The University of California Cooperative Extension and UCR's Center for Conservation Biology present:

ADVANCES IN DESERT WEEDS

Desert Weed Management Symposium

July 16, 2011- 9am to 3:30pm

University of California, Riverside, Palm Desert Graduate Center in Palm Desert, California

Red Brome encroaching on Anza-Borrego State Park

Phacelia flowers

Sahara Mustard

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http://saharamustard.ucanr.org/Advances_in_desert_weeds/ADW.html

THE THEME OF THIS YEAR'S SYMPOSIUM:

We will be going to weed school and earning our management "degree."

The symposium will cover weeds that are encroaching the desert region of Southern California, Arizona and Southern Nevada. This conference will provide information for land managers, biologists and the public to improve their management skills and knowledge.

Program

	Title	Time
Registration (Continental breakfast)		8:30
Carl Bell UCCE San Diego	Introduction	9:00-9:15
Jodie Holt UC Riverside	Weed Ecology and Biology	9:15-10:15
Chris McDonald UCCE San Bernardino	Ecology of Seed Banks	10:15-10:45
Break		10:45-11:00
Cheryl Wilen UCCE South Coast & UC IPM	Integrated Pest Management	11:00-11:30
Milt McGiffen UCCE Riverside	Chemical Weed Management	11:30-12:00
Lunch		12:00-1:00
Carl Bell UCCE San Diego	Pesticide Equipment and Calibration	1:00-1:30
Cameron Barrows UC Riverside	Sahara Mustard Management	1:30-2:00
Bill Neill Riparian Repairs	Four Decades of Controlling Tamarisk In Desert Riparian Areas	2:00-2:30
Annie Kearns Mojave National Preserve	Weed control without a budget!	2:30-3:00
Chris McDonald UCCE San Bernardino	Wrap-up and Questions Eat some cookies on the way out!	3:00-3:15

To receive 5 hours of California DPR CE credits please enter the following on your scantron:

Meeting Code: M-0712-11 Date: 6/16/11

Meeting Name: Advances in Desert Weeds Location: Palm Desert, CA

Welcome to Weed School!

Several non-native exotic weeds have established in the southwestern deserts to the detriment of native plants and animals, and can cause economic harm. Our theme for the Advances in Desert Weeds Symposium is to go back to school, weed school. Our goal for today is to give you the information you need to improve management of weeds in desert ecosystems and earn a management "degree." The program and individual talks are designed to give you a review of and current information regarding invasive plant management. We begin with a review of plant biology and plant ecology. Building upon this information is a review of management tactics and equipment. We continue with examples of managing different invasive plants. Last but not least, we finish with some ideas about managing weeds given current budget constraints.

After listening to today's talks you should be able to answer the following questions:

- What makes a plant invasive?
- Why are invasive weeds spreading?
- How can I better manage invasive plant populations in a cost-effective manner?
- For how many years will I need to manage an invasive plant?
- What are the effects of invasive plants on desert ecosystems?
- What variety of techniques can I use to control invasive plants?

We thank you for taking the time out of your busy schedule to attend this symposium and hope you can use this information to improve your management skills and knowledge.

Do not hesitate to contact us if you have any additional questions or management needs that were not addressed today.

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Weed Biology and Ecology

Jodie S. Holt--Botany and Plant Sciences, UC Riverside, jodie.holt@ucr.edu

Botany or plant biology is the study of organisms in the plant kingdom. Botany includes the disciplines of taxonomy (classification), anatomy (plant structure), morphology (plant form), biochemistry (cellular function), and physiology (functioning of the organism). At the structural level, plants consist of cells, which are grouped into tissues, which are grouped into organs, which together make up the plant body. Plant tissues that are particularly important targets for weed control are meristems (zones of cell division), epidermis (with the waxy cuticle), and vascular tissues (transport tissues of xylem and phloem). Plants can be annual, living less than one year, biennial, living up to two years, or perennial, living more than two years. While annual and biennial plants are herbaceous, perennial plants can be herbaceous or woody. An important distinction among flowering plants is whether they are dicots or monocots, since these two classes of plants differ at the cellular, tissue, and organ level and thus respond differently to weed control.

