeding portions of the field with a high forb:grass seed ratio.

Restoration Ecology
THE JOURNAL OF THE SOCIETY FOR ECOLOGICAL RESTORATION INTERNATIONAL
2012, 20:656-663

http://www.ser2011.org/index_r1_c1.jpg

Ecological restoration is an essential step towards ecological sustainability.

Restoration ecology requires

- a fundamental understanding of aboveground and belowground ecophysiological processes
- a fundamental understanding of community ecology and ecosystem processes
- a clear statement of restoration objectives and metrics
- likely a long-term commitment, recognizing that the time between plant germination and multi-species establishment should be measured in years and not days

This course provides an appreciation and understanding of the first two criteria; a multidisciplinary team approach is required to address the last two criteria.