Plant ecology is the study of organisms in relation to their environment, and encompasses many sub-disciplines including physiological, population, and community ecology. Physiological ecologists study the macro- (large-scale) and micro- (small scale) environments of plants. The environment includes abiotic (physical and chemical) and biotic (living) factors, all of which affect plant growth, abundance, and distribution. A population is a group of individuals of one species, which can differ from other populations of the same species depending on the environments in which they live. Population ecologists study demography, or changes in population size and structure with time. Plant demography is complicated because of the unique characteristics of organisms that are rooted to the ground, including modular and indeterminate growth, vegetative (asexual) forms of reproduction, and effects of competition. Plant communities, or assemblages of plants of many species, have unique properties including composition, physiognomy, habitat, functional groups, keystone species, and assembly rules.

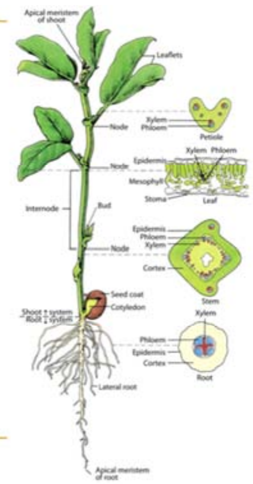
Invasion biology is the study of the introduction, life history, characteristics, and ecological impacts of organisms that occur and spread outside their native range. Invasive plants are a subset of weeds, or plants out of place that interfere with human activities. Weeds and invasive plants interfere with both managed lands (agricultural) and wild lands. The invasion process begins with introduction of a (usually exotic) species, establishment, naturalization, and spread. Plant introductions can be deliberate or accidental; in fact many invasive species were deliberately introduced but subsequently escaped and spread beyond their intended range. A lag period of time typically follows the introduction of an exotic species before it spreads from its point of introduction; this provides an opportunity for early detection and rapid response measures to be initiated. The invasibility of plant communities depends on invader and community properties, and these also offer opportunities for weed prevention and control.

Plant Anatomy—Tissues

- Groups of cells with common origin that perform a particular collective function
  - Meristems—zones of cell division
    - Unique to plants
  - Epidermis—outer layer, shoot has a cuticle
  - Vascular tissue—conduction
  - Ground tissue—various inner tissues
- Some tissues are herbicide targets

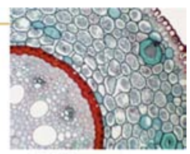
Plant Anatomy—Vascular Tissue

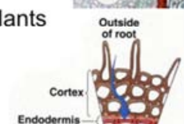
- Xylem
  - Conducts water and minerals
  - Roots upward to shoots
- Phloem
  - Conducts sugars = carbohydrates = photosynthates
  - Source to sink
  - Source = site of production or storage
  - Sink = site of use
- Vascular bundles

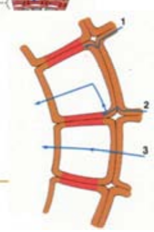


Plant Anatomy and Weed Control

- Apoplast = All nonliving parts of plants
  - Cell walls
  - Intercellular spaces
  - Nonliving cells (xylem)
- Water flows freely through apoplast
- Symplast = all living parts of plants
  - Cytoplasm of living cells
- Casparian strip in root endodermis forces water through symplast

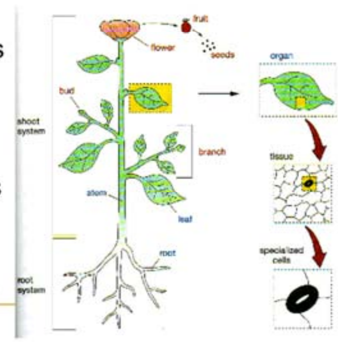






Morphology—Plant Organs

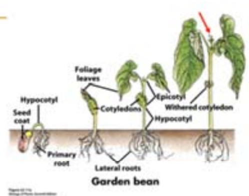
- Groups of tissues that perform a specific function
- Aboveground organs
  - Stems
  - Leaves
  - Buds and flowers
- Belowground organs
  - Roots
  - Storage organs
  - Reproductive organs



Plant Organs

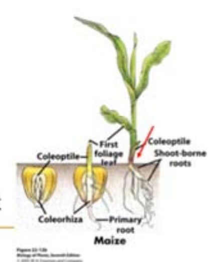
- Dicots
  - Broad leaves
  - 2 cotyledons
  - Veins radiate
  - Tap root
  - Flowers in 4's or 5's
- Monocots
  - Narrow leaves
  - 1 cotyledon
  - Veins parallel
  - Fibrous roots
  - Flowers in 3's

Dicot



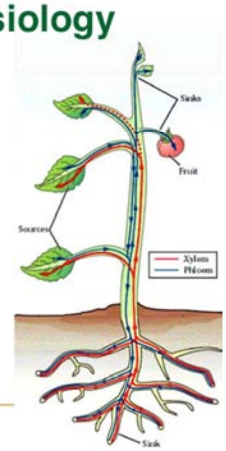
Apical meristems

Monocot



Plant Function—Physiology

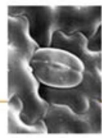
- Translocation = transport of carbohydrates
  - Occurs in phloem (symplast)
  - Mechanism = source to sink flow
  - Storage organs may be sources or sinks
  - Systemic, foliage applied herbicides move this way

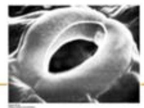


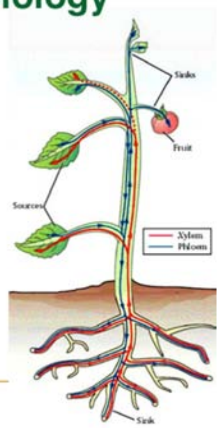
Plant Function—Physiology

- Transpiration = evaporation of water through leaves
  - Occurs in xylem (apoplast)
  - Driving force for uptake and transport of water and minerals from soil
  - Regulated in leaves by stomata
  - Uptake regulated in roots by endodermis (Casparian strip)
  - Systemic, soil-applied herbicides move this way

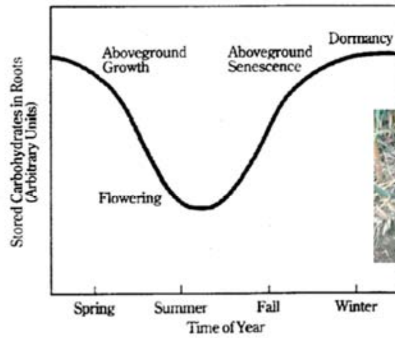
Stomata on leaf surface





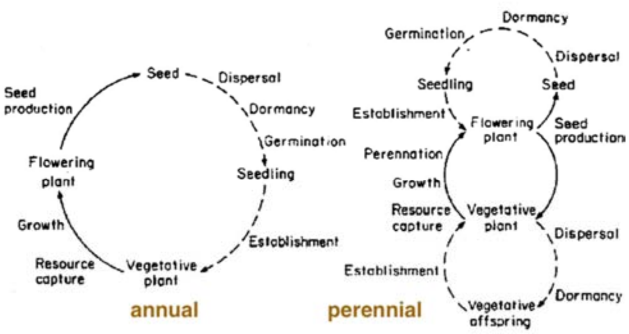


Seasonal Progression of Stored Carbohydrates in Roots of Perennial Plants

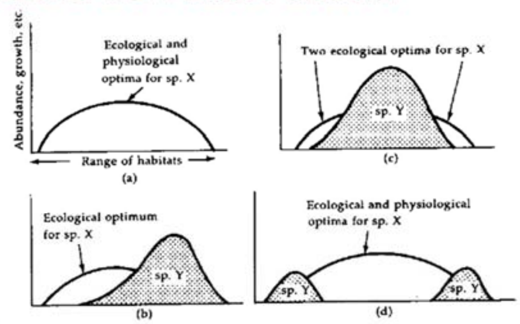


Plant Growth and Development

- Phenology = seasonality of life cycle events

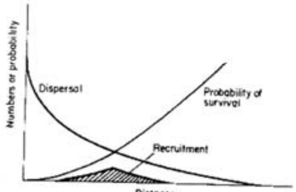


Physiological Ecology—Where Do Plants Grow?



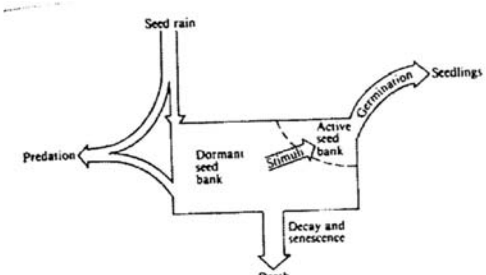
Plant Distribution

- Density = number per unit area
- Distributions are regular, random, or clumped
  - Most plants are clumped
  - Reasons—environmental heterogeneity, dispersal near parents



Seed Ecology

Seedbank model showing deposits and withdrawals:



Notes:

The Ecology of Seed Banks

Chris McDonald—UCCE San Bernardino, Riverside and Imperial Counties, cjmcdonald@ucdavis.edu

The seed bank is the ungerminated seed that has the potential to replace adult plants. The ability of a plant to from a seed bank has been observed for thousands of years, with ancient farmers observing seeds germinating years after plants were removed. A plant is taking a risk during the seedling phase of its life cycle by requiring favorable conditions throughout its growth cycle. To buffer against this risk plant species use seed banks and do so in different ways. On one extreme plants do not use a seed bank, their seeds lack dormancy. This ensures nearly all seeds germinate as soon as conditions are favorable and is akin to the "all in" strategy in poker and other games. On the other end of the gradient plants can have extreme dormancy requirements where seeds only germinate after a severe event, such as fire, flooding, or digestion, breaks dormancy and seeds will then germinate when conditions become favorable after the disturbance. Between these two extremes most plants fall into a bet-hedging strategy where some seeds in the population are viable and others are dormant. This is similar to the adage "don't put all your eggs in one basket." The main advantage to bet-hedging is a plant can germinate a fraction of its seed every year while another fraction of seeds will be safe from unexpected drought or will be ready to germinate in a post-disturbance environment.

Annual plants require some form of seed bank to survive each year while perennial species do not require a seed bank. However, some perennial species still form seed banks. Many invasive plants in the desert favor the "all in" strategy including: red brome, cheatgrass, filaree and possibly Sahara mustard. A common weed species that favors bet-hedging is fountaingrass.

One of the best ways to improve management effectiveness, and reduce headaches, is through an understanding of seed bank longevity. For example, once tamarisk is killed, and all resprouts are dead, there is little need to continually monitor the treated area, because the seed bank of tamarisk only lasts several months. The seed bank of red brome is only viable for 1 year, thus one successful year of management could eradicate this weed. In contrast, cheat grass seeds remain viable for 2-3 years in field conditions, requiring at last 3 years of treatments to eradicate this species. Tumbleweed seeds are believed to be short-lived from 1 to possibly 3 years. Observations of Sahara mustard suggest its seed bank lasts only 3 years. However, data on the seed bank dynamics and longevity of Sahara mustard are lacking.

Notes:

Integrated Pest Management

Cheryl Wilen--Area IPM Advisor, UCCE and UC Statewide IPM Program, cawilen@ucdavis.edu

Integrated Pest Management (IPM) is the basis of all pest management programs. IPM includes the use of a suite of methods to suppress pests based on pest biology and pressure. Methods fall into 5 categories:

Mechanical Physical Cultural Biological Chemical

Chemical control is not the first tool that is considered but may be part of the overall pest management program and is covered by other speakers at this meeting.

Mechanical methods involve the use of tools or machines to manage pests. For weeds in natural areas, this would include mowing, disking, hoeing, tree removers and other equipment. It also includes chain saws and loppers that may be used to remove seed heads.

Physical methods are those that physically manage weeds. The options here include solarization and mulching. Solarization is generally effective for reducing the weed seed bank and also to treat piles of weeds that have been removed so that seeds and vegetative propagules are neutralized. Burning or flaming also fall into this category but I rarely recommend it for southern California due to chance of starting a wildfire.

For weed management in natural areas, cultural methods are a bit harder to incorporate into a weed management program as a method to initially control invasive plants. However, it is very effective to help suppress weeds after most have been removed. Cultural methods include revegetation with desirable species to effectively compete with the invasive plants.

Finally, biological control is effective in a limited number of species. Biocontrol is the use of one living organism to control another. While most examples of the method of pest control are for insect management, there are a few insects that can suppress weeds, generally by killing the seed or bore into stem while still on the plant. Goats and sheep can also be considered as biocontrol agents if the definition is considered in the broadest sense. Animals can be an effective tool for weed management but must be cared for and moved periodically. Seed dispersal and consumption of toxic plants may also become issues. If goats or sheep are to be used, it is best to contract with a company that manages the animals for that purpose.

In order to implement a true IPM program, one needs to become very familiar with the problem(s) at hand. Specifically, the biology of weed you want to manage. Dispersal of seeds, timing of germination, emergence, and flowering, and what the growth stages are will help determine how and when to impose treatments. Additionally, knowledge of the environmental requirements for germination and growth and the plant's response to competition can help a land manager exploit potential "weaknesses" and reduce it's likelihood of germination and spread.

Additionally, IPM practitioners should be prepared to integrate or stack methods, often trying new ideas in concert with methods already in practice.

Finally, land managers need to accept that managing weeds, whether in cropping systems or natural areas, is a long-term project. Areas must be continually monitored and rogue plants be removed as soon as possible. Habitat modification should be re-evaluated or weed control efforts increased if it appears that the invasive plants are reinfesting the site.

Visit these webpages for more information:
The Nature Conservancy - Weed Control Methods Handbook:Tools & Techniques for Use in Natural Areas
www.**invasive**.org/gist/products/handbook/methods-handbook.pdf

Soil Solarization Pest Note: http://ipm.ucdavis.edu/PMG/PESTNOTES/pn74145.html

Notes:

Chemical Weed Control

Milt McGiffen—UCCE Riverside, Botany and Plant Science, milt@ucr.edu

Herbicides are often the weed control method with the least environmental impact, lowest cost, and the greatest efficacy. Proper application can lead to successful control with little off-target effect. There are a limited number of herbicides available for use in natural systems, all of which have systemic activity. Systemic herbicides move from the point of application to shut down important physiological processes, such as photosynthesis, pigment formation, or nitrogen metabolism. Management considerations in developing a weed control program include the appropriate intensity of weed management, the use and efficacy of specific herbicides against specific weeds, amelioration of potential off-target affects, site considerations, and methods for control. I will discuss methods of herbicide application, including: foliar, cut stump, wick, and spot control. Some of the other aspects of effective weed control programs that will be covered include: timing of control, record keeping, surfactants, effect of applicator traffic, and examples of control of problematic invasives.

Notes:

Herbicide Sprayer Calibration

Carl Bell--Regional Advisor - Invasive Plants, UCCE, cebell@ucdavis.edu

Herbicides are very useful tools for control of invasive plants and restoration of degraded natural habitats; but they are far more useful when they are used correctly. In the case of herbicides, correctly means using the right herbicide at the right rate to kill the target weeds. Picking the right herbicide requires thorough knowledge of the herbicide label, along with consulting other informational sources and materials. Applying the herbicide at the right rate requires calibrating spray equipment.

To calibrate is defined simply as making something right. When you put one pound of apples on a grocery store scale, it is calibrated correctly when the display says one pound. Likewise, when you are filling up your gas tank, the pump display should show the true amount of gasoline you are getting. These scales and pumps are tested regularly to make sure they are calibrated accurately, and there is an official sticker on the device as proof.

Herbicide labels have instructions on how much herbicide to apply for effective control. These are called rates and they are expressed in a quantity, a measurable amount of weight (e.g. Pounds) or volume (e.g. Quarts), over an area (e.g. Acres). For example, a glyphosate label may say, "to control annual grasses apply 1-2 quarts per acre in sufficient water to thoroughly wet the plants." In order to apply this recommended rate, the herbicide sprayer must be calibrated. Sprayer calibration is a process that determines the amount of spray solution (i.e. The combination of water, herbicide, surfactant, dye, etc.) applied per acre. There are numerous ways to calibrate the sprayer; a very simple, no-math method is included on the following page. Once you know the volume of spray solution applied per acre, referred to as GPA (gallons per acre), you simply add the recommended quantity of herbicide for each gallon of water in the spray tank and apply it to the weeds.

Working with colleagues Milt McGiffen Jr. and Cheryl Wilen, we have conducted field workshops on this calibration method. In the process, we have collected data on actual application practice for about 80 individuals in southern California. A percent concentration is not a rate because it does not include any information about the spray volume applied. The data we have collected allows us to illustrate the difference. For example, a one percent solution of glyphosate when applied at 25 GPA delivers one quart of herbicide per acre. At 50 GPA the rate is two quarts per acre; at 100 GPA the rate is four quarts per acre. The intended rate for a one percent solution of glyphosate is supposed to be one quart per acre according to the Monsanto label. Our data showed that most individuals were applying at least twice that much herbicide per acre with a backpack sprayer and about four times that much herbicide with a hose-end sprayer. This apparently routine over application of herbicide wastes money and leaves more herbicide in the environment than it should. Calibration is the way to solve this problem.

Easy, No Math, 128th Acre Broadcast Sprayer Calibration

Carl E. Bell, Cheryl Wilen, and Milton McGiffen, Jr.
University of California Cooperative Extension
Invasive Plants in Southern California
http://groups.ucanr.org/socalinvasives/

Herbicide sprayer calibration	
Step 1	**Measure out the 128th acre calibration area: two suggested sizes are 10' by 34' or 18.5' by 18.5'**
Step 2	**Spray the calibration area with water evenly while recording the amount of time to complete the spray; Time ________**
Step 3	**Spray water into a bucket for the same amount of time. Measure the amount of water in the bucket in ounces; this will equal the gallons per acre (GPA) that the sprayer is applying. Put this value in Step 3 in the formula below.**
Herbicide Rate Calculation	
Step 4	**Total volume of herbicide spray tank in gallons. Put this value in Step 4 below.**
Step 5	**From the herbicide label, determine the amount of herbicide product to be applied per acre in ounces. Put this value in Step 5 below.**
Step 6	**Divide Step 4 by Step 3, this will determine the amount of acres sprayed per tank load. Put this value in the box labeled Step 6 below.**
Step 7	**Multiply Step 5 times Step 6, this will determine the amount of herbicide to be added to each tank load.**

Step 4 _________________ ÷ **Step 3** _________ = **Step 6** ________________
(spray tank volume) (GPA) (acres per tank load)

Step 5 _______________ X **Step 6** ____________ = **Step 7** ____________________
(oz herbicide per acre) (acres per tank load) (herbicide per tank load in oz.)

Notes:

1. This works for both liquid and dry herbicides measured in ounces. (1 gallon = 128 oz, 1 quart = 32 oz, 1 pint = 16 oz.)
2. If the area to be sprayed is less than the area that a full tank load will spray, reduce the amount of water and herbicide by the same proportion as the reduction in area to be sprayed. (1 acre = 43,560 square feet.)
3. Each person spraying should do their own calibration and spray mixing.
4. Surfactants are added to the spray mix on a percent volume basis. Multiply the recommended percentage by 128 to determine ounces per gallon of mix. For example, 0.5% surfactant X 128 = 0.64 oz (its OK to round up to the nearest ounce, so 1 oz per gallon of mix).

Notes:

Effects of Sahara Mustard, *Brassica tournefortii*, on the Biodiversity of a Desert Landscape

Cameron W. Barrows UC Riverside's Center for Conservation Biology, cbarrows@ucr.edu

Given the abundance of non-native species invading wildland habitats, managers need to employ informed triage to focus control efforts on weeds with the greatest potential for negative impacts. Our objective here was to determine the threat Sahara mustard, *Brassica tournefortii*, represents to meeting regional goals for protecting biodiversity and to begin exploring potential control approaches. Sahara mustard has spread throughout much of the Mojave and Sonoran Deserts. It has occurred in southern California's Coachella Valley for 80 years. In years when the mustard occurs at high densities it has clear negative impacts on the native flora. In 2005, using 15 pairs of 0.1 ha plots we removed all mustard by hand on half, leaving the other half as controls. We identified reductions in native plant reproduction, shifting composition increasingly toward Sahara mustard while decreasing the fraction of native species. This pattern of the mustard forming an increasing proportion of the annual plant growth has continued each year since then. We also examined the impact of Sahara mustard on wildlife species, including the threatened Coachella Valley fringe-toed lizard, *Uma inornata*. The mustard invasion appears to result in complex responses to the lizards' prey and habitat quality, including increasing sand stabilization levels. Without control measures the long-term impacts to desert biodiversity will be an increasing decline in native annual plants, arthropod species richness, and dune stabilization with broad regional trophic impacts and reductions in potential habitat for a host of dune narrow-endemic species. In 2011 we initiated an experiment to determine if by applying a broad spectrum herbicide (Roundup®) after the mustard has germinated and before the native annuals have germinated would result in effective control. The preliminary results supported the temporally surgical use of herbicides as a tool to control this invasive species.

Notes:

Four Decades of Controlling Invasive Tamarisk/Saltcedar in Desert Riparian Areas

Bill Neill, Riparian Repairs, bgneill@earthlink.net

Tamarisk or saltcedar (*Tamarix ramossisima*) was introduced from Eurasia during the 1800's, and wind dispersal of the tree's tiny seeds, coupled with tolerance of drought, salinity and fire, produced rapid, widespread invasion. Along the upper Gila River of southern Arizona, tamarisk became noticeable after a flood in 1916, common in the 1920's, abundant in the 1930's, and dominant in the 1940's, replacing willow and cottonwood. During the 1950's researchers studied seed viability and experimented with control methods; and in 1965 the U.S. Geological Survey published a distribution map covering the western, mountain and high plains states.

In California, starting in the 1970's the National Park Service was successful at removing tamarisk from an isolated spring in Death Valley; and during the late 1980's and 1990's, other land management agencies initiated control programs using cut-stump and basal-bark application of triclopyr herbicide. Local eradication of tamarisk is practical at isolated springs because seeds rapidly lose viability during hot summers; but along larger river courses, introduction of biocontrol agents is the only option for habitat restoration.

The USDA's Agricultural Research Service and cooperating investigators studied biocontrol options during the 1990's, and in 2001 started to release the tamarisk leaf beetle (*Diorhabda elongata*), which has proven effective at controlling tamarisk between northern Nevada and Texas, but is currently excluded from southern Arizona and portions of southern California because in some areas the endangered southwestern willow flycatcher nests in tamarisk trees.

Notes:

Weed Control for Land Managers Without a Budget

Annie Kearns, Mojave National Preserve, anne_kearns@nps.gov

Like all land management agencies in the arid west, Mojave National Preserve has a seemingly insurmountable weed problem: a huge expanse of previously grazed land containing many species of exotics, difficult accessibility to most areas, a small staff, no group of volunteers ready to tackle the problem, and a very limited budget to address any of these issues. By choosing our battles and trying to be pro-active, we have had some success controlling high-priority invasive exotics. Our strategy consists of: initial survey work, prioritization of weed sites and species, organizing site-specific data for each species, windshield surveys, planning and executing timely weed control site visits geared toward depletion of the seed bank, and long-term strategizing for future needs. Through these ongoing efforts we have seen drastic reductions of some populations of high-priority species, including *Brassica tournefortii.* After three years of consistent control work, *B. tournefortii* was not seen at one site, and had very few individuals at a second site. We are optimistic about measured success with *Salsola* species, *Malcolmia africana* and others.

Notes:

This symposium has been brought to you by: UC Cooperative Extension and UC Riverside's Center for Conservation Biology

WE THANK YOU FOR ATTENDING

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The Center for Conservation Biology (CCB) is a University of California Riverside organized research unit. Our mission is to assist in the conservation and restoration of species and ecosystems by facilitating the collection, evaluation, and dissemination of scientific information. Many activities of the Center are regional, centered on the diverse species and habitats that form the natural heritage of southern California, but other activities extend far beyond this regional focus. The research and other activities of the Center ultimately provide cultural, economic, and aesthetic benefits locally and globally.

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